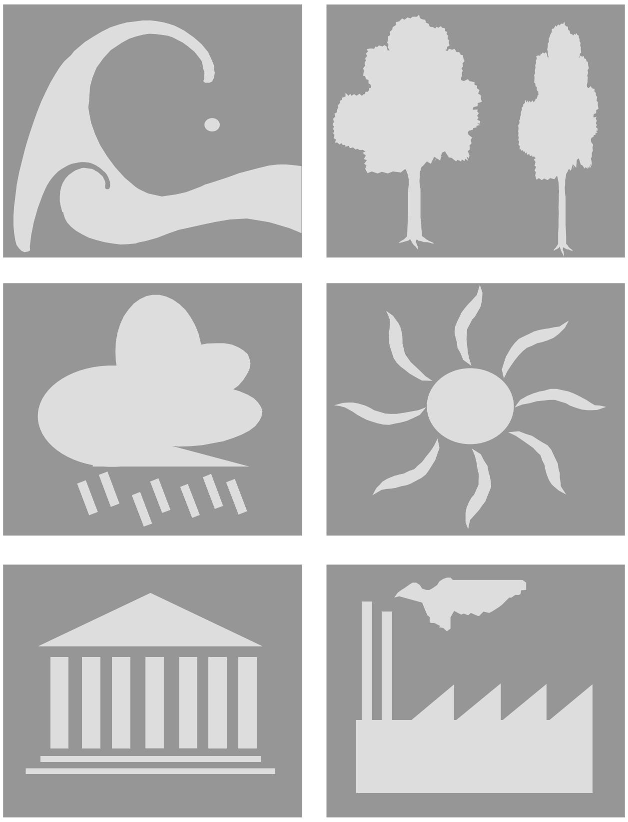
HELLENIC REPUBLIC

MINISTRY OF ENVIRONMENT AND ENERGY



8th NATIONAL COMMUNICATION and 5th Biennial Report UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

December 2022

CHAPTER 1. EXECUTIVE SUMMARY

1.1 National Circumstances

1.1.1 Government structure

The Constitution of 1975, as revised in 1986, 2001, 2008 and in 2019, defines the political system of Greece as a parliamentary democracy with the President being the Head of State.

At the top administrative level is the national government, with ministers appointed by the Prime Minister. The ministries mainly prepare and implement national laws. The Ministry for the Environment and Energy (MEEN) is the main governmental body concerned with the development and implementation of environmental policy in Greece, while other Ministries are responsible for integrating environmental policy targets within their respective fields. MEEN is the competent authority for climate change issues. The Council of Ministers is responsible for the final approval of policies and measures related to Climate Change. In September 2021 the Ministry for Climate Crisis and Civil Protection was created merging the Civil Protection, Hellenic Fire Service and part of the responsibilities regarding adaptation and climate change of MEEN.

1.1.2 Population

In 2011, the total permanent population of Greece was 10.725 million inhabitants, according to the Census of 2011 performed by the Hellenic Statistical Authority. The total population in 2011 decreased by 1.37% compared to the 2001 Census results, with 35.34% of total population living in the greater Athens area. According to the population census results, the average household size is continuously decreasing. For 2020, total permanent population of Greece is estimated equal to 10.719 million inhabitants, slightly lower than this for 2016. The average household size decreased from 2.80 persons per household according to the 2001 population census, to 2.55 persons per household, according to the 2011 population census Population density in Greece is estimated at 84.03 inhabitants/km^2.

1.1.3 Economic profile

Greece is a member of the EU since 1981 and member of the Eurozone since 2001. The euro is the monetary unit of the country since 1st of 2002. After the accession, the Greek economy was developed with high rates, while its capacity to cope with structural problems both in public and in private sector was increased. However, since 2009 the Greek economy experienced its most-severe economic crisis recording four consecutive year recession up to 2013. As a consequence, Greece has received financial and technical assistance from the other Eurozone countries and the IMF in the framework of the first Memorandum of Understanding (May, 2010), the second one (January, 2012) and the third one (August, 2015) in order to deal with its high deficit and Government debt. The implementation of the Memorandums of Understanding was accompanied by the adoption of numerous economic and structural changes of Greece influencing significantly the living standards of Greek citizens. The third Memorandum of Understanding was completed by the August of 2018. In period 2014-2016 no significant change on GDP was noticed while for years 2017, 2018 and 2019 approximately 1.08%, 1.64% and 1.77% growth, respectively, were noted. Nevertheless, this upward trend did not continue in 2020 due to the consequences of the COVID-19 pandemic, where a recession of 9.9% was observed.

1.1.4 Geographical profile

Greece has a total area of 131.957 km2 and occupies the southernmost extension of the Balkan Peninsula. The mainland accounts for 80% of the land area, with the remaining 20% divided among nearly 3000 islands. The Greek landscape, with its extensive coastline, exceeding 15,000 km in length, is closely linked with the sea, since only a small region in the northwest is further than 80 km from the sea. Approximately 25% of it is lowland, particularly the coastal plains along the seashore of the country.

1.1.5 Climate profile

Greece has a Mediterranean climate, with mild and wet winters in the southern lowland and island regions and cold winters with strong snowfalls in the mountainous areas in the central and northern regions and hot, dry summers. The mean temperature during summer (April to September) is approximately 25°C in Athens and southern Greece, while lower in the north. Generally, temperatures are higher in the southern part of the country. Except for a few thunderstorms, rainfall is rare from June to August, where sunny and dry days are mainly observed. The dry, hot weather is often relieved by a system of seasonal breezes. The mean annual temperature for the period 2001 – 2020, as measured at selected meteorological stations of the country, is higher in most of the stations compared to the mean annual temperature of the period 1991 – 2000 while the mean annual temperature for the period 1991 – 2000 is higher compared to these of the period 1961 – 1990. Winters are mild in the south, much colder in the north. The average winter temperature in Athens (October to March) and southern Greece is approximately 14°C, while lower in the north. January is generally the coldest month. Below-freezing temperatures and snow occur mainly in the mountains. Winters are mild in the lowlands with rare frost and snow. Rainfall occurs mostly between October and March.

1.1.6 Energy system

The energy sector relies on fossil fuel combustion for meeting the bulk of energy requirements in Greece. Gross inland consumption in 2020 amounted to approximately 920 PJ. The consumption of solid fuels and oil products accounts for 52.7% of total consumption, while the contribution of biomass and of the rest renewable energy sources (mostly hydropower, solar, wind energy and geothermal) are 5.3% and 8.1% respectively. Finally, the share of natural gas in gross inland consumption is 20.7%, while the rest of gross inland consumption is covered by electricity (net imports – exports). In 2020, gross inland consumption (including liquid, solid, gaseous and biomass fuels) decreased by approximately 14.7% compared to 1990. It should be mentioned that up to 1996 supply of natural gas was exclusively minor quantities from domestic primary production. In essence, the introduction of natural gas in the Greek energy system started in 1997 and since then its consumption has been continuously increasing.

1.1.7 Transportation

Economic development and improved living standards of the previous decade have a significant effect on the ownership of passenger cars. The passenger cars fleet has almost tripled compared to 1990 levels, while an increase of the share of medium and larger size passenger vehicles is observed (from 27% in 1990, to 36% in 2008). In 1990, the number of passenger cars was 1.7 million cars (1 car for every 6 inhabitants), while in 2007 this figure reached 4.8 million cars. Similar trends are also observed for the number of trucks, buses and motorcycles.

1.1.8 Industry

The contribution of the secondary sector to the total gross value added decreases from 21.0 in 1990 to 15.8 in 2020. The structure of gross value added in the secondary sector presents relatively small changes. The contribution of Mining to the gross value added of the secondary sector is about 1.3%, of Construction 21.7%, of Energy industries 15.1% and of Manufacture about 61.9% in 2020.

1.1.9 Waste

Over the period 1990 – 2020, waste generation presented a continuous increase. Municipal solid waste generated quantities increased from 3.1 Mt in 1990 to 5.1 Mt in 2020, while the per capita solid waste generation increased from 0.82 kg/person/day in 1990 to 1.28 kg/person/day in 2020. The share of solid waste disposed in managed solid waste disposal sites (SWDS) has been noticeably increased since 1999 due to the construction of new SWDS, in the framework of the integrated national plan of solid waste disposal on land, developed according to the requirements of the Directive of the European Union 91/156/EEC. The main objectives of the plan is the gradual closure of all the unmanaged SWDS, the reduction of waste generation rates, the exploitation and re-use of the materials including energy recovery and the reduction of biodegradable wastes led to disposal sites according to the provisions of the Directive 99/31/EC**.**

1.1.10 Agriculture

In 2020, the total area of agricultural land in Greece was approximately 3.2 Mha, more than half of which is on relatively steep slopes on which cultivation is carried out without protection against soil erosion. The area of agricultural land decreased by 20% in 2020 compared to 1990.

No significant changes took place since 2000 concerning fallow land, irrigated land and the average area of agricultural holdings.

1.1.11 Forest

According to the results of the First National Forest Inventory, the forests, other wooded land and grasslands in Greece cover 6.5 Mha (49.7% of the area of Greece), of which approximately 3.4 Mha are considered as productive forests. Approximately 42% of the productive forests area is covered by coniferous types and the rest is covered by broadleaved types. The remaining 3.1 Mha are considered as other wooded land. The majority of forest and other wooded land in Greece are located in the mountainous areas of the country. Forest management practices were focused on the protection of soil and of water resources. However, the productivity of Greek forests is lower compared to European average values. This is due to the low density, quality and quantity of growing stock, a result of human induced activities of the past as wildfires, grazing, illegal felling, as well as the lack of systematic silvicultural treatment.

1.2 Greenhouse gas inventory information

1.2.1 Emissions / Removals of GHG in Greece for the period 1990 – 2019

The GHG emissions trends (CO2, CH4, N2O, HFC, PFC and SF6) for the period 1990 – 2020 are presented in ***Tables 1.1a*** and ***1.1b*** (in kt CO2 eq). While, emissions/removals per sector are presented in ***Table 1.2a*** and ***Table 1.2.b***.

It is noted that according to the IPCC Guidelines, emissions estimates for international marine and aviation bunkers were not included in the national totals, however they are reported separately as memo items. KP base year GHG emissions for Greece (1990 for CO_2, CH_4, and N_2O – 1995 for F-gases) were estimated at 106.14 Mt CO_2 eq. Given that LULUCF was a net sink of GHG emissions in 1990 (and for the rest of the reporting period) the relevant emissions / removals are not considered in estimating base year emissions for Greece.

In 2020, GHG emissions (without LULUCF) amounted to 74.84 Mt CO2 eq showing a decrease of 27.66% compared to 1990 levels.

Carbon dioxide emissions accounted for 74.31% of total GHG emissions in 2020 (without LULUCF) and decreased by 33.35% from 1990. Methane emissions accounted for 12.94% of total GHG emissions in 2020 and decreased by 13.18% from 1990, while nitrous oxide emissions accounted for 5.70% of the total GHG emissions in 2020 and decreased by 43.00%

from 1990. Finally, f-gases emissions (from production and consumption) that accounted for 6.89% of total GHG emissions in 2020 were increased by 24.91% from 1995 (base year for F-gases).

Table 1.1a Total GHG emissions in Greece (in kt CO2 eq) for the period 1990-2004

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
A. GHG emissions per gas (excluding LULUCF)															
CO_2	83.438,04	83.407,50	84.975,65	84.284,96	86.430,26	86.963,20	89.114,95	93.801,56	98.621,79	97.934,81	102.973,17	105.361,86	105.000,51	109.066,73	109.485,28
CH_4	11.155,52	11.157,21	11.216,10	11.259,72	11.330,49	11.506,95	11.666,70	11.620,87	11.831,33	11.794,96	11.802,44	11.112,98	11.196,47	11.297,32	11.324,74
N_2O	7.481,08	7.344,18	7.179,67	6.625,65	6.494,28	6.705,26	6.874,48	6.714,43	6.632,92	6.584,45	6.368,83	6.231,85	6.182,28	6.112,73	6.117,42
HFC	1.182,82	1.400,08	1.149,07	2.032,44	2.712,11	4.157,38	4.820,17	5.166,49	5.767,51	6.721,13	5.261,86	4.781,52	5.090,33	4.733,65	4.928,27
PFC	190,26	191,19	187,74	112,94	70,31	62,85	53,73	125,64	155,48	105,31	122,26	84,10	88,29	89,28	87,86
SF_6	2,92889	3,01895	3,11129	3,19918	3,28936	3,42000	3,51120	3,55680	3,60240	3,69360	3,80760	3,87600	4,05840	4,05840	4,26360
Total	**103.450,64**	**103.503,18**	**104.711,35**	**104.318,91**	**107.040,73**	**109.399,06**	**112.533,54**	**117.432,53**	**123.012,64**	**123.144,35**	**126.532,37**	**127.576,19**	**127.561,94**	**131.303,76**	**131.947,82**
B. GHG emissions/removals from LULUCF															
CO_2	-2.177,04	-2.341,11	-2.491,25	-2.941,45	-2.673,77	-2.924,45	-2.329,34	-2.015,59	-1.936,32	-2.560,11	-2.175,92	-2.453,21	-2.787,65	-2.522,61	-2.489,12
CH_4	62,68	31,09	91,81	81,95	76,42	43,38	26,21	57,79	157,63	12,00	208,03	27,94	3,81	5,35	13,53
N_2O	6,46	4,92	10,66	10,73	10,84	8,70	8,07	11,50	20,40	9,20	26,54	13,16	11,95	12,86	14,47
Total	**-2.107,91**	**-2.305,10**	**-2.388,77**	**-2.848,77**	**-2.586,52**	**-2.872,37**	**-2.295,07**	**-1.946,29**	**-1.758,29**	**-2.538,91**	**-1.941,35**	**-2.412,11**	**-2.771,89**	**-2.504,41**	**-2.461,12**
C. GHG Emissions from International Transport															
CO_2	10.580,51	9.569,44	10.762,45	12.332,40	13.393,29	14.004,40	12.530,32	12.475,75	13.767,30	12.829,23	14.018,48	13.513,65	12.342,00	13.304,19	13.474,19
CH_4	17,09	15,33	17,62	20,62	21,76	23,02	20,54	20,62	23,27	20,63	23,94	23,62	21,19	21,91	22,17
N_2O	257,70	251,00	308,49	343,27	379,47	439,16	363,52	362,02	366,45	342,03	365,90	316,01	285,45	275,48	267,53
Total	**10855,29**	**9835,77**	**11088,56**	**12696,30**	**13794,52**	**14466,58**	**12914,38**	**12858,38**	**14157,02**	**13191,89**	**14408,32**	**13853,28**	**12648,64**	**13601,58**	**13763,90**

[1)] Emissions / removals from *Land Use, Land Use Change and Forestry* are not included in national totals
[2)] *Land Use, Land Use Change and Forestry* is not included

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
A. GHG emissions per gas (excluding LULUCF)																
CO_2	113.888,97	112.419,54	114.545,69	111.080,37	104.319,84	97.354,15	94.505,23	91.392,59	81.713,26	78.639,62	74.927,63	71.364,16	74.845,05	71.781,99	65.756,23	55.610,28
CH_4	11.407,33	11.482,28	11.362,41	11.241,70	10.864,03	11.082,19	10.936,97	10.776,02	10.533,54	10.340,35	10.145,94	9.797,52	10.096,52	10.217,07	9.991,41	9.685,20
N_2O	5.942,35	5.773,55	5.881,91	5.635,19	5.271,06	5.471,60	5.223,91	4.796,84	4.496,35	4.294,70	4.226,87	4.282,94	4.343,59	4.260,64	4.249,71	4.264,37
HFC	5.078,03	2.723,63	3.246,63	3.712,35	4.036,02	4.467,76	4.747,22	5.153,36	5.740,51	5.842,57	5.999,45	6.223,77	6.177,73	5.917,00	5.464,57	5.122,68
PFC	91,51	87,21	103,04	118,95	91,35	129,44	110,53	147,77	172,56	134,63	119,52	135,17	125,79	135,31	137,10	148,15
SF_6	6,15600	7,98000	9,46200	7,18200	5,01600	5,85960	5,13000	5,04857	5,15117	4,92154	5,06042	5,20201	5,01111	4,94269	4,92057	4,93861
Total	**136.414,35**	**132.494,19**	**135.149,15**	**131.795,74**	**124.587,31**	**118.511,01**	**115.528,99**	**112.271,63**	**102.661,38**	**99.256,79**	**95.424,48**	**91.808,76**	**95.593,70**	**92.316,96**	**85.603,94**	**74.835,61**
B. GHG emissions/removals from LULUCF																
CO_2	-3.308,21	-3.338,38	-1.826,78	-3.019,05	-3.103,80	-3.076,99	-3.166,00	-3.149,19	-1.614,72	-150,80	-3.745,52	-3.521,90	-3.282,72	-4.066,24	-3.164,36	-3.987,55
CH_4	10,54	20,96	321,27	43,55	46,16	16,41	17,81	43,71	16,00	9,40	10,81	31,67	18,55	19,42	77,68	18,71
N_2O	14,76	16,44	42,11	20,12	20,80	17,50	16,93	19,36	16,55	15,63	15,52	16,96	15,73	15,95	20,84	15,83
Total	**-3.282,91**	**-3.300,98**	**-1.463,40**	**-2.955,37**	**-3.036,83**	**-3.043,08**	**-3.131,25**	**-3.086,12**	**-1.582,16**	**-125,78**	**-3.719,19**	**-3.473,26**	**-3.248,44**	**-4.030,87**	**-3.065,85**	**-3.953,00**
C. GHG Emissions from International Transport																
CO_2	11.815,09	12.727,53	13.103,79	12.862,32	11.147,83	11.373,02	11.652,07	9.727,87	9.382,76	8.878,27	8.657,31	8.664,95	10.401,69	10.995,10	12.239,22	6.744,60
CH_4	19,89	21,52	22,09	21,68	18,35	19,06	19,56	16,00	15,09	13,22	12,52	12,06	15,12	15,62	17,92	11,15
N_2O	223,68	235,55	227,13	216,42	196,01	206,56	195,71	167,63	171,56	160,30	172,75	175,45	198,25	197,32	227,54	169,19
Total	**12058,66**	**12984,61**	**13353,01**	**13100,42**	**11362,19**	**11598,64**	**11867,34**	**9911,50**	**9569,40**	**9051,78**	**8842,57**	**8852,46**	**10615,06**	**11208,05**	**12484,68**	**6924,94**

Table 1.1b Total GHG emissions in Greece (in kt CO2 eq) for the period 2004-2020

[1] Emissions / removals from *Land Use, Land Use Change and Forestry* are not included in national totals

[2] *Land Use, Land Use Change and Forestry* is not included

Table 1.2a CO2 emissions / removals by sector for the period 1990-2004 (in kt)

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Total (without LULUCF)	**83438,04**	**83407,50**	**84975,65**	**84284,96**	**86430,26**	**86963,20**	**89114,95**	**93801,56**	**98621,79**	**97934,81**	**102973,17**	**105361,86**	**105000,51**	**109066,73**	**109485,28**
Total (with LULUCF)	**81261,00**	**81066,39**	**82484,41**	**81343,51**	**83756,49**	**84038,76**	**86785,61**	**91785,97**	**96685,48**	**95374,70**	**100797,25**	**102908,65**	**102212,86**	**106544,12**	**106996,16**
Energy	**74634,33**	**74701,49**	**76635,83**	**76276,52**	**78451,18**	**78501,55**	**80655,97**	**85168,34**	**89760,01**	**89183,53**	**94000,59**	**96359,04**	**96103,01**	**100008,47**	**100441,26**
A. Fuel combustion	43093,70	41932,61	44212,55	44111,98	46089,07	44857,20	44037,52	47473,14	49995,24	50294,82	54739,01	55254,97	54678,66	55921,54	57238,34
1. Energy industries	9338,49	9387,80	9044,66	8760,33	8610,16	9481,90	10087,60	10194,95	10152,18	9139,77	9847,74	9971,73	9426,05	9102,77	8618,35
2. Man. Industry and Construction	14136,62	14932,09	15294,12	15460,88	15753,14	16084,99	16535,05	17236,86	18998,77	19311,12	18364,24	19227,92	19553,34	20628,46	21024,82
3. Transport	8065,52	8449,00	8084,51	7943,33	7998,81	8077,46	9995,79	10263,39	10613,82	10437,82	11049,60	11904,42	12444,96	14355,70	13559,75
4. Other sectors	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE
5. Other	42,70	43,16	36,30	29,47	25,77	22,55	24,96	22,65	15,61	0,85	13,97	9,83	9,63	7,03	6,85
B. Fugitive emissions	**74634,33**	**74701,49**	**76635,83**	**76276,52**	**78451,18**	**78501,55**	**80655,97**	**85168,34**	**89760,01**	**89183,53**	**94000,59**	**96359,04**	**96103,01**	**100008,47**	**100441,26**
IPPU	**8700,38**	**8604,50**	**8247,74**	**7935,01**	**7912,34**	**8393,86**	**8387,79**	**8566,61**	**8802,07**	**8708,47**	**8919,92**	**8955,73**	**8851,34**	**9015,19**	**8999,79**
A. Mineral Industry	6775,43	6696,57	6775,95	6730,23	6702,72	7186,10	7176,80	7255,63	7294,80	7285,27	7492,72	7549,59	7312,47	7348,96	7357,02
B. Chemical Industry	680,65	649,65	248,00	170,01	30,43	32,03	33,38	116,18	382,22	353,33	281,96	135,77	165,68	286,61	304,52
C. Metal Industry	1012,05	1049,91	999,29	814,52	979,88	1006,91	1014,44	1040,53	986,22	918,40	1000,97	1111,55	1239,96	1239,99	1182,25
D. Non-energy products from fuels and solvent use	129,78	102,66	120,57	119,39	102,66	78,27	74,14	64,49	47,98	55,05	50,34	63,90	41,73	44,54	58,59
G. Other product manufacture and use	102,47	105,72	103,93	100,86	96,65	90,56	89,04	89,77	90,86	96,42	93,93	94,93	91,49	95,09	97,41
Agriculture	**60,41**	**60,41**	**58,13**	**55,57**	**43,74**	**40,75**	**45,02**	**46,02**	**43,74**	**43,88**	**41,75**	**38,47**	**37,04**	**36,05**	**35,19**
LULUCF	**-2177,04**	**-2341,11**	**-2491,25**	**-2941,45**	**-2673,77**	**-2924,45**	**-2329,34**	**-2015,59**	**-1936,32**	**-2560,11**	**-2175,92**	**-2453,21**	**-2787,65**	**-2522,61**	**-2489,12**
Waste	**0,22**	**0,22**	**0,22**	**0,22**	**0,22**	**0,22**	**0,22**	**0,22**	**0,22**	**0,22**	**0,22**	**0,22**	**0,48**	**0,85**	**1,05**
International transport [1)]	10580,51	9569,44	10762,45	12332,40	13393,29	14004,40	12530,32	12475,75	13767,30	12829,23	14018,48	13513,65	12342,00	13304,19	13474,19
Aviation	2474,79	2133,99	2226,36	2369,69	2812,41	2637,23	2525,76	2442,94	2563,98	2879,30	2525,76	2347,31	2347,39	3055,51	3140,94
Marine	8105,72	7435,45	8536,09	9962,71	10580,88	11367,17	10004,56	10032,81	11203,32	9949,93	11492,72	11166,34	9994,61	10248,68	10333,25

Table 1.2b CO2 emissions / removals by sector for the period 2004-2020 (in kt)

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Total (without LULUCF)	**113888,97**	**112419,54**	**114545,69**	**111080,37**	**104319,84**	**97354,15**	**94505,23**	**91392,59**	**81713,26**	**78639,62**	**74927,63**	**71364,16**	**74845,05**	**71781,99**	**65756,23**	**55608,20**
Total (with LULUCF)	**110580,76**	**109081,16**	**112718,91**	**108061,33**	**101216,04**	**94277,16**	**91339,24**	**88243,40**	**80098,54**	**78488,82**	**71182,11**	**67842,27**	**71562,33**	**67715,79**	**62641,30**	**53569,50**
Energy	**104262,25**	**103022,75**	**105246,45**	**102432,72**	**97638,29**	**90712,54**	**89545,61**	**85898,19**	**75819,23**	**72451,79**	**69213,62**	**65345,65**	**68482,88**	**65570,92**	**59775,80**	**50513,40**
A. Fuel combustion	58058,17	55895,54	59371,47	58019,05	54480,47	52036,60	53838,38	54507,26	49205,02	45784,63	40776,46	36.909,61	39.817,11	38.149,03	31.885,66	24.428,77
1. Energy industries	10134,37	10369,07	9959,13	9325,77	7436,78	6813,24	4917,03	5457,78	5229,16	5397,33	5166,28	5.291,92	5.715,97	5.048,80	4.568,50	4.405,52
2. Man. Industry and Construction	21333,01	22004,63	22639,51	21938,64	24796,63	22045,52	19771,67	16465,15	16246,67	16270,48	16801,61	17.132,32	16.902,97	17.130,12	17.541,98	15.098,29
3. Transport	14214,11	14104,93	12729,20	12453,05	10674,72	9574,70	10802,99	9257,07	4903,11	4810,77	6262,95	5.812,76	5.864,53	5.119,81	5.645,59	6.284,91
4. Other sectors	522,59	648,58	547,15	696,21	249,69	242,49	215,53	210,93	235,28	188,58	206,32	199,05	182,30	123,17	134,07	295,90
5. Other	5,59	5,62	4,57	3,55	4,44	5,97	5,24	4,95	4,07	3,75	3,64	9,37	7,71	10,97	9,04	5,17
B. Fugitive emissions	**104262,25**	**103022,75**	**105246,45**	**102432,72**	**97638,29**	**90712,54**	**89545,61**	**85898,19**	**75819,23**	**72451,79**	**69213,62**	**65345,65**	**68482,88**	**65570,92**	**59775,80**	**50513,40**
IPPU	**9587,23**	**9358,85**	**9257,87**	**8611,78**	**6639,75**	**6598,93**	**4922,92**	**5460,97**	**5860,12**	**6155,96**	**5681,48**	**5978,12**	**6316,06**	**6163,40**	**5933,23**	**5051,46**
A. Mineral Industry	7926,76	7635,81	7471,57	6957,92	5321,32	4920,64	3108,57	3738,18	4170,20	4359,38	3956,73	4.271,66	4.246,72	4.007,64	3.931,48	3.362,46
B. Chemical Industry	296,92	313,93	317,94	338,06	453,25	632,88	584,38	502,02	516,91	569,38	495,05	461,93	804,62	951,19	877,74	845,53
C. Metal Industry	1215,54	1233,61	1301,47	1167,74	732,64	909,45	1101,47	1100,61	1049,74	1097,03	1098,74	1.112,68	1.128,61	1.062,82	966,14	695,30
D. Non-energy products from fuels and solvent use	53,23	79,72	70,18	53,86	41,91	42,60	40,37	34,90	37,11	46,83	47,15	47,85	51,34	54,68	70,97	62,25
G. Other product manufacture and use	94,77	95,78	96,70	94,20	90,62	93,36	88,13	85,27	86,16	83,33	83,81	84,00	84,77	87,07	86,90	85,92
Agriculture	**31,91**	**29,92**	**33,62**	**28,64**	**24,93**	**30,35**	**25,84**	**25,00**	**26,01**	**23,64**	**23,41**	**26,36**	**34,14**	**32,91**	**34,80**	**35,15**
LULUCF	**-3308,21**	**-3338,38**	**-1826,78**	**-3019,05**	**-3103,80**	**-3076,99**	**-3166,00**	**-3149,19**	**-1614,72**	**-150,80**	**-3745,52**	**-3521,90**	**-3282,72**	**-4066,20**	**-3114,93**	**-2038,71**
Waste	**1,98**	**2,41**	**3,17**	**3,68**	**12,43**	**6,36**	**5,61**	**3,48**	**3,83**	**4,48**	**5,48**	**4,66**	**4,26**	**3,78**	**3,36**	**3,03**
International transport [1)]	**11815,09**	**12727,53**	**13103,79**	**12862,32**	**11147,83**	**11373,02**	**11652,07**	**9727,87**	**9382,76**	**8878,27**	**8657,31**	**8664,95**	**10401,69**	**10995,10**	**12239,22**	**6744,60**
Aviation	2600,48	2779,42	2948,31	2930,90	2717,91	2584,15	2696,04	2386,98	2466,45	2829,92	2869,09	3.079,15	3.434,92	3.858,57	3.988,90	1.323,54
Marine	9214,61	9948,11	10155,48	9931,42	8429,92	8788,87	8956,03	7340,89	6916,31	6048,35	5788,21	5.585,80	6.966,77	7.136,53	8.250,31	5.421,06

GHG emissions trends (excluding LULUCF) were mainly driven by economic development during the period 1990-2000. However, as presented in ***Figure 3.1***, since 2000 a decoupling of GHG emissions from economic development is observed as the annual growth rate of GHG emissions for the period 2000 – 2007 (approximately 1.0%) is lower from both the annual growth rate of gross inland energy consumption (approximately 1.64% for the same period) and the GDP annual growth rate (approximately 4.6%). Moreover, the impact of population increase to GHG emissions was minor. The decreasing trend of emissions in all sectors of energy of the years 2008-2016 is attributed among others (i.e. RES, energy efficiency measures, road infrastructure and public transportation improvements, etc.) to the economic recession that the country is facing. For the period 2017-2019, although GDP slightly increases, GHG emissions continue the decreasing trend. This overall decrease is attributed to the impact of environmental measures adopted, i.e. RES, energy efficiency measures, road infrastructure and public transportation improvements, etc. For 2020 decreasing trend of all parameters is attributed to the Covid 19 pandemic.

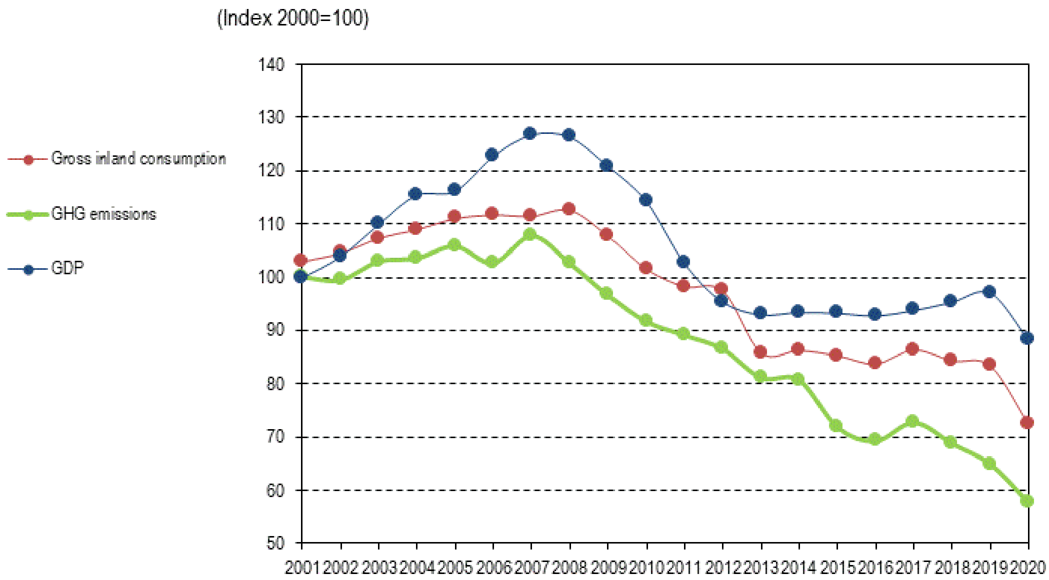


Figure 1.1 Factors underlying GHG emissions trends

1.2.2 National System for the GHG emissions/removals inventory

The **Ministry of Environment and Energy, MEEN**, is the governmental body responsible for the development and implementation of environmental policy in Greece, as well as for the provision of information concerning the state of the environment in Greece in compliance with relevant requirements defined in international conventions, protocols and agreements. Moreover, the MEEN is responsible for the co-ordination of all involved ministries, as well as any relevant public or private organization, in relation to the implementation of the provisions of the Kyoto Protocol, according to the Law 3017/2002 with which Greece ratified the Kyoto Protocol. In this context, the MEEN has the overall responsibility for the national GHG inventory, and the official consideration and approval of the inventory prior to its submission. (Contact person: Kyriakos Psychas, Address: Patission 147, Athens, Greece, e-mail: k.psychas@prv.ypeka.gr, tel.: +30210 8665938). ***Figure 3.12*** provides an overview of the organizational structure of the National Inventory System. The main entities participating in it are:

- The Division of Climate Change and Air Quality of **MEEN** designated as the national entity responsible for the national inventory, which keeps the overall responsibility, but also plays an active role in the inventory planning, preparation and management.
- The preparation of the annual inventory for all sectors has been assigned to **National Technical University of Athens (NTUA) / School of Chemical Engineering**, on a contract basis by MEEN.
- **Governmental ministries and agencies** through their appointed focal persons, ensure the data provision.

International or national associations, along with individual public or private industrial companies contribute to data providing and development of methodological issues as appropriate. The legal framework defining the roles-responsibilities and the co-operation between the MEEN Climate team, the Inventory team and the designated contact points of the competent Ministries was formalized by the Joint Ministerial Decision 22993/2017 (OG B' 1710) entitled "Structure and operation of the National Greenhouse Gases Inventory System". The above-mentioned decision defines the competent authority and its responsibilities concerning the inventory preparation, data providing or other relative information. This formal framework establishes an Interministerial Technical Working Group for the collaboration between the entities involved, assuring the timely collection and quality of the activity data required and solving data access restriction problems raised due to confidentiality issues. According to the Presidential Decree No 189 dated 5th November 2009 the Ministry of Environment and Energy retained the responsibilities regarding the Environment, and Physical Planning of the former Ministry for the Environment, Physical Planning and Public Works. Furthermore, the General Directorate of Energy and Natural Resources, previously belonging to the Ministry of Development, as well as the General Directorate of Forest Development and Protection and Natural Resources, previously belonging to the Ministry of Rural Development and Food, are now a significant part of the Ministry of Environment and Energy (MEEN). These two authorities are currently called the "General Directorate of Energy" and the "General Directorate of Forests and Forest Environment" of MEEN respectively.

1.2.3 National registry

Directive 2009/29/EC adopted in 2009, provides for the centralization of the EU ETS operations into a single European Union registry operated by the European Commission as well as for the inclusion of the aviation sector. At the same time, and with a view to increasing efficiency in the operations of their respective national registries, the EU Member States who are also Parties to the Kyoto Protocol (26) plus Iceland, Liechtenstein and Norway decided to operate their registries in a consolidated manner in accordance with all relevant decisions applicable to the establishment of Party registries - in particular Decision 13/CMP.1 and decision 24/CP.8.

1.3 Policies and Measures

1.3.1 Policy-making process

The Ministry of Environment and Energy (MEEN) is the main governmental body entrusted with the development and implementation of environmental policy in Greece. MEEN is responsible, among others, for the formulation of policies concerning environmental protection, energy, climate change and forestry, for the coordination of implementation efforts and to ensure compliance with the current legislative framework. For this purpose, MEEN cooperates both with other competent ministries and with regional, prefectural and local authorities. Other ministries are responsible for integrating environmental policy and climate change targets within their respective fields. The responsibilities on environmental issues at regional level concern the approval of environmental impact studies and the issuance of decisions on environmental terms. The responsibilities of prefectural authorities concern, among others, (a) the development and application of environmental policies and strategies at local level, (b) the adoption of Prefectural or Common Prefectural Decisions on local environmental issues, and (c) the implementation of the physical planning projects which have been approved by the Ministries. Finally, the municipal and community authorities are responsible for licensing procedures for buildings in urban areas, including specific industrial installations, as well as for issues related to solid waste disposal on land. Climate change mitigation is one of the main targets identified in the Greek policy for sustainable development launched by MEEN in 2002. The objective of the strategy is the development of a set of principles for the formulation of an action plan in line with international challenges, and in accordance with EU policy directions and adjusted to the specific national circumstances. The key environmental issues examined in this framework are: Climate change mitigation, Reduction of air pollutants, Reduction and rational waste management, Rational management of water resources, Prevention of desertification, and Protection of biodiversity and ecosystems. Policies and measures, as well as all other issues and actions regarding mitigation were discussed within the framework of an inter-ministerial committee, comprising representatives from all competent Ministries. Final approval of policies and measures related to climate change mitigation rested with the Council of Ministers. In December 2019, MEEN published the Greek National Energy and Climate Plan pursuant to article 3 of Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action. The National Energy and Climate Plan (NECP) is the Greek government’s strategic plan for climate and energy issues, setting out a detailed roadmap regarding the attainment of specific energy and climate objectives by 2030. The NECP stresses Greece’s priorities and development potential in terms of energy and addressing climate change and aims to serve as the key tool for drawing up the national energy and climate policy in the next decade, taking into account the Commission’s recommendations and the UN sustainable development goals..

1.3.2 Results of policies and measures

The most important overarching and cross-cutting supporting policies and tools which are related with the implementation of measures for the restriction of GHG emissions in Greece is presented. Emphasis is given to the National Energy and Climate Plan, the establishment of emissions trading system since 2005, and the financing mechanisms and fiscal measures that have been developed to support the implementation of projects which inter alia also contribute to the restriction of GHG emissions. **The total realistic quantifiable GHG emissions reduction potential from the implemented and adopted policies and measures (without LULUCF) was estimated to be 36.8Mt CO2eq for 2025 (28.2 Mt under EU-ETS and 8.6 Mt under ESR sectors); and 39.8Mt CO2eq for 2030 (29.8 Mt under EU-ETS and 10.0 Mt under ESR sectors). The effect of LULUCF-related policies was estimated to be 2.4Mt and 2.5Mt CO2 for 2025 and 2030, respectively. The total realistic quantifiable GHG emissions reduction potential from the planned policies and measures (without LULUCF) was estimated to be 16.7Mt CO2eq in 2030 (11.8 Mt under EU-ETS and 4.9 Mt under ESD sectors). The effect of additional LULUCF-related policies was estimated to be 0.13Mt and 0.31Mt CO2 for 2025 and 2030, respectively.**

1.3.3 Minimization of adverse effects

The Kyoto Protocol aims at the implementation of effective policies and measures by Annex I Parties so as to prevent dangerous anthropogenic interference with the climate system, contributing thus in the minimisation of adverse effects of climate change on other Parties and especially developing countries. The Protocol has been designed to minimize the potential adverse effects that may be caused by the implementation of policies and measures adopted by Annex I Parties to specific sectors of economic activity, industrial sectors or other Parties to the Convention, including the adverse effects on the international trade, social, environmental and economic impacts in developing countries, etc. The formulation of climate policy in Greece follows EU policy. EU policy has taken into account the minimization of the adverse effects of emissions reduction policies and measures, according to Articles 4.8 and 4.9 of the Framework Convention on Climate Change and Article 2 of the Kyoto Protocol. Impacts on third countries are mostly indirect and can frequently neither be directly attributed to a specific EU policy, nor directly measured by the EU in developing countries. Therefore, the reported information covers potential adverse social, environmental and economic impacts (including trade impacts) that result from complex assessments of indirect influences and that are based on accessible data sources in developing countries.

1.4 Projections and the Total Effect of Policies and Measures

1.4.1 Quantified economy-wide emission reduction target (QEERT)

Greece, as a Member State of EU, is under the joint quantified economy-wide emission reduction target of EU and its Member States. This section explains this target and the target compliance architecture set up within the EU in order to meet that target.

In 2010, the EU submitted a pledge to reduce its GHG emissions by 2020 by 20 % compared to 1990 levels, in order to contribute to achieving the ultimate objective of the UNFCCC: 'to stabilize GHG concentrations at a level that would prevent dangerous anthropogenic (human-induced) interference with the climate system', or, in other words, to limit the global temperature increase to less than 2°C compared to temperature levels before industrialization (FCCC/CP/2010/7/Add.1). The EU is also committed to raising this target to a 30 % emission reduction by 2020 compared with 1990 levels, provided that other developed countries also commit to achieving comparable emission reductions, and that developing countries contribute adequately, according to their responsibilities and respective capabilities. This offer was reiterated in the submission to the UNFCCC by the EU-28 and Iceland on 30 April 20141.

The definition of the Convention target for 2020 (QEERT) is documented in the revised note provided by the UNFCCC Secretariat on the ‘Compilation of economy-wide emission reduction targets to be implemented by Parties included in Annex I to the Convention’ (FCCC/SB/2011/INF.1/Rev.1 of 7 June 2011). In addition, the EU provided additional information relating to its quantified economy-wide emission reduction target in a submission as part of the process of clarifying the developed country Parties' targets in 2012 (FCCC/AWGLCA/2012/MISC.1).

Table 1.3 Key facts of the Convention target of the EU-28

Parameters	Target
Base Year	1990
Target Year	2020
Emission Reduction target	-20% in 2020 compared to 1990
Gases covered	CO_2, CH_4, N_2O, HFCs, PFCs, SF_6
Global Warming Potential	AR4
Sectors Covered	All IPCC sources and sectors, as measured by the full annual inventory and international aviation to the extent it is included in the EU ETS.
Land Use, Land-Use Change, and Forests (LULUCF)	Not included in the target under Convention. Accounted under KP, reported in EU inventories under the Convention. Assumed to produce net removals
Use of international credits (JI	Possible subject to quantitative and qualitative limits.

[1] European Union, its Member States and Iceland submission pursuant to par 9 of decision 1/CMP.8'
http://ec.europa.eu/clima/policies/international/negotiations/docs/eu_submission_20140430_en.pdf

and CDM)	
Other	Conditional offer to move to a 30% reduction by 2020 compared to 1990 levels as part of a global and comprehensive agreement for the period beyond 2012, provided that other developed countries commit themselves to comparable emission reductions and that developing countries contribute adequately according to their responsibilities and respective capabilities.

1.4.2 Projections

In ***Figure 1.2***, the evolution of GHG emissions (national total, EU-ETS and non ETS) and their projections till year 2040, along with the ESD (2013-2020) and ESR (2021-2030) targets of Greece are presented. The projections of GHG emissions of the WM and WAM scenarios disaggregated by sector and by gas are presented in CTF Table 6(a) and 6(c) (***Tables 5.1-5.4).*** In ***Tables 5.5 and 5.6*** a split of the projections of the GHG emissions is presented between the sectors covered and not covered by the EU ETS.

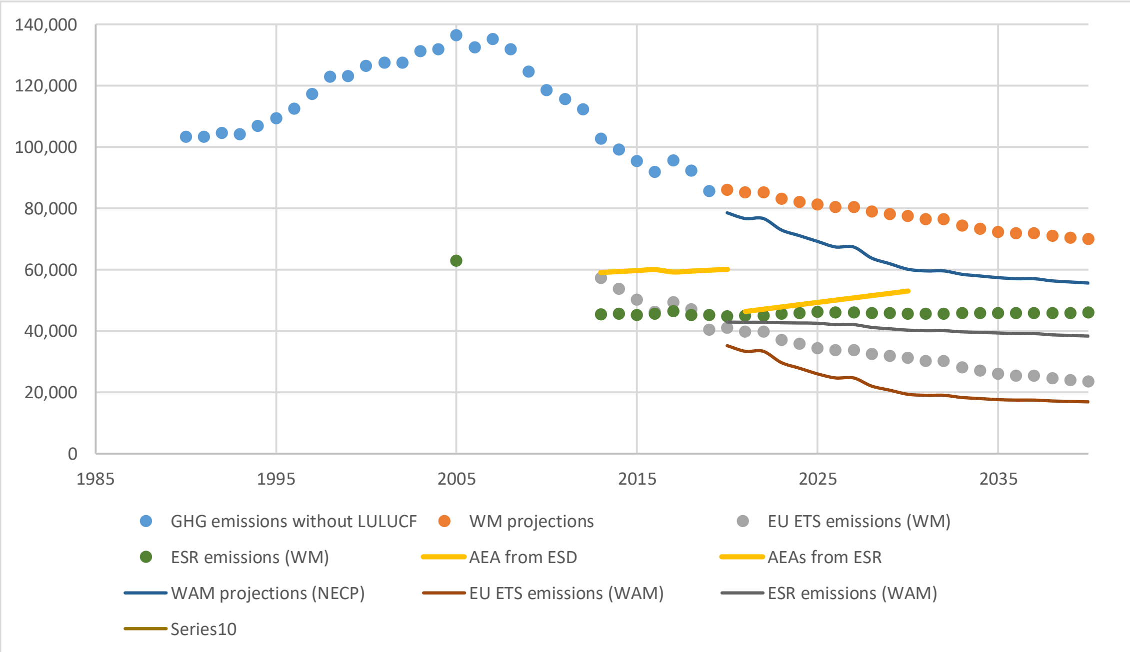


Figure 1.2 Projections of total national GHG emissions (excluding LULUCF), EU ETS and ESD sectors (in ktCO2eq)

Concerning the 2020 non-ETS target (ESD target) of Greece pursuant to European legislation (Commission Decision 2013/162/EU as amended by 2017/147/EU and Commission Decision 2013/634/EU), by comparing the annual emissions allocation for the years 2013-2020 with the projected emissions from ESD sectors, it is concluded that it is anticipated that Greece will meet this target, on the basis of the domestic policies and measures. By comparing the annual emissions allocation for the years 2021-2030 (Table 4.3) with the projected emissions from ESR sectors (Figure 5.1), it is projected that Greece will also meet the ESR target on the basis of the domestic policies and measures.

1.4.3 Assessment of aggregate effects of policies and measures

The aggregate effect of currently implemented and adopted policies and measures (that is incorporated in the "with measures" projections scenario) is presented in ***Table 5.9*** in terms of GHG emissions avoided on a CO2 eq. basis. The effect of policies, or with other words GHG emissions avoided, correspond mainly to CO2, with the exception of policies in industrial processes, waste and agriculture sectors. In the case of waste sector, GHG emissions avoided correspond totally to CH4, while in the agriculture sector about 70% to N2O and 30% to CH4.

In the case of industrial processes sector, GHG emissions avoided correspond totally to HFCs/PFCs.

Table 1.4 Aggregate effect of currently implemented and adopted policies and measures (kt CO2 eq)

Policies and Measures	Effect of implemented and adopted policies and measures					
	2005	2010	2015	2020	2025	2030
Energy sector (CO2)	7521	24069	23298	29674	31692	33655
Transport sector (CO2)	8	801	501	1228	1302	1394
Industrial processes (HFC, PFC)	NA	NA	NA	760	1150	1700
Agriculture (CH4 30%, N2O 70%)	NE	NE	560	715	1000	1300
Waste Sector (only CH4)	NE	NE	1180	1500	1650	1750
LULUCF (CO2)	NE	NE	NE	NE	4063	4122
Total Effect	**7529**	**24470**	**25839**	**33877**	**40857**	**43921**

Table 1.5 Aggregate effect of currently planned policies and measures (kt CO2 eq)

Policies and Measures	Effect of implemented and adopted policies and measures	
	2025	2030
Energy sector (CO2)	11357	16058
Transport sector (CO2)	146	619
LULUCF (CO2)	126	313
Total Effect	**11629**	**16990**

1.4.4 Supplementarity relating to mechanisms under Article 6, 12 and 17, of the Kyoto Protocol

Within EU, supplementarity obligations under the Kyoto Protocol require that any international credit purchases by Member States must be in addition to emission abatement action taken domestically. The use of flexible mechanisms within the EU takes place by operators in the EU ETS and by governments in their achievement of Kyoto targets. As it was reported in the 6th National Communication, Greece has fulfilled its Kyoto Protocol target for the 1st commitment period. The target was met on the basis of the domestic policies and measures (including EU-ETS). The installations subject to the EU-ETS were allowed to use JI and CDM credits. According to the principle of supplementarity of the Kyoto Protocol, installations were allowed to use for compliance credits from these two mechanisms up to 9% of their allocated allowances for years 2008-2012. This figure was calculated according to the supplementarity principle. The use of flexible mechanisms for the 2020 target is described in section A.I.3.2.2 and Table A.I.3. Greece will not use credits from flexible mechanisms for its ESD target. EU-ETS operators could use international credits subject to quantitative and qualitative limits.

1.4.5 Methodology used for the presented GHG emission projections

For scenario development and projections two main procedures have been used:

- ✓ The projections of energy sector are based on the official energy planning (NECP) provided by the MEEN (Directorate of Energy Policy and Energy Efficiency). These data were “translated” to GHG emissions based on the spreadsheet models used for the estimation of annual GHG inventory.

- ✓ Spreadsheet models for the non-energy sectors, in which future changes in activity data are mainly derived from statistical analysis, while emission factors are derived from expert assessments based on the 2006 IPCC guidelines and country specific information.
- ✓ Actual inventory data till year 2019 have been used in the preparation of the emission projections.

Emissions for all sectors were projected using the same models that were used for the BR4, updated to:

- ✓ include improvements in inventory reporting;
- ✓ include emissions for 2019, as reported in the 2017 NIR submission; and
- ✓ update of key assumptions, in order to reflect in the projections the current economic situation, and the most recent forecasts of macroeconomic parameters (e.g. GDP, fuel and carbon prices).

1.5 Vulnerability Assessment, Climate Change Impacts and Adaptation Measures

Overall, the impact of climate change on all sectors of the national economy that were examined in the Bank of Greece report (CCISC 2011) was found to be adverse and often extremely adverse. For instance, the impact on fir, beech and pine forests would be considerable, while fire-fighting costs are expected to shoot up on account of the increasing number and extent of forest fires. Meanwhile, species abundance and biodiversity are expected to decline. Furthermore, climate change, as measured by its projected impact on the tourism climatic index (TCI) by the end of this century, is expected to have serious repercussions on Greek tourism – mainly on the seasonal and geographical patterns of tourist arrivals, hence also tourism receipts. Given that tourism receipts are a crucial resource for Greece, long-term strategic planning is needed in order to upgrade the country’s tourism product in the context of ongoing human-induced climate change. The consequences of climate change on the built environment, transportation, health, mining and other sectors are also important. The Bank of Greece report (CCISC 2011) clearly identified a need for a concrete adaptation policy that would cover all sectors. This should also incorporate a revised foreign policy regarding aspects of particular relevance for Greece. With regard to the assessment of the economic impact, specific studies were carried out using three scenarios: the worst-case scenario of anthropogenic climate change assumes no action to reduce greenhouse gas emissions (Inaction Scenario). Under this scenario, it was estimated that Greek GDP would drop by an annual 2% by 2050 and 6% by 2100, and the total cumulative cost for the Greek economy over the period extending till 2100, expressed as GDP loss relative to base year GDP, would amount to €701 billion (at constant prices of 2008). The second scenario, called the Mitigation Scenario, assumed a constant and drastic reduction in Greece’s green-house gas emissions as part of a broader global effort, resulting in containing the rise in average global temperature to no more than 2º C. The total cumulative cost of the Mitigation Scenario for the entire period till 2100, expressed in terms of GDP loss, comes to €436 billion (at constant prices of 2008). In other words, the total cost for the economy under the Mitigation Scenario is €265 billion less than under the Inaction Scenario, implying that the mitigation policy would reduce the cost of inaction by 40%. Finally, given that an adaptation policy is also necessary as a damage control measure, an Adaptation Scenario was also considered. Under this scenario, Greek GDP would drop by 2.3% and 3.7%, respectively, in 2050 and 2100, while the cost of adaptation policies would total €67 billion. However, the adaptation measures do not fully eliminate but merely contain the damage from climate change. Thus, the cumulative cost for the Greek economy of the residual damage from climate change was estimated at €510 billion (at constant prices of 2008) over the period till 2100. As a result, the total cost for the Greek economy under the Adaptation Scenario is the sum of the cost incurred by the economy on account of the adaptation measures and the cost of the (reduced) damage from climate change; this sum (total cumulative cost through 2100) was estimated at €577 billion (at constant prices of 2008). Greece has established the "National Adaptation Strategy to Climate Change" (NAS) (Law 4414/2016, Government Gazette, 149/A/9.8.2016) which sets out the general objectives, guiding principles and implementation tools of a modern, effective and growth-oriented adaptation strategy in line with EU directives and the international experience. The overarching objective of Greece's adaptation strategy is to strengthen the country's resilience to the impacts of climate change, and to create conditions for well-informed and far-sighted decisions that address risks and opportunities resulting from a changing climate. The NAS provides an initial five-year horizon for building the capacity for adaptation and prioritising and implementing an initial set of actions. Due to the significant uncertainty surrounding climate change and its impacts, as well as in the light of the latest information and developments, the views on the best way to promote adaptation need to be constantly put in new context, which calls for continuous evaluation, training and specialised analysis. Against this background, the first draft of the NAS provides an opportunity for developing a strategic approach to adaptation to climate change, which sets in motion an ongoing process of revision, updating and realignment. Key objectives of the NAS are to:

1. improve the decision-making process, drawing on more thorough information and accurate scientific data on adaptation issues,
2. promote the development and implementation of regional/local action plans that are compatible with the present strategy,
3. initiate adaptation actions and policies across all sectors, with an emphasis on the most vulnerable ones,
4. create a mechanism for monitoring and evaluating adaptation actions and policies, and
5. raise public awareness and disseminate information.

1.6 Financial Resources and Transfer of Technology

Being a DAC-OECD member since 1999, Greece follows closely the work of DAC's Networks, Working Parties, High and Senior Level Meetings and participates with great interest in DAC's Peer Review processes, with a view to learning from other DAC members' experience, keeping an eye on main challenges and fostering a positive momentum as regards the improvement of its own system of development cooperation. Moreover, Greece has actively participated in the preparations for the "Rio+20" UN Conference on Sustainable Development (June 2012, Rio de Janeiro) as well as its follow up, at EU and UN levels, with a view to the formulation, inter alia, of a single and coherent post-2015 development framework that while continuing giving emphasis on poverty eradication, it will focus on sustainable development.

In 2015, Greece has followed closely and participated very actively in the international processes that led to the adoption of the 2030 Agenda for Sustainable Development and the Sustainable Development Goals (SDGs) by UNGA70 on 25.9.2015, the Addis Ababa Action Agenda (AAAA) of the Third International Conference on Financing for Development (Addis Ababa, 13-16.7.2015) adopted by UNGA69 on 27.7.2015 and the Paris Agreement on Climate Change. In particular, Greece has tried to reshape its development cooperation policy, taking into account also its commitment to pursuing the SDGs in coordination with partner countries and other donors. As a result of the economic crisis during the period 2011-2017 and the cuts in the national budget, Greece has gradually adopted a more pragmatic strategic approach as regards its development aid program, which now focuses primarily on multilateral contributions. These contributions are expected to have a positive development impact as regards the achievement of one or more of the Sustainable Development Goals (SDGs). Therefore, it was a strategic choice to concentrate on multilateral assistance, in the context of Greece's strategic priorities. Greece is committed to multilateralism and supports multilateral approaches to global problems. Development cooperation priorities are consistent with Greece's overall foreign policy objectives and help partner countries address their economic, social and environmental problems. Greece has entered into partnerships with international organizations that operate in line with national priorities. Total multilateral ODA subscriptions of Greece to International Organizations in the year 2019 amounted to 224.99 MUSD (0.11% of GNI), a fall by about 42.4% in relation to 2008 (391 MUSD). For 2018 the total multilateral ODA subscriptions amounted to 251.8 MUSD. These Organizations support developing countries and provide assistance in emergency situations. Total flows granted by Greece to EU institutions for foreign development assistance amounted to USD 203.396 million, including Greece's contribution to the European Development Fund (EDF) which totaled USD 79.182 million. ODA amounting to USD 12.249 million was also granted through the United Nations system, the amount of 5.6 million to World Bank Group and the amount of USD 3.695 million to diverse international organizations.

1.7 Research and Systematic Observation

1.7.1 Research

The **General Secretariat for Research and Innovation (GSRI)** of the Ministry of Education and Religious Affairs (*until 10/8/2012 the Secretariat was working under the Ministry of Development, Competitiveness, Infrastructure, Transport and Communications*) is the responsible institution for supporting and promoting research in Greece. The main funding sources in the research sector in Greece include public and private funds. Public funds include the funds provided by the national budget, funds by the Programme of Public Investments, Structural Funds and also the European Commission's funds. For 2019 the Gross Domestic Expenditure on R&D (percentage of GDP) is estimated at 1.27%, while 41.1% has been funded by the State and the 41.4% by the Business Enterprise sector

1.7.2 Systematic Observation

The network of systematic observation of climatic parameters in Greece includes the **Hellenic National Meteorological Service (HNMS), services of the Greek Armed Forces**, the **Ministry of Rural Development and Food**, the **Ministry of the Environment and Energy (MEE)**, **Ministry for Climate Crisis and Civil Protection** as well as a number of national research centers. Furthermore, the **Public Power Corporation of Greece (PPC)** operates a network of meteorological stations in the vicinity of its thermal and hydro power plants and dams for electricity production.

Greece is a member of the European organization for the exploitation of Meteorological Satellites (EUMETSAT), the consortium that operates the meteorological observation satellite METEOSAT, and is represented in EUMETSAT by HNMS. In addition, Greece is a member of ESA and participates in basic, as well as in optional, research projects. Greece also participates in three actions of the Global Monitoring for Environment and Stability (GMES) program of ESA. Also, the HCMR is a member of the European Global Ocean Observing System (Eur-GOOS).

1.8 Education, Public Awareness

1.8.1 Education

As part of the programme for the implementation of the Convention and the New Delhi Programme, and the relevant provisions of the Kyoto Protocol, Greece has carried out a series of actions, aiming at the integration of climate change issues at all educational levels and disciplines, the dissemination of information and promotion of participation of youth, stakeholders, and public, as well as the enhancement of cooperation and co-ordination at regional and international level to promote capacity building. Under the M.E., the Educational Institute of Greece is providing substantial guidance on environmental education to teachers. In the respective website, entitled “Environmental Education”, the Institute suggests specific projects of environmental issues that could be applied by teachers regarding the climate, the forests and the energy forms. The Environmental Education Centres (EEC) are also involved in the implementation of educational programmes and activities. Currently 53 EECs are operating in Greece. In the context of the UN “Decade of Education for Sustainable Development 2005-2014”, the Ministry of Education and Religious Affairs has planned various educational actions for the decade 2005-2014, aiming at the development of school activities that support the formation of energetic citizens and at the same time promote the opening of the school to the society. The Hellenic Association of Teachers for Environmental Education (HATEE) has been established in 1992, and since then it aims at the mutual support, the exchange of views and the coordination between teachers within the framework of environmental education activities. A substantial number of environmental non-governmental organisations (NGOs) are active on environmental education issues, promoting at the same time awareness on specific environmental issues. Regarding Education in universities and technical education centres, the establishment of new departments dealing with environmental issues and the enlargement of the scientific content of many existing ones during the recent years, have created a significant technical knowledge on climate change issues and their causes, both at the level of research as well as at the level of higher education. The public institution that plans and executes the actions in lifelong education in Greece is the General Secretariat of Lifelong Learning that is functioning under the Ministry of Education. Non-educational institutions and research centers play an important role in producing educational material and in organizing activities of continuous education on issues related to climate change.

1.8.2 Environmental information and awareness

Environmental information and awareness is taking place through different tracks, including several Governmental initiatives. Some of the MEEN’s, actions include: the Creation of “Centres for Environmental Information” for environmental protection and administration Institutions in Balkan countries, on issues of environmental politics and administration (DAC/OECD), the National Centre for Viable and Sustainable Development–NCVSD, Special Service of Environmental Inspectors–SSEI, Funding Programs concerning Environmental Awareness. During the rotating annual Chairmanship of the Human Security Network (HSN), Greece (Ministry of Foreign Affairs) chose to focus its activities on the human security implications of climate change in developing countries. The objective of the Hellenic Chairmanship was to raise, at a global level, awareness on the impacts that changing living conditions can have on peoples’ security in developing countries, with a special emphasis on the implications that these circumstances can have on three particularly vulnerable groups, namely women, children and populations fleeing their homes as a result of climate change. NGOs are also taking initiatives relating to climate change issues. Apart for the NGOs, a number of institutions of the civil society show an increasing interest on energy, climate change and environmental issues. These institutions can contribute to the awareness and promotion of good practices, either due to their large membership, or due to their sectoral representation, or finally, due to the specialization of their members in issues critical for the application of solutions for climate change mitigation.

1.8.3 International cooperation

Greece's long-standing cooperation with countries of the African region is channeled through a number of different processes and is especially characterized by the social, economic, commercial, cultural and environmental links induced by sharing the Mediterranean Sea. The different levels of cooperation between Greece and the African countries can be summarized as cooperation at international level, cooperation at regional level, with emphasis on the Mediterranean region, and cooperation at bilateral level. It should be noted that there also exists cooperation between the European Union (EU) and African countries, especially at the international level but also at the regional level, where Greece, as a Member State of the EU, is also actively involved. The Cooperation on environmental issues with Africa concerning climate change is a fundamental issue since Africa is a region particularly vulnerable to environmental changes. Greece is a member to several international organisations through which engages in cooperation and mutual support with African countries in promoting environmental protection and sustainable development. In the UN system, such organisations mainly include the UN Commission on Sustainable Development, the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP). The Ministry's efforts focused on capacity building, and promoted the principles of demand-driven projects and local ownership. Thematic priorities included water and natural resources management, wastewater and solid waste management, climate change, and establishment of transboundary networks and monitoring mechanisms. Greece is currently further intensifying its efforts regarding ODA focusing at climate change adaptation. For example, Greece is currently financing programmes for adaptation to climate change in Least Developed Countries and in regions that, due to their geographical location, are under severe danger from climate change which mainly include Africa and Small Island States. In order to ensure the best possible utilisation of funds and distribution to programmes according to the most significant needs of the threatened regions, the Hellenic development assistance plan is implemented in coordination with regional organisations of the areas under consideration, such as the African Union.

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CHAPTER 2. NATIONAL CIRCUMSTANCES

This chapter includes a short description of Greece's government structure, and geographical, climate, population, and economic profiles of the country. Emphasis is given in identifying those parameters related to national circumstances that affect greenhouse gases (GHG) and describe more completely the national conditions which influence the national emissions/removals over time. The effect of all these parameters on the greenhouse gases (GHG) evolution is described in Chapter 3, and especially in subchapter, namely GHG emissions trends per sector.

2.1 Government structure

The Constitution of 1975, as revised in 1986, 2001, 2008 and in 2019, defines the political system of Greece as a parliamentary democracy with the President being the Head of State.

Legislative power is vested in the national parliament, which comprises 300 members, each elected by direct, secret, and universal ballot. The Parliament's term is four years. The parliament deals with legislative work, while it controls the government and national administration in general.

At the top administrative level is the national government, with ministers appointed by the Prime Minister. The ministries mainly prepare and implement national laws.

The current administrative division of Greece was formed by the 'Kallikratis' Program and is valid from 1 January 2011. According to it, the country is divided into seven decentralized administrations, 13 administrative regions (***Figure 2.1***) and 325 municipalities. Regions and municipalities are self-governing entities, i.e. authorities are elected by universal suffrage of registered residents.

More specifically:

First local authority (OTA) is the "township". Administered by the mayor and city council who are elected every five years by universal suffrage. Each township is divided into partitions, called "local units" and these in turn into "communities". The latter have their own councils, but their role is advisory and cannot make decisions.

Secondary OTA the "periphery", which corresponds to a wide geographic area of the country. Administered by Prefect and regional council are elected every five years by universal suffrage among the registered residents of the municipalities within the region. Each region is divided into " regional units ", which usually coincide with counties. Each regional section has its own Antiperifereiarchi derived from the combination of electoral district commissioner.

The "decentralized management" is not a government institution but decentralization of the state. Comprises from 1 to 12 counties and chief (with the title "Secretary") shall be appointed by the Government and collects all decision-making powers , and the Council has , to which the concerned elected prefects and representatives of regional associations of municipalities , has mainly advisory.

The exception to all this is the Holy Mountain, which forms part of the Greek territory, but is self-governed by their own institutions under the Charter of Mount Athos in 1924.

The Ministry for the Environment and Energy (MEEN) is the main governmental body concerned with the development and implementation of environmental policy in Greece, while other Ministries are responsible for integrating environmental policy targets within their respective fields. MEEN is the competent authority for climate change issues. The Council of Ministers is responsible for the final approval of policies and measures related to Climate Change.

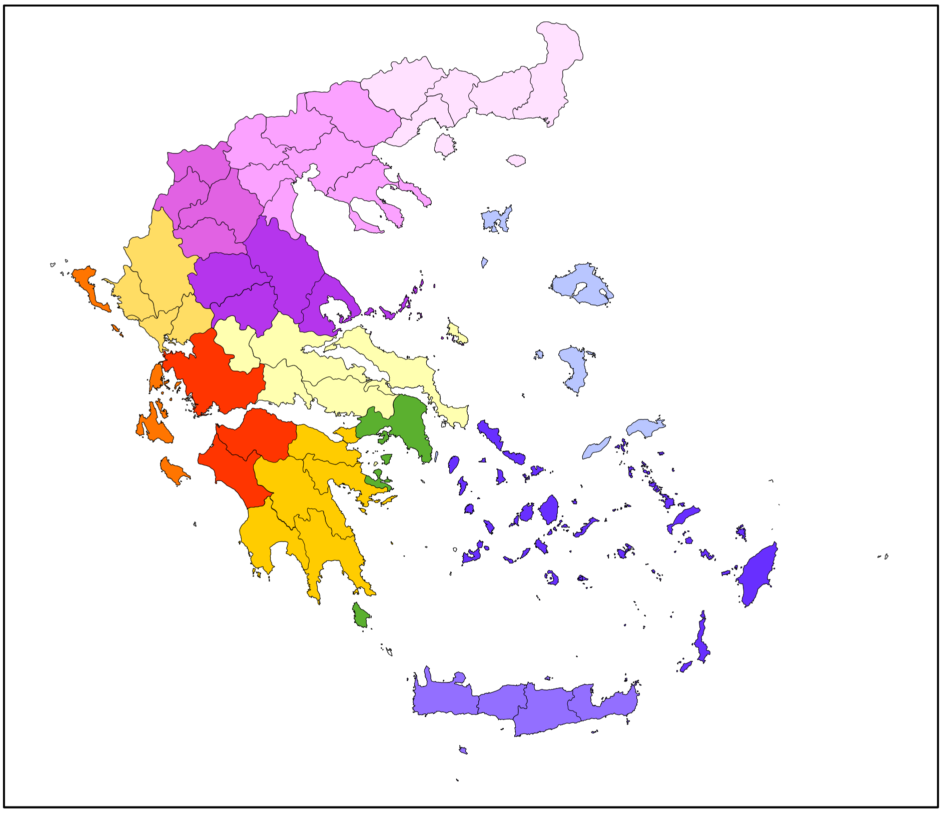

Figure 2.1 Major administrative divisions of Greece

Policies and measures, as well as all other issues and actions regarding mitigation are discussed within the framework of an inter-ministerial collaboration.

2.2 Preparation of national communications

As previously stated, the Ministry of Environment and Energy is responsible for the co-ordination of all involved ministries, as well as any relevant public or private organization, in relation to the implementation of the provisions of the Kyoto Protocol, according to the Law 3017/2002 with which Greece ratified the Kyoto Protocol.

To this end, MEEN is the governmental body with the overall responsibility for the preparation, approval and submission of national communications (Contact person: Kyriakos Psychas, Address: Patission 147, Athens, Greece, e-mail: k.psychas@prv.ypeka.gr, tel.: +30210 8665938).

The National Technical University of Athens (NTUA) / School of Chemical Engineering has, on a contract basis, the technical and scientific responsibility for the compilation of national communications.

Experts from government ministries and agencies participated in the preparation of the present national communication as information providers (s. Annex V):

2.3 Population

In 2011, the total permanent population of Greece was 10.725 million inhabitants, according to the Census of 2011 performed by the Hellenic Statistical Authority. The total population in 2011 decreased by 1.37% compared to the 2001 Census results, with 35.34% of total population living in the greater Athens area. According to the population census results, the average household size is continuously decreasing (***Figure 2.2***). For 2020, total permanent population of Greece is estimated equal to 10.719 million inhabitants, slightly lower than this for 2016.

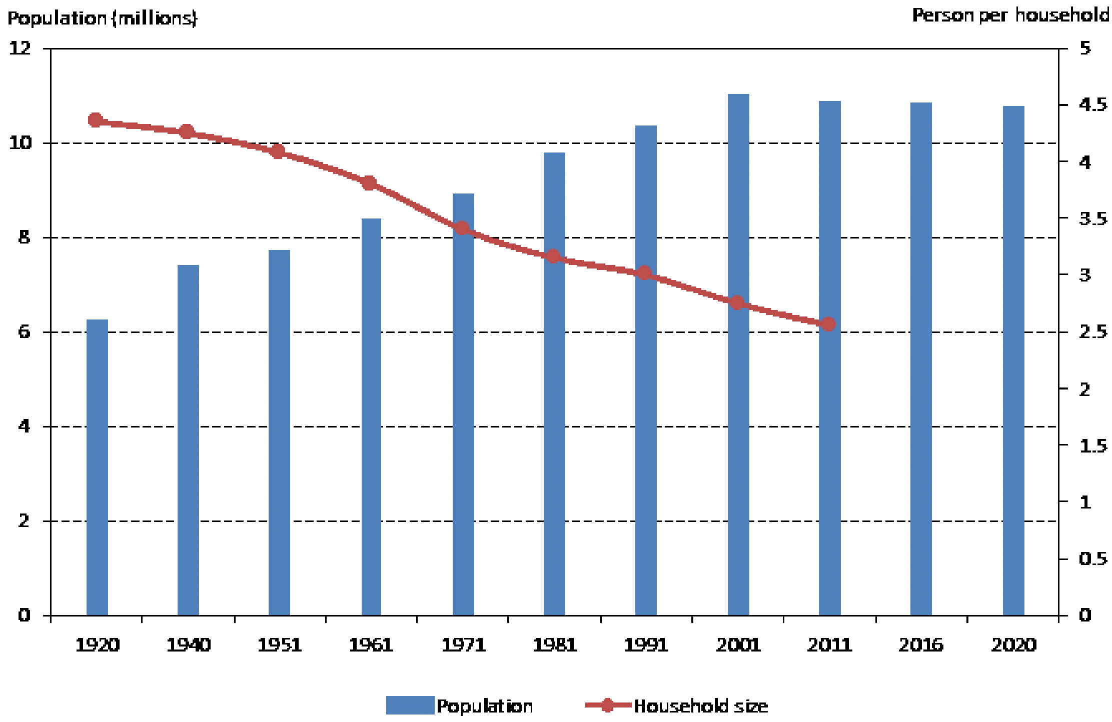

Figure 2.2 Population of Greece and average household size

The average household size decreased from 2.80 persons per household according to the 2001 population census, to 2.55 persons per household, according to the 2011 population census Population density in Greece is estimated at 84.03 inhabitants/km^2.

2.4 Geographic profile

Greece has a total area of 131.957 km2 and occupies the southernmost extension of the Balkan Peninsula. The mainland accounts for 80% of the land area, with the remaining 20% divided among nearly 3000 islands. The Greek landscape, with its extensive coastline, exceeding 15,000 km in length, is closely linked with the sea, since only a small region in the northwest is further than 80 km from the sea. Approximately 25% of it is lowland, particularly the coastal plains along the seashore of the country.

2.4.1 Geomorphologic characteristics

Greece is a mountainous country, two thirds of which are largely covered by mountains of medium height. The great mountain masses run the length of the country from NNW to SSE (the Pindos complex, the Agrafa, Tymfristos, Panetolikon, Oiti, Vardousia, Parnassos, Giona in northern and central Greece, and Panachaikon, Erymanthos, the Aroania mountains, Kyllene, Maenalon, Parnon, Taygetos in the Peloponnese) and divide it into two distinct climatic and phytogeographic regions. The mountain ranges of the east part of the country (Bermio, Pieria, Olympos, Ossa, Mavrovouni, Pelion) are directed from North to South. Finally the mountain ranges of Northern Greece (Voras, Tzena, Paiko, Beles, Angistro, Falakron mountains and the Rhodope range) run east-west, shielding the country from the cold north winds.

Greece presents a variety of rock formations. Geologically and petrologically the rocks of Greece can be divided into pre-Alpine, Alpine and post-Alpine formations. The pre-Alpine formations contain the crystalline schist rocks of the crystalline masses of Greece, and some small areas of sedimentary and igneous rocks. The Alpine and post-Alpine formations include the greater part of the sedimentary cover of Greece, as well as quite large igneous outcrops.

2.4.2 Ecosystems

Greece with its rugged mountainous relief, its complex geology and the numerous islands and convoluted coastline presents a great diversity of natural scenery. In addition, the remoteness of some biotopes has led to the evolution of many endemic and rare animal and plant species. Equally interesting is the great variety of meteorological conditions that vary from dry semi-arid, semi-desert of SE Crete to the cold, humid continental climate of Rhodope mountain range bordering the Northern shores of the Aegean Sea.

The variety of the meteorological conditions combined with the geomorphological features reflects the rich flora and fauna. The diversity of the vegetation is evident by the large number of different habitats from the unique palm forest at Vai, on the eastern tip of Crete, to the boreal woods of birch, pines and spruce in Rhodope mountain range. This diversity is crowded into a very confined area.

Greece is well-known as a country of islands and mountains, but coastal and high-mountain plants together comprise about 17.2 % of the Greek flora. The evaluation on the habitat preferences of plant taxa reveals that Greece is in fact rather a country of cultural, i.e. anthropozoogenic, landscapes (Dimopoulos et al., 2016). Most common are plants of agricultural and ruderal habitats (18.1%), followed by plants of grasslands and dwarf shrublands, with 17.7 % representing submediterranean/temperate lowland to montane pastures and meadows, and 15.4 % Mediterranean annual-rich grasslands and phrygana. Plants of woodlands and shrublands represent only 13.7 %, although these formations are very diverse and widespread in Greece, and almost all tree and shrub species belong here. Specialist plants of high mountains (12.6%), cliffs (9.0%), freshwater (8.9%) and coastal habitats (4.6%) are represented by minor proportions but, considering the small areas occupied by each of these habitat categories, their floras are remarkably prominent in the Greek vegetation.

Due to the geographical position and the various vegetation zones present, the flora of Greece is very rich; moreover, the country's mountainous nature (42 summits over 2000m) and the numerous islands provided through time favorable conditions of isolation and endemism. As a result, significant proportion of plant species and subspecies are endemic: the vascular flora of Greece comprises 5758 species and 1970 subspecies (native and naturalized), representing 6620 taxa, belonging to 1073 genera and 185 families. The endemic vascular flora of Greece comprises 1459 taxa (22 % of the total number of taxa in Greece), corresponding to 1274 endemic species (22.1 % of the total number of Greek species) and 450 endemic subspecies (22.8 % of the total number of Greek subspecies).

In general, if we exclude the azonal vegetation formation of aquatic/riparian vegetation species, the natural vegetation zones in Greece, as a result of the climate are:

- Thermo-mediterranean vegetation (Oleo-Ceratonion);
- Meso-mediterranean vegetation of green oak (Quercion ilicis) balcanic and east mediterranean type;
- Supra-mediterranean vegetation (Ostryo-Carpinion);
- Sub-continental thermophile oak vegetation;
- Oro-mediterranean vegetation zones of South Greece;

- Oro-mediterranean vegetation zones of North Greece;
- Oro-mediterranean vegetation (upper floor) of Pinus silvestris, Picea excelsa.

2.4.3 Land use

The various forms of land use in Greece in 2020 are presented in ***Figure 2.3***.

The information used for the representation of land areas was the following:

- the first National Forest Inventory (1st NFI) prepared by the General Secretariat of Forests
- and Natural Environment (GSFNE, 1992, 1994),
- the afforestation registry and statistics of the Ministry of Environment and Energy,
- the "Agricultural Statistics of Greece" of the Hellenic Statistical Authority (EL.STAT.,
- annual census),
- the "Distribution of the Country′ s Area by Basic Categories of Land Use" of the Hellenic
- Statistical Authority (EL.STAT., decennial survey),
- Greece – National Inventory Report 2021 Chapter 6
- 345
- the "Land Use Change Database" of the Ministry of Environment and Energy, which comprises annual acts of land use change since 1990,
- the "Forest Management Plans Database", of the Ministry of Environment and Energy.
- the Corine Land Cover Database, of the European Environment Agency.

Forest land, divided into Forests (high and coppice forests) and Other Wooded Lands (branchy dwarf trees and scrubs), covers 26.4% of the total area of the country. Grassland, rangeland and pasture with vegetation that falls below the threshold of forest definition, covers 41.7% of the total area of the country. Agricultural land, including fallow land, account for 22.9% of the total area. Settlements, developed land including transportation infrastructure and human settlements of any size, account for 4.26% of the total area. Finally, wetlands, land that is covered or saturated by water for all or the greatest part of the year, and other land, areas that do not fall into any of other land-use categories (e.g. rocky areas, bare soil, mine and quarry land), account for 2.3 % and 2.1 %, respectively.

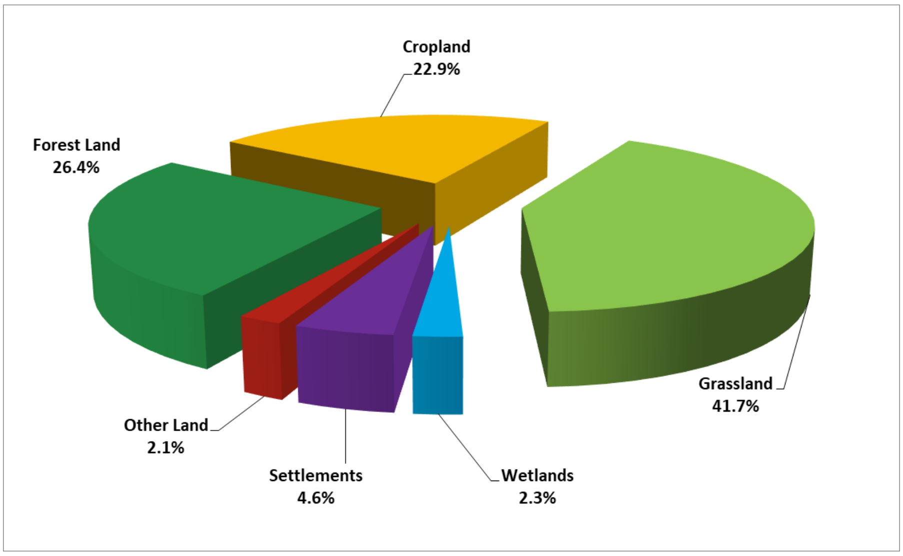

Figure 2.3 Distribution of the area of Greece in 2020 by land-use category

2.5 Climate profile

Greece has a Mediterranean climate, with mild and wet winters in the southern lowland and island regions and cold winters with strong snowfalls in the mountainous areas in the central and northern regions and hot, dry summers. The mean temperature during summer (April to September) is approximately 25°C in Athens and southern Greece, while lower in the north. Generally, temperatures are higher in the southern part of the country. Except for a few thunderstorms, rainfall is rare from June to August, where sunny and dry days are mainly observed. The dry, hot weather is often relieved by a system of seasonal breezes.

As shown in ***Figure 2.4***, the mean annual temperature for the period 2001 – 2020, as measured at selected meteorological stations of the country, is higher in most of the stations compared to the mean annual temperature of the period 1991 – 2000 while the mean annual temperature for the period 1991 – 2000 is higher compared to these of the period 1961 – 1990.

Winters are mild in the south, much colder in the north. The average winter temperature in Athens (October to March) and southern Greece is approximately 14°C, while lower in the north. January is generally the coldest month. Below-freezing temperatures and snow occur mainly in the mountains. Winters are mild in the lowlands with rare frost and snow. Rainfall occurs mostly between October and March. ***Figure 2.5*** presents the average annual precipitation (in mm) for the periods 1961 – 1990, 1991 – 2000 and 2001-2003 as well as for the years 2004, 2012, 2013, 2015, 2018 and 2020, as measured at selected meteorological stations of Greece.

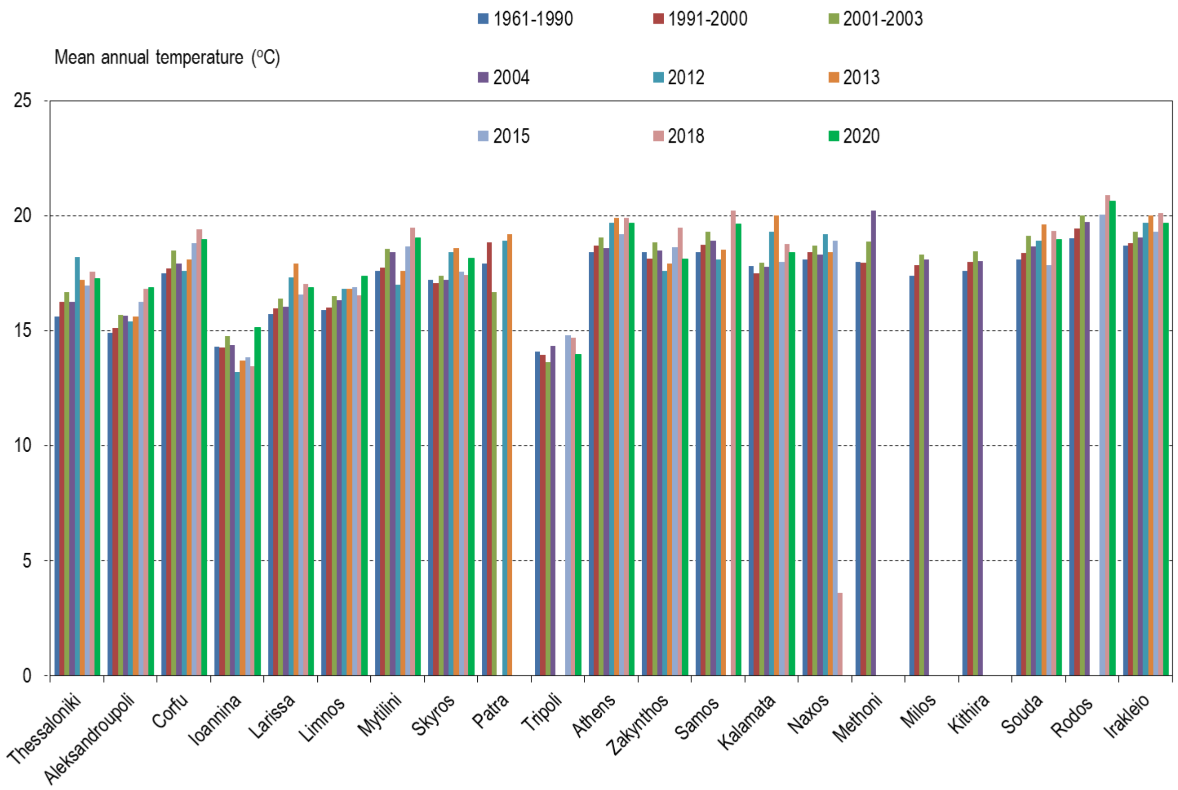

Figure 2.4 Mean annual temperature (in ˚C) at selected meteorological stations for the periods 1961 – 1990 and 1991 – 2000, 2001-2003 and for the years 2004, 2012, 2013, 2015, 2018 and 2020

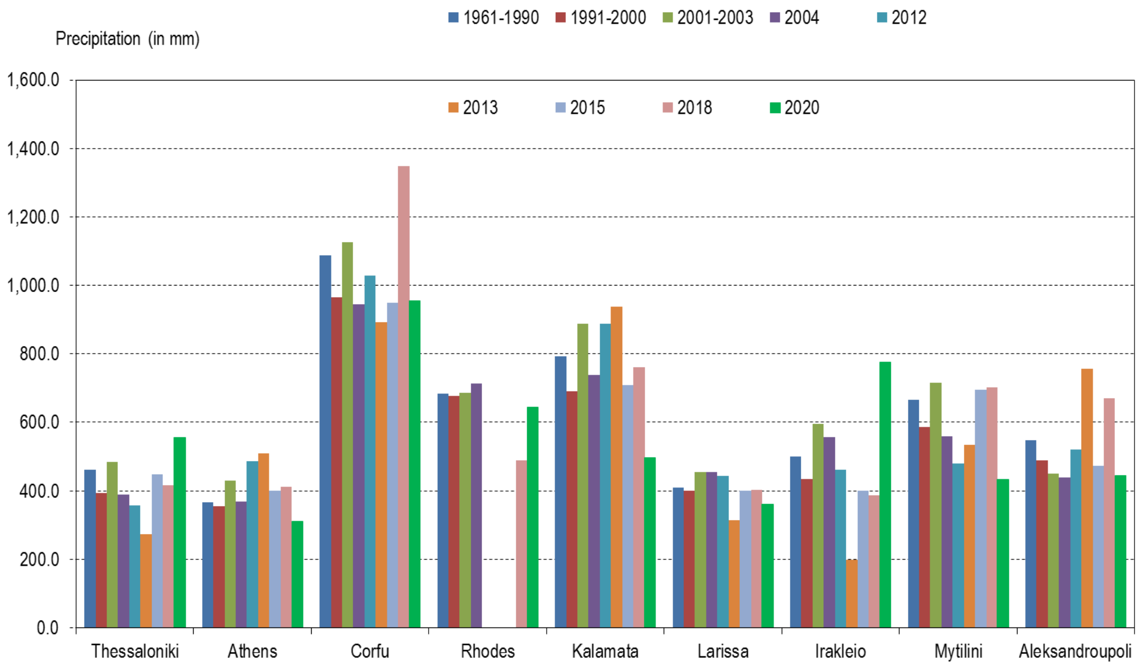

Figure 2.5 Precipitation height (in mm) at selected meteorological stations for the periods 1961 – 1990 and 1991 – 2000, 2001-2003 and for the years 2004, 2012, 2013, 2015, 2018 and 2020

2.6 Economic profile

Greece is a member of the EU since 1981 and member of the Eurozone since 2001. The euro is the monetary unit of the country since 1st of 2002. After the accession, the Greek economy was developed with high rates, while its capacity to cope with structural problems both in public and in private sector was increased.

However, since 2009 the Greek economy experienced its most-severe economic crisis recording four consecutive year recession up to 2013. As a consequence, Greece has received financial and technical assistance from the other Eurozone countries and the IMF in the framework of the first Memorandum of Understanding (May, 2010), the second one (January, 2012) and the third one (August, 2015) in order to deal with its high deficit and Government debt.

The implementation of the Memorandums of Understanding was accompanied by the adoption of numerous economic and structural changes of Greece influencing significantly the living standards of Greek citizens. The third Memorandum of Understanding was completed by the August of 2018.

In period 2014-2016 no significant change on GDP was noticed while for years 2017, 2018 and 2019 approximately 1.08%, 1.64% and 1.77% growth, respectively, were noted. Nevertheless, this upward trend did not continue in 2020 due to the consequences of the COVID-19 pandemic, where a recession of 9.9% was observed.

2.6.1 General

During the period 2000 -2008, Greek growth performance was impressive. The annual rate of increase of the GDP during the period 2000-2004 was approximately 4.5% due to the financial market liberalization coupled with membership in the monetary union, which led to substantial increase in credit expansion and reduction in borrowing costs, the stimulus given by the Olympic Games hosted in Athens in 2004 and the Community Structural Funds. Contrary to expectations of a post-Olympics slump, the economy continued to grow briskly in 2005-2007 period. GDP increased by an average growth rate of 3.0% and thus Greece enjoyed one of the highest growth rates in the EU and the Eurozone.

In next period, from 2009 to 2016, Greek economy faced its most-severe crisis, since it experienced a significant recession having recorded a cumulative decline in real terms exceeding 36% (by the end of 2016 compared to GDP at the end of 2007).

The repercussions from the international financial crisis were unavoidably felt also in Greece especially through the negative impact in the two significant economic sectors (tourism and ship transportation) for the first half of this period (2007-2016), but at a large extent economic downturn relates also to the diminishing growth potential of the country since no significant changes have occurred in the domestic production model towards innovative or high value added activities. It should be noted that during the second half of the period 2007-2016, tourism demonstrates a positive trend resulting in an increased share on the GDP of Greece.

As a result of economic crisis, unemployment in Greece was risen to historically high levels, affecting more severely the vulnerable groups of the population (low skilled and youngsters). Additionally, because of rise in unemployment a significant part of high skilled employees has migrated to Europe and other Continents. The maintenance of social cohesion and social solidarity becomes a challenge and an issue of high priority as the mixture between fiscal consolidation and the provision of a social protection net needs to be carefully balanced.

The number of unemployed in 2012 was at the range of to 1.1 million people on average, for ages above 15. The average unemployment rate (ages above 15) decreased to 23.5% in 2016, from 27.5 in 2013. To be noted that unemployment in 2013 was the highest one compared to 2011, i.e. 17.9%, and to 2018, i.e. 7.8%, – according to EL.STAT. data.

2009 was the year with the highest budget deflect of Greece accounting to 15.1% of GDP and resulting in the developing of the first Memorandums of Understanding. After the austerity measures that adopted budget deflect was decreased to 11.2% of GDP in 2010 and to 8.9% of GDP in 2012 while for 2015 the deflect was accounted at 5.7% of GDP.

Similarly it is the evolution of the general government debt as a per cent of GDP. Before the crisis, it was measured at 103.1% of GDP in 2007 and 109.4% of GDP in 2008. In the first year of the economic crisis, 2009, Greek debt was accounted to 126.7% of GDP and in 2012 to 159.6% of GDP. In 2016 the general government debt was estimated at 176.8% of GDP.

After three Memorandums of Understanding and several economic measures, Greece presented Growth for three continuous years, 2017, 2018 and 2019, while, Greek debt was accounted to 179.5% of GDP in 2017, to 186.4% of GDP in 2018 and to 180.7% of GDP in 2019. However, a new big recession was followed due to COVID-19 pandemic, while debt was estimated equal to 206% of GDP.

Figure 2.6 presents several macroeconomic indicators for the period 2020-2020. The average annual growth rate of gross value added for the period 2000 – 2007 is estimated at 3.65% and for the period 2008-2013 at -4.7%. For period 2014 to 2016 a small decrease in the range of -0.31% is observed, while for the period 2017-2019 a annual growth rate of 1.7% was noted. For 2020 gross value added decreased by 10%. The average annual increase of the private consumption is estimated at 3.80% for the 2000-2007, -4.5 for the period 2008 – 2013, -0.44 for the period 2014-2016, 1.86 for the period 2017-2019 and -7.3 for 2020.

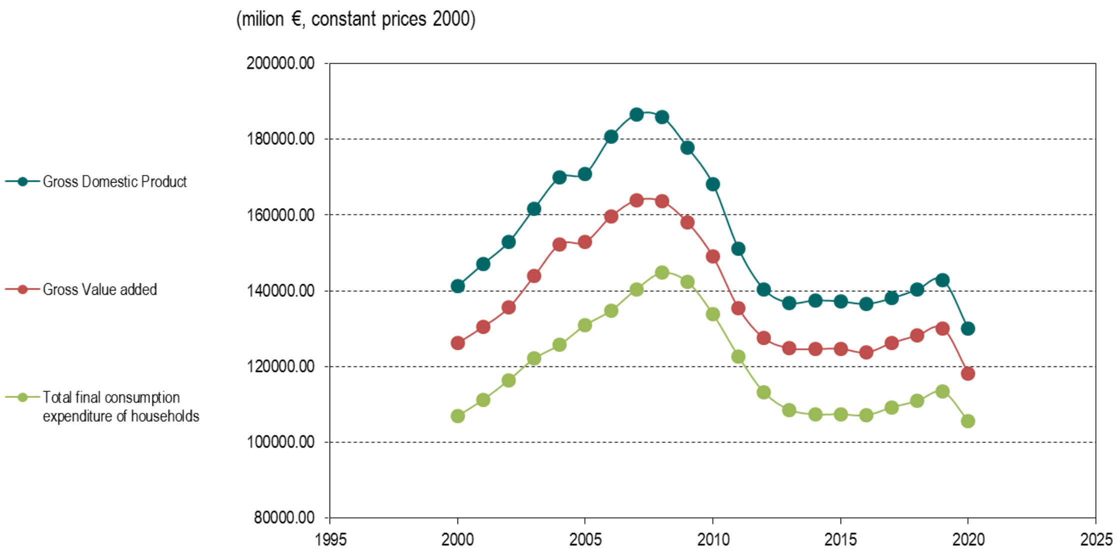

Figure 2.6 Basic macroeconomic indicators of the Greek economy for the period 2000 - 2020

The contribution of the primary, secondary (industry – construction) and tertiary sectors to the total gross value added is presented in ***Figure 2.7***.

In 2020, the tertiary sector accounted for 78.1% of the total gross value added (72.9% in 2000). The contribution of the primary sector remained constant during the period 2000-2020 at 6.1, while the contribution of industry (including energy industry) decreased from 14% in 2000 to 12.3% in 2020. Similarly, the contribution of the construction sector decreased from 7.0 in 2000 to 3.5 in 2020.

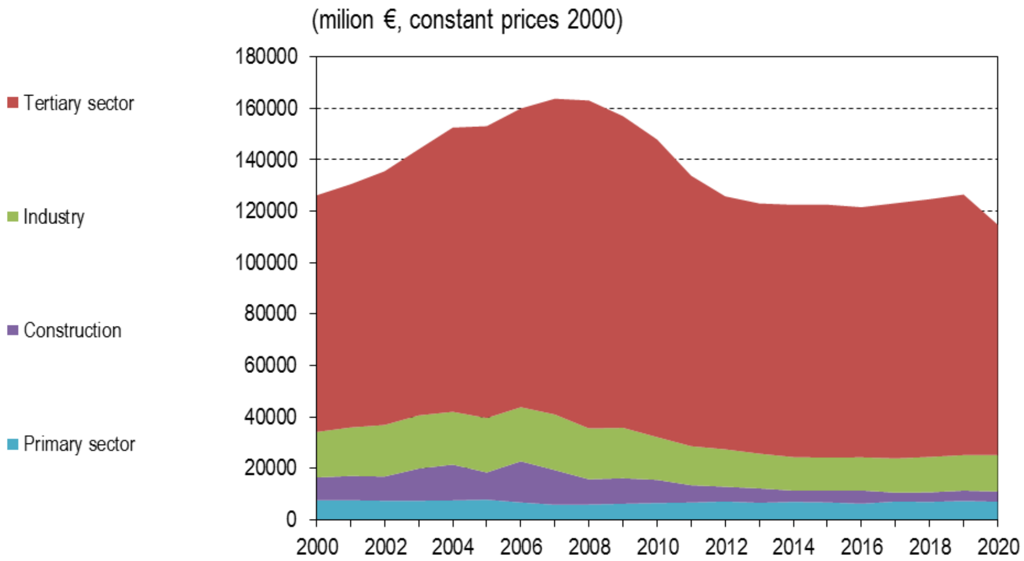

Figure 2.7 Gross value added (in constant prices 2000) per economic sector for the period 2000 – 2020

As it is concluded by the Figure 2.7, with the exception of the Primary sector, the rest of the sectors of economic activity presented negative growth rates as a result of the economic crisis for the period 2007-2013 and an unchanged trend for the period 2014-2016. For the period of 2017-2019 growth is observed for Tertiary and Industry sectors, while in 2020 COVID-19 pandemic had a very negative impact in Tertiary sector.

EU and especially the Eurozone countries are the main trading partners of Greece for both imports and exports. More than 50% of the total trade is taking place with EU countries. As far as the Greek exports are concerned, industrial products have the higher share. Agricultural products constitute the 20%, raw materials the 5% and petroleum products the 12%. On the other hand, industrial products are around the 70% of total Greek imports of goods.

2.6.2 Primary sector

The contribution of the primary sector to the total gross value added remained constant for the period 2000 to 2020. During the same period employment in the sector decreased by 29.7% and as a result employment in the primary sector accounts for 10.5% of total employment in 2020. The corresponding figure in 2000 was approximately 16%.

2.6.2.1 Agriculture

In 2020, the total area of agricultural land in Greece was approximately 3.2 Mha, more than half of which is on relatively steep slopes on which cultivation is carried out without protection against soil erosion. The area of agricultural land decreased by 20% in 2020 compared to 1990.

No significant changes took place since 2000 concerning fallow land, irrigated land (***Figure 2.8***) and the average area of agricultural holdings.

- The percentage of irrigated agricultural land has increased from 29.6% in 1990 to 38% in 2020.
- The majority of cultivated areas (76%) are holdings with an area less than 5 ha. Holdings with an area between 5 ha and 20 ha represent the 20% of cultivated areas and only the rest 4% of the cultivated area is distributed among holdings with an area exceeding 20 ha.

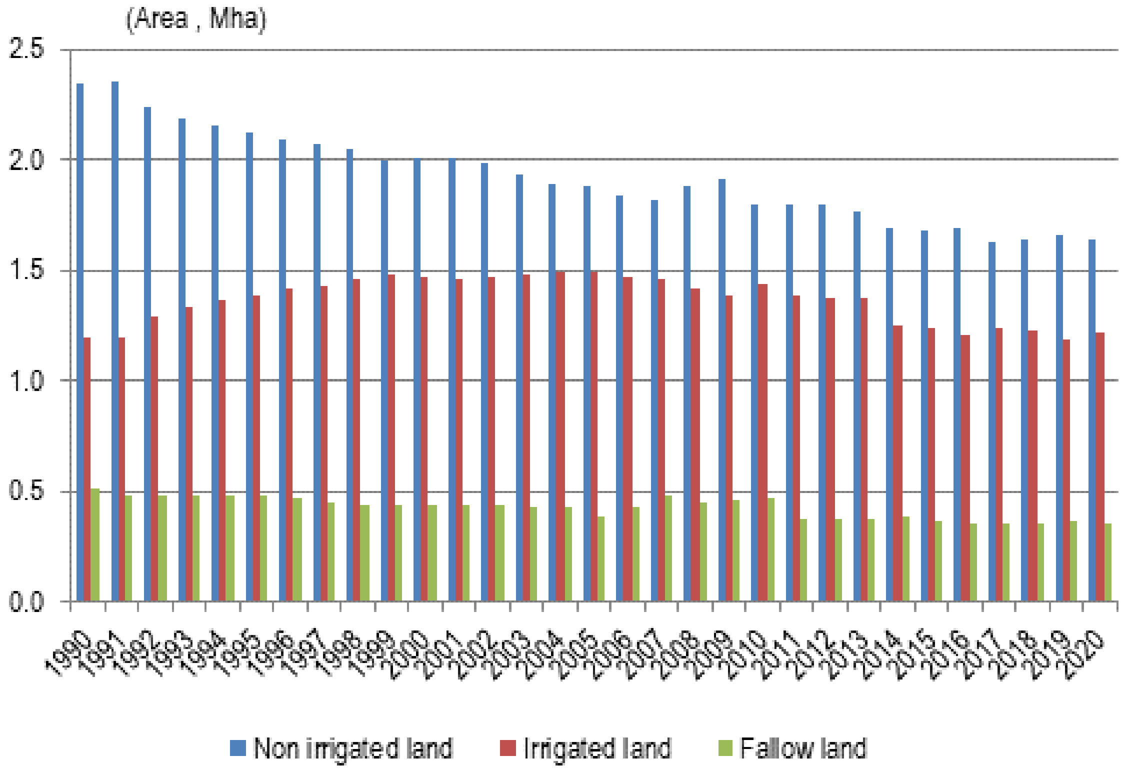

Figure 2.8 Distribution of agricultural land in irrigated and non-irrigated and fallow land (in Mha) for the period 1990 – 2020

Figure 2.9 presents the distribution of agricultural land (excluding fallow land) by basic categories of cultivation types for the year 2009. Arable cultivations account for 64% of the total agricultural land (excluding fallow land), while tree crops, vineyards and garden area represent the 29%, 4% and 3% respectively of the total agricultural land. Compared to 1990, the area of arable cultivations decreased by 2% while the area of tree crops increased by the same percentage.

Cereals for grain represent the most important cultivation in Greece (32% of total agricultural land in 2009 excluding fallows). The total cultivated area with cereals for grain was reduced since 1990 by 17%, while the production increased by 5%. In 2009 the production of corn, rice and oat increased by 16%, 85% and 43% respectively compared to 1990 levels, while the production of wheat, barley and rye decreased by 7%, 26% and 2% respectively.

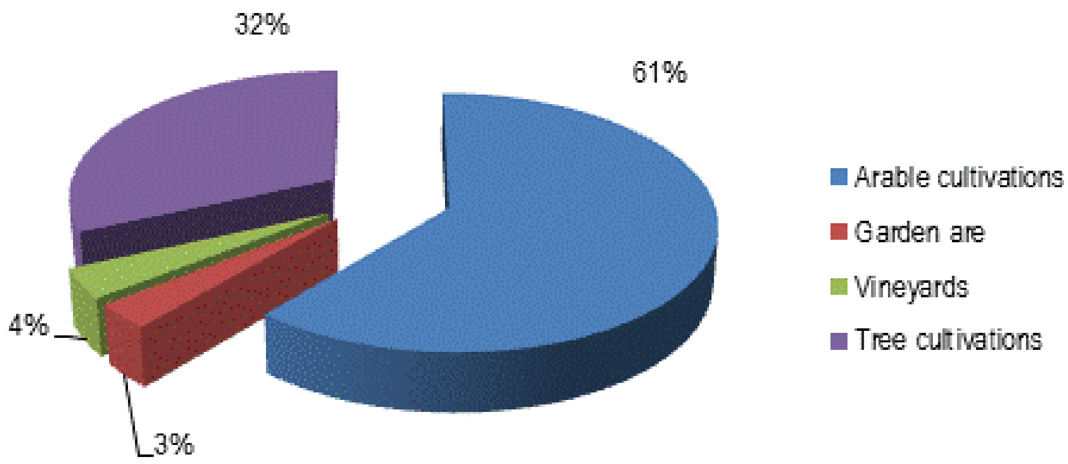

Figure 2.9 Agricultural land by cultivation type for the year 2009

The use of synthetic nitrogen fertilizers in 2020 decreased by approximately 55.2% compared to 1990, and as a result the amount of nitrogen applied to soils decreased from 0.1 t N/ha in 1990 to 0.05 t N/ha in 2015. The decrease in the use of synthetic nitrogen fertilizers could probably be attributed to an increase in organic farming, the price of fertilizer and the impact of initiatives to promote good practice in fertilizer use.

2.6.2.2 Livestock

In 2020, livestock population amounted to approximately 56.0 million animals, of which: cattle 0.95%, sheep 16.1%, goats 7.1%, pigs 1.3% and poultry 74.6%. Livestock population increased by approximately 26% compared to 1990 levels because poultry population increased. However, a decrease is observed in the number of Cattle, Mules and asses, Horses and swine (25%, 98%, 88% and 42% respectively) (see ***Table 2.1***).

2.6.2.3 Forestry

According to the results of the First National Forest Inventory, the forests, other wooded land and grasslands in Greece cover 6.5 Mha (49.7% of the area of Greece), of which approximately 3.4 Mha are considered as productive forests. Approximately 42% of the productive forests area is covered by coniferous types and the rest is covered by broadleaved types. The remaining 3.1 Mha are considered as other wooded land.

The majority of forest and other wooded land in Greece are located in the mountainous areas of the country. Forest management practices were focused on the protection of soil and of water resources. However, the productivity of Greek forests is lower compared to European average values. This is due to the low density, quality and quantity of growing stock, a result of human induced activities of the past as wildfires, grazing, illegal felling, as well as the lack of systematic silvicultural treatment.

Table 2.1 Number of animals (thousands) by species for the period 1990–2020

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Dairy cattle	210	214	203	219	168	192	184	184	172	154	180
Other Cattle	487	471	446	390	371	411	409	413	407	447	386
Sheep	8660	8692	8666	8706	8802	8869	8896	8884	8930	8951	8991
Buffalo	0.769	0.939	0.888	0.902	0.692	0.700	0.735	0.788	0.865	0.877	0.975
Swine	996	986	1001	1014	1009	994	987	998	999	973	964
Horses	45	42	40	38	36	35	33	32	31	30	29
Mules and Ashes	187	173	161	150	140	130	121	115	107	101	96
Goats	5334	5336	5365	5378	5444	5525	5570	5600	5615	5614	5639
Poultry	28282	28843	28818	29256	29379	29059	29157	29583	29704	30727	31010
Year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Dairy cattle	172	152	149	157	153	149	158	137	128	144	130
Other Cattle	386	462	501	506	510	535	512	497	494	535	551
Sheep	9127	9058	9002	8827	8792	8830	8897	8889	8931	8904	8914
Buffalo	1.009	1.024	1.110	1.290	1.237	1.389	1.643	1.764	1.785	1.847	2.137
Swine	934	940	937	940	949	902	892	880	862	840	820
Horses	29	28	28	27	27	27	28	28	29	30	32
Mules and Ashes	89	84	79	73	69	64	60	56	52	50	44
Goats	5667	5669	5621	5509	5422	5402	5346	5275	5180	5123	5010
Poultry	28714	30088	29134	30587	31566	31599	31949	29141	28022	29209	28262
Year	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**		
Dairy cattle	132	130	135	111	106	97	95	86	83		
Other Cattle	553	542	524	471	448	458	446	451	436		
Sheep	8778	8611	8481	8746	8680	8685	8909	8918	8931		
Buffalo	2.167	2.339	4.630	3.812	4.533	4.624	4.489	5.187	5.290		
Swine	793	761	724	714	698	694	720	706	699		
Horses	31	31	24	21	14	9	6	6	5		
Mules and Ashes	47	41	19	16	8	4	3	3	3		
Goats	4895	4782	4234	4127	3976	3956	3942	3949	3951		
Poultry	30804	31078	32362	32111	35857	35823	37605	39497	41459		

The distribution of Greek forests according to ownership status (***Table 2.2***), is the result of the interaction of historical, social, economic and political parameters. The high percentage of public forests and other wooded land (65.5%) is considered favourable, as it serves better the environmental and social role of forests.

Timber production coming from state and non-state forests has fallen considerably during the last years. This reduction, that is sharper in fuelwood category than in commercial harvest, is due mainly to the substitution of wood as heating source by liquid fuels and electricity, the urbanization and the low competitiveness of Greek timber in the international market.

Industrial roundwood in 2014 accounted for 5% of the total timber production and is considerably lower than fuelwood (68%). Sawlogs production is also smaller and accounts for 26% of the total yield.

Employment in the forestry sector refers to a total number of 3,579 permanent staff in 2011 in the Central and the Regional Forest Services. Wood harvest represents the main activity by means of total employment in the sector.

Table 2.2 Distribution of forest and other forest areas per type of ownership

	Forests (1000 ha)	Percentage %	Other wooded land (1000 ha)	Percentage %	Total forests area (1000 ha)	Percentage %
State	2200	65.5	2626	83.3	48.26	74.1
Community	403	12.0	183	5.8	587	9.0
Private	269	8.0	154	4.9	423	6.5
Other	487	14.5	190	6.0	677	10.4
Total	**3359**	**100.0**	**3154**	**100.0**	**6513**	**100.0**

Forestry is closely related to the economy of mountainous and semi-mountainous areas of the country. The contribution of forestry to GDP is low and decreased further over the last decade. The low contribution of the forest sector to the GDP is due to the fact that the forests of the country are of low productivity and their role is primary protective.

2.6.3 Secondary sector

The contribution of the secondary sector to the total gross value added decreases from 21.0 in 1990 to 15.8 in 2020. The structure of gross value added in the secondary sector presents relatively small changes (***Figure 2.10***). The contribution of Mining to the gross value added of the secondary sector is about 1.3%, of Construction 21.7%, of Energy industries 15.1% and of Manufacture about 61.9% in 2020.

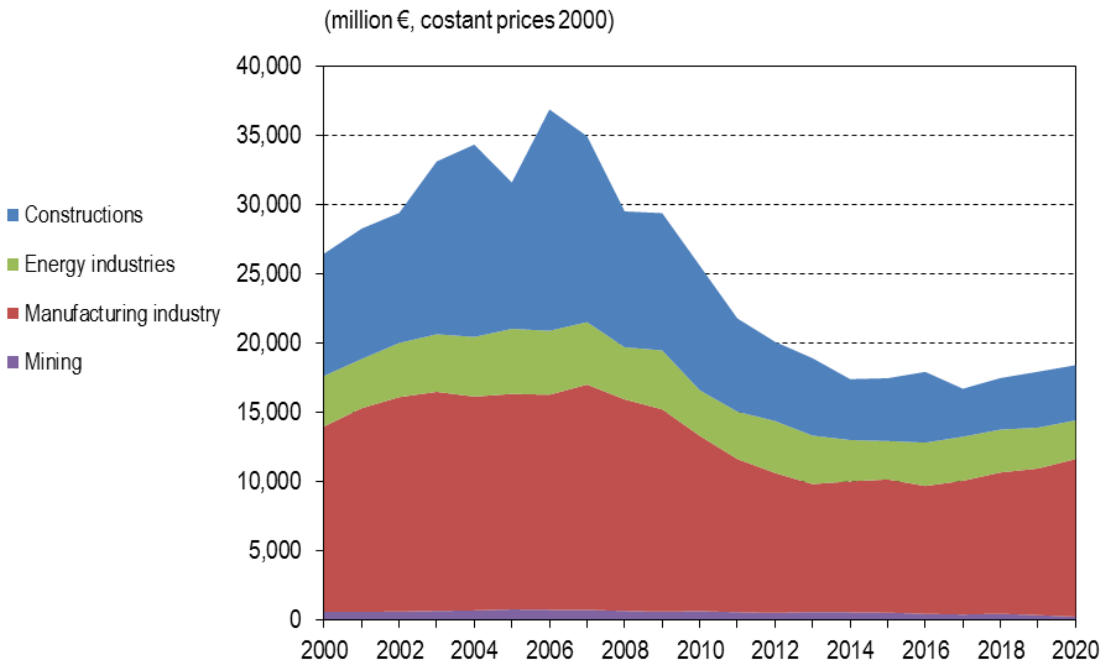

Figure 2.10 The structure of gross value added in the secondary sector for the period 2000 – 2020

Employment in the sector (***Table 2.3***) presents a similar to the gross value added trend. The total number of employees has decreased by 24.2% during the period 2000 – 2020, while the share of the secondary sector in total employment is about 13.4% of the economic active population.

2.6.3.1 Mining

The mining sector consist of two basic categories: mining / extraction of energy resources (i.e., lignite, crude oil and natural gas) and activities related to mining/quarrying of gravel and sand, chromites, nickel ores and other non-ferrous ores, marble, bauxite, clays and kaolin.

- In 2020, the gross value added of the mining sector decreased by 59.3% compared to 2000.
- Employment in the mining sector decreased by 33% compared to 2000.

Table 2.3 Employment in the secondary sector for the period 2000 – 2020 (thousands employees)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Mines	14	15	13	14	14	13	13	14	12	13
Manufacture	449	467	470	461	461	475	476	474	495	476
Energy Industry	61	59	57	52	53	52	53	53	52	50
Construction	295	301	313	340	344	365	365	389	386	369

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Mines	12	11	10	10	11	10	9	10	10	10	9
Manufacture	408	378	350	338	346	323	338	333	355	360	363
Energy Industry	55	56	54	55	60	58	61	59	58	60	60
Construction	278	241	207	203	204	195	197	191	193	192	189

2.6.3.2 Manufacture

The contribution of Manufacture to the gross value added of the secondary sector increases from 51% in 2000 to 62% in 2020. The structure of gross value added of Manufacture is presented in ***Figure 2.11***.

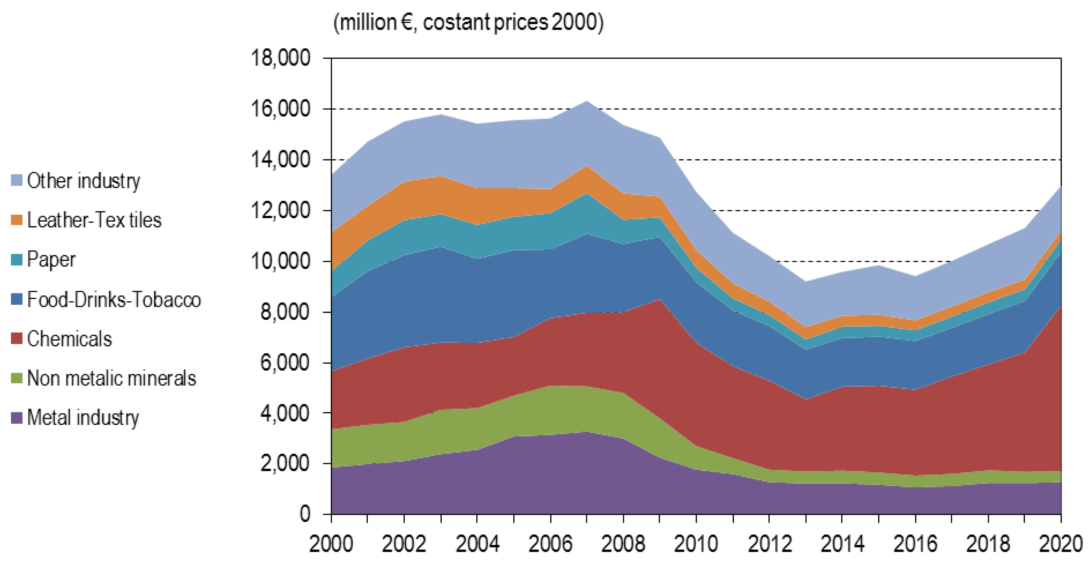

Figure 2.11 The structure of gross value added in Manufacture for the period 2000 – 2020

- In 2020, Chemicals (Mainly of Manufacture of coke and refined petroleum products) presented the highest contribution to the gross value added of Manufacture (50%), followed by the Food, Beverages and Tobacco (16%) and the Metal industry (18%).

- The industrial branches that presented a significant increase of their gross value added during the period 2000-2020, were those of Chemicals (increase by 187% from 2000 to 2020).
- The total industrial production index (base year 2010) for the period 2000-2020 is shown in ***Table 2.4***.

Table 2.4a Industrial production index for the period 2000-2009 (base year, 2015)

Branches	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Food	69.88	72.38	75.42	76.71	82.17	83.19	88.95	89.66	95.26	93.80
Beverages	69.82	73.74	76.06	79.21	83.20	84.85	87.38	89.49	94.29	97.33
Tobacco	77.78	83.08	87.17	88.73	90.14	90.75	93.23	97.25	97.97	103.31
Textiles	86.79	88.95	88.58	89.27	91.40	89.63	91.05	91.85	93.19	92.28
Clothing	85.49	88.40	89.87	92.23	95.20	95.50	95.60	96.26	97.38	98.32
Leather & footwear	75.75	79.81	81.97	83.92	85.56	85.50	86.09	88.57	89.63	91.23
Wood & cork	76.81	79.46	80.01	80.65	84.17	87.09	90.39	95.18	99.45	100.45
Paper & paper products	81.39	88.89	88.87	88.11	86.61	86.27	87.92	90.70	97.53	97.54
Printing & publishing	67.91	78.31	82.46	85.67	86.66	87.67	88.85	90.21	96.58	97.91
Petroleum & coal products	68.49	62.14	61.31	61.15	68.09	84.61	95.55	100.45	121.80	87.68
Chemicals	74.03	77.62	78.95	80.49	79.15	82.11	84.48	86.19	95.18	96.53
Plastics & rubber	73.66	77.48	78.18	80.14	79.68	84.14	87.29	89.34	93.80	94.96
Non-metallic minerals	71.78	75.81	78.45	78.50	80.86	82.84	86.35	91.39	97.17	99.12
Basic metals	70.55	71.91	70.70	70.78	74.09	77.95	84.00	89.17	93.13	90.93
Final metallic products	73.29	74.84	74.74	73.91	78.88	82.34	85.91	91.95	97.50	98.50
Machinery	89.25	92.71	93.63	94.12	93.57	94.05	96.44	97.91	99.34	99.70
Office & computing equipment	51.47	53.90	54.80	56.03	60.00	64.93	79.41	82.77	89.34	88.07
Electrical machines	89.29	91.87	93.12	91.30	91.49	91.97	93.46	98.10	100.30	101.23
Transport equipment	82.34	82.55	82.63	85.11	86.96	87.87	89.53	91.48	94.43	95.45
Other transport equipment	66.26	71.07	75.54	78.01	79.00	80.07	81.81	83.79	88.00	92.05
Furniture & other industries	80.35	82.58	83.78	84.61	86.73	89.36	92.07	95.44	97.74	100.46

Table 2.4b Industrial production index for the period 2010-2020 (base year, 2015)

Branches	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Food	93.75	96.70	97.91	99.75	99.98	100.00	99.62	100.28	99.46	99.09	99.73
Beverages	97.94	99.42	100.64	102.12	101.89	100.00	101.58	101.53	101.38	101.36	102.38
Tobacco	96.82	91.96	95.18	92.38	93.78	100.00	100.12	100.82	100.24	102.03	101.20
Textiles	92.97	98.25	98.02	98.25	97.75	100.00	101.04	101.21	101.48	101.99	103.37
Clothing	98.77	99.65	99.52	100.78	100.58	100.00	99.02	99.15	99.29	100.20	100.68
Leather & footwear	92.96	96.86	97.75	97.81	97.86	100.00	98.59	98.36	95.34	94.82	95.42
Wood & cork	101.93	102.45	103.55	102.99	101.78	100.00	99.14	99.88	100.30	101.15	104.22
Paper & paper products	98.85	102.39	101.56	101.30	101.11	100.00	98.41	98.10	98.37	98.95	98.53
Printing & publishing	97.03	98.16	99.22	98.93	99.17	100.00	100.05	99.41	99.49	100.07	99.73
Petroleum & coal products	115.62	147.18	164.25	153.10	140.98	100.00	83.32	100.48	119.80	118.21	78.11
Chemicals	92.20	95.77	98.60	100.26	99.33	100.00	98.52	99.36	100.26	100.67	99.99
Plastics & rubber	96.05	99.82	100.85	101.33	100.76	100.00	98.94	99.51	99.95	100.49	100.39
Non-metallic minerals	100.13	100.35	101.24	100.56	100.36	100.00	99.55	100.98	101.13	101.26	100.24
Basic metals	99.68	107.37	108.59	104.39	100.87	100.00	94.66	98.43	101.75	101.40	100.40
Final metallic products	100.02	100.30	100.61	100.43	99.96	100.00	100.14	100.88	103.19	103.07	104.24
Machinery	99.96	100.09	100.69	100.84	100.44	100.00	99.46	98.80	99.30	99.64	95.97
Office & computing equipment	101.37	108.36	105.99	101.03	98.71	100.00	94.90	100.43	100.09	103.85	101.98
Electrical machines	101.47	101.67	101.28	101.34	100.35	100.00	99.83	99.92	99.78	99.75	101.77
Transport equipment	96.10	97.01	98.38	98.61	99.50	100.00	100.47	100.73	100.99	100.99	101.67
Other transport equipment	93.17	94.39	98.41	100.09	101.24	100.00	100.00	100.00	100.00	100.40	99.88
Furniture & other industries	101.18	100.36	99.48	99.36	99.26	100.00	99.75	100.18	100.24	100.27	100.48

2.6.3.3 Construction

The contribution of Construction to the gross value added of the secondary sector decreased from 33.4% in 2000 to 21.7% in 2070 due to significant economic recession and its impact on this sector. The gross value added of the sector decreased with an average annual rate of 2.7% for the period 2000 – 2020. As a result, employment decreased by approximately 36% during the period 2000-2020 and by 52% during the period 2007-2020.

2.6.3.4 Energy industries

The contribution of Energy industries to the Gross Value Added of the secondary sector increased from 13.8% in 2000 to 15.1% in 2020. The technical characteristics of the sector are presented in the Paragraph 2.8 below.

2.6.4 Tertiary sector

The contribution of the tertiary sector to the total gross value added increased by 7% from 2000 to 2020, and in 2020 the gross value added of the sector constitutes 78% of the total. The structure of gross value added of the tertiary sector does not present important changes (***Figure 2.12***). The contribution of Trade, Hotels – Restaurants, Transport – Communication, Financial intermediation-Real estate and other services to the gross value added of the sector were 14.7, 13.0, 13.3, 30.8 and 28.2 % respectively.

Employment in the tertiary sector (***Table 2.5***) increased by 26% from 2000 until 2020. The share of the tertiary sector in the total employment increased from 65% of the economic active population in 2000 to 76% in 2020.

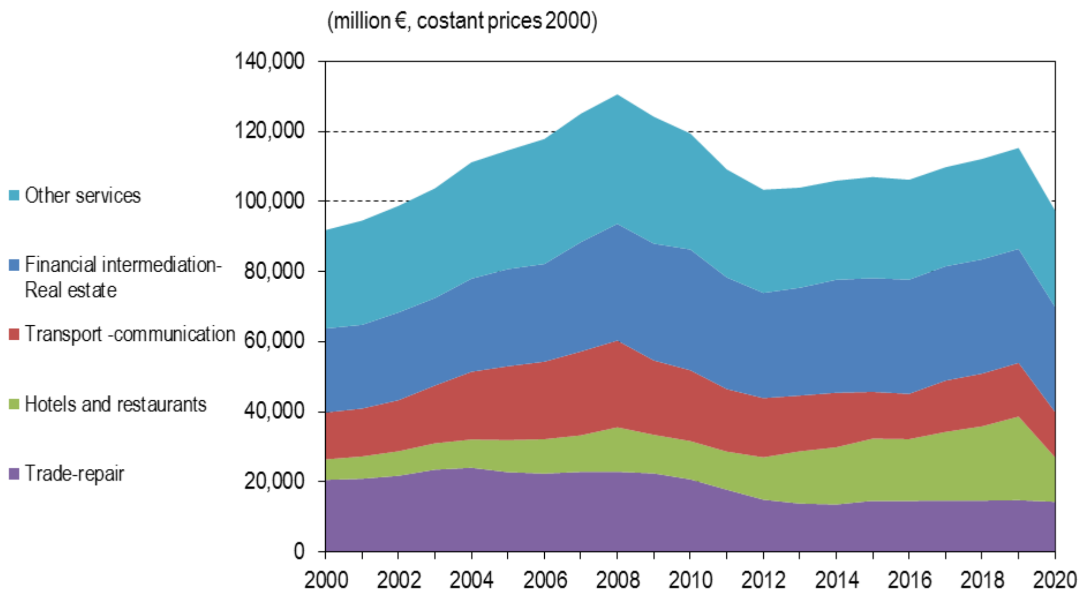

Figure 2.12 Structure of gross value added in the tertiary sector for the period 2000 – 2020

Table 2.5 Employment in the tertiary sector for the period 2000 – 2020 (thousands employees)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Wholesale and retail trade; repair of motor vehicles and motorcycles; transportation and storage; accommodation and food service activities	1514	1533	1570	1598	1646	1660	1694	1720	1744	1739
Information and communication	27	27	30	30	30	33	30	28	30	28
Financial and insurance activities	110	107	105	110	115	116	119	118	122	117
Real estate activities	6	7	8	10	13	13	12	12	14	13
Professional, scientific and technical activities; administrative and support service activities	167	182	200	203	225	230	242	243	257	261
Public administration and defence; compulsory social security; education; human health and social work activities	808	813	840	851	942	926	966	990	982	978
Arts, entertainment and recreation, repair of household goods and other services	171	175	198	212	215	214	218	222	234	243

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Wholesale and retail trade; repair of motor vehicles and motorcycles; transportation and storage; accommodation and food service activities	1752	1668	1596	1582	1669	1637	1765	1776	1897	1928	1877
Information and communication	30	32	29	31	30	31	30	29	31	32	30
Financial and insurance activities	114	110	109	106	100	104	103	99	102	100	98
Real estate activities	14	14	13	12	14	12	13	13	15	15	15
Professional, scientific and technical activities; administrative and support service activities	292	289	303	313	339	308	304	288	306	311	307
Public administration and defence; compulsory social security; education; human health and social work activities	1016	995	964	961	982	976	991	992	1013	1022	1035
Arts, entertainment and recreation, repair of household goods and other services	191	178	162	162	168	157	157	153	163	163	163

The tourist sector in Greece constitutes one of the main economic activities, as it generates wealth, creates jobs and contributes to the alleviation of economic problems in the less developed areas. Greek tourism contributes annually about 20.8% to the G.D.P., creates approximately 950,000 jobs and is a main tool of regional development for2019. Tourist arrivals range around 31,300,000 and the nights spent in tourist accommodations rise to about 92,400,000 per year.

The greek tourism sector is closely connected to climate quality, as to the nature-based resources. The seaside tourism and the nature-based tourism rely on a high diversity of landscapes, ecosystems, coastal areas and flagship species. In this regard 439 natural sites are legally protected (belonging at the "NATURA" European network and the network of special protection areas).

At the same time, the cultural heritage is a solid base for the creation and the expansion of the Greek tourist product. 18,000 listed monuments and archeological sites, many important museums and collections and 422 listed historical settlements form a main component of the Greek tourism product and the tourism identity.

2.7 Transportation

2.7.1 Road transport

Economic development and improved living standards of the previous decade have a significant effect on the ownership of passenger cars. The passenger cars fleet has almost tripled compared to 1990 levels, while an increase of the share of medium and larger size passenger vehicles is observed (from 27% in 1990, to 36% in 2008). In 1990, the number of passenger cars was 1.7 million cars (1 car for every 6 inhabitants), while in 2007 this figure reached 4.8 million cars. Similar trends are also observed for the number of trucks, buses and motorcycles.

This trend is shown to decelerate as a consequence of the economic crisis, although the percentage of car ownership in Greece is lower than the EU average. Moreover, the trend is expected to be affected more by the high taxation imposed on vehicles with engines over 2000cm^3 (in 2016, about 28% of passenger cars have an engine capacity greater than 2000cm^3).

The annual mileage driven by all vehicles categories during the whole time period 1990 –2020 is presented in the ***Figure 2.13***.

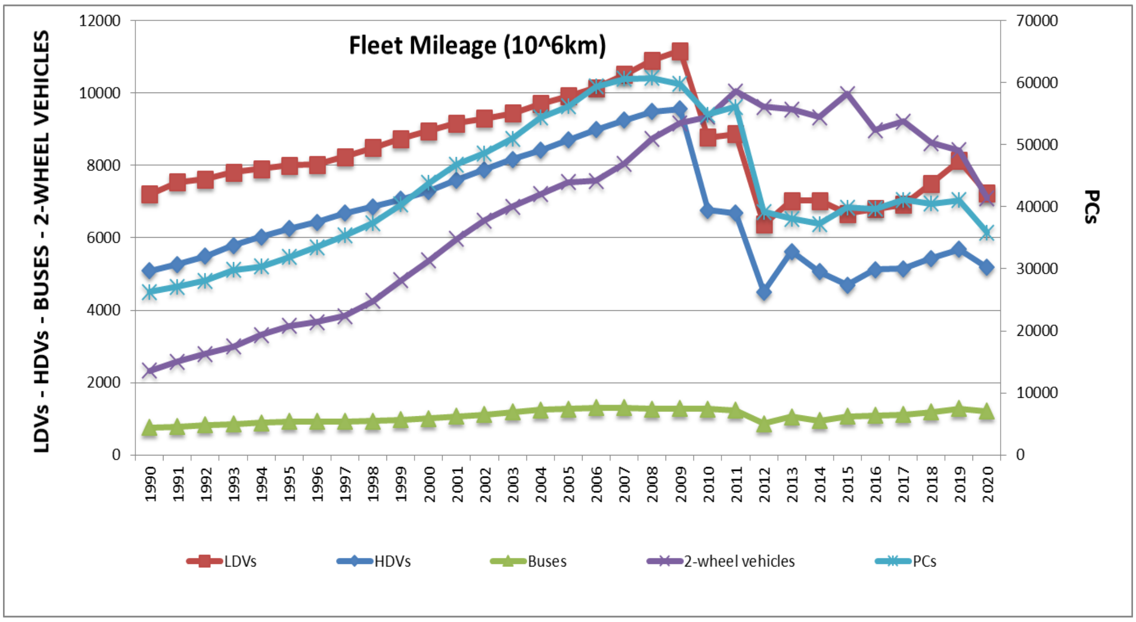

Figure 2.13 Annual mileage driven by all vehicles categories during the whole time period 1990 – 2020

Until 1992, Greece was the only country in Europe that prohibited the use of diesel passenger cars (excluding taxis). The reason for introducing such a measure was the increasing atmospheric pollution in Athens, caused, among others, by smoke and dust emitted by older technology and improperly serviced buses, trucks and taxis. In 1992, the Greek government introduced Law 2052/92, which allowed the use of diesel passenger cars up to 3.5 tons in Greece, except for the areas of Athens, Piraeus and Thessaloniki. Since 2011, diesel cars are allowed in all the Greek cities.

In 2015, a sharp increase of diesel passenger cars emissions was observed due to the fact that the old vehicles withdrawal programme was still running in Greece in 2015. As a result, a considerable incease of diesel vehicles, which are mostly preferred by consumers, was recorded and, given that these new vehicles are circulating much more than the older petrol engined vehicles, an increae of fuel consumption and the corresponding emissions was observed. However, this increasing trend of diesel vehicles in the small sector has started to change in 2017, as new technology low consumption gas vehicles have taken an important share in small cars market.

2.7.2 Shipping

The Greek maritime fleet is one of the largest in the world, and in 2017, it comprised of 4085 vessels (747 fly the Greek flag) of a total dead-weight tonnage of approximately 192.4 GRT, that represent the 16% of world shipping capacity and the 50% of EU. The merchant fleet is composed of ships of average age and specialises in "tramping", or going anywhere in the world on a single trip rather than travelling regular routes. Passenger ships (including ferries and cruise ships) are primarily used for transporting both goods and passengers to and from the numerous islands in the Aegean and Ionian Sea and to countries in the Mediterranean Sea.

2.7.3 Railways

The total length of the railway network in Greece is 2,909 km. Greece was the last European country to develop a railway system, which dates only from the 1880s. Over the last 30 years, the network has undergone an extensive modernization, the aims of which are the improvement of existing tracks, the standardization of metric gauges, the connection to the western European network and the coordination of the development with that of roads. Both the modernization and the extension of the system have proven costly and difficult mainly due to the complex topography of the mountainous region (Pindos Mountain) that divides the western and eastern parts of Greece.

The Strategic Investment Plan of the National Railways Organisation for the time period 2002 – 2012 foresaw the modernization of the railway network with the construction of double, electrified and remote controlled track on the PATHE axis (Patra - Athens – Thessaloniki – Idomeni) as well as the expansion of suburban railway in the wider area of Athens (to Corinthos, Livadia and Chalkida). Those investments enabled minimum speeds of 200 km/h and will reduce travelling times. As a result the share of railways to total passengers and goods transport is increase. The Railways Organisation had approximately 637 employees.

In 2019, a total of 19.6 million passengers were transported, of which 12.7 million used the suburban lines and 6.9 million the national network. A total of 1.3 million tonnes of goods were also transferred.

2.7.4 Air transport

According to the Civil Aviation Organisation data, aircraft traffic in 2016 (***Figure 2.14***) increased by 130% compared to 1990 data, reaching a number of Landing and Take-off (LTO) cycles of approximately 281000 (compared to 122000 in 1990). Passengers that embark and disembark in the airports of the country, mounted approximately at 56.0 millions in 2019. Since 2000 the number of passengers increased by approximately 4.6% annually.

The high decrease of 2020 is attributed to the Covid 19 pandemic.

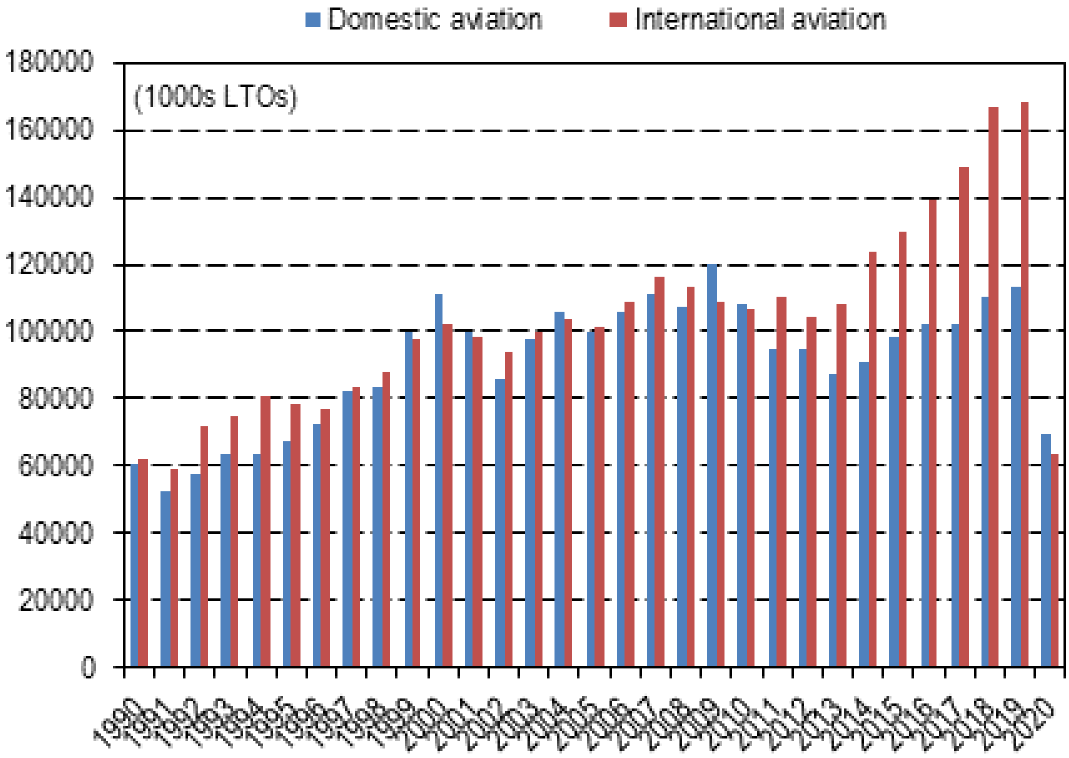

Figure 2.14 Domestic and international air traffic for the period 1990 – 2019

Concerning international traffic at the Athens airport, European airlines represent the highest share, followed by Asian, African, American and Australian airlines.

2.8 The Greek energy system

2.8.1 Energy supply

The energy sector relies on fossil fuel combustion for meeting the bulk of energy requirements in Greece. As shown in ***Figure 2.15***, gross inland consumption in 2020 amounted to approximately 920 PJ. The consumption of solid fuels and oil products accounts for 52.7% of total consumption, while the contribution of biomass and of the rest renewable energy sources (mostly hydropower, solar, wind energy and geothermal) are 5.3% and 8.1% respectively. Finally, the share of natural gas in gross inland consumption is 20.7%, while the rest of gross inland consumption is covered by electricity (net imports – exports). In 2020, gross inland consumption (including liquid, solid, gaseous and biomass fuels) decreased by approximately 14.7% compared to 1990. It should be mentioned that up to 1996 supply of natural gas was exclusively minor quantities from domestic primary production. In essence, the introduction of natural gas in the Greek energy system started in 1997 and since then its consumption has been continuously increasing.

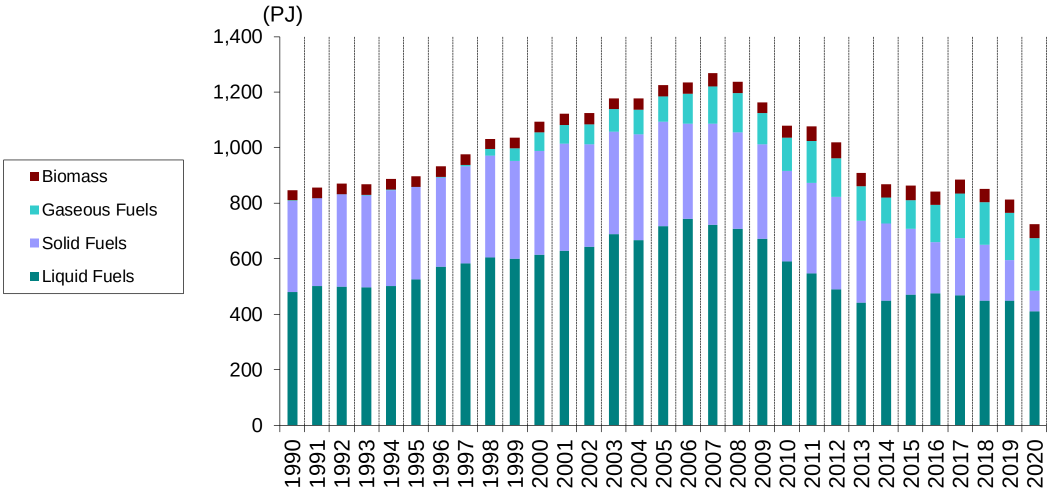

Figure 2.15 Gross inland consumption (in PJ) in Greece for the period 1990 - 2020

Import dependency (defined as the ratio of non-domestic energy supply to gross inland consumption) showed an upward trend during the period 1990 – 2015, increasing from 60% in 1990 to 74% in 2020, as a result of the increased demand for oil products and the penetration of natural gas.

The energy supply sector in Greece consists of (a) primary lignite production, (b) refineries, (c) transport and distribution of natural gas and (d) electricity generation.

(A) Lignite production

Lignite is a significant domestic energy source. It is a key strategic fuel and accounts for 13.7% of electricity production (in 2020). The lignite annual consumption was 13.6 million tonnes for 2019.

Production comes from opencast mines under operation in Peloponnese (Southern Greece) and Macedonia (Northern Greece).

Most of the lignite is used in the power sector. Electricity generated from lignite fell from 31 TWh in 2012 to less than 8 TWh in 2020, because of growth in renewable power sources and a lower overall electricity demand.

Lignite production decreased by 74% between 2012 and 2020, in line with the reduced demand for coal power generation.

Imported hard coal, almost all from the Russian Federation, is used in the cement sector. Industrial coal use accounted for 4% of the total coal consumption in 2020, a large drop from the high share of 20% in the mid-1980s, largely due to the decrease in coal consumption in the non-metallic minerals industry.

(B) Refineries

The Greek market of oil and petroleum products comprises four refineries, approximately 50 companies active in the marketing of petroleum products and a large number of retailers and gas stations. The companies which are activated in the marketing of petroleum products in Greece function as follows:

- They buy ready products from the country's refineries, which they either store in their own facilities or channel directly to the customers through filling stations or by delivery to their customers' production units.

- They import ready products from refineries abroad, which they store in their own facilities and then channel to customers.

Refinery gross output of oil products was 31 Mt in 2019.

Energy consumption in the refineries is based, to the extent possible, on intermediate products (low sulphur heavy fuel oil and refinery gas) while energy management practices are focused on energy conservation.

(C) Transport and distribution of natural gas

The decision for the introduction of natural gas into the Greek energy system was taken in an effort to ensure the modernisation and improvement of the energy balance, as well as the diversification of the country's energy sources. Natural gas is becoming an increasingly important fuel in Greece, rising to a share of 30% in power generation and 15% in the total primary energy supply (TPES) in 2020, and more than doubling its share in total final consumption over the last decade.

Most gas was imported from the Russian Federation, and Greece is planning to improve the security of supply through diversification of its supply sources by enhancing liquefied natural gas (LNG) imports and expanding its role as a gas hub for the South Eastern Europe gas market.

The construction of the required infrastructure (apart from the distribution networks) began in 1992 and is continuously improved. The National Natural Gas Transmission System transports gas from the Greek Bulgarian border (upstream TSO BULGARTRANSGAZ) and the Greek-Turkish border (upstream TSO BOTAS) to consumers in continental Greece. The basic infrastructure of the Greek system for the transportation, storage and distribution of natural gas includes:

- the main pipeline with a length of 512 km,
- the natural Gas transmission branches, 953.2 km in length, extend from the main pipeline, aiming at supplying the regions of Eastern Macedonia and Thrace, Thessaloniki, Platy, Trikala, Volos, Oinofyta, Antikyra, Aliveri, Korinthos, Megalopoli, Thisvi and Attica with natural gas.
- the terminal station of the liquefied natural gas, which includes two storage tanks with a total capacity of 225,000 m3. In July 2007, the revamping (expansion project) of the Liquefied Natural Gas (LNG) Terminal at Revythousa was completed, thus carrying out one of most significant investments in Greece’s energy infrastructure. With this revamping, the Terminal has the capacity to accept and handle triple the quantity of LNG than before and supply the National Transmission System with 5.2 -5.3 billion cubic meters annually.
- The expected length of the low pressure network, to cover the needs of major Greek cities is 6,500 km.

(D) Electricity generation

Electricity production in Greece increases continuously at an average annual rate of 3.4% for the period 1990 – 2008. For the years 2009-2010, it decreases at an average annual rate of 5.1% and increases at an average annual rate of 3.1% in 2011 and 2012. For years 2013 – 2014, it decreased by an average annual rate of 8.9%; and for years 2015-2017, it increased by an average annual rate of 3.1%. In 2019, it decreased by 12.7% compared to 2017. Gross electricity production in 2019 (48.3 TWh) was approximately 37.9% higher compared to 1990 levels (***Figure 2.16***).

Electricity generation from the use of fossil fuels was approximately 64.4% of electricity production in 2020. Specifically, 13.7% of electricity is produced by solid fuels (lignite), while the share of liquid fuels (diesel, heavy fuel oil and refinery gas) and natural gas is 9.7% and

39.8% respectively. The rest of electricity production, i.e. around 36.8%, derives from renewable energy sources as hydropower, wind energy, PVs and biogas.

The allocation of energy consumption by technology was made on the basis of Public Power Corporation (PPC) verified EU ETS reports on the installed capacity and the characteristics of electricity production plants. Therefore:

- Electricity production from lignite is produced exclusively by steam turbines.
- Natural gas is used mainly in combined cycle units and secondarily in gas turbines.
- Heavy fuel oil is used in gas turbines and in internal combustion engines (only in the islands' electricity systems).
- Diesel is used in gas turbines and in internal combustion engines in the islands' electricity systems.

The total installed electricity generating capacity of Greece is 18452 MW in 2020 (4337 MW lignite, 4982 MW NG, 3171 MW hydro and RES 5962).

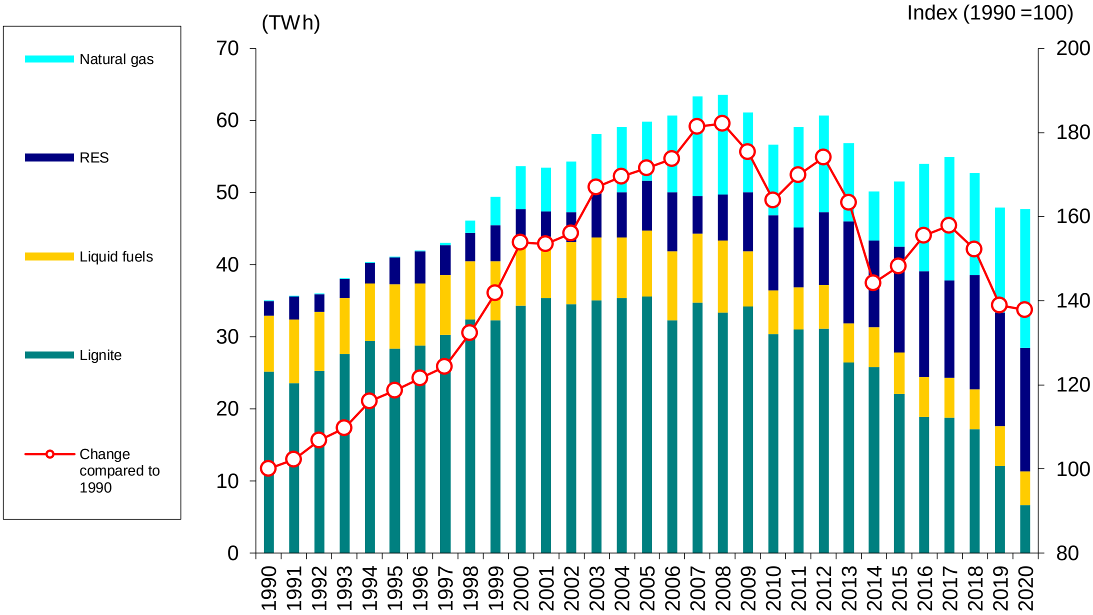

Figure 2.16 Gross electricity generation (in TWh) in Greece for the period 1990 – 2020

2.8.2 Final energy consumption

In 2020, final energy consumption in Greece totalled 14.4 Mtoe. The share of industry in final energy consumption is estimated at 17% in 2020, of transport at 36% while the share of residential and tertiary sector was 47.0%. The average annual rate of increase for the period 1990-2020 is estimated at 0.13%.

Residential and tertiary sector, transportation and industry sector decreased their energy use from 2010 to 2020 (***Figure 2.17***), 8%, 31% and 27% respectively. This resulted in a total decrease of 21% between 2010 and 2020.

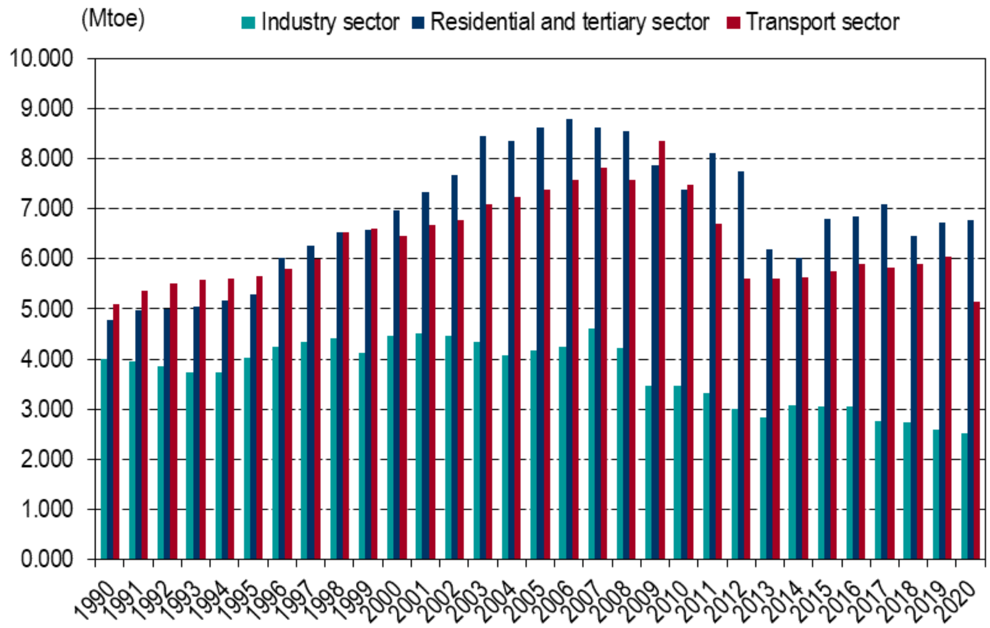

Figure 2.17 Final energy consumption (in Mtoe) by economic sector for the period 1990 – 2020

2.8.2.1 Industry

In 2020, the total energy consumption in industry totalled 2.5 Mtoe (***Figure 2.18***), accounted for 17.0% of the total energy demand in Greece.

The main structural changes regarding energy consumption in industry refer to the gradual replacement of petroleum products by coal products (a trend almost solely attributed to the increased use of steam coal by the cement industry) during the time period 1980–1995 and to the penetration of natural gas for thermal uses and for use as feedstock in the chemical industry.

In 2020, oil products accounted for approximately 27% of the total energy needs of the sector, compared to 52% in 1990 and 69% in 1980. Electricity consumption has steadily increased since 1990, and in 2020 it reached a total of approximately 1.0 Mtoe or 40% of the total energy use of the sector. The use of RES, mainly in food and wood processing industries, represents approximately 3-6% of total energy consumption in industry for the period 1990 – 2020.

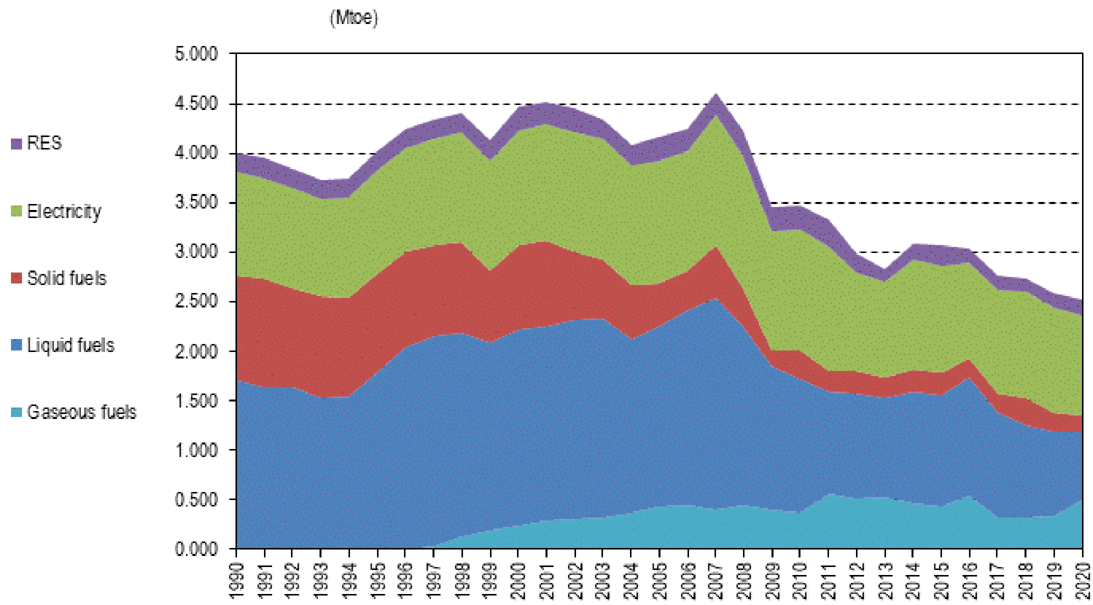

Figure 2.18 Energy consumption (in Mtoe) in industry for the period 1990 – 2020

2.8.2.2 Residential, tertiary sector and agriculture

In 2020, the energy use in the sector totalled 6.8 Mtoe or 47% of the total energy demand in Greece, compared to 4.79 Mtoe in 1990 (***Figure 2.19***). This energy was primarily used for space heating and cooling, and domestic hot water production in residential, public and commercial premises. Other energy uses were in the form of electricity for appliances/equipment and for the operation of building services systems in residential, public and commercial premises. The figure also includes energy use in agriculture (mainly for agricultural machinery).

The changes in the energy consumption of the sector reflect both the improving living standards of the Greek society and an increase in the number of dwellings. These two factors have resulted in improved levels of heating and, recently, of cooling, and a rise in the ownership of home electric appliances. The floor area of commercial premises has also increased substantially, thus contributing to an increase in electricity demand for ventilation, lighting and other office equipment.

The general upward trend of the energy demand, as illustrated in Figure 2.19, is mostly the result of an increased demand for electricity and to a smaller extent for petroleum products. In 2020, consumption of oil products accounted for 26% (1.75 Mtoe) of energy consumption in the sector from 54% in 1990 (2.7 Mtoe). The contribution of RES to total energy consumption in the sector increased from 15% in 1990 (0.7 Mtoe) to 20% in 2019 (1.37 Mtoe).

Until 1985, most of the biomass was used in the countryside as the primary energy source to meet the heating requirements of households and holiday homes. Since then, however, there is a gradual shift of biomass use from the countryside to large urban areas (as a secondary energy source). This change is the result of both the increasing population of the large cities in Greece and the renewed demand for the installation of fireplaces in both private residences and apartment buildings.

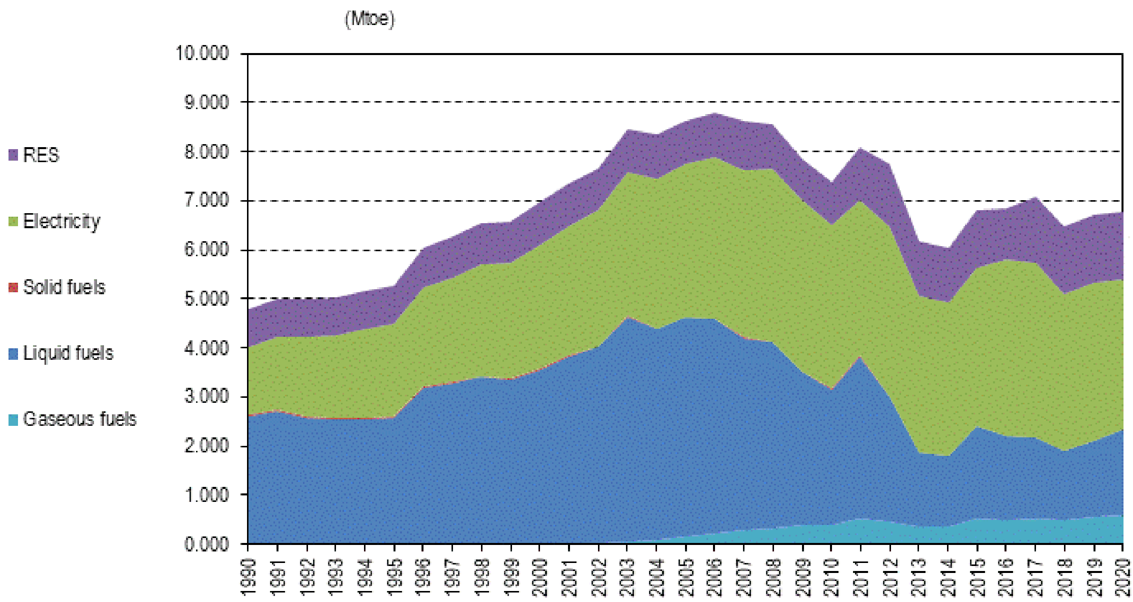

Figure 2.19 Final energy consumption (in Mtoe) in the residential, tertiary sector and in agriculture for the period 1990 - 2020

2.8.2.3 Transport

In 2020, energy consumption for transportation accounted for 5.1 Mtoe (5.1 Mtoe in 1990) or 36% of the total final energy demand in Greece. Oil products accounted for more than 95% of the final energy use. The energy use is in the form of gasoline consumption mainly by passenger cars, while other uses include diesel oil for trucking, maritime transport and railroads; jet fuel for aircraft; and smaller amounts of LPG and diesel oil used by taxis. Small amounts of steam coal are used exclusively by railroads (until 1996), while electricity covers the needs of the electric buses (trolleys) and of the metro that operate in the central Athens area.

2.9 Waste

2.9.1 Solid waste

Over the period 1990 – 2020, waste generation presented a continuous increase. Municipal solid waste generated quantities increased from 3.1 Mt in 1990 to 5.1 Mt in 2020, while the per capita solid waste generation increased from 0.82 kg/person/day in 1990 to 1.28 kg/person/day in 2020. The share of solid waste disposed in managed solid waste disposal sites (SWDS) has been noticeably increased since 1999 due to the construction of new SWDS, in the framework of the integrated national plan of solid waste disposal on land, developed according to the requirements of the Directive of the European Union 91/156/EEC. The main objectives of the plan is the gradual closure of all the unmanaged SWDS, the reduction of waste generation rates, the exploitation and re-use of the materials including energy recovery and the reduction of biodegradable wastes led to disposal sites according to the provisions of the Directive 99/31/EC.

Concerning the composition of waste in 2015, food waste make up the largest share with 42.0%, followed by paper 24.0%, plastic 18.9%, glass 4.12%, Textiles 3.25%, metal 3.35%, garden (yard) waste 1.5% and Wood 1%.

The amount of recycled wastes present a remarkable increase during the last years from 8% in 2000 to **22.4% in 2020** due to the recycle projects that are promoted in Athens and elsewhere.

Biogas recovery and flaring installations operate in 4 large SWDS in Greece (Athens, Thessalonika, Larissa, Halkis and Volos, which accept about 90% of waste disposed to SWDS.

Along with the municipal solid waste, certain amounts of industrial and Construction and demolition solid waste generated and are disposed at the same Solid waste disposal sites. It is estimated that for 2020 about 170 kt waste that were disposed in managed and unmanaged SWDS consisted mainly of by wood and organic non-food materials.

To date, sludge produced in waste water treatment plants is disposed in SWDS. Sludge disposed in the SWDS was estimated at approximately 36 kt annually, until 2020.

The hospitals in Greece have the obligation to dispose clinical wastes in incineration units In 2020 it is estimated that these units accepted approximately 2.7 kt of clinical waste.

2.9.2 Wastewater

The number of wastewater treatment plants (WWTP) has been increased considerably since 1999. The percentage of population of agglomerations with p.e.> 2.000 that is served by a WWTP increased from 32% in 1999 to 91% in 2020, in compliance with the Directive 91/271/EEC concerning the collection, treatment and discharge of the urban wastewater. The remaining 9% of the population is going to be served by a WWTP during the 4th Programming period. In Psyttalia wastewater treatment plant that serves approximately 4 millions of Attica population, the sludge produced is treated under anaerobic conditions resulting in the production of biogas. The biogas produced covers the energy needs of the wastewater treatment facilities, while the surplus is flared.

CHAPTER 3. GREENHOUSE GAS INVENTORY INFORMATION

3.1 Summary tables

This chapter summarizes greenhouse gas (GHG) emissions of Greece for the time period 1990–2020 as reported in the National Inventory Report submitted to the UNFCCC in 2022 (MEEN, 2020).

Emissions estimates were calculated according to the 2006 IPCC Guidelines, and 2013 Revised Supplementary Methods and the Good Practice Guidance Arising from the Kyoto Protocol. It is noted that base year emissions are calculated using 1990 as the base year for carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), and 1995 for fluorinated gases (F-gases: Hydrofluorocarbons, HFC / Perfluorocarbons, PFC / Sulphur hexafluoride, SF6) for KP accounting. The base year for the Convention target is 1990 for all gases.

An overview of GHG emissions for the time period 1990–2020 is presented in ***Table 3.1a*** and ***Table 3.1b***. The detailed CRF trend tables are presented in Annex II.

Total uncertainty for the 2020 emissions is estimated at 13.9% (including Land Use, Land Use Change and Forestry - LULUCF), while the uncertainty carried over into the GHG emissions trend is approximately 10.1% (MEEN, 2022). The uncertainty for GHG emissions per gas (including LULUCF), in 2020, was estimated at:

- 2.9% for CO_2 emissions,
- 24.5% for CH_4 emissions,
- 108.4% for N_2O emissions
- 263.6% for F-gases

It is noted that according to the IPCC Guidelines, emissions estimates for international marine and aviation bunkers were not included in the national totals, however they are reported separately as memo items.

KP base year GHG emissions for Greece (1990 for CO_2, CH_4, and N_2O – 1995 for F-gases) were estimated at 106.14 Mt CO_2 eq. Given that LULUCF was a net sink of GHG emissions in 1990 (and for the rest of the reporting period) the relevant emissions / removals are not considered in estimating base year emissions for Greece.

In 2020, GHG emissions (without LULUCF) amounted to 74.84 Mt CO2 eq showing a decrease of 27.66% compared to 1990 levels. If emissions / removals from LULUCF were to be included then the decrease would be 30.06%

- Carbon dioxide emissions accounted for 74.31% of total GHG emissions in 2020 (without LULUCF) and decreased by 33.35% from 1990. Methane emissions accounted for 12.94% of total GHG emissions in 2020 and decreased by 13.18% from 1990, while nitrous oxide emissions accounted for 5.70% of the total GHG emissions in 2020 and decreased by 43.00% from 1990. Finally, f-gases emissions (from production and consumption) that accounted for 6.89% of total GHG emissions in 2020 were increased by 24.91% from 1995 (base year for F-gases).

Table 3.1a Total GHG emissions in Greece (in kt CO_2 eq) for the period 1990-2004

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
A. GHG emissions per gas (excluding LULUCF)															
CO_2	83.438,04	83.407,50	84.975,65	84.284,96	86.430,26	86.963,20	89.114,95	93.801,56	98.621,79	97.934,81	102.973,17	105.361,86	105.000,51	109.066,73	109.485,28
CH_4	11.155,52	11.157,21	11.216,10	11.259,72	11.330,49	11.506,95	11.666,70	11.620,87	11.831,33	11.794,96	11.802,44	11.112,98	11.196,47	11.297,32	11.324,74
N_2O	7.481,08	7.344,18	7.179,67	6.625,65	6.494,28	6.705,26	6.874,48	6.714,43	6.632,92	6.584,45	6.368,83	6.231,85	6.182,28	6.112,73	6.117,42
HFC	1.182,82	1.400,08	1.149,07	2.032,44	2.712,11	4.157,38	4.820,17	5.166,49	5.767,51	6.721,13	5.261,86	4.781,52	5.090,33	4.733,65	4.928,27
PFC	190,26	191,19	187,74	112,94	70,31	62,85	53,73	125,64	155,48	105,31	122,26	84,10	88,29	89,28	87,86
SF_6	2,92889	3,01895	3,11129	3,19918	3,28936	3,42000	3,51120	3,55680	3,60240	3,69360	3,80760	3,87600	4,05840	4,05840	4,26360
Total	**103.450,64**	**103.503,18**	**104.711,35**	**104.318,91**	**107.040,73**	**109.399,06**	**112.533,54**	**117.432,53**	**123.012,64**	**123.144,35**	**126.532,37**	**127.576,19**	**127.561,94**	**131.303,76**	**131.947,82**
B. GHG emissions/removals from LULUCF															
CO_2	-2.177,04	-2.341,11	-2.491,25	-2.941,45	-2.673,77	-2.924,45	-2.329,34	-2.015,59	-1.936,32	-2.560,11	-2.175,92	-2.453,21	-2.787,65	-2.522,61	-2.489,12
CH_4	62,68	31,09	91,81	81,95	76,42	43,38	26,21	57,79	157,63	12,00	208,03	27,94	3,81	5,35	13,53
N_2O	6,46	4,92	10,66	10,73	10,84	8,70	8,07	11,50	20,40	9,20	26,54	13,16	11,95	12,86	14,47
Total	**-2.107,91**	**-2.305,10**	**-2.388,77**	**-2.848,77**	**-2.586,52**	**-2.872,37**	**-2.295,07**	**-1.946,29**	**-1.758,29**	**-2.538,91**	**-1.941,35**	**-2.412,11**	**-2.771,89**	**-2.504,41**	**-2.461,12**
C. GHG Emissions from International Transport															
CO_2	10.580,51	9.569,44	10.762,45	12.332,40	13.393,29	14.004,40	12.530,32	12.475,75	13.767,30	12.829,23	14.018,48	13.513,65	12.342,00	13.304,19	13.474,19
CH_4	17,09	15,33	17,62	20,62	21,76	23,02	20,54	20,62	23,27	20,63	23,94	23,62	21,19	21,91	22,17
N_2O	257,70	251,00	308,49	343,27	379,47	439,16	363,52	362,02	366,45	342,03	365,90	316,01	285,45	275,48	267,53
Total	**10855,29**	**9835,77**	**11088,56**	**12696,30**	**13794,52**	**14466,58**	**12914,38**	**12858,38**	**14157,02**	**13191,89**	**14408,32**	**13853,28**	**12648,64**	**13601,58**	**13763,90**

[1] Emissions / removals from *Land Use, Land Use Change and Forestry* are not included in national totals
[2] *Land Use, Land Use Change and Forestry* is not included

Table 3.1b Total GHG emissions in Greece (in kt CO2 eq) for the period 2004-2020

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
A. GHG emissions per gas (excluding LULUCF)																
CO_2	113.888,97	112.419,54	114.545,69	111.080,37	104.319,84	97.354,15	94.505,23	91.392,59	81.713,26	78.639,62	74.927,63	71.364,16	74.845,05	71.781,99	65.756,23	55.610,28
CH_4	11.407,33	11.482,28	11.362,41	11.241,70	10.864,03	11.082,19	10.936,97	10.776,02	10.533,54	10.340,35	10.145,94	9.797,52	10.096,52	10.217,07	9.991,41	9.685,20
N_2O	5.942,35	5.773,55	5.881,91	5.635,19	5.271,06	5.471,60	5.223,91	4.796,84	4.496,35	4.294,70	4.226,87	4.282,94	4.343,59	4.260,64	4.249,71	4.264,37
HFC	5.078,03	2.723,63	3.246,63	3.712,35	4.036,02	4.467,76	4.747,22	5.153,36	5.740,51	5.842,57	5.999,45	6.223,77	6.177,73	5.917,00	5.464,57	5.122,68
PFC	91,51	87,21	103,04	118,95	91,35	129,44	110,53	147,77	172,56	134,63	119,52	135,17	125,79	135,31	137,10	148,15
SF_6	6,15600	7,98000	9,46200	7,18200	5,01600	5,85960	5,13000	5,04857	5,15117	4,92154	5,06042	5,20201	5,01111	4,94269	4,92057	4,93861
Total	**136.414,35**	**132.494,19**	**135.149,15**	**131.795,74**	**124.587,31**	**118.511,01**	**115.528,99**	**112.271,63**	**102.661,38**	**99.256,79**	**95.424,48**	**91.808,76**	**95.593,70**	**92.316,96**	**85.603,94**	**74.835,61**
B. GHG emissions/removals from LULUCF																
CO_2	-3.308,21	-3.338,38	-1.826,78	-3.019,05	-3.103,80	-3.076,99	-3.166,00	-3.149,19	-1.614,72	-150,80	-3.745,52	-3.521,90	-3.282,72	-4.066,24	-3.164,36	-3.987,55
CH_4	10,54	20,96	321,27	43,55	46,16	16,41	17,81	43,71	16,00	9,40	10,81	31,67	18,55	19,42	77,68	18,71
N_2O	14,76	16,44	42,11	20,12	20,80	17,50	16,93	19,36	16,55	15,63	15,52	16,96	15,73	15,95	20,84	15,83
Total	**-3.282,91**	**-3.300,98**	**-1.463,40**	**-2.955,37**	**-3.036,83**	**-3.043,08**	**-3.131,25**	**-3.086,12**	**-1.582,16**	**-125,78**	**-3.719,19**	**-3.473,26**	**-3.248,44**	**-4.030,87**	**-3.065,85**	**-3.953,00**
C. GHG Emissions from International Transport																
CO_2	11.815,09	12.727,53	13.103,79	12.862,32	11.147,83	11.373,02	11.652,07	9.727,87	9.382,76	8.878,27	8.657,31	8.664,95	10.401,69	10.995,10	12.239,22	6.744,60
CH_4	19,89	21,52	22,09	21,68	18,35	19,06	19,56	16,00	15,09	13,22	12,52	12,06	15,12	15,62	17,92	11,15
N_2O	223,68	235,55	227,13	216,42	196,01	206,56	195,71	167,63	171,56	160,30	172,75	175,45	198,25	197,32	227,54	169,19
Total	**12058,66**	**12984,61**	**13353,01**	**13100,42**	**11362,19**	**11598,64**	**11867,34**	**9911,50**	**9569,40**	**9051,78**	**8842,57**	**8852,46**	**10615,06**	**11208,05**	**12484,68**	**6924,94**

1) Emissions / removals from *Land Use, Land Use Change and Forestry* are not included in national totals

2) *Land Use, Land Use Change and Forestry* is not included

GHG emissions trends (excluding LULUCF) were mainly driven by economic development during the period 1990-2000. However, as presented in ***Figure 3.1***, since 2000 a decoupling of GHG emissions from economic development is observed as the annual growth rate of GHG emissions for the period 2000 – 2007 (approximately 1.0%) is lower from both the annual growth rate of gross inland energy consumption (approximately 1.64% for the same period) and the GDP annual growth rate (approximately 4.6%). Moreover, the impact of population increase to GHG emissions was minor. The decreasing trend of emissions in all sectors of energy of the years 2008-2016 is attributed among others (i.e. RES, energy efficiency measures, road infrastructure and public transportation improvements, etc.) to the economic recession that the country is facing. For the period 2017-2019, although GDP slightly increases, GHG emissions continue the decreasing trend. This overall decrease is attributed to the impact of environmental measures adopted, i.e. RES, energy efficiency measures, road infrastructure and public transportation improvements, etc. For 2020 decreasing trend of all parameters is attributed to the Covid 19 pandemic.

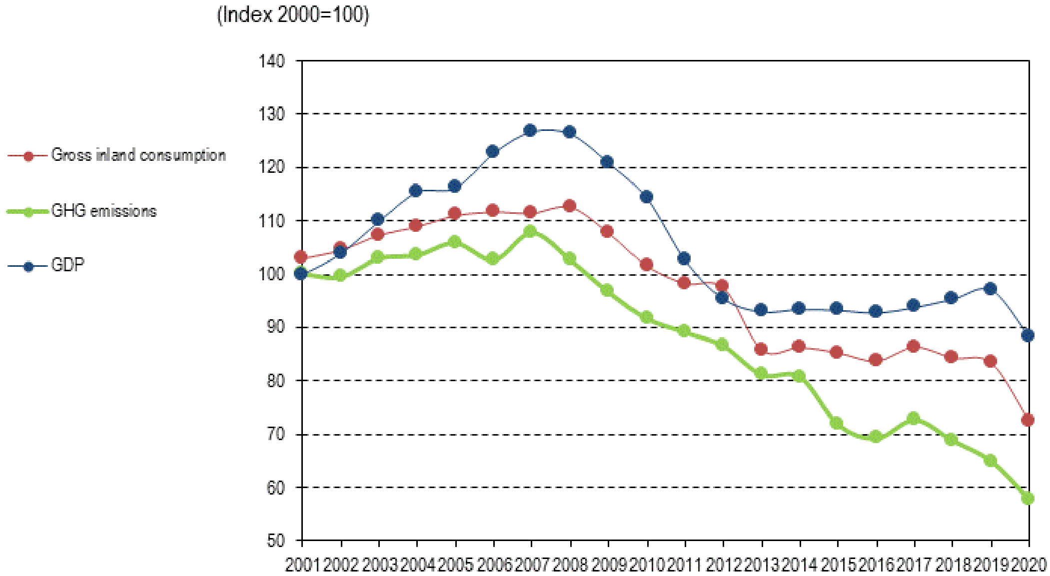

Figure 3.1 Factors underlying GHG emissions trends

3.2 GHG emissions trends

3.2.1 GHG emissions trends per sector

GHG emissions by sector for the period 1990 - 2020 are presented in ***Table 3.2a*** and ***Table 3.2b***, and in ***Figure 3.2*** to ***Figure 3.6***, while the sectoral contribution to GHG emissions for 2020 (excluding LULUCF) is presented in ***Figure 3.7***.

Table 3.2a Total GHG emissions in Greece (in kt CO_2 eq) for the period 1990-2004

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Energy	77.039,30	77.152,37	79.129,39	78.775,85	81.013,21	81.074,89	83.290,17	87.829,80	92.555,84	91.992,42	96.771,29	99.225,52	99.079,97	102.964,64	103.408,78
IPPU	11.277,14	11.213,59	10.644,27	11.095,23	11.686,78	13.603,11	14.371,56	14.852,33	15.569,50	16.406,07	15.193,13	14.592,36	14.778,45	14.539,11	14.690,42
Agriculture	10.269,39	10.296,61	9.998,70	9.456,84	9.196,99	9.570,07	9.621,43	9.537,92	9.496,47	9.401,02	9.211,99	9.184,27	9.174,88	9.146,09	9.187,85
Waste	4.864,81	4.840,61	4.938,99	4.990,99	5.143,76	5.151,00	5.250,38	5.212,48	5.390,82	5.344,85	5.355,96	4.574,03	4.528,64	4.653,92	4.660,76
Total [1)]	**103.450,64**	**103.503,18**	**104.711,35**	**104.318,91**	**107.040,73**	**109.399,06**	**112.533,54**	**117.432,53**	**123.012,64**	**123.144,35**	**126.532,37**	**127.576,19**	**127.561,94**	**131.303,76**	**131.947,82**
LULUCF	**-2.107,91**	**-2.305,10**	**-2.388,77**	**-2.848,77**	**-2.586,52**	**-2.872,37**	**-2.295,07**	**-1.946,29**	**-1.758,29**	**-2.538,91**	**-1.941,35**	**-2.412,11**	**-2.771,89**	**-2.504,41**	**-2.461,12**
Index per sector															
Energy	100,00	100,15	102,71	102,25	105,16	105,24	108,11	114,01	120,14	119,41	125,61	128,80	128,61	133,65	134,23
IPPU	100,00	99,44	94,39	98,39	103,63	120,63	127,44	131,70	138,06	145,48	134,73	129,40	131,05	128,93	130,27
Agriculture	100,00	100,27	97,36	92,09	89,56	93,19	93,69	92,88	92,47	91,54	89,70	89,43	89,34	89,06	89,47
Waste	100,00	99,50	101,52	102,59	105,73	105,88	107,93	107,15	110,81	109,87	110,10	94,02	93,09	95,67	95,81
Total [2)]	**100,00**	**100,05**	**101,22**	**100,84**	**103,47**	**105,75**	**108,78**	**113,52**	**118,91**	**119,04**	**122,31**	**123,32**	**123,31**	**126,92**	**127,55**

1) Emissions / removals from *Land Use, Land Use Change and Forestry* are not included in national totals

2) *Land Use, Land Use Change and Forestry* is not included

Table 3.2b Total GHG emissions in Greece (in kt CO_2 eq) for the period 2004-2020

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Energy	107.254,72	105.947,54	108.192,82	105.296,11	100.327,90	93.148,01	92.027,48	88.303,56	77.926,11	74.490,58	71.186,14	66.966,27	70.257,34	67.303,30	61.252,94	51.622,90
IPPU	15.432,05	12.748,21	13.184,95	13.002,12	11.271,23	11.759,57	10.387,88	11.207,11	11.942,97	12.307,11	11.967,30	12.498,15	12.784,89	12.383,00	11.700,79	10.485,79
Agriculture	8.969,24	8.869,28	9.018,77	8.730,78	8.500,37	8.834,31	8.576,44	8.451,28	8.383,73	7.990,54	7.821,38	7.833,46	7.860,40	7.791,80	7.781,37	7.846,37
Waste	4.758,33	4.929,16	4.752,61	4.766,73	4.487,82	4.769,11	4.537,20	4.309,69	4.408,57	4.468,55	4.449,66	4.510,88	4.691,07	4.838,86	4.868,83	4.880,55
Total [1)]	**136.414,35**	**132.494,19**	**135.149,15**	**131.795,74**	**124.587,31**	**118.511,01**	**115.528,99**	**112.271,63**	**102.661,38**	**99.256,79**	**95.424,48**	**91.808,76**	**95.593,70**	**92.316,96**	**85.603,94**	**74.835,61**
LULUCF	**-3.282,91**	**-3.300,98**	**-1.463,40**	**-2.955,37**	**-3.036,83**	**-3.043,08**	**-3.131,25**	**-3.086,12**	**-1.582,16**	**-125,78**	**-3.719,19**	**-3.473,26**	**-3.248,44**	**-4.030,87**	**-3.065,85**	**-3.953,00**
Index per sector																
Energy	139,22	137,52	140,44	136,68	130,23	120,91	119,46	114,62	101,15	96,69	92,40	86,92	91,20	87,36	79,51	67,01
IPPU	136,84	113,04	116,92	115,30	99,95	104,28	92,11	99,38	105,90	109,13	106,12	110,83	113,37	109,81	103,76	92,98
Agriculture	87,34	86,37	87,82	85,02	82,77	86,03	83,51	82,30	81,64	77,81	76,16	76,28	76,54	75,87	75,77	76,41
Waste	97,81	101,32	97,69	97,98	92,25	98,03	93,27	88,59	90,62	91,85	91,47	92,72	96,43	99,47	100,08	100,32
Total [2)]	**131,86**	**128,07**	**130,64**	**127,40**	**120,43**	**114,56**	**111,68**	**108,53**	**99,24**	**95,95**	**92,24**	**88,75**	**92,41**	**89,24**	**82,75**	**72,34**

[1)] Emissions / removals from *Land Use, Land Use Change and Forestry* are not included in national totals

[2)] *Land Use, Land Use Change and Forestry* is not included

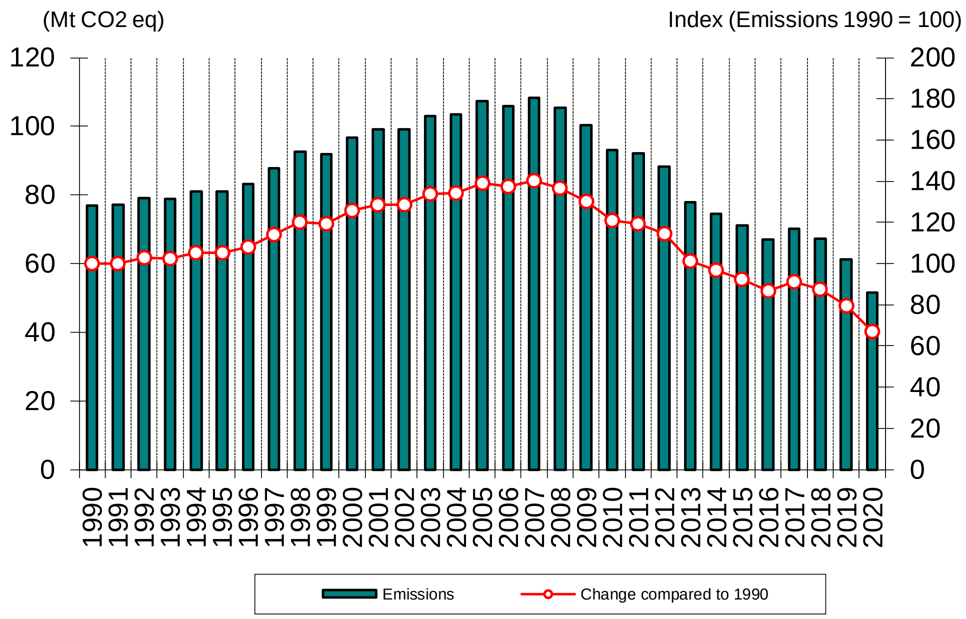

Figure 3.2 Total GHG emissions from Energy (in Mt CO2 eq) for the period 1990 – 2020

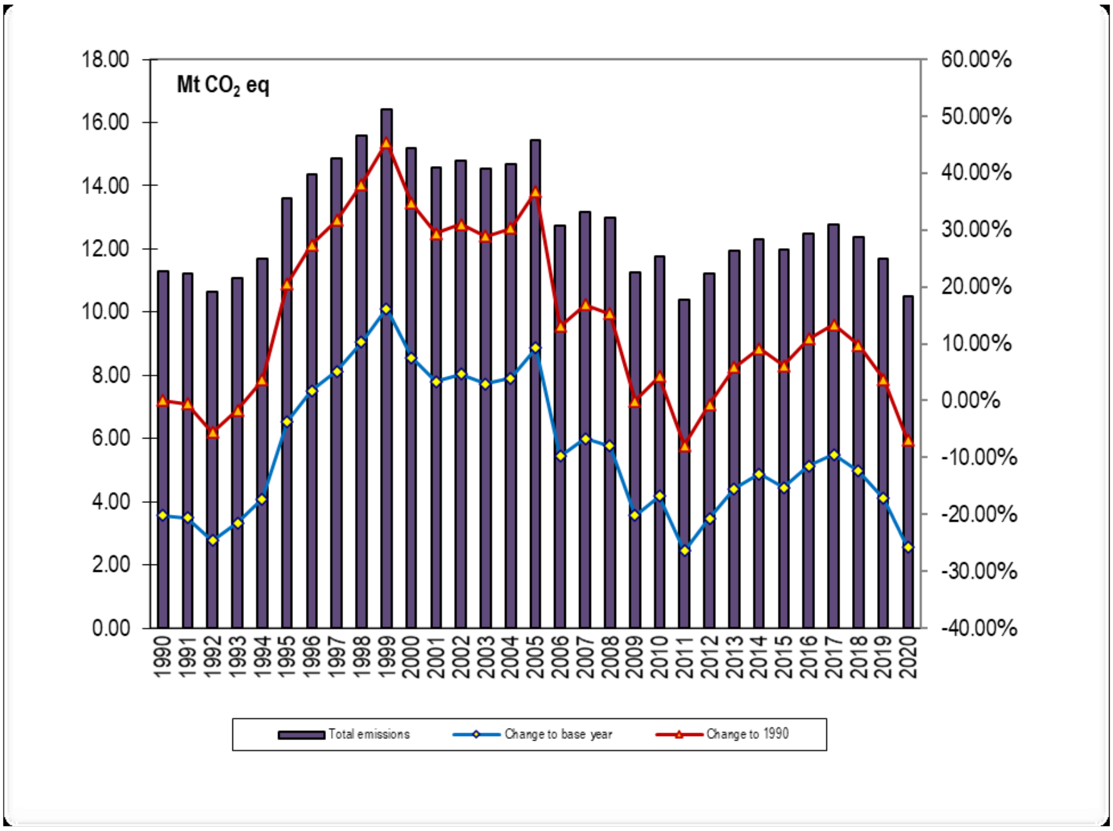

Figure 3.3 Total GHG emissions (in Mt CO2 eq) from Industrial Processes for the period 1990 – 2020

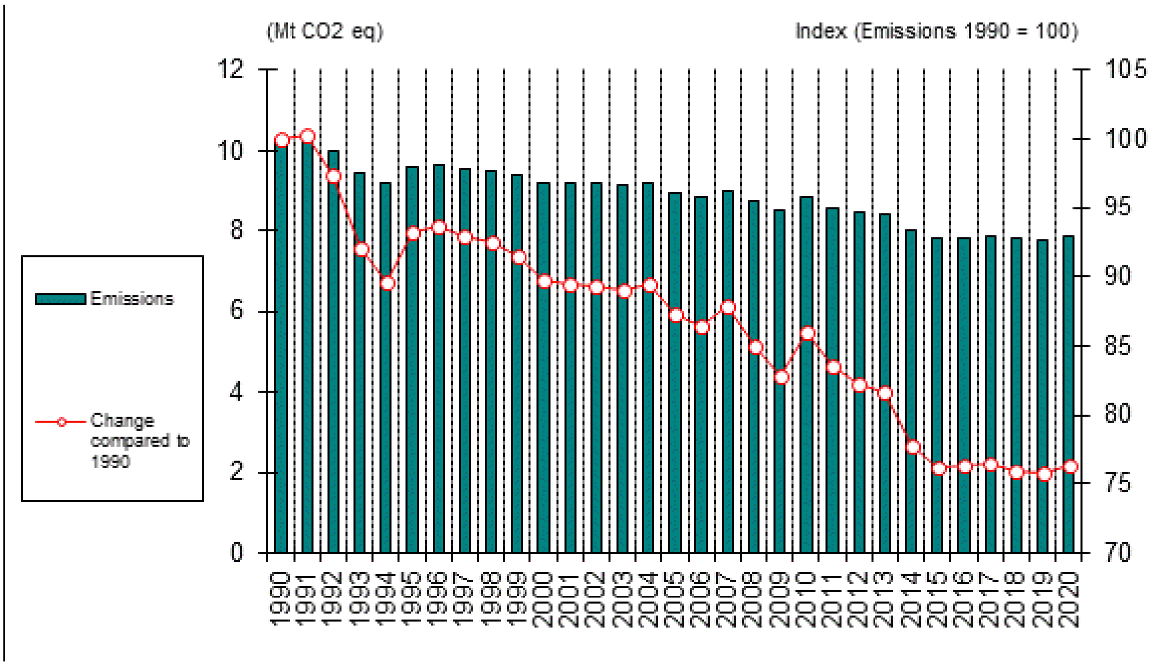

Figure 3.4 Total GHG emissions (in kt CO2 eq) from Agriculture for the period 1990 – 2020

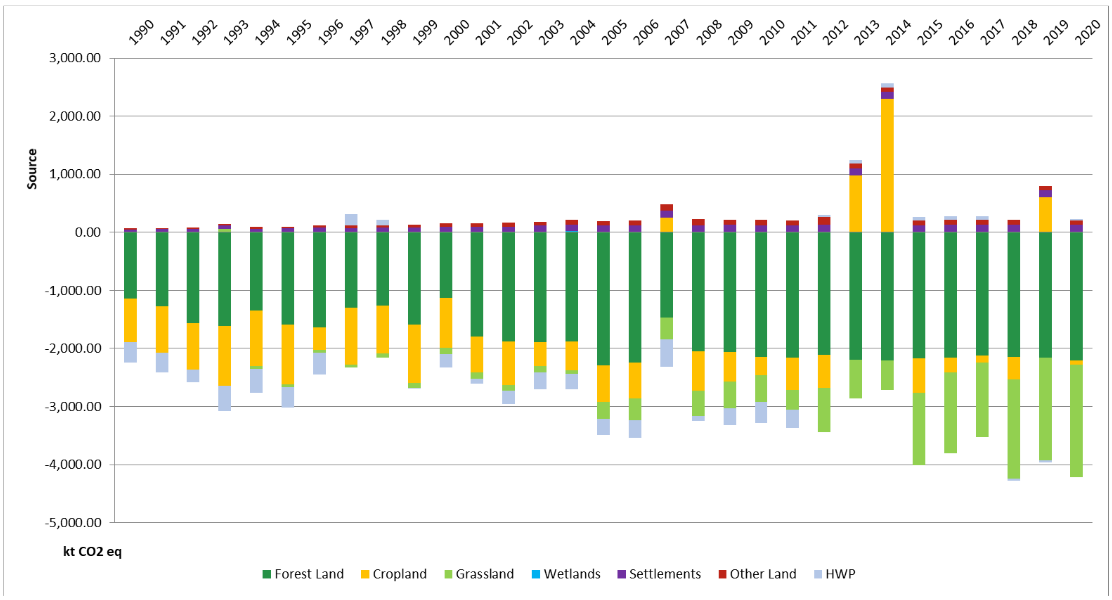

Figure 3.5 Net GHG emissions / removals (in kt CO2 eq) from the Land Use, Land Use Change and Forestry sector by category for the period 1990 – 2020

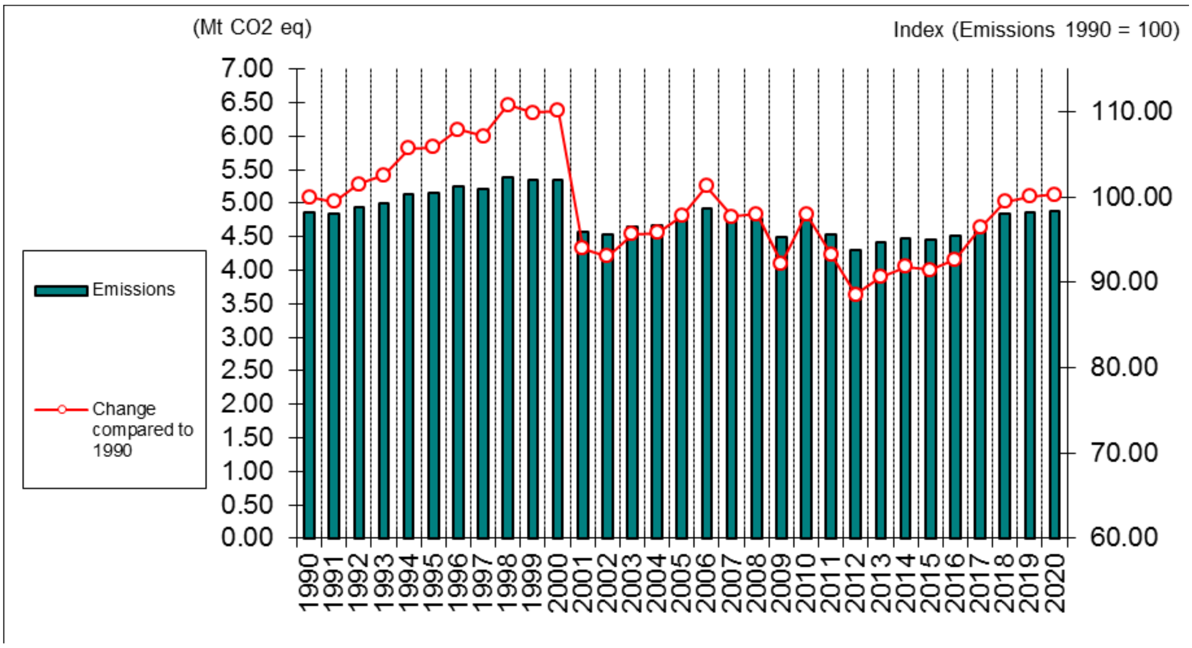

Figure 3.6 Total GHG emissions (in kt CO2 eq) from Waste for the period 1990 – 2020

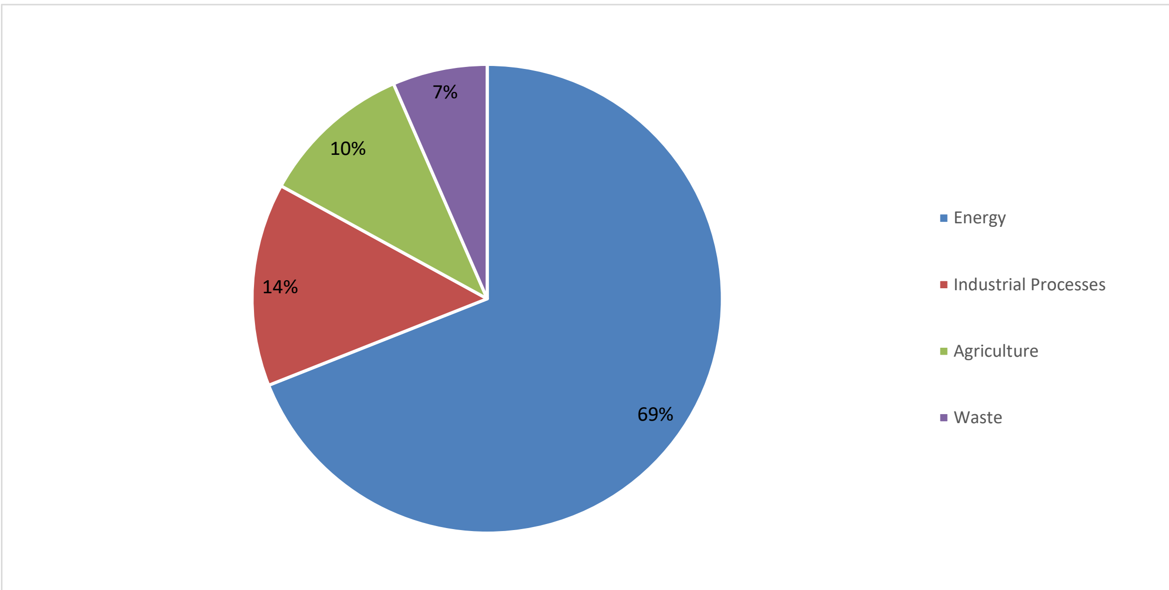

Figure 3.7 Contribution of activity sectors to total GHG emissions (without LULUCF) in 2020

- Emissions from Energy in 2020 accounted for 68.98% of total GHG emissions (without LULUCF) and decreased by approximately 33% compared to 1990 levels.
- The living standards improvement, due to the economic growth, the important growth of the services sector and the introduction of natural gas in the Greek energy system represent the basic factors affecting emissions trends from Energy for the period 1990 – 2007. A reduction of emissions is observed by 41.9% in 2020 compared to 2008, due to the economic recession at the beginning of the period, but also due to measures as the increase of RES and NG share of the energy mixture, along with energy efficiency improvement actions.

- The living standards improvement resulted in an increase of energy consumption and particularly electricity consumption (mainly in the residential – tertiary sector), passenger cars ownership and transportation activity. The increase of electricity consumption led not only to the increase of direct emissions (due to combustion for electricity generation) but also of fugitive methane emissions from lignite mining.
- At the same time total CO2 emissions per electricity produced have decreased mainly as a result of the introduction of the natural gas and RES into the electricity system. It should be mentioned that the availability of hydropower has a significant effect to emissions trends. For instance, the significant increase of electricity demand in 1999 was not followed by a similar increase of emissions because of the penetration of natural gas and the high availability of hydropower.
- The majority of GHG emissions (47.43%) in 2020 derived from energy industries, while the contribution of transport, manufacturing industries and construction and other sectors is estimated at 29.75%, 8.63% and 12.76% respectively. The rest 0.86% and 0.58% of total GHG emissions from Energy derived from fugitive emissions from fuels and other (mobile).
- Within the fuel combustion activities, the only sector with increased emissions compared to 1990 is transport, showing an increase of 5.78%. Emissions from energy industries, manufacturing industries and construction and other sectors (i.e. residential, tertiary and agriculture sectors) had decreased by around 47.43%, 52.64% and 23.90%, respectively, compared to 1990. The decrease in the other sectors is noticeable during the recent years. Finally, fugitive emissions from fuels decreased by 63.48% for the period 1990 – 2020.
- In total, GHG emissions from transport in 2020 increased by approximately 5.5% compared to 1990 emissions (from 14.52 Mt CO2 eq in 1990 to 15.58 Mt CO2 eq in 2020). In 2020, the majority of GHG emissions derived from road transport, the contribution of which increased from 83% in 1990 to approximately 86.96% of total emissions of the sector, as a result of two contradictory parameters: a) the significant increase of the number of vehicles in the country and b) the considerable progress in antipollution technology of the vehicles engines. The share of internal navigation in the emissions of the transport sector fluctuated from 13% in 1990 to 11.46% in 2020. Additionally, internal aviation has a contribution of the order of 1.4% in 2020, while the contribution of railways decreased from 1.4% in 1990 to less than 0.17% in 2020. The contribution of other transport (pipeline transportation) is negligible.
- The living standards improvement resulted in increase of passenger cars ownership and transportation activity. The economic development of the period 1990-2010 had a significant effect on the ownership ofpassenger cars. The passenger cars fleet was almost tripled compared to 1990 levels, while an increase of the share of medium and larger size passenger vehicles is observed (from 27% in 1990, to 36% in 2008). In 1990, the number of passenger cars was 1.7 million cars (1 car for every 6inhabitants), while in 2007 this figure reached 4.8 million cars. Similar trends are also observed for the number of trucks, buses and motorcycles. This trend is shown to decelerate as aconsequence of the economic crisis, although the percentage of car ownership in Greece is lower than the EU average.
- However, negative impact on the GHG emmisions decrease in the period 2010-2020 has the age of passenger car fleet in Greece which increased due to the economic crisis and the weakness of Greeks to replaced their old car (40 per cent

of passenger cars are more than 20 years old). This phenomenon was aggravated more by the high taxation imposed on vehicles with engines over 2000 cm^3.

- Fugitive emissions from coal mining and handling (CH4 emissions) are a key category. CH4 emissions from the mining of lignite in 2020 account for 0.4% of total GHG emissions. A 72.9% decrease for the period 1990 – 2020 is observed. This decrease is attributed to the gradual phasing-out of lignite-fired power plants in recent years. According to the NECP of Greece, there is an undergoing plan for the phasing-out of all but one lignite-plants by 2023. The remaining plant will be converted to NG by 2028.
- GHG emissions from activities related to primary production (extraction), processing, storage and transmission/ distribution of crude oil, petroleum products and natural gas included in Fugitive emissions, in 2020 accounted for 0.26% of total GHG emissions. Overall, emissions in 2020 increased by about 71.2% compared to 1990 levels. The parameters affecting GHG emissions trends from oil and natural gas are the gradual penetration of natural gas in the Greek energy system and the domestic production of crude oil and natural gas. The introduction of natural gas in the Greek energy system started in 1996 and at the moment its development is in progress. The domestic production of crude oil and natural gas present a continuous decreasing trend and as a result emissions from venting and flaring are decreasing.
- Emissions from Industrial Processes and Product use in 2020 accounted for 14.01% of the total emissions (excluding LULUCF) and decreased by 7.02% compared to 1990 levels. Emissions from IPPU are characterized by intense fluctuations during the period 1990 – 2020 reaching a minimum value of 10.39 Mt CO2 eq in 2011 and a maximum value of 16.41 Mt CO2 eq in 1999. The low value for 2011 is directly related to the effects of the economic recession whereas the maximum value is attributed to changes in industrial production and especially in HCFC-22 production. It should be noted that had it not been for the consumption of f-gases subcategory, the decrease of the recent years would have been much deeper.
- Emissions from Agriculture that accounted for 10.48% of total emissions in 2020 (without LULUCF), decreased by approximately 23.59% compared to 1990 levels. Emissions reduction is mainly due to the reduction of N2O emissions from agricultural soils, because of the reduction in the use of synthetic nitrogen fertilizers and animal population. The decrease in the use of synthetic nitrogen fertilizers is attributed to the increase of organic farming, the high price of fertilizers and the impact of initiatives to promote good practice in fertilizer use. The changes of the rest determining parameters of GHG emissions from the sector (e.g. crops production etc.) have a minor effect on GHG emissions trend.
- Emissions from the Waste Sector (6.52% of the total emissions, without LULUCF), increased by approximately 0.32% from 1990. Living standards improvement resulted in an increase of the generated waste and thus of emissions since 1990. However, the increase of recycling along with the exploitation of the biogas produced limits the increase of methane emissions. At the same time, emissions from wastewater handling have considerably decreased, due to the continuous increase of the population served by aerobic wastewater handling facilities.
- The Land Use, Land-Use Change and Forestry sector was a net sink of greenhouse gases during the period 1990 – 2020. The sink capacity of the LULUCF sector fluctuates between -0.13 Mt CO2 eq. and -4.03 Mt CO2 eq., showing fluctuations in trend. This is the result of the decrease of the sink

capacity of the Cropland category on the one hand, and the increase of the sink capacity of the Forest Land category on the other.

3.2.2 GHG Emissions trends per gas

3.2.2.1 Carbon dioxide

Total CO2 emissions decreased from 83.44 Mt in 1990 to 55.61 Mt in 2020 (without LULUCF). The decrease of 33.35% from 1990 to 2020 follows the trends of energy sector.

CO2 emissions from Energy decreased, from 74.66 Mt in 1990 to 50.52 Mt in 2020, presenting a total decrease of 32.35% from 1990 to 2020. Carbon dioxide emissions from Industrial processes and product use in 2020 decreased by 41.94% compared to 1990 levels.. (***Figure 3.8***).

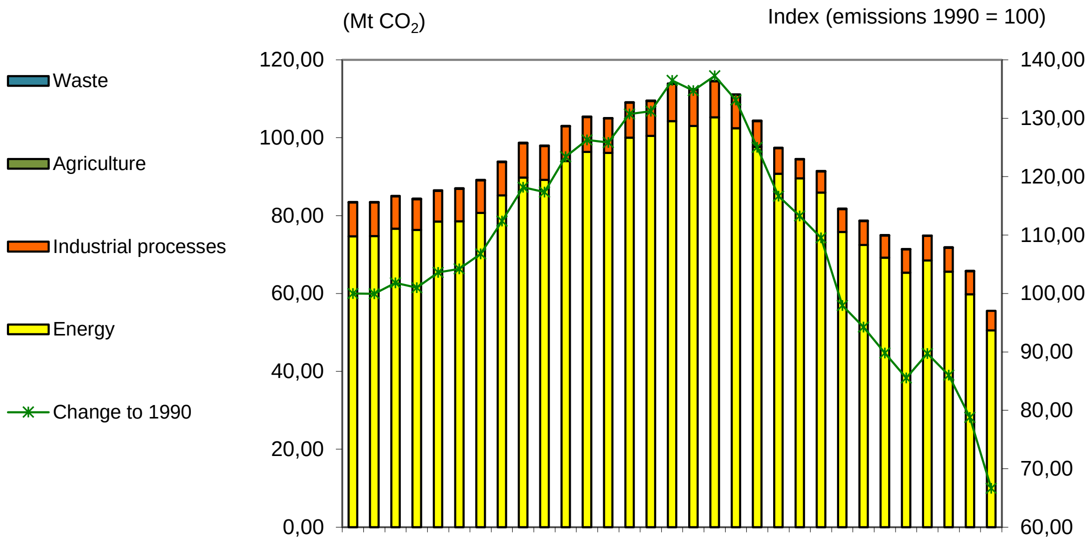

Figure 3.8 CO_2 emissions by sector (in Mt) for the years 1990 – 2020 (without LULUCF)

3.2.2.2 Methane

The trend of methane emissions from 1990 to 2020 by source category is presented in ***Figure 3.9***. In 2020 emissions are slightly smaller than 2019 (1.69%).

Waste represents the largest anthropogenic source of methane emissions in Greece accounting for 47.20% of total methane emissions in 2020 (without LULUCF). Methane emissions from Waste decreased by 0.28% since 1990 and are mainly attributed to Solid Waste Disposal on Land and Wastewater Handling.

Methane emissions from Agriculture in 2020 decreased by 12.57% compared to 1990 levels.

Methane emissions from Agriculture, with enteric fermentation being the main source category in the sector, in 2020 accounted for 45.40% of total methane emissions. Methane emissions from the Energy sector (mainly fugitive emissions from coal mining and production, processing, and distribution of liquid fuels and natural gas) account for almost the remaining 10.48% of the total methane emissions. Finally, the contribution of CH_4 emissions from Iron and Steel Production can be considered negligible.

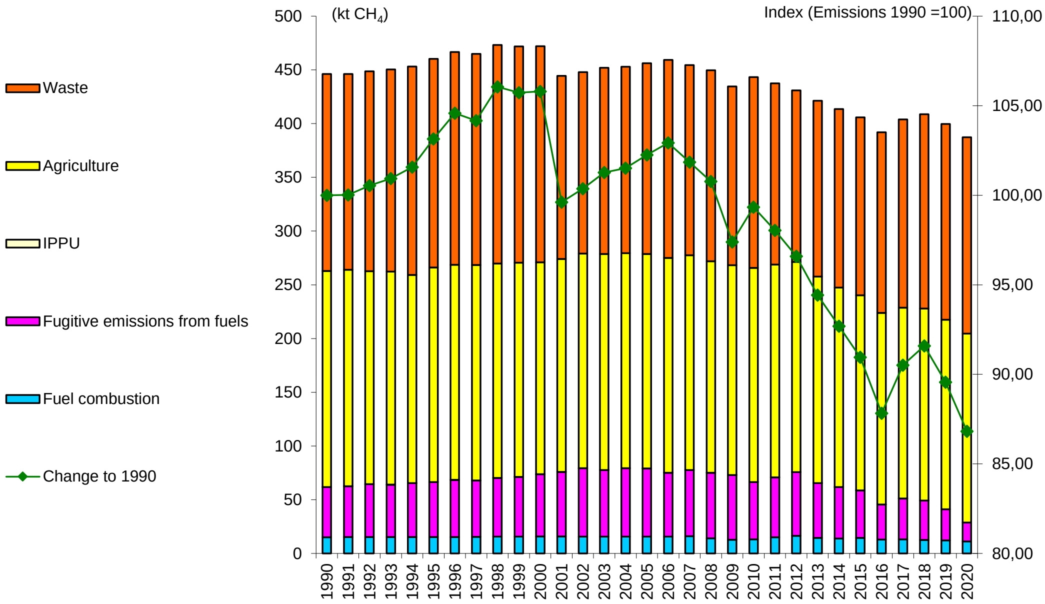

Figure 3.9 CH_4 emissions by sector (kt) for the years 1990 – 2020 (without LULUCF)

3.2.2.3 Nitrous oxide

The trend of nitrous oxide emissions from 1990 to 2020 by source category is presented in ***Figure 3.10***.

Agriculture represents the largest anthropogenic source of nitrous oxide emissions in Greece (79.71% approximately of the total nitrous oxide emissions in 2020, without LULUCF). Emissions from this sector decreased by 35.47% since 1990, mainly because of new agricultural practices applied, affecting the use of synthetic nitrogen fertilizers.

Nitrous oxide is also produced from the reaction between nitrogen and oxygen during fossil fuel combustion. Nitrous oxide emissions from fossil fuels combustion (accounting for 9.23% of total nitrous oxide emissions in 2020) decreased by 52.82% from 1990.

Production of nitric acid is the major source of N2O emissions from Industrial processes and product use and accounts for 3.77% of total N2O emissions in 2020. Nitrous oxide emissions from this source decreased by 86.81% from 1990, due to the reduction of nitric acid production in Greece. N2O emissions from Waste in 2020 (7.29% of total emissions without LULUCF) increased by 9.20% compared to 1990 levels.

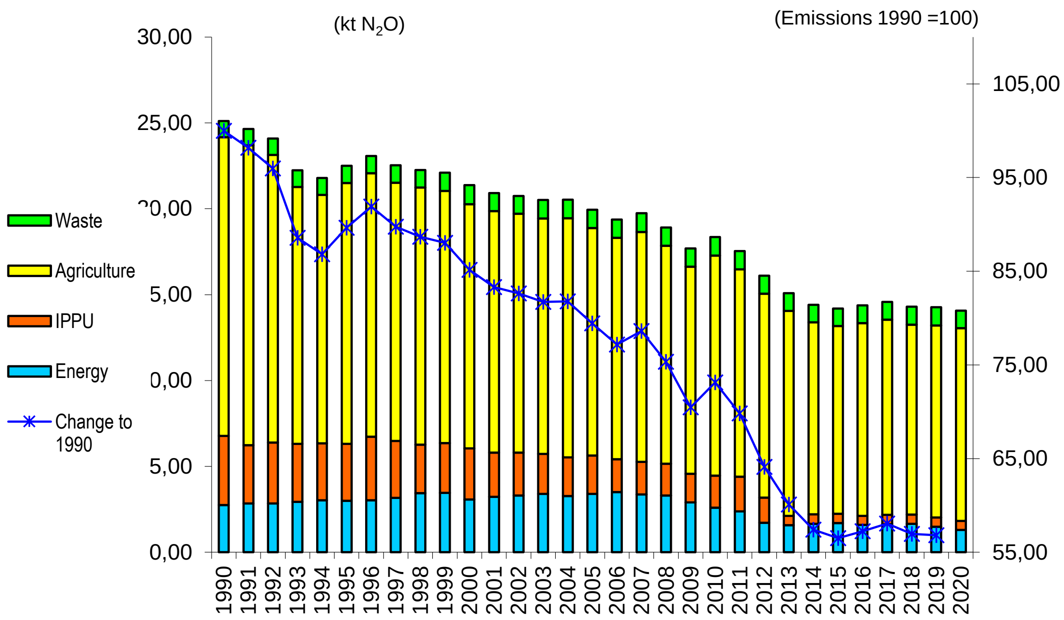

Figure 3.10 N_2O emissions by sector (kt) for the years 1990 – 2020 (without LULUCF)

3.2.2.4 Halocarbons and SF6

HFCs and PFCs are chemical substances, the production of which aims mainly to the substitution of ozone depleting substances (see Montreal Protocol – 1987). HFC and PFC are not harmful to the stratospheric ozone layer and thus their emissions are not controlled by the above-mentioned Protocol. However, many of these substances, as well as SF6, are powerful greenhouse gases; in addition, apart from being characterized by a high Global Warming Potential (GWP), these gases have extremely long atmospheric lifetimes, resulting in their essentially irreversible accumulation in the atmosphere. Especially sulphur hexafluoride is the most potent greenhouse gas according to the IPCC evaluation.

Emission estimates of these gases presented in ***Table 3.3*** originate from:

The production of HCFC-22 (emissions of HFC-23) and aluminium production (emissions of CF4 and C2F6). HFC-23 emissions have been increasing steadily up to 1999 due to an equivalent increase in the production of HCFC-22, while PFC emissions from aluminium have dropped due to the control/reduction of the “anode effect” during the production process, since 1990 (with the exception of the period 1997 – 2000). Emissions in the years 2008-2018 show flunctuations that are mainly attributed to the production levels. HFC-23 emissions are reported as not occurring since 2006, due to the closure of the plant producing HCFC-22.

Manufacturing, operation and maintenance of refrigeration and air conditioning equipment. F-gases emissions increased significantly since 1995 (base year), mainly due to the increase of air conditioning equipment in the residential sector, the increasing trend of emissions from the commercial refrigeration and the introduction of new passenger cars with air-conditioning systems, but also due to substitution of CFCs, following the implementation of the Montreal Protocol, leading to an increase in the number of equipment operating with f-gases until the economic ressesion in 2009. In addition, the new regulations have already been applying in Greece, however, this category in mostly driven fom the existing equipment that present high emissions during its disposal.

Use of f-gases (mainly HFC-134a) in aerosol products. The main application regards the use of HFC-134a in metered dose inhalers, as provided by the National Organization of Medicines and plants of the sector. The increment in the MDIs emissions is important in the recent years, mainly due to the inclusion of new MDIs brands in the recent years. Other aerosol applications regard the use of HFC-134a by one company in Greece, according to data received by the Hellenic Aerosol Association.

Use of HFC-134a and HFC-152a in foam blowing since 2001, as reported by the four plants of the sector. Emissions show a peak in 2006, resulting from the use of f-gases by three of the plants in that particular year.

The use of SF6 in the electricity transmission and distribution system of the Public Power Corporation of Greece. Emissions mainly derive from the use of SF6 in the transmission system, as the equipment used by the distribution system and by the medium voltage Greek clients refers to sealed pressure systems, minimizing the possibility of SF6 leakages.

Finally, the emissions from fire extinguishers, which follow a continuous increasing trend in the inventory years.

Table 3.3 Actual F-gases emissions for the period 1990-2020 (in kt CO2 eq)

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
HFC-23	1.182,82	1.400,08	1.149,07	2.032,34	2.711,95	4.114,99	4.738,96	5.016,14	5.529,61	6.377,16	4.761,24	4.071,51	4.102,40	3.444,78	3.317,29
HFC-32	NO	NO	NO	NO	NO	0.03	0.22	0.73	1.45	2.45	4.78	9.23	15.15	24.38	36.24
HFC-125	NO	NO	NO	NO	NO	6,10	12,12	24,10	39,46	57,46	90,44	137,29	198,05	280,48	381,28
HFC-134a	NO	NO	NO	0,10	0,16	27,34	52,43	95,30	149,77	215,02	305,89	427,11	547,39	677,57	825,17
HFC-143a	NO	NO	NO	NO	NO	8,92	16,44	30,21	47,21	65,88	95,11	127,57	168,30	214,72	266,35
HFC-152a	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	2,78	51,22	81,63	88,67
HFC-227ea	NO	NO	NO	NO	NO	NO	NO	NO	NO	3,16	4,40	6,02	7,83	10,09	13,27
R600a	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
R1234yf	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
PFC-116	31,68	31,83	31,26	18,80	11,71	10,46	8,95	22,61	29,58	23,43	31,46	27,70	34,02	40,86	43,54
TOTAL HFCs	**1182,82**	**1400,08**	**1149,07**	**2032,44**	**2712,11**	**4157,38**	**4820,17**	**5166,49**	**5767,51**	**6721,13**	**5261,86**	**4781,52**	**5090,33**	**4733,65**	**4928,27**
TOTAL PFCs	**190,26**	**191,19**	**187,74**	**112,94**	**70,31**	**62,85**	**53,73**	**125,64**	**155,48**	**105,31**	**122,26**	**84,10**	**88,29**	**89,28**	**87,86**
TOTAL SF6	**2,93**	**3,02**	**3,11**	**3,20**	**3,29**	**3,42**	**3,51**	**3,56**	**3,60**	**3,69**	**3,81**	**3,88**	**4,06**	**4,06**	**4,26**
TOTAL	**1373,08**	**1591,27**	**1336,81**	**2145,38**	**2782,42**	**4220,23**	**4873,89**	**5292,13**	**5922,99**	**6826,44**	**5384,12**	**4865,62**	**5178,62**	**4822,93**	**5016,12**

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
HFC-23	2.832,99	114,65	171,78	186,46	190,76	221,65	196,32	220,06	222,78	180,55	175,92	153,69	143,03	119,39	105,53	97,02
HFC-32	48,77	63,42	79,69	95,41	110,41	133,11	164,13	206,95	279,33	305,00	309,79	344,26	331,08	337,35	310,06	288,48
HFC-125	529,08	639,15	804,19	946,15	1.070,21	1.283,25	1.495,19	1.791,55	2.191,20	2.364,84	2.537,38	2.844,02	2.939,95	2.938,19	2.756,58	2.614,51
HFC-134a	1.166,96	1.343,16	1.525,19	1.741,52	1.809,97	1.864,23	1.884,14	1.847,34	1.958,62	1.873,88	1.896,68	1.829,16	1.683,15	1.516,71	1.348,60	1.214,89
HFC-143a	377,70	409,08	500,06	561,97	597,83	693,47	723,09	790,29	793,33	818,00	774,80	743,50	764,38	689,95	628,88	587,55
HFC-152a	105,66	133,60	141,14	152,37	155,26	159,96	162,36	167,08	158,40	159,04	160,07	160,98	161,82	162,74	163,63	164,49
HFC-227ea	16,86	20,58	24,57	28,46	101,58	112,10	121,99	130,09	136,85	141,26	144,82	148,16	154,31	152,66	151,26	155,72
R600a	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0007	0.0007	0.0013	0.0019	0.0025	0.01
R1234yf	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.06	0.06	0.06	0.06
PFC-116	47,44	49,47	66,62	73,00	69,50	96,62	72,38	99,09	103,65	68,35	64,61	61,56	57,29	52,87	49,64	49,34
TOTAL HFCs	**5078.03**	**2723.63**	**3246.63**	**3712.35**	**4036.02**	**4467.76**	**4747.22**	**5153.93**	**5741.48**	**5842.95**	**5999.84**	**6223.86**	**6177.93**	**5907.58**	**5447.17**	**5122,68**
TOTAL PFCs	**91.51**	**87.21**	**103.04**	**118.95**	**91.35**	**129.44**	**110.53**	**147.77**	**172.56**	**134.63**	**119.52**	**135.17**	**125.79**	**135.31**	**137.10**	**148,15**
TOTAL SF6	**6.16**	**7.98**	**9.46**	**7.18**	**5.02**	**5.86**	**5.13**	**5.05**	**5.15**	**4.92**	**5.06**	**5.20**	**5.01**	**4.94**	**4.92**	**4.92**
TOTAL	**5,175.69**	**2,818.82**	**3,359.14**	**3,838.48**	**4,132.38**	**4,603.06**	**4,862.88**	**5,306.75**	**5,919.19**	**5,982.51**	**6,124.43**	**6,364.23**	**6,308.74**	**6,047.84**	**5,589.19**	**5270,83**

3.2.2.5 Description and interpretation of emission trends for KP-LULUCF inventory in aggregate and by activity, and by gas

Since 1990, land areas afforested were 35.31 kha, land areas deforested were 5.86 kha and land areas under forest management were 1,270.46 kha. In 2020 net removals from ARD activities were -32.27 kt CO2 eq and from Forest Management activities -2,018.26 kt CO2 eq.

Since there is a clear correspondence between the Kyoto Protocol activities "Afforestation / Reforestation" and "Forest Management", and the UNFCCC categories "Land converted to Forest land" and "Forest land remaining Forest land/managed", the description and interpretation of emission/removal trends for the associated UNFCCC categories can be found in Chapter 6.

The Kyoto Protocol activity of Deforestation encompasses the UNFCCC subcategories 4.B.2.1, 4.C.2.1, 4.D.2.2.1, 4.E.2.1 and 4.F.2.1 (Forest land converted to other land uses). In ***Figure 2.11*** emissions from these subcategories during the period 1990-2020 are summed up in order to illustrate the effect of deforestation.

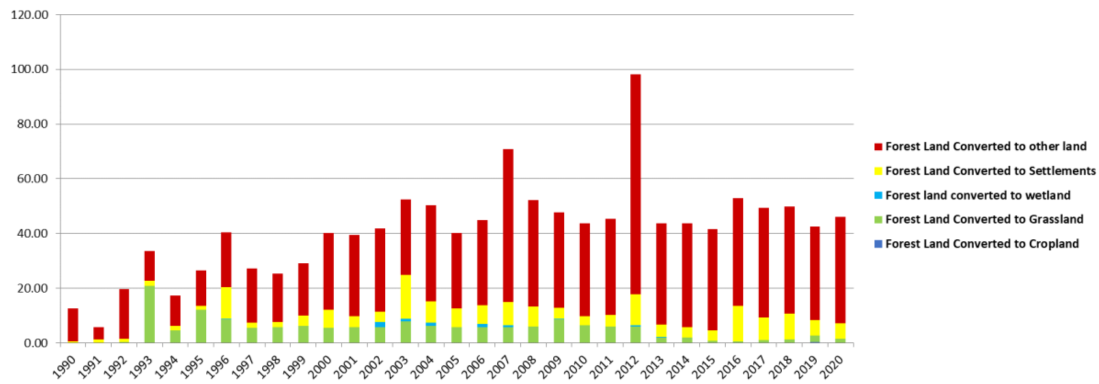

Figure 3.11 CO2 emissions (in kt) from deforestation for the period 1990 – 2020

3.3 National System for the GHG emissions/removals inventory

3.3.1 Overview

The **Ministry of Environment and Energy, MEEN**, is the governmental body responsible for the development and implementation of environmental policy in Greece, as well as for the provision of information concerning the state of the environment in Greece in compliance with relevant requirements defined in international conventions, protocols and agreements. Moreover, the MEEN is responsible for the co-ordination of all involved ministries, as well as any relevant public or private organization, in relation to the implementation of the provisions of the Kyoto Protocol, according to the Law 3017/2002 with which Greece ratified the Kyoto Protocol.

In this context, the MEEN has the overall responsibility for the national GHG inventory, and the official consideration and approval of the inventory prior to its submission. (Contact person: Kyriakos Psychas, Address: Patission 147, Athens, Greece, e-mail: k.psychas@prv.ypeka.gr, tel.: +30210 8665938).

Figure 3.12 provides an overview of the organizational structure of the National Inventory System. The main entities participating in it are:

- The Division of Climate Change and Air Quality of **MEEN** designated as the national entity responsible for the national inventory, which keeps the overall responsibility, but also plays an active role in the inventory planning, preparation and management.
- The preparation of the annual inventory for all sectors has been assigned to **National Technical University of Athens (NTUA) / School of Chemical Engineering**, on a contract basis by MEEN.
- **Governmental ministries and agencies** through their appointed focal persons, ensure the data provision.

International or national associations, along with individual public or private industrial companies contribute to data providing and development of methodological issues as appropriate.

The legal framework defining the roles-responsibilities and the co-operation between the MEEN Climate team, the Inventory team and the designated contact points of the competent Ministries was formalized by the Joint Ministerial Decision 22993/2017 (OG B' 1710) entitled "Structure and operation of the National Greenhouse Gases Inventory System". The above-mentioned decision defines the competent authority and its responsibilities concerning the inventory preparation, data providing or other relative information. This formal framework establishes an Interministerial Technical Working Group for the collaboration between the entities involved, assuring the timely collection and quality of the activity data required and solving data access restriction problems raised due to confidentiality issues.

According to the Presidential Decree No 189 dated 5th November 2009 the Ministry of Environment and Energy retained the responsibilities regarding the Environment, and Physical Planning of the former Ministry for the Environment, Physical Planning and Public Works. Furthermore, the General Directorate of Energy and Natural Resources, previously belonging to the Ministry of Development, as well as the General Directorate of Forest Development and Protection and Natural Resources, previously belonging to the Ministry of Rural Development and Food, are now a significant part of the Ministry of Environment and Energy (MEEN). These two authorities are currently called the "General Directorate of Energy" and the "General Directorate of Forests and Forest Environment" of MEEN respectively.

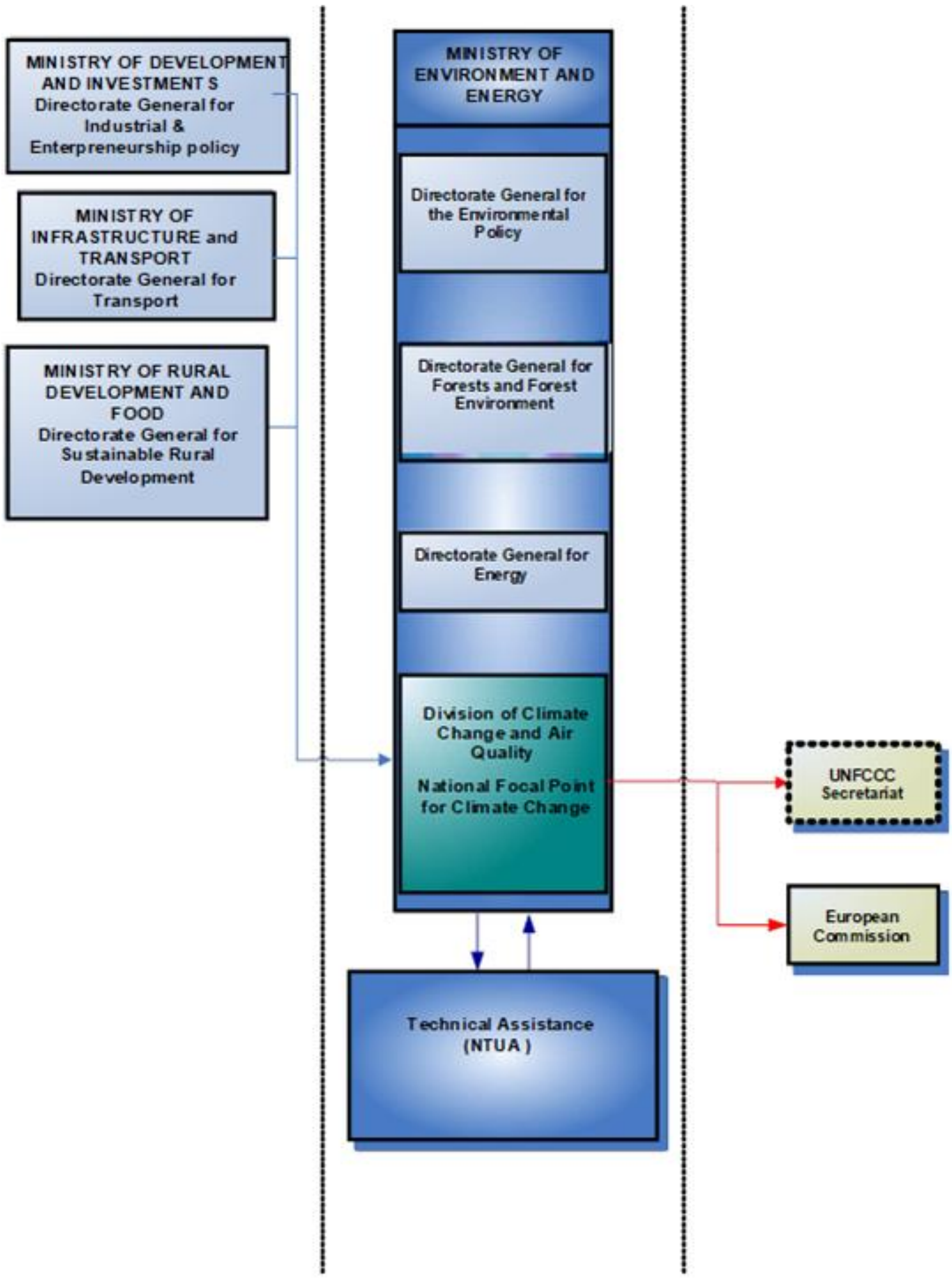

Figure 3.12 Organizational Structure of the National Inventory System

3.3.2 Roles and Responsibilities

3.3.2.1 Ministry of Environment and Energy

The Ministry of Environment and Energy, MEEN, has the overall responsibility, as the national entity, for the national GHG inventory. Among its responsibilities are the following:

- The co-ordination of all ministries and governmental agencies involved, as well as any relevant public or private organization. In this context, it oversees the operation of the National System and decides on the necessary arrangements to ensure compliance with relevant decisions of the COP and the COP/CMP.
- The supervising of the inventory compiling procedure and the official submission of all reports and inventories.
- The response to any issues raised by the inventory review process under Article 8 of the Kyoto Protocol, in co-operation with the technical consultant (NTUA), who has the technical and scientific responsibility for the inventory planning, preparation and management of the inventory, as mentioned above.
- The timely submission of the GHG inventory to the European Commission and to the UNFCCC Secretariat.
- The keeping of the Centralised Inventory File, which is delivered to the inventory team which has the technical responsibility for the inventory planning, preparation and management (currently NTUA) at the beginning of each inventory cycle. The Centralised Inventory File is kept at the premises of the MEEN.
- The administration of the National Registry. Greece cooperates with the Member States of the European Union and with the supplementary transaction log and the registry of the European Community by maintaining the national registries in a consolidated system. The supervision of Quality Assurance/Quality Control Plan (QA/QC)

As it appears from the above description, the role of the MEEN is not narrowed to the co-ordination of the entities involved in the inventory process and the facilitation of the activity data transfer from the data providers to the Technical Assistant (NTUA). MEEN has an active role in monitoring and overseeing the inventory process through continuous communication and frequent scheduled and / or ad-hoc meetings with the Technical Assistant (NTUA) and the competent ministries or other agencies involved.

3.3.2.2 Technical Assistance

❑ The Ministry of Environment and Energy has assigned, on a contract basis, the National Technical University of Athens (NTUA) / School of Chemical Engineering as the national institution that has the technical and scientific responsibility for the planning, preparation and management of the annual national inventory for all sectors. In this framework, NTUA has the following responsibilities / tasks to fulfil for the GHG inventory preparation:

1. Data collection (activity data and emission factors) for all source categories that are Energy, Industrial Processes, Solvents and Other Product Use, Agriculture, Waste and LULUCF).

2. Reliability check of input data through

3. the comparison of the same or similar data from alternative data sources and

4. time-series assessment in order to identify changes that cannot be explained.

5. Selection of the appropriate methodologies according to the 2006 IPCC guidelines, preparation of GHG emissions estimates by applying the methodologies and models having been selected.

6. Data processing and archiving.

7. Assessment of the consistency of the methodologies applied, inventory improvement – recalculations.

8. Reliability check of results.

9. Key categories analysis.

10. Uncertainty assessment.

11. Preparation of Common Reporting Format (CRF) tables.

12. Preparation of National Inventory Report (NIR).

13. Reporting of the required information according to Regulation 525/2013 of the European Parliament and of the Council and its implementing acts.

14. Preparation and keeping of annual Centralised Inventory File. At the end of each cycle of the inventory preparation, all inventory related information is handled to the MEEN's employee responsible for keeping the Centralised Inventory File (member of the Climate Team), who in turn gives the latest version of all relevant files to the NTUA at the beginning of the next inventory cycle.

15. Development of QA/QC procedures.

16. Implementing the QA/QC procedures under the supervision of MEEN.

17. Training the representatives of data providing agencies on inventory issues.

- NTUA co-operates with a number of government agencies and other entities for the preparation of the inventory (see next section). It should be mentioned that this co-operation is not restricted to data collection but it also concerns methodological issues as appropriate. However, the technical consultant (NTUA) are responsible for the final decision concerning methodological issues.
- The names and contact details of the NTUA inventory team follows:

1. Ioannis Sempos (Sebos)

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❑ It should be mentioned that, whenever necessary, the above mentioned NTUA's Inventory Team is ad hoc supported by experts either from the NTUA or other institutions.

3.3.2.3 Government Ministries/ Government agencies

❑ The following government agencies and ministries, develop and maintain, within their terms of operation, data sets and emission methodology information necessary for the estimation of GHG emissions / removals. Most of these institutes have been used as sources of data since the first submission of Greek GHG national inventory. However, new sources of information are being sought both for further inventory development and improvement (higher Tier methodology usage) and quality control issues.

❑ The co-operation with the following government agencies and other entities for the preparation of the inventory is indispensable, as those agencies and entities develop and maintain statistical data necessary for the estimation of GHG emissions / removals.

❑ Each of the following ministries/agencies, has appointed focal persons responsible for data provision:

- The Ministry of Environment and Energy provides
    - annual data for energy consumption and production
    - data for solid waste management data for wastewater treatment
    - activity data and emissions for the installations included in the Emissions Trading system
    - data for f-gases use
    - data for emissions / removals from LULUCF activities (UNFCCC and KP scope).
- The Ministry of Development and Investments provides industry data
- The Ministry of Rural Development and Food provides information and data (through the Hellenic Statistical Authority which processes primary data collected by the Ministry) for the main indices and parameters of rural economy (e.g. animal population, cultivated areas, crops production, etc.).
- The Ministry of Infrastructure and Transport provides information and data for the vehicle fleet and its technical characteristics. The Civil Aviation Organization, supervised by the same Ministry provides information on Landing and Take-off cycles for both domestic and international aviation.
- The Hellenic Statistical Authority represents the main source of information for the estimation of emissions / removals from most of the IPCC source / sink categories.

Data are also obtained from International Organizations as the United Nations Food and Agricultural Organization (FAO), the EUROSTAT, the International Iron and Steel Institute, the International Energy Association. These data are supplementary to the data collected from the aforementioned data providers.

Furthermore, other government organisations, associations, and individual public and private industrial companies contribute to data providing and development of methodological issues as appropriate. For example, data is provided from the National Oganization for Medicines, while data from the Association of Motor Vehicles Importers Representatives or the Hellenic Association of Fertilizer professionals and traders are supplementary to the official data and are used in cases where official data are temporarily not available. Individual industrial companies / installations, either public or private, as Power Public Corporation, cement plants etc., constitute an additional data source for the GHG inventory preparation. However, these data are used as supplementary to the official data (e.g. for QC).

3.3.3 Methodology and data sources

3.3.3.1 Activity data

Data collection, processing and check constitute the activity with the longest duration in the annual inventory cycle. The duration of this activity is related to the amount of the necessary data and the number of the entities involved. The on-time and successful completion of this activity has a major effect on the timeliness preparation and submission of the inventory as well as on its accuracy, completeness and consistency.

It should be noted that information and data collected (through questionnaires developed according to the guidelines described in the Commission Decision 2004/156/EC) in the framework of the formulation of the National Allocation Plan (NAP) for the period 2005 – 2007, according to the EU Directive 2003/87/EC (and its transposition to the national Law, JMD 2004) along with the data from the verified reports from installations under the EU ETS for years 2005-2020 constituted a significant source of information and an additional quality control check.

3.3.3.2 Emission factors

The estimation of GHG emissions / removals per source / sink category is based on the methods described in the 2006 IPCC Guidelines, and 2013 Revised Supplementary Methods and the Good Practice Guidance Arising from the Kyoto Protocol. The emission factors used derive from the above-mentioned methodological sources and special attention was paid in selecting the emission factors that better describe practices in Greece. Furthermore, emission factors were obtained from plant specific information contained in EU ETS reports. An overview of the methods applied for the calculation of emissions / removals is presented in ***ANNEX AIII***, ***Table AIII.1***.

The key categories analysis (see Paragraph 1.5) constitutes the basic tool for methodological choice and for the prioritisation of the necessary improvements. In addition, the results of the various review processes (at national, european and international level) represent key input information for the identification of possible improvements. It should be mentioned however, that data availability as well as availability of resources (both human and financial) also have to be considered.

- Data availability could become a significant restrictive parameter when selecting an estimation methodology. The accuracy and the consistency of the emissions estimated depend on the availability of the data needed for the correct application of the selected methodology.
- Availability of resources needs also to be considered as the searching for and the collection of the necessary data in order to apply a detailed methodology for a source category should not affect the completeness and the on-time preparation of an inventory submission.

3.3.3.3 Global warming potential

Emissions from anthropogenic activities affect the concentration and distribution of greenhouse gases in the atmosphere. These changes can potentially produce a radiative forcing of the Earth's surface and lower atmosphere, by changing either the reflection or absorption of solar radiation or the emissions and absorption of long-wave radiation.

A simple measure of the relative radiative effects of the emissions of various greenhouse gases is the Global Warming Potential (GWP) index. This index is defined as the cumulative radiative forcing between the present and some chosen time-horizon caused by a unit mass of gas emitted now, expressed relative to that for some reference gas. The values for GWP for some of the most potent greenhouse gases are given in ***Annex AIII***, ***Table A.III.2***.

Corresponding values of GWP for other gases (NOx, CO, NMVOC) are not given by the IPCC (nor by other sources for this purpose), since at present it is impossible to calculate the indirect results of these gases, as the scientific knowledge on their chemical reactions taking place in the atmosphere is not sufficient.

3.3.3.4 GHG emissions inventory preparation process

The preparation of the Greek GHG emissions inventory is based on the implementation of the 2006 IPCC Guidelines, and 2013 Revised Supplementary Methods and the Good Practice Guidance Arising from the Kyoto Protocol.

The compilation of the inventory is completed in three main stages:

Stage 1: The first stage consists of data collection and check for all source/sink categories. The main data sources used are the Hellenic Statistical Authority, the national energy balance, the government ministries/agencies involved and large private enterprises, along with the verified reports from installations under the EU ETS.

Quality control of activity data include the comparison of the same or similar data from alternative data sources (e.g. Hellenic Statistical Authority and ETS reports) as well as time-series assessment in order to identify changes that cannot be explained. In cases where problems and/or inconsistencies are identified, the agency's representative, responsible for data providing, is called to explain the inconsistency and/or help solving the problem.

Stage 2: Once the reliability of input data is checked and certified, emissions/removals per source/sink category are estimated. Emissions estimates are then transformed to the format required by the CRF Reporter. This stage also includes the evaluation of the emission factors used and the assessment of the consistency of the methodologies applied in relation to the provisions of the 2006 IPCC Guidelines, and 2013 Revised Supplementary Methods and the Good Practice Guidance Arising from the Kyoto Protocol.

Quality control checks, when at this stage, are related to time-series assessment as well as to the identification and correction of any errors / gaps while estimating emissions / removals and filling in the CRF Reporter.

Stage 3: The last stage involves the compilation of the NIR and its internal (i.e. within technical consultant) check. The official approval procedure follows for one month period of interactions between the technical consultant (NTUA) and the Division of Climate Change and Air Quality of MEEN, starting on the 1st of February of the year of submission. During this period, the technical consultant have to revise the report according to the observations and recommendations of the competent authority. On the basis of this interaction process, the final version of the report is compiled. The Division of Climate Change and Air Quality submits the NIR to the European Commission and to the UNFCCC Secretariat.

The government ministries and agencies and the individual private or public industrial companies referred previously should have collected and delivered to the MEEN Climate Team and the technical consultant (NTUA) the respective activity data needed for the inventory (for year X-2) and any changes in activity data for the period 1990 to year X-2, within the time period of May to November of year X-1 (X is the submission year of CRF tables and NIR referred to X-2 GHG emissions inventory).

- The information that is related to the annual GHG emissions inventory (activity data, emission factors, analytic results, compilation in the required analysis level of the CRF tables) is stored in MS Excel spreadsheets. Moreover, the final results (NIR and CRF tables) are available in the MEEN web site (https://ypen.gov.gr/perivallon/klimatiki-allagi/ektheseis-kai-yfistameni-katastasi/etisies-ethnikes-apografes-aerion-tou-thermokipiouatth-apo-to-2005/).

In addition, and within the context of the Quality Assurance/Quality Control system developed, two master files have been organized aiming at the systematic and safe archiving of inventory information: the Input Data File and the Centralised Inventory File.

- The Input Data File contains (in electronic format and/or hard copy) all input data and parameters that are necessary for the estimation of GHG emissions/removals. Data are stored in files by sector and reference year.
- The Centralised Inventory File includes all information relevant to the GHG emissions/removals inventory. At the end of each cycle of the inventory preparation, all inventory related information is handled by the NTUA to the person responsible for keeping the Centralised Inventory File (member of the Climate Team) in MEEN, who in turn provides the latest version of all relevant files (calculation files and NIR) to the Technical Assistance at the beginning of the next inventory cycle.

- In addition, and within the context of the Quality Assurance/Quality Control system developed, two master files have been organized aiming at the systematic and safe archiving of inventory information: the Input Data File and the Centralised Inventory File.

  - The Input Data File contains (in electronic format and/or hard copy) all input data and parameters that are necessary for the estimation of GHG emissions/removals. Data are stored in files by sector and reference year.
  - The Centralised Inventory File includes all information relevant to the GHG emissions/removals inventory. At the end of each cycle of the inventory preparation, all inventory related information is handled by NTUA to the person responsible for keeping the Centralised Inventory File (member of the Climate Team) in MEEN, who in turn provides the latest version of all relevant files (calculation files and NIR) to the Technical Assistance at the beginning of the next inventory cycle.

More specifically the information stored in the Centralised Inventory Files includes:

- A list of the reports, the input data files and the calculation/estimation files.
- The members of the Inventory Team.
- Final versions, in electronic format and hard copy, of the NIR.
- CRF tables in electronic format and a hard copy of the CRF tables for the last year covered by each submission.
- XML file and database of CRF reporter
- Calculation files, including the uncertainty estimation files.
- Expert review reports.
- Any comments from the public review of the inventory.

- Documentation derived from the implementation of the QA/QC procedures.

3.3.4 Key categories analysis

The 2006 IPCC Guidelines define procedures (in the form of decision trees) for the choice of estimation methods within the context of the IPCC Guidelines. Decision trees formalize the choice of the estimation method most suited to national circumstances considering at the same time the need for accuracy and the available resources (both financial and human). Generally, inventory uncertainty is lower when emissions are estimated using the most rigorous methods, but due to finite resources, this may not be feasible for every source category. Therefore it is good practice to identify those source categories (key source categories) that have the greatest contribution to overall inventory uncertainty in order to make the most efficient use of available resources.

In that context, a key source category is one that is prioritised within the national inventory system because its estimate has a significant influence on a country's total inventory of direct greenhouse gases in terms of the absolute level of emissions (level assessment) or/and to the trend of emissions (trend assessment). As far as possible, key source categories should receive special consideration in terms of two important inventory aspects:

1. The use of source category-specific good practice methods is preferable, unless resources are unavailable.
2. The key source categories should receive additional attention with respect to quality assurance (QA) and quality control (QC).

As a result of the adoption of the LULUCF Good Practice Guidance (Decision 13/CP.9) the concept of key sources has been expanded in order to cover LULUCF emissions by sources and removals by sinks. Therefore the term key category is used in order to include both sources and sinks.

The determination of the key categories for the Greek inventory system is based on the application of the Tier 1 methodology (see Annex I for an analytic presentation of calculations) described in the 2006 IPCC Guidelines.

Tier 1 methodology for the identification of key categories assesses the impacts of various source categories on the level and the trend of the national emissions inventory. Key categories are those which, when summed together in descending order of magnitude, add up to over 95% of total emissions (level assessment) or the trend of the inventory in absolute terms.

It should be mentioned that:

- Source category uncertainty estimates are not taken into consideration.
- Base year estimates were calculated considering 1990 as base year.

The key categories for the Greek inventory system (without LULUCF) are presented in ***Annex III, Table A.III.3***.

Twelve key source categories are found in the energy sector, eight in the IPPU sector, four in agriculture and two in waste sector in 2020 (without LULUCF).

The methodology applied for the determination of the key categories with LULUCF is similar to the one presented above. The key categories identified for the year 2020 are presented in ***Annex III, Table A.III.4***. The comparison of the results of the analysis with and without LULUCF reveals no major differences in the source categories identified (apart from the categories from the LULUCF sector). In the analysis including LULUCF thirteen categories from the Energy Sector, seven from the IPPU sector, seven from agriculture, two from waste sector and four from LULUCF have been identified as key.

There are some differences (inclusions and exclusions of sub-categories) throughout the time series, usually due to the flunctuation of the emissions (this is mostly the case in the industrial processes sector and is justified by the fact that in many cases there is a limited number of plants for each sub-category and the flunctuation of one plant's emissions cannot be easily counterbalanced by the production of the rest).

In accordance with the IPCC Guidelines, the assessment of key categories under article 3.3 and 3.4 of Kyoto Protocol was based on the assessment made for the UNFCCC inventory. In the cases where there is a clear correspondence between the UNFCCC categories and the Kyoto Protocol Activities (i.e. Forest land remaining Forest land/managed and Forest Management), a Kyoto Protocol activity was considered as key when the associated category was identified as key in the UNFCCC inventory.

The Kyoto Protocol activity of Deforestation encompasses the UNFCCC subcategories 4.B.2.1, 4.C.2.1, 4.D.2.2.1, 4.E.2.1 and 4.F.2.1 (Forest land converted to other land uses). The sum of these subcategories is much smaller than the smallest UNFCCC key category. Moreover, none of the categories 4.B.2.1, 4.C.2.1, 4.D.2.2.1, 4.E.2.1 and 4.F.2.1 has been identified as key, and hence Deforestation is not identified as a key category.

3.3.5 Improvement of GHG emissions / removals inventories

The recalculations made are driven by the results of the various review processes, QC checks and internal audits and the ERT reviews of the annual submissions of Greece by the nominated experts from the UNFCCC. In the 2016 submission, several recalculations were implemented as a result of new United Nations Framework Convention on Climate Change (UNFCCC) reporting requirements. These new requirements include the use of the 2006 IPCC Guidelines for National GHG Inventories (2006 IPCC Guidelines) and new global warming potentials (GWPs) (UNFCCC-Decision 24/CP.19, IPCC 2006).

The reasons for recalculations made, can be classified as follows:

- **Changes or refinements in methods**. A methodological change occurs when an inventory agency uses a different tier to estimate emissions from a source category (e.g. for key source categories) or when it moves from a tier described in the IPCC Guidelines to a national method. Methodological changes are often driven by the development of new and different data sets. A methodological refinement occurs when an inventory agency uses the same tier to estimate emissions but applies it using a different data source or a different level of aggregation.
- **Inclusion of new sources**. A new source is defined as a source for which estimates (all or some gases) did not exist in previous inventories either due to lack of data or because it has just been identified.
- **Allocation**. Changes in allocation of emissions to different sectors or sources/sub-sources.
- **Correction of errors.** This case concerns errors during calculating emissions (e.g. transcript errors) or while filling in the required information in the CRF tables. Inconsistencies resolving is also included in this category.
- **Updated activity data.**

3.3.6 Quality assurance – Quality control system

The development and the implementation of an inventory Quality Assurance / Quality Control (QA/QC) plan represents a key tool for meeting the objectives of National Systems under Article 5 Paragraph 1 of the Protocol as described in Decision 20/CP.7.

With the Protocol's application, the pressure upon national GHG emissions inventories increases and therefore quality management is essential in order to comply with the requirements of (a) producing transparent, consistent, comparable, complete and accurate emissions estimates, (b) establishing a reliable central archiving system concerning all necessary information for GHG emissions inventories development and (c) compiling national reports according to the provisions of the adopted decisions.

In this framework, a QA/QC system is being implemented since April 2004. For the implementation of the QA/QC system the NTUA is responsible in close co-operation with the MEEN. The system is based on the ISO 9001:2000 standard and its quality objectives, as stated in the quality management handbook, are the following:

1. Compliance with the 2006 IPCC guidelines and the UNFCCC reporting guidelines while estimating and reporting emissions/removals.
2. Continuous improvement of GHG emissions/removals estimates.
3. Timely submission of necessary information in compliance with relevant requirements defined in international conventions, protocols and agreements.

The accomplishment of the above-mentioned objectives can only be ensured by the implementation, from all the members of the Inventory Team (see ***Figure 3.13*** for the flow chart of activities concerning emissions inventory), of the QA/QC procedures included in the plan for:

- data collection and processing,
- applying methods consistent with 2006 IPCC Guidelines for calculating / recalculating emissions or removals, and 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol
- making quantitative estimates of inventory uncertainty,
- archiving information and record keeping and
- compiling national inventory reports.

The QA/QC system developed covers the following processes (see ***Table 3.4*** for the list of procedures within each process for the relationship between the processes and the activities of the inventory team):

- QA/QC system management, comprising all activities that are necessary for the management and control of the inventory agency in order to ensure the accomplishment of the above-mentioned quality objectives.
- Quality control, that is directly related to the estimation of emissions. The process includes activities related to (a) data inquiry, collection and documentation, (b) methodological choice in accordance with the 2006 IPCC Guidelines, (c) quality control checks for data from secondary sources and (d) record keeping.
- Archiving inventory information, comprising activities related to centralised archiving of inventory information and the compilation of the national inventory report.
- Quality assurance, comprising activities related to the different levels of review processes including the review of input data from experts, if necessary, and comments from the public
- Estimation of uncertainties, defining procedures for estimating and documenting uncertainty estimates per source / sink category and for the whole inventory.
- Inventory improvement, that is related to the preparation and the justification of any recalculations made.

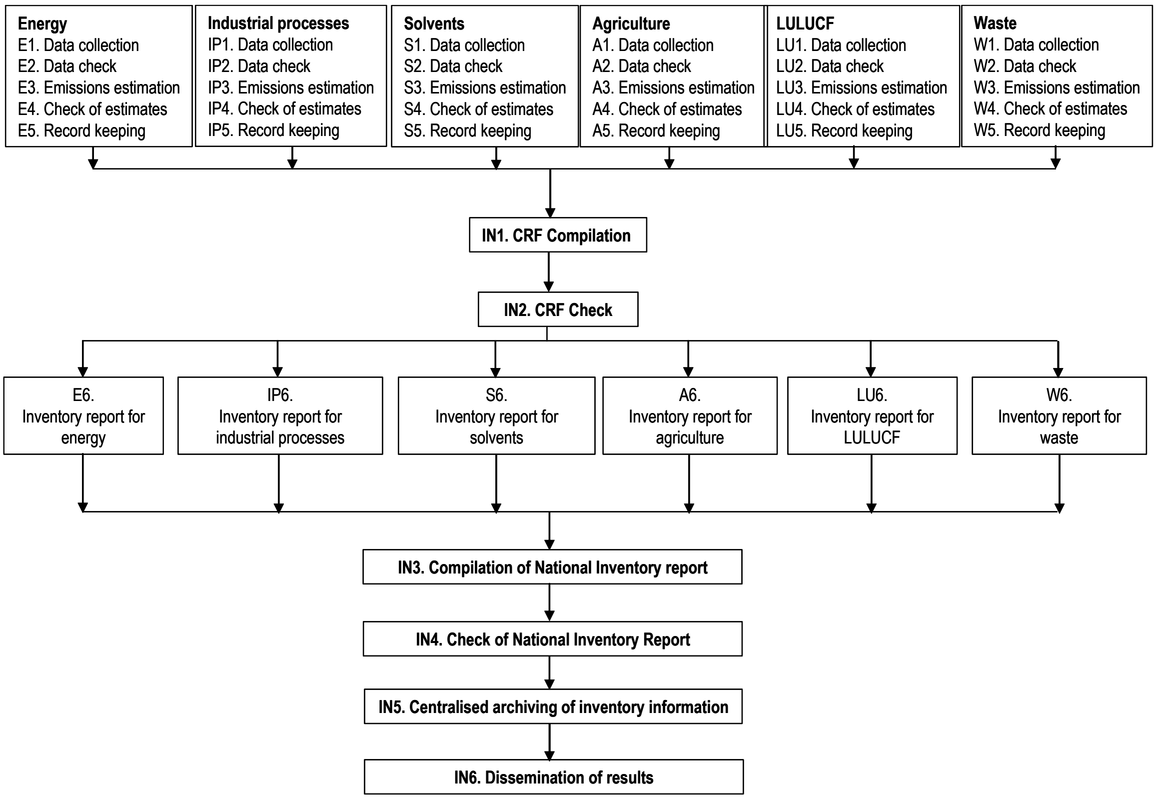

Figure 3.13 Flow chart activities concerning the GHG emissions inventory

Table 3.4 Quality assurance / quality control procedures for the Greek GHG emissions inventory

Process	Procedure code	Procedures
Quality management	QM 01	System review
	QM 02	System improvement
	QM 03	Training
	QM 04	Record keeping
	QM 05	Internal reviews
	QM 06	Non compliance – Corrective and preventive actions
	QM 07	Supplies
	QM 08	Quality management system
	QM 09	Documents control
	QM 10	Internal communication
Quality control	QC 01	Data collection
	QC 02	Estimation of emissions / removals
	QC 03	Data quality control check
	QC 04	Input data record keeping
Archiving of inventory information	AI 01	Centralised archiving of inventory information
	AI 02	Compilation of reports
Quality assurance	QA 01	Expert review of input data and parameters
	QA 02	Expert review of GHG emissions / removals inventory
	QA 03	Review from public
Estimation of uncertainties	EU 01	Uncertainty analysis
Inventory improvement	II 01	Recalculations management

All the procedures described in the QA/QC manual are followed by both MEEN and NTUA. As described in the chapters of the NIR entitled “Source-specific QA/QC and verification”, source-specific Tier 2 QC procedures are applied in the majority of source categories for quality control and verification purposes.

Furthermore, annual internal audits take place by MEEN/NTUA between January and March of each year and audits by independent local experts are planned and implemented.

Each year the EU prerfoms QA/QC checks (called initial checks) to its member states as a part of EU QA/QC system. These tests are preformed annually between 15/1 to 28/2. These checks have been designed to verify the transparency, accuracy, consistency, comparability and completeness of the information submitted and include: (a) an assessment whether all emission source categories and gases required under Regulation (EU) No 525/2013 are reported; (b) an assessment whether emissions data time series are consistent; (c) an assessment whether implied emission factors across Member States are comparable taking the IPCC default emission factors for different national circumstances into account; (d) an assessment of the use of ‘Not Estimated’ notation keys where IPCC tier 1 methodologies exist and where the use of the notation key is not justified in accordance with paragraph 37 of the UNFCCC reporting guidelines on annual greenhouse gas inventories as included in Annex I to Decision 24/CP.19; (e) an analysis of recalculations performed for the inventory submission, in particular if the recalculations are based on methodological changes; (f) a comparison of the verified emissions reported under the Union’s Emissions Trading System with the greenhouse gas emissions reported pursuant to Article 7 of Regulation (EU) No 525/2013 with a view of identifying areas where the emission data and trends as submitted by the Member State under review deviate considerably from those of other Member States;

(g) a comparison of the results of Eurostat’s reference approach with the Member States’ reference approach; (h) a comparison of the results of Eurostat’s sectoral approach with the Member States’ sectoral approach; (i) an assessment whether recommendations from earlier Union or UNFCCC reviews, not implemented by the Member State could lead to a technical correction; (j) an assessment whether there are potential overestimations or underestimations relating to a key category in a Member State’s inventory.

Moreover, EU carries out comprehensive reviews (similar to centralized UNFCC reviews) of the national inventory data submitted by Member States. Three comprehensive reviews of the Greek inventory (all sectors except LULUCF) have been performed by EU, i.e. in 2012, 2016 and 2020.

Finally, in 2013, a Bilateral QA exercise between the Spanish and the Greek Inventory teams was performed. The Spanish inventory team reviewed the Agriculture, Waste and IP (F-gases) sectors of the Greek inventory. On the other hand, the Greek inventory team reviewed the industrial combustion, industrial processes and waste sectors of the Spanish inventory.

3.3.7 Official consideration and approval of the inventory

The official approval procedure follows for one month period of interactions between the technical consultant (NTUA) and the Division of Climate Change and Air Quality of MEEN, starting on the 1st of February of the year of submission. During this period, the technical consultant have to revise the report according to the observations and recommendations of the competent authority. On the basis of this interaction process, the final version of the report is compiled. The Division of Climate Change and Air Quality submits the NIR to the European Commission and to the UNFCCC Secretariat.

3.4 National registry

Directive 2009/29/EC adopted in 2009, provides for the centralization of the EU ETS operations into a single European Union registry operated by the European Commission as well as for the inclusion of the aviation sector. At the same time, and with a view to increasing efficiency in the operations of their respective national registries, the EU Member States who are also Parties to the Kyoto Protocol (26) plus Iceland, Liechtenstein and Norway decided to operate their registries in a consolidated manner in accordance with all relevant decisions applicable to the establishment of Party registries - in particular Decision 13/CMP.1 and decision 24/CP.8.

With a view to complying with the new requirements of Commission Regulation 920/2010 and Commission Regulation 1193/2011, in addition to implementing the platform shared by the consolidating Parties, the registry of EU has undergone a major re-development. The consolidated platform which implements the national registries in a consolidated manner (including the registry of EU) is called Consolidated System of EU registries (CSEUR) and was developed together with the new EU registry on the basis the following modalities:

1. Each Party retains its organization designated as its registry administrator to maintain the national registry of that Party and remains responsible for all the obligations of Parties that are to be fulfilled through registries;
2. Each Kyoto unit issued by the Parties in such a consolidated system is issued by one of the constituent Parties and continues to carry the Party of origin identifier in its unique serial number;
3. Each Party retains its own set of national accounts as required by paragraph 21 of the Annex to Decision 15/CMP.1. Each account within a national registry keeps a unique account number comprising the identifier of the Party and a unique number within the Party where the account is maintained;

4. Kyoto transactions continue to be forwarded to and checked by the UNFCCC Independent Transaction Log (ITL), which remains responsible for verifying the accuracy and validity of those transactions;
5. The transaction log and registries continue to reconcile their data with each other in order to ensure data consistency and facilitate the automated checks of the ITL;
6. The requirements of paragraphs 44 to 48 of the Annex to Decision 13/CMP.1 concerning making non-confidential information accessible to the public would be fulfilled by each Party individually;
7. All registries reside on a consolidated IT platform sharing the same infrastructure technologies. The chosen architecture implements modalities to ensure that the consolidated national registries are uniquely identifiable, protected and distinguishable from each other, notably:
    - With regards to the data exchange, each national registry connects to the ITL directly and establishes a distinct and secure communication link through a consolidated communication channel (VPN tunnel);
    - The ITL remains responsible for authenticating the national registries and takes the full and final record of all transactions involving Kyoto units and other administrative processes such that those actions cannot be disputed or repudiated;
    - With regards to the data storage, the consolidated platform continues to guarantee that data is kept confidential and protected against unauthorized manipulation;
    - The data storage architecture also ensures that the data pertaining to a national registry are distinguishable and uniquely identifiable from the data pertaining to other consolidated national registries;
    - In addition, each consolidated national registry keeps a distinct user access entry point (URL) and a distinct set of authorization and configuration rules.

As concerns the reporting items of paragraph 32 of the Kyoto Protocol reporting guidelines:

(a) The Directorate of Climate Change and Air Quality of the Ministry of Environment and Energy, operates the Greek Greenhouse Gas Registry under the presidential decree 132/2017.

The names and contact information of the registry administrators designated by the Party to maintain the national registry are:

Ms K. Plakaki (k.plakaki@prv.ypeka.gr)

Mr. Nektarios Mamitsas (n.mamitsas@prv.ypeka.gr)

Address:

147 Patission str., 11251, Athens, Greece

tel. +30-210-8647008 | fax. +30-210-8646939

(b) The EU Member States who are also Parties to the Kyoto Protocol (26) plus Iceland, Liechtenstein and Norway have decided to operate their registries in a consolidated manner. The Consolidated System of EU registries was certified on 1 June 2012 and went into production on 20 June 2012. Croatia was migrated and consolidated as of 1 March 2013.

A complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of the EU and all consolidating national registries.

Information on changes in national registry in 2020 are presented in ***Table 3.5***, below.

Table 3.5 Changes to the EU national registry in 2020

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(a) Change of name or contact	None
15/CMP.1 annex II.E paragraph 32.(b) Change regarding cooperation arrangement	No change of cooperation arrangement occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(c) Change to database structure or the capacity of national registry	There has been 5 new EUCR releases (versions 12.4, 13.0.2, 13.2.1, 13.3.3 and 13.5.1) after version 11.5 (the production version at the time of the last Chapter 14 submission). No changes were applied to the database, whose model is provided in Annex A. No change was required to the application backup plan or to the disaster recovery plan. No change to the capacity of the national registry occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(d) Change regarding conformance to technical standards	The changes that have been introduced with versions 12.4, 13.0.2, 13.2.1, 13.3.3 and 13.5.1 compared with version 11.5 of the national registry are presented in Annex B. It is to be noted that each release of the registry is subject to both regression testing and tests related to new functionality. These tests also include thorough testing against the DES and are carried out prior to the relevant major release of the version to Production (see Annex B). No other change in the registry's conformance to the technical standards occurred for the reported period.
15/CMP.1 annex II.E paragraph 32.(e) Change to discrepancies procedures	No change of discrepancies procedures occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(f) Change regarding security	No changes regarding security occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(g) Change to list of publicly available information	No change to the list of publicly available information occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(h) Change of Internet address	No change of discrepancies procedures occurred during the reported period.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(i) Change regarding data integrity measures	No change of data integrity measures occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(j) Change regarding test results	No change during the reported period.

A new central service desk was also set up to support the registry administrators of the consolidated system. The new service desk acts as 2nd level of support to the local support provided by the Parties. It also plays a key communication role with the ITL Service Desk with regards notably to connectivity or reconciliation issues.

(c) The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. A diagram of the database structure was provided in the last inventory submission. Iteration 4, introduced in October 2012, added the AUCTION table and added a column to the ACCOUNT table to hold trusted accounts. Iteration 4 did not make any change to the capacity of the registry. The documents were provided in the last inventory submission. In 2012, the EU registry has undergone major redevelopment with a view to comply with the new requirements of Commission Regulation 920/2010 and Commission Regulation 1193/2011 in addition to implementing the Consolidated System of EU registries (CSEUR). During certification, the consolidated registry was notably subject to connectivity testing, connectivity reliability testing, distinctness testing and interoperability testing to demonstrate capacity and conformance to the Data Exchange Standard (DES). All tests were executed successfully and led to successful certification on 1 June 2012.

(d) The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The overall change to a Consolidated System of EU Registries triggered changes to the registry software and required new conformance testing. The documents were provided in the last inventory submission.

During certification, the consolidated registry was notably subject to connectivity testing, connectivity reliability testing, distinctness testing and interoperability testing to demonstrate capacity and conformance to the DES. All tests were executed successfully and led to successful certification on 1 June 2012.

(e) The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The overall change to a Consolidated System of EU Registries also triggered changes to discrepancies procedures, as reflected in the updated manual intervention document and the operational plan. The documents were provided in the last inventory submission.

(f) The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The overall change to a Consolidated System of EU Registries also triggered changes to security, as reflected in the updated security plan. The documents were provided in the last inventory submission.

(g) Publicly accessible Information is provided through the link of the National Registry in the corresponding Web site of the Ministry for the Environment and Energy: http://www.ypeka.gr/Default.aspx?tabid=775&locale=en-US&language=el-GR

(h) The internet address of the interface to the Greek Greenhouse Gas registry is:

https://ets-registry.webgate.ec.europa.eu/euregistry/GR/index.xhtml

(i) The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The overall change to a Consolidated System of EU Registries also triggered changes to data integrity measures, as reflected in the updated disaster recovery plan. The documents were provided in the last inventory submission.

(j) On 2 October 2012 a new software release (called V4) including functionalities enabling the auctioning of phase 3 and aviation allowances, a new EU ETS account type (trading account) and a trusted account list went into Production. The trusted account list adds to the set of security measures available in the CSEUR. This measure prevents any transfer from a holding account to an account that is not trusted. The October 2012 release affected only ETS functionality and had no impact on Kyoto functions. Both regression testing and tests on the new functionality were successfully carried out prior to release of the version to Production. The site acceptance test was carried out by quality assurance consultants on behalf of and assisted by the European Commission; the report was provided in the last inventory submission.

CHAPTER 4. POLICIES AND MEASURES, INCLUDING THOSE IN ACCORDANCE WITH ARTICLE 2 OF KYOTO PROTOCOL, AND DOMESTIC AND REGIONAL PROGRAMMES AND/OR LEGISLATIVE ARRANGEMENTS AND ENFORCEMENT AND ADMINISTRATIVE PROCEDURES

4.1 Policy-making process

The Ministry of Environment and Energy (MEEN) is the main governmental body entrusted with the development and implementation of environmental policy in Greece. MEEN is responsible, among others, for the formulation of policies concerning environmental protection, energy, climate change and forestry, for the coordination of implementation efforts and to ensure compliance with the current legislative framework. For this purpose, MEEN cooperates both with other competent ministries and with regional, prefectural and local authorities. Other ministries are responsible for integrating environmental policy and climate change targets within their respective fields (see ***Table 4.1***).

Table 4.1 Responsibilities of Ministries concerning issues of environmental policy in Greece

Ministries	Responsibilities
Ministry of Environment and Energy	Energy policy, Climate change - Control of fuel quality - Management of water resources – Waste management - Industrial pollution — Severe Industrial accidents – Nature conservation - Forest protection and management
Ministry of Development and Investments	Economy, infrastructure and industrial development
Ministry of Infrastructure and Transport	Infrastructure development and control of transport and networks
Ministry of Rural Development and Food	Management of water resources for agricultural use –Implementation of agricultural/environmental measures – Information of farmers on environmental issues
Ministry of Foreign Affairs	International environmental obligations
Ministry of Labour and Social Affairs	Safety in the environment of work – Risk management in professional places
Ministry of Interior	Natural and technological disasters
Ministry of Finance	Support of environmental investments - – Energy and Environmental taxation
Ministry of Education and Religion Affairs	Environmental education and research
Ministry of Tourism	Tourist policy and environment
Ministry of Culture and Sports	Conservation of historical and cultural monuments
Ministry of Health	Management of environmental risk and hygiene
Ministry of Shipping and Island Policy	Environmental management and sustainable development of the islands – Protection of marine environment

The responsibilities on environmental issues at regional level concern the approval of environmental impact studies and the issuance of decisions on environmental terms. The responsibilities of prefectural authorities concern, among others, (a) the development and application of environmental policies and strategies at local level, (b) the adoption of Prefectural or Common Prefectural Decisions on local environmental issues, and (c) the implementation of the physical planning projects which have been approved by the Ministries. Finally, the municipal and community authorities are responsible for licensing procedures for buildings in urban areas, including specific industrial installations, as well as for issues related to solid waste disposal on land.

Climate change mitigation is one of the main targets identified in the Greek policy for sustainable development launched by MEEN in 2002. The objective of the strategy is the development of a set of principles for the formulation of an action plan in line with international challenges, and in accordance with EU policy directions and adjusted to the specific national circumstances. The key environmental issues examined in this framework are:

- Climate change mitigation
- Reduction of air pollutants
- Reduction and rational waste management
- Rational management of water resources
- Prevention of desertification
- Protection of biodiversity and ecosystems

Policies and measures, as well as all other issues and actions regarding mitigation were discussed within the framework of an inter-ministerial committee, comprising representatives from all competent Ministries. Final approval of policies and measures related to climate change mitigation rested with the Council of Ministers.

In December 2019, MEEN published the Greek National Energy and Climate Plan pursuant to article 3 of Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action. The National Energy and Climate Plan (NECP) is the Greek government's strategic plan for climate and energy issues, setting out a detailed roadmap regarding the attainment of specific energy and climate objectives by 2030. The NECP stresses Greece's priorities and development potential in terms of energy and addressing climate change and aims to serve as the key tool for drawing up the national energy and climate policy in the next decade, taking into account the Commission's recommendations and the UN sustainable development goals.

4.2 Domestic and regional programmes and/or legislative arrangements and enforcement and administrative procedures

In response to the emerging evidence that climate change could have a major global impact, the United Nations Framework Convention on Climate Change (henceforth the Convention) was adopted on 9 May 1992 and was opened for signature in Rio de Janeiro in June 1992. Greece signed the Convention in Rio and ratified it in 1994 (Law 2205/94).

In that framework, the third meeting of the Conference of the Parties (COP) to the Convention, held in Kyoto (1-11 December 1997), finalised the negotiations related to the establishment of a legal instrument; the Kyoto Protocol on Climate Change. The Protocol provides a foundation upon which future action can be intensified and introduced, for the first time, legally binding commitments for developed countries to reduce emissions of greenhouse gases. Detailed rules for the implementation of the Protocol were set out at the

7th Conference of the Parties (in Marrakech) and are described in the Marrakech Accords adopted in 2001.

At the first Conference of the Parties serving as the Meeting of the Parties to the Protocol (COP/CMP) held in Montreal (December 2005), the rules for the implementation of the Protocol agreed at COP7 were adopted.

The same COP/CMP established a working group called the Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol (AWG-KP) to discuss future commitments for industrialized countries under the Kyoto Protocol.

The Conference of the Parties (COP) in 2007, by its decision 1/CP.13 (the Bali Action Plan) launched a comprehensive process to enable the full, effective and sustained implementation of the Convention through long-term cooperative action, now, up to and beyond 2012, to be conducted under a subsidiary body under the Convention, the Ad Hoc Working Group on Long-term Cooperative Action under the Convention (AWG-LCA).

The Protocol entered into force on 16 February 2005, after its ratification from 141 Parties (with the exception of USA and Australia) including developed countries with a contribution of more than 55% to global CO2 emissions in 1990.

With respect to the EU target under the 1st commitment period of the Kyoto Protocol (i.e. reduction of emissions at 8% for the period 2008-2012), EU has stated that this will be achieved jointly by EU Member-States under the provisions of Article 4 of the Protocol. The Burden-Sharing agreement between all Member States was finalized during the Environment Council in June 1998 and entered into force with Decision 2002/358/EC concerning the approval, on behalf of the European Community, of the Kyoto Protocol. According to this agreement, Greece is committed to limit its GHG emissions increase for the period 2008 – 2012 to +25% compared to base year emissions (1990 for CO2, CH4 and N2O emissions – 1995 for F - gases). Since the base year emissions of Greece were 106,987,169 t CO2 eq, the assigned amount was calculated to be 668,669,806 t CO2 eq (5 * 1.25 * base year emissions).

Greece ratified the Kyoto Protocol in 2002 (Law 3017/2002) and adopted a National Programme for achieving its commitment by a decision of the Council of Ministers (DCM5/2003). By Law 3017/2002 the MEEN is designated as the governmental body responsible for the coordination, within its responsibilities, of all other competent ministries and possibly any other public and / or private entities involved, for:

1. the implementation of the provisions of the Kyoto Protocol and
2. the formulation and monitoring of the National Programme for achieving the national targets set under the Kyoto Protocol.

Moreover, with this law it is defined that all issues related to the implementation of the provisions of the Kyoto Protocol, including among others, the establishment of the necessary administrative structures and procedures, enforcement rules, etc. are to be resolved and adopted by Common Ministerial Decisions of MEEN, and other, as appropriate, competent Ministers. The same procedure is to be followed in order to introduce into the national legislation any decisions of the COP and/or CMP or any necessary modifications to the National Programme.

With the Joint Ministerial Decision 54409/2632/2004, the Directive 2003/87/EC "establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC" has been transposed into the Greek legislation. With this Decision, as it was amended lately by the JMD 181478/965/2017 the Division of Climate Change and Air Quality of MEEN is designated as the responsible authority for the implementation of the relative provisions.. This decision also provides for penalties in the case for non-conformity. Any operator who does not surrender sufficient allowances by 30 April of each year to cover its emissions during the preceding year is liable for the payment of an excess emissions penalty. The excess emissions penalty is 100 € for each tonne of carbon dioxide equivalent emitted by that installation, for which the operator has not surrendered allowances. Payment of the excess emissions penalty does not release the operator from the obligation to surrender an amount of allowances equal to those excess emissions when surrendering allowances in relation to the following calendar year. Other penalties such as fines of the range of 3.000 to 15.000 € and / or temporary ban of operation are inflicted to operators applicable to infringements related to GHG emissions permit, emissions monitoring and submission of ETS reports, etc.

In Doha, Qatar, on 8 December 2012, the "Doha Amendment to the Kyoto Protocol" was adopted. The amendment includes:

- ✓ New commitments for Annex I Parties to the Kyoto Protocol who agreed to take on commitments in a second commitment period from 1 January 2013 to 31 December 2020;
- ✓ A revised list of greenhouse gases (GHG) to be reported on by Parties in the second commitment period; and
- ✓ Amendments to several articles of the Kyoto Protocol which specifically referenced issues pertaining to the first commitment period and which needed to be updated for the second commitment period.

During the first commitment period, 37 industrialized countries and the European Community committed to reduce GHG emissions to an average of five percent against 1990 levels. During the second commitment period, Parties committed to reduce GHG emissions by at least 18 percent below 1990 levels in the eight-year period from 2013 to 2020; however, the composition of Parties in the second commitment period is different from the first. The EU and its Member States agreed to a -20% reduction.

With the Law 4345 / 2015, the ratification of Doha Amendment has been transposed to Greek legislation. However, Greece will deposit the instruments of ratification of the Doha Amendment in December 2017, as it was agreed with the other European Union’s member states.

Paris Agreement

The Paris Agreement builds upon the Convention and – for the first time – brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects, with enhanced support to assist developing countries to do so. As such, it charts a new course in the global climate effort.

The Paris Agreement’s central aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius. Additionally, the agreement aims to strengthen the ability of countries to deal with the impacts of climate change. To reach these ambitious goals, appropriate financial flows, a new technology framework and an enhanced capacity building framework will be put in place, thus supporting action by developing countries and the most vulnerable countries, in line with their own national objectives. The Agreement also provides for enhanced transparency of action and support through a more robust transparency framework.

The Paris Agreement requires all Parties to put forward their best efforts through “nationally determined contributions” (NDCs) and to strengthen these efforts in the years ahead. This includes requirements that all Parties report regularly on their emissions and on their implementation efforts.

The EU and its Member States are committed to a binding target of an at least 40% domestic reduction in greenhouse gas emissions by 2030 compared to 1990, to be fulfilled jointly, as set out in the conclusions by the European Council of October 2014.

In 2018, Parties will take stock of the collective efforts in relation to progress towards the goal set in the Paris Agreement and to inform the preparation of NDCs. There will also be a global stocktake every 5 years to assess the collective progress towards achieving the purpose of the Agreement and to inform further individual actions by Parties.

Greece has ratified the Paris Agreement on 13/11/2016 with Law 4426/2016.

In December 2020, as part of the European Green Deal EU leaders have agreed on a more ambitious goal for cutting greenhouse gases - reducing them by 55% by 2030, rather than 40%.

As already mentioned, MEEN is responsible in Greece for the monitoring of the implementation of policies and measures for achieving of the national targets set under the Kyoto Protocol. The general framework for monitoring and evaluation of policies and measures till 2020 was based on the Monitoring Mechanism Regulation of the EU. In May 2013, Regulation No 525/2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change (Monitoring Mechanism Regulation, MMR) was adopted, repealing Decision No 280/2004/EC (Monitoring Mechanism Decision, MMD). The main aims of the new regulation were to improve the quality of the data reported and assist the EU and Member States with the tracking of their progress towards emission targets for 2013 - 2020. The revised mechanism improves the current reporting rules by introducing the following new reporting elements:

- Enhanced information related to GHG inventories;
- Reporting of approximated GHG inventories for the past year by 31 July each year (this will facilitate to obtain an earlier preliminary estimate of GHG emissions of the previous year (year X-1) compared to the regular inventory submission in which the most recent year is X-2)
- The introduction of an EU inventory review;
- The establishment of national and Union systems for the reporting of policies and measures and projections;
- Financial and technical support provided to developing countries;
- Member States' use of revenues from the auctioning of allowances in the EU emissions trading system (EU ETS). Member States have committed to spend at least half of the revenue from such auctions on measures to fight climate change in the EU and third countries.
- Member States' adaptation to climate change.

The MMR was replaced by the Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action for the period 2021-2030. The new Regulation establishes a governance mechanism to:

(a) implement strategies and measures designed to meet the objectives and targets of the Energy Union and the long- term Union greenhouse gas emissions commitments consistent with the Paris Agreement, and for the first ten-year period, from 2021 to 2030, in particular the Union's 2030 targets for energy and climate;

(b) stimulate cooperation between Member States, including, where appropriate, at regional level, designed to achieve the objectives and targets of the Energy Union;

(c) ensure the timeliness, transparency, accuracy, consistency, comparability and completeness of reporting by the Union and its Member States to the UNFCCC and Paris Agreement secretariat;

(d) contribute to greater regulatory certainty as well as contribute to greater investor certainty and help take full advantage of opportunities for economic development, investment stimulation, job creation and social cohesion.

The Regulation (EU) 2018/1999 contains provisions about the tracking of the progress accomplished towards reaching mitigation targets, including specific templates for the monitoring and evaluation of policies and measures, the reporting of GHG projections, projection parameters and indicators, etc. In addition, it contains provisions for progress reports about the status of integrated national energy and climate plans, national adaptation actions, financial and technology support provided to developing countries, energy security, energy market, energy poverty, research, innovation and competiveness; and about the monitoring and evaluation of policies and respective targets on renewable energy and energy efficiency.

The main instrument of Greece that sets out a detailed roadmap regarding the attainment of specific energy and climate objectives by 2030 is the National Energy and Climate Plan (NECP). The NECP sets out and describes priorities and policy measures in respect of a wide range of development and economic activities intended to benefit Greek society, and therefore it is a reference text for the forthcoming decade.

The status of ongoing RES projects that are within the first stages of licensing process till operation stage is closely monitored by the Service Department for RES projects investors established at the General Secretariat of Energy and Climate Change of the Ministry of Environment, Energy and Climate Change. Moreover, the monthly production of electricity from renewable sources and installed capacity per RES type is monitored by the National Operator of Electricity Market.

The formulation of climate policy in Greece follows EU policy. A key step towards the formulation and implementation of any EU policy is to carry out an Impact Assessment of the proposed policy or key policy changes. The Impact Assessment outlines a process that prepares evidence for political decision-makers on the advantages and disadvantages of possible policy options. The Impact Assessment is carried out by the Directorate General who takes the lead on a particular policy. The Impact Assessment process is an important element of implementing the EU's commitments under Article 4.2(e) (ii) of the UNFCCC to "identify and periodically review its own policies and practices which encourage activities that lead to greater levels of anthropogenic emissions of greenhouse gases not controlled by the Montreal Protocol than would otherwise occur".

Information about policies and measures for the reduction of GHG emissions, GHG inventory and projections, legislative arrangements and enforcement and administrative procedures that are in place to meet the national commitments under the Kyoto Protocol are publicly accessible through the following web links:

1. https://ypen.gov.gr/ (official website of Ministry of Environment and Energy, containing information about national GHG inventories, legislation, emission trading system, national allocation plans, etc., available in greek language).

2. https://ypen.gov.gr/energeia/ (official website of Ministry of Environment and Energy, containing information about national strategy and policies about energy, renewable energy sources, biofuels, etc., available in greek language).

3. https://ec.europa.eu/clima/ets/ (official website of Union Registry).

4. https://unfccc.int/ghg-inventories-annex-i-parties/20201 (UNFCCC website, containing GHG inventories and NC).

5. Information provided through EU's websites as http://cdr.eionet.europa.eu/gr/eu

http://dataservice.eea.europa.eu/PivotApp/pivot.aspx?pivotid=475 .

4.2.1 Activities under articles 3.3 and 3.4 of Kyoto Protocol

The Presidential Decree of 19-11-1928 "On forest management, felling regulations, forest taxation and rent, disposal of products, resin collection and resin cultivation etc." regulates legislatively the sustainable forest management. By this decree, the principle of sustainability is adopted in its simple form, i.e. sustainable yield. However, the management of Greek forests based on sustainable yield started after the Ministry of Agriculture issued circular No 120094/499/1937.

Furthermore, the Administrative Regulation No 10223/958/1953 "Guidelines for the Implementation of Forest Management Plans in State and Private Forests", which has been revised twice (Ministerial Decisions 158072/1120/1965 and 81701/3908/1991) and the Legislative Decree No 86/1969 set very strict regulations in regard to forest management for both the public and private forests

Law 998/1979 "On the protection of the country's forest and other wooded land" determines the specific protection measures concerning maintenance, development and improvement of country’s forests and other forested lands. According to that legislative framework, forest management is applied following specific rules and guidelines for practices driven by the fundamental principle and predominant goal of preserving and promoting the "sustainability" of forests in terms of their provision of products, growing stock and services.

Legislative Decree No 86/1969 codified almost all the laws that had been issued since 1928 and had been amended and completed by Law 4173/1929. This law constitutes the Forest Code of the country and regulates matters concerning protection, management, ownership rights on forest land, taxation, exploitation of state and privately-owned forests, forest improvement works etc. The Forest Code continues up to now to constitute the basic body of forestry legislation.

Law 3208/2003 stresses the principles of sustainability, conservation of biodiversity and multiple uses of forest lands. Special measures have to be taken for the protection of the landscape and conservation of biodiversity during the management planning and utilization of forest ecosystems (art. 2 par. 1).

Pursuant to Article 24 of the Greek Constitution land use changes of forests are prohibited unless it is required for public interest. Thus, deforestation activities are limited and permitted only in specific cases for the public interest and benefit (e.g. construction of roads, railways, high tension lines), following direct administrative procedures under the provision of Greek laws (Legislative Decree No 86/1969, Law No 998/1979, 1734/1987), before being authorized by the Forest Service which is the responsible authority. Any other temporarily loss of forest cover is not considered as deforestation, and is declared instantly reforested following specific administrative procedures under the provisions of Greek laws (art. 61 Legislative Decree No 86/1969, art. 37, 38, 46, 47 Law 998/1979) in order to recover in its former state.

Therefore, activities under art. 3.3 and 3.4 of Kyoto Protocol have to comply with the provisions of the above mentioned laws and thus contribute to the conservation of biodiversity and sustainable use of natural resources.

4.3 Policies and measures and their effect

4.3.1 Overarching and cross-cutting supporting Policies for the restriction of GHG emissions

In this chapter a short overview of the most important overarching and cross-cutting supporting policies and tools which are related with the implementation of measures for the restriction of GHG emissions in Greece is presented. Emphasis is given to the very recently adopted Climate Law of Greece, the National Energy and Climate Plan, the establishment of emissions trading system since 2005, and the financing mechanisms and fiscal measures that have been developed to support the implementation of projects which inter alia also contribute to the restriction of GHG emissions. The individual sectoral policies and measures with a direct – quantifiable mitigation effect are presented in Section 4.3.2 and CTF Table 3.

4.3.1.1 National Climate Law

On the 26th of May the first Climate Law was approved by the Greek parliament (Law 4936 / GG 105 / 27-5-2022). The new law aims to provide the framework for gradually reducing greenhouse gas emissions and achieve carbon neutrality by 2050, which is in line with the climate goals of the EU for becoming the first climate neutral continent. The legislation introduced sets interim targets to cut greenhouse emissions at least 55% by 2030 and 80% by 2040, compared to 1990. Thus until 2050 achieve the final goal of zero net emissions. In addition, it requires to cut of dependency of fossil fuels, such as lignite in electricity production, by 2028. However, this target might be reconsidered to 2025, depending on security supplies.

Among others, the new Climate Law includes provisions about electric mobility. In particular, from 1st January 2024 at least a quarter of new private car leases acquired through leasing or purchase will be purely electric or hybrid electric vehicles. From 2026 all new taxis as well as one third of the new rental vehicles will be zero emission vehicles. Furthermore, from 1st January 2030 new passenger and light commercial vehicles registered will be only zero - emission vehicles. New provisions for buildings were also introduced, such as the prohibition of installation of heating oil boilers from 1st of January 2025 and from the 1st January 2030, only the sale of heating oil mixed with at least 30% percent by volume of renewable liquid fuels will be allowed.

It should also be mentioned that the new Climate Law determines that from 2023 specific corporations, such as banks, telecoms, power suppliers, water and waste utilities, logistics companies and retail businesses with over 500 employees, will need to submit annual reports for their carbon footprint of the previous year. Moreover, initially the climate bill included an obligatory climate risk insurance for new buildings which considered to be located in high-risk areas, meaning areas that can be damaged from fire or floods. However, prior to the law’s enactment, the leadership of the Ministry of Environment and Energy proceeded to improvements of the law, accepting some objections that had been expressed. One of the changes was the withdrawal of the article 23 of the compulsory insurance of the buildings located in vulnerable zones.

The Climate Law also includes the creation, in 2023, of a five-year budget for the sectors of power production, industry, transportation, agriculture, buildings, forestry and waste and land use. It is planned that more than 10 billion euros will be invested in expanding the country’s power grid by 2030 and in parallel accelerate the development of the sector of renewable energy. In addition, the government, due to the energy crisis, has decided to release to vulnerable citizens a one-off grant for power and gas bills with a total cost of 4 billion euros. The new law also indicates that the country will cover the increases in power bills of the households.

The new Law sets a more ambitious target for 2030 compared to the NECP. The target is set to a total 55% reduction in GHG emissions in Greece in 2030 compared to 1990, instead of 40% according to NECP. The scenarios and the policy contribution to achieve the new target have not been defined, yet. Currently, the NECP is being updated in order to reflect the new target. The new NECP is expected to be published in 2023. Consequently, the estimated effect of mitigation actions and the projections scenarios reported in NC8 and BR5 did not reflect the new more ambitious targets of the Climate Law.

4.3.1.2 National Energy and Climate Plan

The National Energy and Climate Plan (NECP), which was recently adopted by Greece (GG 4893 / 31.12,2019), constitutes a strategic plan for the Greek Government on Climate and Energy issues and comprises a detailed roadmap for achieving concrete Energy and Climate Goals by 2030. The NECP presents and analyzes Policy Priorities and Measures in a wide range of economic and development activities for the benefit of Greek society and constitutes the reference text for the next decade.

The NECP highlights our country's energy and climate priorities and development opportunities and aims to be the key tool for shaping/mainstreaming the national energy and climate policy over the next decade, taking into account the recommendations of the European Commission and the UN Sustainable Development Goals (SDGs).

The Government's strategic objective is the energy and climate goals set by the NECP until 2030 to make a decisive contribution to the necessary energy transition in the most economically competitive way for the national economy, to achieve a drastic reduction in greenhouse gas emissions and finally to make our country one of the Member States that has adopted ambitious climate and energy goals through a comprehensive and coherent programme of measures and policies, putting us at the frontline of Energy Union developments for both 2030 and 2050.

In particular, the NECP as a whole sets significantly more ambitious national energy and climate targets by 2030, both in relation to the original NECP presented in January 2019 and the central European targets and also contributes to the new Green Deal currently promoted by the European Commission.

In particular, by 2030, the NECP provides for:

(a) On climate change and emissions issues, a significantly higher central **target of reducing greenhouse gas emissions**, with a reduction of over 40% in reference to 1990 emissions and over 55% over emissions in reference to 2005, surpassing even the central European targets, while it is worth noting that in the original NECP these targets were significantly lower and resulted to a reduction of 33% and 49% respectively. These new greenhouse gas emission reduction targets are also necessary in order to enable the transition to a climate-neutral economy by 2050, as the Greek Government aims to contribute proportionally to the commitment to a climate-neutral economy at EU level. In parallel with the Climate Mitigation and Adaptation Policies, the NECP sets out the initiatives to be undertaken in the framework of the National Climate Change Adaptation Strategy (NAS) and in line with the NAS general objectives, guiding principles and tools for implementing the necessary climate change measures at national, regional and local level.

Accordingly, the waste management sector is an integral part of the national energy and climate planning and therefore the relevant initiatives for the revision of the National and Regional Waste Management Plans, aiming at the intensification of a series of measures for integrated waste management according to the requirements of circular economy.

Moreover, as Circular Economy is a pivotal element of the country's development strategy, including inter alia a four-year strategic planning that spans the whole value chain, the NECP outlines the pillars of this policy.

(b) Regarding **Renewable Energy Sources (RES)**, a significantly higher target in reference to the share of gross final energy consumption of at least 35% is set, instead of the 31% set in the original NECP and also significantly higher than the central European target for RES of 32%.

It is worth noting of the energy transformation that is anticipated for the electricity sector as the share of RES in electricity consumption is projected to exceed 60% and in this context specific Government initiatives are already being promoted and implemented such as the simplification and acceleration of the permitting framework, optimizing the integration of RES into the electricity grids, the operation of storage systems, and the promotion of electromobility.

(c) To improve **energy efficiency**, also a significantly more ambitious target than the original NECP is set, which is also higher than the corresponding European target. In particular, it is set as a quantitative objective that the final energy consumption in 2030 is lower than the one recorded in 2017, fully meeting the relevant European indicator of the NECP's ambition measure.
In addition, an energy efficiency improvement of 38% is achieved qualitatively, according to a specific European methodology, where the corresponding central European target amounts to 32.5% and the initial/draft NECP was set at 32%. Achieving this ambitious target will enhance the competitiveness of the Greek economy and consumer protection. NECP describes a set of measures to improve energy efficiency, most prominently in the building and transport sectors.

The flagship goal under the new revised NECP is **the high ambition but also realistic programme for drastically reducing and definitively ceasing lignite's share in power generation until 2028**, i.e. de-lignification, with a front-loaded timing.

This objective also incorporates the government's vision to address environmental issues in the long run, and to streamline the cost of electricity production in our country immediately.

The programme for delignification of domestic electricity generation also provides for the adoption of integrated programmes to support the Greek lignite areas for this transition to the post-lignite period. In particular, the commitment of the Greek Government is to withdraw lignite units by the year 2028 in a coordinated and responsible manner. Securing jobs and leveraging the high-tech know how of the human resources of these areas is a top priority.

In mid-2020, a comprehensive, multidimensional and frontloaded [MasterPlan – Just Development Transition Plan] will be presented which will be the roadmap for development in the post-lignite era. The Greek Government has the political will and know-how to make use of the resources available at national level but also to seek increased funding from European funds and in particular from the Just Transition Fund.

De-lignification is a major breakthrough in the national energy map and at the same time a huge opportunity for the country. The spirit of innovation that has brought the exploitation of lignite will be imparted into clean forms of energy and the new energy mix of the 21st century.

The NECP also incorporates and describes corresponding measures for other strategic policy priorities such as accelerating the electricity interconnection of islands, operating the new electricity market model without further delays, enhancing energy interconnections and developing strategic storage projects, digitizing energy networks, promoting electromobility, coupling end sectors, as well as research and innovation and competitiveness initiatives demonstrating the Government's holistic approach to planning policies and measures in the areas of Climate and Energy.

4.3.1.3 Emissions trading system – aviation – marine bunker fuels

In 2005 the European CO2 emissions trading system (EU-ETS) started operating. It covers a number of industrial and energy sector installations which exceed specific capacity limits set by Community Directive 2003/87/EC. The major objective of EU-ETS is to help the EU Member States to achieve their obligations in the frame of the Kyoto Protocol in terms of economic efficiency.

In brief, the basic functional characteristics of the emissions trading system include: (a) the determination of a number of emissions allowances which are allocated a priori in the liable installations based on specific rules, while the above mentioned installations are obliged to hand over emissions allowances in annual base equal to the CO2 emissions that emitted in the previous year , (b) the total number of allowances for distribution is lower than the emissions that the indebted installations would emit if the trading system did not exist, so that the created closeness of allowances constitutes an incentive for emissions reductions, (c) in the first and second implementation period (2005-2007 & 2008-2012) the trading of allowances is limited to CO_2 and in installations of specific industrial sectors which exceed the predetermined capacity limits (in the future according to Directive 29/2009/EC amending Directive 2003/87/EC the system will include also other gases and sectors), (d) the distribution of emissions allowances is made on the basis of a National allocation plan which is formulated, placed on consultation and is completed before the beginning of the trading period, (e) a strict framework for monitoring and compliance enforcement of the liable installations is put in place which provides for substantial fines in case on non-compliance, and (f) all the transactions of emissions allowances are recorded in national and interconnected community-wide Registries.

In Greece, the trading system for the period 2008-2012 comprises 140 industrial installations (power plants, refineries, cement plants etc.). An allowance reserve is also created which is intended to cover possible unknown new entrants in the period. According to the 2nd National Allocation Plan (NAP), the allowances of CO_2 emissions that are to be allocated to installations included in the EU-ETS (including the reserve) were fixed to 341.547.710 t CO_2, which requires a considerable decrease of emissions by the enterprises that participate in the system. It is estimated that this decrease of emissions or, with other words, the effect of ETS supporting policy is a 16.7% reduction or 69.2 Mt of CO_2 emissions of ETS installations for the period 2008-2012. Since ETS is a supporting policy, the emissions reduction target is implemented by applying other policies and measures as NG use, RES, CHP etc. So, its effect is not additional to the sum of the other policies and measures.

In 2013, the EU ETS moved in its third phase, running from 2013 to 2020. A major revision in order to strengthen the system means the third phase is significantly different from phases one and two and is based on rules which are far more harmonized than before. The main changes are:

- A single, EU-wide cap on emissions applies in place of the previous system of 27 national caps of each EU Member State;
- Auctioning, not free allocation, is now the default method for allocating allowances. In 2013 more than 40% of allowances will be auctioned, and this share will rise progressively each year. In Greece no free allowances will be allocated to the power sector;
- For those allowances still given away for free, harmonised allocation rules apply which are based on ambitious EU-wide benchmarks of emissions performance. Manufacturing industry will receive 80% of its allowances for free in 2013, a proportion that will decrease in linear fashion each year to 30% in 2020. Sectors facing carbon leakage will receive higher share of free allowances. According to "Benchmarking Decision" 2011/278/EU), installations that meet the benchmarks, i.e. they are among the most efficient in the EU, will in principle receive all the allowances they need. Those that do not reach the benchmarks will receive fewer allowances than they need. These installations will therefore have to reduce their emissions, or buy additional allowances or credits to cover their emissions, or combine these two options. The continued provision of some free allowances limits costs for EU industries in relation to international competitors. Sectors and sub-sectors facing competition from industries outside the EU which are not subject to comparable climate legislation will receive a higher share of free allowances than those which are not at risk of such "carbon leakage."
- Some more sectors and gases are included, as nitrous oxide emissions from the production of certain acids (i.e. nitric, adipic, glyoxal and glyoxylic acids) and emissions of perfluorocarbons from aluminum production.
- Monitoring and reporting: the reform to the EU ETS in Phase III has resulted in important changes with regards to domestic institutional arrangements for the monitoring and reporting of GHG emissions under the EU ETS. EU ETS MRV will be required to comply with two new Commission Regulations from the Phase III of

the EU ETS onwards, one specific to monitoring and reporting and the other to verification and accreditation. The latter introduces a framework of rules for the accreditation of verifiers to ensure that the verification of operator's or aircraft operator's reports in the framework of the Union's greenhouse gas emission allowance trading scheme is carried out by verifiers that possess the technical competence to perform the entrusted task in an independent and impartial manner and in conformity with the requirements and principles set out in this Regulation. These regulations have direct legal effect in the Member States as there is no need to transpose and implement in national legislation since the provisions apply directly to operators or aircraft operators, verifiers, and accreditation parties. The regulations provide clarity on the roles and responsibilities of all parties (i.e. industrial installations and aircraft operators are required to have an approved monitoring plan) which will strengthen the compliance chain.

The European Commission adopted in March 2018 the Directive (EU) 2018/410 in order to revise the EU emissions trading system (EU ETS) for the period after 2020. This is the first step in delivering on the EU's target to reduce greenhouse gas emissions by at least 40% domestically by 2030 in line with the 2030 climate and energy policy framework and as part of its contribution to the Paris Agreement.

To achieve the at least 40% EU target, the sectors covered by the ETS have to reduce their emissions by 43% compared to 2005. To this end, the overall number of emission allowances will decline at an annual rate of 2.2% from 2021 onwards, compared to 1.74% currently. This amounts to an additional emissions reduction in the sectors covered by the ETS of some 556 million tonnes over the decade − equivalent to the annual emissions of the UK.

The Market Stability Reserve (MSR) - the mechanism established by the EU to reduce the surplus of emission allowances in the carbon market and to improve the EU ETS's resilience to future shocks – will be substantially reinforced. Between 2019 and 2023, the amount of allowances put in the reserve will double to 24% of the allowances in circulation. The regular feeding rate of 12% will be restored as of 2024. As a long-term measure to improve the functioning of the EU ETS, and unless otherwise decided in the first review of the MSR in 2021, from 2023 onwards the number of allowances held in the reserve will be limited to the auction volume of the previous year. Holdings above that amount will lose their validity.

The revised EU ETS Directive provides predictable, robust and fair rules to address the risk of carbon leakage. The system of free allocation will be prolonged for another decade and has been revised to focus on sectors at the highest risk of relocating their production outside of the EU. These sectors will receive 100% of their allocation for free. For less exposed sectors, free allocation is foreseen to be phased out after 2026 from a maximum of 30% to 0 at the end of phase 4 (2030). A considerable number of free allowances will be set aside for new and growing installations. This number consists of allowances that were not allocated from the total amount available for free allocation by the end of phase 3 (2020) and 200 million allowances from the MSR.

More flexible rules have been set to better align the level of free allocation with actual production levels:

- ✓ Allocations to individual installations may be adjusted annually to reflect relevant increases and decreases in production. The threshold for adjustments was set at 15% and will be assessed on the basis of a rolling average of two years. To prevent manipulation and abuse of the allocation adjustment system, the Commission may adopt implementing acts to define further arrangements for the adjustments.
- ✓ The list of installations covered by the Directive and eligible for free allocation will be updated every 5 years.

- ✓ The 54 benchmark values determining the level of free allocation to each installation will be updated twice in phase 4 to avoid windfall profits and reflect technological progress since 2008.

Overall, more than 6 billion allowances are expected to be allocated to industry for free over the period 2021-2030.

Several low-carbon funding mechanisms will be set up to help energy-intensive industrial sectors and the power sector meet the innovation and investment challenges of the transition to a low-carbon economy. These include two new funds:

- ✓ The Innovation Fund will support the demonstration of innovative technologies and breakthrough innovation in industry. It will extend existing support under the NER300 programme. The amount of funding available will correspond to the market value of at least 450 million emission allowances.
- ✓ The Modernisation Fund will support investments in modernising the power sector and wider energy systems, boosting energy efficiency, and facilitating a just transition in carbon-dependent regions in 10 lower-income Member States.

Aviation

The aviation sector has been part of the EU ETS since 2012. The original legislation covers all flights in and out of the European Economic Area (EEA). However, for 2012-2016, in order to support the development of a global measure by the International Civil Aviation Organisation (ICAO) for reducing aviation CO2 emissions, the EU provided a derogation limiting obligations solely to flights within the EEA and to flights within the EEA outermost regions.

In light of the adoption of a Resolution by the 2016 ICAO Assembly on the global measure “Carbon Offsetting and Reduction Scheme for International Aviation” (CORSIA), pending the ICAO's adoption of the relevant CORSIA instruments and subsequent decisions by the EU on the possible implementation of CORSIA in the EU, and to provide continued momentum to the international process, the EU decided in 2017 to extend the current derogation from EU ETS obligations for flights to and from third countries until 31 December 2023, subject to review[2]. The review should consider how to implement the ICAO global measure in Union law through a revision of the EU ETS legislation. The review would take due account of the necessary consistency with EU climate objectives and commitments under the Paris Agreement.

In October 2018, the ICAO Council adopted the Standards and Recommended Practices (SARPs) for CORSIA. As of 1 January 2019, aircraft operators will be required to monitor and report their emissions for CORSIA. To this end, the EU has put in place a legally binding monitoring, reporting and verification (MRV) framework based on the CORSIA SARP and the existing MRV framework under the EU ETS[3].

The inclusion of intra-EEA flights in the EU ETS has delivered around 100 Mt of CO2 reductions between 2012 and 2018[4]. While some reductions are likely to be within the aviation sector, encouraged by the EU ETS's economic incentive for limiting emissions or use of aviation biofuels, the majority of reductions are expected to have occurred in other sectors.[5]

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[2] REGULATION (EU) 2017/2392 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 13 December 2017 amending Directive 2003/87/EC to continue current limitations of scope for aviation activities and to prepare to implement a global market-based measure from 2021, OJ L 350, 29.12.2017, p. 7.

[3] The EU MRV framework consists of the two implementing acts (Commission implementing regulation (EU) 2018/2066 of 19 December 2018 and Commission implementing regulation (EU) 2018/2067 of 19 December 2018 and a delegated act (Commission Delegated Regulation (EU) 2016/2072 of 22 September 2016).

[4] 1.5% of aviation emissions may be offset by the use of International Credits. Only CP2 CERs from some limited project types may be used

[5] https://ec.europa.eu/clima/policies/ets/allowances/aviation_en

The Innovation Fund, established by and funded through the EU ETS, will also support the aviation sector through funding of innovation projects in low-carbon technologies and processes; the production of e-fuels[6] and synthetic kerosene to replace carbon intensive refinery products; and in the production of e-fuels, hydrogen and synthetic kerosene where these are forms of energy storage.

Marine bunker fuels

Concerning international maritime transport, Greece in line with the European Union has a strong preference for a global approach to reducing GHG emissions from international shipping led by the International Maritime Organization (IMO).

In June 2013, the European Commission adopted a Communication setting out a strategy for progressively including greenhouse gas emissions from maritime transport in the EU's policy for reducing its overall emissions. The strategy consists of the following consecutive steps:

- Establishing a system for monitoring, reporting and verifying (MRV) of CO2 emissions;
- Setting reduction targets for the maritime transport sector;
- Applying further measures, including market-based instruments, in the medium to long term.

Relating to the first of these three steps, large ships over 5,000 gross tonnes loading /unloading cargo/ passengers from 1 January 2018 at EU maritime ports are to monitor and later report their related CO2 emissions and other relevant information in accordance with their monitoring plan.

Monitoring, reporting and verification of information shall be done in conformity with Regulation 2015/757 (as amended by Delegated Regulation 2016/2071). Three other legal acts are also relevant: Delegated Regulation 2016/20172 regarding verification and accreditation activities, Implementing Regulations 2016/1927 on templates and Implementing Regulation 2016/1928 further defining cargo carried for some ship categories. Main obligations can be summarized are as follows:

- By 30 August 2017, MRV companies shall submit to an accredited MRV shipping verifier a monitoring plans using a template corresponding to the model in Annex I of Implementing Regulation (EU) 2016/1927 (for more information see also our FAQs document). Electronic templates will also be developed under THETIS MRV (the dedicated European Union information system currently under development by the European Maritime Safety Agency)
- From 1st January 2018, MRV companies shall monitor for each of their ship CO2 emissions, fuel consumption and other parameters, such as distance travelled, time at sea and cargo carried on a per voyage basis, so as to gather annual data into a Emissions report submitted to an accredited MRV shipping verifier;
- From 2019, by 30 April of each year MRV companies shall submit to the Commission through THETIS MRV (a dedicated European Union information system currently under development by the European Maritime Safety Agency) a satisfactorily verified Emissions report for each of the ships having performed EEA related maritime transport in the previous reporting period (calendar year);
- From 2019, by 30 June of each year MRV companies shall ensure that, all their ships having performed activities in the precedent reporting period and visiting EEA ports, carry on board a document of compliance issued by THETIS MRV. This obligation might be subject to inspections by Member States' authorities.

4.3.1.4 Financing mechanisms

[6] E-fuels are gaseous and liquid fuels such as hydrogen, methane, synthetic petrol and diesel fuels generated from renewable electricity.

The funding for the support of policies that either straightforward or inter alia contributes in the restriction of GHG emissions is drew from financing mechanisms that in a big extent have been developed in the frame of the Community Support Frameworks.

Information about the financing mechanisms of the programming periods 2000-2006 and 2007-2013 was included in the 6th National Communication. The current funding tools that Greece utilizes are summarized below.

The **Green Fund** is an idea that was implemented by Law 3889/2010 and aims to raise funds for the environment. More specifically, this fund aims to enhance development through environmental protection, enhancement and restoration of the environment, climate change and support of the national environmental policy. The Green Fund introduced the first Programme Guide in October 2011 and the total commitments-absorptions in 2011 amounted to EUR 60 million, while funding programmes of the Green Fund for the year 2012 amounted to EUR 72 million. For the period 2015-2017, funding activities and projects of EUR 142.7 million have been approved and being executed.

LIFE is a financial instrument of the European Union and its main goal is to contribute to the implementation, updating and development of Community environmental policy and legislation, including the integration of the environmental and climate objectives into other policies, thereby contributing to the promotion of sustainable development. Therefore, LIFE finances measures and projects with European added value for the Member States.

The LIFE programme consists of two sub-programmes, one for Environment and one for Climate Action.

Since the launch of the LIFE programme by the European Commission in 1992, a total of 254 projects have been co-financed in Greece. Within the framework of the new LIFE programme, there are some projects on Climate Change which have been funded. The most important of them is the integrated project «LIFE-IP AdaptInGR - Boosting the implementation of adaptation policy across Greece» for adapting Greece to climate change (https://www.adaptivegreece.gr/en-us/). The project aims to catalyse the implementation of the Greek National Adaptation Strategy and of the 13 Regional Adaptation Action Plans at the current 1st adaptation policy cycle (2016-2025) and to prepare the passage to the 2nd adaptation policy cycle (2026+), through appropriate action at national, regional and local levels.

All these projects since 1992 represent a total investment of over €380 million, of which over €210 million has been contributed by the European Union.

There are also two new financial instruments, the Natural Capital Financing Facility (NCFF) and the Private Finance for Energy Efficiency (PF4EE) tool. For details, please visit the LIFE website (ec.europa.eu/life).

The **European Structural and Investment Funds (ESIF)** for the period 2014-2020, on 7-8 February 2013, and based on a Commission proposal, the European Council concluded that climate action objectives will represent at least 20 % of EU spending in the period 2014-2020 and therefore be reflected in the appropriate instruments to ensure that they contribute to strengthen energy security, building a low-carbon, resource-efficient and climate resilient economy that will enhance Europe’s competitiveness and create more and greener jobs. The European Structural and Investment Funds (ESIF) comprise:

- ✓ The European Regional Development Fund (ERDF) including also the goal on European Territorial Cooperation (ETC);
- ✓ The European Social Fund (ESF);
- ✓ The Cohesion Fund (CF);
- ✓ The European Agricultural Fund for Rural Development (EAFRD);
- ✓ The European Maritime and Fisheries Fund (EMFF).

Therefore, 20% of the ESIF funds that Greece will receive for the period 2014-2020 have to be invested in mitigation and adaptation policies and measures, according to the Operational Programmes (OP) that have been prepared for that period.

To help achieve its climate goals, the EU has decided to integrate, or mainstream, climate action across the entire EU budget. The EU’s 2021-2027 long-term budget, together with the NextGenerationEU recovery instrument, amounts to €2.018 trillion in current prices (€1.8 trillion in 2018 prices). This unprecedented response will help repair the economic and social damage caused by the coronavirus pandemic and aid the transition towards a modern and more sustainable Europe. 30% of the EU budget will be spent to fight climate change.

The **Greek Recovery and Resilience Plan (RRP), Greece 2.0**, under the framework of NextGenerationEU, aspires to change the Greek growth model and institutions:

- Via ambitious reforms and investments
- Towards an extroverted, competitive, green and digital growth model

One of the main pillar is the “green transition” with RFF budget 6.2 € bn and expected total mobilized investment resources of 11.6 € bn. The RRP will contribute to the green transition of Greece with 38% of its budget dedicated to the achievement of the climate targets. It contains key investments, such as:

- Upgrading energy efficiency of buildings for households, firms and the public sector
- Investments in energy storage, electric charge points, batteries, electric vehicles
- Improving electric interconnectivity of islands
- National reforestation plan, biodiversity and strengthening of civil protection
- Urban plans and strategic urban regeneration

Special reference is also made to financing development actions in Greek areas whose economy depends strongly on lignite extraction for power generation, in the region of Western Macedonia and the municipality of Megalopolis in particular, to support **just transition** in these areas through the establishment of a ‘Special account for just transition in lignite-producing areas’. The development actions to be financed in each annual cycle of allocation of the revenue from the auctioning of emissions allowances will be determined through an open public consultation on the basis of the following axes:

- Development of clean forms of energy, funded by projects implemented by energy communities with the participation of natural persons, and/or local authorities and/or legal persons governed by private/public law, aiming to promote renewable energy sources and reduce energy poverty. This axis could include, inter alia, biomass/biogas projects, with the participation of local livestock cooperatives and generally autoproduction projects with the possibility of utilising existing energy infrastructure (e.g. distribution and/or transmission networks).
- Preventing energy poverty: Developing natural gas networks for safe energy transition in these areas, conversion of district heating networks.
- Energy savings: Improving the energy performance of public/private buildings in compliance with the minimum energy performance requirements for buildings and tackling energy poverty. Prioritising the promotion of energy communities with the participation of local authorities as eligible entities.
- Supporting the primary sector: Promoting energy crops, namely locally produced biomass for the supply of alternative district heating systems, and enhancing local crops with high added value (e.g. saffron, rose, oregano, tea), new innovative livestock activities, and promoting the export activities of existing cooperatives and their verticalised development. Geothermal field utilisation projects could also be included in this axis to support greenhouse crops and greenhouse parks, as well as circular economy operations including the treatment of sewage sludge and the disposal of products as soil improvers, land reclamation and/or irrigation projects, etc.

- Interventions in the field of circular economy / recovery of secondary materials, by strengthening the market in secondary materials, laying down technical standards for secondary materials, utilising and trading in secondary materials on the market and including them in public projects, aiming to reduce dependence on mineral resources and eventually protecting the environment and climate by reducing the intensity of primary material production activities.
- Treatment and energy utilisation of sewage sludge and disposal of products as soil additives, utilisation of ash, etc. with emphasis on the respective actions/projects/priorities of the National Plan for Circular Economy.
- Industrial heritage: Utilising lignite-fired plants to promote the industrial heritage of the lignite-producing areas in Greece.
- Implementing integrated action programmes in the field of employment (e.g. new forms of energy, agri-food industry, tourism, subsidising new jobs in companies dealing with systems or techniques for managing and saving energy or energy upgrading, etc.), as well as training programmes in the above areas.
- Implementing entrepreneurship and innovation support programmes in various sectors and especially in those mentioned above.
- Providing technical support to potential beneficiaries for the maturation of projects/actions for public works.

4.3.1.5 Fiscal measures

Taxation of energy products

Energy taxes are levied within the framework of the 2003 EU Energy Taxation Directive (Directive 2003/96/EC of the Council of 27 October 2003 for restructuring the European Community framework on the taxation of energy products and electricity); the Directive has been transposed into Greek legislation with Law 3336/2005, in combination with the provisions of the National Customs Code (Law 2960/2001). Tax rates are generally significantly higher than the minimum levels prescribed in the Directive. Driving the ambition further, the energy taxation directive 2003/96/EC will be revised, as part of the European Green Deal.

The following table depicts the current excise duty rates for specified products (Law 4389/2016).

Table 4.2 Excise duty rates for specified products

Excise duties (euro)		
Energy products	**2022**	**Imposition Unit**
Leaded Petrol	681	1000 lt
Unleaded Petrol	700	1000 lt
Gasoil[7]	410	1000 lt
Kerosene[8]	670	1000 lt
Heavy fuel oil	38	1000kg
Liquid petroleum gas (LPG) for propellant use	430	1000 kg
Liquid petroleum gas (LPG) as heating fuel[9]	60	1000 kg
Natural gas for propellant use	0	GJ

[7] A winter period is defined (from 15 October to 30 April each year) during which a reduced rate of 280Eur/1,000 lt is applied if used as heating fuel.
[8] A winter period is defined (from 15 October to 30 April each year) during which a reduced rate of 280Eur/1,000 lt is applied if used as heating fuel.
[9] Industrial/Commercial use / stationary motors: 120 EURO / 1000kg.

Natural gas heating fuel for business use[10]	0.3-1.5	GJ
NG heating fuel for households	0.3	GJ
Coal & coke	0.3	gigajoule
Biodiesel	410	1000 lt
Electricity for consumers of high v and medium voltage (0-10000MWh)	5	MWh
Electricity for consumers of high v and medium voltage (over 10000MWh)	2	MWh
Electricity for households	2.2	MWh
Electricity used for agricultural, horticultural or piscicultural works, and in forestry	0	MWh
Electricity (other)	5	MWh

Fuels used for the purpose of electricity generation are also taxed, with the exception of coal, lignite, coke and natural gas.

Car registration tax

According to the National Customs Code (Law 2960/2001, as amended), motor vehicles for private use which are imported to Greece, in order to be registered and circulate with Greek plates, are subject to registration tax. The relevant rates are determined on the basis of the taxable price, CO2 emissions per km and the anti-pollutant technology of the vehicle (***Table 4.3***). Hybrid cars are subject to 50% of the registration tax, while electric cars are not subject to registration tax.

[10] Excise duty per yearly consumption as follows: 1.5Euro/GJ for 0-36,000 GJ; 0.45 Euro/GJ for 36,001-360,000GJ; 0.4 Euro/GJ for 360,001-1,800,000GJ; 0.35 Euro/GJ for 1,800,001-3,600,000GJ; 0.3 Euro/GJ for >3,600,000GJ

Table 4.3a Registration tax rates for Euro 6 (6b-1/6c-1) and onwards

CO2 emissions (g/km) Taxable price (Euros)	0-100	101-120	121-140	141-160	161-180	181-200	201-250	>250
Up to 14,000	3.8	4	4.4	4.8	5.2	5.6	6.4	8
14,000-17,000	7.6	8	8.8	9.6	10.4	11.2	12.8	16
17,000-20,000	15.2	16	17.6	19.2	20.8	22.4	25.6	32
20,000-25,000	22.8	24	26.4	28.8	31.2	33.6	38.4	48
25,000 and above	30.4	32	35.2	38.4	41.6	44.8	51.2	64

Table 4.3b Registration tax rates for Euro 5b+ / Euro 6b

CO2 emissions (g/km) Taxable price (Euros)	0-100	101-120	121-140	141-160	161-180	181-200	201-250	>250
Up to 14,000	5.7	6	6.6	7.2	7.8	8,4	9.6	12
14,000-17,000	11.4	12	13.2	14.4	15.6	16.8	19.2	24
17,000-20,000	22.8	24	26.4	28.8	31.2	33.6	38.4	48
20,000-25,000	34.2	36	39.6	43.2	46.8	50.4	57.6	72
25,000 and	45.6	48	52.8	57.6	62.4	67.2	76.8	96

above								

Table 4.3c Registration tax rates for other Euros

CO_2 emissions (g/km) Taxable price (Euros)	0-100	101-120	121-140	141-160	161-180	181-200	201-250	>250
Up to 14,000	11.4	12	13.2	14.4	15.6	16.8	19.2	24
14,000-17,000	22.8	24	26.4	28.8	31.2	33.6	38.4	48
17,000-20,000	45.6	48	52.8	57.6	62.4	67.2	76.8	96
20,000-25,000	68.4	72	79.2	86.4	93.6	100.8	115.2	144
25,000 and above	91.2	96	105.6	115.2	124.8	134.4	153.6	192

Table 4.3d Registration tax rates for other non-Euros

Taxable price (Euros)	Registration tax rate
Up to 14,000	48
14,000-17,000	96
17,000-20,000	192
20,000-25,000	288
25,000 and above	384

Motor vehicle circulation fee (road tax)

Owners of motor vehicles and motorcycles using public roads are subject to an annual road tax, paid one-off every year from 1 November until 31 December in advance for next year. The vignette (sticker) was abolished since 2013 (Law 4093/2012). Tax rates, tax base and reliefs are determined by the Ministry of Finance. Motor vehicles are categorized to vehicles for private and public use and within each category to passenger cars, lorries and trucks, buses, trailers and other vehicles. The tax assessment basis is cylinder capacity for private cars, gross weight for lorries and number of passenger seats for buses.

Currently, the road tax for private cars is specified on the basis on the cylinder capacity (cc) for cars that have registered in Greece before 31/10/2010; and on the CO2 emissions for cars registered afterwards.

Table 4.4a Road tax for cars registered till 2000

Category	Engine size (cc)	Annual road tax (euros)
A	Up to 300	22
B	301-785	55
Γ	786-1071	120
Δ	1072-1357	135
E	1358-1548	225
ΣΤ	1549-1738	250
Z	1739-1928	280
H	1929-2357	615
Θ	2358-3000	820
I	3001-4000	1025
K	4001 and above	1230

Table 4.4b Road tax for cars registered during 2001-2005

Category	Engine size (cc)	Annual road tax (euros)
A	Up to 300	22
B	301-785	55
Γ	786-1071	120
Δ	1072-1357	135
E	1358-1548	240
ΣΤ	1549-1738	265
Z	1739-1928	300
H	1929-2357	630
Θ	2358-3000	840
I	3001-4000	1050
K	4001 and above	1260

Table 4.4c Road tax for cars registered during 2006-31.10.2010

Category	Engine size (cc)	Annual road tax (euros)
A	Up to 300	22
B	301-785	55
Γ	786-1071	120
Δ	1072-1357	135
E	1358-1548	255
ΣΤ	1549-1738	280

Z	1739-1928	320
H	1929-2357	690
Θ	2358-3000	920
I	3001-4000	1150
K	4001 and above	1380

Table 4.4d Road tax for cars registered after 1.11.2010 – 31.12.2020

CO2 emissions (gCO2/km)	Annual road tax per gCO2 (euros)
0-90	0
91-100	0.90
101-120	0.98
121-140	1.20
141-160	1.85
161-180	2.45
181-200	2.78
201-250	3.05
251 and above	3.72

Table 4.4ε Road tax for cars registered after 1.1.2021

CO2 emissions (gCO2/km)	Annual road tax per gCO2 (euros)
0-122	0
123-139	0.64
140-166	0.70
167-208	0.85
209-224	1.87
225-240	2.20
241-260	2.50
261-280	2.70
281 and above	2.82

Hybrid cars, which were registered before 31/10/2010, up to 1,549 cc are exempt from road tax. Hybrid cars with a cylinder capacity more than 1,549 cc, are subject to the 60% of the road tax corresponding to a car of conventional technology.

Corporate income taxation

The revenues of the enterprises that operate after approval by the Ministry of Environment and Energy, as an "Alternative Management System", which remain after the deduction of the statutory reserve and its reduction to a gross amount with the addition of the corresponding income tax, are exempt from income tax. As “Alternative Management System" is defined the organization on an individual or collective basis of any legal form of the collection works, including the warranty, transport, re-use and exploitation of used packaging or packaging waste and other products (e.g. batteries, appliances, telecommunication material etc.).

Moreover, the revenues from the sale of electric energy to PPC or other suppliers of electricity, which is produced by households or small business, after their inclusion in the

"Special Program for the Development of Photovoltaic Systems up to ten (10) kw", are exempt from taxation.

Moreover, all renewable energy source technologies are eligible for tax incentives. According to the new development law (4399/2016), investment subsidies will be granted to small hydro plants (up to 15 MW), high-efficiency co-generation plants using renewable energy sources, hybrid renewable energy source plants in the non-interconnected islands (up to 5 MW), production of heating and cooling from renewable energy sources, and high-efficiency district heating and cooling.

4.3.1.6 Local authorities contribution to mitigation of climate change adverse effects

Local authorities have a key role in mitigating climate change, since:

- Over half of greenhouse gas emissions are created in and by cities.
- 80% of the population lives and works in cities, where up to 80% of energy is consumed.
- Local authorities, being the closest administration to the citizens are ideally positioned to understand their concerns.

For that reason, the European Commission commenced an ambitious initiative and/or voluntary effort, named "The Covenant of Mayors", which gives the lead to Europe's pioneering cities to mitigate climate change through the implementation of intelligent local sustainable energy policies that create stable local jobs, increase citizens' quality of life and address crucial social issues. The Covenant of Mayors constitutes a formal commitment to go beyond the EU objectives in terms of CO2 reduction, through the implementation of sustainable energy action plans with concrete measures.

Signatories to the Covenant commit to submitting their local Sustainable Energy Action Plans (SEAPs) within the year following adhesion. These cities are then expected to provide periodic public reports outlining the progress of their Action Plans. Cities also commit to allocating sufficient human resources to the tasks, mobilising society in their geographical areas to take part in the implementation of the action plan, including organisation of local energy days, and networking with other cities.

More information about the "The Covenant of Mayors" can be found at the link: http://www.eumayors.eu/. As concerns Greece, till now more than 230 greek cities (among others Aigaleo, Ios, Kea, Korthi, Lamia, Likovrisi, Lipsi, Milos, Moudros, Nisyros, Oia, Patras, Poseidonia, Ptolemaida, Serres, Skyros, Sykies, Thermi, Trikala) and 1 supporting network of cities (Network of Aegean Islands for Sustainability, DAFNI) have joined the Covenant.

The mitigation actions of climate change that are planned and executed at a local authority level comprise of:

- Traffic studies and reorganization of public transport (use of environment friendly vehicles, etc.).
- Incorporation of RES projects in regional development plans. Introduction of RES systems in public buildings and/or installations running by local authorities. Use of photovoltaic lights for municipal lighting.

- Close co-operation with NGOs as WWF, Greenpeace, etc. in order to raise public awareness.
- Replacement of conventional lamps with energy efficient ones in public buildings.
- Use of eco-friendly paints and solvents.
- Implementation of infrastructure projects and interventions in order to improve energy efficiency in desalination plants and other installations running by local authorities (e.g. reduce consumption of reactive power, energy recovery by turbines installation etc.).
- Use of tertiary treatment in waste water treatment plants and re-use of effluent for irrigation of croplands instead of using water from desalination plants.
- Wastewater treatment by applying non energy intensive systems as photocatalytic methods and aquatic plants.
- Implementation of composting programs for household organic wastes.
- Implementation of production and distribution programmes of drinking water at regions where water is in scarcity (mainly islands), in order to reduce the consumption of bottled water.
- Implementation of rainwater collection programmes at areas where tap water is produced by desalination plants.
- Recycling of electric appliances, batteries, wires, waste oils and packaging materials.

4.3.2 Sectoral mitigation actions

4.3.2.1 Overview

This chapter presents quantitative estimates of the expected effects of implemented and adopted policies and measures in Greece under the Convention (UNFCCC), aiming at reducing GHG emissions in order to meet the Kyoto Protocol targets, along with the targets set by NECP, the CC&E package and EC directives. These policies and measures were adopted in the context of the National Action Plans of the above mentioned directives and the main targets of the National Energy Strategy, with respect to their emissions reduction potential and economic efficiency. Moreover, it presents the planned policies and measures that were reflected in the “with additional measures” projections scenario.

Tables 4.7a and b present estimates of the expected effects of these policies and measures in the time horizon of the years up to 2030. An ex-post estimation of the effect of policies for year 2015 is also included.

The total realistic quantifiable GHG emissions reduction potential from the implemented and adopted policies and measures (without LULUCF) was estimated to be 36.8Mt CO2eq for 2025 (28.2 Mt under EU-ETS and 8.6 Mt under ESR sectors); and 39.8Mt CO2eq for 2030 (29.8 Mt under EU-ETS and 10.0 Mt under ESR sectors). The effect of LULUCF-related policies was estimated to be 2.4Mt and 2.5Mt CO2 for 2025 and 2030, respectively.

The possible interferences between these implemented/adopted measures, which may restrict the estimated GHG emissions reduction potential, were taken into account. Thus, it is obvious that the application of the already implemented and adopted measures for the mitigation of GHG emissions contributes considerably in the restriction of the augmentative trend of emissions (besides the economic recession), leading to the achievement of the Kyoto Protocol objectives and the 2020 targets pursuant to European Union obligations, exclusively with domestic measures and actions (see chapter 5).

The mitigation effect of each policy is estimated by comparing the 'with measures' scenario with a hypothetical baseline scenario that does not include the mitigation effect of the examined policy or measure. The same approach as that used in BR4 has been followed for the estimation of the mitigation effect of the policies. Any change of the mitigation effect of the policies compared to previous submission is attributed to a change of the WM scenario.

Tables 4.8a and b present estimates of the expected effects of planned policies, which are the additional policies in order to comply with the targets set in the National Energy and Climate Plan of Greece.

The total realistic quantifiable GHG emissions reduction potential from the planned policies and measures (without LULUCF) was estimated to be 16.7Mt CO2eq in 2030 (11.8 Mt under EU-ETS and 4.9 Mt under ESD sectors). The effect of additional LULUCF-related policies was estimated to be 0.13Mt and 0.31Mt CO2 for 2025 and 2030, respectively.

Table 4.5a Effects of implemented / adopted policies and measures (included in the "with measures" scenario)

PaM No	Name of mitigation action	Sectors affected	GHGs affected	Objective and/or activity affected	Type of instrument	Status	Start year	Implementing entity or entities	Ex-post mitigation effect (ktCO2eq) Year 2015	Mitigation impact (ktCO2 eq) Year 2020	Mitigation impact (ktCO2 eq) Year 2025	Mitigation impact (ktCO2 eq) Year 2030
1	Improvements in the conventional power generation system	Energy	CO2	Efficiency improvement in the energy and transformation sector (Energy supply); Switch to less carbon-intensive fuels (Energy supply)	Economic, Regulatory	Implemented	1996	Public Power Corporation S.A. (Companies) ; Ministry of Environment and Energy (Government)	7400	15,000	13,300	10,400
2	Promotion of natural gas in residential sector	Energy	CO2	Efficiency improvements of buildings (Energy consumption)	Economic, Regulatory, Fiscal, Information	Implemented	1998	Ministry of Environment and Energy (Government)	260	320	390	475
3	Promotion of natural gas in tertiary sector	Energy	CO2	Efficiency improvement in services/ tertiary sector (Energy consumption); Demand management/reduction (Energy consumption)	Economic, Regulatory, Fiscal, Information	Implemented	1998	Ministry of Environment and Energy (Government)	120	140	170	210
4	Promotion of natural gas in industry	Energy	CO2	Efficiency improvement in industrial end-use sectors (Energy consumption)	Economic, Regulatory, Information	Implemented	1996	Ministry of Environment and Energy (Government)	638	814	832	970
5	Promotion of natural gas in transportation	Transport	CO2	Low carbon fuels/electric cars (Transport)	Economic, Regulatory, Fiscal	Implemented	1999	Ministry of Environment and Energy (Government) ; Ministry of Infrastructure and Transport (Government)	11	18	22	44

PaM No	Name of mitigation action	Sectors affected	GHGs affected	Objective and/or activity affected	Type of instrument	Status	Start year	Implementing entity or entities	Ex-post mitigation effect (ktCO2eq) Year 2015	Mitigation impact (ktCO2 eq) Year 2020	Mitigation impact (ktCO2 eq) Year 2025	Mitigation impact (ktCO2 eq) Year 2030
6	Promotion of RES for electricity generation	Energy	CO2	Increase in renewable energy (Energy supply)	Economic, Fiscal, Regulatory	Implemented	1994	Ministry of Environment and Energy (Government) ; Regulatory Authority for Energy (Other)	14,700	11,000	14,500	19,000
7	Biofuel use in transportation	Transport	CO2	Low carbon fuels/electric cars (Transport)	Fiscal, Regulatory	Implemented	2005	Ministry of Environment and Energy (Government) ; Ministry of Infrastructure end Transport (Government)	490	650	680	700
8	Implementation of energy efficiency measures in Industry (National Energy Efficiency Action Plan)	Energy, Industry/ industrial processes	CO2	Efficiency improvement in industrial end-use sectors (Energy consumption)	Economic, Fiscal, Regulatory, Information	Implemented	2008	Ministry of Environment and Energy (Government)	NE	200	200	200
9	Implementation of energy efficiency measures in Residential and Tertiary Sector (National Energy Efficiency Action Plan)	Energy	CO2	Efficiency improvements of buildings (Energy consumption); Efficiency improvement in services/ tertiary sector (Energy consumption); Efficiency improvement of appliances (Energy	Economic, Fiscal, Regulatory, Information	Implemented	2008	Ministry of Environment and Energy (Government)	180	2,200	2,300	2,400

PaM No	Name of mitigation action	Sectors affected	GHGs affected	Objective and/or activity affected	Type of instrument	Status	Start year	Implementing entity or entities	Ex-post mitigation effect (ktCO2eq) Year 2015	Mitigation impact (ktCO2 eq) Year 2020	Mitigation impact (ktCO2 eq) Year 2025	Mitigation impact (ktCO2 eq) Year 2030
				consumption)								
10	Road transport measures	Transport	CO_2, CH_4, N_2O	Efficiency improvements of vehicles (Transport); Modal shift to public transport or non-motorized transport (Transport); Improved transport infrastructure (Transport); Low carbon fuels/electric cars (Transport)	Economic, Fiscal, Regulatory	Implemented	1983	Ministry of Environment and Energy (Government) ; Ministry of Infrastructure and Transport (Government)	300	560	600	650
11	Recovery of organic waste	Waste management /waste	CH_4	Reduced landfilling (Waste); Enhanced recycling (Waste); Improved landfill management (Waste)	Regulatory, Other (Other (Planning)	Implemented	2002	Ministry of Environment and Energy (Government)	480	600	800	1100
12	Recovery of biogas	Waste management/ waste	CH_4	Enhanced CH_4 collection and use (Waste)	Regulatory, Other (Other (Planning)	Implemented	2002	Ministry of Environment and Energy (Government)	700	900	850	650
13	Reduction of emissions of fluorinated gases	Industry/industrial processes	HFCs, PFCs	Reduction of emissions of fluorinated gases (Industrial processes); Replacement of fluorinated gases by other substances (Industrial processes)	Regulatory, Information	Implemented	2004	Ministry of Environment and Energy (Government)	NA	760	1150	1700
14	Establishing common rules for direct support schemes under	Agriculture	CH_4, N_2O	Other activities improving cropland management (Agriculture); Improved	Other (Other (Planning), Regulatory, Economic	Implemented	2007	Ministry of Rural Development and Food	300	375	550	750

PaM No	Name of mitigation action	Sectors affected	GHGs affected	Objective and/or activity affected	Type of instrument	Status	Start year	Implementing entity or entities	Ex-post mitigation effect (ktCO2eq) Year 2015	Mitigation impact (ktCO2 eq) Year 2020	Mitigation impact (ktCO2 eq) Year 2025	Mitigation impact (ktCO2 eq) Year 2030
	the common agricultural policy: Reduction of the rate of intensity of agricultural land use and improvement of management of animal waste			livestock management (Agriculture); Improved animal waste management systems (Agriculture); Sustainable development of agricultural activities and rural areas, with a focus on climate change mitigation and adaptation objectives. (Other agriculture)				(Government)				
15	Rural Development Programme (RDP): Increase of organic farming.	Agriculture	N2O	Improved management of organic soils (Agriculture); Reduction of fertilizer/manure use on cropland (Agriculture)	Other (Other (Planning), Economic	Implemented	2007	Ministry of Rural Development and Food (Government)	160	220	300	350
16	Common Agricultural Policy (CAP) – Reduction in fertilizers use.	Agriculture	N2O	Reduction of fertilizer/manure use on cropland (Agriculture)	Other (Other (Planning), Regulatory, Economic	Implemented	2007	Ministry of Rural Development and Food (Government)	100	120	150	200
17	Measures in the LULUCF sector	Forestry/ LULUCF	CO2	M Afforestation and reforestation (Land use, land use change and forestry);Enhancing production in existing forests (Land use, land use change and forestry);Enhanced forest management	Regulatory; Planning; Information; Education; Economic	Implemented	2000	Ministry of Environment and Energy	NE	NE	4063	4122

PaM No	Name of mitigation action	Sectors affected	GHGs affected	Objective and/or activity affected	Type of instrument	Status	Start year	Implementing entity or entities	Ex-post mitigation effect (ktCO2eq) Year 2015	Mitigation impact (ktCO2 eq) Year 2020	Mitigation impact (ktCO2 eq) Year 2025	Mitigation impact (ktCO2 eq) Year 2030
				(Land use, land use change and forestry);Restoration of degraded lands (Land use, land use change and forestry);Strengthening protection against natural disturbances (Land use, land use change and forestry)								

Table 4.5b Brief description of implemented / adopted policies and measures (included in the "with measures" scenario)

P&M No	Name of mitigation action	Brief description
1	Improvements in the conventional power generation system	The main implemented / adopted measures for the improvement of the conventional power generation system are: - The gradual decommissioning of old inefficient and more pollutant thermal power units. - The commissioning of new power units that follows BAT and the new IED. - The increase of NG share in electricity production. - The interconnection of certain islands with the mainland grid.
2	Promotion of natural gas in residential sector	The introduction of natural gas in the national energy system is one of the largest investments ever carried out in Greece and it constitutes a major priority of the national energy policy. An important part of the infrastructure, mainly the high pressure transmission system and the medium pressure network, which is necessary for the transport of natural gas to the main regions of consumption, has been completed, while the networks' development in the cities is ongoing. Expansion projects of Greek natural gas system are under way in order to link more cities and industries to the system. The residential and commercial sectors account for small but growing shares of total gas consumption. Following a drop between 2011 and 2013, gas consumption increased in these sectors to new record levels in 2015, accounting for one-fifth of the total gas consumption. However, natural gas represents only 8% of the total energy consumption in the residential and commercial sectors. The actions for the promotion of NG are summarized to the following bullets: (a) Fiscal measures; (b) Pricing (always lower price than the competitive liquid fuels, valid for all sectors); (c) Discount on connection fees; (e) Heavy marketing through TV commercial, ads, etc., focusing on the increased efficiency, economy and environmental "friendliness" of natural gas; (f) Availability of natural gas through continuous development of networks (infrastructure); (g) Liberalization of electricity and natural gas markets.
3	Promotion of natural gas in tertiary sector	The introduction of natural gas in the national energy system is one of the largest investments ever carried out in Greece and it constitutes a major priority of the national energy policy. An important part of the infrastructure, mainly the high pressure transmission system and the medium pressure network, which is necessary for the transport of natural gas to the main regions of consumption, has been completed, while the networks' development in the cities is ongoing. Expansion projects of Greek natural gas system are under way in order to link more cities and industries to the system. The residential and commercial sectors account for small but growing shares of total gas consumption. Following a drop between 2011 and 2013, gas consumption increased in these sectors to new record levels in 2015, accounting for one-fifth of the total gas consumption. However, natural gas represents only 8% of the total energy consumption in the residential and commercial sectors. The actions for the promotion of NG are summarized to the following bullets: (a) Fiscal measures; (b) Pricing (always lower price than the competitive liquid fuels, valid for all sectors); (c) Discount on connection fees; (e) Heavy marketing through TV commercial, ads, etc., focusing on the increased efficiency, economy and environmental "friendliness" of natural gas; (f) Availability of natural gas through continuous development of networks (infrastructure); (g) Liberalization of electricity and natural gas markets.
4	Promotion of natural gas in industry	The introduction of natural gas in the national energy system is one of the largest investments ever carried out in Greece and it constitutes a major priority of the national energy policy. An important part of the infrastructure, mainly the high pressure transmission system and the medium pressure network, which is necessary for the transport of natural gas to the main regions of consumption, has been completed. Hundreds of

P&M No	Name of mitigation action	Brief description
		industrial plants use natural gas covering efficiently their energy needs. Expansion projects of Greek natural gas system are under way in order to link more industries to the system. The industry sector is the second-largest consumer of natural gas, accounting for 29% of the total gas demand in 2015. This includes natural gas used as petrochemical feedstock in the chemical and petrochemical industry, which represents almost half of industrial gas consumption. The non-ferrous metals industry (e.g. aluminium) is the largest consumer of natural gas for energy purposes in the industry sector, accounting for nearly one-third of the total gas consumption in industry. The actions for the promotion of NG are summarized to the following bullets: (a) Pricing (always lower price than the competitive liquid fuels, valid for all sectors); (b) Discount on connection fees; (c) Heavy marketing through TV commercial, ads, etc., focusing on the increased efficiency, economy and environmental “friendliness” of natural gas; (d) Availability of natural gas through continuous development of networks (infrastructure); (e) Liberalization of electricity and natural gas markets; (f) Emission Trading System; (g) Restriction of environmental permits to industrial installations (e.g. prohibition of petcoke use by the ceramics production units).
5	Promotion of natural gas in transportation	A significant of public transportation buses and municipality garbage collection vehicles already use natural gas as fuel, followed by cars of dual-fuel or bi-fuel technology. Apart from the public vehicles (e.g. buses) there are incentives for the replacement of private vehicles and to promote the use of energy-efficient vehicles (vehicles fueled by natural gas and bio-fuels and hybrid vehicles).
6	Promotion of RES for electricity generation	The start year for the policies aiming for the promotion of RES for electricity generation is 1994, when the OPE (Operational Programme Energy within the 2nd Community Support Framework, 1994-1999) and the provisions of the National Development Assistance Act providing investment cost subsidies in combination with Law 2244/94, which specifies favourable buy-back tariffs for electricity generated from renewable energies. Greece developed its policy framework under the European Union (EU) Renewable Energy Directive (Directive 2009/28/EC), which set out an overall binding national target for Greece of 18% of renewable energy sources in gross final energy consumption for 2020. Greece set the following indicative sector targets according to the national renewable energy action plan (NREAP, time frame 2010-2020) for the contribution of renewable energy source to: - gross final energy consumption for heating and cooling: at least 20% - gross final electricity consumption: at least 40% - gross final energy consumption in transportation: at least 10%.
7	Biofuel use in transportation	In 2005, Law L3054/2002 “Organization of the oil market and other provisions” was amended to include biofuels in the existing legal framework for oil products. The new Law, L3423/2005 “Introduction of biofuels and other renewable fuels in the Greek market” (O.G. A’ 304/13.12.2005) transposed Directive 2003/30/EC in the Greek legal system and provided for the introduction of biofuels into the oil market. In order to increase the use of biofuels according to Law 3340/2005 the excise tax for these biofuels was null for the years 2005, 2006 and 2007. Since December 2005 pure biodiesel is blended (according to EN 590:2004) by the 4 Greek oil refineries in diesel used in transport up to 5% by volume. By decision 460/2009 (O.G. B’ 67/28.01.2010) of the State Chemical Council (SCC) the EN 590:2009 standard was adopted formally and the maximum biodiesel percentage was increased to 7%. According to the provisions of Law 3054/2002, a specific quantity of pure biodiesel is allocated to beneficiaries to achieve the 7% mandatory percentage of biodiesel blended in diesel (per volume). Similarly, the obligation to blend petrol with bioethanol to 1% for the year 2019 and 3.3% in 2020 to 5% by volume of energy was introduced, while there is the possibility of increasing this percentage after 2020.
8	Implementation of energy efficiency measures in	Energy-efficiency improvements and CHP units in various areas of the industry sector have been promoted since the 1st National Climate Change Program through the provisions of the Development Assistance Acts, Law 2244/93 (for CHP plants), the OPE (Measures 2.2 and 2.3) and OPC:

P&M No	Name of mitigation action	Brief description
	Industry (National Energy Efficiency Action Plan)	- energy saving interventions (installing building envelope insulation, heat insulated window frames, energy class A air-conditioning units, energy saving light bulbs, high-efficiency burners and boilers, exhaust heat recovery, etc.); - developing and implementing systems for the recovery/saving and/or substitution of conventional energy and water in the production process; - the procurement costs of equipment for energy self-production from RES and substitution of fuels with natural gas or LPG; - bioclimatic and small-scale building interventions to save energy/heat/water; - conducting energy audits and benchmarking; - streamlining of equipment, upgrade of facilities and installation of new energy efficient technologies; - education and training of staff.
9	Implementation of energy efficiency measures in Residential and Tertiary Sector (National Energy Efficiency Action Plan)	Several actions are included in the Energy Efficiency National Action Plans concerning the conservation and rational use of energy in the residential and tertiary sector. Apart from the introduction of natural gas and RES, the measures concern actions for the improvement of the thermal behavior of residential sector buildings and promotion of energy efficiency appliances and heating equipment. These actions are supported significantly by the incorporation in the Greek legislation of the Directive 2002/91/EC by Law 3661/08 "Measures to reduce the energy consumption of buildings"; the Law 4122/2013 "Energy performance of buildings" (transposition of Directive 2010/31/EE); the Law 3855/2010 "Measures to improve energy efficiency in end-use, energy services and other provisions" (transposition of Directive 2006/32/EC); the adoption and application of the "Energy Performance of Buildings Regulation" (KENAK); and the transposition to the Greek legislation of European Directive 27/2012/EU by Law 4342/2015.
10	Road transport measures	GHG emissions from the transport sector present a declining trend mainly due to economic crisis. Nevertheless they are still considerable both in Greece and in European Union, and, consequently the implementation of suitable policies and restriction measures is required. The main axes of intervention and implemented policies and measures in the sector, beyond the introduction of biofuels for road transport and natural gas in the public system of transport that were already described previously, are: (A) Interventions in the transport system; (B) Interventions in public transport; (C) Interventions in vehicles; (D) Measures for addressing air pollution from road traffic in urban centres; and (E) Fiscal measures. The mitigation of transport GHG emissions is also supported by EU transport sector policies: (a) The CO2 and Cars Regulation (EC) No 443/2009; (b) The CO2 and Vans Regulation (EU) No 510/2011; (c) The Directive 1999/94/EC on Car Labelling ; (d) The Regulations that are in place related to environmental and safety requirements of tyres and gear shift indicators (GSI); (e) Directive 2009/30/EC on Fuel Quality ; and (f) Directive 2014/94/EU on Deployment of Alternative Fuels Infrastructure.
11	Recovery of organic waste	Reduction of the quantities of biodegradable wastes landfilled through the installation of solid waste treatment facilities. Acc. to Directive (EU) 2018/850 for the amendment of Directive 1999/31 / EC on the landfill of waste, it is targeted only the 10% of generated municipal solid waste to be landfilled by 2030. Promotion of measures for separate collection of biowaste, recycling, energy recovery and use of sludge in agriculture as fertilizer/compost.

P&M No	Name of mitigation action	Brief description
12	Recovery of biogas	Collection and flaring / energy use systems of landfill gas are being installed in all managed sites for urban centres with population more than 100,000. Already, the managed disposal sites serving the population of the largest cities of Greece are equipped with systems for the collection or for the flaring of biogas. In the Psyttalia wastewater treatment plant that serves approximately 4 millions of Attica population, a part the sludge produced is treated under anaerobic conditions resulting in the production of biogas. The biogas produced covers the energy needs of the wastewater treatment facilities.
13	Reduction of emissions of fluorinated gases	To control emissions from fluorinated greenhouse gases (F-gases), including hydrofluorocarbons (HFCs), the European Union has adopted two legislative acts: the 'MAC Directive' (2006/40/EC) on air conditioning systems used in small motor vehicles, and the 'F-gas Regulation' (No 517/2014) which covers all other key applications in which F-gases are used. The two strategies described in the abovementioned regulation to reduce emissions is to prevent leakage and emissions {Emission prevention and leak checks, Control of by-production, End of life treatment of products and equipment, Training and qualification, Information for users (labelling, product info)} and control of use of F-gases (Ban on new applications, Ban on uses, Phase-down of HFC supply). Several control mechanisms and penalties are implemented in Greece. Checks for compliance with these regulations of the European Union are carried out by the relevant bodies and agencies of the competent authorities, as appropriate, in the context of their remit. In cases of infringement of the provisions of the relevant EU Regulations by legal or natural entities of the public and private sector, sanctions are imposed by the relevant bodies and agencies of competent authorities. It is considered that the action taken by the EU and its Member States under the F-gas Regulation will enable the EU to comply with the Kigali amendment to the Montreal Protocol on a global phase-down of hydrofluorocarbons (HFCs).
14	Common Agricultural Policy (CAP) – Green Direct Payments: reduction of the rate of intensity of agricultural land use and improvement of management of animal waste.	The reduction of the rate of intensity of agricultural land use and the adoption of rules for the obligatory observance of cross compliance system relating to manure management contribute to the reduction of GHGs. Moreover, the disengagement of subsidies from the agricultural production has already enhanced indirectly the reduction of agricultural production and livestock population. In fact, the disengagement of subsidies from the agricultural production along with the enhanced citified way of life consist the main reasons for the reduction of agricultural production.
15	Rural Development Programme (RDP): Increase of organic farming.	Measures and incentives in order to increase the organic farming. Organic production results in a substantial decrease of N2O emissions. According to national statistics, the total land with organic farming in Greece (fully converted and under conversion to organic farming) is 342,584 ha in 2016. The actions of Rural Development Program (2014-2020) for the transition to practices and methods of organic farming will cover 478,317.70 ha of land, while the aid to preserve existing organic farming practices and methods will cover 241,804 ha.
16	Common Agricultural Policy (CAP) – Green Direct Payments: Reduction in fertilizers use	Decrease of the use of synthetic nitrogen fertilizer and protection of the groundwater, resulting in a substantial decrease of N2O emissions.
17	Measures in the LULUCF sector	Forest protection, Forest management, Ecosystem health, Research, Restoration – increase of managed forest land, adaptation

Table 4.6a Effects of planned policies and measures (included in the "with additional measures" scenario)

PaM No	Name of mitigation action	Sectors affected	GHGs affected	Objective and/or activity affected	Type of instrument	Status	Implementing entity or entities	Mitigation impact (ktCO2 eq) Year 2025	Mitigation impact (ktCO2 eq) Year 2030
18	Further promotion of RES for electricity generation	Energy	CO2	Increase in renewable energy (Energy supply)	Economic, Fiscal, Regulatory	Planned	Ministry of Environment and Energy (Government) ; Regulatory Authority for Energy (Other)	8,323	11,792
19	Further biofuel use in transportation	Transport	CO2	Low carbon fuels/electric cars (Transport)	Fiscal, Regulatory	Planned	Ministry of Environment and Energy (Government) ; Ministry of Infrastructure end Transport (Government)	100	429
20	Further promotion of natural gas and energy efficiency in industry	Energy, Industry/industrial processes	CO2	Efficiency improvement in industrial end-use sectors (Energy consumption)	Economic, Fiscal, Regulatory, Information	Planned	Ministry of Environment and Energy (Government)	764	1276
21	Further promotion of natural gas in residential and tertiary sectors and implementation of additional energy efficiency measures in Residential and Tertiary Sector (NECP)	Energy	CO2	Efficiency improvements of buildings (Energy consumption); Efficiency improvement in services/ tertiary sector (Energy consumption); Efficiency improvement of appliances (Energy consumption)	Economic, Fiscal, Regulatory, Information	Planned	Ministry of Environment and Energy (Government)	2270	2990
22	Road transport measures (additional measures as	Transport	CO2, CH4, N2O	Efficiency improvements of vehicles (Transport);	Economic, Fiscal,	Planned	Ministry of Environment and	46	190

PaM No	Name of mitigation action	Sectors affected	GHGs affected	Objective and/or activity affected	Type of instrument	Status	Implementing entity or entities	Mitigation impact (ktCO2 eq) Year 2025	Mitigation impact (ktCO2 eq) Year 2030
	included in NECP and NTSP)			Modal shift to public transport or non-motorized transport (Transport); Improved transport infrastructure (Transport); Low carbon fuels/electric cars (Transport)	Regulatory		Energy (Government) ; Ministry of Infrastructure and Transport (Government)		
23	Measures in the LULUCF sector	LULUCF	CO_2	Promotion of biomass production for energy purposes (Land use, land use change and forestry); Increase of managed forest land over unmanaged forest land	Regulatory; Planning; Information; Education; Economic	Planned	Ministry of Environment and Energy	126	313

Table 4.6b Brief description of planned policies and measures (included in the "with additional measures" scenario)

P&M No	Name of mitigation action	Brief description
18	Further promotion of RES for electricity generation	This mitigation action reflects the effect of the delignitification of the Greek power sector by 2028 and the deployment of RES technologies for electricity production to exceed 60% of gross final consumption, as specified in NECP. This mitigation action refers to planned measures in order to increase the share of RES in electricity generation in 2030 from 54.8% (WEM scenario) to 61% (WAM Scenario). Apart from the strengthening of existing policies, the following measures are planned: -support of innovative and pilot projects with high domestic added value; -use of guarantee of origin of electricity from renewable energy sources; -development of a licensing and planning framework for offshore wind farms; -development of a legislative and regulatory framework for power storage stations; -support for the development of RES energy projects by energy communities through the use of specialized financial tools; -reform of the electricity market regulatory framework to promote the participation of decentralized energy schemes; -development of Demand-side management programs of electricity; -development and optimization of licensing framework as well as technical specifications for district heating from RES, biogas injection into the natural gas network, exploitation of geothermal fields.
19	Further biofuel use in transportation	It refers to planned measures, additional to those included under WEM scenario. Apart from the strengthening of existing policies and measures, the following measures are planned: -continue and reinforce the existing regulatory framework for the obligation of both blending or use pure biofuels. The obligation to blend biodiesel with diesel and gasoline with bioethanol will continue, while new enhanced blending obligations will be considered, as well as the possible extension of the measure to other transport sectors. -development of support schemes for biofuels and special financing tools for the production of advanced biofuels. -pilot actions for the use of gaseous fuels in the transport sector -use of tax incentives to promote alternative fuels in transport (including biofuels)
20	Further promotion of natural gas and energy efficiency in industry	It refers to planned measures, additional to those included under WEM scenario. Apart from the strengthening of existing policies and measures, the following measures are planned: -financial and tax support for energy saving technological investments; -financial support energy efficiency improvement programs for industries and manufacturing enterprises under the new programming period (after 2020); -promotion of relocation of industrial plants at specialized Industrial Business Zones; -promotion of centralized production and distribution of heat at the specialized Industrial Business Zones.
21	Further promotion of natural gas in residential and tertiary sectors and implementation of additional energy efficiency measures in Residential and Tertiary Sector (National Energy Efficiency Action Plan)	It refers to planned measures, additional to those included under WEM scenario. Apart from the strengthening of existing policies and measures, the following measures are planned: -establishment of the National Energy Efficiency Fund; -use of tax incentives for RES facilities (for heating and cooling) in the residential and tertiary sector; -promoting of Energy Savings Contracting in the public sector through targeted funding programs; -financing programs and tax incentives for the renovation of public and private tertiary sector buildings under the new programming period (after 2020); -financing programs for the renovation of public buildings based on the Sustainable Energy Action Plans and Energy Efficiency Action Plans of

P&M No	Name of mitigation action	Brief description
		Municipalities and Regions; -improve of the regulatory framework and strengthen the role of energy managers in public buildings; -promotion of energy management systems in public buildings; -regulatory measures to promote buildings of nearly zero energy; -promotion of Energy Efficiency Agreements in the private sector through targeted financial programs.
22	Road transport measures (additional measures as included in NECP and NTSP)	It refers to planned measures, mainly targeting to the increase the share of electric passenger vehicles in 2030 to 10%, additional to those included under WEM scenario. Aprart from the strengthening of existing policies and measures, the following measures are planned: NECP (National Energy and Climate Plan) -completing the necessary energy charging infrastructure for electric vehicles; -develop a framework for financial support for the use of electric vehicles; -development of sustainable urban mobility plans; -elaboration of plans and implementation of infrastructure for the relocation of commercial transport operations; -fiscal incentives to promote electric (BEV) and pluf-in hybrid vehicles (PHEV) -further incentives for the replacement of private vehicles and light trucks with energy-efficient vehicles. NTSP (National Transport Plan of Greece) -Limitations to import old used cars. Today practically there is no such age limit. -Promoting through taxation new/clean vehicles. -Incentives for the replacement of professional fleet vehicles as well as private passenger vehicles. -Maximum age allowed for all vehicle types.
23	Measures in the LULUCF sector	Restoration – increase of managed forest land and HWP for bioenergy

4.3.2.2 Sectoral policies and measures: Energy

Promotion of natural gas

The introduction of natural gas in the national energy system is one of the largest investments ever carried out in Greece and it constitutes a major priority of the national energy policy. An important part of the infrastructure, mainly the high pressure transmission system and the medium pressure network, which is necessary for the transport of natural gas to the main regions of consumption, has been completed, while the networks' development in the cities is ongoing. Expansion projects of Greek natural gas system are under way in order to link more cities and industries to the system (***Figure 4.1***).

Natural gas is becoming an increasingly important fuel in Greece, rising to a share of 39.8% in power generation and 24.1% in the Gross Inland Consumption in 2020, and more than doubling its share in total final consumption over the last decade. Consumption began increasing in the late 1990s, mainly for power generation and industrial uses, but also later with small shares in the residential and commercial sectors. However, natural gas consumption has fluctuated in recent years, as gas demand decreased with overall energy and electricity demand in the aftermath of the financial crisis, but it has recovered in the last two years. The Greek government has taken several steps towards liberalising and improving efficiency in the gas markets. Most gas is imported from the Russian Federation, and Greece is planning to improve the security of supply through diversification of its supply sources by enhancing liquefied natural gas (LNG) imports and expanding its role as a gas hub for the South Eastern Europe gas market.

Power generation is the largest gas-consuming sector, accounting for around 57% of the total gas consumption in 2020. This share has fallen from levels of around 70% a decade earlier.

The industry sector is the second-largest consumer of natural gas, accounting for 15.7% of the total gas demand in 2020. This includes natural gas used as petrochemical feedstock in the chemical and petrochemical industry, which represents almost half of industrial gas consumption. The non-ferrous metals industry (e.g. aluminium) is the largest consumer of natural gas for energy purposes in the industry sector, accounting for nearly one-third of the total gas consumption in industry.

Natural gas represents 12.1% of the total energy consumption in the residential and commercial sectors.

Natural gas (0.8 PJ in 2020) is also consumed in the transport sector, e.g. natural gas moving buses have been placed in the public transportation system of Athens.

Figure 4.1 Greek National Natural Gas System

In ***Table 4.7*** the achieved (2020) penetration of natural gas in the national energy system is presented. The 2020 figures are obtained from the national energy balance. In 2020 the installed capacity for electricity production from natural gas was 4,777 MW.

The deregulation of electricity and natural gas markets, as well as the completion of the first private power generation units, are considered as the two main reasons for the increase of the penetration level of natural gas in the power generation sector in the next years.

The period since 2011 has seen developments in the legal and regulatory framework for the Greek national gas market. Law 4001/2011 prepared the basis for the second round of gas market reforms by transposing the third European Union (EU) Energy Package (Directive 2009/73/EC) into national law. The law stipulated unbundling of the operation of the national natural gas transmission system (NNGTS), giving third-party access to the gas infrastructure, and strengthening the role of the regulator. Laws 4336/2015, 4337/2015, and 4414/2016 amended Law 4001/2011 to reform network undertakings and the full unbundling of the natural gas distribution and retail market in Greece in successive steps by 2018. Greece has progressed towards applying the new laws by issuing and implementing secondary legislation and notifying the required regulations.

Finally, important role plays the application of the emission trading system, which, due to the limited emission allowances distributed to the electricity producers and the industrial sector, leads to the further utilization of clean technologies and fuels.

Table 4.7 Penetration of NG in the national energy system

Sector	2020
Power sector	133.9
Road transport	0.8
Industry	40.2
Commercial	5.7
Residential	18.5

Figures in PJ (NCV)

The actions for the promotion of NG are summarized to the following bullets:

- ✓ Fiscal measures (e.g. Reduction of personal income taxation for converting the fuel installation from oil to natural gas, or installing a new natural gas fired one).
- ✓ Pricing (always lower price than the competitive liquid fuels, valid for all sectors)
- ✓ Discount on connection fees
- ✓ Heavy marketing through TV commercial, ads, etc., focusing on the increased efficiency, economy and environmental “friendliness” of natural gas
- ✓ Availability of natural gas through continuous development of networks (infrastructure)
- ✓ Liberalization of electricity and natural gas markets
- ✓ Emission Trading System
- ✓ Restriction of environmental permits to industrial installations (e.g. prohibition of petcoke use by the ceramics production units)

The GHG reductions due to use of NG in the power sector are reported in the next section (section 4.3.2.2.2). The estimated reductions of GHG emissions due to implemented / adopted policies in the final demand sectors are presented in ***Table 4.8***.

Table 4.8 Estimated GHG emissions reductions from NG use in final demand sectors

Sector	Policy status	2020	2025	2030
Industry	Implemented / adopted	814	832	970
Residential	Implemented / adopted	320	390	475
Tertiary	Implemented / adopted	140	170	210
Road	Implemented / adopted	18	22	44

Figures in kt CO2eq

It should be mentioned that the PaM “Promotion of natural gas” is related to Energy and at a small extent to Transport sector. The affected GHG from this policy is mainly CO2 (more than 99%).

Improvements in the conventional power generation system

Electricity demand (in terms of production plus net imports) was 48.85 TWh in 2020. Around 64% in 2020 comes from combustible fuels, while the remaining share is originated from wind, solar PV, hydro and other RES. The two dominant fossil fuels in 2020 were lignite and natural gas, which participated by 13.7% and 39.9% in the generation mix, respectively. The largest electricity consuming sector is the residential sector, followed by the commercial sector. Greece has taken several steps towards liberalising and deregulating the wholesale and retail power markets to increase competition. Greece will be transitioning to the new European Union (EU) target market, with forward, day-ahead, intraday, and balancing markets. Greece has made substantial progress in diversifying the electricity fuel mix, especially in the deployment of variable renewable energy, which increased to almost 35.6% of the total generation in 2020.

The main implemented / adopted measures for the improvement of the conventional power generation system are:

- ✓ The gradual decommissioning of old inefficient and more pollutant thermal power units.
- ✓ The commissioning of new power units that follows BAT and the new IED.
- ✓ The increase of NG share in electricity production.
- ✓ The interconnection of certain islands with the mainland grid.

913 MW of lignite capacity have been decommissioned during 2010-2016, while 2112 MW is planned to be decommissioned by 2025. Additionally, liquid fuel-fired power units are expected to be decommissioned, due to the interconnection of Aegean islands. According to NECP and the recently adopted Climate Law, lignite will not be used in electricity generation by 2028. The decommissioned capacity will be substituted by NG-fired plants and RES.

The internal interconnection of some of the northern Cycladic islands is under construction, and is scheduled to come into operation in three steps by the end of 2017, 2019, and 2022. The first phase will connect Syros to the mainland and establish radial interconnections of Paros and Mykonos with Syros; the second phase will link Naxos to Paros and Syros; and the third phase will establish a second link between Syros and the mainland system. This project is considered critical for the following two pillars of the government’s energy policy: enhance security of electricity supply and support the development of renewable energy sources so that Greece can meet its renewable energy and greenhouse gas reduction targets. The Cycladic islands have great wind potential, a large part of which has not yet been exploited.

The interconnection with Crete is still at the planning stage, and is expected to be implemented in two phases (2020 and 2024), with two separate links being constructed.

The above-mentioned implemented / adopted measures are estimated to decrease GHG emissions by 15.0 Mt CO2eq in 2020; 10.4 Mt CO2eq in 2030. The increased share of electricity from RES technologies will cause a reduced use of NG for electricity generation in 2030 compared to 2020.

It should be mentioned that the PaM "Improvements in the conventional power generation system" is related to Energy (Power sector). The affected GHG from this policy is mainly CO2 (more than 99%).

Promotion of renewable energy sources

Overview

Greece developed its policy framework under the European Union (EU) Renewable Energy Directive (Directive 2009/28/EC), which set out an overall binding national target for Greece of 18% of renewable energy sources in gross final energy consumption for 2020. Greece chose to raise its ambitions to a 20% overall share for 2020 (Law 3851/2010).

The progress that Greece has made per sector target is presented in ***Table 4.9*** and ***Figure 4.2***. Greece overachieved its 2020 target. The RES share in 2020 was 21.75%.

Table 4.9 Progress made towards 2020 RES targets (%)

Sector	2010	2015	2019	2020
RES – heating and cooling	18.66	26.56	30.05	31.94
RES – electricity	12.31	22.09	31.10	35.86
RES - transport	1.92	1.10	4.05	5.34
RES - total	10.08	15.69	19.63	21.75

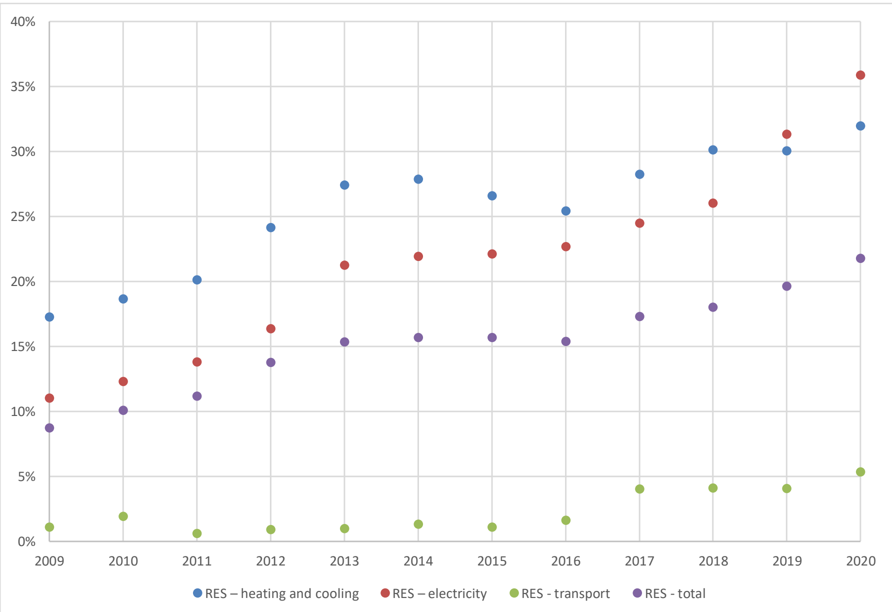


Figure 4.2 RES share trajectory from 2009 to 2020

The national objective to be attained in terms of the RES share in gross final energy consumption is at least 35%. There are also objectives for the RES share in gross final electricity consumption to reach at least 60%, the RES share in covering heating and cooling needs to exceed 40% and the RES share in the transport sector to exceed 14% in line with the relevant EU calculation methodology.

These quantitative objectives translate, depending on the evolution of final consumption, into specific quantitative values either in terms of installed capacity or in terms of a number of RES technologies/systems in final use (e.g. penetration of biofuels in transport, biomass boilers to cover heating and domestic hot water needs, heat pumps in buildings to cover heating and cooling needs, solar-thermal systems, etc.). Consequently, the quantitative correlation of these values is also directly linked to the attainment of the relevant energy efficiency improvement objectives.

Apparently, the key pillar for attaining the core objective for RES is the RES share in electricity consumption, and therefore this sub-sector is the main policy priority and poses the highest demand for the timely and efficient implementation of the measures planned. Attaining this objective requires a sharp increase in RES installed capacity for power generation, which is expected to more than double the current RES installed power for most of the relevant technologies. One can easily understand that this is a very ambitious, but also realistic, objective, taking into account the existing technical and economic potential and the investment interest already expressed. However, attaining that objective requires optimal response and functioning of the public bodies involved, of the regulator and of the operators, as well as of the RES market itself. Therefore, meeting this requirement in an optimal manner in the following period is a key challenge.

Another objective with regard to promoting RES and increasing their share in final consumption is the electrification and coupling of final consumption sectors.

On this axis, the gradual electrification of the transport sector is the major challenge in the following period. More specifically, a considerable penetration of electric vehicles is expected, making a substantial contribution to various dimensions of the NECP, whereas full electrification will be achieved in rail transport much earlier. The aim is to achieve this penetration in the most cost-effective way for the national economy, while at the same time appropriate infrastructure and the necessary regulatory framework must be developed in a timely manner as these are prerequisites for the electrification of the transport sector. A further aim is to combine consumption sectors to the greatest and most efficient extent possible, placing emphasis on maximising the use of RES. The electrification of different uses in final consumption is an essential component in achieving this aim. A typical example is heat pumps which, together with the future greater use of energy storage systems and autoproduction schemes, will make a decisive contribution in this direction.

Electricity

Renewable energy sources reached a share of 35.6% of electricity generation in 2020. This is the result of a rapid growth in wind and solar installed capacity and the decrease in total electricity supply during the past decade. Total power generation peaked at 58.9 terawatt hours (TWh) in 2008 and has fallen by 16.9% since then.

Wind power generation increased from negligible levels in the late 1990s to 9.3 TWh in 2020, equal to 19.3% of the total electricity generation. Solar power has had an impressive growth, too, experiencing an increase from 0.16 TWh in 2010 to 9.2 TWh in 2020. Hydro power has consistently accounted for a significant share of renewable electricity, but with substantial annual fluctuations. Hydro power production was 3.4 TWh in 2020, equal to 7.1% of the total generation. Greece also has a small share of electricity from biofuels, accounting for less than 1% of the total electricity generation.

During 2006-2015, Greece promoted electricity generation from renewable energy sources through a FiT programme (Feed-in-Tariff), which boosted solar PV deployment in Greece. Law 3468/2006, amended by Law 3851/2010 and significantly revised by Law 4254/2014 to introduce technology and project specific criteria, initialised the programme in 2006. The 2014 law retroactively recalculated downward the FiT compensation prices for existing PVs, wind, small hydro, and co-generation installations contained in the signed power purchase agreements. The review aimed to discuss the increasing deficit that appeared in the RES special account, reflecting the high compensation paid to a significant share of existing plants. During 2012-2014, Greece suspended the licensing of new PV installations because the target of 2.200 MW of installed PVs by 2020 had been achieved. Few PV systems have been installed since 2014 in a reflection of the revised lower compensation prices. Greece closed the FiT programme on 31 December 2015.

Law 4414/2016 introduced a new renewable energy source support programme in August 2016. The key objective of the law was to gradually integrate renewable energy sources and co-generation into the electricity market, with a view to the successive introduction of an electricity target model beginning in 2018. The new renewable energy source support programme has been applicable as of January 2016.

Two support forms are available:

- ✓ an FiP (Feed-in-Premium) above the electricity market price
- ✓ a fixed price support.

The principal instrument of Law 4414/2016 is the FiP. Recognising that the electricity market is in transition, the law included several exemptions and temporary arrangements, including a fixed price support. Essentially, the law states that operating aid is paid to renewable energy source installations that enter commercial or pilot operations in the interconnected electricity transmission system and distribution network of Greece, including high-efficiency co-generation generators, as of 1 January 2016.

The exemptions from the FiP and the requirement to participate in the electricity market are applicable for: small-scale renewable energy source power plants (below 3 MW for wind, and below 500 kW for other renewable energy sources); demonstration projects; and renewable energy source power plants in the non-interconnected islanlds (NIIs). For those projects, a fixed price operating aid contract is concluded between the project operator and LAGIE, the electricity market operator.

A special case is small wind plants (below 50 kW), for which a dedicated FiT programme has already been foreseen under Law 4203/2013 and which is expected to become effective in 2017.

According to Law 4414/2016 and as amended by Law 4467/2017, a special arrangement is foreseen for renewable energy sources and co-generation projects with a power purchase agreement signed before 31 December 2015. Those projects will receive operating aid under the FiT of the previous support programme (Law 4254/2014), provided that any such new-build projects enter into commercial or trial operation by 31 March 2019 (in the case of wind, small hydro, biomass, or biogas projects) or by 31 December 2017 for all other renewable technologies and highly efficient co-generation projects.

All other new renewable energy source power plants have to directly participate in the electricity market and have balancing responsibilities. They will receive operating aid in the form of FiPs above the electricity market price. FiPs are calculated as the difference between the revenues obtained by generators from the wholesale market price for each renewable energy source or co-generation technology and the reference value per technology used or per category of power plant.

Law 4414/2016 regulates the reference value. Contracts guarantee the operating aid for 20 years (25 years for solar thermal projects). Ministerial decisions adopted by the Minister of

Environment and Energy, following a proposal from LAGIE and an opinion from RAE, have determined the form, content, and details of such new standard contracts.

For certain technologies or categories of power plants, which have to be determined by a ministerial decision, the reference values required to calculate the FiP must be obtained through competitive bidding processes.

Over the following decade, RES will play a major role in the domestic energy mix, whereas in respect of domestic power generation in particular, they are expected to have a share of more than 50% as early as in 2025. While it was necessary to have a support scheme in place for providing operating support to RES plants in the previous period, now there are specific technologies that are mature in commercial terms and their power generation costs are, in a number of cases, more competitive than those of the respective thermal power plants.

Owing to the above reasons, the promotion of RES technologies for power generation with minimum operating aid is a key priority for the following period, as this will lead to the gradual reduction in the charges imposed on consumers for the development and operation of RES plants. More specifically, operating aid for the most economically competitive RES technologies in market terms, such as photovoltaics and wind farms, is expected to keep decreasing and eventually to be discontinued in the mid-term, as plants using these technologies will be fully competitive in terms of the electricity market and their operation will require no aid of any sort.

Achieving and strengthening that competitiveness in terms of power generation costs is based primarily on the functioning of the competitive bidding mechanism that is already in place. The framework of competitive bidding processes is expected to be extended, supported and modified as appropriate in the coming years, taking into account, each time, the specificities of the Greek energy system and the parameters of the reformed licensing framework, increasing investor interest and ensuring fair competition between the interested parties.

Financing of RES electricity support

Law 4001/2011 created a special account to administer the FiT programme whose cost amounted to around EUR 1.7 billion per year in 2014 and 2015 (with a peak of EUR 2 billion in 2013), for the entire country including NIIs. However, it is important to note that this amount includes the equivalent value and revenues of the renewable energy source generation from the electricity market, amounting to an average of EUR 600 million per year. Under the old programme, there were delays of over six months in the payment of FiTs to developers, and an accumulated deficit in the special account. The new FiP programme is expected to have a net cumulative cost of around EUR 260 million until 2020.

Law 4414/2016 splits the RES and CHP special account into: 1) The RES and CHP Special Account of Interconnected System and Network (special account I) and 2) the RES and CHP Special Account of Non-Interconnected Islands (special account II). The law also provides for two new levies that will give additional income for the renewable energy source account, instead of burdening end consumers through an increase in the existing renewable energy source (ETMEAR) levy.

Special account I is divided into two subaccounts: the Electricity Market subaccount and the Operation Aid subaccount. Inflows into special account I are defined as electricity market revenues and operating aid revenues.

Electricity market revenues consist of four types: 1) day-ahead scheduling (DAS), 2) variation settlements, 3) variable weighted average cost of conventional thermal power plants (VWACCTU), and 4) the special charge, which electricity suppliers have had to pay starting from the last trimester of 2016.

The special charge is calculated as the difference between the applicable wholesale market price and a projection of the price that would have been in place had renewable energy electricity not been included in the wholesale electricity market. It is expected that the past deficit of the RES and CHP special account can be cleared within 2017, based on the provisions of Law 4414/2016.

For the operating aid, revenues are included from the special lignite levy of EUR 2 per MWh, the special levy for renewable energy sources (ETMEAR), greenhouse gas (GHG) emission allowances, and NII supplier payments for the production value of renewable energy sources/co-generation in the NII, based upon the average variable cost of conventional units on NIIs.

A second additional levy, which will take effect from 2018, may be imposed on suppliers by a ministerial decision following an opinion by RAE, to gradually reduce the ETMEAR levy paid by end consumers. The law also provides for the possibility to introduce a special market with guarantees of origin.

Subsidies to renewable energy source investment

Until 2013, all renewable energy source technologies except solar PVs could apply for investment subsidies. Law 4146/2013, amended by Article 68 of Law 4155/2013, limited subsidies only to investments in hydro, pumped hydro, hybrid, biomass, and biogas stations for all the investment plans submitted after 1 January 2014.

However, all renewable energy source technologies are eligible for tax incentives. According to the new development law (4399/2016), investment subsidies will be granted to small hydro plants (up to 15 MW), high-efficiency co-generation plants using renewable energy sources, hybrid renewable energy source plants in the NIIs (up to 5 MW), production of heating and cooling from renewable energy sources, and high-efficiency district heating and cooling. The revenues from the operating aid on the basis of the differential premium or the fixed price shall be depreciated for renewables plant owners that are receiving subsidies on investment, or in an equivalent form (guarantees, tax relief, etc.).

Licensing and permitting of renewable energy source projects

The Greek government is implementing a review of the environmental impact assessment (EIA) framework with the aim to reduce the number of projects requiring an EIA from 22 000 per year to around 2 000-3 000 per year and to reduce the time needed for an EIA procedure from 20 months to 5-6 months through several measures including:

- removing the preliminary assessment
- providing for predetermined environmental terms and conditions for thousands of projects
- abolishing the co-signing of environmental permitting by other ministers
- creating a centralised electronic system for submitting and managing EIAs
- outsourcing the evaluation process of EIAs to the private sector.

Greece is reforming land use and land planning. A spatial plan for renewable energy sources is already in place and planned for offshore wind parks. The fast-track legal framework will provide for immediate licensing of big investment projects. Revision of the 12 regional spatial plans is progressing.

All the producers of electricity from renewable energy sources (with the exception of solar PVs) are paying a special charge equivalent to 3% of their total gross revenues. Of that, 1% goes directly to local citizens, 1.7% to the municipalities concerned, and 0.3% to the special fund for the implementation of regulatory and environmental plans.

Heating and cooling

Greece has around 5 millions square meters solar thermal collectors installed on residential houses and some commercial solar heating and cooling installations. Greece is also a leading manufacturer of solar thermal installations, with more than 50% of the production of solar thermal installations being exported.

The condition that FiTs for rooftop PV applications are only applicable to residences that cover a part of their water heating needs by some other renewable energy source (e.g. solar thermal) has encouraged renewable energy use for heat production. This has stimulated fast and early deployment of both solar PV and solar thermal power in Greece. The new Development Law 4399/2016 provides an income tax relief for co-generation plants and renewable energy source heating and cooling plants and also a stabilisation of the income tax coefficient.

Solid biofuels are used for heating in residential boilers, as a means to combat energy poverty. Residential consumption accounts for the largest share of biofuel demand in Greece. Biomass from straw, olive pruning and olive kernels, cotton stalks, and wood residues is used in the food and wood industries for space and process heating (equivalent to 5.4 PJ in 2020). Greece has installed 97.4 MW electrical from biomass (solid biofuels and biogases).

Transport

Only a small share of biofuels is used for transport (176.9 kt biodiesel and 88.2 kt biogasoline in 2020). Biofuels accounted for 5.34% of the final energy consumption in the transport sector in 2020.

Biofuels are mainly first-generation biodiesels produced from raw materials such as oil seeds, mainly sunflower, used cooking oils, and cottonseed.

According to the provisions of Law 3054/2002, a specific quantity of pure biodiesel is allocated to beneficiaries to achieve the 7% mandatory percentage of biodiesel blended in diesel (per volume). The allocated quantity corresponds to 85% of the biodiesel that is anticipated to be consumed throughout the year. The remaining 15% is freely marketed among refineries, wholesalers, and biodiesel producers or importers. The biodiesel quantities are allocated every year, after a relevant call for tenders and an evaluation and allocation procedure to stakeholders.

The investment law (4399/2016) provides investment support for the production of sustainable biofuels other than food-based biofuels and for the conversion of existing food-based biofuel plants into advanced biofuel plants in accordance with European Commission guidelines. However, biofuels that are subject to supply or blending obligations are excluded from receiving investment support.

Mitigation effect

Based on the results of the quantitative analysis that was carried out, GHG emissions reduction potential from implemented and adopted policies on RES exploitation in electricity generation is expected to be 11 Mt CO2eq in 2020 and 19 Mt CO2eq in 2030. Concerning biofuels in transport sector, the estimated reduction of GHG emissions according to implemented / adopted policies is expected to be 650 ktCO2eq in 2020 and 700 ktCO2eq in 2030.

It should be mentioned that the PaM “Promotion of RES” is related to Energy and Transport sectors. The affected GHG from this policy is mainly to CO2 (more than 99%).

Measures in the industrial sector

The main policy instrument for the reduction of GHG emissions in industry is the EU-ETS. By putting a price on carbon and thereby giving a financial value to each tonne of emissions saved, the industrial plants, which are subjected to EU ETS, need to reduce GHG emissions by taking energy-efficient measures, investing in CHP, switching to fuels and / or other feedstock that emit less CO2 (e.g. NG, biomass), etc. The cap and trade principle of EU ETS is described in section 4.3.1.3.

Energy-efficiency improvements and CHP units in various areas of the industry sector have been promoted since the 1st National Climate Change Program through the provisions of the Development Assistance Acts, Law 2244/93 (for CHP plants), the OPE (Measures 2.2 and 2.3) and OPC:

- energy saving interventions (installing building envelope insulation, heat insulated window frames, energy class A air-conditioning units, energy saving light bulbs, high-efficiency burners and boilers, exhaust heat recovery, etc.);
- developing and implementing systems for the recovery/saving and/or substitution of conventional energy and water in the production process;
- the procurement costs of equipment for energy self-production from RES and substitution of fuels with natural gas or LPG;
- bioclimatic and small-scale building interventions to save energy/heat/water;
- conducting energy audits and benchmarking;
- streamlining of equipment, upgrade of facilities and installation of new energy efficient technologies;
- education and training of staff.

Moreover, in compliance with Article 8 of the EU Energy Efficiency Directive, Greece implemented in December 2016 a requirement for large industry to either conduct an energy audit every four years, or implement an energy or environmental management system. Small to medium-sized enterprises will also have access to quality energy audits due to these policies.

It is estimated that the emissions reductions which can be achieved from the implementation of adopted measures in industry (CHP and PaMs included in national Energy Efficiency Action Plan) can reach 200 kt CO2 eq in 2020. The affected GHG from this policy is mainly CO2 (more than 99%).

Measures in residential and tertiary sector

Several actions are included in the Energy Efficiency National Action Plans concerning the conservation and rational use of energy in the residential and tertiary sector. Apart from the introduction of natural gas and RES, the measures concern actions for the improvement of the thermal behavior of residential sector buildings and promotion of energy efficiency appliances and heating equipment. These actions are supported significantly by the incorporation in the Greek legislation of the Directive 2002/91/EC by Law 3661/08 (Official Gazette 89/A 3661 – 19/5/2008) and JMD D6/B/14826 (Official Gazette 1122B – 17/6/2008), which lays down requirements as regards:

- ✓ the general framework for a methodology of calculation of the integrated energy performance of buildings;
- ✓ the application of minimum requirements on the energy performance of new buildings and existing buildings that are subject to major renovation;
- ✓ energy certification of buildings;
- ✓ regular inspection of boilers, heating installations and air-conditioning systems in buildings;
- ✓ mandatory replacement of all low energy efficiency lights in the public and wider public sector;
- ✓ financial incentives and subsidies for the replacement of low energy class household devices with new energy efficient ones.

The adoption and application of the “Energy Performance of Buildings Regulation” (KENAK):

- ✓ establishes a methodology for the calculation of the energy efficiency of buildings for the estimation of the energy consumption for heating, cooling, air conditioning, lighting and hot water;
- ✓ sets the minimum standards for the architectural design of the buildings, the thermal characteristics of the building materials of the building shell and the standards of the electromechanical installations both for the new and the fully renovated buildings;
- ✓ determines categories for the energy ranking of buildings;
- ✓ stresses the obligation for new or refurbished buildings to meet 60% of their needs for hot water through solar thermal systems.

Furthermore, L3855/2010 on “Measures to improve energy efficiency in end-use, energy services and other provisions”, which transposes Directive 2006/32EC, foresees specific measures for the buildings of the public sector in order to improve their energy performance and achieve energy savings. Additionally, it sets the framework for the establishment of the ESCO market in Greece through Energy Performance Contracts and coordinates the promotion of Green Public Procurement. Other supporting legislation is the Joint Ministerial Decree "Measures to improve energy efficiency and energy saving in the public and broader public sector" where a connection with the natural gas network is made mandatory. It, also, defines, streamlines and facilitates the licensing procedure and framework for the exploitation of geothermal resources for own use through energy systems (ground source heat pumps) for space heating and cooling of a building.

The European Directive 27/2012/EU has been transposed to the national legislation by Law 4342/2015. Pursuant to Article 5 of this Directive, which is entitled “Exemplary role of public bodies’ buildings”, it has to be ensured that each year 3% of the total floor area of heated and/or cooled buildings with a total useful floor area over 500 m2 owned and occupied by its central government is renovated to meet at least the minimum energy performance requirements that were set in application of Article 4 of Directive 2010/31/EU. In Greece, under this provision there are 82 buildings with total floor area 30,971 m2.

In addition to that, in the NECP, an objective is set for the annual energy renovation of a total floor area of the thermal zone of central public administration buildings equal to 5400 square meters, representing 3% of the total floor area, till 2030.

The need to renovate the existing building stock is indisputable, as this will result in significant energy savings and in cost savings for citizens, and will also improve the comfort, safety and health conditions in the use of these buildings.

To that end, it is necessary to establish a central quantitative objective for the renovation and replacement of residential buildings with new nearly zero-energy buildings, which could in aggregate amount to 12-15% of all residential buildings by 2030. The annual objective is to have an average of 60000 buildings or building units upgraded in terms of energy and/or replaced with new more energy-efficient ones. This particular objective will contribute significantly to the major upgrading of the ageing building stock, while at the same time giving a substantial boost to the construction industry through high added value technologies and essentially ensuring increased financial and operating benefits for households in Greece, also enabling them to cover their energy needs.

In particular, the financing programmes for the renovation of both residential and tertiary sector buildings in the context of the new programming period (NECP, till 2030) will be implemented by adjusting and improving the existing financing model, with a view an increase in the existing leverage levels by beneficiaries. These programmes aim to:

- increase the number of potential beneficiaries;
- simplify the certification of interventions, using unit cost data;
- ensure more active involvement of domestic financial institutions in the financing of necessary interventions; and

- promote innovation in the domestic construction and manufacturing industry.

4.3.2.3 Sectoral policies and measures: Transport

GHG emissions from the transport sector present a declining trend mainly due to economic crisis, in the previous years, and to the COVID-19 pandemic in 2020 and on. Nevertheless, they are still considerable both in Greece and in European Union, and, consequently the implementation of suitable policies and restriction measures is required. The main axes of intervention and implemented policies and measures in the sector, beyond the introduction of biofuels for road transport and natural gas in the public system of transport that were already described previously, are shortly presented below:

(A) Interventions in the transport system

Public works to enhance the existing infrastructure described in the previous National Communications (road-grid improvements in the large urban centres, reconstruction of major highways, improvements in the traffic-light system) are in progress.

Programmes for the upgrading of the traffic lights system (road signaling), as well as the overall traffic management and control have been developed since 2002 in Athens. Therefore, half of the traffic lights in the region of Athens (roughly 1500) are in cooperation, while the Centre of Traffic Management, which belongs to the Ministry of Infrastructure, Transport and Networks, collects traffic information from 842 traffic nodes in a daily base. According to collected information, processes for the improvement of the road signaling have been established.

The Law 4439/2016 aims at the development of infrastructures in the transport system for alternative fuels e.g. electricity, hydrogen, biofuels, natural gas, liquefied natural gas, compressed natural gas, liquefied petroleum gas, to substitute conventional fossil fuels.

(B) Interventions in public transport

Important interventions have already been implemented or are under development aiming at the enforcement of public transport. In Athens, the two new metro lines, which were completed and started operation in 2000, are being expanded, while new metro lines are in the implementation phase. In Thessaloniki a new metro line is under construction. Also in 2004, a new tram started operating in Athens with 2 lines reaching from the centre of the city to the southern waterfront suburbs.

Concerning rail transport, since 2000, more than 250 km of new rail lines have been constructed (including replacement of old single lines), while more than 220 km rail lines have been converted to electrical driven. Besides, more than 300 km of new rail lines are under construction phase. Currently, the suburban railway in the wider area of Athens has already started, the connection to Corinthos, Chalkida and Livadia are completed, whereas the Thessaloniki and Patras suburban railways are also in operation.

An extended network of bus lanes of approximately 50 km length has already been created, resulting in the increase of the average speed of buses in Athens from 16 km/h to 23 km/h. The fleet of buses has been renewed to a large extent, while more than 400 buses use natural gas as fuel and 100 buses operate with engines of Euro V technology. Moreover, the renewal of the fleet of electrically driven buses (trolleys) began in 1998 with the supply of 224 vehicles and was extended with the supply of additional 142 vehicles by the end of 2004. More electrically driven buses are going to be added to the bus fleet in the coming years.

Especially in the Metropolitan Athens Area, the public transportation fleet is one of the newest in European level comprising of 360 trolley of antipollution technology and 2153 buses of which:

- ✓ 398 Euro 1
- ✓ 1033 Euro 2 (294 CNG),
- ✓ 402 Euro3 (120 CNG),

- ✓ 220 Euro 4,
- ✓ 100 Euro 5

In addition, by Law 2963/2001 (A 268), an age limit of 23 years has been instituted for all urban, semi-urban and long distance buses. Also the limit of 11 years was set as the higher permissible age for buses in public transport. Under the provisions of the same law, economic incentives were given in the owners for the replacement of vehicles with new or used vehicles of small age. Of the 5000 semi-urban and long distance buses licensed in Greece, 1846 buses have been replaced since 2004, of which 1746 with new and 100 with used of age lower than 5 years. Moreover, the replacement of tourist coaches was encouraged by subsidies provided for in Article 31 of Law 3229/2004. By Article 7 of Law 2446/96, an age limit of 23 years has been also instituted for them. The replacement program was supervised by the Ministry of Tourism and the former Ministry of Economy and Finance. The new National Climate Law (Law 4936)

Finally, the public transport system in Athens is being reorganized on the basis of the new metro and tram lines, with buses and trolleys also playing a complementary role of connecting the metro and tram stations with other areas of the city.

(C) Interventions in vehicles

The main regulation that aims at the restriction of GHG emissions from vehicles is the one requiring regular technical checks of vehicles, which has been mandatory since 1983 and takes place at the Centres for Technical Control of Vehicles (CTCV). The law provides for the establishment of private Centres for Technical Control, the improvement of public ones and the development of a special organization to supervise the operation of the above-mentioned Centres. Currently, according to data of the Ministry of Infrastructure, Transport and Networks, 56 public and 37 private centers operate and other 40 have been licensed and start or expected to start operation in the coming period. With the increase of the CTCV number during the next period, the essential conditions and infrastructures for an important increase of the number of checked vehicles per year are created, in accordance with the objectives of the National Program.

An equally important intervention for GHG emissions reduction from vehicles is the exhaust control card, which is required for all vehicles and should be renewed on an annual basis for private passenger cars and trucks up to 3.5 t. Certified auto-repair shops expressly certified to carry out this task and issue the control card.

Moreover, under the framework of the implementation of policies for the replacement of old vehicles, a list of actions has been taken place. The buses fleet is being renewed, aiming to the improvement of energy efficiency of vehicles.

According to the Law 3109/2003 the age limits for the public use cars (taxi) were revised and economic incentives were given to the taxi - owners for the replacement of their vehicles with new ones (9300 taxis have been replaced).

The establishment of a renewal program for the fleet of motorcycles, with incentives for the final withdrawal of two-wheeled motorcycles over 50 c.c. and aged more than ten years (categorized until 1994 for motorcycles and 1996 for motorbikes) was another important intervention in the transport sector. The program was put in force with Law 3245/2004 – article 2 (A 110) and its force was extended by Law 3333/2005 (A 91).

The voluntary agreement between the European Commission and the European, Japanese and Korean car-manufacturers associations to improve the fuel efficiency of new cars is considered as an adopted measure aiming at the reduction of GHG emissions in conjunction with promotion of ecologic labeling – energy labeling of passenger cars. The agreement foresees the improvement of the fuel efficiency of new cars, so as the CO2 emission factor to reach down to 140gr/km in 2008. The measure is expected to have an important long-term output through the penetration of low emissions vehicles in the total fleet. The mandatory quota with energy efficient vehicles in public services or organizations and the linking of vehicle tax with energy efficiency and CO2 emissions were also adopted.

Finally, the development of urban mobility plans and the promotion of eco-driving, interventions for the safe movement of bicycles in the cities and the construction of new bicycle paths are measures that are expected to contribute to GHG emissions reduction.

(D) Measures for addressing air pollution from road traffic in urban centres

In July 2009, the former Ministry for the Environment, Physical Planning and Public Works (present Ministry of Environment and Energy) introduced a package of measures for addressing air pollution from road traffic. These measures concerned the calculation of Environmental motor vehicle circulation fee (road tax), incentives for fleet renewal and removal of vehicles as well as a proposal for a “Green” traffic ring. These measures were applied only for a few months in 2009 and they were cancelled by the next Ministry of Environment, Energy and Climate Change. In their place new measures were applied. More specifically, new circulation taxes were decided to be applied from November 2010 for all new vehicles according their CO2 emissions. This measure obviously aims at promoting new technology vehicles of low CO2 emissions. Additionally, a new withdrawal system for old passenger cars with financial incentives was set in early 2011 but with poor results because of the economic crisis. This measure was applicable until the end of 2016. Finally, the green ring was adopted in 2012 concerning traffic restriction measures for the older technology cars in the centre of Athens.

(E) Fiscal measures

Fiscal measures (e.g. car registration and road tax) were presented in section 4.3.1.5.

As GHG emissions have already decreased in Greece, as a result of the deep recession, it is expected that the implemented / adopted policies and measures in the transport sector will further contribute in GHG reductions of about 340 kt CO2eq in 2020.

The mitigation of transport GHG emissions is also supported by EU transport sector policies. More specifically, the **CO2 and Cars Regulation (EC) No 443/2009** limits CO2 emissions from new cars to a fleet average of 130 grams of CO2 per kilometre (g/km) by 2015 and 95 g/km by 2021. The 2015 and 2021 targets represent reductions of 18 % and 40 % respectively, compared with the 2007 fleet average. In 2014, Regulation (EU) No 333/2014 on modalities for reaching the 2021 target for cars was adopted. Implementing the 2021 emission targets for cars is expected to result in annual savings of 24.9 Mt CO2 in 2021, and 43.6 Mt CO2 in 2030 (EU wide mitigation impact).

The **CO2 and Vans Regulation (EU) No 510/2011** limits CO2 emissions from new vans to a fleet average of 175 g/km by 2017 and 147 g/km by 2020. These cuts represent reductions of 14 % and 28% respectively, compared with the 2007 average. The annual CO2 equivalent savings are expected to be 1.9 Mt in 2020 and 5.3 Mt in 2030 (EU wide mitigation impact).

The data published by the EEA indicates that the EU car and van fleets will have met their targets well ahead of the deadlines. The average specific emissions of the European fleet in 2014 were 123.4 g/km for new cars (compared to the 130 g/km target for 2015) and 169.2 g/km for new vans (compared to the 175 g/km target for 2017). Provisional data published by the European Environment Agency showed that good progress continues to be made on fuel efficiency of new cars, with the average emissions level of a new car sold in 2016 at 118.1 grams of CO2 per kilometre, significantly below the 2015 target of 130 g[11].

The **Directive 1999/94/EC on Car Labelling** is a demand-side policy and an important complementary measure to help car manufacturers to meet their specific CO2 emission targets and to raise consumer awareness on fuel use and CO2 emissions of new passenger cars. It requires that information relating to the fuel economy and CO2 emissions of new

[11] https://ec.europa.eu/clima/news/new-cars-sold-europe-fuel-efficiency-improvements-continued-2016_en

passenger cars offered for sale or lease in the Union is consistently made available to consumers in order to enable more informed purchase decisions.

A number of Regulations are in place related to **environmental and safety requirements of tyres and gear shift indicators (GSI)**. Regulation (EC) No 661/2009 aims at increasing the fuel efficiency of motor vehicles by introducing tyre pressure monitoring systems and GSI. In addition, Regulation (EC) No 1222/2009 on the labelling of tyres aims at influencing energy demand by promoting the market transformation towards fuel-efficient tyres. The Regulations' total CO2 emission savings from all vehicle types are expected to range from 1.5 to 4 Mt annually by 2020 (EU wide mitigation impact).

Directive 2009/30/EC on Fuel Quality tightens the requirements for a number of fuel parameters. The Directive introduces a binding target for fuel suppliers to reduce lifecycle GHG emissions per unit of energy from fuel and energy supplied by 6 % by 2020 compared to 2010. The reduction is to be obtained through the use of biofuels, alternative fuels, electricity in road transport or reductions in upstream emissions such as from flaring and venting at production sites. The expected savings of 6 % of total well-to-wheel road transport CO2 emissions in 2020 amount to roughly 55 Mt CO2 in 2020 (EU wide mitigation impact)., excluding indirect land use change (ILUC) emissions. Council Directive (EU) 2015/652 specifies calculation methods and reporting requirements under the Fuel Quality Directive.

The **Directive 2014/94/EU on Deployment of Alternative Fuels Infrastructure** requires Member States to adopt national policy frameworks for the market development of alternative fuels and their infrastructure, including targets for the build-up of alternative fuel infrastructure. The Directive also sets common technical specifications for the infrastructure interface and requests development of an alternative fuel labelling system to ensure clarity in the consumer information on vehicle/fuel compatibility, as well as an alternative fuel price comparison methodology. The Directive 2014/94/EU was transposed to Greek legislation by Law 4439/2016.

4.3.2.4 Sectoral policies and measures: Industrial processes

Most of the industrial processes emissions (with the exception mainly of the emission from the use and consumption of fluorinated gases) are regulated by the EU-ETS market-based mechanism (e.g. CO2 emissions from plants producing cement, lime, ceramics, glass, iron and steel, ferroalloys, aluminium (PFCs), nitric acid (N2O)). The cap and trade principle of EU ETS is described in section 4.3.1.3.

To control emissions from fluorinated greenhouse gases (F-gases), including hydrofluorocarbons (HFCs), the European Union has adopted two legislative acts: the 'MAC Directive' (2006/40/EC) on air conditioning systems used in small motor vehicles, and the 'F-gas Regulation' (No 517/2014) which covers all other key applications in which F-gases are used. The two strategies described in the abovementioned regulation to reduce emissions is to prevent leakage and emissions {Emission prevention and leak checks, Control of by-production, End of life treatment of products and equipment, Training and qualification, Information for users (labelling, product info)} and control of use of F-gases (Ban on new applications, Ban on uses, Phase-down of HFC supply). Several control mechanisms and penalties are implemented in Greece. Checks for compliance with these regulations of the European Union are carried out by the relevant bodies and agencies of the competent authorities, as appropriate, in the context of their remit. In cases of infringement of the provisions of the relevant EU Regulations by legal or natural entities of the public and private sector, sanctions are imposed by the relevant bodies and agencies of competent authorities.

It is considered that the action taken by the EU and its Member States under the F-gas Regulation will enable the EU to comply with the Kigali amendment to the Montreal Protocol on a global phase-down of hydrofluorocarbons (HFCs).

It is estimated that the mitigated GHG emissions from the implemented and adopted policies and measures that are related to the reduction of emissions of fluorinated gases are estimated at 760 kt CO2eq for 2020 and 1.7 Mt CO2eq for 2030.

4.3.2.5 Sectoral policies and measures: Agriculture

Agricultural activities can result in methane emissions from livestock digestion processes and storage of animal manure and the use of organic and mineral nitrogen fertilisers can lead to nitrous oxide emissions.

Common Agricultural Policy

The agriculture sector has the specialty that it is mainly driven by one policy, the Common Agricultural Policy (CAP), which determines a common way for all Member States of the European Union. For the period 2014 – 2020[12], three strategic objectives for rural development in the EU have been set in line with the Europe 2020 Strategy: Improving the competitiveness of agriculture, the sustainable management of natural resources and climate action, and a balanced territorial development of rural areas. The legislative framework concerning the rules for agriculture production in Greece is fully harmonized with the European Common Agricultural Policy (CAP).

Regulation (EU) No 1305/2013 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD) foresees that Member States draw up and co-finance multiannual rural development programmes (RDPs), at national or regional level. These programmes have to meet the three strategic objectives for 2014 – 2020, including sustainability and climate action.

The “Horizontal Regulation” (EU) No 1306/2013 provides the financial management rules for the two CAP funds, the European Agricultural Guarantee Fund (EAGF) which finances market measures and direct payments, and the EAFRD which finances support to rural development. It brings together the rules on cross compliance, farm advisory systems and monitoring and evaluation of the CAP. The Regulation on Transitional Provisions (EU) No 1310/2013 is designed to bridge the gap between the two rural development programming periods – before and after the 2013 reform. Under certain circumstances already existing national programmes are also eligible for support in the new programming period.

In 2013, the EU has agreed that at least 20 % of the Union’s budget for 2014 – 2020 should be spent on climate related action. This also affects the CAP and its specific funding programs, which consequently take climate mitigation and adaptation as an additional criterion for support.

Implementation of the new Common Agricultural Policy (CAP) regulations started only in 2015 (with 2014 being a transitional year). In its most recent revision, CAP introduced specific measures for "***Green Direct Payments***” linked to the provision of environmental public goods, linking viable food production, sustainable management of farmland and environmentally-friendly practices. In order to receive payments, farmers shall respect a set of basic rules. Farmers not respecting EU law on environmental, public and animal health, animal welfare or land management will see the EU support they receive reduced. These reductions are proportional to the extent, permanence, severity and repetition of the infringement specified. Cross-compliance covers two elements:

- Statutory Management Requirements (SMRs): These requirements refer to 13 legislative standards in the field of the environment, food safety, animal and plant health and animal welfare.
- Good agricultural and environmental conditions (GAECs): The obligation of keeping land in good agricultural and environmental condition refers to a range of standards

[12] Information about the application of the CAP till 2014 was included in the Greek 6th National Communication.

related to soil protection, maintenance of soil organic matter and structure, avoiding the deterioration of habitats, and water management.

Cross-compliance includes directives and regulations – "statutory management requirements" – that are applied under the sectorial legislation and apply therefore also to farmers not receiving the CAP support covered by cross-compliance:

- ✓ Public, animal and plant health: General Food Law, Hormones ban Directive, Regulations on identification and registration of pigs, bovine, ovine and caprine animals, Regulation on prevention, control and eradication of TSE, Regulation on plant protection products;
- ✓ animal welfare: Directives on the protection of calves, pigs and animals kept for farming purposes;
- ✓ environmental protection: Nitrates Directive, NATURA 2000 Directives (wild birds and habitats).

To this has been added – specifically for farmers receiving CAP payments – a set of standards on good agricultural and environmental condition of land, designed to:

- ✓ prevent soil erosion: minimum soil cover, minimum land management;
- ✓ maintain soil organic matter and soil structure: maintenance of soil organic matter level;
- ✓ biodiversity and ensure a minimum level of maintenance: retention of landscape features including ban on cutting hedges and trees during the bird breeding and rearing season;
- ✓ protect and manage water: establishment of buffer strips along water courses, authorisation on water for irrigation and protection of ground water against pollution.

Rural Development Programme (RDP)

The Rural Development Programme (RDP) for Greece was formally adopted by the European Commission on 11 December 2015 and modified on 28 June 2017, outlining Greece's priorities for using the € 5.6 billion of public money that is available for the period 2014-2020 (€ 4.7 billion from the EU budget and € 0.9 billion of national co-funding).

The Greek RDP focuses mainly on enhancing farm viability and competitiveness, preserving and enhancing ecosystems and promoting local development in rural areas. Farmers will receive support to put 10.3% of the Greek farmland under contracts to preserve biodiversity, 12.1% to improve water management and 10.7% to improve soil management and/or prevent soil erosion. Investment support for restructuring and modernisation will be provided to 6300 agricultural holdings and 23900 young farmers will receive start up aid. In addition, over 5600 agricultural holdings will receive support to develop short supply chains, local markets and to carry out promotional activities and about 600 agri-food businesses will receive support for investments in processing and marketing of agricultural products. Support for knowledge and innovation activities makes up over 5% of the planned public expenditure and the programme will create around 76 618 training places for farmers and other rural businesses. The RDP will also support local development via LEADER Local Action Groups covering nearly half of the country's rural population and improve access to basic services for approximately 10% of the rural population, including IT infrastructures (e.g. broadband internet).

The Greek RDP will fund actions under all six Rural Development priorities – with a particular emphasis on the competitiveness of the agricultural sector and sustainable forestry, and on restoring, preserving and enhancing ecosystems related to agriculture and forestry. In budgetary terms, two of the biggest RDP measures are linked to climate change mitigation and adaptation:

- ✓ € 741 million allocated to Organic farming

✓ € 452 million allocated to Agri-environment and climate measures

The RDP 2014-2020 is required to spend a minimum of 30 % of the total contribution from the EAFRD on climate change mitigation and adaptation as well as environmental issues.

Rural Development Policy's actions that contribute directly to the decrease of greenhouse gas emissions are the following:

- ✓ Organic farming.
- ✓ Decrease of the use of synthetic nitrogen fertilizers.
- ✓ Disengagement of subsidies from the agricultural production (reduction of the rate of intensity of agricultural land use).
- ✓ Use of environment-friendly livestock farming methods and improvement of the management of animal waste.
- ✓ Improvement of energy efficiency, renewable energy generation and use, including biomass.
- ✓ Improve management of soil (maintenance of agricultural activities in mountainous areas, green cover, and permanent grassland) and increase carbon sequestration.

Organic production and decrease of the use of synthetic nitrogen fertilizers result in a substantial decrease of N_2O emissions. According to national statistics, the total land with organic farming in Greece (fully converted and under conversion to organic farming) is 342,584 ha in 2016. The actions of Rural Development Program (2014-2020) for the transition to practices and methods of organic farming will cover 478,317.70 ha of land, while the aid to preserve existing organic farming practices and methods will cover 241,804 ha.

The reduction of the rate of intensity of agricultural land use and adoption of rules for the obligatory observance of cross compliance system relating to manure management and rational use of fertilizers contribute to the reduction of GHGs, too.

Furthermore, the disengagement of subsidies from the agricultural production has already enhanced indirectly the reduction of agricultural production and livestock population. In fact, the disengagement of subsidies from the agricultural production along with the enhanced citified way of life consist the main reasons for the reduction of agricultural production.

In total, the measures in the agricultural sector are expected to reduce GHG emissions as presented in ***Table 4.12***.

Table 4.12 Impact of PaMs in GHG emissions reduction from the agricultural sector (in kt CO2 eq.)

	2015	2020	2025	2030
Reduction in Fertilizers use (N_2O)	100	120	150	200
Organic farming (N_2O)	160	220	300	350
Reduction of the rate of intensity of agricultural land use and improvement of management of animal waste. (CH4, N2O)	300	375	550	750
Total	**800**	**905**	**1050**	**1250**

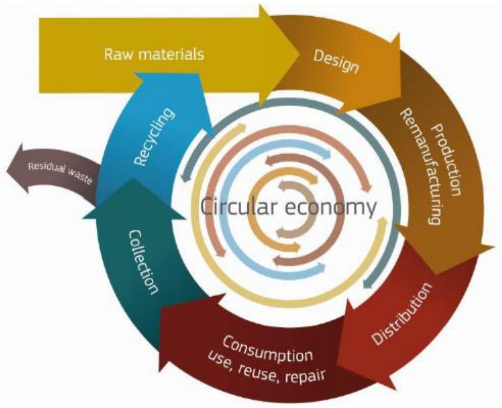
4.3.2.6 Sectoral policies and measures: Waste

Policies and measures relating to solid waste disposal, biological treatment of waste, waste incineration and open burning of waste, as well as wastewater treatment and discharge, are climate relevant. Important GHGs in this sector are CH4, which mainly arises from the treatment and disposal of solid waste, and N2O originating from waste water. In addition, a substitution of primary raw materials by secondary raw materials coming from recycling allow for significant GHG savings due to lower demand for energy needed to extract raw materials and turn them into products.

From waste management to a circular economy

The EU's Circular Economy Action Package was adopted in December 2015. The circular economy package goes beyond waste management alone, by addressing the whole life cycle of resources and products, in order to close the loop. This means dealing with production processes, material and product design, consumer and buyer information, distribution and retail to stimulate waste prevention by increased re-using, repairing, refurbishing and also by recycling existing materials and products to minimize the residual waste, ideally leading to a zero waste society. The strategy set out a number of priority issues, including plastics, food waste, critical raw materials, construction and demolition, biomass and bio-based products, innovation and investment and monitoring progress.

The Ministry of Environment and Energy of Greece has already made a number of institutional interventions, which are in line with the principles of circular economy: (a) The revised National Waste Management Plan (which has been approved and published on 15-12-2015 with the Act no. 49 of Ministerial Council "Amendment and approval of the National Waste Management Plan and the National Strategic Plan for Waste Prevention, ratified according to the 51373/4684/25−11−2015 Joint Ministerial Decision") foresees that 50% of the waste (recyclable and biowaste) will be recovered by recycling and reuse at local level; (b) the development of regional waste management plans (all thirteen have been approved); (c) the financing of projects involving the remaining 50%, with provision for the recovery of resources, energy and secondary materials; (d) the recent law about the alternative management of packaging waste and other products (Law 4496/2017); and (e) the application of the principle "pay as you throw".



Source: European Commission.

Figure 4.3 Main phases of a circular economy model

Waste to landfill - Management of biodegradable waste

With Decision 50910/2727/2003 and Law 4042/2012 and more specifically the National Waste Management Plan (2015), the measures, the terms and the processes for the rational management of waste in national and regional level have been specified.

According to the National Waste Management Plan (2015), the national policy for waste, taking into consideration, among others, waste hierarchy as set in the Directive 2008/98/EC, is formulated in order to achieve the following goals for the year 2020: (i) waste generation per capita shall be reduced drastically, (ii) the preparing for reuse and recycling including separate collection of recyclables – biowaste shall reach 50 % of total produced municipal waste, (iii) energy recovery shall be chosen as a supplemental / final solution when the application of the remaining recovery operations is not possible and (iv) landfill shall be the last choice of waste management whereas landfilled waste shall be reduced at 30% of the total municipal waste generation.

Landfills shall comply with the requirements of Directive 1999/31/EC on the landfill of waste, which has transposed to Greek legislation by JMD 29407/3508/2002. The objective of the Landfill Directive 1999/31/EC is to prevent or reduce as far as possible negative effects on the environment resulting from the landfilling of waste –including emissions of GHG – by introducing stringent technical requirements for waste and landfills.

Biodegradable waste is of interest in terms of GHG emissions, as this is the waste fraction delivering most CH4 emissions during anaerobic decomposition. The necessity to reduce the quantities of biodegradable waste going to landfills is acknowledged by Joint Ministerial Decision 29407/3508 in agreement with Directive 1999/31/EC. Within the framework of the national strategy for the reduction of biodegradable waste, as reviewed according to the National Waste Management Plan (2015), Greece has the target to limit the biodegradable waste going to landfills in 2020 to 35% of the biodegradable waste produced in 1997. The implementation of the Directive is expected to contribute in the reduction of GHG emissions (CH4) at approximately 0.6 Mt CO2eq, 0.8 Mt CO2eq and 1.1 Mt CO2eq in 2020, 2025 and 2030, respectively. The reduction of biodegradable waste landfill is enhanced by the directive for Packaging and Packaging Waste (94/62/EC) Paper/Cardboard recycling.

The Landfill Directive requires, also, the collection of landfill gas from all landfills receiving biodegradable municipal waste. The flaring of landfill gas in all managed sites for urban centres with population more than 100,000 is partially an integrated measure. Already, the managed disposal sites serving the population of the largest cities of Greece are equipped with systems for the collection or for the flaring of biogas. The flaring or the recovery of biogas in SWDS is expected to contribute to the reduction of GHG emissions (CH4) by 900 kt CO2eq, 850 kt CO2eq, and 650 kt CO2eq for the years 2020, 2025 and 2030.

Urban Waste Water Treatment

As regards wastewater, a collection network with its corresponding wastewater treatment plants has already been developed during the last five-years, covering the needs of 70% of the population in 2001 and the 91% in 2015, in compliance with the Directive 91/271/EEC concerning the collection, treatment and discharge of the urban wastewater. In the Psyttalia wastewater treatment plant that serves approximately 4 millions of Attica population, a part the sludge produced is treated under anaerobic conditions resulting in the production of biogas. The biogas produced covers the energy needs of the wastewater treatment facilities, while the surplus is flared.

Finally, the implementation of Directive 86/278/EEC for the use of sludge in agriculture is in force, however until 2012 only a minor amount of sludge is used in agriculture (about 0.04% of produced sewage sludge) on the frame of research projects and pilot studies. Nevertheless an increase in the quantity of sludge in agriculture is observed for the period 2013 - 2015 (about 20% of the dry produced sewage sludge).

Policies targeting waste streams

In this section policies are grouped together which target different waste streams; the GHG reduction potential may become apparent only in the overall life-cycle where emissions are avoided during production or due to smaller amounts of waste.

The Directive 94/62/EC established the general principles of the European Union on packaging and packaging waste. This directive was incorporated into national law by Law 2939/2001 which lays down recycling targets per waste stream and introduces the obligatory participation of the parties responsible (packaging producers) in alternative waste management systems. In Greece, the most known packaging waste recycling system is the system of placed nationwide blue bins, but there are other systems as well with small recycling kiosks. The materials recycled are plastic, glass, aluminum, paper and cardboard, tinplate and wood. The Alternative Waste Management System Packaging SSED-RECYCLING started its operation in 2003 by placing blue recycling bins. The packaging recycling systems have since grown and noted a steady increase in the geographical range, the number of contracted producers and the amount of packaging recycled.

The particular problem of plastic waste is addressed by a Green Paper (COM(2013) 123 final) and a Proposal for an amendment to the Directive 94/62/EC to reduce the consumption of lightweight plastic carrier bags (COM(2013) 761 final). On 28 April 2015, the European Parliament approved of such an amendment that will require EU Member States to either reduce annual average consumption of lightweight plastic bags per citizen, or to ban the handing-over of free bags (Directive (EU) 2015/720). In Greece, as of 1 January 2018, consumers are required to pay an environmental fee per piece of lightweight plastic carrier bag (Law 4496/2017 and JMD 180036/952/10.8.2017 (OJG 2812 B)). The charge is set as from 1 January 2018 at three (3) cents of euro and from 1 January 2019 to seven (7) cents.

The Directive on Waste of Electrical and Electronic Equipment (WEEED) 2012/19/EC requires Member States to take measures to encourage producers to design and produce electrical and electronic equipment which take into account and facilitate dismantling and recovery. Moreover, it sets ambitious collection targets in order to minimize the disposal of WEEE in the form of unsorted municipal waste. It also sets targets for re-use and recycling as well as targets for recovery of WEEE to ensure the correct treatment of all collected WEEE. In Greece, the annual waste electrical and electronic equipment is estimated at 120,000 to 140,000 tons. Waste electrical and electronic equipment has been identified by the Greek legislation as a priority waste stream, due to the dangerous nature of growth in the volume and the significant impact caused by the production of electrical and electronic equipment in the environment. According to the revised National Waste Management Plan, from 2019, the minimum collection rate is set at 65% of the average annual weight of the Electrical and Electronic Equipment placed on the market in the previous three years or alternatively in 85% of the Waste Electrical and Electronic Equipment produced by weight.

The End-of-Life Vehicles Directive (ELVD) 2000/53/EC aims to reduce the amount of waste produced from vehicles when they are scrapped and to increase re-use, recycling and other forms of recovery of end-of-life vehicles and their components. The Motor Vehicles Directive 2005/64/EC sets very high targets for re-use, recycling and other forms of recovery of end-of-life vehicles and their components so as to reduce the disposal of waste as well as to improve the environmental performance of all economic operators involved in the life cycle of vehicles. Further, it sets provisions on the type-approval of motor-vehicles with regards to their reusability, recyclability and recoverability. In Greece, after the launch of the system of Alternative Vehicle Management Association (EDOE) in December 2004, the rate of recycling of ELVs has shown an upward trend. Apart from private owners of old cars, local government agencies have been active and have fully contributed to the removal of abandoned old cars from the streets of the cities. The recycling system of EDOE collaborates with other collective recycling systems, where materials are delivered as oil, tires, batteries and other hazardous waste delivered to hazardous waste management companies. A percentage, almost 75% of ELVs consists of useful metals that are recycled in their respective industries. Finally some parts are sold as used parts (reuse). The national institutional framework for ELVD is governed by PD 116/2004, JMD 186921/1876/30-10-2016 and JMD 15540/548/E103. Under the Presidential Decree 116/2004, quantitative targets for recycling vehicles have been set to 85% for vehicles produced after 1/1/1980 and to 75% for vehicles produced before 1/1/1980. Production date is considered the issue date of the first license. These objectives were increased to 95% reuse and recovery irrespective of the year of production.

The Battery Directive 2006/66/EC provides, *inter alia*, targets for collection and recycling and establishes rules for treatment and disposal of batteries and accumulators. In Greece, in 2013 around 1,700 tons of portable batteries are placed into the market, and around 590 tons of waste portable batteries are collected corresponding to 34% collection rate. The national institutional framework for used batteries is governed by IMD 41624.2057.E103/2010 and JMD 39200/2015.

There are three additional waste streams already covered by the national institutional framework for alternative management:

- ✓ Waste Lubrication Oils - WLO (PD 82/2004). In Greece it is estimated that 60% of oils available in the market becomes waste.
- ✓ Used vehicle tires (PD 109/2004). In Greece, a collective tire recycling system operates since 2004, nationwide since 2006. Currently, the collection of used tires exceeds 95% of used tires in the country (36,307 t in 2016), of which 60% was recycled and 40% were utilized for energy recovery.
- ✓ Construction Demolition and Excavation Wastes - (JMD 36259/1757/E103/2010).

4.3.2.7 Sectoral policies and measures: LULUCF sector

The potential of the LULUCF sector in Greece is still roughly estimated due to lack of data. Efforts towards developing tools to efficiently monitor land use changes and carbon emissions and removals from this sector are underway.

Greece adopted its first National Strategy for Adapting to Climate Change (NSACC)13 with Law 4414/2016 (OGG A'149). The NSACC focuses on the sectoral policies required for agriculture and forestry to adapt to the impacts of climate change, providing the overall strategy and guidance. Specific actions and measures will be prioritized and planned through the Regional Plans for Adapting to Climate Change, in each of the thirteen Regions of Greece are expected to be completed in early 2021 and evaluated/ revised until 2026-2027.

Also, the National Energy and Climate Plan (NCEP)14, adopted in 2019, acts as a roadmap towards achieving specific energy and climate goals until 2030. The priorities for the LULUCF sector until 2030, outlined in the NCEP, include sustainable forest management, promotion of biomass production and afforestation projects. Research and innovation are also prioritized in order to implement advanced techniques in agriculture and forestry. In addition, a National long term-strategy was developed aiming towards climate neutrality by 205015. This strategy addresses the LULUCF sector only in terms of energy crops for the production of biofuels. It is expected that lignocellulosic biomass, or agricultural/ forestry residues, will be applicable on industrial scale for the production of advanced biofuels (2nd generation) after 2030.

Pursuant to Article 24 of the Greek Constitution forest conversion to other land use is strictly regulated and only allowed in exceptional cases. Deforestation is thus limited to specific cases of public interest and benefit (e.g. construction of roads, railways, high tension lines). Any other temporary loss of forest cover due to disturbances is not considered as deforestation and is declared instantly reforested following specific administrative procedures under the provisions of Greek laws (art. 61 Legislative Decree No 86/1969, art. 37, 38, 46, 47 Law 998/1979) in order to gradually return to its former state.

Forest protection and sustainable management is further promoted by the National Forest Strategy for the period 2018-2038, adopted in 2018 (M.D.170195/758/28-11-2018). The NFS stipulates the principles and guidelines of forest related policies with the following indicative priorities:

- Reconstruction of Central & Regional Forest Services, aiming at Sustainable Forest Management optimization

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[13] https://ypen.gov.gr/wp-content/uploads/legacy/Files/Klimatiki%20Allagi/Prosarmogi/20160406_ESPKA_teliko.pdf
[14] https://ec.europa.eu/energy/sites/default/files/el_final_necp_main_en.pdf
[15] https://ec.europa.eu/clima/sites/lts/lts_gr_el.pdf

- Development of national, regional & local road maps for the enhancement of preventive pre-fire planning & forest fires tackling
- Systematic forest management of all ecosystems for the reduction of forest fires, taking into consideration sustainability & multiple forest ES
- Establishment of a permanent & flexible mechanism for national forest inventory & monitoring
- Recognition of forest value and enhancement of forest contribution to bio-economy & circular economy
- Forest management aiming to adapt – mitigate climate change
- Conservation, restoration & enhancement of provided forest ecosystem services
- Enhancement networking and synergies between institutional and non-governmental players for better governance
- Coherence of national forest policy with forest international & European policies, targets and commitments

The measures for the LULUCF sector arise from rural development actions and other financial mechanisms. For the period 2020-2040, the relevant measures, being implemented aim primarily at protecting forest land, its sustainable management, preserving and strengthening its multifunctional role, contributing also to the mitigation of climate change impacts and the development of the forestry sector. Those policies and measures are briefly presented below:

(A) Forest protection & sustainable management

According to that legislative framework, forest management is applied following specific rules and guidelines for practices driven by the fundamental principle and predominant goal of preserving and promoting the "sustainability" of forests in terms of their provision of products, growing stock and services. More information on the forest legislation and the historical background of forest management are available in the previous National Inventory Report (2020).

Table 4.13 Key policies and measures for forest protection & sustainable management (adopted/implemented)

Measure	Description	Funding
Management of Public Forests	Rehabilitation of degraded coppice broadleaved forests to high forests, improvement of forest structure and stability, favoring regeneration, forest cultivation and wood harvesting, conservation and maintenance of forests	Public Investment Program/ Green Fund[16]
Maintaining the health and vitality of forest ecosystems - Effective application of the Community plant health regime	The aim is to promote appropriate actions to take adequate measures to combat insects and fungi, and all pathogen-causes under the obligations arising from the Community legislation for plant health inspections, and from the Commission's implementing decisions on taking urgent measures with regard to the spread of pests	Public Investment Program/ Green Fund
Fire protection of public forests and forested areas	Implementation of preventive forestry actions (e.g. forestry works for the reduction of fuel biomass), forestry work interventions (logging, etc.) in coniferous forests to remove combustible biomass for forest fire protection	Public Investment Program/ Green Fund
Management of public forest nurseries,	Production of high quality planting material that	Public

[16] Annually the General Directorate of Development and Protection of Forests and Forest Environment develops a special «Forestry Financing Program under the Green Fund» which finances many measures implemented in the LULUCF sector

Measure	Description	Funding
seeds gathering and management of seed-production stands and seed-production gardens	will substantially contribute to successful reforestation works	Investment Program/ Green Fund
Special Environmental studies and Management plans for the NATURA 2000 sites	Zoning within protected areas, determination of activities that are allowed or prohibited in each zone, taking into account existing infrastructure and human impact. Conservation targets and management measures to be implemented in order to reconcile environmental protection and sustainable development. The study results will be used by all competent authorities responsible for the protected areas (Management Bodies, Ministry of Energy and the Environment, Administrative Regions, Decentralized Administrations etc., as an important basis for spatial planning, programming and environmental permits of future investments.	PA 2014-2020
Monitoring and assessment of the conservation status of protected species and habitats in Greece	Includes all land uses within protected areas, focusing on the conservation of habitats and species of national and community interest, including forest land, grasslands, agricultural land	PA 2014-2020
Investing in the development of forest areas and the improvement of forest sustainability	Support for afforestation/creation of forested areas, aid for agroforestry systems, support for the prevention and/ or restoration of damages to forests from forest fires, natural disasters and catastrophic events, support for investment in forestry technologies and in processing, distribution and marketing of forest products	Rural Development Regulation[17]

(B) Afforestation/ reforestation projects

- The National Reforestation Plan for the period 2020-2030, which involves 50,000 ha of burned and degraded land. The reforestation activities are expected to be completed in 2026, establishing approximately 30 million seedlings. The overall budget is 310 million Euros (Status: Planned).
- The afforestation of agricultural land pursuant to EEC Regulations 2080/92 and 1257/99, in effect since 1994, under the EEC Regulations. (Status: Implemented).

(C) Adaptation to climate change

- The National inventory and monitoring system for forests and forest areas to support the strategy development for their adaptation to climate change, in response also to the implementation of Regulation 841/2018 (Reporting period 2026-2030). The action involves the creation of a permanent monitoring plots network of biotic and abiotic parameters for assessing the impact of climate change on forests. Estimated budget 6.5 Million Euro, foreseen implementation period 2021 – 2023 (Status: Adopted).
- LIFE-IP AdaptInGR - Boosting the implementation of adaptation policy across Greece. The project aims to catalyse the implementation of the Greek National Adaptation Strategy and of the 13 Regional Adaptation Action Plans at the current 1st adaptation policy cycle (2016-2025) and to prepare the passage to the 2nd adaptation policy cycle (2026+), through appropriate action at national, regional and local levels

[17] 5th Programming Period 2014-2020

- LIFE CLIMATREE (LIFE14 CCM/GR/000635) developed a novel approach for accounting & monitoring carbon sequestration of tree crops and their potential as carbon sink areas. In addition according to "Article 3 of Decision No 529/2013/EU" all member states prepared and maintained annual accounts that accurately reflect all emissions and removals including those of cropland management activities.
- LIFE Foresmit (LIFE14 CCM/IT/000905): The objectives are to define guidelines of good silvicultural practices for the restoration of peri-urban coniferous forests with native broadleaved species; to test and verify in the field effectiveness of different management options; to provide data on vegetation structure, biomass increment, carbon accumulation in all relevant pools of vegetation and soil, and CO_2 and other greenhouse gas emissions, thus giving a complete picture of mitigation potential of management practices (duration 01.09.2015-31.08.2019);
- LIFE Olive-Clima (LIFE11 ENV/GR/000942): The objectives are to identify farming practices leading to carbon sequestration; to reduce GHG emissions and other environmental impacts during crop production; to develop a set of indicators to link farming practices to quantifiable carbon storage; to provide methodologies for farmers (duration 01.10.2012- 30.09.2017)

(D) Grassland management

Regulations of grazing land (Law 4351/2015 amended by art.32 of Law 4599/2019), which refer to grassland, phrygana and shrublands include the establishment of a National Geographic Database and the elaboration of management plans for grazing lands are to be submitted and approved by 31.12.2021 through the Regional Entities of the country and specifically through the Agriculture and Veterinary Fund (Status: Adopted).

(E) Forest cadastre

The Greek Ministry of Environment and Energy has the overall responsibility for the elaboration and development of the National Forest Map project under the national Cadastre Survey. The development of Forest Maps involves the delineation and recording of forest lands that fall under the protective provisions of Greek forest legislation in an accurate, transparent and definitive way.

Forest maps have been prepared for 96% of the Greek territory. However, until June 2020, only 55% were published and available for objections and 50% were completed and officially certified. Law 4685/2020 (art.48), adopted in May 2020, allows the revision of all forest maps, either published or officially certified, in order to include administrative acts that were not taken into account during the initial mapping. This refers mainly to forest conversion to farmland, industrial facilities, and other infrastructure.

Forest maps delineate forest, settlements and other land uses. The “forest” category includes woodlands, reforestation areas, as well as shrublands and grasslands. Therefore, the information forest maps provide is not sufficient to determine land uses in Greece and additional data from Forest Management Plans and Grazing Plans are required for a complete inventory. The delineation of managed forest land however needs to coincide with forest boundaries depicted on the forest maps. This means that in order to accurately map current land uses the forest cadaster will be used as the basemap on which additional geographical datasets will be overlaid (Status: Implemented).

(F) Biomass production from forest and agricultural residues/ short –rotation coppices

The raw material potential from forest harvesting residues and new energy crops is significant to meet the increased future energy needs. This involves the rehabilitation of abandoned land to large scale cultivation and is expected to have a significant impact on the LULUCF sector. Woody energy crops are expected to increase significantly until 2030 to

50,000 ha, and more than double from that point on until 2050 (>100,000 ha), according to the corresponding NECPs (Status: Planned).

Table 4.14 Indicative timetable for the adoption and implementation of the measures mentioned above

Measures adopted/ implemented	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Monitoring and assessment of the conversation status of protected species and habitats in Greece											
Environmental studies for the NATURA 2000 sites											
National Forest Strategy											
LIFE-IP AdaptInGR											
Support for the prevention of damages to forests from forest fires, natural disasters and catastrophic events											
Support forest restoration caused by forest fires, natural disasters and catastrophic events											
Forest protection & sustainable management											
National Reforestation Plan (Plantings)											
National inventory and monitoring system for forests and forest areas											
Aid for agroforestry systems											
Management plans and National Geographic Database for grazing lands											
Thematic management plans for agriculture within protected areas											
Biomass production from forest and agricultural residues/ short –rotation coppices											
Forest cadastre											

4.4 Initiatives to mitigate GHG emissions at the Greek Islands

4.4.1 GR-eco Islands

The GR-eco Islands national initiative of the Greek Government aims to transform Greek islands into models of green economy, energy autonomy, digital innovation and ecological mobility. It includes actions such as the increased use of Renewable Energy sources, the creation of digital infrastructure, the promotion of energy efficiency, the sustainable management of waste and water, e—mobility and the electrification of transport, and the green transformation of agriculture and tourism and the development of part and other infrastructures, through targeted interventions and customised programs of the Ministry of Environment and Energy and the co-competent Ministries under the “umbrella” of the National Plan for Energy and Climate.

Within this framework, on November 5, the Greek Prime Minister Mr Kyriakos Mitsotakis inaugurated on Chalki island the first project, a partnership of Greek and French companies, under the coordination of the Ministry of Environment and Energy.

The choice of Chalki as the first GR-eco Island has a symbolic character, as it is an island in the barren line of the southeastern Aegean, part of the Dodecanese, which holds significant geopolitical interest in the wider region. In addition, it aspires to function as a model for the energy transition of Greek islands.

The local community in Chalki is at the forefront of the energy transition. ChalkiON is the first energy community to own and operate a PV station on a non -interconnected Greek island, with the participation of the local authority.

The design of Chalki’s initiative covers the energy needs of the island. And the virtual net metering is the most appropriate method for the members of the ChalkiON to offset the energy produced by the polar park with the actual consumption of their electricity bills.

After the collection of the data through the electricity bills of Chalki’s residents, the energy needs of the island were calculated to 1.700MWh per year on overage, which makes the installation of the 1MW PV park able to qualify Chalki as the first energy autonomous island in Greece.

The benefits in a nutshell

- ChalkiON (energy community) owner and operator of 1MW PV park
- 55% electricity bill reduction for residents, businesses and the municipality of Chalki
- Annual savings of 180,000-250,000 euros per year
- Carbon reduction of 1,800 tons per year

4.4.2 Astypalea: The first smart & sustainable Mediterranean Island

An interesting project is the transformation of the Astypalea island (which belongs to the Dodecanese group of islands) into a model island for sustainable development. The plan is to prepare a case study for a "smart" low carbon footprint and green island in the Greek Islands. The project "Astypalea, A Smart & Sustainable Island" is the result of a technical and financial co-operation between the Greek Government and the German automotive Volkswagen Group. The island's hybrid power supply system, will consist of a combination of photovoltaic units and wind turbines, as well as a unit of electricity storage in batteries. All vehicles in the island (both private and state) will be electrical. There will be a Greek Government/Volkswagen subsidy program specifically for Astypalea, for the introduction of smart vehicle charging systems and the replacement of all vehicles with electric ones. Under the program, incentives will be introduced to replace conventional cars with electric ones, through a funding program. In total, about 1,000 internal combustion engines will be replaced by electric vehicles.

4.5 Minimization of adverse effects

The Kyoto Protocol aims at the implementation of effective policies and measures by Annex I Parties so as to prevent dangerous anthropogenic interference with the climate system, contributing thus in the minimisation of adverse effects of climate change on other Parties and especially developing countries. The Protocol has been designed to minimize the potential adverse effects that may be caused by the implementation of policies and measures adopted by Annex I Parties to specific sectors of economic activity, industrial sectors or other Parties to the Convention, including the adverse effects on the international trade, social, environmental and economic impacts in developing countries, etc.

The formulation of climate policy in Greece follows EU policy. EU policy has taken into account the minimization of the adverse effects of emissions reduction policies and measures, according to Articles 4.8 and 4.9 of the Framework Convention on Climate Change and Article 2 of the Kyoto Protocol.

Impacts on third countries are mostly indirect and can frequently neither be directly attributed to a specific EU policy, nor directly measured by the EU in developing countries. Therefore, the reported information covers potential adverse social, environmental and economic impacts (including trade impacts) that result from complex assessments of indirect influences and that are based on accessible data sources in developing countries.

The most important continuous activity in this respect is the EU’s wide-ranging impact assessment system accompanying all new policy initiatives. This approach ensures that potential adverse social, environmental and economic impacts on various stake-holders and third Parties are identified and minimized within the legislative process. In general, impact assessments are required for all legislative proposals, but also other important Commission initiatives which are likely to have far-reaching impacts. Consulting interested parties is an obligation for every impact assessment and all affected stakeholders should be engaged, using the most appropriate timing, format and tools to reach them. Existing international policy dialogues are also be used to keep third countries fully informed of forthcoming initiatives, and as a means of exchanging information, data and results of preparatory studies with partner countries and other external stakeholders.

Major EU policies such as the Directive on the promotion of the use of renewable energy (Directive 2009/28/EC, the extension of the EU emission trading scheme (ETS) to the aviation sector (Directive 2008/101/EC), updates of EU policies which should lead to a low carbon and energy efficient economy are also presented in more detail as examples in the 2013 submission of the EU’s national inventory report.

Directive on the promotion of the use of renewable energy - Promotion of biomass and biofuels

The Directive on renewable energy (Directive 2009/28/EC), a part of the EU's climate and energy package, sets ambitious targets for all Member States, such that the EU will reach a 20% share of energy from renewable sources in the overall energy consumption by 2020 (with individual targets for each Member State) and a 10% share of renewable energy specifically in the transport sector, which includes biofuels, biogas, hydrogen and electricity from renewables.

The impact assessments related to enhanced biofuel and biomass use in the EU showed that the cultivation of energy crops have both potential positive and negative impacts. Positively, as the growing of EU demand for bioenergy generates new export revenues and employment opportunities for developing countries and boosts rural economies. Thus there could be clear economic and social benefits. At the same time, the new EU energy crop demand could increase the impact on biodiversity, soil and water resources and can have positive as well as negative effects on air pollutants. The extent of carbon reduction and other environmental effects from the promotion of biofuels can vary according to the feedstock employed, the way the feedstock and the biofuels are produced, how they are transported and how far. Growing future demand for biomass feedstock combined with growing global food consumption could add to the agricultural sector's pressure on land use and result in adverse land use change.

To address the risk of adverse impacts, Article 17 of the EU's Directive on renewable energy sources creates pioneering "sustainability criteria", applicable to all biofuels (biomass used in the transport sector) and bioliquids. The sustainability criteria adopted include: establish a threshold for GHG emission reductions that have to be achieved from the use of biofuels; exclude the use of biofuels from land with high biodiversity value (primary forest and wooded land, protected areas or highly biodiverse grasslands); exclude the use of biofuels from land with high C stocks, such as wetlands, peatlands or continuously forested areas.

Developing country representatives as well as other stakeholder were extensively consulted during the development of the sustainability criteria and preparation of the directive and the extensive consultation process has been documented.

In October 2012 a new Commission proposal was published to limit global land conversion for biofuel production, and raise the climate benefits of biofuels used in the EU (European Commission 2012b). The Commission is therefore proposing to amend the current legislation on biofuels through the Renewable Energy and the Fuel Quality Directives and in particular: to increase the minimum greenhouse gas saving threshold for new installations to 60% in order to improve the efficiency of biofuel production processes as well as discouraging further investments in installations with low greenhouse gas performance;

- ✓ to include indirect land use change (ILUC) factors in the reporting by fuel suppliers and Member States of greenhouse gas savings of biofuels and bioliquids;
- ✓ to limit the amount of food crop-based biofuels and bioliquids that can be counted towards the EU's 10% target for renewable energy in the transport sector by 2020, to the current consumption level, 5% up to 2020, while keeping the overall renewable energy and carbon intensity reduction targets;
- ✓ to provide market incentives for biofuels with no or low indirect land use change emissions, and in particular the 2nd and 3rd generation biofuels produced from feedstock that do not create an additional demand for land, including algae, straw, and various types of waste, as they will contribute more towards the 10% renewable energy in transport target of the Renewable Energy Directive.

With these new measures, the Commission wants to promote biofuels that help achieving substantial emission cuts, do not directly compete with food and are more sustainable at the same time. While the current proposal does not affect the possibility for Member States to provide financial incentives for biofuels, the Commission considers that in the period after 2020 biofuels should only receive financial support if they lead to substantial greenhouse gas savings and are not produced from crops used for food and feed. The Impact Assessment of the proposal for a Directive is analysing social, economic and environmental impacts on third countries in detail.

The recent Communication from the Commission on voluntary schemes and default values in the EU biofuels and bioliquids sustainability scheme (2010/C 160/01) sets up a system for certifying sustainable biofuels, including those imported into the EU. It lays down rules that such schemes must adhere to if they are to be recognized by the Commission. This will ensure that the EU's requirements that biofuels deliver substantial reductions in greenhouse gas emissions and that biofuels do not result from forests, wetlands and nature protection areas.

The European Commission has so far (April 2013) recognised 13 voluntary schemes: International Sustainability and Carbon Certification (ISCC), Bonsucro EU, Round Table on Responsible Soy (RTRS EU RED), Roundtable of Sustainable Biofuels (RSB EU RED), Biomass Biofuels voluntary scheme (2BSvs), Abengoa RED Bioenergy Sustainability Assurance (RSBA), Greenergy Brazilian Bioethanol verification programme, Ensus voluntary scheme under RED for Ensus bioethanol production, Red Tractor Farm Assurance Combinable Crops & Sugar Beet Scheme, SQC (Scottish Quality Farm Assured Combinable Crops (SQC) scheme), Red Cert, NTA 8080 and RSPO RED (Roundtable on Sustainable Palm Oil RED).

Another way the EU will strive to minimize potential adverse impacts of biomass use is to promote second generation biomass technologies. Within the renewable energy Directive, second generation biofuels are promoted through Article 21, paragraph 2 which establishes that the contribution made by biofuels produced from wastes, residues, non-food cellulosic material, and ligno-cellulosic material shall be considered to be twice that made by other biofuels for the purposes of demonstrating compliance with national renewable energy targets; and EU research also has a major focus on bioenergy technologies. The goal of second generation biofuel processes is to extend the amount of biofuel that can be produced sustainably by using biomass consisting of the residual non-food parts of current crops, such as stems, leaves and husks that are left behind once the food crop has been extracted, as well as other crops that are not used for food purposes (non food crops) and also industry waste such as woodchips, skins and pulp from fruit pressing. Second generation biofuels are expected to expand the biomass feedstock available for biofuel production. Further research and impact assessments in this area are necessary to assess e.g. the long-term effects of the energy use of non-food parts of crops compared to their existing use. The Commission continues the efforts to promote second and third generation biofuels, shifting away from food-crop based fuels. In this light, it recently put forth a proposal to limit to 5% the use of food-based fuels in meeting the EU renewable energy target in transport (see discussion above on Proposal from October 2012).

Inclusion of aviation in the EU emission trading scheme

In 2005 the Commission adopted a Communication entitled "Reducing the Climate Change Impact of Aviation", which evaluated the policy options available to this end and was accompanied by an impact assessment. The impact assessment concluded that, in view of the likely strong future growth in air traffic emissions, further measures are urgently needed. Therefore, the Commission decided to pursue a new market-based approach at EU level and included aviation activities in the EU’s scheme for greenhouse gas emission allowance trading. The finally adopted legislation was the result of an extensive stakeholder consultation including an internet consultation and an Aviation Working Group of experts set up as part of the European Climate Change Programme that identified the integration of aviation in the EU ETS as the lowest cost option to address the challenge of reducing emissions from this sector. The impact assessment also specifically addressed the effects on developing countries (European Commission 2006).

Aircraft operators from developing countries will be affected to the extent they operate on routes covered by the scheme. Data from Eurocontrol on the nationality of operators has been used to make an estimate of the aggregated costs for third country airlines from regions that include developing countries. As operators from third countries generally represent a limited share of emissions covered, the impact is also modest. For example, the total additional operating costs according to the impact assessment for all operators based in Africa would, at current activity levels, vary from €2 to €35 million per year depending on allowance prices and the share of allowances auctioned. In terms of the economic impacts, a larger proportion of the compliance costs would naturally be borne by carriers from Annex I countries as they generally have a higher market share on the routes covered. However, carriers from developing countries that are able to operate in competition with Annex I carriers on such routes would need to be covered in order to avoid a) distortions of competition and b) discrimination as to nationality in line with the Chicago Convention.

For carriers with relatively old and inefficient fleets the impact may be higher as the effective proportion of allowances acquired for free through benchmarking is lower. However, as third country airlines would generally only have a fraction of their fleet operating in Europe, they may in some cases be able to reduce any negative effects by shifting their most efficient aircraft to operate on routes covered by the scheme.

To the extent that aviation's inclusion in the EU ETS creates additional demand for credits from JI and CDM projects, there will also be indirect positive effects as such projects imply additional investments in clean technologies in developing countries.

Similarly, additional finance for climate change mitigation and adaptation in developing countries should be raised through the auction of emissions allowances by EU Member States. The legislation provides a list of such areas by which the Member State should use the monies raised, and specifically mentions use for adaptation in developing countries.

The aviation sector joined the EU emissions trading system in January 2012, requiring airlines to hand over emission allowances to cover CO2 emissions from all domestic and international flights to and from airports in the EU and the EFTA countries, Iceland, Liechtenstein and Norway. In November the Commission proposed deferring the application of the scheme to 2013 for flights to and from countries outside this group (the so-called ‘stop-the clock’ proposal as a goodwill gesture to allow more time for a global market-based agreement addressing aviation emissions to be reached within the International Civil Aviation Organisation (ICAO) in 2013. The Commission's proposal demonstrates the EU's strong political commitment to facilitate and bring forward the successful conclusion of these ICAO processes. The legislation continues to apply to all flights within and between the 30 European countries.

Proposal for a Regulation of the European Parliament and of the Council on the monitoring, reporting and verification of carbon dioxide emissions from maritime transport

This proposal addresses ships above 5000 gross tons in respect of emissions released during their voyages from the last port of call to a port under the jurisdiction of a Member State and from a port under the jurisdiction of a Member State regardless of their flag. With regard to economic effects on third countries, the impact assessment of this proposal concludes that “based on the pass-through of costs and savings in maritime transport and on the price building mechanisms in different sectors, measurable in-creases of commodity prices (with transport costs being only an insignificant element of the commodities' prices) are only expected for natural gas of up to 0.1-0.5% and for iron ore of up to 0.1-0.3%. Such price impacts are far below the usual price fluctuation for these products. In conclusion, no impacts deriving from possible increases of commodity prices are expected for third countries.

Commission regulation implementing Directive 2009/125/EC with regard to eco-design requirements for computers, servers and displays

Experts from third countries were involved in the stakeholder consultation process and the initiative was discussed in meetings of Commission staff with third country government representatives as e.g., USA, China, India etc.

The impact assessment found no significant impacts on the competitiveness of industry of the EU or third countries and in particular in the SMEs sector due to the small absolute costs related to product re-design and re-assessment.

With regard to impacts on trade, the process for establishing eco-design requirements for computers, servers and displays has been fully transparent, and a notification under WTO-TBT was issued 60 days prior to the vote by the Regulatory Committee.

4.6 Policies and measures no longer in place

There are no policies and measures listed in previous national communications that are no longer in place.

4.7 Effect of policies and measures on the modification of long-term trends

The **Long-Term Strategy for 2050** is a Roadmap for the Greek Government on Climate and Energy, in the context of the country's participation in the collective European goal of a successful and sustainable transition to a climate-neutral economy by 2050 at European Union level.

The Government's strategic goal is to participate proportionately in the commitment to a climate-neutral economy at EU level and to contribute to the new Green Agreement promoted by the European Commission.

With the completion of the elaboration and adoption of the National Energy and Climate Plan (NECP), which analyzes the energy and climate goals set by the country as well as the Policy Priorities and the measures for their implementation, the Government is also investigating the optimal mix of structure and evolution of the energy system by the year 2050 to achieve specific climate goals to determine the framework for the long-term energy and climate strategy of the country for the year 2050. The purpose of the Strategy is to evaluate alternatives and transition routes towards an economy that will approach climate neutrality.

Moving towards a climate-neutral economy requires the elimination of greenhouse gas emissions in all sectors. The target in the relevant scenarios is to reduce emissions by 95% in 2050, compared to emission levels in 1990. These targets help keep global warming below 1.5 degrees Celsius in the second half of the century. If the target for temperatures below 2 degrees Celsius is adopted, emission reduction targets in 2050 may be reduced to 85% below 1990 levels.

The Long-Term Strategy for 2050 analyzes scenarios for the evolution of the energy system and the consumption pattern in the final sectors, with the ultimate goal of transition to a climate-neutral economy by 2050 without presenting specific specialized measures. These scenarios will be further discussed and elaborated in the future, in order to select the appropriate policy measures and corresponding technologies that will change the operating model of the consumption and production system.

With a focus on improving energy efficiency, which should be maximized, expanding and ultimately maximizing the use of RES, especially in electricity generation, the emphasis on technologies and storage fuels, alternative technologies in the energy and industrial sector, as well as by changing the overall consumption pattern in the end-use areas, it will be possible to achieve in an optimum way the energy and climate change planned under the Strategy.

The long-term strategy towards climate neutrality in 2050 includes key policies that fall into the following areas:

1. Improving energy efficiency
2. Electrification of transport and heat
3. Renewable energy sources
4. Neutral mobility in the transport sector
5. Industrial competitiveness and climate neutrality
6. Network infrastructure and market integration policies
7. Bio-economy

4.8 Policies and Measures Related to Bunker Fuels (Art. 2 (2) Kyoto Protocol)

Please refer to section 4.3.1.4.

4.9 Policies and Measures Promoting Sustainable Development (Art. 2 (1) Kyoto Protocol)

In May 2002, the Hellenic Ministry for the Environment, Physical Planning and Public Works (MEPPPW) and in particular its National Centre for the Environment and Sustainable Development (NCESD), drew up the Greek National Strategy for Sustainable Development, that was approved by the National Ministerial Council, in June same year. The 2002 Strategy was prepared through collaboration with the "National Coordination Committee of the Government Policy in the field of Spatial Planning and Sustainable Development" that was at the time also acting as the National Preparatory Committee of Greece in view of the Johannesburg World Summit on Sustainable Development (WSSD, 2002), encompassing representatives from various competent Ministries and the NCESD, while representatives from Local Authorities, employer and trade unions, research institutes and NGOs also participated in the preparation process, directly through thematic working groups or through participation in wider Workshops.

The main aim of the 2002 NSSD was the achievement of economic development, while safeguarding social cohesion and environmental quality. The main sectors of action were climate change abatement; reduction of air pollutants; reduction and rational management of solid waste; water resources management; combating desertification; protection of biodiversity and natural ecosystems; and sustainable management of forests. Social and economic sectors for the promotion of relevant activities included the sectors of energy, transport, agriculture, industry, tourism, spatial planning and employment.

For the coordination and the better implementation of the NSSD, the "National Council for Physical Planning and Sustainable Development" was operationalised, in which representatives from MEPPPW, Local Authorities, employer and trade unions, research institutes and NGOs participated. Inter-Ministerial coordination proven to be rather weak in the beginning, was strengthened for the drafting of the National Strategic Reference Framework (2007-2013) where the principles of the 2002 NSSD were encompassed to a large extend.

Following the Parliamentary Elections in October 2009 and the establishment of a new "Ministry of Environment, Energy and Climate Change" (MEECC), political priorities for Greece, throughout the whole Government structure, have been set under the overarching objective of "Green Growth". Thus new challenges and emerging approaches (e.g. efforts towards climate change mitigation and adaptation) at the international, regional and national level as well as the new Ministry's vision, aims, competencies, tasks and structure have been aligned aiming at effectively implementing Greece's current overarching political strategic objective, that of "Green Growth".

To this end, MEECC has drawn up a new ambitious National Strategy on "Green Growth" for growth and development while respecting the environment, responding to actual needs with practical means. Within this strategy, energy conservation and increase of the percentage of RES is a key issue. This new Strategy is also linked to the recent Europe 2020 EU Strategy. More specifically, the Strategy aims at:

- ✓ increase of development investments;
- ✓ reforming the production basis of the economy and reinvigorating economic activity;
- ✓ balancing rural development;
- ✓ creating new jobs and reducing unemployment.

Its principles and requirements include:

- ✓ investment in education;
- ✓ investment in knowledge-base expansion;
- ✓ investment in innovation;
- ✓ investment in new technologies.

The Strategy introduces a cross-sectoral approach. The priority sectors encompassed include:

- ✓ Agriculture;
- ✓ Tourism;
- ✓ Manufacturing;
- ✓ Construction / infrastructure development;
- ✓ Energy.

The thematic pillars of the Strategy are four and include:

- ✓ Addressing climate change challenges and transition to a competitive low-carbon economy. This pillar incorporates a number of policies that focus on improving energy efficiency, increasing the country's energy potential of renewable energy and natural gas, ensuring energy supply, providing reliable energy services and products to consumers and the promotion of environmentally friendly production and consumption patterns through "Green Procurement".
- ✓ Sustainable management of natural resources. this pillar gathers actions aimed at protection and enhancement of biodiversity, management and protection of water resources and

forests, as well as planning for the rapid response to environmental risks and crises. Achieving these objectives is approached by undergoing growth investment in construction projects and projects utilizing natural resources and the restoration of natural landscapes.

- ✓ Improvement of quality of life based on an environmental-friendly approach. The actions of the third pillar seek to improve the quality of life through the promotion of sustainable development and to ensure the productive and social cohesion while ensuring environmental protection. Under the pillar, a number of major urban regeneration interventions, both in the capital and in the region are included. Also important actions to improve the urban environment such as reducing noise and pollution and the development of sustainable mobility are incorporated. Further, significant investments in recycling and waste management are promoted.
- ✓ Reinforcement of institutional tools and mechanisms for environmental governance. The fourth pillar of the program is to strengthen environmental governance through a set of actions. The key axes of these actions are to strengthen the institutions and mechanisms of environmental governance through institutional interventions and investments so as to enhance their physical and human resources. At the same time, citizen access to environmental information is promoted in the framework of the relevant European Directive (INSPIRE). In parallel, the institution of voluntary actions is supported through awareness actions and measures for the organization and financial assistance of the voluntary actions.

The UN's 2030 Agenda for Sustainable Development, and the 17 Sustainable Development Goals (SDGs) within it, were agreed by world leaders in September 2015 The SDGs are of a global nature and of general application with a timetable for implementation by 2030 They create implementation commitments for all developed and developing countries, taking into account different national realities, levels of development, national policies and priorities. Agenda 2030 promotes the integration of all three dimensions of sustainable development - social, environmental and economic - into all sectoral policies while also promoting the linkage and coherence of the policy and legislative frameworks relating to the SDGs.

Greece recognizes the important contribution of the SDGs in promoting, inter alia, social well-being, poverty eradication and fair and inclusive growth. In this context, it is of particular importance for our country to mobilize its forces in order to set its priorities for Agenda 2030 and effectively implement the SDGs through their appropriate adaptation to national priorities and needs.

The Office of Coordination, Institutional, International and European Affairs of the General Secretariat of the Government is the central governmental authority responsible for coordinating and monitoring of the implementation of the UN Sustainable Development Goals at national level (Article 43 of Law 4440/2016).

CHAPTER 5. PROJECTIONS AND THE TOTAL EFFECT OF POLICIES AND MEASURES, AND SUPPLEMENTARITY RELATING TO KYOTO PROTOCOL MECHANISMS

5.1 Projections

This Chapter describes a “with measures” (WM) or “with existing measures” (WEM) scenario concerning the national projections of greenhouse gas emissions by sources and their removal by sinks for the years 2020, 2025, 2030, 2035 and 2040. The “with measures” scenario assumes that no additional emission reduction policies and measures are adopted than the existing ones (implemented and adopted).

A “with additional measures” (WAM) scenario is also reported, which reflects the effect of all implemented / adopted and planned policies and measures. This scenario includes the additional policies and measures as specified in the National Energy and Climate Plan (NECP), which was recently adopted by Greece (GG 4893 / 31.12,2019). The NECP constitutes a strategic plan for the Greek Government on Climate and Energy issues and comprises a detailed roadmap for achieving concrete Energy and Climate Goals by 2030. The NECP highlights our country's energy and climate priorities and development opportunities and aims to be the key tool for shaping/mainstreaming the national energy and climate policy over the next decade. More information about the plan were reported in section 4.1.2.1.

The GHG emission projections presented in this chapter are based on the latest official energy projection scenarios that are developed by the Ministry of Environment and Energy.

For the LULUCF sector the WAM scenario includes the:

- national reforestation plan of 50,000 ha to be implemented until 2025
- increase of woody energy crops for biomass production by 50,000 ha until 2030.

In ***Figure 5.1***, the evolution of GHG emissions (national total, EU-ETS and non ETS) and their projections till year 2040, along with the ESD (2013-2020) and ESR (2021-2030) targets of Greece are presented. The projections of GHG emissions of the WM and WAM scenarios disaggregated by sector and by gas are presented in CTF Table 6(a) and 6(c) (***Tables 5.1-5.4).*** In ***Tables 5.5 and 5.6*** a split of the projections of the GHG emissions is presented between the sectors covered and not covered by the EU ETS.

It should be mentioned that actual inventory data till the year 2019 have been used in the preparation of the emission projections (obtained from the 2021 GHG Inventory Submission of Greece). The 2020 emission data presented in chapter 5 of the NC8 and CTF Tables 6(a) and 6(c) were not taken from the 2022 GHG Inventory submission of Greece, but they were part of the projection exercise, which is described in chapter 5. On the other hand, the 2020 emission data included in CTR Tables 1 and 4 are based on the 2022 GHG inventory submission of Greece (April 2022). The difference between the 2020 GHG emission data presented in this chapter and CTF Tables 1 and 4 reflects to an extent the effect of COVID-19 confinement and other restriction measures.

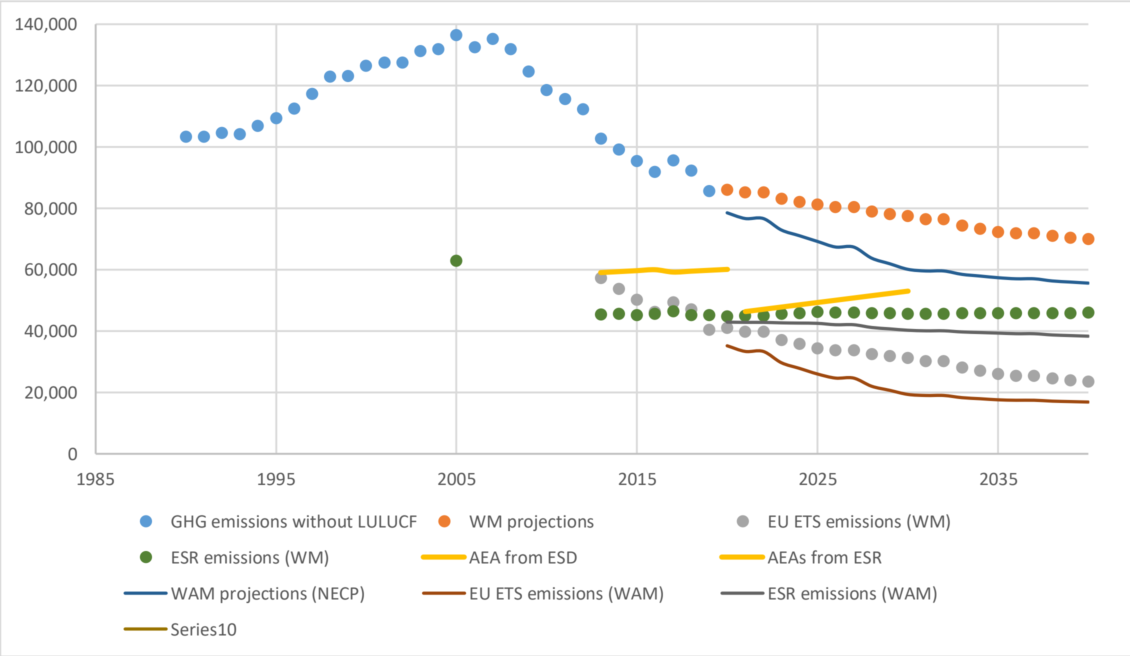


Figure 5.1 Projections of total national GHG emissions (excluding LULUCF), EU ETS and ESD sectors (in ktCO2eq)

Table 5.1 CTF Table 6(a) Projection of GHG emissions in the "with measures" scenario, disaggregated by sector (kt CO2 eq)

		GHG emissions and removals								With measures	
GHG emissions projections	Unit	Base Year	1990	1995	2000	2005	2010	2015	2017	2020	2030
Sector											
Energy	kt CO_2 eq	62,363.31	62,363.31	64,363.97	77,814.39	85,239.27	70,601.56	53,924.29	52,912.14	46,654.57	37,116.16
Transport	kt CO_2 eq	14,506.98	14,506.98	16,584.24	18,859.96	21,891.95	22,476.45	17,100.38	17,241.44	17,730.61	17,443.62
Industry/industrial processes	kt CO_2 eq	11,226.96	11,226.96	13,569.65	15,176.41	15,426.20	11,741.12	11,996.39	12,786.81	10,677.82	10,011.86
Agriculture	kt CO_2 eq	10,140.24	10,140.24	9,487.90	9,146.79	8,959.22	8,838.65	7,846.02	7,850.33	8,061.30	9,141.94
Forestry/LULUCF	kt CO_2 eq	-2,107.91	-2,107.91	-2,872.37	-1,941.35	-3,282.91	-3,043.08	-3,719.19	-3,209.10	-1,634.28	-644.79
Waste management/waste	kt CO_2 eq	4,863.82	4,863.82	5,150.20	5,348.87	4,764.61	4,778.71	4,463.30	4,630.06	4,775.91	4,420.92
Other Sectors											
International aviation	kt CO_2 eq	2,496.15	2,496.15	2,658.59	2,547.12	2,622.63	2,606.17	2,893.53	3,463.76	2,874.95	3,409.54
International navigation	kt CO_2 eq	8,359.14	8,359.14	11,807.99	11,861.20	9,436.02	8,992.47	5,949.04	7,150.88	6,454.36	7,302.24
Total with LULUCF [f]	kt CO_2 eq	100,993.41	100,993.41	106,283.60	124,405.08	132,998.34	115,393.41	91,611.18	92,211.69	86,265.93	77,489.71
Total without LULUCF	kt CO_2 eq	103,101.31	103,101.31	109,155.97	126,346.42	136,281.25	118,436.49	95,330.37	95,420.78	87,900.20	78,134.51

Table 5.2 CTF Table 6(a) Projections of GHG emissions in the "with measures" scenario, disaggregated by gas (kt CO2 eq)

		GHG emissions and removals								With measures	
GHG emissions projections	Unit	Base Year	1990	1995	2000	2005	2010	2015	2017	2020	2030
Gases											
CO_2 emissions including net CO_2 from LULUCF	kt CO_2 eq	81,198.32	81,198.32	84,021.19	100,806.38	110,616.91	94,265.98	71,213.52	71,601.47	66,584.30	57,704.81
CO_2 emissions excluding net CO_2 from LULUCF	kt CO_2 eq	83,375.36	83,375.36	86,945.64	102,982.30	113,925.11	97,342.98	74,959.05	74,844.84	68,288.99	58,420.01
CH_4 emissions including CH_4 from LULUCF	kt CO_2 eq	10,969.48	10,969.48	11,347.00	11,837.78	11,249.61	11,017.62	10,014.01	9,933.37	9,992.69	10,129.39
CH_4 emissions excluding CH_4 from LULUCF	kt CO_2 eq	10,906.80	10,906.80	11,303.62	11,629.75	11,239.07	11,001.20	10,003.21	9,914.82	9,937.58	10,074.29
N_2O emissions including N_2O from LULUCF	kt CO_2 eq	7,449.60	7,449.60	6,691.76	6,372.98	5,956.13	5,506.75	4,259.22	4,366.72	4,606.47	5,013.55
N_2O emissions excluding N_2O from LULUCF	kt CO_2 eq	7,443.14	7,443.14	6,683.06	6,346.44	5,941.37	5,489.25	4,243.70	4,351.00	4,591.17	4,998.25
HFCs	kt CO_2 eq	1,182.82	1,182.82	4,157.38	5,261.86	5,078.03	4,467.76	5,999.84	6,179.32	4,946.90	4,506.29
PFCs	kt CO_2 eq	190.26	190.26	62.85	122.26	91.51	129.44	119.52	125.79	130.00	130.00
SF_6	kt CO_2 eq	2.93	2.93	3.42	3.81	6.16	5.86	5.06	5.01	5.56	5.67
NF_3	kt CO_2 eq	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total with LULUCF [f]	kt CO_2 eq	100,993.41	100,993.41	106,283.60	124,405.08	132,998.34	115,393.41	91,611.18	92,211.69	86,265.93	77,489.71
Total without LULUCF	kt CO_2 eq	103,101.31	103,101.31	109,155.97	126,346.42	136,281.25	118,436.49	95,330.37	95,420.78	87,900.20	78,134.51

Table 5.3 CTF Table 6(c) Projection of GHG emissions in the "with additional measures" scenario, disaggregated by sector (kt CO2 eq)

		GHG emissions and removals								With additional measures	
GHG emissions projections	Unit	Base Year	1990	1995	2000	2005	2010	2015	2017	2020	2030
Sector											
Energy	kt CO_2 eq	62,363.31	62,363.31	64,363.97	77,814.39	85,239.27	70,601.56	53,924.29	52,912.14	38,987.07	20,393.03
Transport	kt CO_2 eq	14,506.98	14,506.98	16,584.24	18,859.96	21,891.95	22,476.45	17,100.38	17,241.44	17,806.33	16,866.40
Industry/industrial processes	kt CO_2 eq	11,226.96	11,226.96	13,569.65	15,176.41	15,426.20	11,741.12	11,996.39	12,786.81	10,677.95	10,032.64
Agriculture	kt CO_2 eq	10,140.24	10,140.24	9,487.90	9,146.79	8,959.22	8,838.65	7,846.02	7,850.33	8,061.30	9,141.94
Forestry/LULUCF	kt CO_2 eq	-2,107.91	-2,107.91	-2,872.37	-1,941.35	-3,282.91	-3,043.08	-3,719.19	-3,209.10	-1,634.28	-644.79
Waste management/waste	kt CO_2 eq	4,863.82	4,863.82	5,150.20	5,348.87	4,764.61	4,778.71	4,463.30	4,630.06	4,775.91	4,420.92
Other Sectors											
International aviation	kt CO_2 eq	2,496.15	2,496.15	2,658.59	2,547.12	2,622.63	2,606.17	2,893.53	3,463.76	3,151.37	3,474.52
International navigation	kt CO_2 eq	8,359.14	8,359.14	11,807.99	11,861.20	9,436.02	8,992.47	5,949.04	7,150.88	6,485.71	7,512.70
Total with LULUCF [f]	kt CO_2 eq	100,993.41	100,993.41	106,283.60	124,405.08	132,998.34	115,393.41	91,611.18	92,211.69	78,674.28	60,210.14
Total without LULUCF	kt CO_2 eq	103,101.31	103,101.31	109,155.97	126,346.42	136,281.25	118,436.49	95,330.37	95,420.78	80,308.56	60,854.93

Table 5.4 CTF Table 6(c) Projections of GHG emissions in the "with additional measures" scenario, disaggregated by gas (kt CO2 eq)

		GHG emissions and removals								With additional measures	
GHG emissions projections	Unit	Base Year	1990	1995	2000	2005	2010	2015	2017	2020	2030
Gases											
CO_2 emissions including net CO_2 from LULUCF	kt CO_2 eq	81,198.32	81,198.32	84,021.19	100,806.38	110,616.91	94,265.98	71,213.52	71,601.47	59,255.73	40,808.37
CO_2 emissions excluding net CO_2 from LULUCF	kt CO_2 eq	83,375.36	83,375.36	86,945.64	102,982.30	113,925.11	97,342.98	74,959.05	74,844.84	60,960.42	41,523.58
CH_4 emissions including CH_4 from LULUCF	kt CO_2 eq	10,969.48	10,969.48	11,347.00	11,837.78	11,249.61	11,017.62	10,014.01	9,933.37	9,766.01	9,799.72
CH_4 emissions excluding CH_4 from LULUCF	kt CO_2 eq	10,906.80	10,906.80	11,303.62	11,629.75	11,239.07	11,001.20	10,003.21	9,914.82	9,710.91	9,744.62
N_2O emissions including N_2O from LULUCF	kt CO_2 eq	7,449.60	7,449.60	6,691.76	6,372.98	5,956.13	5,506.75	4,259.22	4,366.72	4,570.07	4,960.14
N_2O emissions excluding N_2O from LULUCF	kt CO_2 eq	7,443.14	7,443.14	6,683.06	6,346.44	5,941.37	5,489.25	4,243.70	4,351.00	4,554.77	4,944.84
HFCs	kt CO_2 eq	1,182.82	1,182.82	4,157.38	5,261.86	5,078.03	4,467.76	5,999.84	6,179.32	4,946.90	4,506.29
PFCs	kt CO_2 eq	190.26	190.26	62.85	122.26	91.51	129.44	119.52	125.79	130.00	130.00
SF_6	kt CO_2 eq	2.93	2.93	3.42	3.81	6.16	5.86	5.06	5.01	5.56	5.62
NF_3	kt CO_2 eq	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total with LULUCF [f]	kt CO_2 eq	100,993.41	100,993.41	106,283.60	124,405.08	132,998.34	115,393.41	91,611.18	92,211.69	78,674.28	60,210.14
Total without LULUCF	kt CO_2 eq	103,101.31	103,101.31	109,155.97	126,346.42	136,281.25	118,436.49	95,330.37	95,420.78	80,308.56	60,854.93

Table 5.5 Projections based on WM scenario of total national GHG emissions (excluding LULUCF), EU ETS and ESR sectors (in ktCO2eq)

Year	National emissions excl LULUCF	EU ETS	ESR
2020	86,127	41,104	44,783
2025	81,150	34,394	46,171
2030	77,413	31,221	45,592
2035	72,310	25,909	45,786
2040	70,052	23,508	45,913

Table 5.6 Projections based on WAM scenario of total national GHG emissions (excluding LULUCF), EU ETS and ESR sectors (in ktCO2eq)

Year	National emissions excl LULUCF	EU ETS	ESR
2020	78,469	35,259	42,971
2025	69,169	25,971	42,558
2030	60,124	19,252	40,212
2035	57,395	17,476	39,239
2040	55,634	16,741	38,190

Concerning the 2020 non-ETS target (ESD target) of Greece pursuant to European legislation (Commission Decision 2013/162/EU as amended by 2017/147/EU and Commission Decision 2013/634/EU), by comparing the annual emissions allocation for the years 2013-2020 (***Table 5.7***) with the projected emissions from ESD sectors (Figure 5.1), it is concluded that it is anticipated that Greece will meet this target, on the basis of the domestic policies and measures. It should be mentioned that the above conclusion is based on the comparison of projections and annual emissions allocation calculated by applying global warming potential values from the fourth IPCC assessment report.

Concerning the 2030 non-ETS target (ESR target) of Greece pursuant to European Regulation 2018/842, each Member State shall ensure that its greenhouse gas emissions in each year between 2021 and 2029 do not exceed the limit defined by a linear trajectory, starting on the average of its greenhouse gas emissions during 2016, 2017 and 2018 and ending in 2030 on the limit set for that Member State (-16% for Greece). The linear trajectory of a Member State shall start either at five-twelfths of the distance from 2019 to 2020 or in 2020, whichever results in a lower allocation for that Member State.

The Annual Emission Allocations of Greece for the period 2021-2030, which correspond to a reduction of emissions of 16% by 2030 compared to 2005 pursuant to Article 4(1) of Regulation (EU) 2018/842, are presented in ***Table 5.8***. The AEAs for this period were set out by Comission Implementing Decision (EU) 2020/2126. They are given in GWP AR5.

By comparing the annual emissions allocation for the years 2021-2030 (Table 4.3) with the projected emissions from ESR sectors (Figure 5.1), it is projected that Greece will also meet the ESR target on the basis of the domestic policies and measures.

To be noted that Figure 5.1 and Tables 5.1-5.6 are based on GWP AR4, while Table 5.8 is based on GWP AR5. However, the difference of the total GHG emissions is less than 0.5% by moving from GWP AR4 to AR5, and therefore it does not affect the conclusion about the achievement of the target.

Table 5.7 Annual Emission Allocations (AEAs) of Greece for the year 2013 to 2020 calculated applying global warming potential values from the fourth IPCC assessment report

Year	AEAs (t CO2eq)
2013	58,955,025
2014	59,281,845
2015	59,608,666
2016	59,935,486
2017	59,131,332
2018	59,437,285
2019	59,743,238
2020	60,049,191

Table 5.8 Annual Emission Allocations (AEAs) of Greece for the year 2021 to 2030 calculated applying global warming potential values from the fifth IPCC assessment report

Year	AEAs (t CO2eq)
2021	46,227,407
2022	46,969,645
2023	47,711,883
2024	48,454,122
2025	49,196,360
2026	49,938,598
2027	50,680,836
2028	51,423,075
2029	52,165,313
2030	52,907,551

5.2 Assessment of aggregate effects of policies and measures

In this chapter the estimated and expected total effect of implemented / adopted and planned policies and measures is presented. The effects of individual policies and measures are reported in the policies and measures section (chapter 4).

The aggregate effect of currently implemented and adopted policies and measures (that is incorporated in the "with measures" projections scenario) is presented in ***Tables 5.9*** in terms of GHG emissions avoided on a CO2 equivalent basis. The effect of policies, or with other words GHG emissions avoided, correspond mainly to CO2, with the exception of policies in industrial processes, waste and agriculture sectors. In the case of waste sector, GHG emissions avoided correspond totally to CH4, while in the agriculture sector about 70% to N2O and 30% to CH4. In the case of industrial processes sector, GHG emissions avoided correspond totally to HFCs and PFCs.

Table 5.9 Aggregate effect of currently implemented and adopted policies and measures (kt CO2 eq)

Policies and Measures	Effect of implemented and adopted policies and measures					
	2005	2010	2015	2020	2025	2030
Energy sector (CO2)	7521	24069	23298	29674	31692	33655
Transport sector (CO2)	8	801	501	1228	1302	1394
Industrial processes (HFC, PFC)	NA	NA	NA	760	1150	1700
Agriculture (CH4 30%, N2O 70%)	NE	NE	560	715	1000	1300
Waste Sector (only CH4)	NE	NE	1180	1500	1650	1750
LULUCF (CO2)	NE	NE	NE	NE	4063	4122
Total Effect	**7529**	**24470**	**25839**	**33877**	**40857**	**43921**

Table 5.10 Aggregate effect of currently planned policies and measures (kt CO2 eq)

Policies and Measures	Effect of implemented and adopted policies and measures	
	2025	2030
Energy sector (CO2)	11357	16058
Transport sector (CO2)	146	619
LULUCF (CO2)	126	313
Total Effect	**11629**	**16990**

5.3 Supplementarity relating to mechanisms under Article 6, 12 and 17, of the Kyoto Protocol

Within EU, supplementarity obligations under the Kyoto Protocol require that any international credit purchases by Member States must be in addition to emission abatement action taken domestically. The use of flexible mechanisms within the EU takes place by operators in the EU ETS and by governments in their achievement of Kyoto targets.

As it was reported in the 6th National Communication, Greece has fulfilled its Kyoto Protocol target for the 1st commitment period. The target was met on the basis of the domestic policies and measures (including EU-ETS). The installations subject to the EU-ETS were allowed to use JI and CDM credits. According to the principle of supplementarity of the Kyoto Protocol, installations were allowed to use for compliance credits from these two mechanisms up to 9% of their allocated allowances for years 2008-2012. This figure was calculated according to the supplementarity principle.

The use of flexible mechanisms for the 2020 target is described in section A.I.3.2.2 and Table A.I.3. Greece will not use credits from flexible mechanisms for its ESD target. EU-ETS operators could use international credits subject to quantitative and qualitative limits.

5.4 Methodology used for the presented GHG emission projections

For scenario development and projections two main procedures have been used:

- ✓ The projections of energy sector are based on the official energy planning (NECP) provided by the MEEN (Directorate of Energy Policy and Energy Efficiency). These data were “translated” to GHG emissions based on the spreadsheet models used for the estimation of annual GHG inventory.
- ✓ Spreadsheet models for the non-energy sectors, in which future changes in activity data are mainly derived from statistical analysis, while emission factors are derived from expert assessments based on the 2006 IPCC guidelines and country specific information.

- ✓ Actual inventory data till year 2019 have been used in the preparation of the emission projections.

Emissions for all sectors were projected using the same models that were used for the BR4, updated to:

- ✓ include improvements in inventory reporting;
- ✓ include emissions for 2019, as reported in the 2017 NIR submission; and
- ✓ update of key assumptions, in order to reflect in the projections the current economic situation, and the most recent forecasts of macroeconomic parameters (e.g. GDP, fuel and carbon prices).

5.4.1 Energy Sector

5.4.1.1 Methodology

The energy planning is performed by the MEEN (Directorate of Energy Policy and Energy Efficiency). It is based on the execution of energy planning models, which was performed by the Center for Renewable Energy Sources / Energy Systems Analysis Lab. In order to simulate the Greek energy system and to project its future structure, the Integrated MARKAL-EFOM System (TIMES) in combination with PropSim were used.

The main input data for TIMES are: GDP and population forecasts, import prices of energy commodities, CO2 prices, costs of energy technologies, and potential of indigenous energy sources (conventional and renewable). The main input data for PropSim are chronological curves of customer load and production of non-dispatchable power plants, expansion plan of power system (energy technology capacities, investments on power plants), and electricity demand.

The use of these models leads to the conduction of analytical quantitative targets per technology, such as the demanded power for wind turbines, small - scale hydro or biomass or the quantification of energy savings in the industrial and residential sectors, etc.

The evaluation of policies has been performed using the TIMES energy model. TIMES constitutes a tool that simulates and optimizes the energy market. It is being continuously developed in the context of the Energy Technology Systems Analysis Programme (ETSAP) of the International Energy Agency (IEA), in which Greece participates as a Member State. The TIMES model is driven by the predicted useful energy demand. By determining the evolution of the useful energy demand (i.e. heating, ventilating and air conditioning, lighting), in the input of the model, and combining it with the course of techno-economical parameters of various energy technologies, the model optimizes the energy technology and fuel combination that satisfies the energy demand and the targets set by energy strategies (concerning emissions, energy conservation, etc.).

The basic components in TIMES model are specific types of energy or emission control technology. Each is represented quantitatively by a set of performance and cost characteristics. A menu of both existing and future technologies is input to the model. Both the supply and demand sides are integrated, so that one side responds automatically to changes in the other. The model selects the combination of technologies that minimizes total energy system cost.

Thus, unlike some "bottom-up" technical-economic models, TIMES does not require - or permit - an a priori ranking of greenhouse gas abatement measures as an input to the model. The model chooses the preferred technologies and provides the ranking as a result. Indeed, the choice of abatement measures often depends upon the degree of future abatement that is required.

In order to improve the simulation of the electricity system, the PropSim model has been used. Using PropSim enables the identification of the best possible electricity generation system that satisfies the given energy demand. The model simulates the operation of the generation system derived and calculates the peak load capacity required, the balancing units capacity required to cover the residual load hourly variations and the storage capacity required to restrict energy curtailment.

In addition, the following models have been used:

- ➢ WASP IV, which permits the user to find an optimal expansion plan for a power generating system over a long period through discrete investments); and

- HSIMUL (developed by CRES) for the hourly simulation of the electricity market, to estimate the production shares of each unit of the system

5.4.1.2 Scenario definition

The level of emissions estimated in WM and WAM scenarios depends on assumptions regarding main parameters, such as population, economic growth, energy prices etc. It also depends on the specific policies incorporated into the scenario. The implemented / adopted and the planned policies and measures, which were presented in **Chapter 4**, are incorporated in the “with measures” and “with additional measures” scenarios, respectively. The main assumptions made for the projection of GHG emissions in WM and WAM scenarios are presented in **section 5.4.1.3** and **CTF Table 5**. The projections of energy production and consumption data were converted to GHG emissions by following the 2006 IPCC Guidelines and by applying global warming potential values from the fourth IPCC assessment report, in line with the national GHG inventory submissions. Emission factors are derived from expert assessments based on the 2006 IPCC guidelines and country specific information.

The “with measures” scenario (WM) encompasses currently implemented and adopted policies and measures. The “with additional measures” scenario (WAM) reflects the mitigation effect of planned policies and measures, in addition to currently implemented and adopted policies and measures. It reflects the additional policies and measures of the adopted NECP. Both scenarios assume an emission allowance cost and the international fuel prices reported in **section 5.4.1.3**. The evolution of demand for useful energy in the final consumption sectors (buildings, transport, etc.) is shaped by both the evolution of economic activity per sector and the evolution of population, housing, household size, production capacity of individual industrial sectors and other macroeconomic and demographic parameters.

The base year for energy projections is 2019, as it was the most recent year for which a GHG inventory was available by the time of compilation of this report. It should be mentioned that the projections of energy consumption data are based on an exercise that was conducted for NECP, which was published in December 2019. However, these data were subjected to small adjustments to be consistent with the most resent GHG submission and emission time-series of the years 1990-2019. In addition, the effect of COVID-19 pandemic was reflected in the emissions of 2020 for road transport and aviation (both national and international) based on a study for Attica Region.

The following national targets will be achieved by the WM and WAM scenarios as concerns 2020:

- Non ETS sectors reduction target -4% (from 2005 level).
- Simulation of ETS operation assuming a cost of CO2 emissions for ETS industries indicated in section 5.4.1.3.
- 18% RES target (Gross final consumption pursuant the Renewable Energy Directive)
- Energy Efficiency targets according to Directive 2006/32/EC (national final energy savings 9% by 2016). Additionally, the energy conservation will evolve according to European target of 20%, as it is defined in Directive 2012/27/EU (final energy consumption in 2020 will be 18.4 Mtoe).

Concerning 2030, the following national targets are anticipated to be achieved by WAM scenarios (NECP targets):

- Overachievement of the non ETS sectors reduction target -16% (from 2005 level).
- Simulation of ETS operation assuming a cost of CO2 emissions for ETS industries indicated in section 5.4.1.3.
- RES share in gross final energy consumption of at least 35%. Exceed 60% RES share
- Ceasing lignite's share in power generation until 2028 (de-lignification).
- Energy efficiency improvement of at least 38%. Final energy consumption 16.1-16.5 Mtoe. Achieve cumulative energy savings of a 7.3 Mtoe over the period 2021-2030. Additional targets:

- By 2029, interconnect the energy systems of all islands to the mainland, and where this is not possible or in the case of islands that will be connected to the mainland at a later date, install innovative hybrid systems for energy production by RES.
- 19% share of renewables by 2030 in final consumption in the transport sector – share of advanced biofuels used in the transport sector to be 3.5% by 2030 (based on EU methodology);
- By 2030, raise the share of electric passenger cars up to 30% of new registrations;
- Energy renovations for a 3%, on a yearly basis, of the total surface area of the thermal loads of central administration public buildings by 2030;
- By 2030, reach to a 12-15% energy renovation of buildings / building units of the residential building stock.

Table 5.11 compares some energy indices of the two scenarios, namely WM and WAM.

Table 5.11 Energy indices in 2030

Energy indexes	WM	WAM (NECP)
Share of RES in Gross final energy consumption	25%	35%
Share of RES in Gross consumption of electricity	48%	61%
Share of RES in final consumption for heating and cooling	29%	42.5%
Share of RES in final consumption in transport sector	10%	19%
Final energy consumption	18.2 Mtoe	16.5 Mtoe
Final electricity consumption	53.4 TWh	57.2 TWh
Total RES-E installed capacity	15.3 GW	19.03 GW

Regarding the evolution of RES share in final consumption, they are presented in ***Table 5.12*** and ***Table 5.13***, according to the WAM scenario (NECP). In particular, while the share of RES in electricity generation and heating is relatively linear, the contribution of RES to transport is projected to be more pronounced after 2025, especially towards the end of the next decade and the period 2028-2030, whereby, in economic terms, the optimal penetration of electric vehicles is projected, where renewable fuels will have the most dominant share in the electricity mix compared to all other fuels, as well as the use of advanced biofuels.

Table 5.12 Evolution of RES shares per sector by 2030

Evolution of RES shares	2020	2022	2025	2027	2030
Share of RES in Gross final energy consumption (%)	18.0	19.9	22.9	26.2	31.0
Share of RES in final consumption for heating and cooling (%)	24.5	25.9	28.4	30.1	32.3
Share of RES in Gross consumption of electricity (%)	29.1	34.6	41.2	48.7	56.4
Share of RES in final consumption in transport sector (%)	6.0	6.7	8.7	11.2	20.0

Table 5.13 Progress towards achieving the RES target per sector by 2030.

Progress in the share of energy from RES to achieve the 2030 target	2022	2025	2027	2030
Share of RES in Gross final energy consumption (%)	14	37	63	100
Share of RES in final consumption for heating and cooling (%)	18	50	72	100
Share of RES in Gross consumption of electricity (%)	20	44	72	100
Share of RES in final consumption in transport sector (%)	5	19	37	100

In the field of RES electricity, the leading applications for the next period that will contribute to the achievement of the targets are wind farms and photovoltaic parks, which are considered to be the most mature and competitive ones in market and economic terms.

Regarding the evolution of RES to meet thermal needs in final consumption, a significant increase in the role of heat pumps is anticipated, especially in the tertiary sector. Moreover, an increased participation of thermal solar systems and geothermal energy as well as a steady contribution of biomass is expected.

The estimation of the GHG emissions is based on the formation of analytical energy balances for the years 2020, 2025, 2030, 2035 and 2040 and the computation of emissions per fuel and technology in every sector. ***Table 5.14*** and ***Table 5.15*** include the projections of emissions from the energy sector under WM and WAM (NECP) scenarios, respectively.

Table 5.14 GHG emissions from the energy sector (in ktCO2eq) for 'with measures' scenario of projections

Sector / Year	2015	2020	2025	2030	2035	2040
Energy Industries	40,912	32,125	25,746	22,672	17,250	14,920
Fugitives emissions	1,106	732	553	499	319	283
Man. Industry and Construction	5,250	5,588	5,564	5,704	5,949	6,014
Transport	17,100	17,707	17,911	17,444	16,978	16,697
Tertiary	714.04	1,075	1,084	1,107	1,158	1,293
Residential	5,181	5,961	5,873	5,914	6,135	6,128
Agriculture	554.17	869	852	858	840	837
Other	208.08	203	203	203	203	203
TOTAL	71,025	64,260	57,785	54,401	48,831	46,375

Table 5.15 GHG emissions from the energy sector (in ktCO2eq) for 'with additional measures' scenario of projections

Sector / Year	2015	2020	2025	2030	2035	2040
Energy Industries	40,912	26,440	17,362	10,825	9,021	8,831
Fugitives emissions	1,106	505	287	123	108	104
Man. Industry and Construction	5,250	5,159	4,800	4,428	4,292	3,861
Transport	17,100	17,783	17,860	16,864	15,810	14,937
Tertiary	714.04	842	905	824	782	733
Residential	5,181	5,098	3,781	3,209	3,118	2,755
Agriculture	554.17	631	620	614	577	538
Other	208.08	203	203	203	203	203
TOTAL	71,025	56,661	45,819	37,090	33,911	31,961

5.4.1.3 Main assumptions

The level of emissions estimated in any scenario depends on assumptions regarding main parameters, such as population, economic growth, energy prices etc. It also depends on the specific policies incorporated into the scenario. Implemented and adopted policies and measures, which were presented in chapter 3, are incorporated in the "with measures" scenario, while planned policies and measures are incorporated in "with additional measures" scenario. The main assumptions made for the projection of GHG emissions, which are the same for both WM and WAM scenarios and were also reported in CTF Table 5, are analyzed as follows:

International fuel prices: they are presented in Table below (source: NECP).

Table 5.16 International fuel prices according to IEA

Fuel	2020	2025	2030	2035	2040
Crude oil [€ 2016/GJ]	11.90	15.73	17.33	18.08	19.14
Natural Gas [€ 2016/GJ]	6.80	7.71	8.12	10.08	10.42
Coal [€ 2016/GJ]	2.85	3.16	3.79	4.01	4.18

Price of CO2 emission allowances (EUAs): the EUA's price during the period 2020-2040 is presented in ***Table 5.17*** (source: NECP).

Table 5.17 CO2 emission allowances price

Year	2020	2025	2030	2035	2040
CO2 emission allowances € 2016 /tCO2	24.00	28.77	31.23	43.50	51.70

Demographic characteristics: the population during the period 2020-2040 is presented in ***Table 5.18*** (source: NECP).

Table 5.18 Population evolution 2020-2040

Year	2020	2025	2030	2035	2040
Population [bil]	10.69	10.54	10.37	10.20	10.03

Macroeconomic data: Energy demand development of the system depends to a great extent on the development of relevant economic activity sectors, the effect of current economic recession and the way that they are diffused in the population and the impacts in its living standards. In ***Table 5.19*** the projected macroeconomic data till 2040 are presented. The projections of main macroeconomic indexes were provided by the Ministry of Finance.

Table 5.19 Gross domestic product growth (Average Annual)

Year	2020	2025	2030	2035	2040
GDP (bil Euro 2016)	200.08	221.66	244.73	270.21	295.42

5.4.2 Non-energy sectors

5.4.2.1 Methodology

GHG emissions in the non-energy sectors are calculated using spreadsheet models that calculate emissions based on activity data, emission factors and sector specific assumptions, according to the following general equation:

$$E_{g,t} = \sum_{j=1}^{J} A_{0,j} \cdot (1 + r(x_i))^t \cdot C_{g,j}$$

where,

j : An activity, which constitutes a source of GHG emissions (source)

Eg,t : Projection of emissions of g-greenhouse gas in year-t

A0,j : Activity data of the j-source of emissions in base year

r(xi) : Growth rate of activity data for j-source based on the changes of the determinant parameter x

Cg,j : Emission factor of the g-greenhouse gas for the j-source consistent to the latest GHG inventory submission and 2006 IPCC Guidelines.

The growth factor accounts for changes (increases or decreases) in the emission-generating activity. In estimating the growth factor, time-series analysis and/or regression analysis using appropriate determinant parameters of the available activity data is used. Potential determinant parameters include population, value added, product output, etc.

The base year for projections is 2019, as it was the most recent year for which a GHG inventory was available by the time of compilation of this report.

5.4.2.2 Industrial processes and product use sector

Projected emissions from industrial processes and product use sector are based mainly on the analysis (a) of the activity data of the respective industrial branches and (b) the apparent consumption of refrigeration and air-conditioning appliances. The emission factors used are similar to those reported in the latest inventory, according to 2006 IPCC guidelines and country specific data.

The main assumptions that were adopted in the context of the present analysis in order to evaluate the future development of GHG emissions from the industrial processes sector are presented in Table 4.13. The economic recession of our times is taken into consideration. In order to ensure consistency with energy sector’s projections, the emissions from the sectors: mineral products, metal production and chemical industry, were projected on the basis of the emission projections of the energy sector, as it is indicated in ***Table 5.20***. Projected emissions under both scenarios (WM and WAM) are practically identical.

Table 5.20 Main assumptions for the "with measures" scenario in IPPU sector.

Process	Projections
Mineral products (Mt)	The energy projected to be consumed by Times model was used as a driver for the estimation of process emissions.
Metal production (Mt)	The energy projected to be consumed in metal production plants by Times model was used as a driver for the estimation of process emissions.
Chemical industry	One Nitric acid production unit will be in operation from 2007 and afterwards. The energy projected to be consumed in ammonia production plants by Times model was used as a driver for the estimation of emissions of ammonia production
Production of F-gases	HCFC-22 production has been stopped since 2006.
Consumption of F-gases	The mitigation effect of EU Regulation 517/2014 was reflected in the projections.

The projections of GHG from IPPU sector (***Table 5.21***) show a decrease compared with 1990 levels. Key highlights include:

- ✓ HFCs emissions from HCFC-22 manufacture does not occur since 2006, because the HCFC-22 production unit ceased operation.
- ✓ HFCs emissions due to the use of refrigeration and air-conditioning equipment present an annual rate of decrease almost 2% from 2020 to 2040, while the total decrement in 2040 from 2020 is 33.49%. This decrease is attributed to the implementation of the new EU Regulation of the European Parliament and of the Council of 16 April 2014 (No 517/2014) on fluorinated greenhouse gases. In specific, the reduction in the emissions is expected due to the prevention of leakages and emissions (emission prevention and leak checks, end of life treatment of products and equipment, training and qualification, information for users (labelling, product infos) and the control of use of F-gases (ban on new applications, ban on uses, phase-down of HFC supply). Directive 2006/40 of the European Parliament and of the Council of 17 May 2006 relating to emissions from air-conditioning systems in motor vehicles amending Council 70/156/EEC is also anticipating reducing F-gases emissions from MACs.

Table 5.21 Projections of GHG emissions from the IPPU sector (in kt CO_2eq)

Year	2015	2020	2025	2030	2035	2040
Mineral products	3,957	3,909	3,728	3,724	3,765	3,795
Chemical industry	516	902	880	834	826	797
Metal production	1,209	1,241	1,200	1,187	1,174	1,100
Non-energy products from fuels and solvent use	33	36	36	36	36	36
Other product manufacture and use	230	240	259	277	295	312
Product uses as substitutes for ODS	6,053	4,852	4,003	3,434	3,509	3,473
Total	**11,998**	**11,180**	**10,106**	**9,492**	**9,604**	**9,513**

5.4.2.3 Waste sector

Solid waste disposal on land is the major source of GHG emissions from the waste sector. For the projection of emissions from solid waste, the generation rate of quantities of solid waste was considered as shown in ***Table 5.22***, based on the data provided by "National waste management plan, 2020-2030", which has been approved and published on 31-08-2020 with the Act no. 39 of Ministerial Council "Approval of the National Waste Management Plan.

In order to estimate the composition of MSW generated on an annual basis, the assumptions presented in the last National Inventory Report (2019) were used. It was assumed that the share of putrescibles decreases by 0.3% annually, the share of metals and glass decreases annually by 0.1% and 0.02% respectively, the share of paper and plastics increases by 0.2% annually and the share of wood and textiles remains constant 1% and 3.25%, respectively.

The composition of the solid waste landfilled at disposal sites was estimated taking into account the composition of MSW generated and the amounts of waste recycling and compost, as per "National waste management plan, 2020-2030". The Municipal solid waste generation, the Municipal solid waste going to landfills and the share of CH4 recovery in total CH4 generation from landfills are presented in Table 5.22.

Table 5.22 Main assumptions of projections scenarios for solid waste disposal on land

	2015	2019	2020	2025	2030	2035	2040
Municipal solid waste (MSW) generation (kt)	3800	4032	3980	3759	3767	3862	3959
Municipal solid waste (MSW) going to landfills (kt)	3012	2841	2519	985	297	254	231
Share of CH_4 recovery in total CH_4 generation from landfills (%)	31.7	28.6	32.1	33.8	33.6	32.9	32.1

Policy issues that affect significantly the projection of GHG emissions from solid waste disposal on land and wastewater handling include (a) the implementation of Council Directive 1999/31, regarding sanitary landfill (which is the main reason for the significant increase of waste recycled, especially from 2010 and onwards and the increase on the implementation of systems for flaring or recovery of biogas), (b) the Directive (EU) 2018/850 for the amendment of Directive 1999/31 / EC on the landfill of waste, (c) the Directive on Packaging and Packaging Waste (94/62/EC) concerning the Paper and Cardboard recycling, as amended by Directives (EU) 2018/851 and 2018/852 and (d) the Directive (EU) 2019/904 of the european parliament and of the council (5 June 2019) on the reduction of the impact of certain plastic products on the environment.

The estimation of methane emissions from solid waste disposal on land was performed with the FOD method while the default 2006 IPCC methodology was followed for the other source categories (domestic wastewater handling, human sewage and industrial wastewater handling). The total emissions from waste sector are presented in ***Table 5.23***.

Table 5.23 GHG emissions from the waste sector (kt CO_2eq)

Year	2015	2019	2020	2025	2030	2035	2040
Solid Waste Disposal on Land	3148	3325	3165	2874	2482	2109	1811
Wastewater	1267	1423	1435	1522	1617	1723	1818
Waste Incineration	6.0	3.6	4.1	4.5	4.9	5.4	5.9
Compost	29.0	87.9	117.6	266.8	315.2	330.9	346.2
Total	**4450**	**4840**	**4722**	**4668**	**4419**	**4168**	**3982**

5.4.2.4 Agriculture

The main determinant parameters of GHG emissions from agriculture are the animal population, the quantities of synthetic nitrogen fertilizers applied on soils and the agricultural crops production.

Regarding the animal population, the rate of change of population of each animal category is estimated based on the analysis of the expected GDP evolution for the next decades.

The use of synthetic nitrogen fertilizers (***Table 5.24***) increases continuously with a mean annual rate of 0.5% for the period 2000 – 2030. The decrease in the use of synthetic nitrogen fertilizers for the period 2010-2020 could probably be attributed to the mitigation measures and to the effect of the economic crisis, while for the period 2020-2040 an increase in the use of synthetic nitrogen fertilizer is foreseen as the result of the anticipated economic recovery despite the impact of the mitigation measures. Data for the period 1990-2019 derive from the Pan-Hellenic Association of Professional Fertilizers Producers & Dealers (PHAPFPD), while the projections are based on the analysis of the trends observed in the whole period 1990-2019.

Table 5.24 Animal population (thousands) per species (3-year average)

	Historical		Projection				
Animal population (thousands)	**2015**	**2019**	**2020**	**2025**	**2030**	**2035**	**2040**
Dairy cattle	111	96	101	108	116	124	131
Non dairy cattle	471	451	474	509	545	583	614
Buffalos	4	5	5	5	5	6	6
Sheep	8746	8797	8989	9651	10328	11053	11643
Goats	4127	3949	4094	4396	4704	5034	5303
Horses	21	7	16	17	18	19	20
Asses & mules	16	4	9	9	10	11	11
Swine	714	727	719	771	826	884	931
Poultry	32111	37982	37078	39809	42603	45594	48028

Table 5.25 Projection of nitrogen inputs in soils (in kt) from synthetic fertilizers

	Historical		Projection				
	2015	**2019**	**2020**	**2025**	**2030**	**2035**	**2040**
Synthetic fertilizers (kt N)	164	190	182	186	191	196	199

Finally, for the projection of agricultural crops production, similarly with the animal population, an analysis based on the expected GDP evolution for the next decades, was performed. In ***Table 5.26***, the projections of agricultural crops production areas for the period examined are presented.

For the estimation of CH4 emissions from enteric fermentation of cattle and sheep, which account for 80% of methane from this sub-source, Tier 2 methodologies were applied, while for the other animal default emission factors by 2006 IPCC Guidelines for Eastern Europe are used. The CH4 emissions from manure management are estimated based on emissions factors suggested by 2006 PCC Guidelines for developed countries. The emission factors used for the estimation of N2O from manure management are the ones suggested by IPCC Guidelines for Western Europe for cattle and buffalo and for Mediterranean countries for the rest of the animals. The methodologies and emission factors suggested by the 2006 IPCC Guidelines were used for the estimation of GHG emissions from agricultural soils, rice cultivations and field burning of agricultural residues. Finally, other parameters like manure management systems and percentage of agricultural residues burned on site are kept constant at 2000 levels, while it is also assumed that climate parameters will not undergo significant changes.

Table 5.26 Projection of agricultural crops production

	Historical		Projection				
Production (ktn)	**2015**	**2019**	**2020**	**2025**	**2030**	**2035**	**2040**
Wheat	1459	1447	1696	1821	1949	2086	2197
Barley	413	364	376	404	432	463	487
Oats	107	108	105	112	120	129	136
Rye	33	25	29	31	33	36	38
Maize	1716	1378	1528	1640	1755	1878	1979

Rice	264	260	293	315	337	360	379
Beans	21	17	17	19	20	21	22
Peas	0.4	0.5	0.6	0.6	0.7	0.7	0.8
Potatoes	581	464	493	529	567	606	639
Sugarbeet	353	192	312	335	359	384	405

Total GHG emissions from agriculture are presented in ***Table 5.27***.

Table 5.27 GHG emissions from agriculture in the "with measures" scenario (kt CO_2eq)

	Historical		Projection				
Year	**2015**	**2019**	**2020**	**2025**	**2030**	**2035**	**2040**
Enteric Fermentation	3730	3646	3756	4033	4316	4619	4866
Manure Management	926	930	939	1009	1079	1155	1217
Rice Cultivation	145	153	170	182	195	209	220
Agricultural Soils	2963	3077	3104	3272	3446	3636	3779
Field Burning of Agricultural Residues	39	35	39	42	45	48	51
Urea application	23	35	35	38	41	43	46
Total	**7827**	**7875**	**8044**	**8576**	**9122**	**9711**	**10178**

In general, emissions from the agriculture sector for the period 2015-2020 remain constant. Except of the citified way of life which has been adopted and the abandonment of rural areas, this trend could be attributed to reduction of agricultural production and to the reduction in the use of synthetic nitrogen fertilizers.

For the rest period, an increase in emissions from the agriculture sector is foreseen as a consequence of anticipated economic recovery. It must be mentioned that the mitigation measures for this period have also been taken into consideration resulting in a slight increase of GHGs emissions compared to what would be in their absence.

5.4.2.5 Land Use, Land Use Change and Forestry

Projected emissions from the LULUCF sector are based mainly on the analysis of the activity data during the period 1990 – 2019. The emission factors used are similar to those reported in the latest inventory, according to 2006 IPCC guidelines and country specific data. CO2 is the greenhouse gas mostly affected by the LULUCF sector, following carbon stocks changes in different carbon pools. Non-CO2 greenhouse gases (CH4 and N2O) and indirect GHG are released in relatively small quantities, mainly when biomass is burnt.

The main assumptions that were adopted in the context of the present analysis in order to evaluate the future development of GHG emissions from the industrial processes sector are presented in ***Table 5.28***.

Table 5.28 Main assumptions for the "with measures" scenario in LULUCF sector.

Land accounting categories[18]	Projections
Afforested land	The implementation of EEC Regulations 2080/92 and 1257/99 is expected to decrease by 10% each decade until 2040 (WEM scenario). Woody energy crops are expected to double until 2030 and triple until 2040, under the WAM scenario
Deforested land	Area under deforestation activities is expected to follow the trend during the period 2010 – 2019, gradually decreasing by 10% in 2040 in relation to 2019 levels
Managed forest land	15% annual harvesting rate is estimated, annual increment is based on mean values from the database of Forest Management Plans

[18] EU Regulation 841/2018

Land accounting categories[18]	Projections
	The area of managed forest land is expected to increase after 2025, when the forest cadaster and the national forest monitoring project are planned to be completed, incorporating also land currently classified as "unmanaged" (+70% by 2030 and +150% in 2040, compared to 2019 base year)
Managed cropland	The area of cropland is expected to increase due to land reclamation for energy crops (+5% by 2030 and +10% in 2040, compared to 2019 base year)
Managed grassland	The management plans for the grazing land are expected to be completed until 2025. Grassland area is expected to decrease, either due to conversion to forest land or recultivation (formerly abandoned cropland)
Managed wetland	Wetland area is expected to follow the trend during the period 2010 – 2019, gradually increasing by 5% until 2030 and +10% in 2040 compared to 2019 levels

An analysis of data and trends of the last decades was elaborated in order to estimate the evolution of GHG emissions and removals, and the following assumptions have been made:

- The annual biomass uptake in these lands, as well as the annual losses as a result of the loggings, follow the trend observed from 2000 onwards.
- The contribution of harvested wood products pool in total net emissions/removals follows the trend observed from 2000 onwards.
- Carbon stock changes in areas under conversion to forest land will remain constant and equal to the average estimated during the period 2010 – 2019.
- Areas affected by wildfires each year are considered equal to the average area burnt in the period 1990 – 2019 (this assumption results in reduced inter-annual variation in net emissions/ removals of greenhouse gases from this sector in relation to the variation observed during 1990 – 2019).
- N2O emissions arising from N mineralization associated with loss of soil organic matter resulting from change of land use or management of mineral soils will remain constant and equal to the average during the period 1990 – 2019.

The sink capacity of the LULUCF sector is projected to increase in the future, from -3.62 Mt CO2 eq. in 2019 to -5.4 Mt CO2 eq. in 2040 under the WEM scenario, and to -6.5 Mt CO2 eq. under the WAM scenario.

The projections of GHG for the LULUCF sector in Greece show an increase compared to 1990 levels until 2040, under the WEM scenario, which are presented in **Table 5.29** below.

Table 5.29 Aggregate effect of currently implemented and adopted policies and measures (kt CO2 eq.)

Policies and Measures	Effect of implemented and adopted policies and measures			
	2019	2025	2030	2040
Managed forest land	-1600.67	-2326.51	-2415.11	-4025.18
Afforested land	-105.73	-84	-79.04	-71.17
Total Effect	**-1706.4**	**-2410.51**	**-2494.15**	**-4096.35**

The minus sign (-) indicates that these policies affect the enhancement of removals of CO2.

The aggregate effect of the WAM scenario in relation to the WEM scenario is presented in ***Table 5.30*** below.

Table 5.30 Aggregate effect of planned policies and measures (kt CO2 eq.)

Policies and Measures	Effect of implemented and adopted policies and measures			
	2025	2030	2035	2040
Managed forest land	0.00	-55.00	-275.00	-550.00

Afforested land	-22.90	-52.70	-122.20	-192.30
Harvested wood products	-103.20	-205.00	-304.07	-400.50
Total Effect	**-126.10**	**-312.70**	**-701.27**	**-1142.80**

The minus sign (-) indicates that these policies affect the enhancement of removals of CO2.

Managed Forest Land

During the period 1990–2019 managed forest land acts as a net carbon sink. In order for forest land to be considered as managed, a forest management plan should be in effect from 1990 or later. These forests cover approximately 36% of the total forest land of Greece. Emissions/removals from forest land are the result of the balance mainly in biomass increment from forest growth and biomass loss due to loggings and wildfires. Net removals from forest land show an upward trend in the inventory period that is attributed mainly to the reduction in loggings and the afforestation programmes started in 1994.

Projections for managed forest land for 2025 are based on the forest reference level (FRL). FRLs to be applied by the Member States for the period 2021-2025 are included in the annex of the Commission Delegated Regulation amending Annex IV to Regulation (EU) 2018/841 of the European Parliament and of the Council. The Greek FRL for the period from 2021 to 2025 is -2,337.640 Mt CO2 eq. per year. This value was based on the Corrigendum to the NFAP submitted by Greece in 2020[19] (***Table 5.31***).

Table 5.31 Estimation of FRL for the period 2021 - 2025

Kt CO_2 eq.	2021	2022	2023	2024	2025	Average
CO_2 (living biomass)	-2,107.11	-2,188.77	-2,201.58	-2,169.48	-2,159.11	-2,165.21
CO_2 (HWP_FOD)	-161.01	-187.11	-165.99	-183.84	-170.02	-173.59
CH_4	1.15	1.15	1.15	1.15	1.15	1.15
N_2O	0.01	0.01	0.01	0.01	0.01	0.01
Total CO_2 eq. (HWP_FOD)	-2,266.96	-2,374.72	-2,366.41	-2,352.16	-2,327.97	**-2,337.64**
Total CO_2 eq. (HWP_IO)	-2,105.95	-2,187.61	-2,200.42	-2,168.32	-2,157.95	-2,164.05

The policies implemented and adopted for the forestry sector are expected to gradually increase the area of managed forest land, after 2025 and incorporate the majority of forest land by 2040.

Wildfires constitute a common disturbance in the Mediterranean basin, and particularly in Greece. They account for the emissions of managed forest land, with significant annual variation further intensified by climate change. Emissions from wildfires were taken into account for the projections, following the 10-year trend during the period 1990–2019.

Reforestation of degraded or burned forest land is included also in this category, expected to further increase removals based on the WAM scenario, after 2030. The main assumptions for the estimation of the sink that will be created through the planned national reforestation project include:

- Planting area 50,000 ha until 2030
- Species planted: 90% conifers and 10% broadleaves (diameter 4cm & height 1.6m)
- Planting space 2.5 x 2.5 m

Afforestation

This category includes cropland that has been afforested in the context of EEC Regulations 2080/92 and 1257/99 with artificial planting, and also grassland converted to forest through natural expansion of forest. This activity is projected to remain a sink in both the WEM and WAM scenarios. Grassland conversion to forestland constitutes a natural process, not associated with emissions by sources and

[19] https://ekpaa.ypeka.gr/wp-content/uploads/2020/04/Corrigendum-to-the-NFAP.pdf

removals by sinks, since that kind of conversion is not directly human induced. Removals are therefore not estimated in the NIR for grassland conversion.

Deforestation

With regard to emissions resulting from the conversion of forest land (deforestation) those are expected to remain at low levels. Greek law allows the land-use change of forest land only in cases of national interest and thus there is only a very small area where such land-use conversions occur (e.g. construction of high-tension lines). The share of emissions from forest land conversions is projected to be at approximately 1% of the total emissions/removals of the sector.

Harvested Wood Products

HWP pool is projected to represent a sink during the period 2020-2040, in both WEM and WAM scenarios. In the WEM scenario, HWP removals are not expected to change significantly from the 2019 values (5% increase every 10 years). National policies about future harvested wood products (HWP) from domestic forests point towards the increase of the harvesting rate after 2030. This change is incorporated in the WAM scenario, increase projections of removals by 50% in 2030 and by 100% by 2040.

Managed cropland

During the period 1990-2019 removals from cropland, fluctuate between 0.1-1.0 Mt CO2 eq. yr-1. Following the trend observed during the inventory period, and especially the last decade, cropland is projected to represent a sink in the following period, as a result of maintaining existing and establishment of new perennial woody crops. The share of removals from cropland to the total removals is expected to be between 0.1 – 0.5 Mt during the period 2020-2040.

Managed grassland

Grassland category is projected to continue to act as a sink in the period 2020-2040, even though its area is expected to gradually decrease based on the trend of the past 10 years (-0.04%). Projections were based on this assumption, mainly owed to the conversion of cropland to grassland. Emissions from that category are primarily the result of land conversion to settlements or other land and also wildfires. The share of removals from managed grassland is expected to fluctuate between -1.8 Mt CO2 eq. in 2020 and -1 Mt CO2 eq. in 2040.

Managed wetland

Wetland category is projected to act as a source in the period 2020-2040 mainly due to conversion of forest and grassland to flooded land. The trend of the last 10-year period was applied for the projections, divided in half due to the absence of policies and measures at this point to increase wetlands (+5%). Its share in the overall emissions from the LULUCF sector is expected to remain low (<2%).

5.5 Results of the sensitivity analysis performed for the projections

During the preparation of projections, many alternative scenarios based on sensitivity analysis of their input variables and underlying assumptions were examined.

This chapter contains the results of the analysis of 5 scenarios are presented. The scenarios are described in ***Table 5.32***.

Apart for the energy sector, no other sector is included in sensitivity analysis, since the energy sector is the biggest source of GHG emissions.

Table 5.32 Main assumptions of Sensitivity Analysis Scenarios

Scenario No	Main assumptions
SensSc1	WM scenario 2017
SensSc2	The annual rate of change in final energy demand of all sectors (Residential, Tertiary, Transport and Industry) is 30% lower compared to WM levels
SensSc3	The annual rate of change in final energy demand in Industry is 30% lower and in the Tertiary sector is 30% higher compared to WM levels

SensSc4	WM scenario 2021
SensSc5	WAM scenario 2021

In ***Figure 5.2***, the evolution of GHG emission projections of the scenarios listed in Table 4.21 is illustrated. A split on total emissions covered by Directive 2003/87/EC and by Regulation (EU) 2018/842 respectively and the projected emissions by sources and removals by sinks under the Regulation (EU) 2018/841 is not available. As it can be observed from the figure, the current WM and WAM scenarios correspond to lower emission levels compared to the scenarios reported in previous submissions. For example, for the year 2030, the emissions under WM-2021 and WAM-2021 are 10.0% and 30.1% lower compared to WM-2017. This is attributed to the deviation of the main assumptions between the scenarios, e.g. the CO2 emission allowances considered under WM-2021 and WAM-2021 are 70-95% higher compared to WM-2017; and to the fact that the 2021 scenarios reflect new targets that were adopted under the framework of the NECP pursuant to Regulation (EU) 2018/1999, e.g. the target of Greece of renewable energy sources in gross final energy consumption for 2030 was set to 31%, while in WM-2017 was 25%.

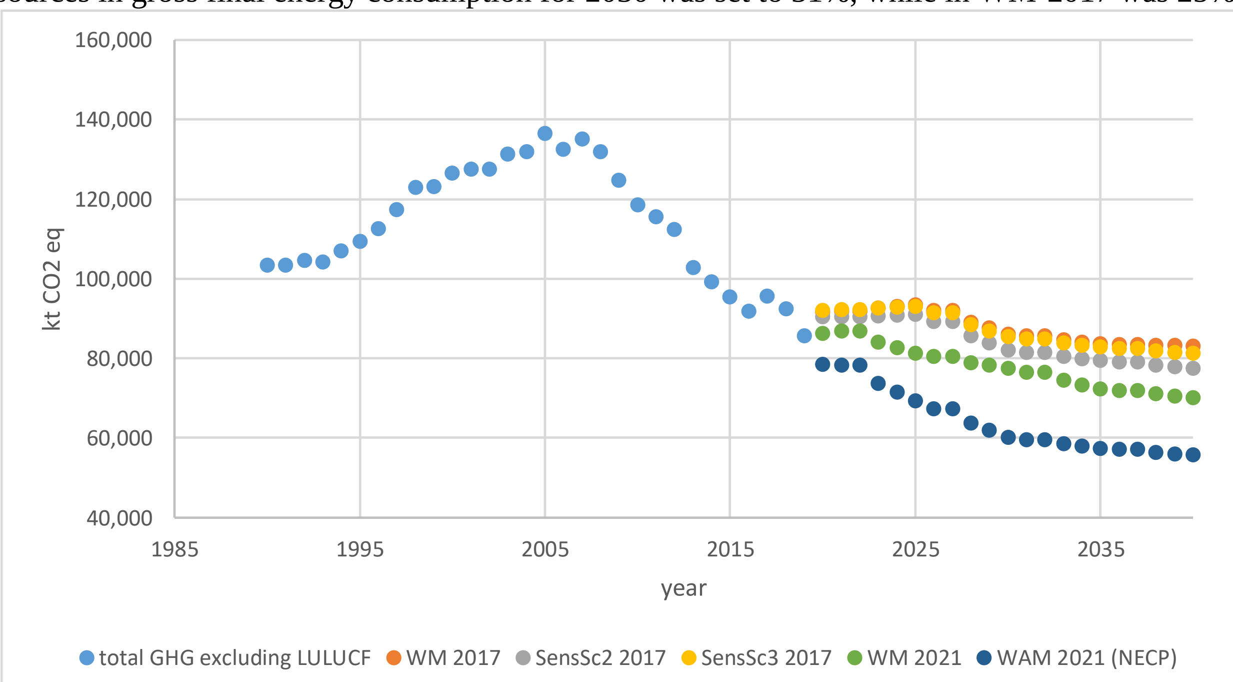


Figure 5.2 Evolution of GHG emission projections corresponding to the sensitivity analysis scenarios examined

5.6 Projections of indirect GHGs

In ***Table 5.33***, the emission projections of the air-pollutants NOx, SOx, NMVOC, PM2.5, NH3 and BC are presented. These projections have to be reported every two years based on fuel sold under the UNECE LRTAP Convention as well as under the NEC Directive 2016/2284/EU. They are based on the "with additional measure" scenario of the projections of GHG emissions.

Table 5.33 Emission projections for years 2020 till 2040

Pollutant	2019 Emission Inventory		Projections			
(kt)	2005	2015	2020	2025	2030	2040
NOx	482.61	262.95	231.00	210.23	183.08	182.12
NMVOC	333.79	164.83	141.84	132.17	123.67	112.21
SOx	578.89	101.65	56.80	45.19	33.78	32.13
NH3	74.74	64.24	65.42	63.35	66.94	68.09
PM2.5	68.52	42.55	30.19	28.40	27.40	27.51

CHAPTER 6. VULNERABILITY ASSESSMENT, CLIMATE CHANGE IMPACTS AND ADAPTATION MEASURES

As the effects of climate change are increasingly being felt, Greece has endorsed a National Climate Change Adaptation Strategy (NAS) as well as 13 Regional Adaptation Plans (RAAPs). The NAS and RAAPs built on multi-sectoral climate change impact and vulnerability assessments (CCIV).

The potential impacts of climate change in Greece, the most vulnerable sectors and regions, as well as the Greek climate adaptation policy are thoroughly described in the following chapters (6.1-6.6).

Within the framework of the project 'LIFE-IP AdaptInGR - Boosting the implementation of adaptation policy across Greece - LIFE17 IPC/GR/000006' a geographic data visualization tool was developed (https://geo.adaptivegreecehub.gr/). This online mapping tool presents the results of Climate Change projections in a simple and understandable way using maps and graphs, with the aim of enhancing understanding of the impacts of climate change, supporting the analysis of the impacts of Climate Change and planning adaptation policies and measures. The climate data in question have been produced for 2 future periods 2031-2060 (near future) and 2071-2100 (far future) with a reference period of 1971-2000 (present climate).

6.1 Climate modelling, projections and scenarios

The Bank of Greece report (CCISC) (Bank of Greece 2011) on the impacts of climate change has high-lighted the wealth of Greece’s natural resource but also the risks to the country’s natural and human environment. Greece has a very long coastline of some 16,300 km (equal to roughly one-third of the Earth’s circumference), of which around 1,000 km are areas highly vulnerable to climate change. This vulnerability is associated with a rise in Greece’s average sea level by an estimated 0.2-2 m by the year 2100. Of course, the vulnerability of the coasts is determined not only by the risk of a mean sea level rise and extreme wave events, but also by local factors (tectonics, geomorphology, etc.). Of the total coastline of the Aegean, about 58% is coasts of high vulnerability to the projected developments.

The effects of both the long-term change in sea level and transient extreme events impact on several sectors of the economy, including tourism, land use and transportation. Overall, the impact of climate change on all sectors of the national economy that were examined in the Bank of Greece report (CCISC 2011) was found to be adverse and often extremely adverse. For instance, the impact on fir, beech and pine forests would be considerable, while fire-fighting costs are expected to shoot up on account of the increasing number and extent of forest fires. Meanwhile, species abundance and biodiversity are expected to decline. Furthermore, climate change, as measured by its projected impact on the tourism climatic index (TCI) by the end of this century, is expected to have serious repercussions on Greek tourism – mainly on the seasonal and geographical patterns of tourist arrivals, hence also tourism receipts. Given that tourism receipts are a crucial resource for Greece, long-term strategic planning is needed in order to upgrade the country’s tourism product in the context of ongoing human-induced climate change. The consequences of climate change on the built environment, transportation, health, mining and other sectors are also important. The Bank of Greece report (CCISC 2011) clearly identified a need for a concrete adaptation policy that would cover all sectors. This should also incorporate a revised foreign policy regarding aspects of particular relevance for Greece.

With regard to the assessment of the economic impact, specific studies were carried out using three scenarios: the worst-case scenario of anthropogenic climate change assumes no action to reduce greenhouse gas emissions (Inaction Scenario). Under this scenario, it was estimated that Greek GDP would drop by an annual 2% by 2050 and 6% by 2100, and the total cumulative cost for the Greek economy over the period extending till 2100, expressed as GDP loss relative to base year GDP, would amount to €701 billion (at constant prices of 2008). The second scenario, called the Mitigation Scenario, assumed a constant and drastic reduction in Greece's green-house gas emissions as part of a broader global effort, resulting in containing the rise in average global temperature to no more than 2º C. The total cumulative cost of the Mitigation Scenario for the entire period till 2100, expressed in terms of GDP loss, comes to €436 billion (at constant prices of 2008). In other words, the total cost for the economy under the Mitigation Scenario is €265 billion less than under the Inaction Scenario, implying that the mitigation policy would reduce the cost of inaction by 40%. Finally, given that an adaptation policy is also necessary as a damage control measure, an Adaptation Scenario was also considered. Under this scenario, Greek GDP would drop by 2.3% and 3.7%, respectively, in 2050 and 2100, while the cost of adaptation policies would total €67 billion. However, the adaptation measures do not fully eliminate but merely contain the damage from climate change. Thus, the cumulative cost for the Greek economy of the residual damage from climate change was estimated at €510 billion (at constant prices of 2008) over the period till 2100. As a result, the total cost for the Greek economy under the Adaptation Scenario is the sum of the cost incurred by the economy on account of the adaptation measures and the cost of the (reduced) damage from climate change; this sum (total cumulative cost through 2100) was estimated at €577 billion (at constant prices of 2008).

Sectoral assessments have also been performed by various teams. The Independent Power Transmission Operator projects the trend in the peak loads taking into account the temperature and duration of heat waves. The National Committee for Combating Desertification has published a Potential Desertification Risk Map for Greece, while the Standardized Precipitation Risk is estimated by the Drought Management Centre of Southeastern Europe, based on data provided by the Agricultural University of Athens and the Hellenic National Meteorological Service. Special case studies on the drought characterization, have been performed by the National Technical University of Athens (NTUA) ('Mediterranean Drought Preparedness and Mitigation Planning - MEDROPLAN' Project), while the Laboratory of Higher Geodesy – NTUA has used the Coastal Vulnerability Index to map the vulnerability of coastal areas.

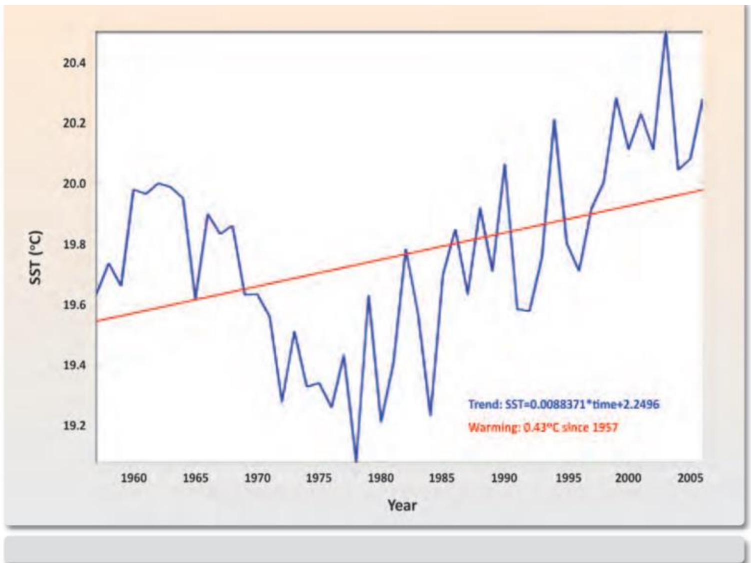
The National Observatory of Athens (NOA) has also conducted numerous climate projections and impact assessments, which refer to various sectors (agriculture, tourism) and areas (urban, rural, islands, etc). In addition, in 2009 the NOA and WWF published the scientific study 'Tomorrow of Greece: Climate change impacts in Greece in the short future'. Further, in October 2001, a Roadmap to Adaptation for Greece was elaborated by a number of institutions including Universities, the Technical Chamber and WWF.

6.1.1 Temperature changes

The climate in Greece is typical of the Mediterranean climate: mild and rainy winters, relatively warm and dry summers with, generally, long sunshine duration almost all the year. A great variety of climate subtypes, always in the Mediterranean climate frame, are encountered in several regions, due to the influence of topography (great mountain chains along the central part and other mountainous bodies) on the air coming from the moisture sources of the central Mediterranean Sea. As a result, the dry climate of Attiki (the great area of capital, Athens) and of the east part of Greece in general, changes significantly towards a wet one in North and West Greece.

In terms of climatology, the year can be broadly divided mainly into two seasons. The cold and rainy period lasts from the mid of October until the end of March, and the warm and non-rain season lasting from April until September. During the first period the coldest months are January and February, with a mean minimum temperature ranging between 5 to 10ºC near the coasts and 0 to 5ºC over mainland areas, with lower values (generally below freezing) over the northern part of the country. As regards to the summer period, the warmest days usually include the last days of July up to the first week of August, when the typical mean maximum temperature lies in the range of 29 and 35ºC. During the warm period the high temperatures are dampened from the fresh sea breezes in the coastal areas of the country and from the north winds blowing mainly in Aegean, well known as 'Etesian'.

Current climate change has been estimated to account for a temperature increase of about 1ºC (ground surface temperature) in the last 500 years (Huang, Pollack et al. 2000; Pollack and Smerdon 2004) and of 0.76ºC in the last 100 years (IPCC 2007). Temperatures in the second half of the 20th century were, as estimated, very likely to have been higher than during any other 50- year period in the last 500 years, and likely the highest in the past 1,300 years (IPCC 2007).

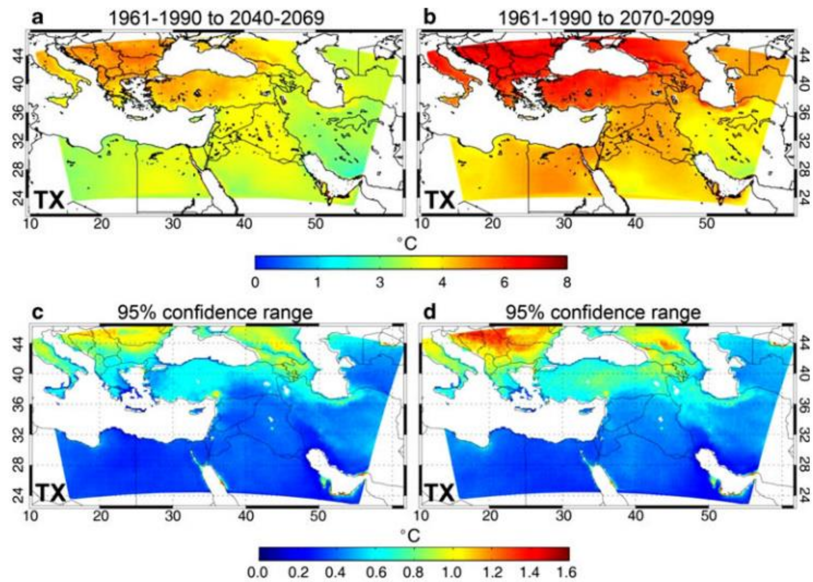


Source: (Bank.of.Greece 2011) "The environmental, economic and social impacts of climate change in Greece"

Mean annual sea surface temperature (SST) in the Mediterranean during the 1957-2006 period (Based on Hadley climatology, Belkin, 2009) -

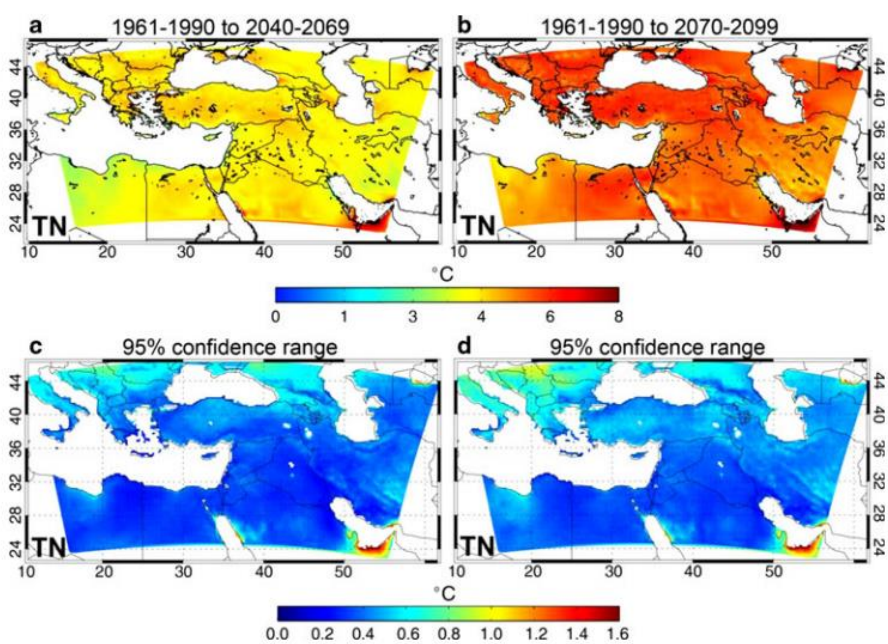
In ***Figure 6.1*** and ***Figure 6.2*** model projections of daytime maximum (TX) and nighttime maximum (TN) temperature during summer by the middle and the end of the twenty-first century are presented, concerning the Eastern Mediterranean and Middle East region (EMME). They also show the 95-percentile confidence ranges obtained by bootstrapping. The ranges in the lower panels are the differences between the upper and lower confidence limits.

Furthermore, ***Figure 6.3*** indicates that the regional warming will be gradual, both of daytime maximum (TX) and nighttime maximum (TN), ranging from 1°C to 3°C in the near-future (2010–2039), to 3–5°C in the mid-century period (2040–2069) and 3.5–7°C by the end of the century (2070–2099). In each period, this warming is more spatially uniform for winter TN, while for TX it is most pronounced at latitudes north of 36°–38°N (reaching 6–7°C in the Balkans, Turkey and the Caucasus by 2070–2099) and weaker in the southern EMME (~3.5°C).



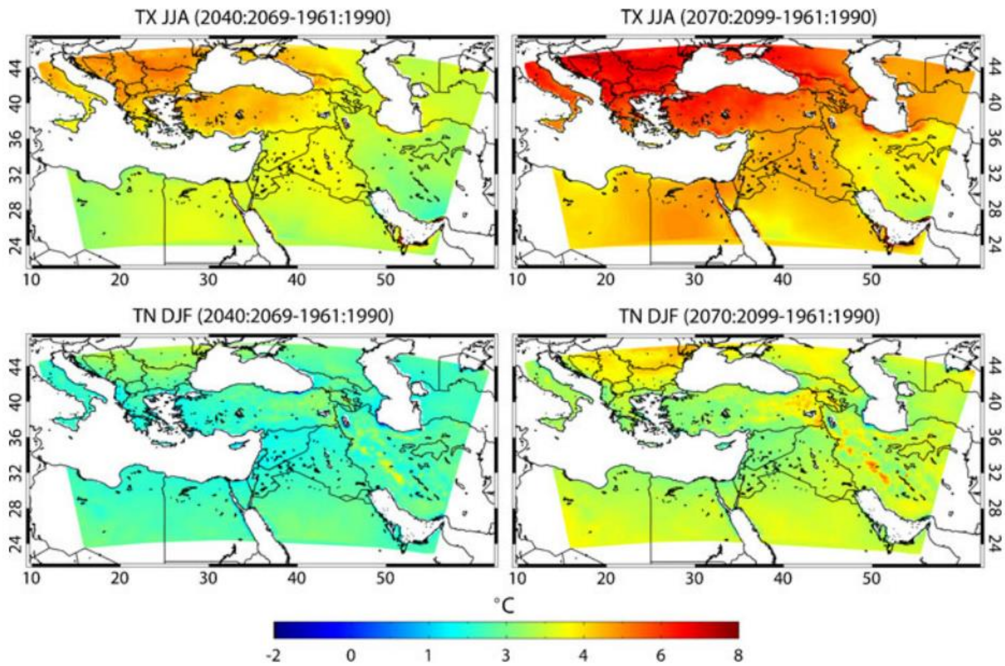
Source: (Lelieveld, Hadjinicolaou et al. 2013). Model projected heat extremes and air pollution in the eastern Mediterranean and Middle East in the twenty-first century, 2013.

Figure 6.1 Changing daytime maximum temperature TX (a, b) and the 95 percentile confidence ranges (c, d) averaged over June–July– August, for the periods 2040–2069 (a, c) and 2070–2099 (b, d) relative to the period 1961–1990. Model calculations are for the A1B scenario.



Source: (Lelieveld, Hadjinicolaou et al. 2013). Model projected heat extremes and air pollution in the eastern Mediterranean and Middle East in the twenty-first century, 2013.

Figure 6.2 Changing night-time minimum temperature TN (a, b) and the 95 percentile confidence ranges (c, d), averaged over June–July–August, for the periods 2040–2069 (a, c) and 2070–2099 (b, d) relative to the period 1961–1990. Model calculations are for the A1B scenario



Source: (Lelieveld, Hadjinicolaou et al. 2013), Climate change and impacts in the Eastern Mediterranean and the Middle East, 2013.

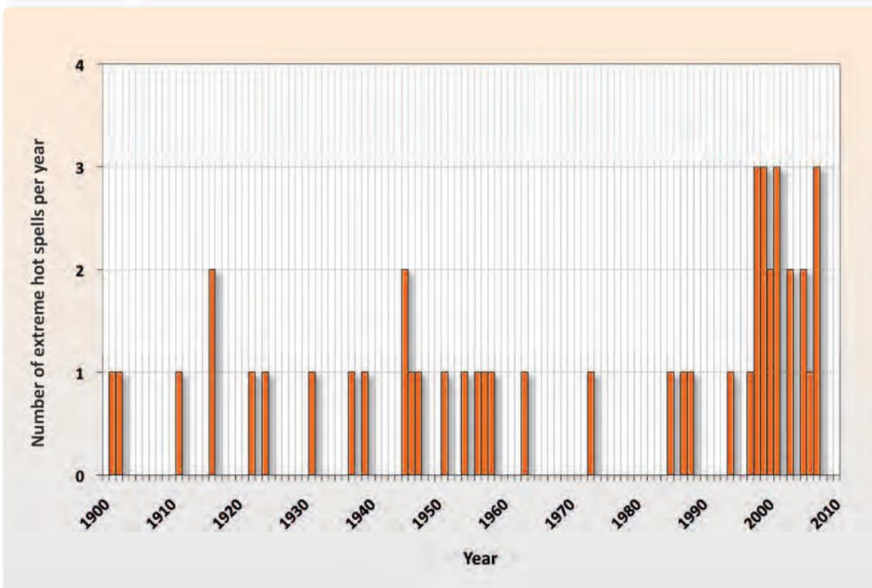
Figure 6.3 Patterns of changing mean summer maximum (JJA) and mean winter minimum (DJF) temperatures, TX (top) and TN (bottom), respectively, calculated from PRECIS output. The left panels show the mean changes for 2040–2069 and the right panels for 2070–2099 relative to the 1961–1990 control period.

6.1.2 Extreme weather events and their regional impact in Greece

The severity of the climate change impact is more likely to be associated with changes in the frequency of extreme weather events than with a drawn-out 'average' climate evolution, given that, in the case of extreme events, a simple change in mean value above a critical threshold can bring about a disproportionate, non-linear impact.

The complexity of the natural and social systems' interactions with the climate system makes it difficult to assess and describe the impacts of climate change in a comprehensive and straight-forward manner. Instead, one has to use indicators gauging changes in observable and measurable characteristics of natural systems and human societies that are heavily dependent on climate change and can point to changes in the broader system. For instance, a longer or shorter growing season can serve as an indicator of a climate change impact on agriculture.

According to the "Environmental, Economic and Social impacts of climate change in Greece" report performed by the Bank of Greece (Bank.of.Greece 2011), the climate model RACMO2, developed by the Royal Meteorological Institute of the Netherlands (KNMI), was used with a horizontal resolution of 0.25° (~25 km). These datasets cover a 30-year reference period, 1961-1990, for the current climate, and two future periods, 2021-2050 and 2071-2100, for the study of climate change using Scenario A1B of the IPCC. For each of Greece's 13 climate zones, the change in the relevant climate indices was computed between each future period (2021-2050 and 2071-2100) and the reference period (1961-1990). Scenario A1B is a mid-line scenario in terms of carbon dioxide emissions and economic growth. The first future period, 2021-2050, was chosen with the specific needs of policy-makers in mind, in order to assist them with nearer-term planning, whereas the second period, 2071-2100, serves to underscore the extent of the changes toward the end of the 21st century. Using the data from this model, it was possible to study the variation in climate parameters and indices between the reference period and each one of the two future periods, and to determine climate change for each of Greece's 13 climate zones.



Source: (Bank.of.Greece 2011) "The environmental, economic and social impacts of climate change in Greece" –

Number of extreme hot spells (at least 3 consecutive days with temperatures >37ºC) per year, (1900-2007/Thisseion Station, National Observatory of Athens)

Maximum summer and minimum winter temperatures

In ***Table 6.1*** the average annual temperatures in the most important regions of Greece are presented for 2012.

Table 6. 1 Average Annual Temperatures in certain regions of Greece.

Region	Place	High °C	Low °C
Aegean Islands	Mytilini	21	14
Crete	Heraklion	22	15
Peloponnese	Kalamata	23	12
Western Greece	Agrinio	23	10
	Patras	22	12
Central Greece	Athens	22	14
	Lamia	22	11
	Larissa	21	9
Northern Greece	Thessaloniki	20	10
	Florina	17	6

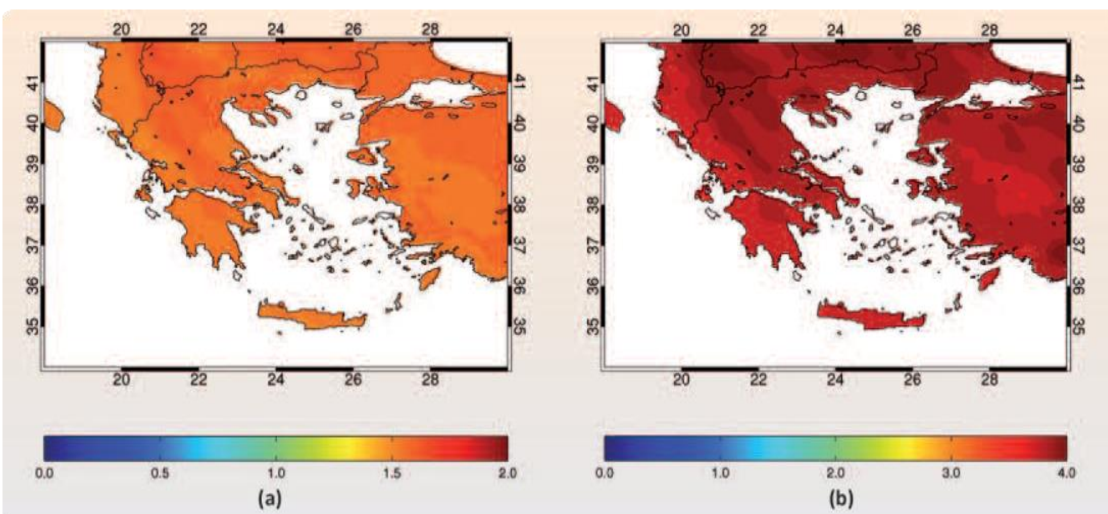
Source: Hellenic National Meteorological Service, 2012.

According to the Hellenic National Meteorological Service an important heat wave was observed during 15-16 of July 2012, affecting especially the eastern part of the Greek mainland. (Tripoli: Tmax = 42.1° C on 16 July 2012, Hellinikon: Tmax = 41.4° C on 15 July 2012, Livadia: Tmax = 43.4° C on 16 Jul 2012 and Sparti: Tmax = 43.2° C on 16 Jul 2012). In addition, During 7-8 of August 2012, a 2-days heat-wave episode occurred, affecting the whole country, not only the mainland but also the islands of Ionian Sea (west part) (Larissa: Tmax = 41.8° C on 7 Aug 2012, Astros: Tmax = 42.0° C on 8 Aug 201, Veria: Tmax = 42.1° C on 7 Aug 2012 and Sparti: Tmax = 42.1° C on 8 Aug 2012).

January 2012 was colder than normal almost for the whole country but especially for NW part of Greece. The peak was on 16-20 of January 2012, where Florina reported the second all-time record of Tmin for the country (Tmin = -25.1° C on 17 and 18 Jan 2012). Also, on 17 Jan 2012 the following Meteorological Stations (MS) set records of Tmin: Kerkira: -5.6° C, Andravida -4.8° C. During 12-15 of December 2012, a 4-days cold-wave episode occurred, affecting the west Macedonia (NW part of Greece) (Florina: -18.0°C, Kastoria (-14.0° C).

As can be seen from the projected changes in mean minimum winter temperature represented in ***Figure 6.4***, minimum winter temperatures in all of Greece's regions will be ~1.5ºC higher in 2021-2050 and ~3.5ºC higher in 2071-2100, than in the reference period 1961-1990. These results concur with large-scale findings, which have recorded a significant upward trend in minimum temperatures over the past few decades. The warming trend will be more pronounced in the more mountainous areas, especially in the mountain ranges of Pindos and of Northern Greece, where it is projected to reach 2ºC in 2021-2050 and 4ºC in 2071-2100 (Bank.of.Greece 2011).

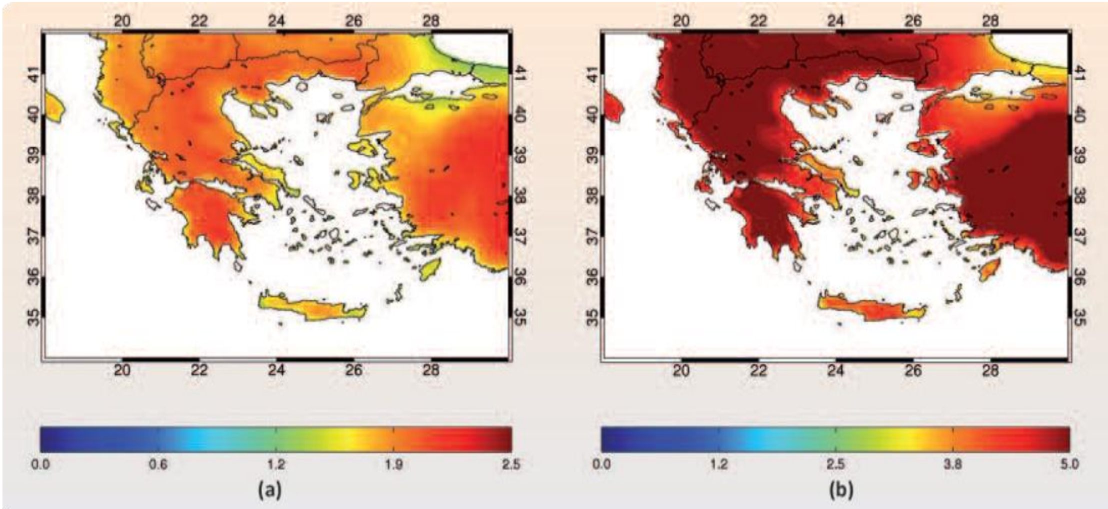
The increase in this parameter is likely to have an impact on forests, presently adapted to colder weather conditions. If the conditions become prohibitive, certain categories of forests (e.g. fir) would have to shift to higher altitudes.



Source: (Bank.of.Greece 2011) "The environmental, economic and social impacts of climate change in Greece"

Figure 6.4 Variation in the mean minimum winter temperature in (a) 2021-2050 and (b) 2071-2100, relative to 1961-1990 (in ºC)

The projected changes in mean maximum summer temperatures are represented in ***Figure 6.5***. The increase in mean maximum summer temperatures in the period 2021-2050 will be greater than that of the winter minimums and will exceed 1.5ºC and in some cases reach as much as 2.5ºC. In the period 2071-2100, the increase in mean maximum summer temperatures may be as much as 5ºC. Most affected will be the continental inland regions, situated far from the cooling effects of the sea, whereas regions with strong sea breezes (Crete, Aegean islands) will experience a significantly smaller variation in maximum summer temperatures.

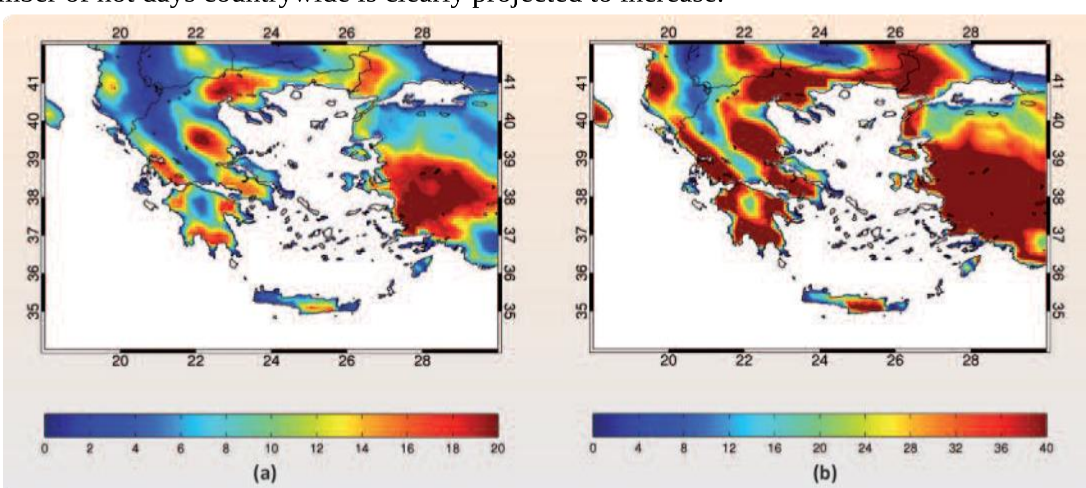


Source: (Bank.of.Greece 2011) “The environmental, economic and social impacts of climate change in Greece”

Figure 6.5 Variation in the mean maximum summer temperature in (a) 2021-2050 and(b) 2071-2100, relative to 1961-1990 (in ºC)

Warm days and warm nights

The projected variation in the number of days with maximum temperatures above 35ºC, as represented in ***Figure 6.6***, is expected to have a significant impact on human discomfort, especially in urban areas, as the number of hot days countrywide is clearly projected to increase.



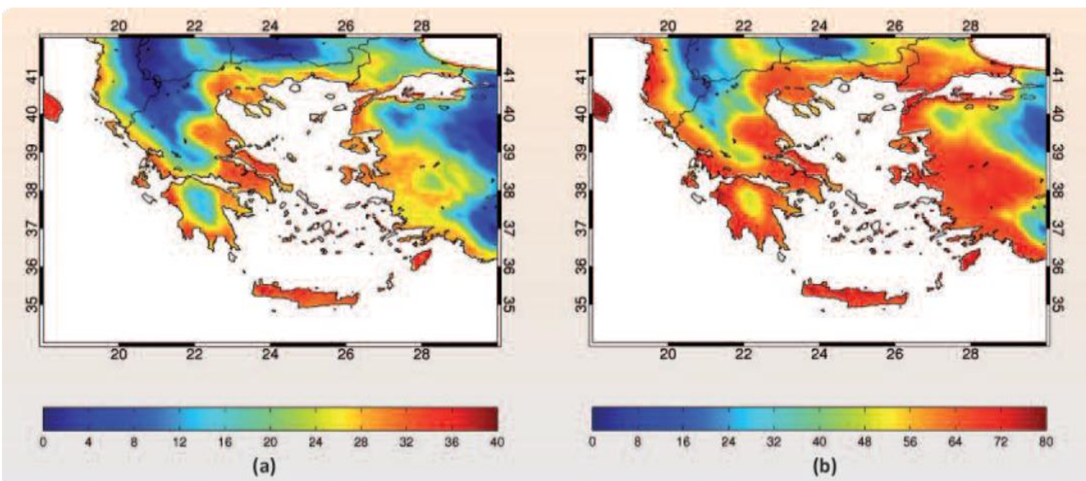
Source: (Bank.of.Greece 2011) “The environmental, economic and social impacts of climate change in Greece”

Figure 6.6 Variation in the number of days with maximum temperature > 35ºC in (a) 2021-2050 and (b) 2071-2100, relative to 1961-1990

The most noticeable changes are projected for the low-lying inland regions of Central Greece, Thessaly, the Southern Peloponnese as well as Central Macedonia, where up to 20 additional very warm days are expected per year in 2021-2050 and up to 40 in 2071-2100, relative to the reference period 1961-1990. The change is expected to be somewhat milder in Crete and Attica, where the number of additional very warm days per year should not exceed 15 in 2021-2050 and 30 in 2071-2100, and milder yet in the Aegean and the Ionian islands, which will count 10 additional very warm days per year in 2021-2050 and 15 additional ones in 2071-2100, due to the proximity of the sea and the tempering effect of sea breezes.

Another temperature-related and significant parameter is the change in the annual number of warm nights. Nights are defined as warm (or tropical) when the minimum temperature does not fall below 20ºC. This parameter is closely associated with human health, as a tropical night following an extremely hot day can increase human discomfort. As can be seen from ***Figure 6.7***, the annual number of tropical nights is projected to increase almost everywhere in Greece, but substantially more so in the coastal and island regions than in the continental mainland regions.

Crete, the coastal regions of Eastern Greece and the Aegean islands are expected to have 40 additional warm nights per year in 2021-2050 and 80 additional warm nights per year in 2071-2100. In Western Greece and Eastern Macedonia-Thrace, however, the increase in the annual number of warm nights will be less than 30 in 2021-2050 and 70 in 2071-2100, with even smaller increases projected for Western Macedonia (15 or less additional warm nights per year in 2021-2050 and 30 or less in 2071-2100) (Bank.of.Greece 2011).



Source: (Bank.of.Greece 2011) "The environmental, economic and social impacts of climate change in Greece"

Figure 6.7 Variation in the number of days with minimum temperature > 20ºC in (a) 2021-2050 and (b) 2071-2100, relative to 1961-1990

Days with precipitation and dry days

Apart from maximum temperature extremes and their association with human discomfort, another source of concern is flash flooding, especially if its frequency were to increase on account of climate change. The Average Annual Precipitation in certain Greek regions is presented in *Error! Reference source not found.*

On 5 of February 2012 at the area of Ilia (West Peloponnese-SW Greece), an extreme precipitation event occurred. According to the Hellenic National Meteorological Service in MS of Pyrgos R-24h = 151.4 mm were recorded, in 8 hours period (max 10-minutes Rain Rate: 14.1 mm) and in AWS of Pyrgos R-24h = 177.8 mm. The maximum precipitation recorded in the region was 180.7 mm for the period 1976-2004.

Table 6.2 Average Annual Precipitation in certain regions of Greece.

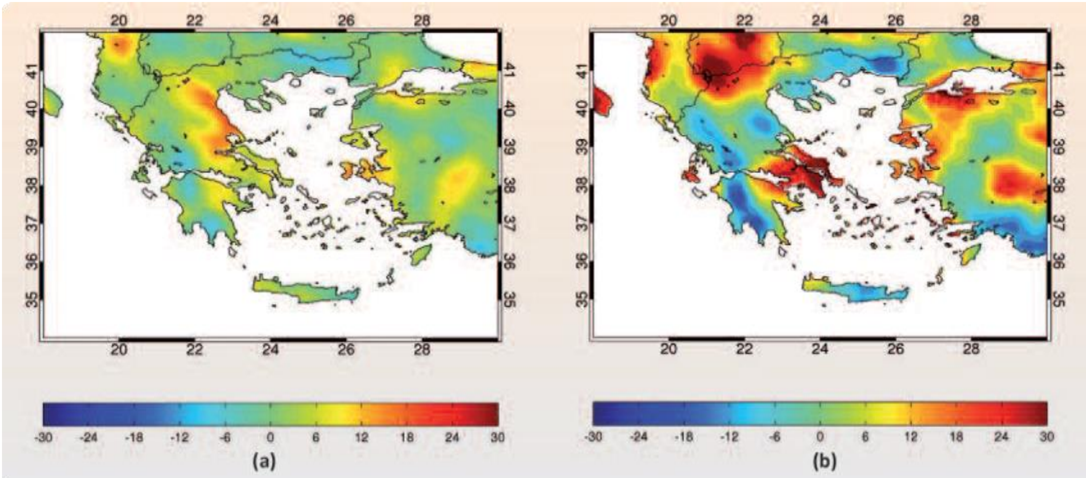
Region	Days	Place	High °C	Millimetres
Aegean Islands	8	Mytilini	25.5	648
Crete	92	Heraklion	19.0	483
Peloponnese	77	Kalamata	30.7	780
Western Greece	112	Agrinio	36.7	931
	86	Patras	26.1	663
Central Greece	98	Athens	14.4	365
	110	Lamia	22.6	574
	117	Larissa	16.7	423
Northern Greece	114	Thessaloniki	17.7	449
	116	Florina	25.4	646

Source: Hellenic National Meteorological Service, 2012.

During 27-28 October 2012 a stationary low pressure system over Italy with a SW upper flow over Greece caused extreme floods and large amount of precipitation over the mainland of Ipiros (NW of the country), Thessalia (Central Greece) and the Pindos mountain-range. On 29 October 2012, as the low pressure system moved eastwards produced intense thunderstorms and a large precipitation amount. In MS Ioannina R-24h = 147.7 mm on 28 Oct 2012 set as new record of period 1956-2012. In AWS Theodoriana the 48-hours-R was 217.8 + 193.2 mm =411.0 mm on 27-28 Oct 2012 and in AWS Gardiki it was 107.6 + 392.8 mm =500.4 mm on 27-28 Oct 2012. Severe damages at the roads and the network of electricity and telecommunication, as well as landslides to Pindos Mountain were reported. At the west part of Athens area, hail caused damages at the infrastructures and the cars.

As can be seen from ***Figure 6.8***, the percentage variation in annual maximum consecutive 3-day precipitation is projected to increase. Together with the projected decrease in total annual rainfall, this means that extreme precipitation events will increase in intensity, thereby raising the flood risk. As can be seen from the left panel of ***Figure 6.8***, maximum consecutive 3-day precipitation period during 2021-2050 will remain essentially unchanged, relative to the reference period 1961-1990, in regions like Western Greece, Eastern Macedonia-Thrace and Crete, but will increase significantly in others.

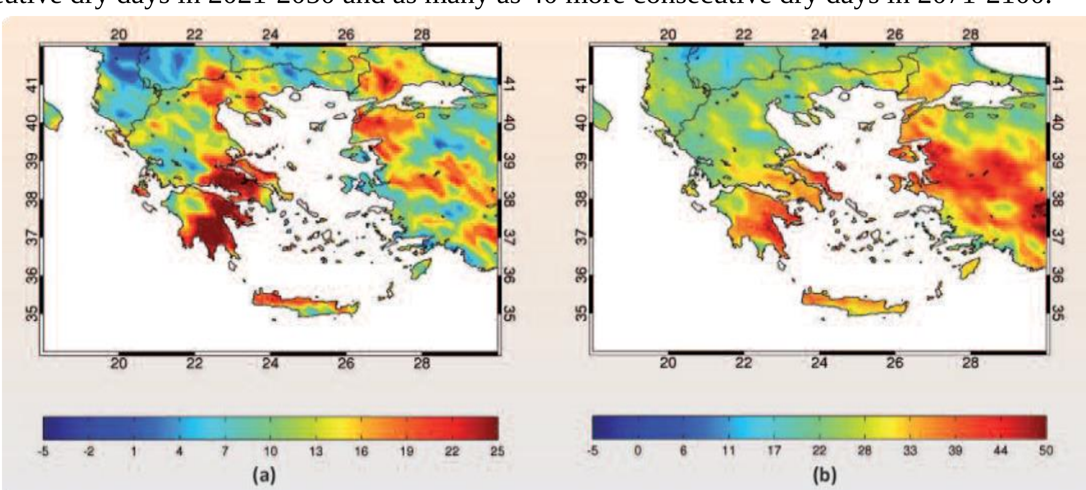
In the eastern continental regions, in particular, maximum consecutive 3-day precipitation is projected to increase by 20%. These contrasts become even more pronounced toward the end of the 21st century, with the amount of extreme rainfall projected to decrease by 10-20% in regions of Western Greece and Thrace, but to increase by 30% in the Eastern Central Greece and the NW Macedonia. Small variations are projected for the rest of the country.



Source: (Bank.of.Greece 2011) "The environmental, economic and social impacts of climate change in Greece"

Figure 6.8 Percentage change in annual maximum consecutive 3-day precipitation in (a) 2021-2050 and (b) 2071-2100, relative to 1961-1990

Projections were also made regarding the variation in the maximum duration of dry spells, i.e. consecutive dry days, defined as days with no or less than 1 mm precipitation. As can be seen from ***Figure 6.9***, the length of dry spells will clearly increase. The smallest variations in dry spell length are projected for Greece's western regions in 2021-2050 (less than 10 more consecutive dry days) and for Western and Northern Greece in 2071-2100 (less than 20 more consecutive dry days). The largest increases in dry spell length are projected for the eastern continental regions (Eastern Central Greece, the Eastern Peloponnese and Euboea) and Northern Crete, which will have more than 20 additional consecutive dry days in 2021-2050 and as many as 40 more consecutive dry days in 2071-2100.



Source: (Bank.of.Greece 2011) "The environmental, economic and social impacts of climate change in Greece"

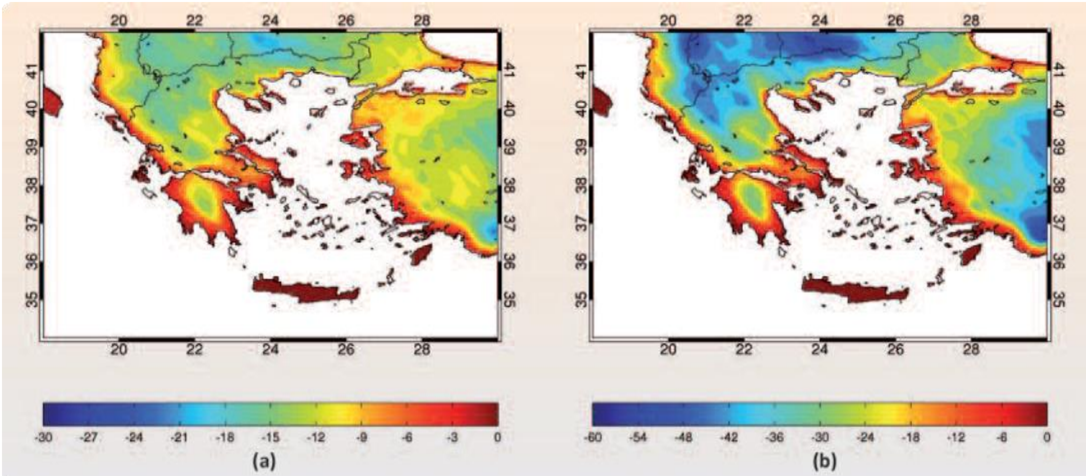
Figure 6.9 Variation in maximum length of dry spell (in consecutive dry days) in (a) 2021-2050 and (b) 2071-2100, relative to 1961-1990

Frost days and growing season

The projected changes in the number of frost days per year are represented in ***Figure 6.10***.

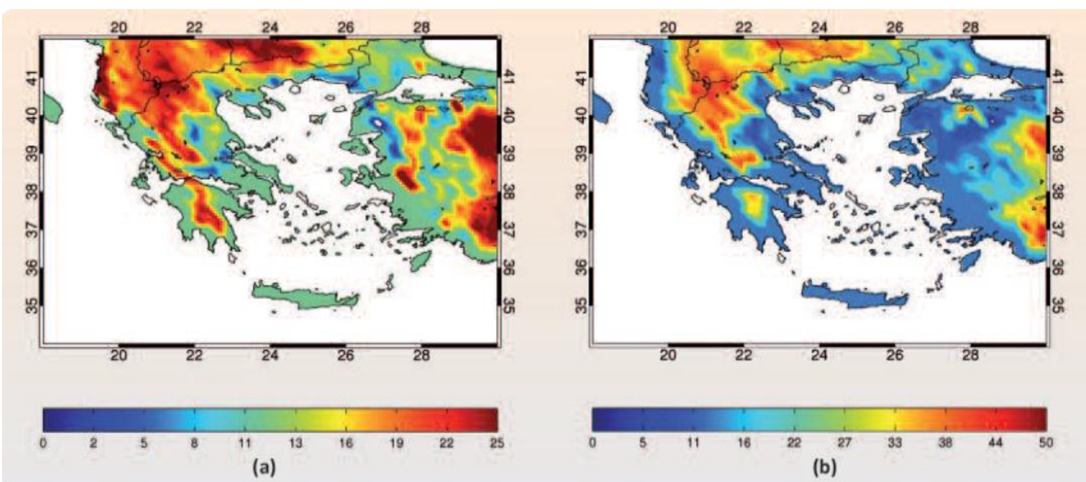
This is an important parameter for agricultural regions, especially those where frost-sensitive crops, like citrus fruit, are grown. The number of frost days per year is projected to decrease in Macedonia and Thrace by 15 in 2021-2050 and by 40 in 2071-2100, and in the continental regions of Thessaly and the

Peloponnese by 10 to 15 in 2021-2050 and by 25 in 2071-2100. Smaller decreases are projected for the rest of Greece, mainly because of the small number of frost days that these regions have even today.



Source: (Bank.of.Greece 2011) "The environmental, economic and social impacts of climate change in Greece"

Figure 6.10 Variation in number of night frosts in (a) 2021-2050 and (b) 2071-2100, relative to 1961-1990



Source: (Bank.of.Greece 2011) "The environmental, economic and social impacts of climate change in Greece"

Figure 6.11 Variation in growing season length (in days) in (a) 2021-2050 and (b) 2071-2100, relative to 1961-1990

In addition to the number of frost days, the length of the growing season was also examined, defined as the period favorable to plant and crop growth between the last spring frost and the first autumn frost. The projected changes in the length of the growing season are represented in ***Figure 6.11***. The observable lengthening can be attributed to the earlier occurrence of the last spring frost and to the later occurrence of the first autumn frost. The largest increases in growth season length (in the order of 25 days for 2021-2050 and 45 days for 2071-2100) are projected for the country's continental mountain regions. Length increases of 10-15 days for 2021-2050 and 15-25 days for 2071-2100 are projected for the rest of the country (Bank.of.Greece 2011).

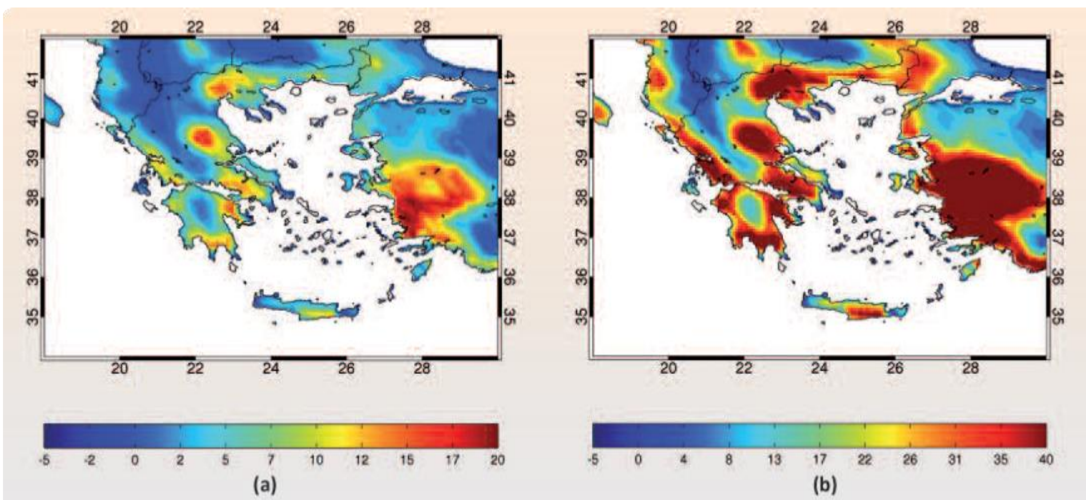
Energy demand for heating and cooling

In order to estimate future energy demand, the degree-days method was used, which consists in calculating the daily difference (in ºC) between a mean temperature and a base temperature. The base temperature can be given a value such that heating or cooling consumption would be at a minimum. Since the choice of such a base temperature would result in the degree-day index taking on positive values in the warm season and negative values in the cold season, two separate indices were used: (a) Heating Degree Days (*HDD*) and (b) Cooling Degree Days (*CDD*), using the following mathematical formulas:

$$HDD = \max(T^* - T, 0) \quad CDD = \max(T - T^{**}, 0)$$

where T^* and T^{**} are the respective base temperatures for *HDD* and *CDD* that can be either the same or different, and T is the daily mean temperature, as obtained from the daily temperatures of the regional climate models for the reference period and the future periods. The *HDD* (*CDD*) index is usually summed up for a specific period (annual or seasonal), and therefore provides a measure of the severity of winter (summer) conditions in terms of outdoor dry-bulb temperature. This, in turn, is a measure of the likely aggregate energy demand for reasonable heating (cooling) during that period in a particular location. In the present study, a base temperature of 15ºC was adopted for our *HDD* calculations and 25ºC for our *CDD* calculations (Giannakopoulos, Le Sager et al. 2009a; Giannakopoulos, Hadjinicolaou et al. 2009b).

One major impact of global warming is that the electricity demand for cooling will increase in summer. This could lead to more frequent network overloads and power disruptions, calling into question the ability to meet demand. The projected changes in the number of days per year with significant cooling needs (defined as days with a temperature 5ºC or more above the *CDD* base temperature) are represented in ***Figure 6.12.***

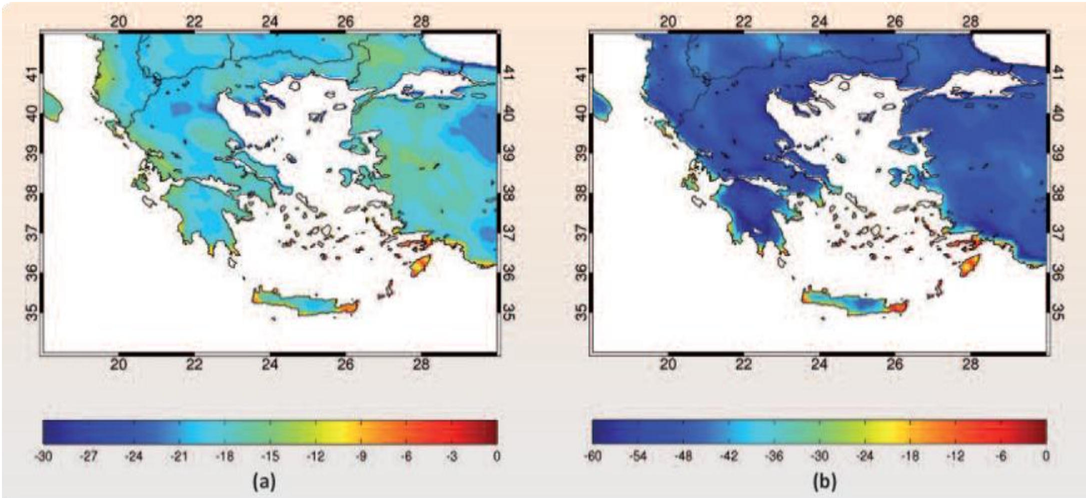


Source: (Bank.of.Greece 2011) “The environmental, economic and social impacts of climate change in Greece”

Figure 6.12 Variation in number of days with strong cooling demand in (a) 2021-2050 and (b) 2071-2100, relative to 1961-1990

As can be seen, the low-lying continental regions are projected to have an additional 10-20 days per year with a significant demand for cooling in the period 2021-2050 and 30-40 additional days per year in the period 2071-2100, relative to the reference period 1961-1990. In the island and mountain regions, the respective increases will be smaller (Bank.of.Greece 2011).

One positive aspect of climate change is that energy needs for heating in winter are expected to decline. As shown by the projected changes in the number of days requiring heavy heating, represented in ***Figure 6.13***, the electricity demand for heating in winter will clearly decline in almost all parts of Greece, by roughly 20 days per year in 2021-2050 and by 45 days per year in 2071-2100.



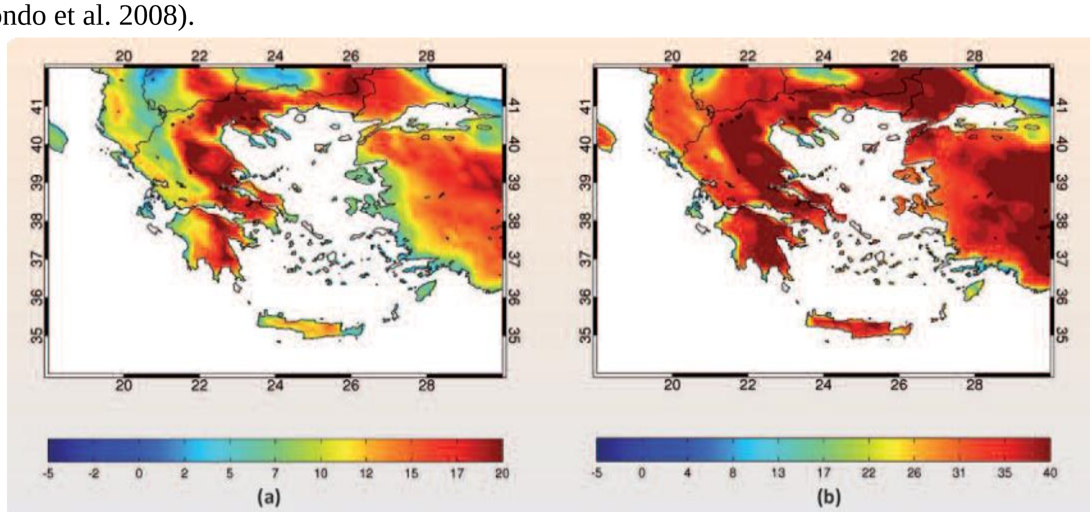
Source: (Bank.of.Greece 2011) "The environmental, economic and social impacts of climate change in Greece"

Figure 6.13 Variation in number of days with strong heating needs in (a) 2021-2050 and (b) 2071-2100, relative to 1961-1990

Forest fires

Forest fires, like all other ecosystem processes, are highly sensitive to climate change, as fire behavior responds immediately to fuel moisture, which in turn is affected by precipitation, relative humidity, air temperature and wind speed. The projected rise in temperature as a result of climate change should therefore increase fuel dryness and reduce relative humidity, more markedly in those regions where rainfall will decrease. The increased frequency of extreme climate events is expected to have a significant impact on the vulnerability of forests to fires.

The Forest Fire Weather Index (*FWI*) is a daily meteorological-based index, designed in Canada and used worldwide to estimate the wildland fire potential for a standard fuel type. It is computed from six standard components, each measuring a different aspect of fire danger. The *FWI* is a numerical rating of a fire's intensity and is used to estimate the difficulty of fire control. The system depends solely on weather readings taken each day at noon: temperature, relative humidity, wind speed and rainfall. The Regional Climate Models' (RCM) daily outputs of maximum temperature (T_{max}), relative humidity (*RH*), wind speed at 10 m above ground and total rainfall were used as input variables to the *FWI* system. For the Mediterranean basin, several studies have shown that the *FWI* system and its components were well suited to the estimation of fire risk in the region (Moriondo, Good et al. 2006). *FWI* values over 15 were found to be indicative of an elevated fire risk, while *FWI* values over 30 indicate extreme fire risk (Good, Moriondo et al. 2008).



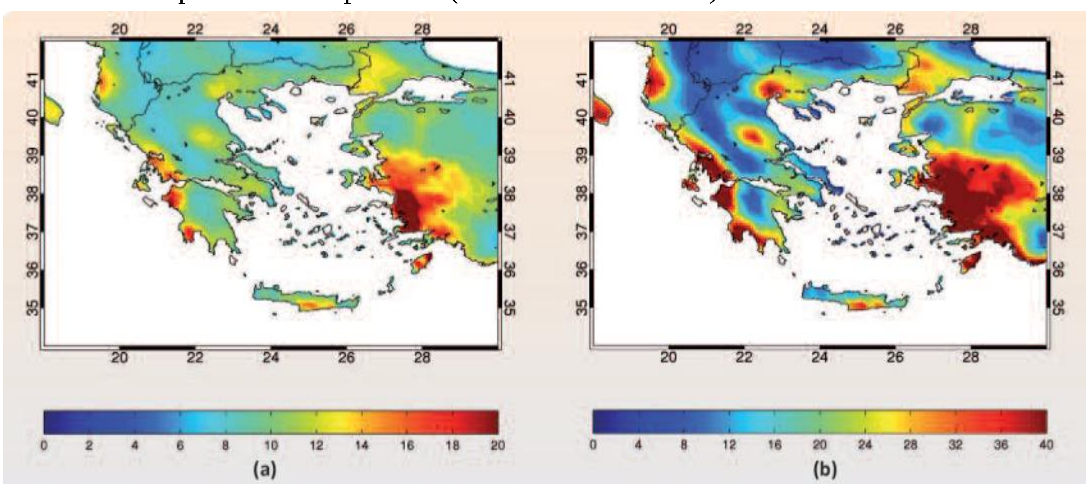
Source: (Bank.of.Greece 2011) "The environmental, economic and social impacts of climate change in Greece"

Figure 6.14 Variation in number of days with extremely high risk of fire in (a) 2021-2050 and (b) 2071-2100, relative to 1961-1990

The projected changes in the number of extreme fire danger days are presented in ***Figure 6.15***. Apart from forest regions, this parameter is equally important to agricultural and tourist areas. In all of Eastern Greece, from Thrace down to the Peloponnese, extreme fire danger days are likely to increase by 20 in 2021-2050 and 40 in 2071-2100. Smaller increases are projected for Western Greece, mostly on account of the higher humidity conditions.

Days with increased thermal discomfort

Heat effects on human comfort (or discomfort) are assessed by computing the humidex (Masterton and Richardson, 1979). This index, used generally during warmer periods to describe how hot or humid the weather feels to the average individual, is derived by combining temperature and humidity values into one number to reflect the perceived temperature (Bank.of.Greece 2011).



Source: (Bank.of.Greece 2011) "The environmental, economic and social impacts of climate change in Greece"

Figure 6.15 Variation in number of days with high thermal discomfort (humidex > 38°C) in (a) 2021-2050 and (b) 2071-2100, relative to 1961-1990

Humidex (equivalent to dry temperature in °C) is computed with the following formula:

$$T\text{ (h)} = T_{\max} + 5/9^{*} (e - 10)$$

where e is the vapor pressure (given by 6.112 * 10^(7.5 * $T_{\max}$/ (237.7 + $T_{\max}$)) * h/100), $T_{\max}$ is the maximum air temperature (°C) at 2 m above ground and h is the relative humidity (%).

Six humidex categories have been established to inform the general public of discomfort conditions:

- <29°C: no discomfort
- 30-34°C: some discomfort
- 35-39°C: discomfort; avoid intense exertion
- 40-45°C: great discomfort; avoid exertion
- 46-53°C: significant danger; avoid any activity
- >54°C: imminent danger; heatstroke

The projected changes in the number of consecutive days during summer with a humidex value above 38°C are represented in ***Figure 6.15***. Interestingly, the coastal and island regions were found to be most affected, contrary to the findings for heat wave occurrences which showed the continental regions to be most vulnerable. In particular, in the coastal regions of the Ionian and the Dodecanese islands, the period with humidex>38°C is projected to be 20 days longer in 2021-2050 and 40 days longer in 2071-2100, with obvious repercussions on human discomfort and, ultimately, health. In the low-lying continental regions and in Crete, the period with humidex>38ºC is projected to be some 15 days longer in 2021-2050 and 25 days longer in 2071-2100, whereas the mountainous regions will not experience significant changes and will retain their cool summer climate.

6.1.3 Changes in the intensity and distribution of landslides and floods in Greece

In the Mediterranean most of the floods are caused by intense rainfall in a short time frame, making flash flooding the most common type of inundation. On the contrary to the central European rivers the lack of large river networks and regional rains makes regional flooding virtually absent.

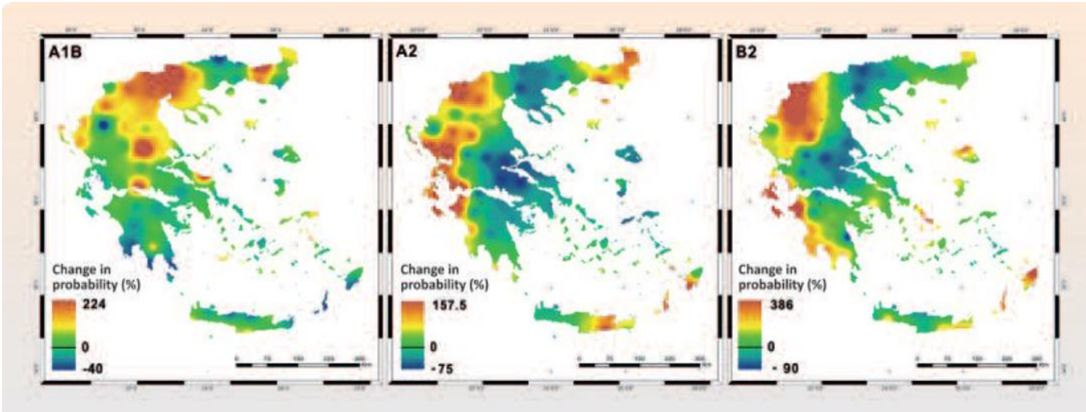
The temporal distribution of flood events in Greece between 1880 and 2010 presents a significant increase during the last decades. This is not a trend in natural processes (i.e. climate change) but is due to:

- The increase of population, leading to augmented pressure for urban expansion, sometimes in unacceptable locations increasing in turn the number of individuals and properties at risk.
- The enhancement of means of reporting and recording disasters through the years (advances in IT technology and media). It is also important that during specific periods such as 1941–1945 (Second World War), poor reporting capabilities and lack of means prevented the community from recording sufficiently flood events.
- The increased social and media interest in climate related catastrophes in the last decades and the lower tolerance threshold of the society with respect to natural hazards which lead to reporting of events of smaller significance.
- The increased human interference in hydrological processes, through the expansion of public works, road networks and impervious surfaces, especially near the cities.

However, due to the fact that reporting of floods is related with the damages inflicted, the increase of events is a measure of increase in damages and properties at risk, indicating an increase of flooding interference with human activities. This fact suggests that there is a deteriorating trend in flooding problem in Greece and a need for improvement of the current land use planning (Diakakis, Mavroulis et al. 2012).

Concerning landslides and floods in Greece the datasets used by the experts composing the report focusing on “The environmental, economic and social impacts of climate change in Greece” (Bank.of.Greece 2011) were taken from an ECHAM5 model run for Scenario A1B and from a HadCM3 model run for Scenarios A2 and B2. With regard to landslides, the effect of rainfall intensity variability was examined, which is a factor crucial to landslide occurrence (Caine 1980). This meant that the probability of rainfall exceeding certain thresholds was studied, beyond which landslides become highly probable (Caine 1980). This probability change served as a means of assessing changes in landslide probability and, thus in landslide hazard. For the purpose of our calculations, the global threshold was used as proposed by Caine (1980) and the regional threshold proposed by Calcaterra et al. (2000) for the Mediterranean.

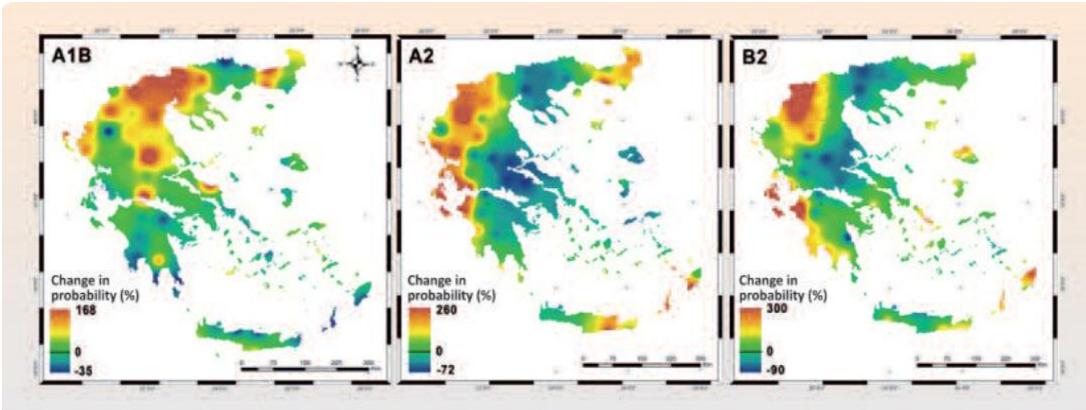
The final results were obtained by calculating the percentage change in probability of rainfall exceeding the thresholds between the reference period (1960-1990) and the periods 2071-2100 (for Scenarios A2 and B2) and 2090-2099 (for Scenario A1B). The results present similar spatial distributions with regard to both thresholds, and point to significant increases, but also decreases, in landslide probability depending on the region (***Figure 6.16***).



Source: (Bank.of.Greece 2011) “The environmental, economic and social impacts of climate change in Greece”

Figure 6.16 Percentage change in probability of exceedance of rainfall intensity threshold for landslides

More specifically, the landslide probability increases 1.5 times (Scenario A2) and 3 times (Scenario B2) in Western Macedonia, Western Greece and the Western Peloponnese, while smaller increases of 1.4 times (Scenario A2) and 2 times (Scenario B2) are projected for Eastern Crete, the Dodecanese and Evros (Eastern Thrace). In contrast, the landslide probability is projected to be 50% lower (Scenario A2) and 90% lower (Scenario B2) in Central Greece, Central Macedonia and the Peloponnese. Under Scenario A1B, the landslide probability is projected to increase by up to 2 times in the largest part of Greece, with the greatest increases observed in Central Macedonia and Thessaly (100-224%), whereas decreases are projected for the Southern Peloponnese and some parts of the Dodecanese.

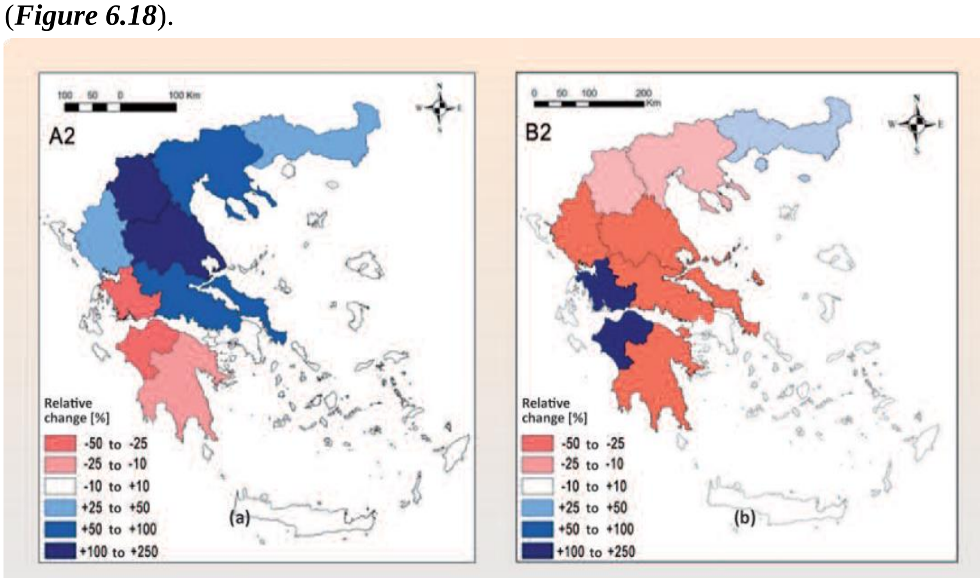


Source: (Bank.of.Greece 2011) "The environmental, economic and social impacts of climate change in Greece"

Figure 6.17 Percentage change in probability of exceedance of rainfall intensity threshold above which flood risk becomes high

Turning to floods, the future variability of heavy rainfall was examined, as well as the effect of such variability on the flood occurrence regime. This indicator was chosen because of its established association with flood phenomena (Loukas, Vasiliades et al. 2002; Georgakakos 2006; Norbiato, Borga et al. 2008). The results point to significant variation in flooding probability across the different regions depending on the climate scenario and to increases in average values under all the scenarios for the periods 2071-2100 and 2090-2099. Specifically, the probability of flooding was projected to be 2.6 times higher (Scenario A2) and 3 times higher (Scenario B2) in the Western Peloponnese, Epirus and Western Macedonia, but 50% lower (Scenario A2) and 90% lower (Scenario B2) in Central Greece and Central Macedonia. Under Scenario A1B, the probability increases by as much as 168% almost everywhere in the country, with the highest increases recorded for Central Macedonia and Thessaly, but decreases by as much as 35% in the Southern Peloponnese, Northern Crete and the Dodecanese.

The change in flood damage was calculated on the basis of models developed to assess the country-specific consequences of flooding (Ciscar et al., 2009), as well as the estimated change in flow of major waterways (***Figure 6.18***).



* Under Scenarios A2 and B2 (HadCM3) between the periods 1960-1990 and 2070-2100

Figure 6.18 Relative percentage change in the estimated annual cost of direct damage from floods

In summary, based on the results of climate modeling and subsequent analysis, the future variation of flood and landslide risk regimes presents, on average, present an increasing trend. However, in certain regions, the probability of such disaster event occurrence will decline.

6.1.4 Change in mean sea level and its impact on Greece's shorelines

Global sea level changes in the geological past

The global mean sea level is estimated to have risen 120-130 m since the last glacial maximum (about 21 ka) (Shackleton 2000; Siddall, Rohling et al. 2003; Peltier and Fairbanks 2006). During the current interglacial, the rate of sea level increase is estimated to have been close to 11 mm/year from 14 to 7 ka BP (Bard, Hamelin et al. 1996), and to have dropped to 1 mm/year over the last 6 ka (Lambeck and Purcell 2005). Recent studies have shown that the sea level is still on the rise today (IPCC 2007; Poulos, Ghionis et al. 2009a).

Focusing more specifically on the area of Greece, the sea level during 21-18 ka BP (end of the last glacial period) was 105-120 m lower than it is today (Lambeck and Bard 2000), but according to (Lambeck 1995) and (Lambeck and Purcell 2005), it rose rapidly between 11.5 ka and 6 ka, due to glacio-eustatic fluctuations, to 2 m below current sea level (Northern Aegean) and to 6 m below current sea level (Southern Aegean). Indicatively, the rate of sea level rise during 8-6 ka BP was about ~8.5 mm/year in Southern Euboea, 12.3 mm/year in SW Akarnania (Vött 2007) and 6 mm/year in the Peloponnese (Lambeck and Purcell 2005). During the last 5,000- 6,000 years, the sea level continued to rise at a rate of <1 mm/year, without ever exceeding the current levels and without excluding small variations in the rate of increase (Lambeck and Purcell 2005; Vött 2007; Poulos, Ghionis et al. 2009a).

Current and future mean sea levels

As shown by instrumental measurements (tide gauges, satellite altimetry), mean sea level has been rising at a rate of 1.8 mm/year since the late-19th century, while based on satellite measurements for the last 15 years, this rate has accelerated to 3 mm/year. As reported in IPCC (2007), by 2100 the air temperature is projected to rise by 1.1-2.9ºC under the most conservative scenario (B1) and by as much as 2.4-6.4ºC under the worst-case scenario (A1FI). Meanwhile, sea level rise for the period 2090-2099, relative to the period 1980-1999, is projected to range between 0.18 m and 0.38 m under Scenario B1, and between 0.26-0.59 m under Scenario A1FI. However, subsequent studies anticipate an even greater sea level rise by 2100. According to the semi-empirical model advanced by Rahmstorf (2007) relating the rates of change in global surface temperature to sea level, a rise in temperature of 1ºC corresponds to a sea level rise of 10-30 cm. Applying this ratio to the rise in temperature of 1.4-5.8ºC projected by the SRES scenarios (IPCC 2007), sea level rise figures of 0.5-1.4 m were obtained. The most adverse projections are reported in Pfeffer et al. (2008), with sea level rise likely to reach 0.8 m to 2 m. According to this study, the IPCC (2007) has not successfully modeled the dynamic development (decline) of the Greenland and Antarctic glaciers (Bank.of.Greece 2011).

Coastline classification into geomorphologic-geodynamic categories and map representation

Given that the sea level rise by 2100 is, depending on the scenario, projected to be between 0.2 m and 2 m, the parts of Greece's coastline that would find themselves 'endangered' if the sea level were to rise by 1 m are examined. However, the vulnerability of a coastal region cannot be safely estimated on the basis of the rate and scale of sea level rise alone. Other local factors, such as tectonics, sediment transport (from inland) and coastal geomorphology/lithology, also need to be taken into account (Bank.of.Greece 2011).

Tectonics obviously play a highly important role in tectonically active areas, as a rise in sea level can be offset (amplified) by tectonic uplift (subsidence). Typical examples in Greece are the coastal zone of the Northern Peloponnese, with an uplift rate of 0.3 to 1.5 mm/year, Crete with 0.7 to 4 mm/year and Rhodes with 1.2 to 1.9 mm/year. Thus, a supposed average value of sea level rise of 4.3 mm/year would be reduced to 3.5 mm/year due to the counteraction of a mean tectonic uplift of 0.8 mm/year.

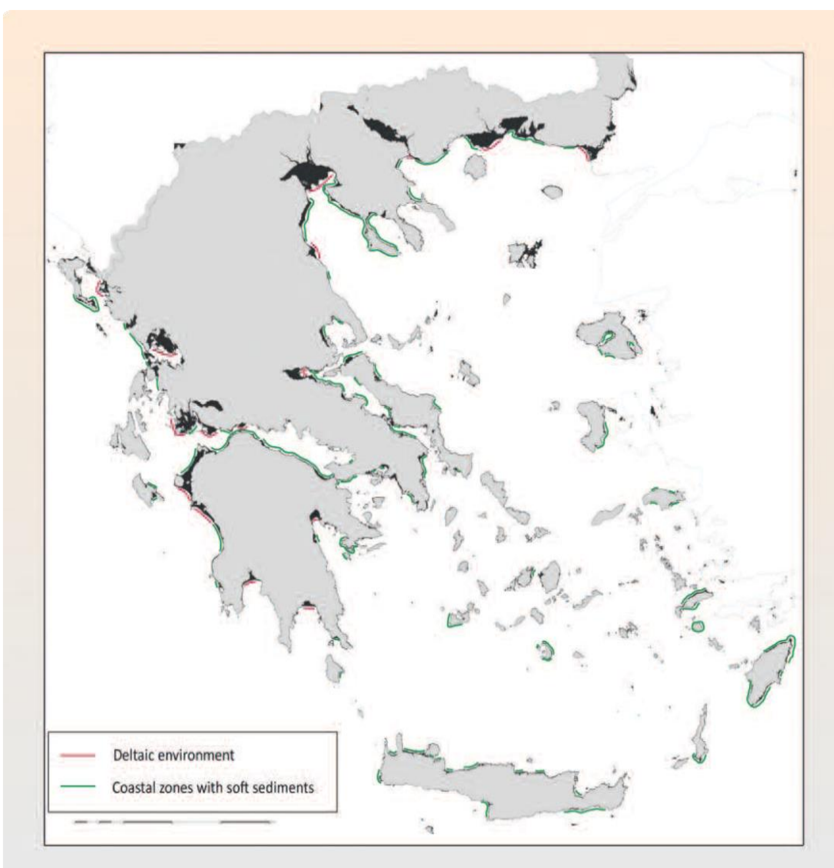
A change (i.e. increase) in **sediment discharge and deposition** in large river delta-front estuaries can cause the delta front to advance and locally offset the sea level rise. Conversely, a decrease in river sediment discharge could reinforce the incursion of the sea following a sea level rise.

Lastly, another important determinant of coastal vulnerability to sea level rise is the coast's **morphology** and, specifically, the slope and lithological composition, factors directly associated with erosion rates. An erosion rate can range from very high (several meters per year) in the case of coastlines with a low-lying geomorphology and an 'erodible' lithology, to low (mms per year) in the case of hard coastal limestone formations (e.g. cliffs).

Taking all of the above factors into consideration and using a map scale of 1:50,000, Greece's coastal areas can be subdivided into the following three main zones (***Figure 6.19***) (Bank.of.Greece 2011):

1) Deltaic coastal areas. Represented in red in ***Figure 6.19***, these low-lying coastal areas are formed of loose, unconsolidated sediment deposits and are highly vulnerable to sea level rise.
2) Coastal areas consisting of non-consolidated sediments of Neogene and Quaternary age. Represented in green, these coastal areas, usually of low altitude, are prone to recessional erosion and present a medium vulnerability to sea level rise.
3) Rocky coastal areas. These coastal areas (without any specific coloring/marking in ***Figure 6.19***) consist mostly of hard rock of low vulnerability to erosion and sea level rise, form the bulk of Greece's coastline.

The estimation of the length of these three types of coastal areas, as illustrated in ***Figure 6.19***, shows that out of the total ~16,300 km of coastline, 960 km (6%) correspond to deltaic areas of high vulnerability (red colour); 2,400 km (15%) correspond to non-consolidated sediments of medium vulnerability (green colour), and the remaining 12,810 km (79%) correspond to rocky coastal regions of low vulnerability. Thus, the total coastline length presenting medium to high vulnerability to sea level rise amounts to 3,360 km or 21% of Greece's total shoreline.



Source: (Bank.of.Greece 2011) "The environmental, economic and social impacts of climate change in Greece"

Figure 6.19 Classification map of Greece's coastal zones

Estimates of shoreline retreat due to the rise in mean sea level

Table 6. 3 presents indicative approximate values of flooded coastal areas and shoreline retreat (without any correction for tectonic and geodynamic effects) in response to possible sea level rises, respectively, of 0.5 m and 1 m in high-risk deltaic areas, such as the Axios river delta, the Aliakmon river delta and the Alfeios river delta (Bank.of.Greece 2011). The shoreline retreat was estimated to range between 30 m and 2,750 m in response to a possible sea level rise of 0.5 m, and between 400 and 6,500 m in response to a rise of 1 m.

Assessing the severity of a possible sea level rise impact on coastal regions involves a degree of uncertainty, concerning:

a) The intensity of the sea level rise, with projections ranging between 0.2 m and 2 m. The sea level rise will be determined by the interaction between several factors, both natural (e.g. astronomical forcing) and anthropogenic (e.g. greenhouse gases). The severity of each factor will determine the overall evolution of the current climate cycle, which should soon be crossing the finish line of the current 'warm' interglacial period.

b) The relationship between tectonic uplift and the eustatic sea level rise. In several areas of Greece, the high tectonic uplift may locally offset and sometimes even exceed the eustatic sea level rise.

c) The sedimentation of clastic materials in coastal areas, which is determined by geological and climatic conditions, as well as by anthropogenic intervention (e.g. dams, river sand mining). In the case of river delta areas for instance, these factors could alter their vulnerability to sea level rise.

Table 6. 3 Estimated coastline retreat (in m) and coastal inundation from a potential sea-level rise of 0.5 m and 1 m, for various deltaic areas of Thermaikos Gulf and Kyparissiakos Gulf (Poulos, Ghionis et al. 2009b; Bank.of.Greece 2011)

Coastal area	Sea-level rise (m)	Coastline retreat, Bruun's model (m)	Coastline retreat due to:		Total coastline retreat (m)	Inundated area (km^2)
			sea-level rise (m)	coast erosion (m)		
Alfeios Delta (northern part)	0.5	51.1	175	15	190	224
	1.0	102.2	810	-110	700	683
Alfeios Delta (southern part)	0.5	54.5	15-30	0-15	30	35
	1.0	109.0	10-100	400	400-450	344
Axios Delta	0.5	52.7	250-2,000	0	250-2,000	10,825
	1.0	213.6	2.000-2,500	0	2,000-2,500	28,482
Aliakmon Delta	0.5	63.6	50-1,750	0	50-1,750	4,875
	1.0	195.4	250-2,500	0	250-2,500	8,950
Deltaic plain of Loudias-Aliakmonas	0.5		500-2,750	0	500-2,750	8,900
	1.0		5,000-6,500	0	5,000-6,500	25,575

6.2 Assessment of risks and vulnerability to climate change

The Ministry of Environment & Energy (MEEN) is the competent authority for coordinating actions for climate change and works towards both mitigation and adaptation to the implications of climate change as well as the enhancement of mechanisms and institutions for environmental governance. In this capacity, MEEN is responsible for the identification of climate change impacts, the planning and coordination of adaptation measures and policies and the establishment and preparation of a national adaptation strategy. However, the newly formed ministry titled: “Ministry of climate crisis and civil protection” will progressively undertake the relevant activities and responsibilities.

The Ministry of Environment and Energy, the Athens Academy and the Bank of Greece signed a memorandum of cooperation for the development of the "National Strategy for Adapting to Climate Change". The first National Strategy for Adapting to Climate Change has been adopted by the Law 4414/2016 (OGG A’149) artDeltaic coastal areas.45 and is available on the Ministry's website and the website of the Bank of Greece (https://www.bankofgreece.gr/RelatedDocuments/National_Adaptation_Strategy_Excerpts.pdf) .

6.2.1 Climate risk and vulnerability at the regional level

According to the study of the Bank of Greece (CCISC) (Bank of Greece 2011), total estimated damages from climate change, by economic activity, is shown in the last row of ***Table 6.1***. These damages must be broken down by geographic region to provide an indication of each region’s vulnerability to climate change on the basis of the relative intensity of its economic activity. Given that climate change is expected to impact mainly on productive activities, a reasonable allocation formula would be the relationship between the output of a specific activity/sector in a region and total output from all activities/sectors in the same region.

Thus, the ratio $\varepsilon_{ij} = \frac{Y_{ij}}{Y_j}$ can be used as an allocation formula where is total output in region j =1,13 and Y_{ij} is the output of activity i in region j.

As a sectoral or geographical breakdown of output data from ELSTAT or any other reliable source is not available, this ratio was approximated by the ratio of total regional output to total national output and by the employment share of activity i in region j (Source: Labour Force Survey, ELSTAT). ***Table 6.18*** provides a breakdown of damages by economic activity and sector based on this approach, while ***Table 6.19*** ranks damages for individual activities and sectors on a scale from 1 (the smallest damage) to 13 (the greatest damage).

These estimates represent a first attempt at quantification, given the time and re-source constraints of the present study. For the purposes of strategic planning, an approach for assessing vulnerabilities would be to identify three levels of vulnerability, e.g. low (L) 1-3, medium (M) 4-7 and high (H) 8-13, and classify regions by vulnerability and activity. In agriculture for instance, the regions of CENTRAL MACEDONIA, PELOPONNESE, WESTERN MACEDONIA, THESSALY, EASTERN MACEDONIA AND THRACE, and CRETE exhibit a high level of vulnerability. Another approach would consist in estimating total damage from climate change in each region (***Table 6.18***, last column) relative to the value added in each region. Vulnerabilities under this approach are shown in ***Table 6.20***.

Table 6. 4 Damages / Economic activity by region and economic sector, EUR millions (CCISC Study)

Geographical region	Agriculture	Forestry	Fisheries	Mining and quarrying	Water supply	Built envi-ronment	Trans-porta-tion	Tourism	Health	Total damage (D)	Value added (2011) (VA)	D/VA
NATIONAL AGGREGATE												
EASTERN MACEDONIA AND THRACE	105.246	3.747	0.857	25.938	15.276	1.518	2.128	32.876	3.274	190.859	7216.00	0.026449
CENTRAL MACEDONIA	169.858	6.048	1.382	133.897	31.543	3.870	9.212	145.160	12.906	513.876	24992.00	0.020562
WESTERN	33.845	1.205	0.275	348.744	3.496	1.078	1.021	24.133	1.226	415.023	4021.00	0.103214

MACEDONIA												
EPIRUS	40.196	1.431	0.327	7.146	4.209	1.193	1.626	26.660	2.624	85.413	4055.00	0.021064
THESSALY	110.471	3.933	0.899	16.246	19.136	2.113	2.150	48.175	4.250	207.372	8812.00	0.023533
IONIAN ISLANDS	31.899	1.136	0.260	0.000	0.685	0.782	1.477	41.447	0.854	78.539	3098.00	0.025352
WESTERN GREECE	114.731	4.085	0.934	0.000	9.359	1.998	3.616	53.965	4.522	193.211	8555.00	0.022585
CENTRAL GREECE	79.861	2.843	0.650	172.094	13.514	1.834	3.036	68.592	2.501	344.926	7984.00	0.043202
ATTICA	35.889	1.278	0.292	160.317	113.300	13.901	57.696	429.395	52.979	865.046	88921.00	0.009728
PELOPONNESE	117.335	4.178	0.955	55.721	3.282	1.933	2.875	45.973	2.685	234.936	7755.00	0.030295
NORTHERN AEGEAN	19.077	0.679	0.155	0.000	2.185	0.603	1.055	17.745	1.000	42.501	2592.00	0.016397
SOUTHERN AEGEAN	29.047	1.034	0.236	48.506	15.998	1.914	2.054	69.599	2.672	171.060	5747.00	0.029765
CRETE	95.545	3.402	0.778	31.181	11.018	2.264	3.053	81.280	3.506	232.028	8623.00	0.026908
Total	983.000	35.000	8.000	999.790	243.000	35.000	91.000	1085.000	95.000			

Table 6. 5 Breakdown of vulnerability by region and economic sector

Geographical region	Agriculture	Forestry	Fisheries	Mining and quarrying	Water supply	Built envi-ronment	Trans-porta-tion	Tourism	Health
EASTERN MACEDONIA AND THRACE	9	9	9	4	10	5	6	4	8
CENTRAL MACEDONIA	13	13	13	8	12	12	12	12	12
WESTERN MACEDONIA	4	4	4	11	4	3	1	2	3
EPIRUS	6	6	6	2	5	4	4	3	5
THESSALY	10	10	10	3	11	10	7	7	10
IONIAN ISLANDS	3	3	3	1	1	2	3	5	1
WESTERN GREECE	11	11	11	1	6	9	11	8	11
CENTRAL GREECE	7	7	7	10	8	6	9	9	4
ATTICA	5	5	5	9	13	13	13	13	13
PELOPONNESE	12	12	12	7	3	8	8	6	7
NORTHERN AEGEAN	1	1	1	1	2	1	2	1	2
SOUTHERN AEGEAN	2	2	2	6	9	7	5	10	6
CRETE	8	8	8	5	7	11	10	11	9

Table 6. 6 Breakdown of vulnerability by region and economic sector

Geographical region	Total damage (D)	Value added (2011) (VA)	D/VA	Vulnerability
EASTERN MACEDONIA AND THRACE	190.859	7216.00	0.026449	8
CENTRAL MACEDONIA	513.876	24992.00	0.020562	3
WESTERN MACEDONIA	415.023	4021.00	0.103214	13
EPIRUS	85.413	4055.00	0.021064	4
THESSALY	207.372	8812.00	0.023533	6
IONIAN ISLANDS	78.539	3098.00	0.025352	7
WESTERN GREECE	193.211	8555.00	0.022585	5
CENTRAL GREECE	344.926	7984.00	0.043202	12
ATTICA	865.046	88921.00	0.009728	1
PELOPONNESE	234.936	7755.00	0.030295	11
NORTHERN AEGEAN	42.501	2592.00	0.016397	2
SOUTHERN AEGEAN	171.060	5747.00	0.029765	10
CRETE	232.028	8623.00	0.026908	9

6.2.2 Extreme weather events

The study of the Bank of Greece (CCISC) (Bank of Greece 2011), has shown that changes in the frequency and intensity of extreme events will be one of the main declines of climate change for Greece with consequent negative effects on the vulnerability of societies and ecosystems with their exposure to environmental risks.

In particular, heatwaves are very likely to become more frequent with larger duration and intensity. Less intense cold weather is expected, however, occasional intense cold periods will continue to appear even in the second half of the 21st century. The summer drought is expected to increase even further, leading to a prolongation of drought and pressures on water stocks in areas with already increased vulnerability. At the same time, high - intensity rainfall is expected to become more frequent in the next 70 years, with consequence in the urban areas the sudden floods, due to the intense local rainfall, to become more and more common.

Changes in these extreme weather events are expected to affect particularly sectors such as agriculture, fisheries, human health, water resources, biodiversity, ecosystems as well as the infrastructure, the transportation, and the energy. Therefore, adaptation to climate change regarding these extreme events is part of the adaptation strategies for the improvement of the resilience of these sectors and is also included in the proposed strategies.

Directive 2007/60 / EC on the assessment and management of flood risks urges Member States to develop Flood Risk Management Plans in vulnerable areas based on flood hazard maps at river basin district level. Water flood risk management studies have already been launched by the Special Secretariat for Water in five relative areas in the country.

Additionally to the sectorial adaptation measures, especially for extreme events, a timely warning is necessary. Therefore, it is recommended the development, at national and regional level in Europe, integrated (Integrated Climate Services) for Greece in the context of European standards. The provision of central European services for climate change is being implemented today by the Copernicus Climate Change Service (http://www.copernicus.eu/main/climate-change), a partnership between European Commission and the European Center for Medium-term Meteorological Forecasting. Also European support services for climate change adaptation strategies are provided by the CLIMATEADAPT online platform (http://climate-adapt.eea.europa.eu/) of the European Environment Agency. Public services related to adaptation issues should be developed in order to facilitate and promote the interaction and collaboration between users, private and public bodies to be able to develop effective adaptation measures, which should:

- provide easy access to meteorological and hydrological observations, meteorological and climatic forecasts and products, focusing mainly on adaptation to climate change,
- facilitate the production of timely and accurate warnings for the extreme phenomena at national / regional level,
- provide updated information on climate trends in the past, at present and future,
- facilitate the promotion of qualitative analysis of the current climate as well as the projections of future climate change, for governments, countries, municipalities, businesses as well as for research purposes,
- provide and enhance the use of adaptation tools.

The first step to achieve these goals is to organize and develop a uniform climate and national observation system and climate database. The continued operation of such a cognitive climate-logical basis will be an excellent source of documented time series of climatic variables from the beginning of the 20th century to the present. These time series will also establish the predictability of the models for the ongoing updating of the climate change adaptation strategy.

6.2.3 Some preliminary conclusions and priority areas for intervention

The above vulnerability assessment is a first attempt to quantify and rank the anticipated climate risks for the Greek territory. It is clear that priority should be given to those sectors expected to be most negatively affected by climate change, and to averting those impacts that would entail the highest costs for the economy. According to the CCISC analyses (Bank.of.Greece 2011), agriculture is the sector expected to be most severely affected by climate change in Greece, while the impacts on tourism and coastal systems should have major consequences on household incomes and the economy as a whole. Of particular significance is also the water reserves sector, given its implications for agriculture and water supply. The adaptation policies need therefore to be focused on the above areas and the implementation of appropriate actions must be planned in timely manner, so as to mitigate the likely adverse impacts.

Furthermore, it is advisable to maintain strategic food and water reserves in order to meet the basic needs of the country’s population in case of large-scale extreme weather events, such as prolonged drought.

Thus the main priority areas as described in the National Strategy for Adapting to Climate Change are:

- ✓ Agriculture and stock-breeding
- ✓ Forestry
- ✓ Biodiversity and ecosystems
- ✓ Fisheries
- ✓ Aquaculture
- ✓ Water resources
- ✓ Coastal zones
- ✓ Tourism
- ✓ Energy
- ✓ Infrastructure and Transport
- ✓ Health
- ✓ The built environment
- ✓ Mining and quarrying
- ✓ Cultural heritage
- ✓ Insurance sector

6.3 Climate change impact per sector

6.3.1 Agriculture and stock-breeding

To estimate the impact of climate change on Greek agriculture statistical models (Lobell, Burke et al. 2008) and crop simulation or mechanistic models (CropSyst, AquaCrop, CERES, etc.) were used under the report performed for the Bank of Greece (Bank.of.Greece 2011). Therefore the AquaCrop model (version 3.1, 2010), derived from the revised FAO report was used, as: it assesses the effect of water on both plant growth and crop productivity; compared with other models, it requires fewer parameters; it is simpler to use; and, lastly, it is more accurate, with lower error probabilities (Raes, Steduto et al. 2009).

The detailed climate and meteorological data used in the simulation (daily maximum and minimum temperature, daily rainfall, and daily evapotranspiration) were drawn from the Research Centre for Atmospheric Physics and Climatology of the Academy of Athens. The assumption was made that crop management practices (sowing, harvesting, etc.), and irrigation and fertilizer use (quantity and frequency) will remain unchanged at current levels. However, the study did take into consideration the impact of desertification on crop yield. Desertification was estimated based on the data of a special study, which made it possible to estimate the annual rate of land loss by climate zone (Bank.of.Greece 2011). In all, the impact of climatic change and desertification on the production of a number of crops was estimated. The desertification data used are linear projections of the outcomes of the above studies, since there are no scenarios forecasting the course of desertification in relation to climate change. However, in light of the anticipated decrease in rainfall and the higher intensity of extreme weather events, current forecasts may need to be revised upward, by an additional 5-10%.

As shown in ***Table 6.4***, using the AquaCrop model and research data from the Greek and international literature, of the three scenarios considered, Scenario B2 appears to be most favourable to crop production. The impacts of climate change become increasingly ‘less negative to positive’ the further one moves north and east: consequently, Eastern Macedonia-Thrace and Western-Central Macedonia are the zones that will benefit the most or suffer the least depending on the crop/case. The most vulnerable arable crop was shown to be wheat, while cotton production is projected to decrease the most under both Scenarios A1B and A2 in Central-E astern Greece. The impact of climate change on tree crop production by mid-century will range from neutral to positive but will become increasingly negative by 2100, especially in the country’s southern and island regions. Vegetable crops will move northward and the growing season, longer than it is today due to milder-warmer winters, will result in increased production. Moreover, as regards the effect of invasive pests, diseases and weeds on crop production, the prevailing view is that warmer climatic conditions will generally favor the proliferation of pests, since insect pests are able to complete a larger number of biological cycles during the course of a year. In addition, warmer winters will allow crop-threatening insects to survive the winter in places where this is not possible today; thereby giving them a ‘head start’ during the next growing season (Gutierrez, Ponti et al. 2009). Similarly, thermophilic weed species (Cassia, Amaranthus, Sesbania, Crotalaria, Rottboellia, Imperata, Panicum, Striga, etc.) are also expected to expand into colder zones and higher altitudes (Karamanos 2009).

Economic impacts

Despite its contraction in recent decades, agriculture remains important to the Greek economy, with agricultural production accounting for 5-6% of GDP and agricultural employment accounting for 17% of total employment. The agroindustry, which represents one fourth of the national industry, contributes one third of the industrial product and accounts for one third of industrial sector employment. The impact of climate change on Greek agricultural production was analysed by downscaling IPCC Scenarios A1B (3.5ºC), A2 (4.5ºC) and B2 (3.1ºC) (IPCC 2007a) to the regional climate zone level of Greece.

Climate is a key to agricultural production, and largely determines the type, quantity and quality of agricultural produce. The climate variables that most affect crop productivity are: temperature, precipitation, solar radiation (intensity and duration of exposure) and atmosphere composition (IPCC 2007b; Mendelsohn and Dinar 2009). Impacts on productivity affect farmer income and employment.

Depending on the welfare measure used (price, cost or value), the methodologies developed can be classified into one of the three following categories: pricing, cost-pricing and valuating. If, for instance, climate change causes the cotton production to fall by 20%, then the farmer's income from cotton will fall accordingly. This change reflects the cost of inaction to climate change to be incurred by the cotton producer. If the producer resorts to using more fertilizer to make up for his production loss, he will incur higher production costs. These costs represent the cost of adaptation to climate change. The effects of climate change alone, excluding desertification, were found to have an immediate positive effect on farmer income until 2041-2050, a turning point, after which the economic impacts (for 2051-2100) worsen. In contrast, the impact of climate-change induced desertification is expected to be negative. As is well-established, desertification negatively impacts agricultural production and, consequently, farmer income, due to the loss of fertile farmland and the decrease in cultivable area. The overall impact of climate change on farmer income, factoring in desertification, was found to be negative under Scenarios A1B and A2, but positive under Scenario B2. Unless measures to counter desertification are taken, climate change will thus negatively impact farmer income. It should be stressed that these estimates do not take into account changes in other determinants of agricultural production directly affected by climatic change, such as the impact of weeds and insect pests (including invasive species) and possible changes in pollinator efficiency (Bank.of.Greece 2011).

Table 6. 7a Assessment of possible impacts of climate change in different climate zones in Greece

Climate zones	Scenarios	A1B		A2		B2	
	Periods	2041-2050	2091-2100	2041-2050	2091-2100	2041-2050	2091-2100
Eastern Macedonia and Thrace	Cotton						
	Wheat						
	Maize						
	Nuts & fruits						
	Olives						
	Vines						
	Vegetables						
Western and Central Macedonia	Cotton						
	Wheat						
	Maize						
	Nuts & fruits						
	Olives						
	Vines						
	Vegetables						
Central and Eastern Greece	Cotton						
	Wheat						
	Maize						
	Nuts & fruits						
	Olives						
	Vines						
	Vegetables						
Western Greece	Cotton						
	Wheat						
	Maize						
	Nuts & fruits						
	Olives						
	Vines						
	Vegetables						
Ionian Sea	Cotton						
	Wheat						
	Maize						
	Nuts & fruits						
	Olives						
	Vines						
	Vegetables						
Western Peloponnese	Cotton						
	Wheat						
	Maize						
	Nuts & fruits						
	Olives						
	Vines						
	Vegetables						

Source: (Bank.of.Greece 2011) "The environmental, economic and social impacts of climate change in Greece"

Table 6. 7b Assessment of possible impacts of climate change in different climate zones in Greece (continued)

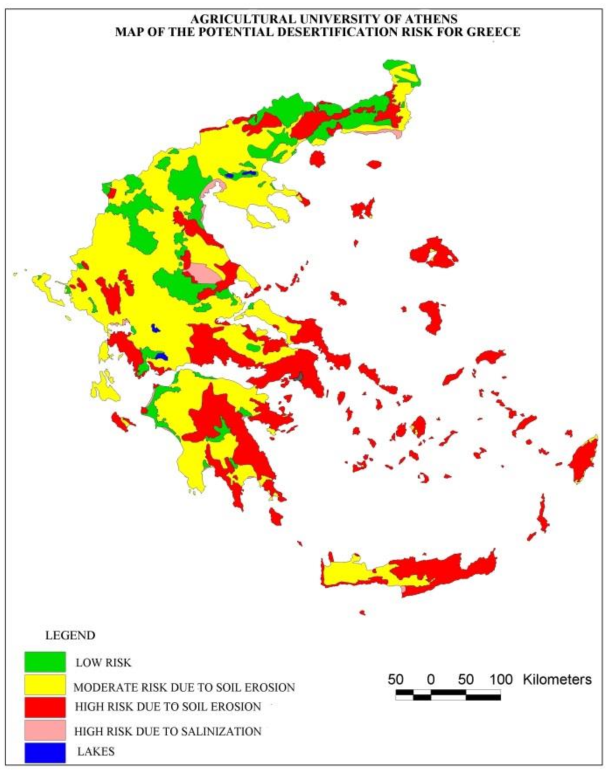
Climate zones	Scenarios / Periods	A1B 2041-2050	A1B 2091-2100	A2 2041-2050	A2 2091-2100	B2 2041-2050	B2 2091-2100
Eastern Peloponnese	Cotton						
	Wheat						
	Maize	roughly the same	decrease<10%	roughly the same	decrease>10%	roughly the same	roughly the same
	Nuts & fruits	roughly the same	roughly the same	roughly the same	decrease<10%	roughly the same	roughly the same
	Olives	roughly the same	decrease<10%	roughly the same	decrease<10%	roughly the same	roughly the same
	Vines	roughly the same	decrease<10%	increase<10%	decrease<10%	increase<10%	roughly the same
	Vegetables	roughly the same	decrease>10%	increase<10%	decrease>10%	increase<10%	roughly the same
Cyclades	Cotton						
	Wheat						
	Maize						
	Nuts & fruits	roughly the same	decrease<10%	roughly the same	decrease>10%	roughly the same	decrease<10%
	Olives	roughly the same	decrease<10%	roughly the same	decrease>10%	roughly the same	roughly the same
	Vines	roughly the same	decrease<10%	roughly the same	decrease>10%	roughly the same	roughly the same
	Vegetables	decrease<10%	decrease>10%	decrease<10%	decrease>10%	decrease<10%	decrease<10%
North-Eastern Aegean	Cotton						
	Wheat						
	Maize						
	Nuts & fruits	increase<10%	decrease<10%	increase<10%	increase<10%	increase<10%	increase<10%
	Olives	increase<10%	roughly the same	increase<10%	increase<10%	increase<10%	increase>10%
	Vines	increase<10%	roughly the same	increase<10%	increase<10%	increase<10%	increase>10%
	Vegetables	increase<10%	roughly the same	increase<10%	roughly the same	increase<10%	increase>10%
Dodecanese	Cotton						
	Wheat						
	Maize						
	Nuts & fruits	roughly the same	decrease<10%	roughly the same	decrease>10%	decrease<10%	increase<10%
	Olives	roughly the same	decrease<10%	roughly the same	decrease<10%	roughly the same	increase<10%
	Vines	roughly the same	decrease<10%	roughly the same	decrease<10%	roughly the same	increase<10%
	Vegetables	decrease<10%	decrease>10%	decrease<10%	decrease>10%	decrease<10%	increase<10%
Crete	Cotton						
	Wheat						
	Maize						
	Nuts & fruits	roughly the same	decrease<10%	roughly the same	decrease>10%	decrease<10%	decrease<10%
	Olives	roughly the same	decrease<10%	roughly the same	decrease<10%	roughly the same	roughly the same
	Vines	roughly the same	decrease<10%	roughly the same	decrease<10%	roughly the same	roughly the same
	Vegetables	decrease<10%	decrease>10%	decrease<10%	decrease>10%	decrease<10%	increase<10%
Key		increase>10%					
		increase<10%					
		roughly the same					
		decrease<10%					
		decrease>10%					
		not cultivated					

Source: (Bank.of.Greece 2011) "The environmental, economic and social impacts of climate change in Greece"

Desertification

The potential desertification risk in Greece is estimated primarily by the National Committee for Combating Desertification. The Committee has published various national reports regarding the implementation of the United Nations Convention to Combat Desertification. According to the latest available information, the map of potential desertification risk can be found in ***Figure 6.20.***

As it can be seen in the map, the main reasons for the desertification are soil erosion and salinization. According to Yassoglou (Yassoglou 2000) the pressures that are associated to climate change and lead to soil desertification are drought, over-exploitation of land (including over-grazing) and water resources, irrational irrigational schemes, forest fires and land abandonment. On the other hand, salinization is also associated(though not uniquely) with climate change. In particular, some of the effects of climate change include soil salinization and also secondary salinization through irrigation and sea water level rises. In combination with the higher evapotranspiration rates, the lack of sufficient water resources and the increased irrigation that is generally experienced in the recent years, as it has been already mentioned, may force farmers to apply new irrigation schemes that will lead to secondary salinization of valuable lands. According to Yassoglou, this will have tremendous negative socioeconomic effects.

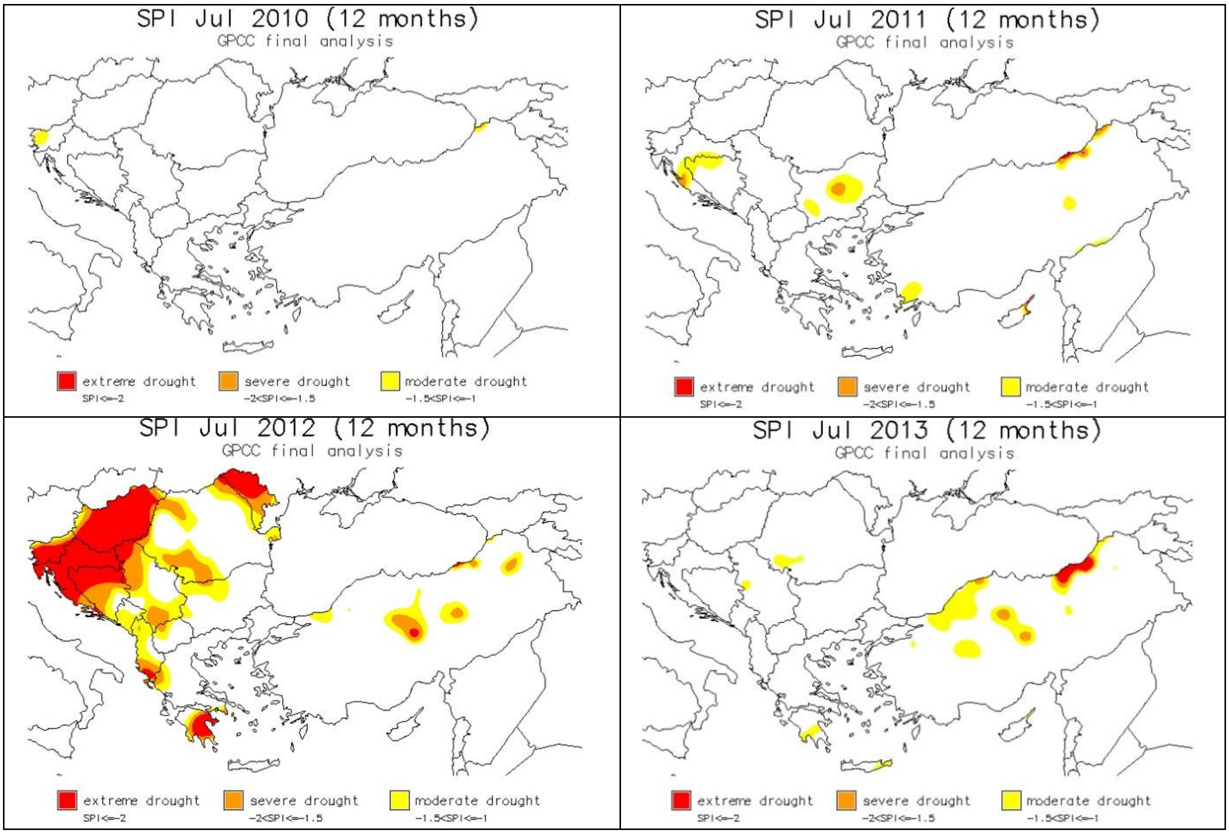


Source: National Committee for Combating Desertification, 2009 (Available on the website http://www.gnccd.com)

Figure 6.20 Map of the potential desertification risk for Greece.

In the Standardized Precipitation Index (SPI)[20] is presented for Greece and for the years 2005-2008, according to data collected from the Drought Management Centre of Southeastern Europe (http://www.dmcsee.org). As it can be seen from the charts, the higher drought was experienced in summer 2007, whereas many areas identified as exposed to high risk of desertification in ***Figure 6.21*** are indeed suffering from extreme droughts in 2007-2008.

[20] The SPI can be calculated at various time scales which reflect the impact of the drought on the availability of water resources. The SPI calculation is based on the distribution of precipitation over long time periods (30 years (1961-1990) was used). The long term precipitation record is fit to a probability distribution, which is then normalized so that the mean (average) SPI for any place and time period is zero (DMCSEE, Drought Management Centre for Southeastern Europe, 2007).



Source: Drought Management Centre for south-eastern Europe, 2009 (Accessed in the website **http://www.dmcsee.org**)

Figure 6.21 Standardized Precipitation Index (SPI) for Greece in years 2005, 2006, 2007 and 2008.

Particular studies on the drought characterization, referring to intensity, frequency and duration of the drought, in special areas of the Greek territory have been performed in the context of the Mediterranean Drought Preparedness and Mitigation Planning project (MEDROPLAN) by the National Technical University of Athens. Results cover the area of Nestos (45% of the basin in northern Greece) and Mournos basins (central Greece), showing an intense drought period during the years 1989-1993 in both cases. In addition, 120 climatic scenarios have been created by altering the original precipitation and potential evapotranspiration data by different percentages up to -40% and +24% respectively. The stream flow reduction has been calculated 20-35% for moderate drought conditions, 35-50% for severe droughts and up to 65% for extreme drought conditions.

The most significant impacts of droughts in the Nestos and the Mornos Basins (***Figure 6. 22***) refer to stream flow reduction and the reduction in agricultural production. In addition, in the Nestos River Basin an important effect on the wetland ecosystem and biodiversity loss have been observed. In the Mornos River Basin the pressure on the water supply system of the city of Athens has been a very significant issue.

Figure 6.22 Nestos and Mornos Basins in Greece

Economic impacts

The average domestic production of wood products during the years 1988-2008 was 1,960,000 m^3. According to data from the 2008 report on Forest Service Activities, 28% of the total wood production was round wood. According to the NSSG (2007), domestic wood production covered only one-third of the national demand for roundwood, but the entire demand for fuelwood.

Table 6. 8 Average annual timber production, 1988-2008

Type of timber	1000 m^3	% of the total
Roundwood	547.43	27.9
Commercial fuelwood	828.33	42.3
Non-commercial fuelwood	584.48	29.8
Total	1,960.24	100.0

Source: (Bank.of.Greece 2011) "The environmental, economic and social impacts of climate change in Greece"

The production of roundwood (which includes sawn wood, carpentry and joinery wood, windows, doors and their frames, parquet panels, etc.) has decreased, while the production of industrial timberwood (particle boards, pre-laminated boards, MDF, wooden crates, etc.) has increased. Both categories (roundwood and industrial timberwood) form part of the wood manufacturing industry. Greece's total wood production in the last 20 years has been considerably below potential, mainly on account of high production costs, cheap wood imports and forest service mismanagement. The annual production of roundwood peaked in 1999 at 812,000 m^3, which is double the present production. Non-commercial fuelwood is used exclusively for heating.

Based on data available for Greece, the economic impact multiplier associated with wood manufacturing is 4.65, meaning that each initial €1 of forest wood is converted into an end-value of €4.65.

It should be noted that until 1987 the prices paid to producers for industrial roundwood and fuelwood were determined by tender procedures by the Forest Service. Since 1987, pursuant to Presidential Decree 126/1986, agro- forest cooperatives and associations have the right to sell the timber they have harvested in public forests on the open market. In 2010, fuelwood sold for €22.3/m^3 and beech roundwood for

€60.3/m^3 (Forestry Department of the Pella Prefecture, 2010). Given that roundwood accounts for 27.9% of total wood production, with fuelwood accounting for the rest, the weighted average price of wood was estimated at: (0.279 x €60.3) + (0.721 x €22.3) = €32.90/m^3. Consequently, the economic impact of forest spatial redistribution by 2050 would amount to €2.6 to €10.6 million/year, while the impact of the anticipated decrease in wood production by 2100 would amount to €17.4 to €22.6 million. Using our economic multiplier of 4.65, the total economic impact by 2100 is estimated at €80.9 to €105.1 million/year.

There are no official prices for forage. Considering, however, that 10 kg of forage are roughly equivalent to 1 kg of usable meat and adopting €5/kg as the present average price of meat, the economic loss from reduced rangeland production is estimated at €156 to €390 million/year by 2100. Using the same assumptions, the economic loss associated with the loss of wetland area due to SLR would amount to an estimated present value of €13 to €26 million/year by 2100. The impact of SLR on forest production is estimated to be insignificant.

As shown in ***Table 6.*** , the present value of the direct economic impact of climate change on forest ecosystems, for the two more likely scenarios B2 and A2 and using two different discount rates, ranges between €1.4 billion (Scenario B2; 3% discount rate) and €9.5 billion (Scenario A2; 1% discount rate). It should be noted that, due to the length of the period examined, the discount rate has a much greater impact than the two climate scenarios used. In any case, due to the magnitude of uncertainties surrounding such forecasts and estimates, the estimated values should be taken as a lower bound of the real economic impacts (Bank.of.Greece 2011).

Table 6. 9 Estimated present value of the economic impact on forest ecosystems by 2100 (EUR millions)

Discount rate (%)	1%		3%	
	Scenario B2	Scenario A2	Scenario B2	Scenario A2
Redistribution of forests	46.7	94.8	14.9	30.4
Fires	721.2	1,462.1	231.0	470.9
Sea-level rise	116.8	237.4	37.4	76.2
Wood and forage biomass	3,154.2	7,300.9	1,014.0	2,320.2
Usable water	235.4	376.7	75.5	120.9
Total	**4,274.4**	**9,471.9**	**1,372.8**	**3,018.6**

6.3.2 Forestry

Forest ecosystems and grassland areas occupy approximately 66.5% of Greece's land surface (forests 26.2%, grasslands 40.3%). Forest ecosystems provide a wide range of wood and non-wood products, including wood biomass, forage, fruits, mushrooms, honey, botanical herbs; affect water quantity and quality; enhance air quality and the sequestration of CO_2; play a valuable role in soil protection and biodiversity conservation by providing habitats and food for a host of living creatures. They also have considerable cultural and aesthetic value and provide opportunities for numerous recreational activities (hiking, camping, hunting, etc.), all essential to human wellbeing. The ability of forest ecosystems to yield products and quality services depends primarily on their stability, a function of their biodiversity, vigorousness and growth dynamic.

Forest production depends primarily on environmental factors, such as temperature, solar radiation, soil water and nutrients, but is also affected by synecological factors, such as inter- and intra- competition, interactions with animals and microorganisms, as well as wildfires (Johnsen, Samuelson et al. 2001). A small rise in temperature and decrease in precipitation was recorded in the course of the 20th century, a trend expected to continue in the 21st century as well, with precipitation projected to decrease in Greece: Scenario B2 (-35 mm), Scenario A2 (-84 mm).

It has been estimated that the overall decrease in precipitation by 2100 will not be uniform across Greece. Precipitation is expected to decrease in continental Greece (where the country's productive forests are located), but to increase in the islands of the Aegean (except Crete). Forest ecosystems will suffer from the combined effect of reduced precipitation and increased temperatures during the hot and dry period, while facing a higher risk of devastation from wildfires (Giannakopoulos, Le Sager et al. 2009a).

Unlike the flood periods, the largest increases in dry season will occur in the eastern mainland and in northern Crete, where 20 additional days of drought are expected by 2021-2050 and up to 40 additional days in 2071-2100. It is expected that the change in climatic conditions will significantly increase the number of days with an extremely high fire risk, 40 days in 2071-2100 across Eastern Greece from Thrace to the Peloponnese, while smaller increases are expected in Western Greece.

The effects in the fir, beech and pine forests are important, and the increase in costs due to the increase in the number and extent of forest fires is essential. In addition, a decrease in the abundance of species and biodiversity in general is expected.

Assuming that today's forest management strategy remains unchanged and that no additional measures are taken, it is estimated that the impacts of climate change on forest ecosystems by 2100 will include (a) a spatial redistribution of the country's forests, and (b) a decrease in total canopy cover. More specifically, temperate coniferous and broadleaf evergreen forests are expected to expand by 2% to 4%, while spruce, fir, beech and black pine forests will shrink by 4% to 8%. Moreover, some coastal forest ecosystems are at risk of converting to pastures and desertification (1-2%) (Le Houerou 1992). Spatial redistribution and the decrease in productive forest area by 160,000 ha to 320,000 ha on average would lower yearly wood biomass production by 0.5 m^3/ha or by a total of 80,000 m^3 or 160,000 m^3.

Global warming is expected to affect both the number of summer wildfires and total burned area, while the interval between two successive fires in the same area will decrease (Mouillot, Rambal et al. 2002). Forests in southern continental Greece and Crete are expected to be most affected (Carvalho, Flannigan et al. 2009; Giannakopoulos, Le Sager et al. 2009a). From 2000 to 2010, there were over 100,000 fire occurrences in Greece, consuming an average of 62,000 ha of arable and forest land each year. As estimated, total burned areas and total annual costs of fire fighting/suppression, damage and rehabilitation/reforestation will increase by about 10 to 20% relative to today's levels (Carvalho, Flannigan et al. 2009; Giannakopoulos, Le Sager et al. 2009a; Schelhaas, Hengeveld et al. 2010). The total costs of fire extinction and damage, estimated today at over €400 million per year, are expected with global warming to increase by €40 to €80 million/year.

As a result of changes in forest structure (such as reduced canopy density) and the increased severity of weather extremes, surface runoff and erosion are expected to increase by 16 to 30% with adverse repercussions on deep infiltration and underground aquifer recharge. This, combined with the expected higher evapotranspiration, will reduce the amounts of usable water resources (Arora and Boer 2001) by 25 to 40% i.e. by 5 to 8 billion m^3/year. In addition, non-use values and other environmental services are expected to fall by 5% to 10% (Founda and Giannakopoulos 2009).

The disastrous impacts of 2007 forest fires on biodiversity have been estimated by scientific teams of the Agricultural University of Athens in the context of the "Study on the rehabilitation and development of the agricultural and forestry sectors and on the environmental protection in the areas touched by the fires of the summer 2007" (Agricultural University of Athens 2007). The main findings include the following:

Important surface of the areas touched by fires have been occupied by deciduous trees like chestnuts, oaks (*Quercus ilex*) and plane trees (*Platanus aceriolia*). As regards to grazing forest areas, the main species include evergreen broad-leaved species of bushes. The latter ones constitute the main type of grazing areas for agricultural animals. The evergreen broad-leaved in general have been adapted to a regime of repetitive forest fires and are experiencing revegetation in a quite short period after the fire, in a way that after two or five years they can be used again as grazing areas. Of course, this is always dependent on the area, the climate, the ground and the topography. With reference to conifers forests that prosper in low temperatures (*Pinus halepensis* and *Pinus pinea*), the largest area burnt is in the Prefecture of Ilia, in

Peloponnese (61.6% of the total burnt area of conifers). Also, the Prefectures of Ilia and Arcadia are the ones that experienced the biggest distraction of deciduous broad-leaved forests.

The disturbance of Greek biodiversity due to forest fires includes other species too, like olive trees, fig trees, vineyards, nuts, while beekeeping has been also affected, since a lot of hives have been burnt and for the rest the flora destruction makes difficult the discovery of food. Finally, as regards to livestock, destructions include animals (sheep, goats, cattle, equine), habitats and grazing lands.

Sea level rise (SLR) is predicted to accelerate relative to today, reaching 0.25 to 1 m by 2100, thereby bringing about changes in the spatial distribution of present coastal area land uses (Nicholls 2004; Rahmstorf 2007). According to the report concerning “The environmental, economic and social impacts of climate change in Greece”(Bank of Greece 2011), a SLR of 0.5 m by 2100 would result in the inundation of 15% of Greece’s present total coastal wetland area (1,000 km^2). Such a rise is not expected to substantially impact coastal forest production, whereas total rangeland production will decline by 26,000 to 52,000 tonnes. The coastal wetlands expected to face the greatest impact are the deltas of rivers Evros, Nestos, Axios, Loudias, Aliakmon and Acheloos, the lagoons of Messolonghi and Kyllini, and the Amvrakikos and Pagassitikos gulfs. The islands likely to be most strongly affected include Lemnos, Samos, Rhodes, Crete and Corfu (Nicholls 2005).

The above changes will entail negative impacts on tourism and recreation, mainly during July and August, as the average air temperature and heat wave frequency, intensity and duration are set to increase. The earlier start of the tourist season (in May) and its prolongation into September are likely to offset such repercussions. Thus, total tourist traffic is not projected to change significantly by 2100.

6.3.3 Biodiversity and ecosystems

Greece has one of the richest biodiversities in Europe and the Mediterranean on account of combined multiple factors, which include the country’s climatic variety, geographical location (at the junction of three continents), complex geologic history, and great topographic diversity (pronounced relief, land discontinuity, large number of caves, gulfs and seas, and until recently only moderate human intervention), all of which have fostered the development and support of a wide variety of plants, animals, ecosystems and landscapes. An important characteristic of Greek biodiversity is the high endemism observed in most animal and plant groups. Many endemic species have a very small distribution area (limited e.g. to one islet or one mountain) and are thus vulnerable to disturbance (Bank.of.Greece 2011).

Climate change ranks among the top direct causes of biodiversity loss, as well as of changes in ecosystem services globally (Millennium Assessment, 2005). The effects of climate change on biodiversity are multifaceted. Biodiversity can be affected by a combination of: (a) direct impacts on organisms (e.g. the effects of temperature on survival rates, reproductive success, distribution and behavioral patterns); (b) impacts through biotic interactions (e.g. conferral of competitive advantage); and (c) impacts through changes in abiotic factors (e.g. inundation, shifts in ocean currents).

However, climate change is not the only pressure on biodiversity and its effects are strongly dependent on interactions with other pressures, such as land-use change and habitat loss (Millennium Assessment, 2005), which reduce the abilities of organisms to adjust their distributions in response to changing climate.

Southern Europe is already experiencing extremely dry weather conditions, with precipitation levels having declined by as much as 20% in the course of the 20th century (EEA 2010). In fact, Mediterranean ecosystems rank among the most vulnerable in Europe (EEA 2005; Schroter, Cramer et al. 2005) and are close to reaching their environmental ‘tipping point’. Greece figures among the most vulnerable regions of Europe on account of rising temperatures and lower precipitation levels in areas already facing water scarcity, and on account of rising sea levels along its long coastal zone (EC 2009).

As regards the effects of climate change on species, differences in response and shifts in spatial distribution are expected for many species across Europe (Harrison, Berry et al. 2006). As part of a research project, projections of late 21st century distributions for 1,350 European plants species under seven climate change scenarios were made (Thuiller, Lavorel et al. 2005). More than half of the species studied could be vulnerable or threatened by 2080. In Southern Europe, particularly in parts of the Iberian Peninsula, Italy and Greece, species abundance is expected to decrease, while species distribution/migration will depend on habitat suitability.

The ***endemic plant and vertebrate species*** in the Mediterranean region seem to be particularly vulnerable to climate change. Under the assumption of no migration, most amphibians and reptiles in SW Europe are expected to face a significant loss of their distribution range (Araújo, Thuiller et al. 2006).

In order to estimate climate change impacts on biodiversity, Harrison et al. (2006) used the SPECIES neural network model to simulate the possible ‘climate space’ of 47 species throughout Europe. Concerning the study in Greece, in summary, three species —the Matricaria chamomilla, the Sciurus anomalus and the Quercus macrolepis— face a significant decrease in their forecast climate space within Greece, with losses of 88%, 98% and 56%, respectively, under one climate change scenario. Two plant species, the Genista acanthoclada and the Sarcopoterium spinosum, show large increases in climate space (as high as 386% and 198% under one scenario), spreading from the SW through Central and Northern Europe, and across Western France and Spain. Of all the olive tree species, the Olea europea gains the most ground, expanding west and northwest of its distribution area (Bank.of.Greece 2011).

According to Schwartz et al. (2006), the largest decreases in species abundance are expected to occur in Southern Europe, in regions of the Iberian Peninsula, Italy and Greece, with many Mediterranean islands projected, under specific conditions, to lose up to 100% of their current species abundance. With respect to certain ***mammals*** in Greece, according to Levinsky et al. (2007), the spiny mouse (Acomys minous) and the endemic Cretan white-toothed shrew (Crocidura zimmermanni) are predicted to become extinct under both severe and mild climatic scenarios, under the assumption of no migration. The same also holds for the mouse-tailed dormouse (Myomimus roachi) and the Caucasian squirrel (Sciurus anomalus). The endemic species, represented in the model with all of their climate locations, appear more vulnerable to climate change (based on the assumption of no migration) than other species, mainly due to their more limited distribution (Schwartz, Iverson et al. 2006).

As regards ***flora***, Kazakis et al. (2007) correlated the vascular plants of Crete’s White Mountains (Lefka Ori) with climate data. Under a scenario of temperature increase, southern aspect areas are likely to be invaded first by thermophilous species, while northern aspect areas are likely to be more resistant to changes. Species distribution shifts will also depend on habitat availability. Many, already threatened, narrow-niche endemic species will be affected first.

With respect to ***inland water fish*** and according to the Red Data List of the International Union for Conservation of Nature (IUCN), 60 of the 127 species native to Greece (~47%) are threatened by climate change. Of these 60 species, 31 are endemic and 35, according to the IUCN criteria, have been classified in risk categories; 10 (Crucially Endangered), 11 (Endangered) or 14 (Vulnerable).

As regards Greece’s ***forest ecosystems***, three changes could be attributed to or associated with climate change: the dieback of the Greek fir, the invasion of conifers into deciduous broadleaved forests, and the dieback of the Scots pine. In more detail:

- The first massive dieback of Greek fir in areas of the Peloponnese, but elsewhere in Greece as well, occurred in 1989, after two dry and extremely hot summers (1987, 1988) and was initially attributed to a bark beetle epidemic. However, bark-eating beetles are known to act secondarily and to attack already weakened trees. This dieback is still ongoing, possibly at lower intensity.
- Conifers, particularly the hybrid Greek fir (Abies borisii regis) and the Black pine (Pinus nigra), have begun to invade broadleaved forests, mostly forests of broadleaved oak (Quercus frainetto), Turkey oak (Quercus cerris), chestnut tree (Castanea sativa) and, to a lesser extent, beech.
- The dieback of the Scots pine in the Pieria mountain range has been attributed to an attack by fungi and insects, which could however be secondary.

Turning to ***wetland systems***, many ephemeral wetlands are expected to disappear, while other permanent ones will shrink. Mediterranean coastal wetlands seem in many areas to be particularly at risk of decline or considerable variation in sediment deposition, as their location makes them vulnerable to rising sea levels. Any significant loss of wetland area is expected to affect avian migratory routes, largely determined by the suitability of wintering and resting grounds on the south-bound journey. With respect to wetlands in Greece, based on unpublished data from the Greek Biotope/Wetland Centre (Bank.of.Greece 2011) and on water balance simulations for Lakes Chimaditis and Kerkini using historical climate data and Scenarios, Lake Chimaditis is expected to decrease in area by 20% to 37% and Lake Kerkini by 5% to 14%. Meanwhile, Lake Trichonis, Greece's largest lake is expected to present a water level decrease and its total nitrogen concentrations increase (Dimitriou and Moussoulis 2010).

The ***seagrass meadows*** of endemic Mediterranean marine angiosperm Posidonia oceanica seem to be highly vulnerable to the physical and chemical changes induced by extreme weather events (e.g. storms and floods; (Orr 1992), as such events lead to the increased discharge of suspended solids and pollutants into the marine environment.

As far as ***marine ecosystems*** are concerned, the Mediterranean Sea is projected to see an increase in temperature and a decrease in run-off (EEA-JRC-WHO 2008). Changes in the biochemical and physical seawater properties resulting from global warming are likely to alter marine biodiversity and productivity, trigger trophic web mismatches, and favor disease outbreaks, toxic algal bloom and the proliferation of warmer-temperature tolerant species (Gambaiani, Mayol et al. 2009). The gradual rise in sea surface temperature (SST) in the Mediterranean has facilitated the entry, acclimatization and settlement of tropical marine microalgae and other organisms (macroalgae, molluscs, fish; (Occhipinti-Ambrogi 2007)). An interannual analysis based on a recent inventory showed that the number of alien species in the Greek seas has increased in recent years (Pancucci-Papadopoulou 2005).

Apart from the physical impacts on biodiversity and ecosystems, an effort was also made in the present study to estimate the ***economic impacts*** of climate change. As mentioned earlier, biodiversity loss entails a degradation of ecosystem services. According to an ecosystem service approach reported by the Bank of Greece (Bank.of.Greece 2011) a valuation of the impacts of biodiversity loss was performed. A major initiative in the field of ecosystem service valuation and the development of 'toolkits' for policy makers was "The Economics of Ecosystems and Biodiversity" (TEEB), supported inter alia by the European Commission.

Using TEEB data, the economic costs of ecosystem service loss for forests and Lakes Chimaditis and Kerkini, was estimated, as envisaged for Greece for the period 2011-2100. According to Brenner-Guillermo (2007), the total economic value of ecosystem services provided by forests comes to $3,789/ha/year (base year: 2004). This value is the aggregate of the following components: water supply, genetic resource conservation, climate regulation, waste management/water purification, erosion prevention, nutrient cycling and soil fertility, pollination, biological control, 'gene pool' protection, recreation and tourism opportunities and various cultural services. At roughly the same time, Croitoru and Merlo (2005) estimated the total economic value of Mediterranean forests at $96/ha/year. The reason why this second estimate is so much lower is that it only covers the following components: wood and non-wood forest products, grazing, recreation, hunting, water-shed protection and carbon sequestration, as well as non-use values (existence values and bequest values for future generations).

Table 6. 10 Discounted cost of forest ecosystem service loss for lakes Chimaditis and Kerkini, 2011-2100

	Scenario A1B	Scenario A2	Scenario A1B	Scenario A2
Economic value of services ($/ha)	3,789		96	
	Lake Chimaditis			
Present value of cost (1%) (million $)	20,292	17,114	91,238	76,949
Present value of cost (3%) (million $)	8,540	6,868	38,397	30,881
	Lake Kerkini			
Present value of cost (1%) (million $)	35,593	39,592	160,034	178,016
Present value of cost (3%) (million $)	13,873	15,889	62,375	71,440

Source: (Bank.of.Greece 2011) "The environmental, economic and social impacts of climate change in Greece"

Table 6. presents the discounted cost of ecosystem service loss associated with the physical impacts of climate change for Lakes Chimaditis and Kerkini, using two different economic values per hectare and per year for the services provided by open freshwater ecosystems: the first value (per year) is the one estimated by Brenner-Guillermo (2007) at $1,890/ha (base year: 2004), as the aggregate of two main services: water supply ($1,011/ha) and recreation/aesthetic value ($880/ha). The second value is the one calculated by Costanza et al. (1997) at $8,498/ha, comprising such services as water regulation, water supply, waste treatment, food production, and recreation (Bank.of.Greece 2011).

6.3.4 Fisheries and Aquaculture

Fisheries and aquacultures referred as two different sectors in the NAS, however, in this document they are presented in the same chapter as the climate change impacts are similar for these sectors. The main factors of climate change that will affect the goods and services provided by the country's fisheries and aquaculture sector are related, first, to the expected rise in temperature and in CO2 dissolved in various water bodies, and, secondarily, to rising sea levels. Overexploitation and non-selective fishing gear, together with pollution and aquatic environment disruption (e.g. seafloor disturbance) are the main reasons for the reduced yield of natural fisheries. In addition, the impacts of changing climate on the physico-chemical and biological properties of water bodies (rivers, lakes, lagoons, seas) are expected to have different repercussions in each case on output potential and uses.

The total approx. area of Greece's lake water bodies is roughly 910 km^2 (natural lakes: 580 km^2; artificial lakes: 330 km^2). The seven largest natural lakes (Trichonis, Volvi, Vegoritis, Vistonis, Koronia, Little Prespa and Great Prespa) are situated for the most part in the plain areas of Northern Greece, while the five largest artificial ones (Kremasta, Polyphytos, Kerkini, Kastraki and Plastiras) are situated in mountainous/semi-mountainous areas of the country's central districts. The ecological status of most lakes in Greece has not been fully determined. The average fish production capacity of Greek lakes is estimated at 20-25 kg/ha per year (Ministry of Agricultural Development and Food, 1986-2005) (Konstantinou, Hela et al. 2006; Kagalou, Papastergiadou et al. 2008).

Of Greece's 26 rivers, three (i.e. rivers Evros, Nestos and Strymon) have their source in Bulgaria, one (river Axios) has its source in FYROM, while another one (river Aoos) has its source in Greece (in the northern part of the Pindos range) but its estuary in Albania. The overall ecological status of Greek rivers can be described as unstable and unpredictable, particularly in the plain regions they run through.

Mainland Greece comprises a total of 76 lagoons, covering a total area of roughly 350 km^2 (72% landlocked). Messolonghi (86.5 km^2) is the largest, followed by lagoons Vistonis (45 km^2) and Logarou (35 km^2). The overall ecological status of the above lagoons can be described as unstable due to their varying physico-chemical properties and their level of eutrophication. More predominant are the euryhaline species of fish, followed by certain stenohaline (marine) species, various invertebrates, and in some cases freshwater species.

Furthermore, Greece has the longest coastline of all the countries of the Mediterranean and the EU, with a total length of roughly 16,300 km and a total 1,354 gulfs and bays. The total sea area of Greece (470,000 km^2) is 3.6 times its total land area. Administratively, the country is divided into 13 regions, 12 of which are coastal (only one is land-locked). The length of coastline prone to erosion has been estimated at 3,945 km (28.6%). More than 85% of the total population lives within 50 km of the coast, and 69% of the national GDP (€140,268 million) is produced there.

Greece’s larger gulfs - such as the Thermaikos, Pagassitikos, Saronikos (Saronic), Corinthiakos (Corinth), Evoikos (Euboean), Amvrakikos - are the more ecologically degraded. Some of the more closed gulfs, such as the Thermaikos, experience seasonal toxic phytoplankton blooms. The marine environment’s ecological degradation is primarily due to the disposal of solid and liquid waste from the coast, navigation (e.g. crude oil tankers), and overfishing, and, to a lesser extent, to the unorthodox use of floating cages in coastal fish farming. The open seas are, on the other hand, less affected by human activities, and their overall ecological status is satisfactory to very good (Bank.of.Greece 2011).

Physical impacts of climate change on Greece’s fisheries production

The apparent rise in temperature, combined with lower precipitation levels, can lead to unexpected fluctuations in river flows and to unpredictable ecological degradation downstream, as competition for water obviously reduces water availability. Numerous lakes are also projected to be at similar risk, particularly at times of prolonged drought. This is expected to lead to a degraded environment for the ichthyofauna and to a possible decrease in the productive potential of inland waters (Bobori and Economidis 2006; FAO 2008; Allison, Perry et al. 2009).

The rise in sea temperatures is likely to accelerate the growth rate of poikilothermal aquatic animals. It is difficult, however, to predict whether this could translate into higher fisheries production, given that verification would require an area that is not fished and that the fisheries status of an area is predominantly determined today by overfishing, rather than by natural factors. Interestingly, despite the fact that the SST of the Aegean has risen in recent decades by 1.5ºC, catches have not increased (in fact, they have decreased). It has been estimated that for every increase of 1ºC in SST over the period from 1990 to 2008, the average fish production in almost all categories fell by 0.8% (taking into account the reduction in the fishing fleet, and leaving all other factors unchanged). These lower production levels may, apart from overfishing, also be attributable to changes in nutrient levels in the Greek seas.

The temperature rise will, in addition to a sea level rise (SLR), also bring about changes in biodiversity, fishing ground characteristics (biological, physical, chemical and hydrological) and available stocks of commercial importance. The total area of wetlands, which provide important spawning and nursery grounds, would be greatly diminished. The rise in temperature would also affect the migration of fish to and from their spawning and feeding grounds. A generalised change in sea temperature could quite possibly cause changes in water circulation (surface, toward the coast, upward, downward, coastal currents), with all that this would entail for the ecological/productive capacity of different water bodies. At this stage, it should be pointed out that changes in rainfall seem to affect only cephalopods and malacostraca (with decreases of 20 mm in rainfall translating into 2% less production) (Bank.of.Greece 2011).

Physical impacts of climate change on aquaculture in Greece

The continued use of intensive aquaculture production systems is soon expected to generate serious ecological/environmental problems, particularly in cases where coastal floating cages are used. As a result, production is likely to decrease. In addition, the increased frequency and intensity of extreme weather events, e.g. tornados, could cause considerable damage not only to fishing boats and floating cages, but also to fish and mussel farming facilities along the coast (Papoutsoglou 1994; Pagou 2005; Bank.of.Greece 2011).

Finally, because of the apparent rise in sea and lagoon water levels, aquaculture systems and methods are likely to be seriously reconsidered (e.g. the need to avoid coastal areas). The rise in coastal sea levels is also likely to affect the reproduction and growth of various species of fish, as well as the overall level of fisheries productivity (EC 2008; FAO 2008).

Analysis of fish catch variations in Greece and future estimates

(a) Analysis of fish catch variations in Greece in relation to SST variations, and future estimates (Bank.of.Greece 2011): An increase of 3.3ºC in SST by 2100 (according to the climate model simulations) would, based on the foregoing analysis, translate into decreases in Greece of benthic fish catches by 3.6% of the mean and of mesopelagic fish catches by 4.2% of the mean. Large and small pelagic fish catches would increase by 40 tonnes respectively, i.e. by 1.7% and 0.13% of the mean. Total catches would fall by roughly 2.5% of the mean. The variation in catches over 1990-2009 are presented in ***Table 6.8***.

Table 6. 11 Total fisheries production and variations, 1990-2009 (In tonnes)

Types of fish	Total	Annual variation	Variation over 20 years
Benthic	1,335,953	-1,854	-37,080
Small pelagic	611,967	+0.3	+6
Mesopelagic	248,789	-571	-11,420
Large pelagic	47,595	-66	-1,320
Total	2,244,304	-2,491	-49,814

(b) Correlating catch variations with variations in rainfall (Bank.of.Greece 2011): The impacts of anthropogenic climate change on fisheries production, as estimated on a global scale by the Intergovernmental Panel on Climate Change (IPCC), can be summarised as follows:

1. Changes and local fluctuations in sea and inland water fisheries production are to be expected, as well as a mixing of different species.

2. The stock of sea fish species that reproduce in inland waters (e.g. the European eel) or needing low salinity wetlands is also expected to decrease.

Economic impacts

With respect to the economic cost assessment of climate change for commercial fisheries, the average annual volume of fish catches between 1990 and 2009 came to 112,215 tonnes. Assuming that this average annual fish catch volume will remain unchanged until 2100 and based on r estimates that a 3.3ºC rise in SST by 2100 would entail reduced total catches by 2.5% (or 2,805.37 tonnes) and that, according to NSSG data (2009), 2007 catch prices ranged from €0.6 to €25.1 (with a mean of €5.3 and a median of €4.2), the income loss at 2007 prices in 2100 would amount to €14,868,461 (based on the mean), or €11,782,554 (based on the median).

The welfare loss due to the effect of climatic changes on biodiversity is estimated at €37.91/person and at €602/household. The difference between these estimates is due to the fact that the first uses the redistribution of present taxation as a payment vehicle in their valuation study. A review of the relevant literature shows that, in this case, estimates are higher than in studies where new taxes are used to finance the good in question. Consequently, when carrying out a cost/benefit analysis, it is preferable to use the more conservative estimates per household. The relevant population affected by the climate change-related impacts on marine biodiversity was defined to be the population living within 50 km of the coast.

By extrapolation, the total economic cost due to biodiversity loss ranges from €287,457,124 to €1,895,654,656 (Bank.of.Greece 2011).

6.3.5 Water resources

The state of Greece's water reserves and water management is of specific interest, with certain particularities indicative of the level of actual development and organization. With regard to these particularities, Greece presents a wide variety and complexity of situations, the most predominant of which are (Bank.of.Greece 2011):

- the uneven temporal distribution of precipitation, with over 85% of total precipitation falling during the winter (wet season) and the rest occurring in the summer (dry season);
- the highly uneven spatial distribution of precipitation, with higher rates of precipitation reported in Western Greece (west of the Pindos mountain range) and lower rates reported in Eastern Greece;
- the fact that the northern part of Greece is (quantitatively and qualitatively) affected by transboundary waters, with four major rivers originating in neighbouring countries, i.e. three in Bulgaria (the rivers Evros, Nestos, Strymon) and one in FYROM (the river Axios);
- an important period of water demand imbalance, with peak abstraction for irrigation and tourism typically occurring in the summer months when water availability is generally at a minimum (almost no rainfall).
- the highly uneven spatial distribution of demand, as a result of overconsumption associated with the excessive concentration of people in urban centers, the coastal zone and other areas;
- the country's complex configuration, both in geological terms (aquifer and surface flow) and geomorphological terms (surface flow generation);
- the tremendous length of Greece's coastline (approximately 16,300 km), relative to the country's total area, which, combined with the over-pumping of coastal aquifers, favours inland seawater intrusion; and
- the conditions specific to most of the Aegean Sea's many islands (low levels of rainfall, small overall surface, rough topographic relief with high surface runoff and low soil infiltration).

In terms of water reserves, Greece rightly qualifies as a 'rich' country, in comparison, of course, with the rest of the broader Mediterranean region, and this for a number of reasons associated with, and responsible for, the atmospheric precipitation regime. Quite remarkably for a country situated in the Mediterranean basin, Greece's mean annual precipitation is in the order of 800 mm, both on account of more general factors shaping the country's climate and weather patterns and on account of the country's complex topographic relief. A key factor in this respect is the Pindos mountain range, which receives moist winds from the west. Thus, precipitation west of the Pindos ridge is far heavier than in the regions to the east.

Water balance per region

The difference between the quantity of the known water resources and the quantity that is currently used is not always reflecting a real surplus, since it is not the total of known water that can be totally exploited because of technico-economical and quality limitations, as well as to the continuously rising water demand in specific areas and time seasons.

The National Program on Management and Protection of Water Resources presents three scenarios of water balances, following the current, the medium-term and the long-term situation of water demand and supply, respectively. The scenarios refer to the values of water supply-demand during July, since this is the worse season as regards water balances (increased demand, minimum supply). Each of the water regions of the country have been characterized, using the following terminology:

- *Superfluous:* if the supply exceeds demand by more than 110%.
- *Marginally superfluous:* if the supply exceeds demand by a percentage oscillating between 100% and 110%.
- *Marginally unbalanced:* if the supply is oscillating between the 90% and 100% of the demand.
- *Unbalanced:* If the supply is less than 90% of the demand.

Table 6. 12 Comparison of water supply and demand during July (in hm^3): Current situation by water region.

No	Water Regions	Supply	Demand	Observations
1	Western Peloponnese	73	55	Superfluous
2	Northern Peloponnese	122	104	Superfluous
3	Eastern Peloponnese	56	67	Unbalanced
4	Western Sterea Ellada	417	82	Superfluous
5	Epirus	206	39	Superfluous
6	Attica	64	64	Marginally superfluous(1)
7	Eastern Sterea Ellada	128	176	Unbalanced(2)
8	Thessaly	223	337	Unbalanced
9	Western Macedonia	159	136	Superfluous
10	Central Macedonia	137	130	Marginally superfluous
11	Eastern Macedonia	354	132	Superfluous
12	Thrace	424	253	Superfluous
13	Crete	130	133	Marginally unbalanced(3)
14	Islands of the Aegean Sea	7	25	Unbalanced
	TOTAL	**2500**	**1733**	

(1)Water resources are principally transported by neighboring water regions.

(2)The number of irrigated areas as reported by NSSG is considered overestimated. As a result while the particular region is currently marginally sufficient, it is presented here as unbalanced.

(3)Like it is happening at present, the demand is expected to be met by water springs and drills.

Source: National Programme on Management and Protection of Water Resources, 2008.

Table 6. 13 Comparison of water supply and demand during July (in hm^3): Medium-term scenario by water region.

No	Water Regions	Supply	Demand	Observations
1	Western Peloponnese	88	85	Marginally superfluous
2	Northern Peloponnese	122	120	Marginally superfluous
3	Eastern Peloponnese	56	67	Unbalanced
4	Western Sterea Ellada	417	84	Superfluous
5	Epirus	206	45	Superfluous
6	Attica	57	56	Marginally superfluous(1)
7	Eastern Sterea Ellada	128	187	Unbalanced(2)
8	Thessaly	372	337	Marginally superfluous
9	Western Macedonia	159	146	Marginally superfluous
10	Central Macedonia	148	152	Marginally unbalanced
11	Eastern Macedonia	354	140	Superfluous
12	Thrace	424	352	Superfluous
13	Crete	130	133	Marginally unbalanced(3)
14	Islands of the Aegean Sea	11	25	Unbalanced
	TOTAL	**2624**	**1927**	

(1)Water resources are principally transported by neighboring water regions.

(2)The number of irrigated areas as reported by NSSG is considered overestimated. As a result while the particular region is currently marginally sufficient, it is presented here as unbalanced.

(3)Like it is happening at present, the demand is expected to be met by water springs and drills.

Source: National Programme on Management and Protection of Water Resources, 2008.

Table 6. 14 Comparison of water supply and demand during July (in hm^3): Long-term scenario by water region.

No	Water Regions	Supply	Demand	Observations
1	Western Peloponnese	125	123	Marginally superfluous
2	Northern Peloponnese	122	140	Unbalanced
3	Eastern Peloponnese	56	163	Unbalanced
4	Western Sterea Ellada	417	94	Superfluous
5	Epirus	206	56	Superfluous
6	Attica	57	81	Unbalanced (1)
7	Eastern Sterea Ellada	128	287	Unbalanced(2)
8	Thessaly	425	337	Superfluous
9	Western Macedonia	159	146	Marginally superfluous
10	Central Macedonia	159	188	Unbalanced
11	Eastern Macedonia	354	140	Superfluous
12	Thrace	578	680	Unbalanced
13	Crete	170	164	Marginally unbalanced(3)
14	Islands of the Aegean Sea	21	25	Unbalanced
	TOTAL	**2905**	**2622**	

(1)Water resources are principally transported by neighboring water regions.

(2)The number of irrigated areas as reported by NSSG is considered overestimated. As a result while the particular region is currently marginally sufficient, it is presented here as unbalanced.

(3)Like it is happening at present, the demand is expected to be met by water springs and drills.

Source: National Programme on Management and Protection of Water Resources, 2008.

The results for each scenario are presented in the following tables. In the current circumstances, an important water quantity (in particular, groundwater) is accepted by the water region 1 (8% of its potential). This quantity corresponds to the 9% of the region 2, from which is exported. In absolute values the most important internal water transport between regions is the one from the region 4 mainly to region 6 (Attica). This is an example of the urban water deficiency, as all this imported water is used for the water supply of Athens.

In the medium and long term scenarios, the current situation is different due to the completion of the works regarding the diversion of the Acheloos River towards the region of Thessaly (8). In that way, the water region 4 will export 13% of its potential towards the regions 6 and 8 and the region of Thessaly, which is currently unbalanced, will receive about 16% of its water potential. It is important to note that in order to avoid water stress in some areas of the country the percentage of internal water transport is projected to be doubled.

International water sources are flown into the country from regions 10, 11 and 12 (northern Greece). It is therefore very important to stress out that the impact of climate change on the rivers of neighbour countries will also affect the Greek balance.

Conflict and mismatch between water requirements and water resources

The spatial examination of water sufficiency on a regional or national scale is where the concept of available water reserves comes into play. These reserves represent resources minus water abstraction on a local scale, and resources minus consumption on a national (or drainage basin) scale. One fundamental reason for this distinction is that water abstracted (for instance, at a local scale) may re-enter the system, thus becoming available for re-use, meaning that the available water resources need to be 'recalculated' to take any water re-entrances into account. In any event, management programs need to distinguish between "water transfer" (from one basin or sub-basin to another, which alters the regional distribution of natural and exploitable natural resources) and "water addition" (transfer of water from a site of withdrawal to another area for use).

When examining water as a natural resource in adequacy terms, a clear distinction needs to be made between two very different concepts, sometimes confused even by specialists and policy makers. The first concept, drought or aridity, refers to a deficiency in the water supply to the environment – either direct (rainfall) or indirect (surface and underground), relative to the measurements of past time series. The second concept, water scarcity, refers to a decrease in available water potential, in comparison with present or anticipated use. Water scarcity can be a result of a drought (in which case the two concepts may quantitatively coincide), but can also occur at a time of normal or above-average water supply, as a result either of water mismanagement or of incorrect water use planning.

When discussing water availability issues, another major consideration is the breakdown of consumption by sector. At the global level, agriculture is the prime consumer of water: water consumption driven by agricultural needs has not only risen exponentially, it is projected to exceed 3,000 million m^3 by 2025 (Bank.of.Greece 2011), i.e. six times the consumption of the early 20th century. The industrial sector, second in terms of quantities consumed, also accounts for a steady rise in water consumption. By 2025, the water consumed by the global industrial sector is projected to be in the order of 1,000 million m^3. Water consumption by households, i.e. the sector that has always had the smallest consumption, is also projected to increase significantly.

Typical cases of water scarcity are presented by the Greek islands, especially the smaller ones, but also by the Attica region. Several islands (for instance the Cyclades) used to have sufficient water resources, despite low precipitation levels, small total surface area (hence limited potential for water accumulation) and high temperature and sunshine levels (thus high evaporation). However, the shift in land use away from traditional agriculture, stockbreeding, etc. to tourism activities, the sharp influx of tourists during the summer, improved living standards (more frequent showering and laundering, etc.) and changes in lifestyle (swimming pools, car washing, gardening, etc.) generate a higher demand for water, which the existing water potential cannot meet. The problem is further exacerbated by the uneven distribution of rainfall, both temporal and spatial. Similar in nature is the problem faced by the Attica region, which includes the wider urban area of Athens and Piraeus and the surrounding municipalities. As a result of intense rural migration and residential, economic and administrative centralization, the Attica basin at the end of the 1990s accounted for over 40% of the total national population and close to 70% of total national economic activity (Bank.of.Greece 2011).

Droughts

Like other natural hazards, drought has both a natural and social component. The risk associated with drought for any region is a product of both the region's exposure to the event and the vulnerability of society to the event. Vulnerability, on the other hand, is determined by social factors such as population changes, population shifts (regional and rural to urban), demographic characteristics, technology, government policies, environmental awareness, water use trends, social behaviour, level of water development and/or exploitation, and water availability in general. These factors change over time and thus vulnerability is likely to increase or decrease in response to these changes. Subsequent droughts in the same region will have different effects, even if they are identical in intensity, duration, and spatial characteristics, because societal characteristics evolve through time.

Drought is a natural hazard that differs from other hazards in that it has a slow onset, evolves over months or even years, affects a large spatial region, and causes little structural damage. Its onset and end, and the severity of drought are often difficult to determine. Like other hazards, the impacts of drought span economic, environmental, and social sectors and can be reduced through mitigation and preparedness. Because droughts are a normal part of climate variability for virtually all regions, it is important to develop plans to deal with these extended periods of water shortage in a timely, systematic manner as they evolve. To be effective, these plans must evaluate both a region's exposure and vulnerability to the hazard and incorporate these elements into a drought preparedness plan that is dynamic, evolving with societal changes.

Droughts differ from one another in three essential characteristics: intensity, duration, and spatial coverage. Intensity refers to the degree of the precipitation shortfall and/or the severity of impacts associated with the shortfall. It is generally measured by the departure of some climatic index from normal and is closely linked to duration in the determination of impact. Another distinguishing feature of drought is its duration. Droughts also differ in terms of their spatial characteristics. Drought impacts are closely related not only to the magnitude of the event, but also the timing of the onset, duration, and spatial extent. The spatial and temporal characteristics of drought affect the planning and responses.

Physical impacts of climate change on Greece's water sector

The hydrological cycle begins with evaporation and atmospheric precipitation (rainfall, snowfall, hail, etc.). Upon reaching the earth's surface, precipitation waters are separated at a primary stage into evaporation/transpiration (through vegetation), drainage (through the hydro-graphic networks), and infiltration. At a secondary stage, the picture becomes more complex, as drained water may, further down the line, either evaporate or partly infiltrate and, conversely, infiltrated water may flow out to the surface through spring discharges, only to undergo surface drainage and partial evaporation. These processes can occur several times. Moreover, before recharging the underground aquifer, infiltration water first satisfies the water needs of the ground and underground zones and of the root system (detained, adsorbed, capillary water), where plant and animal organisms grow. Therefore, any change in the atmospheric precipitation regime inevitably entails significant changes in the entire hydrological cycle, as well as in hydrological (surface) and hydrogeological (underground) water balances.

The primary factor that determines the distribution of total annual precipitation in Greece, which averages 800 mm, is the presence of the Pindos mountain range, to the West of which precipitation levels are considerably more important than in Eastern Greece. The water deficit is normal, with the distribution of surface drainage broadly matching rainfall distribution. For instance concerning the Thessaly water district: the increase in rainfall from 130 mm in 1989-1990 to 170 mm in 1990-1991 (increase of about 30%) resulted in an increase in drainage from 26 mm to 50 mm (increase of about 90%). The decrease in rainfall from 170 mm to 140 mm (decrease of about 17%) brought about a decrease in drainage, from 50 mm to 33 mm (decrease of about 70%). This seems to indicate that an increase in rainfall is associated with a three-fold increase in drainage, whereas a decrease in rainfall is associated with a roughly similar decrease in drainage.

Three factors ―geographical location (winward/leeward), morphology and geology― determine water accumulation, both in surface water bodies (lakes) and underground (extensive karstic fields). The vulnerability of karstic formations to pollution means, however, that there can be degradation in water system quality. Climate change is expected to result in increased evaporation and transpiration, increased needs for irrigation and, perhaps, tourism, and increased pollution concentrations, due to decreased dilution (increased load in smaller water volumes) (Stournaras 2007; Bank.of.Greece 2011).

Evapotranspiration represents an important hydrological loss, occurring both on the surface and in upper soil layers. Evapotranspiration rates in Greece are high, particularly in the drier eastern regions.

The impacts of climatic change on water systems (mainly underground water systems) can be summarised as follows:

1. An overall decrease in aquifer infiltration and recharge, as a result of decreased rainfall and higher evapotranspiration.
2. Increased salinity of coastal and subsea aquifers, particularly karstic ones, as a result of the advance of the sea-water intrusion farther inland due to the decline of groundwater levels caused by lower inflow and overpumping.
3. Higher pollutant load concentrations in coastal water bodies and the sea, due to decreased dilution.
4. Faster degradation of deltaic regions, in cases where degradation has already begun as a result of transversal dam construction upstream (reduced drainage and sediment discharge) and parallel levee construction in the flat zone of the deltas (debris channeled to a single outlet).
5. Contamination or drainage of coastal wetlands.
6. Amplification of the desertification phenomenon as a result of water deficits and soil changes (compaction, sealing, etc.).

Fresh water salinization

Freshwater inland resources can be contaminated due to the intrusion of saline water, both underground and on surface, increasing drought problems (e.g. experienced in 2003 in the southern region of the

Venice lagoon), both for human use and agriculture production. Problems of saline intrusion would be further exacerbated by reductions in runoff and by increased withdrawals in response to higher demand. Excessive demand already contributes to saline intrusion problems in many coastal areas of Italy, Spain, Greece and North Africa.

Large areas of the Mediterranean coastline have already been affected by saline intrusion driven by abstraction of water for agriculture and public water supply, with demand for the latter being markedly increased by tourism. Across Greece, for example, it is estimated that the total surface area of aquifers impacted by seawater intrusion is about 1,500 km^2 (Daskalaki P. and Voudouris 2007). The Argolid Plain in eastern Peloponnesus in Greece has undergone a rapid expansion of irrigated agriculture since the 1950s. Groundwater abstraction to support the irrigation of oranges, horticultural crops and olives has been excessive and led to the intrusion of sea water into aquifers. This phenomenon was first recorded in the early 1960s, when groundwater, pumped from certain wells, showed an increase in the concentration of chloride. On the Argolid Plain boreholes have had to be abandoned due to excessive levels of salinity found in the groundwater as a result of such salt water intrusion.

A typology of the economic impacts of water use

Water resources provide goods and services, the management of which has an economic and a socio-political dimension, and concerns several sectors of the economy. The possible economic impacts of climate change on freshwater availability are, thus, likely to affect a wide range of activities highly important to society, with additional repercussions further down the line. The major economic impacts expected include:

1. Lower productivity on account of the shortage (and, as a result, the poorer quality) of water resources in sectors where water is a major input in the production process (agriculture, hydroelectric power plants, industry, forestry, aquaculture, etc.).
2. Increased cost of pollution and wastewater treatment.
3. Increased risks (flooding, fires, etc.).
4. Decrease in benefits from recreation activities.
5. Loss of benefits due to damage to water ecosystems.
6. Higher cost of extracting underground waters.
7. Increased risk of further seawater intrusion into underground aquifers.
8. Impacts on human health.
9. Negative impact on welfare, as a result of possible restrictions on water use.

The intensity of these economic impacts is, of course, expected to vary in function of the severity of the respective climate changes.

Water reserves, climate change and the economic cost of non-action in Greece

Published research on the economic assessment of water resources in Greece covers a wide range of goods and services. Unfortunately, the heterogeneity of the units used to measure the impacts makes the use of the relevant results for ‘benefit transfer’ problematic. Furthermore, the monetary valuations available from Greek studies do not seem to serve even ‘conservative’ estimates.

In Greece, the needs of the Attica and greater Thessaloniki areas are met, respectively, by the Athens Water Supply and Sewerage Company (EYDAP) and the Thessaloniki Water Supply and Sewerage Company (EYATH). In all other regions, the domestic water supply is managed either by a Municipal Water Supply and Sewerage Company (DEYA) or, otherwise, by a similar municipal service. These companies are usually able to recover their operating and administrative costs, plus part of the capital costs of the water supply and sewerage networks and of municipal well drillings, if needed. In brief, from the perspective of the Greek consumer, there is a wide disparity in what water bills actually cover and which body they are payable to, while from the perspective of the water companies only part of their total costs are recovered. In order to estimate the impacts at a Water District level, reference values were used corresponding to the average prices charged by the DEYAs for 1 m3 of water (Hellenic Union of

Municipal Enterprises for Water Supply and Sewerage, 2007). Meanwhile, in order to estimate the costs from climate change the following research assumptions were adopted: a) to estimate future demand, average expected water consumption was set at 200 liters daily per person for permanent residents and at 300 liters per person and overnight stay for tourists; b) the number of overnight stays in future was considered to remain stable, i.e. the same as today's; c) the price of water was also considered to remain stable. The cost estimates are given both undiscounted and discounted using discount rates of 1% and 3%.

During the decade 2041-2050, the impact of climate change on the water supply sector alone would cost from 0.89% to 1.32% of GDP. During the decade 2091-2100, the decline in GDP would start at 0.51% in the best case and climb as high as 1.84% of GDP (Bank.of.Greece 2011).

The final stage of the economic valuation process consisted in estimating the cost of the climate change impact in Net Present Value (NPV) terms. The NPVs were estimated both undiscounted and discounted (using discount rates of 1% and 3%). When discounting was used, the total cost for the Greek economy was found to be greatest at 1.69% of GDP, and lowest at 0.34% of GDP. The climatic zones most vulnerable from an economic point of view were shown to be Central Macedonia and Central, Eastern and Western Greece.

6.3.6 Coastal zones

State of play of Greece's coastal zone

With a total shoreline of roughly 16,300 km, Greece has the most extensive coastal zone of any country in Europe. Almost half of this coastal zone is located in continental Greece, with the remaining half dispersed among Greece's 3,000 islands (or 9,800, if islets are included). About 33% of the Greek population resides in coastal areas within 1-2 km of the coast. If we define 'coastal population' as the population residing within 50 km of the coast, Greece's coastal population represents 85% of the total.

Twelve of Greece's total 13 administrative regions (prefectures) qualify as coastal (only one administrative region is landlocked). Located in the coastal zone are: (a) the country's largest urban centres (Athens, Thessaloniki, Patras, Heraklion, Kavala, Volos), (b) 80% of national industrial activity, (c) 90% of tourism and recreation activities, (d) 35% of the country's farmland (usually highly productive), (e) the country's fisheries and aquaculture, and (f) an important part of the country's infrastructure (ports, airports, roads, power and telecommunication networks, etc.).

The coastal zone encompasses important habitats, which contribute to the conservation of biogenetic reserves. Indicatively, over 6,000 different species of flora, 670 species of vertebrates, and 436 species of avifauna are found in the coastal zone.

Marine ecosystems, by sequestrating carbon, play a major role in regulating the climate, while phytoplankton through the process of photosynthesis releases oxygen into the atmosphere.

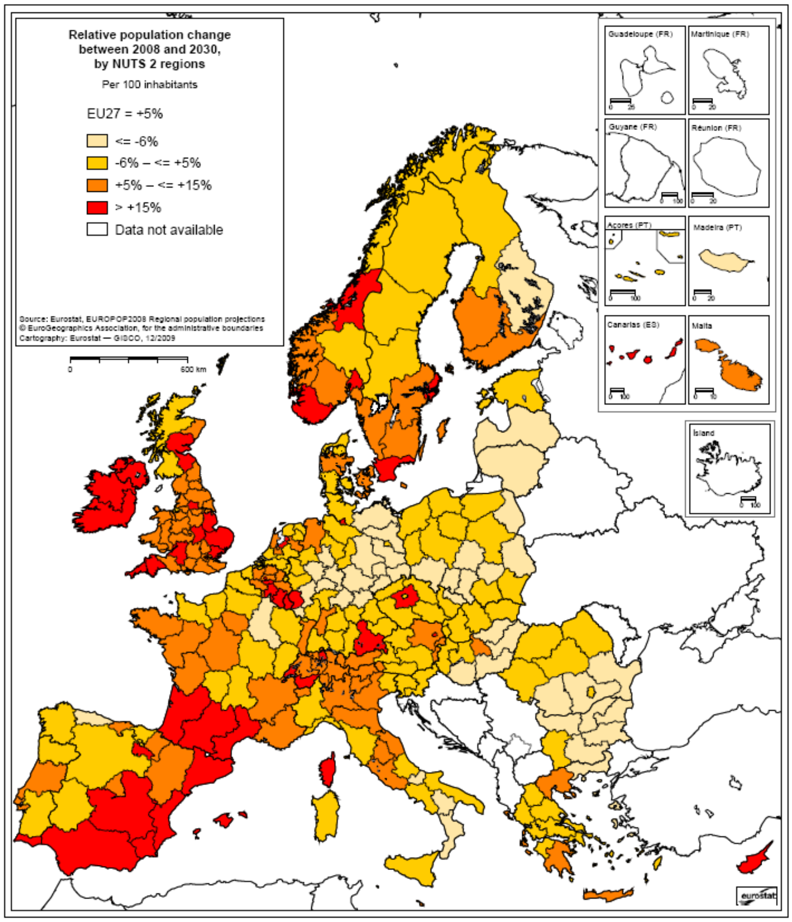
Coastal areas help generate and preserve microclimates. The presence of coastal forests and wetlands ensures the minimization of floods, erosion and other natural disasters, and offers valuable regulating and supporting ecosystem services. The last 20 years have seen a boom in the construction of summer houses in Greece's coastal areas. The total urbanized area in the coastal zone is estimated at 1,315 km^2, or 1.31% of the total area of Greece.

The threats to the Greek coastal and marine environment can be natural (e.g. erosion), but mostly stem from anthropogenic driving forces (e.g. overexploitation of natural resources, urbanisation, pollution, eutrophication, invasive species).

One major problem of the Greek coastal zone is the high rate of **coastline erosion**: over 20% of the total coastline is currently under threat (EUROSION 2004), making Greece the 4th most vulnerable country of the 22 coastal EU Member States. The main reasons for the increased erosion are the particularly strong winds and storm surges in the Aegean Sea, anthropogenic interventions – e.g. dams that reduce sediment discharge (Llasat, Llasat-Botija et al.) – and the geomorphology of the coastline substrate: 2,400 km (15% of the total shoreline) correspond to non-consolidated sediment deposits, while 960 km (6% of the total shoreline) correspond to coastal deltaic areas.

Erosion is expected to increase in the immediate future, due to (a) the anticipated rise in mean sea level; (b) the intensification of extreme wave phenomena; and (c) the further reduction of river sediment discharge as a result of variations in rainfall and the construction of river management works.

According to regional population projections (Eurostat, 2009) the majority of the European regions are projected to have a larger population in 2030, as shown in ***Figure 6.23***.



For Norway and Switzerland level 2 statistical regions
Source: Eurostat, regional EUROPOP2008

Source: Eurostat (http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/)

Figure 6.23 Relative population change between 2008 and 2030

Changes in sea level and geomorphology/geodynamics

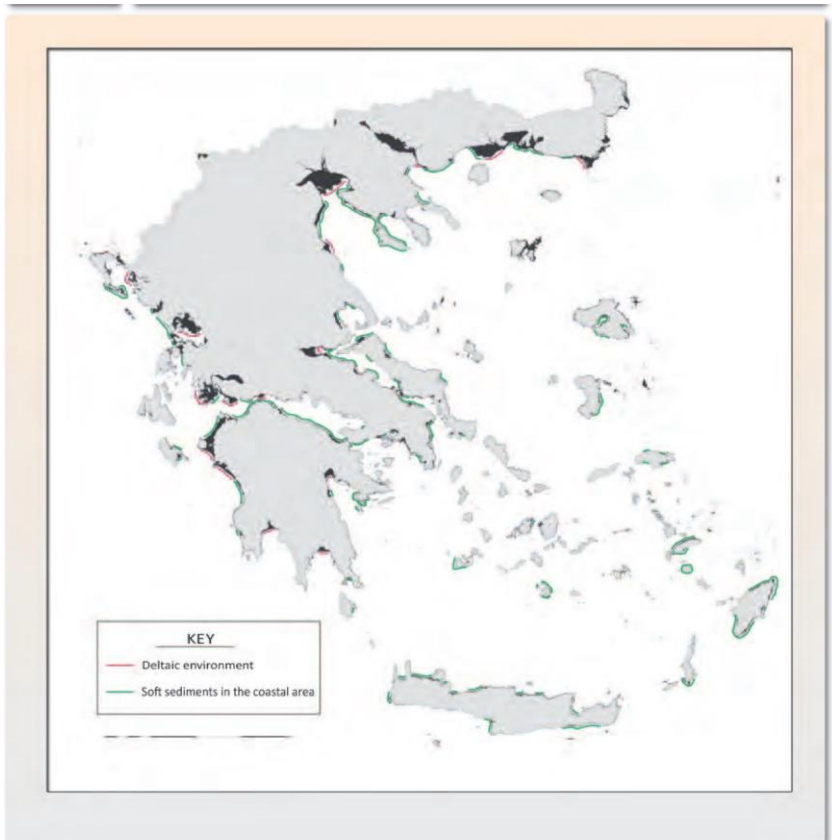
The role of tectonics is especially important in tectonically active zones (Vött 2007), as it can counterbalance the relative sea level rise (SLR) when there is a tectonic uplift, or conversely, amplify the SLR when there is tectonic subsidence. Typical examples include the coastal zone of the Northern Peloponnese (with an uplift rate of 0.3 to 1.5 mm/year), Crete (with 0.7 to 4 mm/year) and Rhodes (with 1.2 to 1.9 mm/year). Thus, a supposed average SLR rate of 4.3 mm/year would be reduced to 3.5 mm/year due to the counteraction of a mean tectonic uplift of 0.8 mm/year. Changes, i.e. increases in fluvial sediment discharge and deposition in deltaic plains can result in the advance of the shoreline and locally offset the sea level rise (Poulos and Collins 2002; Bank.of.Greece 2011). Conversely, reduced fluvial sediment discharge can reinforce the incursion of the sea following a sea level rise.

Using maps of a scale of 1:50,000 and basing ourselves on the SLR recorded in past decades, it was possible to indicatively map Greece's coastal areas according to their vulnerability to a potential SLR of 0.2 to 2 m by 2100. Thus, three main categories were identified:

1) **Deltaic coastal areas**. Formed of loose, unconsolidated sediment deposits and are highly vulnerable to sea level rise.

2) **Coastal areas consisting of non-consolidated sediments of Neogene and Quaternary age**. Coastal areas, usually of low altitude, are prone to recessional erosion and present medium vulnerability to sea level rise.

3) **Rocky coastal.** These coastal areas, sometimes of high altitude, consist mostly of hard rock of low vulnerability to erosion and SLR, and form the bulk of Greece's coastline.



Coastal areas in Greece with medium (green colour) and high (red colour) vulnerability. Black colour indicates areas with altitudes below 20 m, usually of loose sedimentary deposits.
Source: Papanikolaou et al. (2010).

Source: (Bank of Greece, 2011) " The environmental, economic and social impacts of climate change in Greece"

Based on the above categorisation, the **'high risk'** coastal areas of Greece include the deltaic areas of the following rivers: Evinos (Messolonghi); Kalamas (Igoumenitsa); Acheloos; Mornos (Nafpaktos); Pineios; Alfeios (Ilia); Aliakmon and Axios (in the Thermaikos gulf); Pineios (NW Aegean, near Platamon); Strymon (near Amfipolis); Nestos (towards Abdera); Evros; as well as the deltaic regions in the Malliakos, Amvrakikos, Lakonikos, Messiniakos and Argolikos gulfs. All of the other coastal areas are characterised as being of 'low vulnerability' and usually consist of rocky and high altitude coastal formations.

Assessing the severity of SLR impacts on coastal areas involves uncertainties with regard to: (a) The intensity of the sea level rise, ranging between 0.2 m and 2 m. SLR is determined by the interaction of several parameters, natural (e.g. astronomical) and anthropogenic (e.g. greenhouse gas forcing). The severity of each factor will affect the overall development of the climate cycle we are currently in, which seems to be at the peak of the current 'warm' interglacial period. (b) The relationship between tectonic uplift and eustatic SLR. Quite important in several areas of Greece, the tectonic uplift may be significant enough to offset or locally even exceed SLR. (c) The sedimentation of clastic materials in coastal areas, determined by geological and climatic conditions, as well as by human intervention (e.g. dams, river sand mining) and capable, e.g. in the case of river deltas, of altering the vulnerability to SLR. An estimation of the length of these three types of coastal areas showed that from a total of 16,300 km, 960 km (6%) correspond to deltaic areas of high vulnerability, 2,400 km (15%) correspond to non-consolidated sediments of medium vulnerability, with the remaining 12,810 km (79%) corresponding to rocky coastal areas of low vulnerability. The total length of coastline presenting 'medium to high' vulnerability to SLR therefore roughly amounts to 3,360 km (21% of Greece's total shoreline).

Storm surges – wave storms

Apart from long-term SLR, other climate phenomena capable of causing coastal erosion are the anticipated increase in storminess and frequency of storm surges (IPCC 2007). The strong coastal waves caused by stormy winds (and accompanying wave currents) cause erosion, whereas the normal, low-mid energy waves cause sediment deposition (Komar 1998). Storm surges and SLR are distinct phenomena. However, SLR (which is caused by the thermal expansion of seawater as it warms and the melting of continental ice) may increase the intensity and frequency of storm surges. Changes in mean sea level and in storm intensity (amplified by climate change) may cause extreme wave phenomena and potentially serious damage to coastal areas. The reason for this is that strong winds affect larger water masses which unleash more energy in storm surges, while the height of the waves increases relatively to the mean sea level rise. As a result, the waves penetrate further into the coastal areas, producing significant impacts on coastline morphology (Krestenitis, Androulidakis et al. 2010). The impacts of storm surges include:

- flooding of coastal areas;
- destruction of coastal infrastructure (roads, coastal engineering works, etc.);
- coastal erosion; and
- intrusion of salt water in coastal habitats, lagoons, river, estuaries, etc.

Economic impacts of mean sea level rise in Greece

For a more thorough approach to the issue, two different categories of economic impacts were assessed: the long-term effects of SLR (by 2100) and the short-term effects of extreme weather events (annually, base year: 2010). The valuation of long-term SLR damage took into consideration gradual SLR as specified by the IPCC scenarios, whereas the valuation of short-term SLR damage took into consideration the increased frequency of storm surges as an impact of climate change, taking place in parallel with SLR. It Therefore, from a socioeconomic impact standpoint, a recurring phenomenon leading to short- term SLR and causing important economic damage is equally important as long-term and accelerating SLR (over a horizon of 90 years). To our knowledge, economic impact studies of past storm surges in Greece are rare and their results can therefore not be extrapolated to the entire coastal zone. For this reason, an additional stated preference survey economic assessment was conducted to assess the social cost of storm surges (Bank.of.Greece 2011).

In order to estimate the impacts of long-term SLR the total land area was calculated that would be lost for each of the five uses under study and the total loss of coastal area. A market pricing approach was then used for housing, tourism and agriculture uses, in order to estimate unit and total financial loss from inundation due to SLR. For wetlands and forestry, a widely used application of value transfer was employed. The value transfer approach was also used to estimate the loss of aesthetic values. Loss of public infrastructure (airports, ports) and industrial zones were not taken into account.

Economic impacts of long-term SLR

The total losses and the cost indexes were calculated for SLRs of 0.5 m and 1 m and for the five land uses under study (housing, tourism, wetlands, forestry and agriculture).The total losses were calculated as the area to be flooded times the respective unit value for each specific land use. The cost indexes were calculated by dividing the total losses with the length of coastline in the case studies. The cost indexes therefore represent quantified indicators of total land loss, which is 'incorporated' and expressed per kilometer of coastline for the five land uses under investigation. The estimated financial losses from the case studies were then extrapolated to the national level. The total cost of the impacts of SLR by 2100 for Greece as a whole is presented per land- use in the next Table.

Table 6. 15 Total economic cost of SLR in 2100 per land use (EUR thousands).

Land use	SLR 0.5 m	SLR 1 m
Housing & tourism	347,738,400	630,842,400
Wetlands	138,000	247,000
Forests	160	520
Agriulture	7,883,553	18,252,911
Total	355,760,113	649,342,831

Source: (Bank.of.Greece 2011) "The environmental, economic and social impacts of climate change in Greece"

It should be recalled here that the estimated losses essentially express 'use values', except for wetlands, for which the estimated cost index also partly includes 'non-use' values. However, the 'non-use' (e.g. cultural and spiritual) value of many coastal ecosystems is a non-negligible part of their total economic value. A similar approach is the widespread use of 'hedonic pricing' in the real estate market, according to which the price of non-built land also encompasses such location factors as view, proximity to areas of cultural and spiritual importance, etc.

Economic impacts of storm-driven wave and surge events: the short-term aspect of SLR

Storm-driven wave and surge events, which make up the short-term aspect of SLR, account for substantial annual impacts on the coastal area. Recording such impacts under the present study was considered important, due both to their economic weight and to the possibility of annual recurrences, making them factors of increased coastal vulnerability. Given, however, the limited data from on-site research and, as a result, of the inability to generalize the losses to the entire coastal zone, an open-ended contingent valuation survey was conducted on the economic assessment of loss (damage) from short-term SLR. The participants were asked about their 'willingness to pay' (WTP) for the construction of storm surge protection works in their area. The mean willingness to pay was estimated at €200.7 per household (standard deviation: €286).

According to the Report of Greece on Coastal Zone Management (Ministry of the Environment, Energy and Climate Change, 2006), the country's coastal population amounts to 9,293,982 or 85% of the total population (10,934,097 inhabitants). Assuming an average of three members per household, the total number of Greek households comes to 3,674,381, of which 3,097,994 live in coastal areas. Using a mean willingness to pay of €200.7 per household and extrapolating it to the Greek coastal population, the total value of protection from short- term SLR for Greek households comes to €621,767,426 (Bank.of.Greece 2011).

6.3.7 Tourism

Tourism is one of Greece's leading industries, in terms of GDP, employment, and the current account balance, considering that tourism receipts substantially reduce the current account deficit. Despite its increasing weight in the Greek economy, Greek tourism faces important structural problems, such as strong seasonality, regional concentration and difficulties in coping with new trends in demand and increasing regional competition.

Climate is a principal resource for tourism, as it co-determines the suitability of locations for a wide range of tourist activities, and, as such, makes tourism vulnerable to climate change. High temperature and other weather extremes, together with water shortages, are just some of the impacts that climate change is expected to have on the tourism industry. Two leading studies, one by Germany's Deutsche Bank (Deutsche.Bank.Report 2008) and another by the World Tourism Organization (WTO, Climate change and Tourism: Responding to Global Challenges, 2008) forecast a redistribution of tourist arrivals from

Southern Europe to countries with lower average summer temperatures in Middle-Northern Europe (Baltic Sea region, Benelux and Scandinavia).

Therefore the direct impacts of climate change on tourism establishments will be presented, distinguishing between:

- demand-side implications, affecting the revenue of tourism businesses and its annual distribution; and
- supply-side implications, affecting the operating cost structure of tourism establishments either directly (operating costs, infrastructure maintenance costs), indirectly (need for new infrastructure, higher financing costs, cost of repositioning the tourism product in the national and international markets) or potentially due to extreme climate change-related events (indemnifications, opportunity cost, higher insurance costs).

The magnitude and extent of these impacts vary in function of:

- the characteristics of the specific tourism business and the services it offers (category, type of clientele, credit policy, customer loyalty rate, dependence on tour operators);
- the specifics of each accommodation establishment (size, age, features and maintenance); and finally,
- the accommodation establishment's geographical location.

State of play of Greece's tourism infrastructure at the national and regional level

Over the last few years there has been a considerable expansion in hotel capacity at the aggregate national level, as well as an increase in higher-rated hotels (4-star and 5-star), in both absolute and percentage terms. However, Greece still trails its main competitors in average number of bed spaces per establishment and in the share of upper-category (luxury) beds in total number of beds. The Greek tourism industry thus consists mostly of small, lower-category establishments, unable to provide the high-quality services needed to attract high-income tourists in large numbers.

In terms of regional breakdown, Greece's bed capacity highly concentrated in specific regions (Crete: 21%, Dodecanese: 17%, Macedonia: 14%, Central Greece: 13%, Ionian Islands: 11%). Upper-rated hotels are also highly concentrated in a small number of regions. In addition, the capacity utilisation rate in most regions is low (except urban centers, the Dodecanese and Crete), indicating the existence of an underutilized tourism stock, as a result of overinvestment and/or insufficient advertising and regional promotion.

Another problem is high seasonality, which results in full capacity remaining idle for extensive periods each year (often for six months or more). Indicatively, the annual accommodation capacity of Greek hotels is 182 million overnight stays, while actual overnight stays in 2007 —a representative year for Greek tourism— amounted to 64 million. Greece's Research Institute for Tourism has estimated that Greece as a whole has an over-capacity of 184.2% and that the current hotel capacity could, depending on the scenario, cover future increases in demand over the next 14 to 35 years.

Finally, significant differences are observed across regions in the average length of time during which hotels remain open each year. Attica and Western Macedonia are the only two regions with high percentages of year-round accommodation capacity, whereas regions with a high accommodation capacity remain open only seasonally (Crete: 82%, Ionian Islands: 84%, the Dodecanese: 90%).

The economic impacts of climate change on tourism in Greece

As mentioned above, we consider two sources of economic impacts of climate change on tourist activity: the change in revenue and the increase in operating expenses of tourism enterprises. The economic impacts on revenue are far more important than those on operating costs. To estimate the change in revenue, at the regional and seasonal level, the Tourism Climatic Index (TCI) was used.

The TCI combines different climate variables —either recorded or estimated by meteorological studies— into a single index, designed to evaluate the climatic suitability of a region to support outdoor tourism activities. The TCI has been widely used in relevant studies, and a number of authors have even suggested adding or modifying the variables and weights used in the index (Amelung and Viner 2006). Despite its drawbacks, the TCI has the advantage of being easy to calculate and easy to comprehend and thus remains widely used.

The calculation of the TCI for the period 2070-2100 was based on Scenarios A2 and B2. The TCI calculations for the period 2010-2070 were based on the results of Scenario A1B for rainfall, cloud cover and wind speed, and on the results of Scenario A2 for temperature. The use of results from two different scenarios is not expected to affect TCI values considerably, due to the very small differences in the results of Scenarios A1B and A2 (until 2070) and to the insignificance, in most cases, of these differences, once the continuous values are converted into the discrete values scale.

Owing to lack of data on maximum daily temperature in combination with minimum possible humidity (CID) and the average 24-hour temperature (CIA), these two temperature variables were merged into one and given a weighting coefficient of 50% in the final index. As it was found:

• At the countrywide level and on an annual basis, the TCI decreases slightly over the first two decades, but improves markedly towards the end of the century.

• At the countrywide level but on a seasonal basis, the TCI remains unchanged roughly till mid-century, but in the second half of the century improves (increases) in winter and in spring, and improves considerably in autumn. In contrast, it deteriorates (declines) considerably in summer.

• At the regional level, the overall picture drawn for Greece as a whole holds, but with important differences across regions. In other words, there are no significant changes roughly up to mid-century, but in the second half of the century the TCI in some regions improves in winter and spring, improves quite significantly in autumn and decreases considerably in summer.

Impacts on arrivals, overnight stays and revenue

The assumption commonly made in the international literature is that TCI fluctuations exhibit, ceteris paribus, a linear correlation with the number of arrivals, the number of overnight stays and, by extension, regional tourism receipts and can be used in tourist demand forecasting and management models (Bank.of.Greece 2011).

In ***Table 6.*** , Panel A presents estimated arrivals, overnight stays and revenue till 2100, without taking climate change impacts into consideration. The estimates were made assuming increases of 3.5% in 2010-2020 (WTTC forecast for Greece) and progressively decelerating increases every two decades of 3%, 2.5%, 2%, 1.5% and finally 1% in 2090-2100. A discount rate of 1.4% (similar the one used in the Stern report) was used in order to derive present values of future streams. It should be stressed that the data in each row refer to the entire corresponding decade and not to a single year.

In ***Table 6.*** , Panel B, the annual TCI was applied to the figures of Panel A, in order to obtain a first overall estimate of climate change impact on physical and economic figures. Panel C presents the differences in figures between Panels A and B. As was expected on an annual basis and at countrywide level, Greek tourism seems to benefit from climate change. The impacts are negative or neutral for the period 2010-2040, but turn significantly positive in the period 2061-2100.

For example, in decade 2091-2100, without taking climate changes into consideration, 41.6 million tourist arrivals are expected on average each year, a number which increases by an additional 10.2 million **—**or close to +25%**—** when taking climate changes into account. Similarly significant increases are also observed in the respective figures for overnight stays and tourism receipts.

However, the picture changes considerably when we proceed to a seasonal breakdown of the data. ***Table 6. ,*** Panel D presents estimates of the physical and economic figures once the TCI seasonal changes are taken into account. First, the physical and financial figures of base year 2007 were converted into seasonal ones, using seasonality coefficients calculated based on the monthly actual distribution of receipts in the same year. Specifically, the outcome of our computations provided the following coefficients: 4.56% for winter, 14.16% for spring, 56.11% for summer, and 25.17% for autumn. Finally, having obtained the seasonal breakdown of the physical and economic figures, the respective seasonal TCIs were applied.

As ***Table 6. ,*** Panel D clearly shows, although climate change continues to have a positive effect on all figures, the increases are much lower than the ones of Panel C. For instance, the increase in arrivals due to climate change in 2091-2100 falls on an annual basis from 25%, as mentioned above, to 5.2%.

Aggregation on a seasonal basis sizably lessens the climate change impacts, which however remain positive at countrywide level.

Although the above estimates show ***an overall positive impact of climate change*** on the physical and economic fundamentals of tourism, it should be stressed that there are differences emerging when ones moves to a regional breakdown. For instance the effect of climate change on a seasonal basis for two leading tourism regions, the Dodecanese islands and Crete, was investigated, which account for roughly 40% of the country’s total tourism output.

More specifically, the following coefficients were used for Crete: 0.85% for winter, 15.96% for spring, 58.44% for summer, and 24.75% for autumn. For the Dodecanese, the corresponding coefficients were: 0.58%, 13.40%, 61.71% and 24.31%. Having aggregated the receipts on a seasonal basis the effect of TCI changes was estimated.

Table 6. 16 Forecast arrivals, overnight stays and revenue (For the whole Greek territory discounted and non-discounted to present value, on an annual basis, as well as adjustment of all fore- casts taking into account the impact of TCI both on an annual and a seasonal basis)

Time period	Panel A. Changes assuming decelerating increases from 3.5% to 1% and i=1.4% Without taking into account TCI changes				Panel B. Taking into account TCI changes on an annual basis			
	Arrivals	Overnight stays	Receipts (in thousand euro)	Receipts discounted to present value (in thousand euro)	Arrivals	Overnight stays	Receipts (in thousand euro)	Receipts discounted to present value (in thousand euro)
2007	16,037,592	65,420,236	11,319,200	11,319,200	16,037,592	65,420,236	11,319,200	11,319,200
2011-2020	188,143,297	767,470,509	132,789,985	121,412,900	185,058,981	754,889,025	130,613,100	119,422,525
2021-2030	215,685,205	879,818,929	152,228,837	137,264,579	212,149,382	865,395,668	149,733,282	135,014,340
2031-2040	247,258,916	1,008,613,802	174,513,301	155,185,855	247,258,916	1,008,613,802	174,513,301	155,185,855
2041-2050	277,013,603	1,129,988,548	195,513,914	171,460,195	299,719,636	1,222,610,560	211,539,644	185,514,310
2051-2060	310,348,915	1,265,969,310	219,041,702	189,441,225	335,787,351	1,369,737,286	236,995,939	204,969,195
2061-2070	339,823,403	1,386,201,074	239,844,552	204,568,892	395,532,158	1,613,447,151	279,163,331	238,104,776
2071-2080	372,097,146	1,517,851,501	262,623,093	220,904,565	433,096,678	1,766,679,615	305,676,059	257,118,428
2081-2090	398,245,218	1,624,514,214	281,078,187	233,163,716	496,174,370	2,023,984,923	350,195,773	290,499,056
2091-2100	416,652,612	1,699,601,299	294,069,973	240,572,816	519,108,172	2,117,536,044	366,382,261	299,730,065
	Panel D. Taking into account TCI changes on a seasonal basis				Panel C. Differences between forecasts not taking/taking into account TCI changes on an annual basis			
2007	16,037,5	65,420,236		11,319,200	0	0	0	0
2011-2020	192,024,9	783,304,306		123,917,788	-3,084,316	-12,581,484	-2,176,885	-1,990,375
2021-2030	219,245,0	894,340,269		139,530,120	-3,535,823	-14,423,261	-2,495,555	-2,250,239
2031-2040	257,461,3	1,050,231,522		161,589,180	0	0	0	0
2041-2050	293,260,7	1,196,263,518		181,516,509	22,706,033	92,622,012	16,025,731	14,054,114
2051-2060	328,551,1	1,340,219,688		200,552,145	25,438,436	103,767,976	17,954,238	15,527,969
2061-2070	366,765,3	1,496,102,085		220,787,555	55,708,755	227,246,078	39,318,779	33,535,884
2071-2080	398,702,0	1,626,377,767		236,699,225	60,999,532	248,828,115	43,052,966	36,213,863
2081-2090	430,006,2	1,754,073,094		251,759,078	97,929,152	399,470,708	69,117,587	57,335,340
2091-2100	438,395,3	1,788,293,885		253,126,951	102,455,560	417,934,746	72,312,288	59,157,250

Source: (Bank.of.Greece 2011) “The environmental, economic and social impacts of climate change in Greece”

As regards the region of Crete, quite significant reductions of receipts are observed in the summer months, a season during which more than 50% of revenues are raised, and during which the TCI falls. On an annual basis, however, and assuming full time elasticity of tourist arrivals, receipts for the region of Crete increase, mainly because of the extremely significant improvement of the TCI during autumn and spring, when approximately 40% of receipts are collected. But in the case of the region of the Dodecanese islands, the considerable decrease in receipts in the summer months is not offset by the increases in the spring and autumn months. This is due to the fact that approximately 60% of total tourism receipts are collected in the summer months.

The above analysis, despite the embedded simplifications and generalisations, proves that conclusions based on data regarding the entire territory on an annual basis can be misleading. Drawing useful conclusions requires taking into consideration both the seasonal and the regional dimensions of climate change impacts.

Therefore, Greece would be able to benefit from climate change in economic terms so long as it can overcome the institutional factors that limit the tourist arrival period mainly to the summer months (school vacations, workers' holidays), and co-shape, together with the suitable climate, arrivals' figures and seasonality. This solution presupposes identifying new target tourist markets not bound by the above limitations (pensioners, weekend breaks, professional and conference tourism) and increasing the appeal of Greece's tourism product to prospective tourists and, more importantly, international tour operators.

In order to provide a sense of the magnitude of the economic impacts of climate change, it was observed that in the last three decades of the 21st century summer receipts for Crete and the Dodecanese islands will decrease by €7 billion and €5.5 billion, respectively. Should these destinations fail to counterbalance the losses at issue by proportionally increasing arrivals in other seasons of the year during which the TCI improves, the losses entailed for tourism receipts on an annual basis will stand at roughly €240 million and €185 million, respectively. These amounts are relatively small when expressed as a percentage of the country's estimated annual tourism receipts for the base year 2007 (close to 5%). However, their level can prove to be devastating for the long-term survival and profitability of Greek hotel enterprises when expressed as a percentage of these enterprises' profits. Indicatively, for the year 2007, the turnover of all Greek hotels came to €9.93 billion, with a gross profit margin of 33.8%, a margin of earnings before interest, taxes, depreciation and amortization (EBITDA) of 24.5%, and a net profit margin of 0.98%. The translation of these percentages into figures practically means that gross annual income for the year 2008 stood at €3.35 billion, net income before interest, taxes, depreciation and amortisation at €2.43 billion, and net (distributable) profits at €973 million. Therefore, a reduction of arrivals due to climate change based on the scenarios' forecasts, and consequently a reduction of revenue by about €430 million for only two regions, would suffice to cut annual net results of hotel enterprises at national level by almost one third.

The strong negative impact of the limited reduction of receipts on annual net results stems from the fact that the hotel units' operating leverage is very high. According to the data presented above, this leverage borders on 80%, leading to a high break-even point, a limited margin of safety and strong transformation of fluctuations in tourism receipts and expenses into analogous fluctuations in annual results.

At this point it should be emphasized that the multiplier for the tourism industry is quite high, and so changes in the industry's profitability have further considerable economic impacts on other, cooperating or even ―more often than not― dependent industries. Moreover, the fact that tourism is a services-providing industry translates into increased employment for a considerable number of (mostly seasonal) workers and, conversely, into a loss of a proportionately large number of jobs when tourist arrivals or average spending per visitor decrease.

These observations yield a rather optimistic view of reality, as they take no account of the parallel improvement of the same climatic parameters in the countries of origin of the tourists visiting Greece. If climate conditions in these countries change in a way that improves the local TCI, then the above estimates would probably be far more negative. For example, the final PESETA report forecasts TCI improvement in Central and Northern Europe during spring, summer and autumn, and based on these estimates concludes that there will be a shift in tourist demand from Southern to Central and Northern Europe.

In addition to the seasonal variation of TCI changes, equally essential is the variation across regions, which, as was demonstrated earlier, can have very serious economic impacts. It should be emphasized that the analysis carried out above for the regions of Crete and the Dodecanese was based on a seasonal breakdown of overnight stays. But it did not take into consideration the seasonality of operation of these beds, which however stands at 88.91% for the Dodecanese islands and at 81.85% for Crete. These observations highlight the huge negative economic impacts that climate change (through a deteriorating local TCI alone) can have on the revenue and profitability of Greek hotel enterprises. These impacts are masked by non-deterioration or improvement of the TCI in other seasons (during which most tourist beds remain idle) and in other regions of the country, which however account for a limited share in tourism receipts.

6.3.8 Energy

Climate change will affect both the energy input and the energy demand. According to the National Observatory of Athens, general remarks on the energy input are summarized in the following:

- Hydropower will be the renewable energy source mostly affected by climate change, due to the reduction of precipitation and the increase of temperature.
- Wind power generation and photovoltaic panels are not expected to be significantly affected by climate change.
- The air temperature increase will reduce the efficiency of thermo-electrical units due to the increased needs for cooling water.
- There will also be an increase of the loss on electricity distribution networks. The increase of the frequency of extreme events is estimated to increase damages on power generation infrastructure and power distribution networks resulting in an increase of the frequency and the duration of power cut.

As regards to the energy consumption, it is generally accepted that in Greece it varies both seasonally and from year to year. Although the latter is mainly associated with economic, social and demographic factors, and seems to follow an increasing trend, the former is controlled by prevailing weather fluctuations and also by factors unrelated to weather effects (weekend and holiday effects).

The climate impact on the energy consumption is depicted mostly in the estimation of the monthly peak loads. In that way the Hellenic Transmission System Operator S.A. (www.desmie.gr) has projected the trend in the peak loads based on the assumption than in a given month all the economic activities will remain steady for all working days, so that the everyday peak load is mainly depending on the climatic variations. In that way, in every working day of the month the peak load is estimated as the sum of a basic load, independent of the temperature, and of a load that depends on it. The impact of the weather on the latter is estimated using appropriate functions (load-temperature modelling). The modelling is being implemented by the combination of the energy demand with the relevant climatic information. Firstly, each parameter is separated and estimated according to the historical data, and then it is projected in the future.

It is common sense that warmer climate conditions will probably lead to decreased demand in winter and increased demand during summer, as a result of the increase of summer days.

Moreover, the effect of higher temperatures in summer is likely to be considerably larger on peak energy demand than on net demand, suggesting that there will be a need to install additional generating capacity over and above that needed to cater for underlying economic growth (Giannakopoulos, Le Sager et al. 2009a).

The Hellenic Transmission System Operator is the association having the responsibility of the covering the functioning, exploitation, maintenance and development of the Greek electricity system. The association has performed three projection scenarios of the peak load that follow the methodology that has been described above, and are characterised as:

- *Reference scenario:* the maximum expected peak load is based on the assumption of normally high temperature during the summer months, with a possibility of being up to that value of 97.7%.

- *Extreme scenario:* the maximum expected peak load is based on the assumption of abnormally extended heat wave days during July, with a possibility of being up to that value of 99.86%.

- *Mild scenario:* the maximum expected peak load is based on the assumption of mild summer days during July, with a possibility of being up to that value of 90%.

On a more long-term period of time, the changes in the number of days with large cooling and heating demand are shown in ***Figure 6.24***. As it can be seen from the chart on the left, the increase of the cold degree days will be quite important in northern part of Greece, leading to the corresponding increase in the electricity demand. As regards to the heating needs, the Southeast Mediterranean seems to experience a smaller decrease of the heating degree days than the rest of the Europe, possibly because it is already a warmer region (chart on the right of the same Figure).

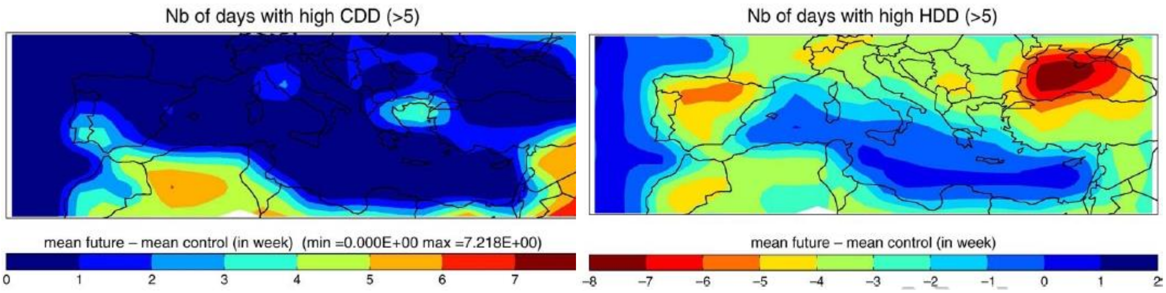


Figure 6.24 Change in the number of days with (a) large cooling demand and (b) large heating demand between the future and the control period (1961-1990)

A change of energy sources is also expected to occur in the country: a low water supply reduces energy production from hydroelectric plants, as well as from conventional power plants, which require water for cooling and for driving the turbines. Additional capacity may need to be installed unless adaptation or mitigation strategies are to put into place. On the other hand, conditions for renewable energy production, such as solar power, may improve under climate change.

Finally, projected monthly difference between the historical data of 1961-1990 and the projections of the PRECIS regional climatic model under the A2 and B2 scenarios, as they have been performed by the National Observatory of Athens (National Communication 5) are being presented in ***Figure 6.25***.

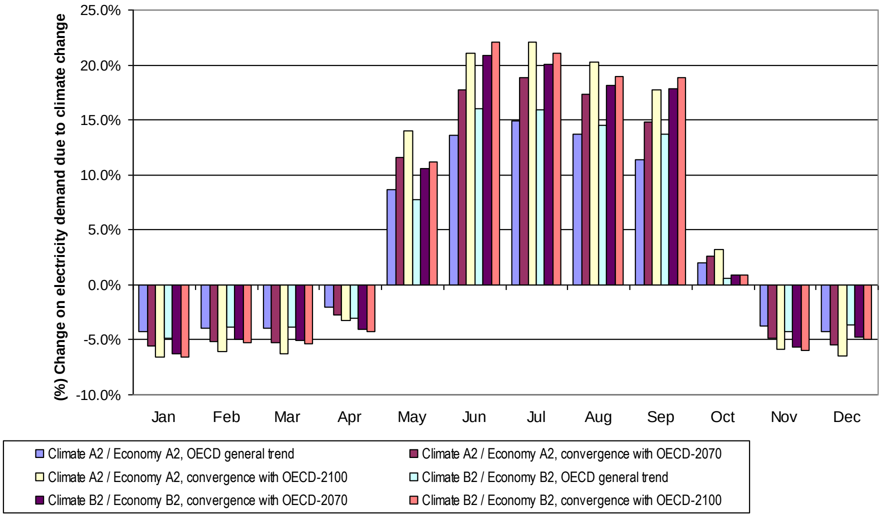


Figure 6.25 Change of the monthly electricity demand in Greece during the period 2071-2100 exclusively as a result of climate change under the A2 and B2 IPCC scenarios.

6.3.9 Infrastructure and Transport

The direct physical impacts of climate change on transport can be broken down into three main categories:

1. impacts on transport infrastructure involving:
   i. reconstruction and repair of damage from natural disasters; and
   ii. proactive/preventive works to protect existing transport infrastructure;
2. impacts on transport infrastructure maintenance; and
3. impacts due to alteration to the system's operation and reliability due e.g. to delays and other changes (e.g. rerouting).

Due to the complexity of the transport sector, the lack of specialized national and international literature, and the often insufficient and/or absence of specific data and measurements at national or local level, the research team developed a methodology adapted to these particularities and to Greek reality. The methodology adopted by the group of exerts performing the analysis of the environmental, economic and social impacts of climate change in Greece on behalf of the Bank of Greece comprised the following separate phases (Bank.of.Greece 2011):

Phase 1: Mapping of the key Greek transport infrastructure network and 'vulnerability' classification/assessment of operation components (infrastructure and services). The transport network's individual components were examined for four different geographic zones, established for the purposes of the present study:

• Zone I: Western Greece;

• Zone II: Central Greece;

• Zone III: Eastern Greece; and

• Zone IV: Island regions.

Phase 2: Estimating transport demand. This phase included estimating the current levels of transport demand, and forecasting future demand levels over specific time horizons.

Phase 3: Valuating the cost of climate change impacts on Greece's transport sector. For each of the three climate change scenarios developed within the general framework of the overall study, valuations were made of the cost of climate change impacts on transport infrastructure and on the provided transport services.

Main results of Phase 1: Mapping of the Greek transport infrastructure network and 'vulnerability' assessment

The mapping of the transport network and the vulnerability of its individual attributes to specific climate change parameters was assessed for each of the four zones into which the country was divided. The analysis showed that, with respect to its national transport infrastructure system, Greece can be characterized as one of Europe's most 'vulnerable' regions, mainly because it has one of the longest coastlines, with 113 m of coast for every km^2 in area (compared with a global average of only 4.5 m/km^2). Thus, several (mainly) urban regions and transport networks are located within the distance of influence from this coastline. It should be noted that 33% of the Greek population lives in coastal cities, towns or villages situated within 2 km of the sea, while 12 of the country's 13 former Administrative Regions are coastal. Moreover, the Greece's largest urban centers with the highest number of movements/trips, such as Piraeus, Thessaloniki, Patras, Heraklion, Volos and Kavala, are situated in coastal zones.

Based on the above, in combination with the data from the climate change scenarios examined in the study (which project SLR to be roughly 40 cm to 50 cm), it is clear that a significant part of the country's transport infrastructure network lies at the frontline of risk from climate change impacts.

Summary data on the transport network's vulnerability are presented for each zone examined in ***Table 6.14***. The aim of the analysis was to identify what share of the road and railway networks and the number of airports that lie within a 'high-risk' zone, within 50 m of the coastline.

In addition, the operation of most of the country's ports is directly at risk from SLR, with direct implications for the operation of the national sea transport system, the existence and smooth operation of which are essential to the continuity and cohesion of the country's transport network.

Main results of Phase 2: Estimating transport demand

The transport demand on the national road, railway, maritime and air transport networks (passengers and freight) was estimated up to 2050 using HIT data collected in the context of the Transport Observatory service it provides through its portal (www.hitportal.gr), and up to 2100 based on average annual rates of increase derived from existing studies and projects after a review of the international literature.

Tables 6.15 and ***6.16*** present the summary estimates of demand for passenger and freight transport, respectively, as derived from the HIT analysis for specific time horizons and based on the estimated rates of increase taken from existing studies.

Table 6. 17 Quantitative data on transport network vulnerability, per zone

Zone I: Western Greece	Percentage of road network within 50 m of the sea	National: 1.41	Provincial: 1.93
	Percentage of railway network within 50 m of the sea	2.65	
	Number of airports at sea level	1 (State airport of Corfu "I. Kapodistrias")	
Zone II: Central Greece	Percentage of road network within 50 m of the sea	National: –	Provincial: 0.76
	Percentage of railway network within 50 m of the sea	0	
	Number of airports at sea level	0	
Zone III: Eastern Greece	Percentage of road network within 50 m of the sea	National: 1.53	Provincial: 1.92
	Percentage of railway network within 50 m of the sea	0.61	
	Number of airports at sea level	2 (Thessaloniki international airport "Macedonia", Skiathos airport)	
Zone IV: Island regions	Percentage of road network within 50 m of the sea	6.64	
	Percentage of railway network within 50 m of the sea	0	
	Number of airports at sea level	1 (Heraklion international airport)	

Source: (Bank.of.Greece 2011) "The environmental, economic and social impacts of climate change in Greece"

Table 6. 18 Estimated demand for passenger transport, per mode of transport

	Road transport (billion vehicle-km/year)			Railway transport (billion pkm/year)	Air transport (million pkm/year)	Sea transport (million pkm/year)
	National network	Provincial network	Total in pkm/year			
Reference	12.9	8.7	38	1.9	38.7	86
2015	14.6	9.9	42	2.0	43.9	98
2030	16.0	10.5	46	2.3	53.0	107
2050	17.3	11.2	50	2.7	63.6	115
2100	20.0	12.9	58	3.3	85.2	132

Source: (Bank.of.Greece 2011) "The environmental, economic and social impacts of climate change in Greece"

The tables point to a clear upward trend in demand for passenger and freight transport in Greece. The future levels of demand were estimated as part of the economic valuation of climate change impacts on the transport system over different time horizons, as presented in the next phase of the study.

Table 6. 19 Estimated demand for freight transport

	Road transport (billion tkm/year)	Railway transport (billion tkm/year)	Air transport (thousand tonnes/year)	Sea transport (million tonnes/year)
Reference year	25.6	0.7	130	151
2015	29.5	0.8	151.3	189
2030	37.0	1.0	190.0	240
2050	46.5	1.4	239.5	302
2100	67.5	2.0	335.0	350

Source: (Bank.of.Greece 2011) "The environmental, economic and social impacts of climate change in Greece"

Main results of Phase 3: Valuating the cost of climate change impacts on Greece's transport sector

Based on the data calculated in the previous phases (regarding transport network components, estimated network vulnerability, and existing and estimated transport demand) and on the detailed methodologies for estimating the specific aspects of climate change impacts likely to be felt in Greece (i.e. mean temperature rise, increased heat wave frequency, SLR anticipated for the wider Mediterranean basin, higher frequency and intensity of flooding incidents, and reduced snowfall), the third phase of the methodology consisted in calculating the additional costs likely to be incurred as a result of repair of infrastructure damage/deterioration, prevention, increased maintenance, and finally, the estimated delays to be expected from the average annual temperature rise under the three scenarios considered.

From the estimated economic impacts the highest costs are expected to come from delays/cancellations (i.e. the cost of passenger value of time – VOT) in all types of transport as a result of the different aspects of climate change, without overlooking the costs associated with the redevelopment and redesign of transport infrastructure and increased maintenance needs.

6.3.10 Health

Climate change affects the human organism both directly and indirectly. According to the WHO, climate change impacts on health can be grouped into the following three categories (WHO 2003; Bank.of.Greece 2011):

a) Direct impacts, usually caused by extreme weather events (e.g. death due to heat waves).

b) Indirect impacts, as a result of environmental changes and ecological disruptions due to climate change (e.g. higher risk of vector-borne or rodent-borne infectious diseases).

c) Other impacts on populations confronted with environmental degradation and economic problems as a result of climate change (e.g. nutritional or even psychological problems).

According to WHO forecasts, climate change and global warming are expected to have significant impacts on human health. These impacts will stem from more frequent occurrences of storms, floods, dry spells and fires, with effects on water and food availability and on overall healthcare system management. The rise in temperature will contribute to higher morbidity and mortality associated with nutrition, water and air quality. The increased frequency of heat waves is expected to lead to higher mortality due to heat stroke and heat stress.

The core conclusion of studies on the impacts of climate change on human health on a global scale is that climate change can lead inter alia (WHO 2003; Bank.of.Greece 2011) to:

a) increased mortality due to the temperature rise and, conversely, decreased mortality in colder countries for the same reason;

b) greater frequency of infectious disease epidemics due to floods and extreme weather events;

c) substantial impacts on human health due to the relocation of populations in response to rising sea levels and the increased frequency of extreme weather events.

The US health authorities have identified 11 broad human health categories likely to be affected by climate change (CDC 2009):

i. asthma, respiratory allergies and airway diseases;
ii. cancer;
iii. cardiovascular disease and stroke;
iv. food-borne diseases and nutrition;
v. heat-related morbidity and mortality;
vi. human developmental effects;
vii. mental health and stress-related disorders;
viii. neurological diseases and disorders;
ix. vector-borne and zoonotic diseases;
x. waterborne diseases; and
xi. weather-related morbidity and mortality (due to extreme weather events).

The populations particularly at risk from these climate change-related diseases are:

- the elderly;
- children;
- people with pre-existing chronic medical conditions;
- poor people with poor nutrition or suffering from malnutrition, living in low-income areas and with difficult access to healthcare services;
- the populations of islands and mountainous regions at risk of water and food shortages; and
- undocumented immigrants, at the fringe of society, faced with labor market, social and healthcare exclusion.

Economic impacts

As regards the economic impacts of climate change on health, the PESETA report states, inter alia, the following (Bank.of.Greece 2011):

a) For the period 2011-2040, without acclimatization, the cost of climate change will amount to €30 billion per year (based on a value of a ‘statistical life’ of €1.11 million) or to €13 billion per year (based on a value of a ‘life year’ of €59,000). Assuming that acclimatization takes place, this cost is drastically reduced to €4.5 billion and €1.9 billion, respectively. The benefit from fewer cold-related deaths comes, respectively, to €55.8 billion and €23.7 billion (without acclimatization) and to €21.5 billion and €9.2 billion (with acclimatization). It should be noted that the balance is, in any event, positive, i.e. using economic costs as the sole criterion; climate change is estimated to be beneficial.

b) For the period 2071-2100, under Scenario A2 (without acclimatization), the cost of climate change will amount to €118 billion per year based on the value of a statistical life, or €50 billion per year based on the value of a life year. Adopting Scenario B2, this cost is estimated at €56 billion and €30 billion, respectively. For this period, the economic benefit of fewer cold-related deaths is estimated at €95.8 billion (Scenario A2, without acclimatization) based on the statistical life value, and at €40.7 billion (Scenario A2, without acclimatization) based on the life year value. Under Scenario B2 in the absence of acclimatization, these figures are estimated at €64.2 billion and €27.3 billion, respectively. It should be noted here that the economic benefits from fewer cold-related deaths are not always outweigh the economic loss from additional heat-related deaths.

A similar cost valuation procedure for flood-related depression estimated the relevant costs at €1 billion to €1.4 billion per year (under Scenario A2) or €0.8 to €1.1 billion per year (under Scenario B2). The PESETA report does not valuate the economic cost of increased vector-borne diseases due to climate change, but proceeds to a qualitative assessment stating that this cost is forecast to be lower than the foregoing one.

Natural disasters and mortality in Greece

The number of recorded natural disasters in the period 1900-2010, as well as the number of deaths and the economic impact related thereto, are presented per disaster category for all of Greece in ***Table 6.*** . Of all the presented categories of natural disasters with an impact on human populations, climate change is expected to affect the frequency of low and high temperature extremes, floods, storms and fires.

Table 6. 20 Impact of natural disasters on population mortality and the Greek economy in 1900-2010

Natural disasters	Type of event	Number of events	Deaths	Population affected	Cost (USD thousands)
Drought	Drought	1	-	-	1,000,000
	average per event		-	-	1,000,000
Earthquakes (seismic activity)	Earthquakes	29	951	960,398	7,099,300
	average per event		33	33,117	244,803
Temperature extremes	Cold waves	1	5	-	-
	average per event		5	-	-
	Heat waves	5	1,119	176	3,000
	average per event		224	35	600
Floods	Unspecified	8	66	9,730	188,000
	average per event		8	1,216	23,500
	General flood	12	18	6,100	1,043,359
	average per event		2	508	86,947
Storms	Unspecified	6	56	612	690,000
	average per event		9	102	115,000
	Local storm	1	22	-	-
	average per event		22	-	-
Volcano	Volcano eruption	1	48	-	-
	average per event		48	-	-
Wildfire	Forest fire	11	94	8,559	1,750,000
	average per event		9	778	159,091
	Scrub/grassland **fire**	2	14	500	675,000
	average per event		7	250	337,500

Source: (Bank.of.Greece 2011) “The environmental, economic and social impacts of climate change in Greece”

In more detail, the results of future climate model simulations point to a sharp increase in the frequency of heat waves and forest fires and, conversely, to a decrease in the frequency of cold waves by 2100. As for heavy rainfall and flooding events, their frequency in most of the country (including Athens, where more than 50% of the total national population is concentrated) is expected to rise. The implies that the number of deaths due to climate change-related extreme weather events in the course of the 21st century will gradually increase, not only in Athens, but in other large cities as well.

Based on a report concerning the environmental, economic and social impacts of climate change in Greece (Bank.of.Greece 2011), the annual additional deaths were as follows:

- In summer, the additional deaths are estimated at 21 per day
- In winter, the additional deaths will be 3 fewer per day
- In the intermediate seasons (spring and autumn), no substantial change in death numbers is expected.
- Thus, total excess deaths per year will come to 90 x (21-3) = 1,620.

Based on the above calculations, the economic impact for the Attica region will thus be in the order of €95 million per year.

It should also be noted that these estimates do not take into account possible improvements from increased awareness and, more importantly, from prevention action taken by people at high risk (e.g. the elderly, the chronically ill) to avoid exposure to temperature extremes. A case in point is Central Europe where, in the aftermath of the deadly 2003 heat wave, the number of annual additional deaths due to hot temperature extremes has remained noticeably below 2003 levels. This can only be attributed to raised awareness and to prevention/risk avoidance action taken by the vulnerable groups themselves. With successful awareness campaigns and proper preventive measures, the increase in heat-related deaths forecast in this study could possibly be reduced to below 10%.

Changes in air pollutant levels and impacts on mortality in the Athens area

Forecasting the trends in air pollutant concentrations in coming decades is important for the study of climatic changes and their impacts on human health, agricultural production and natural ecosystems. These changes, including rising temperatures and changes in meteorological parameters and different emissions, affect the levels of atmospheric pollutants.

Surface ozone (O_3), also called tropospheric ozone, belongs to the category of atmospheric pollutants that adversely impact human health. Unabated emissions of ozone-producing precursor compounds, such as nitrogen oxides (NO_x) and volatile organic compounds (VOC), in conjunction with the changes mentioned above, are expected to have a multifaceted impact on future ozone levels. It should be noted that high levels of surface ozone have already been recorded in Greece, as well as in the broader Eastern Mediterranean region, including non-urban areas, particularly in summer (Kourtidis, Zerefos et al. 2002; Zerefos, Kourtidis et al. 2002; Kalabokas, Mihalopoulos et al. 2008).

According to the results obtained using the CTM Oslo model ozone levels are expected by 2100 to have fallen by 20% in Greece and by 16.5% in Athens. It should be noted that the CTM Oslo model does not take temperature changes into account. Gryparis et al. (2004) studied the link between mortality variation and ozone levels for the Athens area and found that an increase in ozone concentration by10 μg/m^3 was associated with 0.5% higher mortality.

Assuming that (a) the population of Athens will remain broadly unchanged, (b) the total number of deaths occurring in Athens per year (30,000) will remain broadly unchanged, and (c) the percentage (0.5%) stated in the above study is linear, it is estimated that the change in ozone levels in the Athens area by 16 μg/m^3 – corresponding to a decrease in concentration from 97.5 μg/m^3 in 2000 to 81.5 μg/m^3 by 2100 – would result in 0.8% (or 245) fewer deaths per year.

The roughly 70% decrease in NO_2 levels by 2100 forecast by the CTM Oslo model will have a positive impact (further decline in pollution-related mortality), even if specific figures cannot be advanced due to statistical uncertainties (Analitis, Katsouyanni et al. 2006; Samoli, Aga et al. 2006). Nonetheless, under Scenario A1B, particularly in Attica, the number of annual additional deaths due to higher temperature extremes in summer and lower temperatures in winter will amount to 1,620 in 2091-2100. The economic impact of temperature extremes under the same scenario A1B for Attica is estimated at €95 million per year. Under Scenarios A2 and B2, extreme temperature-related deaths are forecast to increase by 2,260 and 1,455 per year, respectively, while the economic costs are expected to come to €135 million (Scenario

A2) and to €85 million (Scenario B2). The projected changes in air pollutants particularly harmful to human health, like ozone, are expected by the end of the 21st century to lead to a fewer number of deaths (around 10% fewer than the expected number of deaths from temperature extremes) (Bank.of.Greece 2011).

6.3.11 The built environment

Cities are at the forefront of the fastest growing environmental and climate changes. This is due to the changes in land use, urban development which is not based on environmental principles, urban expansion but also to increased man-made activity that enhances, spatially and time, heat sources, etc. Therefore, cities' ability to adapt to climate change needs to be studied.

The relationship between cities and climate change is multifaceted:

- Cities consume about 60 to 80% of the energy produced in global scale and are major sources of carbon dioxide emissions.
- Climate change provokes risks to urban infrastructure and quality of life due to the rise of sea level, extreme weather events, drought and soils.
- Building infrastructure is vulnerable to extreme weather events that may be due to climate change.
- Cities are being developed and operated in a way that affects their demand for energy and consequently carbon dioxide emissions.
- Urban energy flows depend on uses of land use and land cover. The rate of heating at regional or local level scale may be delayed through the use of land use / land cover.

In particular, the continuous expansion of cities and the rapid increase in energy needs, especially during the summer, have contributed to the creation of an extremely dangerous energy footprint which has a direct effect on climate.

One of the biggest problems facing modern cities is the lack of green spaces. The occupation of urban space by cement has significant energy and environmental impacts since buildings are responsible for a large proportion of energy consumption but also for emissions of pollutants and gases. In particular, in Greece buildings are responsible for 40% of the total energy consumption and 45% of its CO2 emissions in the atmosphere. At the same time, the lack of green surfaces affects public health, but it also affect the psychology of the citizens, exacerbating a feeling of discomfort.

In 2011, the Ministry of the Environment and Energy published a Ministerial Decision on "Terms, conditions and procedure for the construction of planted surfaces in roofs and outdoor spaces of buildings"

(http://www.opengov.gr/minenv/wp-content/uploads/downloads/2011/12/Y.A.-fytemenes-epifaneies.pdf).

The increase of green areas contributes to the aesthetic, morphological and quality upgrading of cities, but also improves the quality of our lives. Planted surfaces improve their microclimate urban areas, reduce dust and cloud, strengthen and protect the insulation of buildings, increase the energy performance of buildings and create a natural environment for urban flora and fauna, the so-called "Green corridors". They also contribute to the equitable distribution of green spaces and balance inequalities in affected urban areas. Especially, for deprived urban areas where there is over - construction and in housing the weakest sections of the population, the creation of green areas can make a decisive contribution to flood management phenomena. The reason is very specific: because the water of rain does not finds land to be absorbed, falling into the cement, flows more flooded underground and shops.

The Decision also states that a Special Register of Plant Landscapes will be established, in order a first data bank to be created and kept updated for the construction of planted land as submitted to the local building services. Especially for the Athens area and the Prefecture of Attica in the new Regulatory Plan (Law 4277/2014, Government Gazette 156 A) are described, inter alia, objectives and directions regarding the urban environment and adaptation to climate change.

6.3.12 Mining and quarrying

The contribution of the mining industry to the Greek economy, in relation to the past, has decreased significantly and now accounts for 3-5% of GDP, taking into account also the mining and processing industry. However, there are serious prospects for improvement, as the country has considerable amount of minerals. According to the US Geological Survey (2015), Greece in 2014 was the world's largest perlite producer (40% of world production), the first largest bentonite producer in the EU and the world's second (9% of world production), the first bauxite producer in the EU and eleventh in the world, the second largest lignite producer in the EU and the world's fifth largest producer of nickel in the EU (40% of EU production), the first country to export whitewash and magnesia to the EU, the third country to export marble to the EU (after Italy, Spain) and among the first six countries of the world and the only producing country. It is also worth mentioning that it has significant deposits of gold as well as significant geothermal potential.

The mining industry is considered to be of national importance as it contributes:

- to balancing the trade balance due to its strong export character (exports account for over 70% of its sales),
- the energy security and self-sufficiency of the country (it is characteristic that more than 50% of the generated electricity comes from domestic lignite),
- in employment (about 15,000 direct jobs in industry and co-operating subcontractors),
- the development of national infrastructures.

Among others, the industry constitutes growth lever of other activities since it is interrelated with other sectors of the economy, from the construction sector to the tertiary sector, as evidenced by the output multipliers (2-2.4), income (1.4 -1.7) and employment (1.8-4.2).

The mining industry, however, as well as other economic activities related to natural resources, will address a range of challenges and problems due to climate change. The response to the extractive industry to date at an international level (and even more in Greece) does not seem to be the equivalent of the potential impact.

It is characteristic that less than 50% of Canadian mining companies are taking measures to address the impact of climate change, although about 50% say it is already affected by it and 60% believe that the impact will be negative in the future.

The potential impacts of climate change on the mining sector concern the inputs of the production process (eg energy, water, labor), the supply chain (eg land or sea transport routes of raw materials and products) and Purchase of Mineral Raw Materials (eg, changes in consumer patterns may lead to a decrease in demand for particular Purchase of Mineral Raw Materials). They are expected to affect all stages of the activity (eg exploration and exploration, mine development and construction of the necessary infrastructure, operation and rehabilitation of the extractive industry, etc.).

For example, these impacts may be related to:

- infrastructure disasters (eg road erosion, sloping slopes and deposits, etc.) due to extreme weather events,
- reduction of available water resources due to lower rainfall and increased evaporation,
- loss of working days due to extreme temperatures,
- the need to strengthen measures and actions to protect and restore the environment, for example the maintenance of rehabilitation works due to ground cover erosion and increased irrigation needs, further increase in safety factors when designing barricades etc.,

- increasing operating costs, e.g. due to increases in energy costs, infrastructure costs, the restoration of damage caused by extreme weather events, etc.,
- a burden on the relationship between mining and local society due to the "competition" in the use of resources (eg the water reserves in the area), the increase in environmental impact (eg increased particulate emissions due to lower humidity and higher temperature), the actual or perceived increase in risks to the environment and public health (eg increased concern for accidents involving landfill sites and other extractive waste).

6.3.13 Cultural heritage

The cultural heritage of Greece has a particularly large area, both spatially and temporally. It covers a period of more than 5,000 years with a particularly high spatial density, since in each region there are products of significant cultural activity. Apart from national capital, the unique cultural character of Greece and the exceptional architectural heritage attract millions of tourists every year and constitute an important sector of the Greek tourism industry.

The current climate change, the expected changes in the intensity and frequency of natural phenomena and the synergy of all the above are expected to affect elements of the environment that are part of the cultural heritage, historical monuments that are directly exposed to the environment but also collections exposed to museum sites. Floods, earthquakes, fires, strong winds, and the long-term impact of adverse climatic conditions can even destroy sites and cultural heritage sites, and in many cases, part of this disaster lies in mismanagement of the crisis. So far, there has not been a comprehensive national approach to the issue of the protection of cultural heritage from natural hazards and disasters, and at European level there is a lack of harmonization of individual recommendations (European Parliament, 2007).

6.3.14 Insurance sector

Economic losses from extreme weather events are measured as direct losses of economic assets and infrastructures and indirect losses of economic flows (eg GDP). According to the European Environment Agency, between 1980 and 2013, the cost of natural disasters across the European Union amounted to € 368 billion (2013 prices), while spending on extreme weather events increased from € 9 billion in the 1980s to more than € 13 billion in the 2000s (2013 prices), (European Environment Agency, 2012).

It is noted that over the same period (1980-2013), the loss of human lives due to the extreme weather phenomenon account unfortunately 83.204 people. Most deaths, about 70,000, are due to the heat wave that swept Europe in 2003.

Since its establishment in 2002, the European Union Solidarity Fund (EUSF) has been used in 67 cases for disaster relief, providing assistance in excess of € 3.7 billion in 24 different European countries. Globally, annual material damage from weather and climate events in the 1960s and 1990s increased eightfold, while in the same period, insurance losses increased seventeen times. In Greece, the total compensation of the insurance market for the rainfall losses of 24 October 2014 in Attica exceeded € 4 million, according to estimates by the Hellenic Insurance Companies Association.

Indicatively, for the period 1980-2013 in Greece the percentage of insured capital for damage caused by extreme weather events is about 1% while for the European Union the average is about 32%.

6.4 Adaptation policies and strategies to Climate Change

The Law 4414/2016, articles 42-45 (Governmental Gazzette, issue A, 149/2016) and the Ministerial Decision 11258/2017 (Governmental Gazzette, issue B, 873/2017) defined the framework for climate change adaptation policy in Greece.

The Law 4414/2016 includes the formal endorsement of the first Greek National Adaptation Strategy to Climate Change (NAS), defines the Ministry of Energy & Environment (MEEN) as the national competent authority for national adaptation policy and foresees the process for the revision of the NAS along a 10-year planning cycle. It requires the 13 Regional Authorities of Greece to develop and implement Regional Adaptation Action Plans (RAAPs) within a 7-year planning cycle. It also foresees the establishment of a National Climate Change Adaptation Committee (NCCAC), to act as the formal coordination and advisory body at national level for adaptation policy design and implementation.The NCCAC comprises representatives from all Ministries that have a sectoral role in adaptation policy planning and in funding of adaptation actions, as well as representatives of other stakeholder bodies and governmental authorities with a role in adaptation policy. In addition, a new law “National Climate Law - Transition to Climate Neutrality and Adaptation to Climate Change” has come into force. This law was voted by the Hellenic Parliament on May 2022 and marks a kick start towards setting up the necessary robust national policy framework enabling the transition to zero greenhouse gas emissions. Overall, the new legal framework is very ambitious and is expected to bring a major shift in Greece’s power production and overall economy in the years to come, designating environmental considerations as one of the key drivers for sustainable growth and development. According to this document, NAS covers a period of at least ten (10) years, is evaluated at least every five years by the Ministry of Climate Crisis and Civil Protection and is revised, if necessary, following the opinion of the National Council for Climate Change Adaptation (as defined in par. 2A of article 26, with the procedure of par. 1 of the same document).

The Greek NAS is an overarching policy document, which defines the goals, principles and priorities of adaptation and lists potential adaptation measures (actions) for all environmental and socio-economic sectors that are likely to be significantly affected by climate change in Greece. As such, it provides guidance, insight and priorities, which should be further downscaled (i.e. detailed) at regional level and translated into Regional Adaptation Action Plans.

It should be noted that the diversity of climate, socio-economic and environmental conditions vary substantially across the country; as such detailed plans can only be developed and implemented at sub-national (i.e. regional) level to address regionally and locally vulnerable sectors and hotspots. To this end, each RAAP will define priority actions on the basis of the specificities and characteristics of each Region.

Further information on the NAS, the NCCAC and the RAAPs are provided at the following chapters.

Figure 6.26 The Greek Climate Change Adaptation Framework

6.4.1 National Adaptation Strategy to Climate Change

Greece recently established the "National Adaptation Strategy to Climate Change" (NAS) (Law 4414/2016, Government Gazette, 149/A/9.8.2016) which sets out the general objectives, guiding principles and implementation tools of a modern, effective and growth-oriented adaptation strategy in line with EU directives and the international experience.

The drafting of the NAS was part of a Memorandum of Understanding among the MEEN, the Climate Change Impacts Study Committee of the Bank of Greece (CCISC) and the Biomedical Research Foundation of the Academy of Athens. The CCISC prepared a strategy draft document, building on its existing work and the extensive CCISC report on climate change impacts and vulnerability assessment (see chapter 6.1 above). The NAS underwent public consultation. The MEEN was involved in the drafting of the NAS and at assessing the comments received during the public consultation. It also completed and finalised the draft.

The NAS is the first step in a continuous and flexible process for planning and implementing the necessary adjustment measures at national, regional and local levels and aspires to leverage the capabilities of Greece's public authorities, economy and society at large, in an aim to address the impacts of climate change in coming years.

The overarching objective of the present NAS is to contribute to the country's resilience against climate change impacts. To this end, the necessary conditions must be created for well-informed and far-sighted (both public and private) decisions that will determine the productive and consumption fabric of the Greek society, by addressing risks and opportunities resulting from a changing climate. The NAS outlines Greece's strategic orientation aimed at providing guidelines. As such, it does not analyse in depth the required sectoral policies, nor does it judge the feasibility of individual adaptation measures and actions at the local/regional level or attempt to rank the suggested measures and actions. Such issues fall within the scope of Regional Adaptation Action Plans which will elaborate on the NAS guidelines, by setting the immediate adaptation priorities at the local level.

NAS identifies the following core objectives:

1. the systematization and improvement of short- and long-term decision making for Climate Change Adaptation (CCA);
2. the linking of CCA with a sustainable development model through Regional and Local Action Plans;
3. the promotion of actions and adaptation policies in all sectors, and particularly the most vulnerable ones;

4. the establishment of a monitoring mechanism for the evaluation and review of adaptation policies and actions; and
5. the strengthening of the adaptive capacity of the Greek society through awareness and dissemination actions.

Adaptation to climate change requires a comprehensive, interdisciplinary approach that will involve inter-sectoral measures, whose implementation would rely on specific institutions of a national and regional scope. In particular, the guiding principles of the NAS are the following:

- **Compatibility**: Adaptation policies and measures should be compatible with the strategies and priorities of the general and sectoral national environmental policies.

- **Scientific accuracy and completeness**: Adaptation policies and measures should be scientifically substantiated with up-to-date information derived from authoritative research in Greece and the rest of the world. Any such policies and measures should be (re)evaluated in the light of new scientific evidence.

- **Stakeholder** involvement and consultation: an important factor for a successful adaptation strategy is the involvement of, and consultation with, all parties concerned, including pubic administration, the scientific community and civil society.

- **Social acceptance**: Adaptation policies and measures should entail the lowest possible costs for society/the economy, reduce regional disparities and ensure a more equitable distribution of adaptation costs across social groups.

- **Growth:** adaptation policies and measures should be designed in a manner that fosters long-term economic growth.

The Greek NAS has a 10-year implementation horizon (i.e. it should be reviewed and revised by 2026). For specific sectors (i.e. natural ecosystems and biodiversity; agriculture and food security; forestry; fisheries and aquaculture; water resources; coastal zones; tourism; human health; energy and industry; transport; the built environment; cultural heritage; insurance industry), the NAS suggests alternative adaptation options, to guide adaptation planning for the 13 administrative regions of Greece. In the following chapters are listed the potential adaptations actions per sector suggested by the NAS.

Taking account of the risk and vulnerability assessment, this section in NAS, and therefore the description also in this NC, explores the available adaptation technologies and policies by sector. Alternative adaptation options are outlined on the basis of their main features, to the extent possible.

Given that NAS is a strategy orientated document which aims to establishing guidelines, this chapter is not taking position on the feasibility of individual actions and adaptation measures at regional / local level and does not attempt to prioritize the indicative proposed measures and actions, both at field level and at regional / local level. The final selection, the prioritisation and scheduling of the appropriate actions and measures are the content and essence of the thirteen (13) Regional Adaptation Plans which will be composed based on the particularities of each region.

6.4.1.1 Agriculture and stock-breeding

Action 1. Acquisition of innovative knowledge and dissemination to trainers and final recipients (rural professionals). This action includes the collection of research findings by research bodies, their exploitation through the development of specific adaptation strategies and manipulations and their dissemination to final recipients.

Action 2. Promote regional planning based on vulnerability levels and new data. Sustainable Rural Development Programs must be developed at Region level, with mandatory integration of adaptation actions to climate change.

Action 3. Establishment or improvement of existing monitoring systems of critical parameters, based on new knowledge on the effects of climate change on the components of the production system. Recording and preparedness systems are essential to assess potential threats to the agro-livestock sector. Systems must be designed with flexibility to adapt quickly to new situations. Efficiency indicators: the number of approved programs.

Action 4. Sustainable management of natural resources. It includes extensive actions for the sustainable management of soil, water resources and biodiversity.

Action 6. Changes in biological material and cultivation techniques. They include actions aimed at creating new varieties (excluding genetic modification) and adapting cultivation techniques to climate change. All require reinforcement of national research and collaborations with the outside.

Action 7. Risk management of climate change disasters. It basically includes adaptation and extension of agricultural insurance for damage caused by extreme weather events not covered today (eg, high temperatures, drought, floods). Efficiency indicators: the number of producers compensated for extreme weather events.

6.4.1.2 Forestry

Action 1. Acquisition and exploitation of innovative knowledge.

Efficiency indicators: rate of practical applications.

Measure 1.1. Priority in the forest research in the context of climate change financing of research institutions, priority setting, annual assessment and results dissemination.

Measure 1.2. Publication of all kinds of data that arise from forest ecosystem studies funded by public bodies (as long as there is no intellectual property). This will contribute to the duplication avoidance, thus reducing the waste of human and financial resources. By make publicly available these data, which today do not exist or are scarce, there will be control from the entire scientific community, while at the same time taking advantage of the data for drawing up more comprehensive management plans adapted to the upcoming climate change.

Action 2. Ensure biodiversity of forest ecosystems

Efficiency indicators: Impact on robustness and qualitative production of multiple products and services from ecosystems.

Measure 2.1. Classification of Protected Areas to give higher care to ecosystems with thermophilic and dry-resistant species and protection of those at risk from climate change.

Measure 2.2. Selection of varieties of forest species for planting or favoring species for natural regeneration, resistant to the expected drier and warmer environment, as well as in the extreme weather phenomena. Use of wider planting links in afforestations to restrict competition for soil water and application economics.

Measure 2.3. Studies development and implementation by region for forest complexes and not just for forests, which are intended to improve composition and the architectural structure of forest ecosystems, taking into account the level of vulnerability. These will seek to preserve biodiversity on the level of gene diversity, plant and animal species diversity, the diversity of ecosystems and natural landscapes. This objective can be achieved by the application of specific silvicultural practices, which are more intense than in the past, to restrict competition to the desired species.

Measure 2.4. Take measures to identify and control spatial expansion of foreign species (weeds).

Action 3. Sustainable management of natural resources

Efficiency indicators: quantity and quality of products and services produced.

Measure 3.1. Creation of uneven aged forest structures via preference, by mixing species, avoiding clear-cuttings for increased biodiversity and stability of ecosystems. But at the same time, attention should be paid to the management of the ground vegetation so that the relationship production - usable water and runoff is optimized.

Measure 3.2. Adaptation of silvicultural interventions to create more sparse forest clusters, capable of producing with limited soil moisture, higher temperatures and respond to the extreme weather phenomena.

Measure 3.3. Adaptation of ground-floor vegetation management with cleaning and controlled grazing in order to reduce competition for soil moisture at trees and the risk of fires.

Measure 3.4. Implementation of rational grazing in forest-grassland ecosystems to optimize the biodiversity and the production of multiple products and services.

Action 4. Limitation of fires

Efficiency indicators: number of fires, burned area.

Measure 4.1. Forest cadastre development (land use, vegetation composition and property status inventory) that will also limit the fires that are related to public land encroachment.

Measure 4.2. Modernizing the legislative framework with regard to prevention, restoration of damages caused by fires as well as their suppression.

Measure 4.3. Ensure that within a maximum of 10 days after fire to sow the most susceptible to soil erosion areas with cold-resistant grass in order during the first critical post-fire period to protect and stabilize the soil. With this intervention the need of costly water-engineering constructions is limited, erosion and floods are avoided, and the useable water balance is improved.

Measure 4.4. Put more emphasis on prevention, which is also the most cost-effective, ensuring accessibility, limiting fuel material by silvicultural interventions and controlled grazing.

Measure 4.5. Modernization of fire-fighting equipment, installation of warning systems and software for rapid and uninterrupted evacuation, training for avoiding human casualties and the rehabilitation of ecosystems.

Measure 4.6. Silvicultural interventions, combined with controlled grazing for limiting the flammable sub-floor, the main starting point of fires.

Action 5. Production of usable water

Efficiency indicators: Quantity and quality of water produced

Measure 5.1. Management of natural ecosystems for optimization of usable water.

Measure 5.2. Construction of debris constraining dams and waterdams to normalize water runoff and reduce erosion and floods.

Measure 5.3. Construction of dams and projects for the aquifers enrichment.

6.4.1.3 Biodiversity and ecosystems

Action 1. Improve knowledge on the biodiversity of Greece and the impact of climate change on it and on ecosystem services. The purpose of this Action is to collect existing information and, if possible, to complement knowledge on the biodiversity of Greece and the effects of climate change on it, both at ecosystems and species level. An additional objective of the Action is to seek information on the effects of climate change and on ecosystem services, as well as to fill in identified data gaps to identify the vulnerability of biodiversity and assess its response to expected climate change. The result of this action will be the creation of a dynamic database that will gather the information available on both research activity on the impact of climate change on biodiversity and the results of ecological models that will summarize the vulnerability of species and ecosystems in discrete scenarios of climate change.

Measure 1.1. Creating a database of research results and management programs in relation to the impact of climate change on biodiversity;

Measure 1.2. Integration of biodiversity adaptation programs in national research priorities;

Measure 1.3. Risk assessment and development of vulnerability forecasting models.

Action 2. Enhance adaptation of biodiversity elements to the impacts of climate change. In order to enhance the potential of biodiversity components to respond effectively to climate change, it is necessary to know and record the current situation and to actively implement the national institutional framework for the protection, preservation and / or restoration of natural ecosystems and their adaptation to climate change, in line with the National Strategy for Biodiversity in Greece. Effective management, ecological coherence and interconnection of Natura 2000 sites contribute to the adaptation of biodiversity data to climate change.

Measure 2.1. Implementation of a national institutional framework for the protection of biodiversity at national and local level;

Measure 2.2. Surveillance-insurance, retention and recovery of biodiversity;

Measure 2.3. Conservation and sustainable management of vulnerable ecosystems and species within Natura 2000 sites;

Measure 2.4. Strengthening the ecological coherence of the Natura 2000 network.

Action 3. Enhancement of ecosystem functions.

Measure 3.1. The purpose of the action is to protect the natural ecosystems (forests, wetlands, etc.) and the promotion of their sustainable management, to adapt to climate change;

Measure 3.2. Promoting measures to restore natural ecosystems (forests, shrublands, wetlands, etc.);

Measure 3.3. Promoting measures to conserve biodiversity.

Action 4. Land use arrangements. The purpose of this action is to curb the further reduction and fragmentation of natural ecosystems and the loss of rare, threatened and / or protected flora and fauna species. At the same time, care is taken to enhance ecosystem services as a shield against the effects of climate change.

Action 5. Education, information, awareness raising, training, promotion and promotion of alternative forms of tourism. Action 5 aims to raise public awareness of the importance of maintaining biodiversity and adapting it to climate change, empowering relevant services, and promoting the key elements of each region.

Measure 5.1. Educational programs on biodiversity and adaptation to climate change;

Measure 5.2. Informing and awareness on biodiversity and adaptation to climate change;

Measure 5.3. Strengthening the competent authorities;

Measure 5.4. Highlighting major areas and promoting alternatives types of tourism.

Action 6. Incorporating climate change into development plans and biodiversity monitoring tools. This action relates to the implementation of Action 1.

Measure 6.1. Strengthening existing tools for biodiversity monitoring in order to take into account the impacts of climate change;

Measure 6.2. Integrating the impacts of climate change into development plans.

6.4.1.4 Fisheries

Action 1. Shaping knowledge of the impact of climate change on fisheries. The purpose of this action is to gather the overall existing information on the impact of climate change on fisheries, including marine ecosystems, marine fish stocks and fish stocks.

Action 2. Adaptation to the new fisheries situation created by the impacts of climate change.

Action 3. Sustainable management of marine biological resources.

Action 4. Understand the action of the natural and ecological parameters that determine the mechanisms of the impact of climate change on fishing.

Action 5. Assess the economic impact of climate change on fisheries.

Action 6. Educational programs on the impact of climate change on fisheries.

6.4.1.5 Aquaculture

Action 1. Study and record of the impact of climate change on current used techniques and the techniques in aquaculture in order to develop new more resistant methods and techniques, and / or to shift existing units to less vulnerable sites.

6.4.1.6 Water resources

Action 1. Creating a geo-portal of integrating information on the impacts of climate change on water resources. The purpose of this action is to gather all the information (data, studies, descriptive information) on the impact of climate change on water resources and the dissemination of information on the internet.

Action 2. Projects addressing the impacts of climate change on water resources in the following sectors:

- Rising sea level / Coastal zones
- Reducing (quantitative and qualitative) the performance of waterworks.
- Change in basin level of runoff.
- Changing the weight of construction.
- Precautionary measures
- Study of hydrographs of source discharges.
- Anticorrosion protection of soils.
- Desertification
- Maintaining ecological provision
- Irrigating water
- Irrigation networks
- Returned irrigation flow
- Water supply networks
- Bottled water
- Cross-border waters.
- Desertification

Action 3. Saving water - Effective water use - Reducing pumping of aquifers. It concerns mainly areas where there is a shortage of water both in winter and in summer.

Action 4. Development of land-use activities and uses that are compatible with local available water resources. This includes identifying potential adaptation scenarios for activities involving heavy water consumption in areas experiencing shortages, optimizing aquatic resources, developing efficient farming activities and reducing soil impermeability, thereby promoting water scarcity.

Action 5. Inclusion of the impacts of climate change on water planning and water management, particularly in the subsequent water services intervention programs (2013-2018) and water management development programs (2016-2021). This action aims to integrate the expected impacts of climate change and the adaptation measures required in water management planning tools on a hydrographic basin scale.

Action 6. Assessment of the impact of climate change on hydropower generation. Since the "fuel" of hydroelectric projects is water, the purpose of this action is to study and assess the impact of the imminent reduction of surface drainage on the country's hydroelectric projects, both in economic terms (reduction of energy production) and socio- (reduction of available water for agricultural use) and environmental aspects (maintenance of ecological supply)

Action 7. Educational programs on the impact of climate change on water resources.

6.4.1.7 Coastal zones

The Greek coastline can be geomorphologically classified according to the EUROSION (2001) program in four main types of coastline. In each coastal category, individual categories can be distinguished based on the expected rate of change of sea level and the possible cases of variation of the stereotype from other factors can be categorized. Also, potential impacts on infrastructure and tourist facilities (including possible impacts on coastal degradation) can be categorized.

The design of adaptation policies to the effects of sea-level rise can be based on three approaches: Retreat, Accommodation, Protection.

The protection through the construction of coastal technical works has been extensively covered by the Bank of Greece technical report (CCISC) (Bank of Greece 2011). The managed retreat approach is one of the proposed solutions for effective adaptation to sea-level rise risks and damage in coastal areas but also to avoid the potential impact on ecosystems by limiting the extent of coastal areas (coastal squeeze).

6.4.1.8 Tourism

Action 1. Impact on the attractiveness of the destination area taking into account the thermal comfort indicators.

Action 2. Impact on the factors that support tourism activity and are related to the country's water and energy reserves and the necessary support actions.

Action 3. Impact on competitiveness / attractiveness of regions / tourist destinations in relation to seasonality, with particular emphasis on mountain and island regions.

Action 4. Impact on the cost of protection projects in basic tourism infrastructure.

Action 5. Impact on tourist unit costs.

Action 6. Support actions.

6.4.1.9 Energy

Action 1. Main System Energy Infrastructure Protection.

Action 2. Projects for the protection of coastal energy and island systems.

Action 3. Expansion and protection of water resources

Action 4. Research and Development.

Action 5. Horizontal and coordinated actions.

6.4.1.10 Infrastructure and Transport

Changes expected from climate change will affect transport infrastructure and networks, regardless of means of transport.

Action 1. Organization and decision-making process.

Action 2. Technical content.

Action 3. Legislative content.

Action 4. Information flow and use of communication and information technologies.

6.4.1.11 Health

An important role can be played by the Health Map (developed by the Ministry of Health, the Center for Disease Control and Prevention and the National School of Public Health / available at http://ygeiamap.gov.gr/), which represents the basic tool for the planning and pursuit of national health policy. It is a mechanism for the continuous collection and processing of data on the level of health, morbidity and health needs of the population, the main factors affecting health, the measurement of needs in specific groups of the population, etc. Analyzing these data, real needs in primary and hospital health services as well as prevention and health promotion services.

The Hellenic Center for Disease Control & Prevention focuses on communicable diseases that are directly linked to climate change. The impact of climate change on infectious diseases varies, as both the reproductive rate of the transmitters and their activity are affected. Some important examples are analyzed in the NAS concerning: Extreme weather conditions, air pollution, diseases transmitted via transmitters and increased incidents of allergies due to climate change

6.4.1.12 The built environment

Action 1. Adapt urban planning to climate change and improve the thermal environment in cities by changing the microclimate of the built environment (urban centers).

Action 2. Reduce the thermal and energy needs of buildings in the direction of zero energy footprint.

6.4.1.13 Mining and quarrying

Action 1. Reinforce the industry's climate change reporting.

Action 2. Incorporating climate change into the design, monitoring and operation of mining activities. This Action requires the implementation of adaptation measures from both the mining and the state side.

6.4.1.14 Cultural heritage

Action 1. Knowledge and recording of the risks of climate change in the cultural heritage (institutionalization of new and updating of existing systems for the recording of parameters related to the effects of climate change).

Action 2. Risk management of climate change in the cultural heritage.

Action 3. Incorporate the protection of cultural heritage and adaptive policies into wider national policies.

Action 4. Professional training and public awareness.

6.4.1.15 Insurance sector

For the needs of the national climate change adaptation strategy, the insurance sector can be seen from three different perspectives: as a market, as a climate adaptation tool and as an investor. As such, the insurance sector can support adaptive practices (a) helping to manage climate risks, (b) applying incentives to prevent them, and (c) providing information on the economic dimensions of risks and mitigation/mitigation measures.

The European Commission is exploring the adequacy and availability of appropriate climate insurance in the Member States as a component of the European Climate Change Adaptation Strategy, aiming at "moving towards a general culture of prevention and mitigation of disaster risks" (European Commission, 2013). Gaps in this area are already clear: despite the increased flood risk in Europe, only 1/3 of vulnerable households are insured. As a result, out of a total of € 4.3 billion of the average annual loss, only € 2.3 billion is covered by insurance contracts. More generally, disaster insurance currently has a low penetration rate in some Member States, with the result that disaster insurance markets cannot fully meet the risks involved (Joint Research Center, 2012 and revision, www.eea.europa.eu/data-and-maps/indicators/direct-losses-from-weatherdisasters2/assessment).

6.4.2 The National Climate Change Adaptation Committee

A National Climate Change Adaptation Committee (NCCAC) has been established, as the formal coordination and advisory mechanism body for adaptation policy monitoring, evaluation and formulation (Law 4414/2016, article 44).

It is chaired by the Minister of Environment & Energy and comprises representatives of all competent ministries (Environment, Economics, Internal Affairs, Economy & Development, Tourism, Infrastructure & Transport, Health, Maritime Affairs & Insular Policy, Rural Development & Food, Education, Research & Religious Affairs, Culture and Sports, National Defence), as well as representatives from the Union of Greek Regions, the Central Union of Greek Municipalities, the Hellenic Meteorological Service, the Association of Industries; NGOs and members from the academia specialising on climate change adaptation issues. Additional participants can be invited to participate on the basis of identified needs.

The composition of the NCCAC reflects the need for the horizontal coordination of sectoral policies, for ensuring feedback and vertical coordination among different levels of government, as well as and for involving non-governmental authorities on all aspects relating to climate change adaptation.

The Ministerial Decision for the formal appointment of the NCCAC Members was issued on September 15th 2017, including also the procedures for its operation. The NCCAC is responsible for: (a) the specification/operationalization of adaptation policies, and the suggestion towards the MEEN and other competent Ministries of relevant policies, measures, actions and legislative/regulatory measures; (b) the specification of horizontal policies/actions included in the NAS, especially those concerning awareness, dissemination and capacity building; (c) the development of recommendations for the review or revision of the NAS and of the RAAPs; (d) the development of recommendations for any matter relating to climate change adaptation, as put forward by the Minister of Environment and Energy.

6.4.3 Implementation of the strategy

The 13 Regional Authorities of Greece have to develop and implement Regional Adaptation Action Plans (RAAPs) (Law 4414/2016, article 43). Law 4414/2016 sets the minimum technical specifications for their content. The RAAPs content has been further elaborated by the Ministerial Decision (MD) 11258/2017 (Government Gazzette, issue B, 873/2017). The MD requires Regional Authorities to perform a detailed assessment of potential climate change impacts for a short, mid-term and long-term time horizon, to identify and map relevant climate-related risks, vulnerabilities and hotspots, to prioritise adaptation action on the basis of their cost-effectiveness and benefits, to identify synergies with other policies and regional plans (e.g. land-use plans, water management and flood risk management plans) and to integrate, as needed, priority measures into regional planning.

More specifically the RAAPs shall include:

a. Analysis of projections of future climate conditions at regional level. More specifically, analysis of the trends of the main climate parameters for the short, mid (2050) and long (2100) term and for more than one scenario, using existing data and well-established regional climate models. The analysis will include existing trends and potential changes in extreme weather events, temperature, sea-level rise, etc.

b. Vulnerability assessment of specific sectors and/or geographical areas within each region based on the outcomes of the climate condition projections.

c. Assessment of climate change impacts (environmental, social, economical etc.) on the previously identified sectors and/or geographical areas at the short, mid (2050) and long (2100) term. The impacts are assessed based on their: probability, magnitude (area and/or population affected), intensity, complexity, timing, reversibility/possibility to mitigate, cross-border and/or cross-sectoral character etc.

d. Identification of priority sectors and priority geographical areas for action.

e. Examination of the potential measures/actions included in the NAS based on the particular regional circumstances, priorities and needs and development of concrete regional action plans. Wherever there is a case for sector or sub-regional analysis, specific actions per sector or sub-regional area will be indicated. The actions will be prioritized based on cost-effectiveness and cost-benefit analyses. The effectiveness corresponds to the climate change prevention, mitigation and restoration capacity (in order of priority) of the actions, while the benefit to the wider economic, environmental and social benefits from their implementation, so as to facilitate focus on 'win-win' and 'no-regret' actions. The analyses will aim to prioritize cost-effective and environmentally, economically and socially beneficial actions.

The development of the 13 RAAPs is ongoing with several Regions being more advanced than others. It is expected that the RAAPs will have been finalised by the end of 2018, with the help of subcontractors.

The Sectoral Operational Programme on 'Transport Infrastructure, Environment and Sustainable development' and the 13 Regional Operational Programmes (one for each administrative region of Greece) of the National Strategic Reference Framework 2014-2020 (NSRF, cohesion policy) include specific budget and measures under the Thematic Objective #5 'Climate Change Adaptation & Disaster Risk Management'. These instruments, together with the Rural Development Programme are the main funding source of adaptation actions at national level and in the 13 administrative regions until 2020.

NAS additionally to the RAAPs, Greece has established and implemented several plans in specific sectors and also participated in several European and National programs regarding adaptation to climate change.

In line with this spirit, the **General National Framework for Spatial Planning and Sustainable Development** (National Gazette 128 A/3.7.2008) includes the following measures that could be considered as adaptive to climate change:

- Rapid promotion of the RES use
- Infrastructure for the promotion of natural gas use (esp. in the field of electricity production)
- Energy saving measures
- Forest fire prevention measures and reforestation measures
- Implementation of bioclimatic architecture
- Reinforcement of the natural regeneration mechanisms (forests, wetlands etc.) and of their biodiversity.

It should be also noted that some policy orientations going through the entire General Framework Spatial Plan could be considered as indirect adaptation measures. These orientations mainly refer to the following:

- The territorial organization of the very important infrastructure and energy service networks (Art. 6)
- The management of the national resources, the protection of the atmosphere and the prevention/response to natural disasters (Art. 10)

In addition **CIRCE Integrated Project**, funded under the European Commission's Sixth Framework Programme, aimed to reach its objective, highlighting impacts and possible adaptation actions of the climate change in the Mediterranean region, that includes Europe, North Africa and Middle East. The objectives of the project have been:

- to predict and to quantify physical impacts of climate change in the Mediterranean area;
- to evaluate the consequences of climate change for the society and the economy of the populations located in the Mediterranean area;

− to develop an integrated approach to understand combined effects of climate change;

− to identify adaptation and mitigation strategies in collaboration with regional stakeholders.

Under the **Seventh Framework Programs** (FP7) of the European Commission the following projects concerning adaptation, mitigation and policies were implemented (see also para. 8.1.2): ClimateCost, MEECE — Marine Ecosystem Evolution in a Changing Environment, ADAGIO, SERPEC-CC.

Adaptation measures for responding to specific sectoral climate change impacts at a regional level are being implemented. These include, inter alia, the construction of regional river basin management plans, regional framework spatial plans, and the anti-flooding measures implemented by important coastal cities and regions (City of Thessaloniki, Heraklion) etc.

A number of Greek regions have participated in various regional programmes:

- The Development Enterprise of Achaia /Western Greece Region, participates in the INTERREG IVC project F:ACTS: Forms for Adapting to Climate Change through Territorial Strategies focusing on increasing resilience of risk prone areas to climate change effects.
- The Municipality of Patras participates in the Life+ Project 'Act-Adapting to Climate Change in Time' (https://webgate.ec.europa.eu/life/publicWebsite/index.cfm?fuseaction=search.dspPage&n_proj_id=3452) and in the CC-Waters Project (Climate Change and impacts on Water Supply) (http://www.ccwaters.eu).
- The Region of Crete participates in the RegioClima project, whose purpose is the enhancement of cooperation between EU regions (building of regional alliances, coordination of regional action, elaboration of adaptation strategies) (http://www.regioclima.eu/).
- The Strategic Plan for Athens / Attica 2011, published by the Organization for MasterPlan and Environmental Protection of Athens, also takes into account adaptation to climate change in specific sectors (spatial planning, environmental protection etc.).

6.4.4 Other Policies and Programs for adaptation on climate change in several sectors

The Regional Adaptation Action Plans will analyse the synergies of proposed adaptation actions with other existing national policies, such as biodiversity, disaster risk management and infrastructure-related policies, and will suggest ways of integrating adaptation. They will also investigate their complementarity and compatibility with other regional plans (e.g. spatial plans, flood risk management plans), in order to inform these plans and to include adaptation considerations. In addition, the climate projections and the climate change impact and vulnerability assessments to be conducted as part of the RAAPs, will provide useful data and information about future climate conditions and their impacts, to planners and decision makers.

In short, the RAAPs will provide the necessary information to support mainstreaming adaptation into planning processes and more specifically to revise existing plans and policies in order to include adaptation considerations. Nevertheless, adaptation-related actions have been already embedded in some sectors.

The sectoral adaptation-related actions are presented in the following chapters.

6.4.4.1 Adaptation policies concerning natural ecosystems and biodiversity

Law 3937/2011 (National Gazette, 60/A/31.3.2011) regarding the conservation of Biodiversity was adopted in March 2011. This law identifies national priorities, sets out the framework for

the **National System of Protected Areas** and defines the main tools for biodiversity management (climate-adapt.eea.europa.eu).
Among the measures to reduce greenhouse gas emissions are priority 'low cost co-benefit options' that simultaneously contribute to conservation and sustainable use of biodiversity. Some of these measures are listed in ***Table 6.21.***

Table 6. 4 Measures to address the impact of climate change at ecosystem level (EC 2009; Bank.of.Greece 2011)

Climate impact	Ecosystem-based adaptation
Increased droughts	Use appropriate agricultural and forestry practices to increase the water retention capacity and mitigate droughts
Heat extremes	Increase green spaces in cities to improve the microclimate and air quality
River flooding	Maintain and restore wetlands and riverbeds which will act as natural buffers against floods
Increased fire risk	Cultivate diverse forests, which are more robust against pest attacks and present a lower fire risk

Inaction or even delayed action could result in ecosystem degradation and even loss, which would reduce the overall carbon storage and sequestration capacity of ecosystems. The climate system has 'tipping' points, beyond which the response of ecosystems can become unpredictable. Under such conditions, carbon sinks could become carbon sources.
Currently, in line with the COP 10 Decision X/2 of the Convention on Biological Diversity (CBD) there is a National Biodiversity Strategy (NBS) (National Gazette, 2383/B/08.09.2014) focusing on 13 targets, including climate change adaptation:

1. Increase of knowledge of biodiversity
2. Conservation and restoration of species and habitats
3. National System of Protected Areas
4. Conservation of genetic resources - ABS
5. Sectoral policy integration

Provisions about integrating biodiversity considerations into the development and implementation of other relevant policies which inter alia include:

- Agriculture, aquaculture, forestry and fishery
- Renewable energy production
- Tourism
- Industry
- Infrastructure

6. Conservation of landscape diversity
7. Prevention and reduction of impacts on biodiversity because of the climate change

7.1: Capacity building on the adaptation of biodiversity to climate change

This sub-target includes the development of ecosystem and species vulnerability assessments. The priority actions are:

- Identification of areas of high risk
- Identification and assessments of vulnerable species and habitats
- Priority actions for the conservation and adaptation of species and habitats that are more vulnerable

- Assessments for the future species' distribution patterns according to their evolution process

7.2: Reducing biodiversity impacts of climate change mitigation and adaptation measures

This sub-target is aiming to the decrement of negative impacts of climate change mitigation and adaptation measures inter alia based on:

- Strategic Environmental Assessment of the effects of certain plans and programs on the environment,
- Environmental Impact Assessment of plans & projects within protected areas and Natura 2000 sites
- Application of the ecosystem approach.

8. Invasive alien species and biodiversity protection

9. Bilateral and multilateral cooperation

10. Improvement of quality and effectiveness of public administration

11. Communication, Education and Public awareness

12. Community participation on biodiversity conservation

13. Assessment and evaluation of the intrinsic, ecological, genetic, social, cultural values of biological diversity

The NBS includes a 5-year implementantion plan (2014-2018) detailing concrete steps to take to achieve its targets.

Although Greece has a long-standing conservation policy (the legislation on nature conservation dates back to the 1930s, with the laws providing for protection of mainland national parks and forests), it was not until recently that special concern has been given to the impacts of climate change to biodiversity and to the adaptation potential/procedures of the latter. For the time being Greece continues to extend the protected areas network, holding a large variety of Mediterranean habitats included in the reference list of the Natura 2000 initiative (EU Bird Directive 79/409/EEC and Habitat Directive 92/43/EEC): from open sea, tidal areas and sea dunes, to several types of shrubs and grasslands and Mediterranean mountainous forests of coniferous. Since 1999, additional areas of 105000 hectares (ha) and 1075000 ha have been designated as Sites of Community Importance (SCI) and Special Protection Areas (SPA), respectively. As of 2008, the Greek list includes 239 SCIs and 163 SPAs. When overlapping is excluded, the Natura 2000 network covers 21% of the Greek land surface and 5.5% of the territorial waters. In the same time studies regarding bird habitats have been delivered and are currently being under evaluation in order to additionally designate 42 new areas as SPAs.

Greek legislation provides for protection of a large number of native flora and wildlife species (916 plants, 139 vertebrates and 82 invertebrates), and for strict controls over international trade of species. In the last decade, the number of species involved in protection projects considerably increased, including the grey wolf, the brown bear, the monk seal, and the loggerhead sea turtle, as well as several vascular plants. Major projects have been financed by the EU financial instrument LIFE-Nature and national funding sources (e.g. ETERPS Fund). Financial support has mostly been allocated to research institutes, development companies and NGOs.

Protected areas represent an instrument for species conservation: the National Marine Park of Alonissos contributes to the protection of the monk seal, and the National Marine Park of Zakynthos is the natural habitat of the rare and threatened loggerhead sea turtle; protected forests contribute to the protection of tree-nesting birds of prey (e.g. the black vulture). Outside protected areas, measures for species protection include regulation on the hunting period, a binding fishing code, access restrictions, limited user rights, and compensations for income loss.

In addition, by 2010 an agreement between Albania, the Former Yugoslav Republic of Macedonia, Greece and the European Commission was established on the Protection and Sustainable Development of the Prespa Park Area.

Various are also the interactions between biodiversity protection and other sectors like Agriculture, Forestry and Fisheries. Especially in the Fisheries areas many of the affected from climate change species, like *Posidonia oceanica*[21] and *Mediterranean monk seal*[22] are being protected.

Finally, **CITES** (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) is an international agreement between governments (179 parties), among which is Greece. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival. Because the trade in wild animals and plants crosses borders between countries, the effort to regulate it requires international cooperation to safeguard certain species from over-exploitation. CITES was conceived in the spirit of such cooperation. Today, it accords varying degrees of protection to more than 35,000 species of animals and plants, whether they are traded as live specimens, fur coats or dried herbs. The text of the Convention was finally agreed at a meeting of representatives of 80 countries in Washington, D.C., the United States of America, on 3 March 1973, and on 1 July 1975 CITES entered in force.

Natura 2000 network has a key role in protecting and enhancing our natural capital. In addition to safeguarding nature’s intrinsic value, investing in Natura 2000 provides multiple benefits to society and the economy at the local, regional, national and EU level. It also delivers other socio-economic benefits such as maintaining water flow and quality, conserving natural pollinators, preserving landscape and amenity values, and supporting tourism and recreation.

Recently, the MEEN has proceeded with a call of tender for the development of 11 Special Environmental Studies (SES) and Management Plans (MPs). Natura network sites have been institutionally protected by joining the Nationwide Network of Protected Areas (Law 3937/11), and have been identified as "Areas for the Protection of Habitats and Species". However, it is necessary to further specify their institutionalization in a way defining and determining land uses, activities, special conditions and building construction restrictions within their boundaries. To that end, SES and MPs are needed. The SES and MPS to be produced will concern Natura sites that number over 500 (old and new sites) and are divided into 23 sub-groups. The direct result of the project will be to complement the planning and reinforcement of national policies for the protection of nature at national and regional level. The project will implement the National System of Protected Areas, which today have a weak protection status, as a results of the absence of the relevant Presidential Decrees/PD (the PD requires the SES) and the necessary MPs.

6.4.4.2 Adaptation policies concerning agricultural production

The responsibility for agricultural issues in Greece falls under the Ministry of Rural Development and Food (MRDF). There is close cooperation / co-competency with the Ministry of Environment and Energy (MEEN)on several issues (biodiversity, water resources, GMOs, land-use planning etc.), and cooperation with other Ministries (Ministry of Finance etc.) (climate-adapt.eea.europa.eu). The MRDF has established a dedicated Department for Climate Change focusing both on mitigation and adaptation. As the impacts on agricultural production are expected to be significant, the EU has launched a debate in view of adopting measures and

[21] The Regulation 1967/2006 of the European Union introduces the prohibition of fishery with trawls etc. over sea beds with sea vegetation, especially Posidonia Oceanica.

[22] The Hellenic Society for the Study and Protection of the Monk Seal promoted a 2005-09 project (co-funded under the EU LIFE-Nature programme) to draft and implement an action plan to mitigate the seal-fisheries conflict, with the active participation of fishermen. The project also aims at evaluating and revising the National Conservation Strategy for the Mediterranean Monk Seal.

adjusting its Common Agricultural Policy to climate change. All studies seem to concur that even a 2ºC global temperature rise would have considerable effects on agricultural production, thereby making mitigation and adaptation measures imperative (Copenhagen Diagnosis,(Allison, I. et al. 2009)).

Aiming to the adaptation of the country concerning the agricultural sector Greece has participated in the Project **ADAGIO -** ADAptation of AGriculture in European RegIOns at Environmental Risk under Climate Change. The project focused on:

- Improving awareness and user-orientation of adaptation strategies
- Improving local representation
- Considering the main vulnerable regions to Climate Change in Europe

Given that there will be differences across Greece’s agroclimatic zones (with Southern Greece, Crete and the Aegean islands the most vulnerable) and because of geographic specificities within each zone (rivers, land at risk of degradation from erosion or salination, etc.), the recommended measures will also need to be tailored to the local level. Choosing the wrong course of action, such as drilling too deep for water (McKeon & Hall 2000), could have devastating consequences for farming units (e.g. soil salination). For all these reasons, the diversity of the Greek landscape will have to be taken into account in any plan to consolidate, reorganize and restructure farming practices. Particular emphasis would need to be placed on water management and water use efficiency, soil fertility, greenhouse technology, crop selection tailored to specific agroclimatic conditions, as well as the development of new, improved/adapted crop varieties.

The national agricultural policy is fully harmonized with European Common Agricultural Policy (CAP). It incorporates actions contributing to the decrease of greenhouse gas emissions from agricultural activities. The relevant legal framework includes:

- COUNCIL REGULATION (EC) No 73/2009 of 19 January 2009 establishing common rules for direct support schemes for farmers under the common agricultural policy
- COUNCIL REGULATION (EC) No 1782/2003 of 29 September 2003 establishing common rules for direct support schemes under the common agricultural policy
- COUNCIL REGULATION (EC) No 1698/2005 of 20 September 2005 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD)
- COUNCIL REGULATION (EC) No 1290/2005 of 21 June 2005 on the financing of the common agricultural policy

In the CAP reform 2003 the support to farmers was disengaged from the agricultural production and as a result there was a reduction of the rate of intensity of agricultural land use and of the inputs (e.g. synthetic nitrogen fertilizers), Cross Compliance System (CCS) was established and a direct support became obligatory for all farmers within Regulations (EC) 73/2009 and (EC) 1782/2003. CCS provides, among others, the:

- ✓ management of farm waste
- ✓ prohibition of burning of cultivation residual materials
- ✓ rational use of synthetic nitrogen fertilizers
- ✓ limitations to fertilizer use in relation to water resources

CCS sets upper and lower limits to grazing density resulting to the decrease of livestock population.

The Rural Development Program’s (RDP) actions contribute, directly or indirectly, to the decrease of greenhouse gas emissions. RDP accomplishes the aims of Agricultural Development Policy concerning Environmental Protection and Sustainable Management of natural resources. RDP is based on Regulations 1698/2005, 1290/2005, 834/2007 and 74/2009, incorporating the guidelines of Directives 91/271 and 2000/60. Furthermore, RDP of Greece is a co-financed by European Agricultural Fund for Rural Development (EAFRD).

The RDP actions that contribute **directly** to the decrease of greenhouse gas emissions are:

- ✓ Organic production
- ✓ Decrease of the use of synthetic nitrogen fertilizers by 30% beyond the limit defined in cross compliance system
- ✓ Decrease of grazing density through the decrease of livestock population
- ✓ Decrease of agricultural production

The RDP actions that contribute **indirectly** to the decrease of greenhouse gas emissions are summarized as:

- ✓ Obligatory observance of cross compliance
- ✓ Obligatory observance of the good agricultural and environmental condition of the farm
- ✓ Obligatory observance of cross compliance system relating to waste management
- ✓ Use of environment-friendly livestock farming methods, regardless of production size

Desertification

The **National Action Plan for Combating Desertification** (2001) sets as an objective to combat efficiently the desertification trends in the 35% of the whole Greek territory that is under direct threat and to prevent the desertification process elsewhere. The National Action Plan includes a critical analysis and assessment of the factors and processes that control desertification pressures in Greece as well as general and sector-specific measures (Please refer also to 6.3.4.3 and 6.3.4.5).

The main issues in relation to agriculture are **erosion of soils and drought problems**. Means of addressing them include (Hellenic Republic, Ministry for the Environment, Physical Planning and Public Works of Greece, 2002):

- Land Use Planning under sustainability criteria to protect soils from erosion by establishing clear criteria for inclusion of agricultural land, in planning scheme, by appropriate selection of anti-erosion measures and by improving cultivating techniques;
- Covering of land with crop residues, rocks and chemical amendments, (thus reducing the danger of erosion and simultaneously conserving the moisture of the soil) to combat drought and improve ground water conservation.

6.4.4.3 Adaptation policies concerning forest ecosystems

The responsibility for forests in Greece falls under the Ministry of Environment and Energy (MEEN).

The study on the Strategy for Environmental Assessment of the Rural Development Programme 2014-2020 (SEARDP) has identified the mitigation and adaptation to climate change as one of the major environmental issues. More specifically, with regard to forest management, it acknowledges that the forest soils are the largest carbon pool and that in addition to fire protection, there is a need for protection against possible forest diseases that will accompany the effects of climate change and the migration of fungi or insects. In this context, many forests may need actions to increase their resilience to climate change. In addition, there is a need to increase the area under forest management by afforestation/reforestation and by creating agro-forestry systems.

One of the needs that will be fulfilled through the RDP 2014-2020 is the adaptation to climate change of the agriculture and forests. In the context of the SEARDP it was diagnosed that the measures of the Rural Development Program during the period 2014-2020 contribute to mitigation and adaptation to climate change. Interventions in forest ecosystems are counted towards mitigation and adaptation to climate change because forests are an integral part of the environment affect agricultural production and are affected by it. Afforestation has a beneficial effect on soil, water, air and biodiversity. Afforestation and the expansion of forested areas respond to the need to strengthen ecosystems and carbon sequestration and to move towards a low-carbon economy. Afforestation also contributes to the protection of the environment, the prevention from natural hazards and fires and contributes to the adaptation of climate change. The big problem after a forest fire which needs immediate action is the risk of erosion of areas that have lost their protective cover and the floods that follow. Prior to any afforestation, suitable work should be done to prevent the erosion and to limit the surface water runoff. This is why interventions related to water-engineering constructions and anti-erosion in mountainous areas are proposed.

Adaptation to climate change is included in the list of the proposed measures for the RDP 2014-2020 and more specifically in the sub-measure 16.5 “Support for joint action undertaken to mitigate or adapt to climate change and support for common approaches in environmental projects and current environmental practices”.

Adaptation of forest ecosystems to climate change is strengthened through the actions and measures implemented from the Forest Service (Central and local). Indicatively some of them are listed below:

- Strengthening scientific cooperation, coordination and networking through program implementation in forestry research and forestry policy to enhance sustainable and multifunctional forestry within the ERA NET (Networking the European Research Area);
- Fire protection of public forests and wooded lands (Opening - maintenance - improvement of forest roads);
- Forest Studies;
- Management of Public Forests;
- Cultivation of public forest nurseries, seed gathering and management of seed gardens and clusters;
- Construction of new forest recreational sites and renovation of old ones;
- Maintaining the health and vitality of forest ecosystems-Effective application of the Community plant health regime;
- Systematic and intensive forest health monitoring in Greece within the framework of the world forest organization - ICP FORESTS;
- Implementation of the annual Forest Protection Program;
- Preventive measures for the fire protection of public forests and wooded lands;
- Biological fight of chestnut ulcer;
- Anti-erosion and flood protection of the watersheds of burnt forests and wooded lands;
- Supply of vehicles;
- Costs of development, supplementing and correcting of forest maps (in the context of the National Cadastre Project);
- Improving the ecological and social value of forests;
- Applied research;
- Forest protection and upgrading;
- Implementation of adaptation to climate change strategy, prevention and risk management under the Priority Axis 11 of the Operational Program "Transport infrastructure, environment & sustainable development" 2014-2020. Investment priority 5i - Support for investments to adapt to climate change and ecosystem-based techniques / Action 3: Enhancement of the ecosystems’ adaptability, of biodiversity and of forests;

- Strategies and actions to promote the integration of the European Environmental acquis under the Priority Axis 12 of the Operational Program "Transport infrastructure, environment & sustainable development" 2014-2020. Investment priority 6d - Protection and restoration of biodiversity and of soil and promotion of ecosystem services, including through the Natura 2000 network, and of green infrastructures;
- Under the RDP 2014-2020 the following measures/sub-measures are included:
  - ✓ Sub-measure 4.3.3 Opening and improvement of forest road network;
  - ✓ Sub-measure 8.1 support for afforestation/creation of forested areas;
  - ✓ Sub-measure 8.2 Aid for agroforestry systems;
  - ✓ Sub-measure 8.3 Support for the prevention of damages to forests from forest fires, natural disasters and catastrophic events;
  - ✓ Sub-measure 8.4 Support forest restoration caused by forest fires, natural disasters and catastrophic events;
  - ✓ Sub-measure 12.2 compensation for forest areas of Natura 2000 network.

In addition, under the **Life+** financing instrument the project "Adaptation of forest management to climate change in Greece (AdaptFor)" was implemented by the Goulandris Natural History Museum / Greek Biotope - Wetland Centre in cooperation with the MEEN. The project aimed at:

a) Demonstrating the approach of adapting forest management to climate change.

b) Enhancing the capacity of forest services to adapt forest management to climate change and disseminating the need for adaptation of forest management to other stakeholders and to the general public.

The project had selected four pilot sites. Changes in vegetation have been observed (e.g. dying out of fir, invasion of conifers in evergreen broadleaved forests). This project works at local level and will then integrate the outcomes to the current procedures of forest management and will give guidance and train the forest services at regional and national levels.

Concerning public Education and Awareness, the Secretariat of Forests has organized a seminar to foresters of the Forest Service – **Paws-med project in EU Long-life learning programme** – (March 2011). The main objective of such seminars was to pass the knowledge of planning and implementing Forest Pedagogy from experts to the foresters of the local Forest Services. In turn, they will conduct guided tours in forests to target groups. In addition, the purpose is to increase the awareness of children, students, special groups, and general public about the protection of the forests, the impacts of climate change and the decertification and degradation.

Desertification

The **National Action Plan for Combating Desertification** was approved in 2001 (Common Ministerial Decision 996005/31719). The implementation of the plan is coordinated by the National Committee to Combat Desertification. The Ministry of Rural Development and Food ensures secretarial and technical support to the committee, which brings together relevant ministries, universities and research institutes and NGOs to: formulate proposals for combating desertification; co-ordinate national, regional and local action plans; pursue co-operation with the EU and other international bodies on desertification programs; promote research; and raise public awareness (climate-adapt.eea.europa.eu).

In Forestry, measures to reduce the frequency and decrease the spread of forest fires are under consideration. These measures include:

- Introduction of less flammable plants;

- Thinning, clearing and maintenance of forest structure;
- Ground cover clearing, thinning, disbudding, appropriate settlement or removal of residues and possibly, implementation of controlled grazing;
- Forest fire detection systems to facilitate quick response.

More specifically, thinning and pruning may significantly reduce the risk of developing active and passive crown fires, giving the opportunity for successful countering of a possible fire from ground and air forces, since the fireline intensity of the front is significantly reduced, as a result of the fire's confinement to the surface. Pruning includes the cutting, removal or fragmentation and dispersion of the lower parts of the tree crown, especially the dead ones. After pruning treatments, due to the removal of the lower sections of a dried crown, the maximum possible distance of the lower parts of the crown from the ground that may convey the fire into the entire foliage has increased. In addition, the progressive enrichment with broadleaf species might increase the moisture content in these positions and further reduce the risk of a forest fire spreading. Controlled or prescribed burning as a means to reduce surface fuel is not allowed under Greek legislation (Zagas et al. 2013).

In addition, measures to counter after-fire impacts and avoid soil erosion have been adopted which include prohibition of grazing in burned lands and soil support to allow for natural regeneration by not clearing burned trees and bushes or by planting appropriate trees, bushes and plants where rapid natural coverage of the ground is not ensured.

Since 2003, a wide array of desertification-specific projects have been carried out to better assess the extent and impacts of desertification within the country, estimate the effectiveness of policies and measures already undertaken, and propose new remedial and preventative steps. In addition, substantial levels of funding are being allocated to other projects that contribute to the anti-desertification fight, but which are not designated as desertification-related activities in the budgets of the implementing ministries and institutes. For example: EUR 650 million have been allocated by the Greek government for re-establishment of lands impacted by forest fires over the 2007-10 period; in 2006, expenditure to support early retirement of aged farmers and afforestation of agricultural land amounted to EUR 236 million and EUR 19 million, respectively (including contribution from the EU); over the period 2000-06, EUR 122 million were spent to support organic farming. Also, in the recent years, the Committee for Combating Desertification has oriented its actions to broadening the public awareness on the problem. To this end the Committee has created a website that contains all available information over the desertification issue in Greece (http://www.gnccd.com) and has organized a meeting on the 16th of June 2007 (World Day to Combat Desertification and Drought), from which very useful conclusions have been drawn. Greece has also been one of the founding members of the Drought Management Centre for South Eastern Europe (2007) while it has founded a focal point to ensure the implementation of the National Plan. Various projects have also been undertaken by Greek Universities and Institutes, such as the Xerochore project[23], undertaken by the Environmental & Energy Management Research Unit of the National Technical University of Athens and the update of desertification maps that is being performed by the Agricultural University of Athens.

6.4.4.4 Adaptation policies concerning fisheries and aquaculture

The impacts of rising temperatures on marine ecosystem structures and fish populations have already been felt. In addition, changes in fish populations inevitably impact employment levels in the fisheries sector as well as consumer options.

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[23] XEROCHORE is a Support Action aimed at assisting in the development of a European Drought Policy in accordance with the EU-Water Framework Directive (EU-WFD). The Support Action is financed by the 7th Framework Programme (Grant Agreement Number: 211837) and spans a duration of 18 months (May 2008 - November 2009).

The Greek Operational Programme "FISHERIES 2007-2013" was approved by the European Commission, decision no. E(2007)6402/11-12-2007. The EU co-financing is from the European Fisheries Fund (E.F.F.), in consistence with the Council Regulation (EC) no. 1198/2006. The overall strategy was summarized as "the viable and sustainable development of the Fisheries sector whilst reinforcing sector competitiveness and preserving social and economic cohesion".

The strategic objectives of the Operational Programme were reflected in and were to be attained through the implementation of four (4) priority axes, among which PRIORITY AXIS 1 is "Measures for the adaptation of the fishing fleet". The strategy objective for this Axis was to achieve a stable balance between fisheries resources and the respective fishing activities, thereby simultaneously ensuring the sector's financial sustainability, in accordance with the principles of the Common Fisheries Policy.

The **general objectives** of the priority axis were as follows:

- To achieve sustainable balance between the levels of fisheries stock and fisheries activities by adapting fishing effort.
- To create a competitive and financially viable sector through investments on fishing vessels in order to ensure to a satisfactory standard of living for employees in addition to restructuring of fisheries undertakings
- To address the specific needs of small scale coastal fishing.
- To support the socio-economic role of sea fisheries in coastal and insular areas.

Within the context of the aforementioned strategy and general objectives, the following **specific aims** weredefined:

- To protect and preserve fisheries resources via a gradual transition from a fisheries management policy based on the control of fishing effort to an ecosystem-based management.
- To restructure and modernize the fishing fleet by improving work & safety, conditions, the quality and hygiene of products, energy efficiency and selectivity.
- To support small-scale coastal fishing.
- To improve the age structure of employment in the sea fisheries sector
- To promote diversification of activity and parallel employment.
- To support populations dependent on the fisheries sector in coastal and isolated areas.

Concerning aquacultures, possible adaptation measures to climate change include institutional measures, policy measures and action planning which are summarized as follows (Remoundou and Kountouri 2011):

Insurance aquaculture: this measure could help to avoid the risk of bankruptcy for fish farmers from damage to their facilities due to extreme weather events. The state could provide incentives so that even small farmers could insure and avoid long-term reductions in production and social problems of the abandonment of their profession.

Technology transfer and research: Proper research is necessary so that the aquacultures can adapt to the impacts of climate change. The countries need to intensify cooperation towards the direction of detection and prevention of new diseases, the study of the physiology of marine species, the research into new and better able species to adapt and better nutritional systems that are both effective and environmentally friendly.

Diversification of crop species: In many countries there is already a tendency to differentiate the cultivars and cultivation techniques. This differentiation allows the operation of the process of natural selection that will determine which species are more resistant and therefore will survive. Diversification also represents a kind of insurance against diseases and market conditions. Diversification, however, requires both proper training of farmers and adequate consumer information for new species.

Adoption of selection systems for the installation and monitoring of aquacultures: The selection of those units of aquaculture should be based upon a risk assessment study. This study especially in coastal and more vulnerable areas should reflect the risks associated with time to take appropriate protective measures, e.g. to determine the correct depth of the cells, so that they are not in warmer layers associated with low oxygen or to properly define the distance between crops in order to reduce the risk of disease transmission. For this purpose continually improved information systems forecasting the risks associated with facilities and biomass should be communicated quickly and reliably. Furthermore, it is important to install advanced water monitoring systems at local level (watersheds) to provide accurate information regarding the physical and chemical status of water bodies and the presence of harmful pathogens or plankton.

6.4.4.5 Adaptation policies concerning water resources

Institutions and Legislation

Greece incorporated the EU Water Framework Directive (60/2000/EC) in 2003 (Law 3199/2003), while the framework of measures and procedures for Integrated Water Resource Management was established in 2007 (Presidential Decree 51/2007).

The national objectives are mainly based on the implementation of the various EU water-related directives, supplemented, when appropriate, by additional provisions. The National Strategy for the Management of Water Resources has amongst its aims to use existing water reserves sustainably. The **River Basin Management Plans 2009-2015** (ec.europa.eu/environment/water/participation/map_mc/map.htm).was adopted by 8 out of the 14 Districts of Greece. The River Basin Management Plans 2016-2021 are currently under public consultation: http://wfdver.ypeka.gr/

In Greece, the Special Secretariat for Water is responsible for the development and implementation of all programs related to the protection and management of the water resources of Greece and the coordination of all competent authorities dealing with the aquatic environment. The implementation of the Water Framework and the Marine Strategy Directives as well of the related daughter Directives fall within the scope of the activities of the Secretariat.

The Secretariat, in collaboration with the Regional Water Authorities, formulates and, upon approval by the National Council for Water, implements the River Basin Management Plans and the national monitoring program. The Secretariat is composed of four Directorates and is headed by a Special Secretary, appointed by the Ministry of Environment, Energy and Climate Change and the Government.

More specifically the Secretariat is responsible for:

- the coordination of all agencies and state institutions, related to water issues and the regional Water Directorates
- the implementation of the Water Framework Directive (60/2000/EC)
- the implementation of the Marine Strategy Directive (2008/56)
- the implementation of the national monitoring program
- the implementation of the Floods Directive (2007/60/EC)
- the implementation of the Urban Wastewater Directive and reuse programs
- the implementation of the Nitrates Directive (91/676/EEC)
- the implementation of the Bathing Waters Directive(76/160/EEC)
- transboundary and international water issues

In addition, other authorities involved in the water management and coordination of activities of regional directorates are:

- A new Central Water Agency was established within the Ministry of Environment in 2006, with responsibilities of definition and supervision of the national water policy; the Central Water Agency reports directly to the Environment minister (instead of the director-general of the ministry, as was the case previously), showing the importance that water management is receiving currently in the country.

- The National Water Committee is a political body consisting of six ministers and responsible for setting water policy and overseeing implementation; the Committee meets once a year.

- The National Water Council consists of 27 members, stakeholders and NGOs. It provides its opinion to the National Water Committee on the water protection and management programmes. It is also informed annually by the National Water Committee about the state of the waters and the implementation of the legislation.

- At the regional level, Regional Water Directorates in each of Greece's 14 regions are responsible for the formulation and implementation of the basin plans. A Regional Water Council, consisting of about 30 members (stakeholders, NGOs), provides a consultative function in each region.

Greece updated its water management framework by adopting first a water law (Law 3199/2003) in December 2003, and then the measures and procedures for integrated water resource management in 2007 (Presidential Decree 51/2007). The new legislation is based on the EU Water Framework Directive, with emphasis on:

- ecological functions of water

- river basin management approach

- economic evaluation and full-cost pricing of water services.

International and Mediterranean water issues

It is understood that initiatives from Greece and the country's active participation in ongoing programs of International Organizations (eg UNEP-MAP), such as the **MED POL Programme,** are essential. In addition, the actions under the "Union for the Mediterranean" confirm the country’s orientation towards strengthening transnational partnerships.

It should be noted that Greece is leading the “Mediterranean Component of the EU Water Initiative - MED EUWI” since 2003, by supporting it economically and politically in order to implement specific actions for “water and sanitation” and “integrated water resources management”, at national and regional level. The most important current activity of Greece as a Mediterranean country, as well as the leader of the MED EUWI, at regional level, is the preparation of the “Mediterranean Strategy for Water Resources”.

At international level, our country also actively participates in the “World Water Forum”, organized every three years by the World Water Council. The 6th World Water Forum was held in March 2012 in Marseille, France with the main theme “Water Security”.

It should also be noted that in May 2010 Greece and Turkey signed a "Joint Declaration on the Protection of the River of Evros", while on July 27, 2010 the ministers of Environment of

Greece and Bulgaria also signed a Joint Declaration for the cooperation in the use of water resources in their respective domains of shared river basins, which provides actions to prepare management plans for transboundary river basins, in accordance with the principles and recommendations of the Directive 2000/60/EC.

Operational initiatives to counteract water stress

With the aim of raising the storage capacity of the freshwater reservoirs, the MEECC has started with the construction of dams. In addition, a first pilot project on using recycled wastewater for irrigation purposes is currently on-going in Thessaly.

One of the most ambiguous projects aiming at the adaptation of water scarcity in the area of Thessaly is the Acheloos water transfer project. For the past 20 years, the Acheloos water transfer project has sparked long and lively debates, while maintaining support from the Parliament’s majority. The proponents of the scheme, many of them Thessaly farmers, have pointed to the more secure and regular yearly agricultural yields that would result from the project. They also claim that the project is needed to: i) supply water to towns in Thessaly and to mitigate the high water deficit of the plain; ii) save the river Pinios, which often dries up during summer; iii) halt saline intrusion, and protect and restore groundwater reserves; iv) minimize land subsidence due to groundwater depletion; and v) change farming practices. According to some studies (e.g. the 2006 water management study for the Pinios and the Acheloos river basins; the 2008 water management study for Epirus, Central Greece and Thessaly) the water transfer will not have any serious adverse effect neither on the Acheloos river’s ecosystem nor on the ability to meet water demand in the river basin and the Prefectures of Aetolia and Acarnania.

However, the opponents of the scheme, mainly national and international NGOs, have argued that the dams and reduced flows in the Acheloos will change the habitats of several endangered and internationally protected species irreversibly and that others will suffer serious disturbance both during and after the construction work. They also fear that the Ramsar site at Messolongi would suffer from a critical reduction in freshwater input, which would fundamentally alter its character. In addition, NGOs claim the scheme will have adverse socio-economic and cultural impacts, including the destruction of important monuments, such as the 11th century monastery of St George of Myrophyllo.

In March 2008, the Greek government released a national water management programme that renewed its commitment to the **Acheloos project**. The current plan for the Acheloos diversion project includes the construction of four major dams and reservoirs, a 17.4 km long diversion channel to Thessaly and two tunnels. The system is designed to take 600 million cubic metres of water (instead of 1 100 million cubic metres of the original project) annually from the Acheloos basin to the other side of the Pindos Mountains. This volume is close to 11% of the mean annual yield of the Acheloos and enough to irrigate between 240 000 ha and 380 000 ha. On the Thessaly side, the design and construction of extensive infrastructure are required, including on the irrigation network. Works on some infrastructure are in progress, including the Gyrtoni barrage dam and the Smokovo pressure pipe irrigation network. As of end 2008, construction was still underway, as were the efforts to stop it.

Other adaptation measures include the pricing of municipal water services. Up to now, tariff structures typically include a progressive volumetric rate for different consumer categories, in addition to a fixed monthly standing charge that depends on the diameter of the pipe connecting the consumer to the network. Households pay a disproportionally high price compared to commercial users, which after 2010 will be in violation of the Water Framework Directive. Hence, Greece has established rational pricing policies for municipal water services, including incentives for water conservation. Progress is being made towards full cost recovery from household billing and on average amounts to about 60%. According to information received by the Central Water Agency of the MEECC, there is quite a variation among basins, with Attica and Thrace showing a cost recovery of 108% and 103%, respectively, whereas at the other end of the scale Thessaly and East Peloponnese only achieve 34% and 38%, respectively.

Desertification

In the water resources sector, according to the National Action Plan for Combating Desertification, the suggested measures for water conservation are of particular interest as water shortage in a number of areas in now endemic. The rational management of water resources is important to provide security of supply to address a variety of needs, but also to protect the quality of aquifers and other groundwater reserves. The measures concern:

- Reduction of water loss through the improvement of irrigation efficiency (restoration of the networks structure, implementation of integrated management systems of irrigation water, recycling and reuse of water). It is expected that with the implementation of these measures the conservation achieved will vary from 10% to 50% of current use;
- Reduction of water losses and demand in urban and industrial use. The suggested measures are the upgrading of piping networks for the reduction of leaks and rapid leak tracing and restoration of the network damages, as well as the introduction of incentives for the construction of private tanks and collection of rain water;
- Increase of water supply through funding of programs for water recycling and reuse, studies for the risks associated with water shortage in threatening areas, restraint and storage of surface runoff water, transfer of surface water to areas threatened by desertification, management of forests ecosystems so as to limit rainwater losses through surface flow and implementation of systems for artificial concentration of ground water, re-injection of water surplus and replenishment of its reserves.

Besides, socio-economic measures are taken. Main objectives pursued are among others the sustainability in agricultural production and the protection of agricultural population through the supply of technical and information support to farmers, training and support of new farmers, implementation of the LEADER Community Initiative that supports farmers etc. (Swedish.Government.Official.Reports 2007; Zagas, Raptis et al. 2013).

Droughts

The MEDROPLAN Project: "Mediterranean Drought Preparedness and Mitigation Planning" focused on developing Guidelines for drought preparedness plans and to setting up a Network for drought preparedness in Mediterranean countries (http://www.iamz.ciheam.org/medroplan/project_description.htm). The Guidelines provided an integrated approach to face droughts from a risk management perspective and therefore minimizing the impacts of drought in the population and resources. The final Guidelines were translated into six languages.

Water resources in the semi-arid countries and particularly in the Mediterranean region are limited, scarce, and difficult to predict from year to year. With limited and scarce water resources and demand rising due to population growth and improving standard of living, water management problems are tremendous even without drought events, due to the imbalance between availability and demand.

Among the project's achievements were:

1 Improved understanding of drought, its causes, and its social, economic, and environmental effects

2 Methodological framework for risk based approach to drought management

3 Incorporation of science into drought management by education, awareness, and outreach

4 Analysis of the current know-how, technology, information, and expertise built from extensive stakeholders' knowledge in drought management

5 Advanced training courses and workshops for institutional resource managers focused on urban and irrigation water management (please refer also to 9.2.2.6)

Floods

Regarding Flood Risks, Greece has transposed the EU Directive 2007/60/EC in 2010 (National Gazette 1108/B/21.07.2010). Directive 2007/60/EC, known as the **Floods Directive**, requires that Member States assess if all water courses and coast lines are at risk from flooding, to map the potential flooded areas and endangered assets and humans in order to take adequate and coordinated measures to reduce the risk. The Directive introduces a three-step approach:

- Member States have to undertake a preliminary assessment of flood risk in river basins and coastal zones.
- Where significant risk is identified, flood hazard maps and flood risk maps have to be developed.
- Flood risk management plans must be developed for these zones. These plans have to include measures that will reduce the potential adverse consequences of flooding for human health, the environment cultural heritage and economic activity, and they should focus on prevention, protection and preparedness.

The 1st stage of the preliminary assessment was completed and all available information is published in the Water Information System for Europe (WISE) (http://water.europa.eu/). For all such zones flood risk maps should be prepared by the end of 2013 and subsequently flood risk management plans focused on prevention, protection and preparedness by 2015. The Directive applies to inland waters as well as all coastal waters across the whole territory of the EU. The Directive shall be carried out in coordination with the **Water Framework Directive,** notably by flood risk management plans and river basin management plans being coordinated, and through coordination of the public participation procedures in the preparation of these plans. Member States shall furthermore coordinate their flood risk management practices in shared river basins, including with third counties, and shall in solidarity not undertake measures that would increase the flood risk in downstream countries. Member States will take into consideration long term developments, including climate change, as well as sustainable land use practices in the flood risk management cycle addressed in this Directive.

The consequences of potential future floods are currently under evaluation in order to select flood prone areas at a national level. In addition, technical specifications for the development of flood mapping and flood risk management plans are under preparation (climate-adapt.eea.europa.eu).

In addition, a national general emergency plan (“Xenokratis”) was enacted in Greece for the prevention, mitigation and control of natural hazards, including floods. Flood forecasting and warning is carried out in cooperation by the Hellenic National Meteorological Service (HNMS), which is responsible for issuing emergency forecasts and warnings for intense precipitation phenomena, the Hellenic Civil Protection Authority and the respective regional prefectures and municipalities. A national general emergency plan (“Xenokratis”) was enacted in Greece for the prevention, mitigation and control of natural hazards, including floods. Flood forecasting and warning is carried out in cooperation by the Hellenic National Meteorological Service (HNMS), which is responsible for issuing emergency forecasts and warnings for intense precipitation phenomena, the Hellenic Civil Protection Authority and the respective regional prefectures and municipalities (UNECE 2009).

Potential for adaptation and for addressing the impacts of climate change

Adaptation is expected to play a major role in developing countries, likely to be affected both more severely and sooner by climate change. In Greece, the problem generated by the general impacts of climate change (reduced rainfall, and increases in temperature, evaporation and water consumption needs), could be further compounded by the irrational use of water for irrigation in the summer months (e.g. water irrigation canons and flood irrigation), water loss due to obsolete systems in urban water supply networks, the rising demand for water associated with population increases (influx of tourists, permanent population) and improving living standards (increased number of second/summer homes, parks, better everyday life conditions, etc.). To this overall situation, one would also have to add the acute impacts from increased evapotranspiration, increased irrigation and rising water consumption brought about by land use changes, notably the conversion of former farmland into resort areas.

The need for vigilance and to address the issue promptly and comprehensively is imperative. In the field of water systems, what is needed is the elaboration of a comprehensive integrated water management plan and corrective interventions to reduce the considerable loss of water (e.g. in public distribution and supply networks or via evaporation). Particular attention should also be drawn to specific small-scale instances (i.e. certain islands or a sector such as tourism) that could seriously undermine the overall water management effort (unregulated operation of private, licensed or unlicensed water well drillings).

Policy-led adaptation, in order to be reliable and effective and to entail minimal side-effects, must be based on a comprehensive integrated water management plan and corrective interventions to reduce water loss. Such a management plan should include (Bank.of.Greece 2011):

- an elaborate national land-use plan, with a delineation and description of the uses of all surface and underground water bodies and lands;
- the implementation of a national water management plan, adjusted to prevailing conditions, with a permanent monitoring of implementation;
- a modernization of irrigation systems;
- a modernization of urban water supply systems;
- the establishment and protection of minimum, ecologically sound, freshwater reserves;
- the regulation of water abstractions, with restrictions applicable to each case;
- the reuse of water (e.g. for park irrigation);
- the artificial recharge of groundwater (aquifers); and
- the establishment of water abstraction protection zones, at least for abstractions intended to public water supply needs, either directly (networks) or indirectly (bottling).

There is a wide and complex range of adaptation options available, belonging to two main categories depending on whether their purpose is (a) to satisfy demand, or (b) to manage, i.e. curb, demand. Policies geared towards satisfying total demand rely on large hydraulic infrastructure as their main tool, opting for such projects as dam construction, water transfer projects (within a basin or between basins), aquifer recharge works and —when technically feasible— desalination. Policies geared toward managing, i.e. curbing, water demand, on the other hand, almost entirely rely on water pricing. The principle underlying this approach is that the rational pricing of water, in accordance with Directive 2000/60/EC on Water Resources, will provide an incentive for efficient water use. At the same time, an adequate pricing policy can ensure revenue much needed to ensure the maintenance of water supply infrastructure and the solvency of water companies. The complexity of the whole endeavor lies in the need to strike a balance between the two policy orientations (Bank.of.Greece 2011).

The economic effectiveness of adaptation policy hinges upon a planning ability taking into account the technical and economic adaptation potential, and the specificities of each case. Cost/benefit analysis has been shown to be the most appropriate tool for choosing and applying the optimal mix of adaptation actions. However, alternative forms of adaptation policy can be assessed as to their cost and effectiveness only if the necessary specialized data for water resource management is available.

Listed below are some of the more advisable adaptation actions (in terms of the benefits they would yield), the implementation costs of which have yet to be established:

- the preservation (non-use) of underground water reserves, suitable for future use in public water supply, in priority those situated near present-day consumptions;
- the water conservation potential on the users side, e.g. from the use of water saving appliances; and
- various institutional actions, such as pricing, incentives to reduce consumption, information/education/awareness campaigns, and the gradual banning of particularly water-consuming urban uses.

6.4.4.6 Adaptation policies concerning coastal zones

The General **National Framework for Spatial Planning and Sustainable Development** (National Gazette 128/A/3.7.2008) includes priorities that could be considered as contributing to climate change adaptation, such as energy saving measures, forest fire prevention and reforestation measures, implementation of bioclimatic energy etc. and food (MRDF). With reference to coastal zone management, the consequences are already embedded in the law concerning the creation of new settlements or the expansion of existing ones. Additional useful provisions exist in the Specific Framework Spatial Plans that were published in 2009 and refer to Tourism and Industry (National Gazette 1138/B/11.06.2009). In order to promote the management of coastal zones exposed to particular and complex pressures, including climate change, a Specific Framework Spatial Plan of Coastal Areas and Islands has been developed and presented to the public (climate-adapt.eea.europa.eu).

Part of the strategy to cope with the consequences of climate change in coastal zones is already embedded in the law concerning the creation of new settlements or the expansion of existing ones. It provides for the following:

- Avoid the expansion of existing settlements, especially along the coast;
- Define boundaries of areas which could be built up;
- Encourage expansion in the areas where population density permits it;
- Protect beaches and natural coastal areas, assure public access.

Additional useful provisions exist in the Specific Framework Spatial Plans that were published in the Government Gazette in the first semester of 2009 and refer to Tourism and Industry. The provisions of the Specific Framework Spatial Plan for Tourism include specific commitments for the coastal zones, in order to reduce potential impacts of climate change. Furthermore, in order to promote the management of coastal zones that are exposed to particular and complex pressures, including the climate change impacts, a Specific Framework Spatial Plan of Coastal Areas and Islands has been elaborated and presented to the public.

According to Law 3983/2011 "**National Strategy for the protection and management of the marine environment** – in compliance with Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 and other provisions" the Directive 2008/56 of the European Communities on the **Marine Strategy Directive** was incorporated into national legislation, which constitutes the environmental pillar of the future EU policy in this regard. The aim is to maintain and restore high environmental status of the marine environment by the year 2020. To achieve this goal requires specific sets of actions which should be completed under a binding timetable.

After incorporating the directive into national legislation the application of the first project begun with the collaboration of "Special Secretariat for Water" (http://www.ypeka.gr/Default.aspx?tabid=246&locale=en-US&language=el-GR) of the Ministry of Environment, Energy and Climate Change. The purpose of this project is: (a) preliminary assessment of the environmental status of marine waters and the environmental impact that grow in them, (b) to define quality standards of Good Environmental Status and (c) to define the objectives towards achieving Good Environmental Condition. The project will be completed by autumn 2012 and a report upon completion of the consultation process will be submitted to the EU in accordance with the requirements of the Directive.

According to the **"Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean",** the European Union and the countries surrounding the Mediterranean are collaborating parties under the Mediterranean Action Plan. The aim is to formulate policies and strategies for the protection of biodiversity and the marine and coastal environment. In recognition of the importance of climate change for the Mediterranean region, in 2008 the Members of the Barcelona Convention signed a Protocol on Integrated Coastal Zone Management in the Mediterranean, prioritizing adaptation to climate change. The proclamation of Marrakesh, adopted by the Barcelona Convention in November 2009, highlights the need for immediate action to address the serious impacts of climate change on ecosystems and resources.

As estimated by the authors of the report on the "Environmental, economic and social impacts of climate change in Greece" (Bank.of.Greece 2011), the impacts on Greece's coastal areas of gradual long-term SLR and of storm-driven wave and surge events are expected to be particularly important in the next decades. The implementation of a coordinated adaptation policy is thus warranted to ensure the protection of Greece's extensive coastline of 16,300 km. As pointed out in the latest national report submitted to the UNFCCC regarding climate change (Hellenic.Republic 2006), the basic adaptation policy suggested involved a total estimate of the risk that Greece's coastal regions face on account of climate change and SLR.

A number of studies have already presented interesting data on the cost of implementing adaptation policies. For instance, the Scottish Natural Heritage (SNH 2000) estimated the cost of various 'soft' and 'hard' engineering works for effective shoreline management against the impacts of erosion impacts. The adaptation policies studied under the PESETA program (Richards and Nicholls 2009) were dike construction and beach nourishment.

Hard engineering structures that are used in Greece to protect the coast from eroding include seawalls, groins, breakwaters, revetments, flood embankments, placement of gabions and rock armouring. Approximately 15% of the eroding coastline is artificially protected. The most commonly used soft protection methods are beach nourishment, sediment recycling (transport of sediment from the down drift end of a beach back to its up drift end), and stabilization of coastal dunes with vegetation (Alexandrakis G. 2010).

6.4.4.7 Adaptation policies concerning tourism

In the Mediterranean region, the likely reduction of tourism during the hotter summer months may be compensated for by promoting changes in the temporal pattern of seaside tourism, for example by encouraging visitors during the cooler months. Climate change may even be beneficial for the Mediterranean tourist industry if it levels-out demand, reducing the summer peak, while increasing occupancy in the shoulder seasons.

The following measures promoted by the tourism sector are to be defined by the Ministry of Culture and Tourism and the Greek National Tourism Organization in cooperation with other Ministries and national bodies:

- Strengthening the assessment of tourism investments and leading them to sustainable development in order to ensure the positive role of tourism on the other related economic sectors.
- Empowering legislative tools in cooperation with the Ministry of Environment, Energy and Climate Change regarding appropriate land use, coastal zoning and spatial management and aiming to deal with the climate change consequences.

- Introducing fiscal incentives to encourage efficient energy use and/or renewable energy, water and waste management as well as the construction of “green buildings” for the tourism industry.
- Promoting dialogue in order to engage on the sustainability issue all stakeholders of the tourism supply chain
- Activating the Tourism Satellite Account and the Observatory of Tourism for the enhancement of the economic and qualitative data of the tourism activity as a tool for the planning and the implementation of the relative policies.

Priorities of the Greek National Tourism Organization include:

- Adaption of an appropriate marketing strategy aiming at diversification through the development of new tourism product and distinctive destination brands
- Promotion of sustainable tourism (ecotourism, nature based tourism, rural tourism)
- Promotion of Green Destinations (i.e. the “European Destinations of Excellence”) and areas where alternative forms of tourism and sustainable management of the whole tourism supply chain are implemented.
- Motivation of entrepreneurs through awareness-raising and through incentives for applying certification and quality systems
- Encouragment of sustainable business practices, providing tools and guidance to the tourism industry and investors and new technologies to improve energy efficiency
- Encouragment of clusters, i.e. public-private networks and partnerships

The Organisation of Tourism Education and Training (OTEK) aims to enhance tourism companies’ staff awareness on the consequences of climate change and engage them in appropriate actions.

According to each destination’s characteristics specific measures can also be taken for:

a) Coastal and inland destinations
    - Developing plans for water conservation techniques (i.e. rainwater storage, use of water-saving devices and waste water recycling)
    - Raising awareness among tourists and residents and educating businesses and their staff in environmental issues.
    - Promoting drainage and watershed management to reduce flood and erosion
    - Enhancing siting, design and planning guidelines for tourism establishments in order to ensure the conservation of the coastal ecosystem and the quality of landscape
    - Promoting alternative and more environmental-friendly forms of tourism

b) Nature-based and traditional settlements-based destinations
    - Establishing monitoring survey programs to assess changes on the ecosystem, the landscape and the human heritage
    - Applying integrated tourism carrying capacity assessment techniques considering physical, economic, environmental and socio-cultural aspects
    - Facing and removing external stresses, human interventions and overuse of sites that are likely to degrade the destination
    - Ensure local communities’ active participation in management processes

Cost of adaptation for tourism establishments

From the point of view of the expenses required to cope with climate change and mitigate its impacts, the economic impacts are assessed as moderate. These impacts are limited to a possible increase in energy consumption, mainly for ventilation and cooling during the summer months. Given that energy accounts for 5% of the operating costs of accommodation establishments and only 10% thereof involves ventilation and cooling, the anticipated increase in energy costs will not exceed 0.5% of operating costs in the event that energy consumption should double.

A more serious impact will be the increase in depreciation related to the acquisition of new systems for expanding/improving existing infrastructure (renewable fuel-fired systems, innovative heat insulation materials, double-pane windows, water recycling systems, solid waste collection and recycling systems, etc.). As depreciations represent 18.6% of hotels' total operating costs, it is estimated that an organized effort to increase energy efficiency and eco-friendly operation could increase this item by 10-20%, burdening hotels' operating costs by an additional 2-4%.

Standardizing these efforts by acquiring a relevant certificate (such as ISO or EMAS) or a tourism Eco label could add an additional 0.2-0.3% to operating costs. One should also take into consideration the higher maintenance costs for newly acquired equipment, the costs of training personnel in the operation of such equipment and, of course, the costs of acquisition (in cases where acquisitions are made with external capital). All of the above could result in an additional increase in costs in the order of 1% (Bank.of.Greece 2011).

International experience has brought to the fore the gradual increase of insurance premia paid by accommodation establishments for coverage against extreme events that could compromise their ability to operate at a given time. Indicatively, insurance premia for hotels in the US tripled from 2000 to 2010. Admittedly, extreme weather events such as the ones that led to such an increase (e.g. hurricanes and tornados in the southern US), have yet not occurred in Greece, at least not at such severity and frequency. However, the effects of forest fires in the last few years could be taken into account in the estimations as —at least partly— a result of climate change. A potential deterioration of weather conditions and of their consequences, such as wildfires, would undoubtedly lead the Greek insurance market to rapidly adjust its rates accordingly.

The Hellenic Chamber of Hotels, the Research Institute for Tourism, and the Association of Greek Tourism Enterprises, as well as the local unions of hotel owners, should play a key role in the planning, adaptation and implementation of this effort, contributing their experience and some of their resources, but in the authors' opinion the additional economic cost per accommodation establishment would be very small (Bank.of.Greece 2011).

6.4.4.8 Adaptation policies concerning human health care

The National Action Plan for the 'Response of Environmental Hazards Threatening Health' for 2008-2012 includes a special action dedicated to the 'Exploring of Climate Change Impacts on Health', primarily referring to the identification, research and documentation of the impacts. The General Secretariat for Civil Protection is responsible for the implementation of all the corresponding phases of preparation, mobilization and coordination of actions regarding Civil Protection (Law 3013, Official Gazette 102A/04.06.2002), including prevention and protection from forest fires, floods, extreme weather events etc. (climate-adapt.eea.europa.eu).

A problem as global as climate change requires action on an international scale. According to WHO estimates (Neira, Bertollini et al. 2008; WHO 2008), a significant number of deaths each year are attributed to climate change, including:

i. 800,000 deaths due to urban atmospheric pollution;

ii. 1.7 million deaths due to lack of access to clean water and sanitation;

iii. 3.5 million deaths from malnutrition; and

iv. 60,000 deaths due to extreme weather conditions and disasters.

International strategic action and policies for climate change and health have been undertaken by the European Commission, the WHO and other international organizations. In the WHO

Global Conference on Health Promotion in 2008, all 193 Member States unanimously supported the adoption of preventive measures to address the impacts of climate change on health. What follows is a brief presentation of the international and national policy actions taken.

At the international level, a series of measures have been developed with a view to (Bank.of.Greece 2011):

1) Developing the scientific documentation on the public health, social and economic implications of health-related climate change impacts. Research networks that study the link between climate change and health have been set up, with co-funding from international organizations and national governments. The results of their research have contributed substantially to the formulation of international action plans to address climate change impacts more effectively.
2) Raising public awareness through prevention programs and specially-designed actions to address the public health impacts of climate change promptly and effectively. Preventive actions in the health sector generate multiple benefits for society and are assessed as highly cost-effective.
3) Promoting major infrastructure works (dams, etc.), co-financed by international organizations, to help improve health standards and prevent future disasters due to climate change.

At the national level, the governments of Europe have been developing actions to address the impacts of climate change (Bank.of.Greece 2011):

1) The national health ministries have launched actions to ensure equal access to health services and social justice for all victims of climate change. This requires investment in relevant infrastructure (e.g. climate-controlled hospital rooms, operating theatres, sanitation) to prevent even partial discrimination in the provision of healthcare.
2) The national health ministries will also need to design special action plans to address the public health problems associated with climate change and/or natural disasters. The ability to treat large numbers of patients in disaster situations calls for special planning and measures, to be undertaken by experts in 'disaster management'.
3) Primary and out-hospital healthcare services must adequately designed, equipped and staffed to be able to cope with the problems caused by climate changes.
4) Hospitals will also need proper infrastructure and equipment to promptly diagnose and efficiently treat patients affected by climate change.
5) Healthcare personnel will need to receive training in environmental epidemiology and the health implications of climate change, as well as courses and training on matters of social mobilization and sudden disaster management.

6.4.4.9 Adaptation policies concerning energy

The program **Intelligent Energy Europe (IEE)** has contributed to the European Strategic for Energy 2020 and facilitates the implementation of the European Action Plan for Energy Efficiency and Directive 2009/28/EC on the promotion of the use of Renewable Energy. It was the main tool of the European Union for the treatment of non-technological barriers to the dissemination of energy efficiency and the use of renewable energy sources in all sectors including transport, durinmg the 2007-2013 EU programming period (please refer also to 6.3.10). Exemplary types of actions supported by the program are, amongst others, the European exchange of experience/expertise, dissemination of good practices, strengthening institutional and administrative capacity, education and training, the creation of standards and regulations etc.

General Framework of Spatial Planning and Sustainable Development

Among the goals of the General FSPSD (YPECHODE 2008) the following specific objectives are included “in view of the acute problems caused by climate change”:

- Constant care for energy-saving;
- Promotion of alternative, and in particular renewable, energy sources;
- Protection and enhancement of natural processes;
- Adaptation to new climate change conditions and mitigation of their consequences (fires, floods, erosion, drought, water salinization, desertification etc.), by putting in place mitigation mechanisms, appropriate infrastructures and plans for action.

Special sections are devoted to planning measures for mountain, coastal, island and agricultural areas, with an emphasis on their sustainability, biodiversity, environmental protection, natural regeneration and carrying capacity. Extensive reference is made to the protection of nature, the management of protected zones and land or marine ecosystems and the effects of climate change on ambient temperatures, sea level, and water resources. The General Framework also includes long sections on the sustainable management of freshwater bodies, soil and forest vegetation, and on disaster prevention (Wassenhoven and Sapountzaki).

With respect to climate change, in addition to measures for the protection of water, soil and air, the General Framework requires the (Wassenhoven and Sapountzaki):

- Use of renewable sources of energy;
- Introduction of energy-friendly and non-polluting means of transport;
- Construction of natural gas infrastructures;
- Reduction of greenhouse gas emissions by industrial plants;
- Use of new and optimal industrial technologies;
- Adoption of energy saving measures;
- Prevention of forest fires and reforestation action;
- Use of bioclimatic construction methods in buildings;
- Strengthening of natural regeneration feedback mechanisms in natural ecosystems.

6.4.4.10 Adaptation policies measures concerning transport

Further to estimating the climate change impacts, the sectoral study (Bank.of.Greece 2011) has also formulated a set of proposed policies and specific policy measures for coping with the impacts on the transport system as a whole and on the respective networks per mode of transport. In summary, the proposals include:

1. Cooperation between the competent authorities with a view to ranking and evaluating the country’s transport infrastructure components in terms of importance, vulnerability and current state.
2. Development of monitoring systems for crucial infrastructure and use of ‘smart’ decision-making, risk management and disaster management systems, etc.
3. Recording of detailed data concerning the operation of the country’s transport system in cases of extreme weather events; development of impact evaluation indicators.
4. Revision of the design specifications of current transport infrastructure, taking climate change parameters into account (e.g. port infrastructure design based on new weather patterns and respective data on wave size and frequency, etc.).
5. Use of new materials, more resilient to extreme weather conditions.
6. Strategic planning of land use and transport infrastructure, taking into account the forms of climate change impact in Greece’s vulnerable regions.
7. Policy measures aimed at reducing transport demand, e.g. teleworking, carpooling, mobility management, school transport, etc.

8. Promotion and support of eco-driving.

9. Use of 'smart' technologies and systems with a view to improving freight transport and maximizing capacity use of all means of transport (target: zero empty routes).

10. Strengthening intermodal freight transport and reducing the share of road transport in favor of sea and railway transport.

11. Promotion of the use of energy efficient (hybrid/electric) vehicles through incentive measures and the construction of necessary infrastructure (e.g. electric vehicle charging stations).

Table 6. 5 Summary of information on vulnerability and adaptation to climate change

Vulnerable Area	Vulnerability / Adaptation
Agriculture and food security	Vulnerability: Shorter growing season; higher risk of heat stress during flowering period; extreme events during developing period; higher risk of raining days during sowing days; higher rainfall intensity; longer dry spells. Adaptation: Program of Rural Development 2007-2013
Biodiversity and natural ecosystems	Vulnerability: Mainly decrease of species population and variety, invasion of alien species Adaptation: National Biodiversity Strategy (evaluation under the new governmental authorities); specific measures for touristic destinations
Coastal zones	Vulnerability: Flooding and erosion; freshwater shortage; coastal ecosystems Adaptation: Specific Framework for Spatial Planning Plans for the Tourism sector and for Coastal Areas; National Strategy for the Management of Water Resources; Societies for the protection of Species / National marine parks; specific measures for touristic destinations
Drought	Vulnerability: Soil degradation, salinization Adaptation: National Action Plan for Combating Desertification
Fisheries	Vulnerability: Fluctuation of marine species population Adaptation: Binding fishing code
Forests	Vulnerability: Forest fires, floods, losing of forest biodiversity Adaptation: Program of Rural Development 2007-2013
Human health	Vulnerability: Up to the moment mainly danger because of forest fires and floods, as well as air pollution aggravated in cases of extreme heat waves Adaptation: Circular of the General Secretariat of Civil protection regarding floods and air pollution, public awareness, National Action Plan for the 'Response of Environmental Hazards Threatening Health'
Infrastructure and economy	Vulnerability: effect on tourism, loss of properties in cases of erosion, forest fires and floods Adaptation: Rural Development Regulation (2007-2013), National, National Action Plan for Combating Desertification, Greek National Tourism Organization
Water resources	Vulnerability: Water quantity and quality Adaptation: National Strategy for the Management of Water Resources (regional objectives to be finalized by the end of 2009), National Biodiversity Strategy (under public consultation)

6.5 Monitoring, reporting and evaluation of adaptation actions and processes

6.5.1 Monitoring, reporting and evaluation (MRE) methodology related to reducing climate impacts, vulnerabilities, risks, and increasing adaptive capacity

The national Monitoring and Evaluation system (M&E) is currently under development.

According to the current planning it will include qualitative and quantitative indicators of different types, including indicators that are related to reducing climate impacts, vulnerabilities, risks and increasing adaptive capacity. Such indicators are:

- ✓Exposure indicators: Indicators measuring the exposure of humans, habitats and species, environmental functions, services, resources, infrastructure and financial, social or cultural capital in places or conditions that may be negatively affected by climate change;
- ✓Sensitivity indicators: indicators measuring or indicating the level one system has been affected positively or negatively by climate change impacts;
- ✓Adaptive capacity indicators: Indicators that indicate the ability of systems, institutions, humans or other organisms to adapt to a potential change, to seize opportunities or face potential impacts.
- ✓Hazard indicators: Indicators that indicate the potential existence of a natural or human-induced event, tension or impact that can lead to the loss of human life, injury or other impacts to health, as well as losses to property, infrastructure, life resources, ecosystems, environmental resources and the provision of services.

The M&E system will explore the potential of using of existing sets of indicators already monitored by competent authorities at the different levels of public administration in a way that several consultations with sectoral authorities are required. The design and pilot implementation of the system is planned under the LIFE-IP AdaptInGR project.

6.5.1.1 MRE methodology related to the implementation of adaptation actions

As already mentioned, pursuant to the Law 4416/2014 (Article 44), the NCCAC will regularly monitor NAS implementation and propose changes to political, legislative or other means and arrangements necessary to promote action. Pursuant to the same Law (Article 43) and the Ministerial Decision 11258/2017 (Article 2, Paragraph 11), an indicator-based system will be developed for each RAAP, which will be used to continually monitor the progress and effectiveness of implementation. The timeline and the periodicity of monitoring is not indicated.

An integrated climate change adaptation monitoring and evaluation framework to allow monitoring and evaluating progress in terms of climate change adaptation policy implementation and to provide the basis for the future reviews and revisions of the Greek NAS and the RAAPs will be developed through the EU-funded LIFE-IP AdaptInGR project, coordinated by MEEN. The objective of the framework is to collect and provide information that will improve the decision-making procedures regarding the planning, implementation, revision and update of processes and actions that aim at the enhancement of resilience and the adaptative capacity of Greece, in collaboration with the competent institutional authorities.

The M&E framework will be further improved, refined and fine-tuned through two M&E implementation cycles. The National Environment and Climate Change Agency (NECCA) will undertake all actions relating to monitoring, reporting and evaluation of climate change adaptation policy after the end of the LIFE-IP AdaptInGR project (2026).

6.5.1.2 State of play of the implementation of measures planned under 'Strategies and Plans', including an overview of the subnational level and the disbursement of funding to increase climate resilience

Adaptation actions are primarily financed by EU funds. The Sectoral Operational Programme on ‘Transport Infrastructure, Environment and Sustainable Development’ and the 13 Regional Operational Programmes (one for each administrative region of Greece) of the National Strategic Reference Framework 2014-2020 (NSRF, cohesion policy) include specific budget and measures under the Thematic Objective 5 ‘Climate Change Adaptation & Disaster Risk Management’. These instruments, together with the Rural Development Programme, are the main source of EU funding for adaptation actions nationally and in the 13 administrative regions until 2020.

In the period 2014-2020, the main adaptation actions implemented at regional level were linked to the NAS Objective 3 and more specifically to the implementation of measures for reducing the intensity and magnitude of climate change impacts, the protection from extreme weather events (including the provision of relevant equipment), as well as the elaboration of risk assessment studies. The actions also referred to the regional adaptation planning and the development of the RAAPs, which is linked to the NAS Objective 2, while a limited number of actions contributed to the establishment of a monitoring mechanism for the evaluation and review of adaptation policies and actions (NAS Objective 4). Finally, a very limited number of actions have aimed at awareness –raising and thus have contributed to NAS Objective 5.

6.5.1.3 State of play of the implementation of measures planned under 'Strategies and Plans': spending earmarked for climate adaptation including in disaster risk management

As already mentioned, adaptation actions are primarily financed by EU funds.

The Sectoral Operational Programme on ‘Transport Infrastructure, Environment and Sustainable development (2014-2020)’, together with the National Rural Development Programme (2014-2020), the National Operational Programme for Fisheries and the Sea (2014-2020), the National Operational Programme for Competitiveness, Entrepreneurship & Innovation (2014-2020) are the main sources of EU funding for adaptation actions nationally until 2020.

The 'Transport, Infrastructure, Environment and Sustainable Development' Programme includes actions referring to the elaboration of studies aiming to trigger the implementation of plans and/or measures across Greece. Such actions contribute to the mainstreaming of adaptation to strategic planning such as the Flood Risk Management Plans. In total approximately 115,8 million Euros have been earmarked by the Programme for climate adaptation up to December 2020.

The Green Fund (GRFU) is a Public Legal Entity, associated to MEEN. Practically GRFU financing represents the only national funds devoted to the environment. Among its activities and programmes, the GRFU finances projects related to climate adaptation. More specifically, the GRFU supports the national contribution of LIFE projects related to adaptation. In addition to this and in the context of its calls and funding programmes, the GRFU finances Greek Municipalities to acquire and create green spaces for public use, contributing to the adaptation of Greek cities to climate change. With respect to the forests, and in the frame of the Forest Protection and Restoration programme, support is given to fire prevention, flood control and anti-corrosive measures. Finally, the LIFE-IP AdaptInGR project, coordinated by MEEN, receives funding by the EU LIFE Programme (total budget=14,189,548 €, EC Co-funding: 58.73%).

6.5.1.4 To the extent possible, state of play of the implementation of measures planned under 'Strategies and Plans': the share of spending used to support climate adaptation in each sector

As mentioned above, the main sources of adaptation funding considered are linked to EU funds. Currently there is no official financial monitoring system of the NAS and the RAAPS, therefore it is difficult to provide information on the share of spending to support adaptation in each sector

In the context of the LIFE-IP AdaptInGR project a financial monitoring regarding the progress of adaptation actions related to the NAS and achieved through specific funds (Structural

Investment Funds, Rural Development Programme) is being implemented. According to the information available on the basis of this, the main adaptation sectors of intervention relevant to actions financed through the Sectoral Operational Programme on ‘Transport Infrastructure, Environment and Sustainable Development’ in the period 2014-2020, include the protection from floods; the prevention, protection and response to forest fires and the protection/restoration of coastal zones. In some cases, links with the cultural heritage were also made.

Adaptation actions in relation to the agriculture and forestry sectors considered during the reporting period are mainly financed by the Rural Development Programme.

The Hellenic Agricultural Insurance Organization (ELGA) is the country’s main insurance carrier for plant production and livestock capital. It compensates farmers for plant and livestock capital loss caused by extreme weather conditions (e.g. floods, hail, and frost). ELGA has recently announced its plans to update its insurance regulation to include, inter alia, climate change aspects.

The Greek state, also, provides compensation and emergency allowances to relief and support the victims of natural disasters (e.g. floods in Mandra and wildfires in Mati). In addition, the European Union Solidarity Fund (EUSF) responds to major natural disasters and expresses European solidarity to disaster-stricken regions within Europe. It covers a range of different catastrophic events including floods, forest fires, storms and drought.

6.5.1.5 Progress towards reducing climate impacts, vulnerabilities and risks

For the time being, no monitoring reports have been published, therefore there is no official estimation of the progress towards reducing impacts, vulnerabilities and risks. Information about the progress achieved will be provided in due course, on the basis of the results of the Monitoring and Evaluation cycles planned under the LIFE-IP AdaptInGR project.

6.5.1.6 Progress towards increasing adaptive capacity

For the time being, no monitoring reports have been published, therefore there is no official estimation of the progress towards increasing adaptive capacity. Some elements regarding the current level of adaptive capacity in the various affected sectors are mentioned in the relevant section. Information about the progress achieved will be provided in due course, on the basis of the results of the Monitoring and Evaluation cycles planned under the LIFE-IP AdaptInGR project..

6.5.1.7 Progress towards meeting adaptation priorities

For the time being, no monitoring reports have been published, therefore there is no official estimation of the progress towards meeting adaptation priorities.

Under the monitoring actions of the LIFE-IP AdaptInGR project, the MEEN is in progress of performing the evaluation of the implementation of the NAS per vulnerability sector.

6.5.1.8 Progress towards addressing barriers to adaptation

There is currently no evaluation of the progress achieved towards addressing barriers to adaptation.

6.5.1.9 Steps taken to review and update vulnerability and risk assessments

An updated assessment of the impacts and vulnerabilities across Greece is planned to be delivered by the end of 2024 under the LIFE-IP AdaptInGR project. The CCIV will be based on RCPs and take into account updated climate projections. It will address impacts on the following sectors: water systems, fisheries and aquaculture, agriculture, biodiversity and ecosystems, tourism, built environment, transport, health, industry. Through a bottom-up approach, damages will be estimated for each sector both with and without adaptation and then aggregated. Also, a top-down approach will be used for cost estimates through a Computable General Equilibrium model as this can incorporate market interactions and allow for indirect impacts to be estimated.

The assessment will draw upon the 2011 Comprehensive Climate Change Impact Assessment, developed at the initiative of the Bank of Greece (BoG), as well as subsequent research of the Climate Change Impacts Study Committee (CCISC) of the BoG (i.e. for the Tourism sector).

6.5.1.10 Steps taken to review and update national adaptation policies, strategies, plans, and measures

Article 42 of Law 4414/2016 foresees the revision of the NAS at least once every ten years. Provided that the first NAS was endorsed under this law in 2016, the process for the review and revision of the Greek NAS in planned to be finalized by 2026.

The process will be supported by the actions of the LIFE-IP AdaptInGR project. More specifically the process will take into account the results of the two Monitoring and Evaluation cycles that are planned to be implemented during the project to estimate the progress towards reducing climate impacts, vulnerabilities and risks, reaching the national adaptation objectives and addressing barriers to adaptation. In addition, the updated CCIV assessment will also be taken into account. The aim of the revision will include:

- The identification of new priorities (vulnerable areas, new sectors), suggestion of new actions and prioritization of new/remaining adaptation measures;
- The identification of new directions and priorities for the National Adaptation Strategy and development of the relevant strategic directions, exploring, if needed; the requirement for specific Sectoral Adaptation Strategies;
- Bringing forward concrete suggestions to enhance cooperation and build up agreements and joint plans with neighboring countries on common climate challenges (cross-border flood risk management, management of protected areas and disaster risk management/mitigation).

The review of the NAS will be coordinated by MEEN. The revision and review of the NAS will be presented to the National Council for Climate Change Adaptation for its formal opinion, while MEEN will prepare the institutional arrangements for its adoption, according to the provisions of the Greek institutional framework. For the review of the Greek NAS and prior to adoption of any new priority, extensive public/stakeholder consultation will be performed, according to the provisions of the Greek legislation.

6.5.1.11 Overview of good practice with regard to steps taken to review and update subnational adaptation plans, policies, strategies and measures

Article 43 of Law 4414/2016 foresees the evaluation and review of the RAAPs at least once every seven years; given the current progress in the development of the 13 RAAPs it is expected that their review and update will be performed in the years 2027/2028.

The revision of the RAAPs is going to be supported by the processes designed under the LIFE-IP AdaptInGR project. More specifically by 2026, the project will provide recommendations for the revision of each of the RAAPs on the basis of the results from the M&E cycles and the updated CCIV assessment. The project will also propose new, more elaborate terms of reference for adaptation planning for each Region, according to local specificities and progress achieved in the implementation of the RAAPs.

6.6 Cooperation, good practices, synergies, experience and lessons learned in the field of adaptation

6.6.1 Synergies of adaptation actions with other international frameworks and/or conventions

International and European initiatives have set the foundation for the adaptation policies.

The Paris Agreement, being the most recent relevant agreement at international level, supports the increasing of adaptive capacity to the impacts of climate change and the enhancement of the climate resilience through national adaptation action. Greece ratified the Paris Agreement in 2016. Under Law 4426/2016, the Ministry of Environment and Energy (MEEN) holds the responsibility for its implementation.

In addition, the 2030 Agenda and the Sustainable Development Goals (SDGs), through SDG 13 ‘Climate Action’, urges for action to combat climate change and its impacts through strategic planning in all countries, including city areas or metropolitan regions. The monitoring and coordination for the implementation of the SDGs in Greece is given to the Greek Government Presidency, so as to ensure the consistency of policies.

Finally, there are mechanisms in place to coordinate disaster risk management and climate adaptation and thereby ensure coherence between the two policies. The MEEN, notably the Climate Change & Air Quality Directorate, the Forest Protection & Forest Environment Directorate, and the Special Secretariat for Water) is represented within the structure of the Hellenic National Platform for Disaster Risk Reduction (UN Sendai Framework, Hyogo Framework for Action). The Platform was established in 2012 and is coordinated by the General Secretarial for Civil Protection.

6.6.2 Cooperation with Union Member States, international cooperation, and with regional and international organisations to share information and to strengthen science, institutions and adaptation knowledge

The NAS recognises that Greece shares a significant amount of water resources, mountainous areas and forests with neighbouring countries and that it is, therefore, important to establish communication channels with those countries. A number of specific actions are mentioned in the NAS, including identifying and recording transboundary adaptation issues, creating processes for the development of common policies, creating shared data collection stations, training and capacity building. The development of these actions is still in progress. In addition, the RAAPs assess the transboundary character of climate impacts (Ministerial Decision 11258/2017) to identify needs for international cooperation. Transboundary public consultations on the RAAPs will also occur through the Strategic Environmental Assessment (SEA) process to consider potential transboundary impacts. Transboundary public consultations, as part of the SEA process, have taken place for the transboundary flood risk management plans (the consultation on the Evros River Basin shared by Greece and Bulgaria has recently been concluded).

In the Eastern Mediterranean Region two trilateral schemes of technical cooperation and partnership have been recently initiated, at a high political level, between Greece, Cyprus and Israel and between Greece, Cyprus and Egypt, in 2016 and in 2017, respectively. The ultimate objective of these cooperative schemes is to enhance peace and stability in the region and facilitate the sharing of experiences, knowledge and know-how in order to promote joint projects of mutual interest, find solutions to common concerns and promote interconnectivity and complementarity of actions.

Cooperation on adaptation issues is a priority in the 2017 trilateral cooperation agreements between Greece-Cyprus-Israel and Greece-Cyprus-Egypt mainly focusing on the exchange of knowledge and know-how on adaptation policy monitoring, evaluation and good practice at regional and local scales.

Finally, there are already bilateral and multilateral sectoral programmes aiming at strengthening science and sharing of knowledge. For example, a Greece-Cyprus bilateral cooperation programme funded through Interreg ‘Greece-Cyprus’ develops an Environmental Risk Management Information System on Floods, aiming to be used by citizens and NGOs, as well as by professionals and organizations. Similarly, under Balkan Mediterranean, different Greek institutions, including regional and local authorities, cooperate with partners from neighbouring countries on climate change issues regarding coastal erosion and early warning systems on drought and fire.

6.6.3 Cooperation with Union Member States, international cooperation, and with regional and international organisations to enhance adaptation action at the sub-national, national, macro-regional and international level

With respect to the cooperation for enhancing adaptation action, it seems that the current focus of official cooperation is more set on the knowledge sharing. Under the LIFE-IP AdaptInGR, the MEEN will also pursue the replication of the project results through the ongoing trilateral cooperation between Greece-Cyprus-Israel and Greece-Cyprus-Egypt on the following issues:

- Indicators and methodologies for monitoring adaptation policy implementation.
- Integrated energy and adaptation planning in the frame of a low carbon climate-resilient strategy, addressing both national-level planning and local development (i.e. good practice sharing in urban regeneration, building refurbishment etc.).
- Flood risk management and coastal zone management, .
- Best practice examples, as identified through the LIFE-IP AdaptInGR pilots.

The cooperation on adaptation actions is also achieved through a number of bilateral and multilateral projects, funded mainly through EU competitive programmes. Examples of such programmes include Interreg and LIFE. Such examples include:

- a Greece-Bulgaria bilateral cooperation programme funded through Interreg ‘Greece-Bulgraria’ foreseeing the development of common technical specifications for national flood risk management plans covering the border area and the subsequent revision of the existing plans to improve cohesion and coordination.
- Cooperation between Greece and other, mostly neighbouring, Union Member States on adaptation action in agriculture (i.e. LIFE Adapt2Clima project), urban adaptation (i.e. LIFE UrbanProof) and health (i.e. LIFE Medea).

CHAPTER 7. FINANCIAL RESOURCES AND TRANSFER OF TECHNOLOGY

7.1 Introduction

This chapter contains information on the provision of financial, technological, and capacity building support to non-Annex I Parties.

Greece is committed, as both a UN and an EU Member State, to the global partnership to eradicate extreme poverty and contributes financially to the achievement of the UN Agenda of the Sustainable Development Goals.

Being a DAC-OECD member since 1999, Greece follows closely the work of DAC's Networks, Working Parties, High and Senior Level Meetings and participates with great interest in DAC's Peer Review processes, with a view to learning from other DAC members' experience, keeping an eye on main challenges, and fostering a positive momentum as regards the improvement of its own system of development cooperation. Moreover, Greece has actively participated in the preparations for the "Rio+20" UN Conference on Sustainable Development (June 2012, Rio de Janeiro) as well as its follow up, at EU and UN levels, with a view to the formulation, inter alia, of a single and coherent post-2015 development framework that while continuing giving emphasis on poverty eradication, it will focus on sustainable development.

In 2015, Greece has followed closely and participated very actively in the international processes that led to the adoption of the 2030 Agenda for Sustainable Development and the Sustainable Development Goals (SDGs) by UNGA70 on 25.9.2015, the Addis Ababa Action Agenda (AAAA) of the Third International Conference on Financing for Development (Addis Ababa, 13-16.7.2015) adopted by UNGA69 on 27.7.2015 and the Paris Agreement on Climate Change. In particular, Greece has tried to reshape its development cooperation policy, taking into account also its commitment to pursuing the SDGs in coordination with partner countries and other donors.

As a result of the economic crisis during the period 2011-2017 and the cuts in the national budget, Greece has gradually adopted a more pragmatic strategic approach as regards its development aid program, which now focuses primarily on multilateral contributions. These contributions are expected to have a positive development impact as regards the achievement of one or more of the Sustainable Development Goals (SDGs). Therefore, it was a strategic choice to concentrate on multilateral assistance, in the context of Greece's strategic priorities. Greece is committed to multilateralism and supports multilateral approaches to global problems. Development cooperation priorities are consistent with Greece's overall foreign policy objectives and help partner countries address their economic, social, and environmental problems. Greece has entered into partnerships with international organizations that operate in line with national priorities.

As regards bilateral aid, the relevant ODA flows focused primarily on in-donor refugee costs, taking into account the steadfast national commitment towards assisting refugees in Greece in order to meet their pressing humanitarian and development needs.

The mandates and activities of the multilateral organizations that are financially supported by Greece reflect the country's interest in and commitment to a sustainable and prosperous future for the world, in terms of progress in a number of thematic areas of development cooperation, such as international peace and security, climate and the environment, health, education, culture and migration. While Greece's development assistance budget is confirmed on an annual basis, the Government enters into a range of long-term commitments for funding multilateral organizations. Funding to multilateral partners is based on multi-year funding commitments, which increase predictability, as well as on core funding support.

Overall responsibility for development cooperation lies with the Ministry of Foreign Affairs, where the General Directorate for International Development Cooperation (Hellenic Aid) has systems in place to track, measure and record climate change related assistance provided to developing countries.

Hellenic Aid has a new law 4781/2021 (Official Gazette 31A΄/28.2.2021) regarding development cooperation policy and organizational structure, replacing Law 2731/1999. At present, a new Presidential Decree on the organization, staffing and operation of international development cooperation to replace the Presidential Decree No. 224/2000 and a new manual on implementing development cooperation programs by social Partners are under preparation. In addition, the Four-Year Strategy of Greece's Development Cooperation Strategy for the period 2022-2025 is finalized but at the process of approval by the Foreign Minister. "Environment / Climate Change" is a horizontal priority thematic area.

Greece participated in the DAC/OECD Report Integrating Environmental and Climate Action into Development Cooperation-Reporting on DAC Members' 2020 High Level Meeting Acknowledging the importance to mobilize additional public and private finance (especially from the banking sector), Greece is exploring ways to mainstream climate change mitigation and adaptation in its ODA and develop synergies for the achievement of the SDGs. In order to facilitate and finance the transfer of, access to and deployment of climate-friendly technologies for the benefit of non-Annex I Parties; to support the development and enhancement of endogenous capacities and technologies of non-Annex I Parties; and promote and scale up private investment in mitigation and adaptation activities in developing countries, by National Law 4369/2016 (article 50) has been legislated that part of the funds from auctions of undistributed emission allowances from the EU ETS may be allocated to assistance for developing countries to reduce their GHG emissions and to adapt to climate change.

The common practice for ensuring that the selection of topics for the provision of support (e.g., finance, capacity-building, etc.) is addressing existing and emerging needs identified by non-Annex I Parties is either achieved through the assessments provided by an existing network or through the direct communication with the countries in question. Especially for the Trilateral Cooperation between Greece-Cyprus-Israel in question, as described next in this chapter, the thematic areas identified are issues of common concern; the same is the case for the Trilateral Cooperation between Greece-Cyprus-Egypt. The issues selected respond to the existing and emerging needs identified by the competent authorities of the two non-Annex I countries i.e Egypt and Israel.

7.2 Methodology for tracking the provision of finance, technology and capacity building support

Financial, technological, and capacity-building support reported in this National Communication / Biennial Report are considered to be "new and additional resources", meaning that they were committed after and not included in the previous National Communication or Biennial Report. Greek budget is determined on an annual basis, so that each annual commitment cycle represents new and additional resources. In addition to the definitions listed below, support is considered to target climate-specific activities if:

- ✓ it is provided bilaterally by Greece and is related to mitigation and / or adaptation to climate change;
- ✓ it is provided to a climate change organization, which is a regional, national, or international environmental and scientific organization addressing and /or researching climate change–global warming–sustainability.

Definition of climate finance: Climate finance aims at reducing emissions and enhancing sinks of greenhouse gases and aims at reducing the vulnerability of, and maintaining and increasing the resilience of, human and ecological systems to negative climate change impacts (adapted from the UNFCCC Standing Committee on Finance’s definition of climate finance).

Definition of mitigation activities: An activity should be considered as climate change mitigation related if it contributes to the objective of stabilisation of GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system by promoting efforts to reduce or limit GHG emissions or to enhance GHG sequestration (adapted from the operational definition and criteria for eligibility used in the OECD-DAC Policy Markers).

Definition of adaptation activities: An activity should be considered as adaptation related if it intends to reduce the vulnerability of human or natural systems to the impacts of climate change and climate-related risks, by maintaining or increasing adaptive capacity and resilience. This encompasses a range of activities from information and knowledge generation to capacity development, planning and the implementation of climate change adaptation actions (adapted from the operational definition and criteria for eligibility used in the OECD-DAC Policy Markers).

Definition of climate relevant technology development and transfer: a broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change amongst different stakeholders such as governments, private sector entities, financial institutions, non-governmental organizations (NGOs) and research/education institutions. The broad and inclusive term “transfer” comprises the process of learning to understand, utilize and replicate the technology, including the capacity to choose and adapt to local conditions and integrate it with indigenous technologies (adapted from the IPCC definition of climate relevant technology transfer).

Definition of climate relevant capacity building: capacity-building is a process which seeks to build, develop, strengthen, enhance and improve existing scientific and technical skills, capabilities and institutions particularly in developing countries, to enable them to assess, adapt, manage and develop technologies. Capacity building must be country-driven, addressing specific needs and conditions of developing countries and reflecting their national sustainable development strategies, priorities and initiatives (adapted from the UNFCCC definition of capacity building activities).

Greece uses the OECD Development Assistance Committee (DAC) Rio markers to categorise the purpose of the assistance. For example, among others, funds are classified and tracked per channel of delivery; type of flow; type of finance; geographical region; recipient countries; type of aid; sector of aid; and SDG targets.

The Rio markers are policy indicators and were not originally intended to accurately quantify climate finance. Therefore, an activity can have more than one principal or significant policy objective (i.e. it can be marked for several Rio markers; mitigation, adaptation and other Rio conventions such as Biodiversity and Desertification). Further information on the Rio markers available here: https://www.oecd.org/dac/environment-development/Revised%20climate%20marker%20handbook_FINAL.pdf.

For the reporting of information, Greece has used the following approach to "translate" the Rio markers data into estimated climate finance flows:

- If an activity is marked as principal for mitigation or adaptation, 100% of the support is considered and reported as climate finance;
- If an aid activity is marked as significant for mitigation or adaptation, then only a part of the support is considered and reported as climate finance. The shares of

imputed multilateral contributions provided in the OECD webpage are used in this case.

- To avoid double counting, any activity can only count as 100%, 40% or 0%. If an activity is marked for both mitigation and adaptation, only the highest marking will count when calculating the total climate relevant financial contributing of the activity.

For the share of imputed multilateral contribution 2018-2019 weighted average, please visit OECD webpage: https://www.oecd.org/dac/financing-sustainable-development/development-finance-topics/climate-change.htm

Under each Presidency of the Council of the EU (which lasts for six months, either from January until June or from July until December), Greece participates in a formal meeting of the Council of the EU, consisting of Ministers in charge of international development cooperation (Foreign Affairs Council/Development), as well as in an informal meeting of the EU Directors-General of Development Cooperation. In addition, it attends OECD/DAC High- and Senior-level meetings. Hellenic Aid has an active participation in the meetings of the Working Parties of the Council of the EU, including the Working Party on Development Co-operation (CODEV PI) and on the EU's relations with Africa, Caribbean and the Pacific (ACP WP), Agenda 2030, CODEV-PI, and NDICI-Global Europe και NDICI International Development Conferences).

Currently, Greece does not have a system to track private financial flows, as Greece's current emphasis is on tracking public financial flows associated with climate change.

7.3 Finance

The provision of financial support by Greece to non-Annex I Parties is presented in the following paragraphs and ***CTF Tables 7, 7(a) and 7(b)***.

7.3.1 ODA general trends

While the international crisis was raging, Greece continued in 2017 and up to the summer of 2018 to have its economy supported by a mechanism backed by the European Commission (EC), the European Central Bank (ECB) and the International Monetary Fund (IMF), in order to combat the fundamental causes of its fiscal imbalances and structural weaknesses and ensure viability of public finances and improvement of its international competitiveness.

Greece does not currently provide information to developing countries on predicted financial flows as it would be difficult to do so accurately. However, it tooks into account the need for adequacy and predictability in the flow of the provided resources for the future. As the economy recovers it is expected that the Greece's ODA and subsequently the climate finance provided to developing countries will resume a positive trajectory.

Table 7.1 ODA Volumes 2008-2021

Year	Bilateral ODA (MUSD)	Bilateral ODA (%GNI)	Multilateral ODA (MUSD)	Multilateral ODA (%GNI)	Total ODA (MUSD)	Total ODA (%GNI)
2008	312	0.09	391	0.12	703	**0.21**
2009	297	0.09	310	0.10	607	**0.19**
2010	212	0.07	296	0.10	508	**0.17**
2011	154	0.05	271	0.10	425	**0.15**
2012	107	0.04	220	0.09	327	**0.13**
2013	43.61	0.02	195.45	0.08	239.07	**0.10**
2014	46.10	0.02	201.34	0.09	247.44	**0.11**
2015	71.88	0.04	166.82	0.08	238.70	**0.12**
2016	159.15	0.08	209.38	0.11	368.53	**0.19**
2017	85	0.04	229	0.12	314	**0.16**
2018	38.64	0.02	251.8	0.12	290.44	**0.13**
2019	142.75	0.07	224.99	0.11	367.74	**0.18**
2020	84.78	0.04	240.67	0.13	325.44	**0.17**
2021*	74,49	0,03	266,36	0,12	340,85	**0,16**

* preliminary figures

Source: Data retrieved by the "ANNUAL REPORT OF THE GREEK BILATERAL AND MULTILATERAL OFFICIAL DEVELOPMENT CO-OPERATION AND ASSISTANCE", MINISTRY OF FOREIGN AFFAIRS, DIRECTORATE GENERAL FOR INTERNATIONAL DEVELOPMENT CO-OPERATION (Y.D.A.S), November 2009 - June 2021

Total Official Development Assistance of Greece (bilateral and multilateral ODA) in 2019 reached USD 367.74 million (0.18% of Gross National Income, GNI 2019=209.950 billion USD), which represents an increase compared to 2018 (USD 290.44 million, i.e. 0.13% of Gross National Income). In relation to 2008, total ODA has a decreasing trend, due to the difficult fiscal circumstances (approximately 47.7%), while ODA/GNI ratio dropped respectively from 0.21% in 2008 to 0.18% in 2019. However, it is noted that the average total ODA of years 2016-2019 is higher than in the years 2013-2015.

Total Official Development Assistance of Greece (bilateral and multilateral ODA) in 2020 reached USD 325.44 million (0.17% of Gross National Income), which represents a decrease compared to 2019 (USD 367.74 million, i.e. 0.18% of Gross National Income).

7.3.2 Bilateral cooperation

Total bilateral ODA granted by Greece in 2020 was USD 84.78 million (USD 142.75 million respectively in 2019). Bilateral ODA is provided by various Ministries. The amount of USD 80.37 million was granted for in-donor refugee costs (USD 134.43 million respectively in 2019), USD 4.37 million for international organizations' programmes and funds (out of which the amount of USD 4 million was contributed to the EU "Facility for Refugees" in Turkey) and USD 0.03 million were allocated to foreign students from developing countries (scholarships) for their studies in Greek universities. Bilateral assistance fell by -36.2% due to lower costs for in-donor refugees.

Categorizations of bilateral aid according to OECD/DAC statistical directives:

Aid Allocation by Geographical Region (in USD):

- Europe: 4.01 million
- Asia: 0.29 million
- Africa: 0.05 million (Sub-Saharan Africa 0.04 million)
- America 0.04 million

- Developing countries, unspecified: 80.39 million (including, inter alia, in-donor refugee costs in Greece)

Aid Allocation by Main Recipient Countries (in USD):

- Turkey: 4.00 million
- Syria: 0.21 million
- Albania: 0.01 million
- Egypt: 0.01 million
- Ukraine: 0.01 million
- Serbia: 0.01 million
- Humanitarian assistance expenditure for 2020 amounted to USD 0.21 million

Total bilateral ODA granted by Greece in 2019 was USD 142.75 million (2018 – USD 38.64 million). Bilateral ODA is provided by various Ministries. The amount of USD 134.43 million was granted for in-donor refugee costs (USD 27.92 million respectively in 2018), USD 4.37 million for international organizations' programmes and funds (out of which the amount of USD 4.23 million was contributed to the EU "Facility for Refugees" in Turkey) and USD 2.4 million were awarded to foreign students from developing countries as scholarships for their studies in Greek universities.

Categorizations of bilateral aid according to OECD/DAC statistical directives:

Aid Allocation by Geographical Region (in USD):

- Europe: 8.873 million
- Africa: 0.803 million (Sub-Saharan Africa 0.399 million)
- Asia: 0.563 million
- Developing countries, unspecified: 134.428 million (including, inter alia, in-donor refugee costs in Greece)

Aid Allocation by Main Recipient Countries (in USD):

- Turkey: 4.556 million
- Albania: 1.656 million
- Egypt: 0.398 million
- Ukraine: 0.326 million
- West Bank and Gaza Strip: 0.225 million
- Serbia: 0.193 million
- Humanitarian assistance expenditure amounted to USD 4.29 million

For the categorizations of bilateral aid for the years before 2019, please refer to previous BRs.

The assistance provided by Greece for assisting developing country Parties that are particularly vulnerable to the adverse effects of climate change in meeting the costs of adaptation to those adverse effects is reported in CTF Table 7(b) for the current BR reporting years. Greece has provided assistance to the International Union for the Conservation of Nature, the Trust Fund for the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area, and the Ramsar Convention/MedWet Initiative targeting developing countries in the Middle East and North Africa and in Eastern Europe that are particularly vulnerable to the adverse effects of climate change.

7.3.3 Multilateral contributions

Greek multilateral development assistance is granted by line Ministries which, depending on their purpose and responsibilities, disburse funds for international development purposes through International Organizations.

Total multilateral Official Development Assistance (ODA) granted by Greece in 2020 amounted to USD 240.67 million (USD 224.99 million in 2019). Multilateral ODA is provided by line Ministries which, depending on their scope of competences, provide funds for international development purposes via International Organizations. These Organizations support developing countries and provide assistance in emergency situations. Total flows granted by Greece to EU institutions for foreign development assistance amounted to USD 222.04 million, including Greece's contribution to the European Development Fund (EDF) which totaled USD 80.62 million. ODA amounting to USD 9.15 million was also granted through the United Nations system, the amount of 5.13 million to World Bank Group and the amount of USD 3.99 million to other international organizations

Total multilateral ODA subscriptions of Greece to International Organizations in the year 2019 amounted to 224.99 MUSD (0.11% of GNI), a fall by about 42.4% in relation to 2008 (391 MUSD). For 2018 the total multilateral ODA subscriptions amounted to 251.8 MUSD. These Organizations support developing countries and provide assistance in emergency situations. Total flows granted by Greece to EU institutions for foreign development assistance amounted to USD 203.396 million, including Greece's contribution to the European Development Fund (EDF) which totaled USD 79.182 million. ODA amounting to USD 12.249 million was also granted through the United Nations system, the amount of 5.6 million to World Bank Group and the amount of USD 3.695 million to diverse international organizations.

The EU with its member states is the biggest provider of development aid worldwide. It finances series of programmes in developing countries to build democratic systems of governance and effective public institutions, accountable to citizens. The EU is particularly concerned to ensure that funding provided for development is used effectively, and that EU institutions are fully accountable, not only to EU citizens but also to their developing partners.

Contributions from the EU and its member states to support developing countries in reducing their greenhouse gas emissions and coping with the impacts of climate change continued to rise in 2020, confirming a steady upward trend since 2013.

The climate finance support provided by the EU and its member states (the UK included) amounted to €23.2 billion[24] in 2019, a 6.9% increase compared to 2018. The total without the UK stood at €21.9 billion, a 7.4% increase compared to the total for the EU 27 in 2018.

In 2020, €23.39 billion[25] in climate finance was committed by the European Union and its 27 member states to support developing countries in reducing their greenhouse gas emissions and adapting to the impacts of climate change. In 2020, close to 50% of the funding for developing countries was dedicated to either climate adaptation or cross-cutting action (involving both climate change mitigation and adaptation initiatives) and close to half of the total funding was committed in the form of grants, according to data compiled by the European Commission.[26]

Greece's overall ODA-eligible financial contributions towards Multilateral Organizations and programmes over the years 2008-2019 are listed in ***Table 7.3***.

A substantial part of Greece's multilateral ODA is dedicated to organizations and/or programmes aiming to address global environmental issues and to support national sustainable

[24] Climate finance from public budgets, including €2.5 billion from the EU budget and European Development Fund and €3.2 billion from the European Investment Bank.

[25] Climate finance from public budgets includes EUR 2.5 billion from the EU budget and European Development Fund and EUR 2.7 billion from the European Investment Bank. The overall figure is calculated on the basis of commitments made for bilateral and multilateral support.

[26] https://www.consilium.europa.eu/en/press/press-releases/2021/10/29/council-approves-2020-climate-finance-figure/

development initiatives, including capacity-building activities related to technology transfer for limiting/reducing GHG emissions, implementation of the UNFCCC Convention and preparations for effective participation in the Kyoto Protocol.

Greece, represented by the Ministry of Economy and Finance, has contributed to the Global Environment Facility's (GEF) Replenishments, as shown in ***Table 7.2***. Greece participated in the financing of GEF from its 1st to 4th Replenishments (GEF 1 – GEF 4), by paying in full the amounts presented in ***Table 7.2***. Greece has not committed to participate in subsequent replenishments after GEF4.

Contributions to United Nations Conventions and their Secretariats are channeled through other line Ministries, like MEEN.

Table 7.2 Financial Contributions to the Global Environmental Facility (GEF)

	Period	Contribution
Global Environmental Facility	July 1, 1994 to June 30, 1998 (1st Replenishment)	USD 5 million,
	July 1, 1998 to June 30, 2002 (2nd Replenishment)	SDR 4 million
	July 1, 2002 to June 30, 2006 (3rd Replenishment)	EURO 5,73 million
	July 1, 2006 – June 30, 2010 (4th Replenishment)	EURO 4,28 million

Source: Hellenic Ministry of Economy and Finance

Table 7.3 ODA eligible financial contributions to multilateral institutions and programmes (2008-2019)

Multilateral institutions and programmes (in MUSD)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
United Nations	14.19	13.75	12.85	12.15	10.15	13.38	14.43	7.64	12.99	13.63	15.79	12.25	9.15
European Union	238.87	286.06	277.60	256.36	204.05	135.44	181.23	157.90	191.45	191.24	212.99	203.40	222.04
World Bank Group	79.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.23	12.46	5.6	5.13
Regional Banks	44.27	0.72	1.01	0.00	0.69	0.00	0.00	0.00	0.00	0.00	3.40	-	-
Other Agencies	14.15	9.80	4.44	2.36	5.22	2.26	5.68	1.27	4.94	7.61	6.87	3.695	3.99
TOTAL	**390.99**	**310.33**	**295.90**	**270.87**	**220.11**	**195.45**	**201.34**	**166.82**	**209.45**	**228.71**	**251.51**	**224.99**	**240.67**

Source: Years: 2008-2019 MFA/Hellenic Aid, Directorate 3

The financial support provided through multilateral channels is aimed at assisting non-Annex I Parties in mitigating GHG emissions and adapting to the adverse effects of climate change and any economic or social consequences of response measures, in line with the scope, priorities and strategic plans of the relevant international organizations. In addition, the support provided through bilateral and regional contributions is transferred through regional channels that shares those objectives. Greece, also, contributes to EU funds, the aim of which is to assist non-Annex I Parties in adapting to any economic or social consequences of response measures. The various sources of financial assistance provided by the EU include the European Commission's support to developing countries, the Global Climate Change Alliance (an EU flagship initiative) and the EU External Investment Plan; contributing to the joint goal of mobilizing USD 100 billion per year by 2020 to support developing countries; and the replenishment of the Green Climate Fund.

7.4 Technology development and transfer and Capacity-building

Access to knowledge and technologies are not enough on their own, the right set of specific local conditions needs to be in place to attract project developers and investors. This so-called ‘enabling environment’ involves a set of interrelated conditions - legal, organisational, fiscal, informational, political, and cultural. A skilled workforce is also crucial to maintain know-how in the community. Therefore, the successful transfer of climate technologies to developing countries requires support to increase local administrative capacities. The basis of the following technology transfer and capacity building activities, to which Greece participates, is the close cooperation with governments in developing countries to reinforce administrative capacities and support the development of legal and regulatory frameworks which are conducive to mitigating and adapting to climate change.

Greece’s major policy objectives concerning international environmental co-operation include:

- contribution to the international efforts for promoting the implementation of the 2030 Agenda and the Sustainable Development Goals (SDGs), the Paris Agreement, as well as other international agreements and frameworks related to sustainable development, such as the Addis Ababa Action Agenda;
- contribution to sound environment management and sustainable development in Europe as an active Member State of the European Union;
- building strong “beyond borders” partnerships with partner countries that face similar challenges and share common goals, through bilateral and trilateral technical cooperation schemes, especially in its geographic neighborhood, i.e. South-East Mediterranean and South-East Europe;
- enhance the country’s engagement in multilateral and regional environmental bodies, e.g. UN Environment Programme (UNEP), International Maritime Organisation (IMO).

Greece participated constructively in the post-2012 negotiation process leading in September 2015 to the adoption of the 2030 Agenda and the SDGs. Greece participated constructively in the post-2012 negotiation process leading in September 2015 to the adoption of the 2030 Agenda and the SDGs. In the context of the UN High Level Political Forum on Sustainable Development (HLPF), Greece presented its first Voluntary National Review (VNR) for the implementation of the SDGs in 2018 covering all 17 SDGs through eight National Priorities for adapting the SDGs to national needs and circumstances, defined, through an open dialogue within all government units and stakeholders.

After the VNR, in May 2019, Greece launched a process of developing a national set of SDG indicators for the quantitative monitoring of our performance, building on both the global UN SDG indicators framework as well as on the EUROSTAT indicators: this list includes around 160 indicators (90 selected from the global SDGs indicator framework and 70 from EUROSTAT adjusted to national priorities and circumstances and in line with the existing obligations for monitoring and reporting by line Ministries). These indicators were endorsed by all Ministries and by the National Statistical Authority of Greece, ELSTAT.

Greece is now preparing its second VNR to be presented at the 2022 HLPF

The 2030 Agenda and the SDGs shape the Greek Government’s global engagement. The common global vision and ambition expressed in the SDGs are in line with the interests, values and principles for which Greece has worked globally for decades. Greece sees the 2030 Agenda and the SDGs as a visionary and transformative framework for a new, equitable and sustainable development path.

Greece’s development activities in the field of climate change are based on, and emphasize the importance of, the principles of national ownership, stakeholder participation, country driven demand, cooperation between donors and across programs, and impact assessment and monitoring (when appropriate).

The provision of technology development and transfer and capacity building support by Greece to non-Annex I Parties is presented in the next paragraphs and in ***CTF Table 8 and 9***.

7.4.1 Multilateral/Regional cooperation

7.4.1.1 International Initiative on "Addressing climate change impacts on cultural and natural heritage"

Greece, deeply concerned about the serious threat that climate change poses to cultural and natural heritage, and being at the forefront of the on-going endeavor to protect natural and cultural heritage from adverse climate change impacts, as asserted by the Greek Prime Minister's statement at the Climate Action Summit in New York (September 2019), with the supporting partnership of UNESCO and the WMO (World Meteorological Organization), launched the proposal "Addressing climate change impacts on cultural and natural heritage". The scope of the initiative is to accelerate global action, before the damage to our common heritage becomes irreversible, and assess the relevant mitigation and adaptation/resilience issues and good practices in the fields of climate change and cultural heritage, including impacts on small island states. So far, more than 100 UN member states and many NGOs and organisations have expressed their support to this initiative, launched at the UN Climate Action Summit (September 2019). Upon recommendation of the UN Secretary General, a follow-up committee (Flexible Mechanism) has been set up, with the participation of Greece, UNESCO, the WMO and UNFCCC.

7.4.1.2 Regional cooperation on environmental protection within the Black Sea Economic Cooperation (BSEC) Organisation (technology transfer activity and capacity building)

Greece, as a BSEC member, is actively engaged in efforts initiated by the Permanent International Secretariat (PERMIS) of BSEC to promote cooperation and exchange best practices for mitigation and adaptation of climate change, energy efficiency and green energy investments, especially among countries with developing economies.

Such priority issues are quoted in: i) "*Declaration of the Ministers in charge of energy of the BSEC Member States on the enhancement of the gas infrastructure development (Belgrade, 11 April 2012)*" (Annex VI to BS/ENM/R(2012)1), ii) "*Joint Belgrade Declaration on Climate Change and Green Economy - BSEC Contribution to Rio+20*" (23 April 2012) and iii) the "*Plan of Action of the BSEC Working Group on Energy for the period 2015-2017*".

KEPA facilitated BSEC - Member States, especially those with developing economies, to fulfil their commitments and to deliver increased ambition for the achievement of the Paris Agreement goal. This contribution was further developed with the launching of the "BSEC – Green Energy Network" (BS/EN/WG/TF/R(2012)1; BS/EN/WG/R(2010)2; BS/ENM/R(2010)2; BS/FM/R(2014)2 and Annex VII to BS/FM/R(2014)2).

The **BSEC Green Energy Network** was established by the decision of the Council of Ministers of Foreign Affairs taken on 12 December 2014, with the mandate to facilitate exchanging information and sharing experience and know-how among national administrative bodies and/or centers and organizations mandated to promote renewable energy sources and energy efficiency measures and policies in the BSEC Region (BS/EN/WG/TF/R(2014)2).

The Network started to function in 2015 and is endeavouring to undertake and facilitate actions at international, regional and national levels with a view to developing, transferring and exchanging updated knowledge, including consultations for the development and assessment of specified green policy mixtures and actions.

Under the aforementioned framework, BSEC and the Greek government, through the KEPA of the NKUA, endorse actions, that:

- support the regional policy dialogue for green energy investments;
- promote further the development of the "BSEC – Green Energy Network", as a knowledge and green investment hub for the BSEC region;
- result the organization of "Green Investment Forum" in the BSEC – MS.
- facilitate "knowledge transfer" and "capacity building" on Climate Change Policy and Green Energy Investments issues in all BSEC Member States and especially those with developing economies;
- assist BSEC countries to design and implement new policies and actions to achieve their NDC pledges;
- contribute to the achievement of Sustainable Development Goals;
- provide them, especially those with developing economies, tools facilitating the development of forward-looking scenarios and evaluation of their policy mixtures towards their commitments on climate change issues.

Members of the Network especially those from countries with developing economies are invited to organize and participate in regional/international activities, such as workshops, seminars, webinars and conferences.

They can take advantage, free of charge, of the existing communication infrastructure of KEPA – NKUA, consisted of scientific journals, periodical editions, newsletters so as to increase the level of cooperation among them and their national stakeholders.

They are welcome to contribute to *enhancing the knowledge transfer and capacity building* of their governments, updating them on the state of the emerging international "green policy" instruments.

The Network contributes, through knowledge dissemination, to encouraging market stakeholders; to take advantage of existing international financing opportunities and convince regional and national banking institutions to enhance their "green" transition process.

Finally, members of the Network and especially those from countries with developing economies are facilitated through brokerage events to participate in internationally financed programs, like those of Horizon Europe of the European Union, or to develop ad hoc "tailor - made" consortia upon requests from the BSEC Member States.

Implemented activities during period 2018 – 2021

2018

*The total financial contribution of KEPA towards the BSEC region, during the period 2018-19, was **€257,000**.*

January – September 2018

KEPA coordinated and supported the submission of the following proposals in an effort to contribute to knowledge transfer and capacity building among institutes coming from BSEC Member States with developing economies. The KEPA staff worked with entities from the region and guided them so as to prepare jointly the proposals. More specifically,

1. As coordinator of the BSEC – Green Energy Network, KEPA motivated and coordinated the development and submission of **three (3) proposals to the Black Sea Project Promotion Facility (BSPPF)** in line to the Terms of References (ToR) of a call for proposals[27]. The titles and partners for each of these proposals were the following:

   A - Title: "Promoting Smart – NZEB among the BSEC – MS, ***The case of Bulgaria***". Partners: Energy Policy and Development Centre of NKUA – Greece; Technical University of Sofia – **Bulgaria**; Institute for Statistical Studies and Economics of Knowledge of the National Research University "Higher School of Economics" – **Russia;** BSEC – Green Energy Network. Submission date: **3 April 2018.**

   B – Title: "Promoting deep renovation packages for the building sector among the BSEC – MS, ***The case of Moldova***". Partners: Energy Policy and Development Centre of NKUA – Greece; Institute of Power Engineering of Moldova (IPE) – **Moldova**; Technical University of Sofia – **Bulgaria**; Kuban University – **Russia;** BSEC – Green Energy Network. Submission date: **14 May 2018.**

   C – Title: "Promoting deep renovation packages for the building sector among the BSEC – MS, ***The case of Albania***". Partners: Energy Policy and Development Centre of NKUA – Greece; South East Europe Institute of Energy and Sustainable Development – **Albania**; Technical University of Sofia – **Bulgaria**; Institute for Statistical Studies and Economics of Knowledge of the National Research University "Higher School of Economics" – **Russia;**
   BSEC – Green Energy Network. Submission date: **14 May 2018.**

   All proposals were market oriented. In all three proposals, business conferences were foreseen, in each beneficiary country (**Albania, Bulgaria, Moldova**) encouraging local SMEs to cooperate in making business while outcomes of all these programs reflecting the state of progress in five (5) BSEC–MS, were planned to be presented in international and regional conferences, forum and events organized by KEPA and BSEC-Green Energy Network (BSEC-GEN).

   *The financial contribution of KEPA was **€100,000**.*

   This amount includes administrative and organizational costs, work for knowledge transfer and capacity building so that partners could provide the necessary and appropriate material for the preparation of the proposals.

2. **KEPA coordinated and submitted a proposal at the EEA and Norway Grants Fund for Regional Cooperation.** The project title was "Promoting low carbon economy, through deep energy efficiency investments in buildings" with a consortium of 9 partners from **Albania, Belarus, Bulgaria, Cyprus, Greece, Moldova, Romania and Russia**. During a two (2) month preparation period, KEPA was communicating with all partners and provided them guidelines and informing them about the procedures.

   The proposal was submitted in late June 2018. **Partners:** BSEC – Green Energy Network; Association Cluster for promoting Nearly Zero Energy Buildings – Pro-nZEB – **Romania**; Cyprus Association of Civil Engineers – Cyprus; Hellenic Passive House Institute – Greece; South East Europe Institute for Energy and Sustainable

[27] published in http://www.bsec-organization.org/UploadedDocuments/PromotionFacility/Call%20for%20Proposals.pdf and https://www.bstdb.org/products-and-services/special-funds-for-technical-assistance

Development – **Albania**; Institute of Power Engineering – **Moldova**; Kuban State University – **Russia**; Brest State Technical University – **Belarus**; Municipal Energy Efficiency Network EcoEnergy – **Bulgaria**.

*The estimated financial cost for knowledge transfer and capacity building by KEPA towards the partners coming from countries with developing economies was **€30,000**.*

3. **KEPA prepared and submitted under a Horizon 2020 open call one proposal in September 2018**. The full title was "Transforming Energy Poor Consumers to Prosumers" with a consortium of 14 partners from **Albania, Greece, Italy, Moldova, Romania and Serbia (three of these countries are listed as countries with developing economies)**.

   The partners were: Energy Policy and Development Centre (NKUA-KEPA) – Greece; Hellenic Passive House Institute (HPHI) – Greece; E-TRIKALA S.A. – Greece; University of Belgrade – Faculty of Mining and Geology (UB-FMG) – **Serbia**; Grad Sabac (GS) – **Serbia**; South East European Institute for Energy and Sustainable Development (SEEIESD) – **Albania**; Bashkiadropull (BD) – **Albania**; Institutl De Energetica Al Academiei De Sttiinte A Moldovei (IPE) **Moldova**; Consiliul Raional Drochia (CRD) – **Moldova**; Universita Commerciale Luigi Bocconi (UB-IEFE) – Italy; BSEC Organization – Green Energy Network (BSEC-GEN), International Organization; Institutl National de Cercetare – Dezvoltare in constructii Urbanism si Dezvoltare territoriala durabila (Urban – Incerc (U-I)) – **Romania**; Universitatea Babes – Bolyai (UBB) **Romania**; Municipul Cluj-Napoca (MCN) – **Romania.**

   *The estimated financial contribution by KEPA was **€56,000.***

   *It covers knowledge transfer and capacity building in developing, coordinating and submitting the proposal**.***

11th International Conference on Energy and Climate Change and the 4th Green Energy Investments Forum (October 2018)

KEPA organized the 11th International Conference on Energy and Climate Change and the 4th Green Energy Investments Forum during 10-12 October 2018, under the BSEC – PERMIS auspices.

*The estimated financial cost covering a preparation period of one year was **€50,000**.*

Release of an Appeal on Energy Poverty (October 2018)

During the 4th Green Energy Investments Forum in Athens (10th of October 2018), KEPA made an appeal to the Secretary General of PERMIS, to undertake an initiative targeting mitigation of energy poverty, in a sustainable way, among its Member States with the technical support of KEPA as the coordinator of BSEC-GEN.

Internationally disseminated newsletter (January – December 2018)

KEPA disseminates to approximately 29,000 recipients in 170 countries the PROMITHEAS Newsletter about energy and climate change issues.

*The estimated financial cost covering preparation, editing and dissemination for one year is **€21,000.***

<u>2019</u>

The total financing contribution of KEPA towards the BSEC region, in 2019, was ***€146,000****.*

5th Green Energy Investments Forum, Sofia – Bulgaria (16 April 2019)

The 5th Green Energy Investment Forum was held on 16 April 2019 at the Hall Ruen, Congress Center, Inter Expo Center in Sofia in the frame of the Bulgarian Chairmanship of the BSEC.

The participants shared the view that the forum provided a useful platform for the exchange of ideas and the discussion about funding opportunities for green energy projects in BSEC Member States aiming to achieve the UN goals for sustainable development in the Black Sea region. Highlighted was the increased interest in development of green energy regional cooperation and the need to develop and implement more specific projects about energy efficiency, renewable energy and combating the effects of climate change. Participants expressed the hope that the forum would have new editions in the following years (Information from the official press release of the Bulgarian Ministry of Foreign Affairs. Available at: https://www.mfa.bg/en/customnews/21380).

The financing contribution of KEPA for the event was ***€10,000****.*

The amount concerns preparations costs for the event (dissemination of information at regional and international level through the PROMITHEAS Newsletter; expenses for knowledge transfer actions).

12th International Conference on Energy and Climate Change and the 6th Green Energy Investments Forum (October 2019)

KEPA organized the 12th International Conference on Energy and Climate Change and the 6th Green Energy Investments Forum during 9-11 October 2019.

The financing contribution of KEPA for the whole event was ***€50,000****.*

These costs cover a preparation period of one year.

Meeting of the BSEC Working Group on Energy (November 2019, Istanbul – Turkey)

The Meeting of the BSEC Working Group on Energy was held at the BSEC Headquarters, on 29 November 2019 (BS/WG/EN/R(2019)1). KEPA in its capacity as BSEC-GEN coordinator was invited *at its own costs* to participate as special guest and make proposals. The Working Group was informed about the activities of the BSEC Green Energy Network and of the "Conclusions and Recommendations" of the Green Energy Investment Forum, held in Athens on 9 October 2019.

Participants discussed about regional cooperation in the BSEC framework for contributing to the implementation of the 7th Sustainable Development Goal «Ensure access to affordable, reliable, sustainable and modern energy for all» and exchanged views after taking note of the information provided by the BSEC PERMIS on the issue.

The Working Group endorsed the proposal made by the Coordinator of the BSEC Green Energy Network aimed at promoting regional cooperation in the framework of implementing the SDG 7 and agreed on the importance of organizing special events (conferences, seminars, workshops) for exchange of information on the activities of BSEC Member States in implementing SDG7.

The Working Group also welcomed the proposal of organizing a Youth Contest on SDG 7 by the BSEC Green Energy Network, under the auspices of the BSEC PERMIS.

*The total financing contribution of KEPA for the whole event was **€40,000**.*

*Initiative **"75UN - 75 Trees UNAI SDG7"** (December 2019)*

The Initiative "**75UN - 75 Trees UNAI SDG7**" was launched in December 2019 as the participation of the Energy Policy and Development Centre (KEPA), the global hub of the United Nations Academic Impact (UNAI) for the 7th Sustainable Development Goal (SDG7), in the celebrations for the 75th anniversary of the UN foundation.

The Initiative aimed at involving citizens in efforts to save and enhance the world's forest wealth. To this aim, KEPA, after consulting with UNAI, addressed its invitation to governments, regional and local governments, all forms of legal entities, simple people and especially young people to plant at least 75 trees during 2020 and take care of them.

*The total cost of KEPA in developing and releasing the initiative was **€25.000**.*

Internationally disseminated newsletter (January – December 2019)

KEPA disseminated for one more year to approximately 29,000 recipients in 170 countries the PROMITHEAS Newsletter about energy and climate change issues. KEPA incorporated in the newsletter issues about the relevant SDGs.

*The estimated financial cost covering preparation, editing and dissemination for one year is **€21,000.***

<u>2020</u>

*The total financial contribution of KEPA towards the BSEC region for 2020 was **€ 211,000.***

"Mitigation of Energy Poverty in a Sustainable Way" (January – March 2020)

In January 2020, KEPA was invited by PERMIS – BSEC to submit for funding the proposal "Mitigation of Energy Poverty in a Sustainable Way". The **overall** objective of the proposal was to initiate and establish a "Structured Policy Dialogue" that would allow the transformation of Energy Poor Consumers (EPC) into Sustainable Energy Prosumers (SEP) by their aggregation into energy communities that were to take advantage of the existing procedures of "Smart Finance" for "Smart Zero Energy Buildings". Developed good practices were going to be disseminated to all BSEC Member States (MS), through the Permanent International Secretariat, the Working Groups on Energy and the established Green Energy Investments Fora of the BSEC-GEN. Also, the consortium foresaw the expansion and continuation of the Structured Policy Dialogue by leveraging funds from national and sub-national authorities, EU (H2020, EIB, and EBRD) and other international funding sources.

This was proposed to be a win-win path in the BSEC MS efforts to respond to the UN Secretary-General appeal to increase their "ambition" in the combat against Climate Change, to implement the 2030 Sustainable Development Agenda of the UN, increase their social cohesion and to promote the economic development in their countries. The **expected outcomes** included:

1. the engagement of the appropriate actors to finance and implement the proposed project proposals by the aggregated EPC entities;

2. the increase of awareness among the BSEC - MS national, subnational authorities on the socio-economic benefits of confronting energy poverty through the proposed structured policy dialogue targeting green sustainable solutions;
3. the expansion of the structured policy dialogue among additional partners from the BSEC-MS by securing financing round table discussions;
4. the dissemination of "lessons learned" and "best practices" regionally and internationally (UNAI Hub SDG7, Covenant of Mayors, etc.).
5. the increase of awareness on Energy Efficiency issues among the BSEC – MS and their motivation to take advantage of the good practices combining “smart buildings” and “smart finance” procedures.

*The financing cost for KEPA was **€20,000***

The financing cost includes development, coordination, submission, knowledge transfer and capacity building services.

International Youth Contest for Clean energy (SDG7, SDG13) (February 2020)

KEPA submitted to EUKI this proposal. It concerned a 2-years International Youth Contest in SEE (**Bulgaria**, Greece, Italy, **Serbia**) to develop & implement Clean Energy (SDG7) Action Plans (APs) in educational building facilities leading to measurable GHG reductions (SDG13). High school/university student groups motivated by their professors in close cooperation with public authorities & market forces were going to be asked to develop & implement their own APs. The 1st annual round of the contest was going to award 3 best national and regional APs (planned). The 2nd -year the contest would award 3 executed APs with highest achieved GHG emission reductions. Additional awards were foreseen for best impact of APs in local societies. Foreseen activities: 2 annual summer schools & Webinars of knowledge transfer for motivators & their youth-groups; support to a “group of excellence” formed by participating students & relevant awards for innovative APs. Info was already disseminated to Black Sea (BSEC organization) countries & worldwide (UNAI Hub for SDG7) since both entities officially supported the contest.
*The financing cost for KEPA was **€5,000**.*

UNAI Webinar (June 2020)

Webinar in the “75 for UN75: 75 Minutes of Conversation” series was held on 8 June 2020. It was organized by UNAI on the topic “*The role of Higher Education in combating poverty and ensuring social justice*”. Prof. Dimitrios Mavrakis, Director of KEPA, was invited speaker.

*The financing cost of the presentation for KEPA was **€10,000**.*

International and regional activities (September 2020)

On 21 September 2020 there was a UNAI release about BSEC and the initiative “75 UN – 75 Trees UNAI SDG7”.

Prof. Dimitrios Mavrakis (Coordinator of UNAI Hub SDG7 and BSEC – Green Energy Network) was moderator and speaker at the Energy week - Black Sea 2020 - (bsenergyweek.com) that was held during 29-30 September 2020.

Proposal for innovative Hydropower technology in Central Asia (September 2020)

The HydroPlus proposal (submitted to EU - Horizon 2020) aimed to demonstrate innovative solutions targeting the unexploited small-scale hydropower potential in Central Asia (CA) using innovative European hydropower technology.

Three (3) EU partners (Greece, France, Poland) and eight (8) CA partners (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan) proposed to join efforts so as to create a prototype of small Hydro Energy Power Plant (HEPP), that was to be installed at four (4) test river-sites in four (4) different countries (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan).

The project aimed to contribute, additionally, in analyzing the Water/Food/Energy/Climate nexus in CA via assessment of socio-economic and environmental sustainability, general economic analyses and study of HEPP impact against the technological development of the CA.

*The financing cost for KEPA was **€10,000.***

13th International Conference on Energy and Climate Change and the 7th Green Energy Investments Forum (October 2020)

KEPA organized the 13th International Conference on Energy and Climate Change and the 7th Green Energy Investments Forum (Virtual event) during 7-9 October 2020. There were participants from Albania, Georgia, Moldova, Romania, Serbia and Turkey.

*The estimated cost of the events was **€50,000**.*
Self-funding as explained previously.

"Workshop for Young Diplomats from BSEC Member States on "Sustainable Development in the Black Sea Region"" (October 2020)

The BSEC PERMIS, with the cooperation of the Konrad Adenauer Stiftung Turkey (KAS), organized on 12 October 2020, the 3rd Edition of the "Workshop for Young Diplomats from BSEC Member States on Sustainable Development in the Black Sea Region" (First online Workshop/Webinar). Eighteen (18) young diplomats from eleven (11) Member States, all of them newly recruited with limited experience in their respective Ministries of Foreign Affairs, participated.

Prof. Dimitrios Mavrakis (Coordinator of UNAI Hub SDG7 and BSEC – Green Energy Network) participated as invited speaker.

*The cost for developing and presenting the relevant material was **€ 10,000.***

"Initiative 75UN – 75 Trees UNAI SDG7" (November 2020)

With the support of BSEC - PERMIS seven Member States (**Armenia, Azerbaijan, Bulgaria, Moldova, Romania Ukraine and Turkey**) responded in 2020 to the invitation of participating at the initiative, while 29 Municipalities from Greece with the support of the Central Union of Greek Municipalities endorsed the initiative and responded also.

The **University of Manitoba (Canada)** UNAI Hub SDG6 planted 75 trees inside its campus during November 2020.

By the end of 2020, eleven million trees have been declared planted or were about to be planted despite the obvious problems of the pandemic. Based on the results and especially the willingness of the participants, it was decided to continue and upgrade the Initiative for the coming years.

*The total cost of KEPA in developing and releasing the initiative was **€25.000**.*

Tele-meeting of the BSEC Working Group on Energy (10 December 2020)

The Working Group took note of the information provided by the BSEC PERMIS on the conclusions and recommendations of the 7th "Green Energy Investment Forum" and on the implementation of the initiative "75 UN – 75 trees UNAI SDG7" proposed by KEPA, in its dual capacity as the UNAI Hub SDG7 and Coordinator of the Green Energy Network of the Black Sea Economic Co-operation Organization (BSEC - GEN) (BS/WG/EN/R(2020)1).

Professor Dimitrios Mavrakis presented the activities of the Green Energy Network, and the latest developments about the implementation of the initiative "75 UN – 75 trees UNAI SDG7". He invited the representatives of the Republic of Armenia, the Republic of Azerbaijan, the Republic of Bulgaria and Georgia to participate in the forthcoming Green Energy Investments Forum that was proposed to be organized in Bulgaria in 2021. He also proposed to the participants of the BSEC – WGE to consider the possibility of organizing a Joint Meeting on Energy and Climate Change with the aim to focus on the Resilient and Sustainable Recovery Plans that the BSEC Member States may have developed.

*The cost for developing and presenting the relevant material was **€ 30,000.***

UNAI Webinars (December 2020)

KEPA participates at the UNAI Webinar that was held on *10 December 2020.*

The **Nagaoka University of Technology** – Japan (UNAI Hub SDG 9) organized the «SDG Seminar of Online Technical Collaboration Forum 2020» during 21-25 December 2021. Prof. Dimitrios Mavrakis was a key-note speaker.

The participation cost was covered by Nagaoka University.

Upgrading Scientific Journal of KEPA (December 2020)

KEPA announced the decision of Mr. Ramu Damodaran, Chief of the UNAI to upgrade the scientific journal, published by KEPA. Upgrading will be under the supervision of Prof. Dimitrios Mavrakis with the aim to become a UNAI journal on the research areas of the SDGs. The goal is to provide to all UNAI members and especially those from developing countries an open access journal with topics for all SDGs. Indicative budget (mostly self-funding by KEPA): **30000Euro** (expenses include upgraded web-site, administrative and scientific work).

Internationally disseminated newsletter (January – December 2020)

KEPA disseminated for one more year to approximately 29,000 recipients in 170 countries the PROMITHEAS Newsletter.

*The annual estimated financial cost, as explained, is **€21,000.***

<u>2021</u>

*The total financing cost of KEPA, during 2021, was **€122,000.***

January 2021

The Kristu Jayanti College (Bangalore - India), the global hub of the United Nations Academic Impact (UNAI hub SDG1) for Sustainable Development Goal 1 (SDG 1 - No poverty) hosted on 22-23 January 2021 the Virtual International Conference on “Translating Sustainable Development Goals into Action: The Power of Higher Education Institutions”.

Prof. Dimitrios Mavrakis, Director of KEPA, was invited to deliver a speech with the title "The challenge of Resilient-Sustainable Recovery Plans". https://kristujayanti.edu.in/UNSDG2021/index.html

*The cost for developing and presenting the relevant material was **€ 10,000.***

14th International Conference on Energy and Climate Change and the 8th Green Energy Investments Forum (October 2021)

KEPA organized the 14th International Conference on Energy and Climate Change, the 8th Green Energy Investments Forum (Virtual event) and an official dinner to BSEC -MS ambassadors and Greek Market stakeholders in Athens during 13-15 October 2021.

*The financing cost was **€60,000Euro**.*

International Forestation Initiative (November 2021)

KEPA in its capacity as the United Nations Academic Impact (UNAI) Hub for the 7th Sustainable Development Goal (SDG7), co-organized with the Central Union of Greek Municipalities (KEDE) the 1st Conference "International Forestation Initiative" in Bourazani at the premises of the Burazani Wild Life Resort, during 12-13 November 2021. The objectives of the meeting were:

1. The promotion of the Initiative (“75 UN - 75 Trees UNAI SDG7”) for the planting of trees in urban, suburban and forest environment by local governments, legal entities of the public and private sectors and individuals;
2. The presentation of the existing financial tools for such activities;
3. The investigation of the terms and prospects of issuing CO_2 capture certificates originating from the planting of trees;
4. The promotion of procedures for financial support towards activities of the Initiative in the countries of BSEC and
5. The possibilities of creating an International Cooperative Initiative (ICI) in the framework of the activities of the UNFCCC.

The Conference was attended by the Deputy Secretary General of BSEC – PERMIS H.E. Amb. Traian Chebeleu, with the aim to discuss ways of further increasing the participation of the BSEC – Member States in the initiative and investigating ways of financing it.

The cost of the event was covered by the Green Fund of the Greek Ministry of Environment and Energy.

*The financing cost of the extrovert activities covered by the Greek Green Fund were **€1,000.***

Tele-meeting of the BSEC Working Group on Energy (2 December 2021)

Prof. Dimitrios MAVRAKIS attended the meeting as a special guest and made a number of presentations concerning: i) the perspective of establishing wholesale electricity and natural gas markets in the region of the BSEC, in combination with the establishment of a regional legal entity consisted of the existing or to be developed underground natural gas storages, in line with the relevant report prepared by KEPA and circulated by PERMIS to BSEC – MS, ii) activities of the BSEC – Green Energy Network (BSEC – GEN) and, iii) the conclusions of the 8th "Green Energy Investments Forum" held in Athens on 13 October 2021. He proposed BSEC -GEN to organize a Green Energy Investments Forum in Chisinau under the BSEC Chairmanship in-office by the Republic of Moldova during the first semester of 2022 and invited BSEC-MS to participate in the 9th Green Energy Investments Forum that is scheduled to take place in Athens on 12 October 2022.

*The cost for developing and presenting the relevant material was **€ 30,000.***

Webinar UNAI (December 2021)

The Nagaoka University of Technology (UNAI Hub SDG 9) organized for the second year the "On line SDG Seminar - Technical Collaboration Forum 2021" during 13-17 December 2021. Again, Prof. Dimitrios Mavrakis was invited and participated as key-note speaker.

The participation cost was covered by Nagaoka University.

Internationally disseminated newsletter (January – December 2021)

KEPA disseminated for one more year to approximately 29,000 recipients in 170 countries the PROMITHEAS Newsletter.

*The annual estimated financial cost, as explained, is **€21,000.***

Knowledge transfer and capacity building activities in the region

KEPA under its dual capacity as UNAI hub SDG7 and BSEC-GEN focuses and will continue to work on this type of activities due to the gained experience and the impact they have mainly for the BSEC MS.

KEPA has so far activated funds of approximately 2.5 million Euro through the projects PROMITHEAS-2 (FP6), PROMITHEAS-4 (FP7) and HERON (Horizon 2020). These projects included activities that allowed: i) the transfer of capacity building from EU to BSEC countries about the development of climate change policies adjusted to the specific needs of each examined national case (development of scenarios for mitigation and adaptation, seminars, long-distance learning); ii) the organization of conferences and workshops during which market stakeholders, policy and decision makers discussed about national energy and climate change issues.

Most of the on-going activities of knowledge transfer and capacity building are self-funded by KEPA, while its initiatives receive attention and support in the region. The cost is estimated at €736,000 for the period 2018-2021.

During the last four years (2018 – 2021) BSEC governments and non-state actors have been helped on knowledge transfer and capacity building regarding energy and climate change issues through the following activities:

1. Development of project-proposals. KEPA has prepared and **submitted eight (8) proposals**. In all of these at least one BSEC Member State was a partner.
2. Initiative "75UN – 75 Trees UNAI SDG7" and BSEC: In January of year 2020, the Organization Black Sea Economic Cooperation (BSEC) sent information about the initiative to its Member States and invited them to participate. In September 2020, BSEC, in response to the relevant request of KEPA, sent filled applications about the initiative for registration from 4 of its member states, while three other member states expressed their intention to participate. A press release was circulated by the BSEC Organization.

   KEPA contacted entities in Japan and Central Asia for participation at the initiative. Through the KEPA Newsletter, which is distributed to 29,000 recipients in 170 countries, KEPA received the following expressions of interest about the initiative

   1. Mykolas Romeris University – Lithuania.
   2. Norwegian Univerisity of Science and Technology - Norway.
   3. National Research Centre – Eygpt.
   4. Fundación Cetemas – Spain.
   5. Open University of Cyprus – Cyprus.

At the end of 2020, 9 countries (Azerbaijan, Armenia, Bulgaria, Greece, Canada, Moldova, Romania, Ukraine and Turkey) participated at the initiative.

3. The **PROMITHEAS Newsletter** (bimonthly) allows BSEC entities (Ministries, agencies, research centres, universities, academia, consultants, SMEs etc) activated in energy and climate change issues to be informed about recent developments on these issues and to present their relevant activities and policies. KEPA prepares and disseminates the PROMITHEAS newsletter to approximately 29,000 recipients in 170 countries for the last fourteen years. *Annual cost for preparing, editing and circulating the newsletter is **€21,000***.
4. The **Scientific Journal** (bilingual (in English and Russian)) titled *"Euro-Asian Journal of Sustainable Energy Development"* allows, mainly but not exclusively, to the scientific potential of EU and BSEC Member States (MS) to present their research work on climate change, energy and sustainable development issues. The journal is published by KEPA since 2008 and receives ISSN numbers for printed and electronic versions. The members of the Scientific Committee are from the BSEC region, Italy, Japan, Norway and United Kingdom. Currently, efforts are focusing in upgrading it into a UNAI Journal.
5. The **PROMITHEAS Network on Energy and Climate Change policy issues** allows to scientific entities of the BSEC region to interact, exchange views and cooperate on research issues for climate change, energy and sustainable development. Also, in the frame of the network activities, consortia are formed and submit research proposals to funding mechanisms such as HORIZON 2020, Europaid etc. KEPA is the coordinator of the PROMITHEASnet, The Energy and Climate Policy Network, which consists of participants from 16 countries mainly coming from the Black Sea, Caspian Sea and Central Asia regions (Albania, Armenia, Azerbaijan, Bulgaria, Georgia, Hellas, Kazakhstan, Kyrgyzstan, Moldova, Romania, Russian Federation, Serbia, Tajikistan, Turkey, Ukraine and Uzbekistan). There is one member from the Mediterranean (Lebanon). It was established in 2005 as a BSEC Project Development Fund (PDF) project with NKUA-KEPA as the

coordinator. It aims to promote cooperation between EU and BSEC relevant institutions and, through this, to enhance bonds of scientific cooperation, knowledge transfer and dissemination, to contribute to economic issues relevant to its contents and to regional stability and economic development (see at: http://www.promitheasnet.kepa.uoa.gr).

6. Due to the pandemic, organized **events** for reinforcing the skills of the scientific and research potential of the BSEC region were limited to only the following one (physical and on line participation):

   Annual International Conference on Energy and Climate Change (Implementation period: 2008-2021) – **Funding source:** self-funded, sponsored by funding agencies (banks) and energy companies, registration fees from attendees. **Aim:** This Conference started as an activity of a FP6 funded project and has developed into an annual International Conference for scientists and researchers working in energy and climate change policy issues. It is hosted by the oldest university of Greece, the National and Kapodistrian University of Athens (NKUA); organized by the NKUA-KEPA, coordinator of the PROMITHEAS Network and set under the aegis of the BSEC Organization and of the United Nations Academic Impact (UNAI).

   The Conference, starting from 2013, is scheduled to promote the Green Economy issue and following its structure to bring together members and representatives from the scientific community, governmental authorities, members of parliaments, market stakeholders, banking officers and representatives from international and regional organizations. Proceedings receive ISBN numbers for printed and electronic version. The last five years the Conference is divided into three (3) main parts.

   The "*Green Energy Investments Forum*" on the first day, is organized in cooperation with the Permanent International Secretariat of the Organization of the Black Sea Economic Cooperation (***BSEC PERMIS***) and aims to reinforce the regional and extroverted cooperation among educational institutes, market forces, banks and governments for "green energy" issues.

   The second "*Scientific papers*" is devoted to peer – viewed presentations and discussions, as in all previous years. Scientists and researchers mainly from EU and BSEC countries participate and present their work.

   Finally, the third is shaped as a *"Brokerage session"* that brings together scientists, policy makers and market stakeholders and facilitate them to present their activities (projects and programs), discuss about funding opportunities, especially in the context of Horizon Europe calls and finally to increase the cross-interaction on innovative ideas and cooperation on common importance topics.

   The Hellenic Government in addition to the annually organized forum in Athens supports the organization of biannual forum in all BSEC- MS during their Chairmanship in Office of BSEC, as a concrete contribution to knowledge transfer and green investment facilitation for all BSEC – MS.

   Available information at: http://www.promitheasnet.kepa.uoa.gr.

7.4.1.3 South East Europe

At the regional South East European (SEE) level, the Hellenic Ministry of Foreign Affairs participates very actively in the drafting of the SEE 2030 Strategy. The objective of the Strategy is to reach regional sustainable economic growth based on the principles of the global 2030 Agenda and the SDGs, through reducing poverty and inequality in the region, empowering women, improving social inclusion, decelerating depopulation by increasing the quality of life, and accelerating green and digital transition in the 13 SEE economies. It provides an overall guidance on how SEE can further raise ambitions in SDG implementation. The SEE 2030 Strategy would be approved at the SEECP Summit in Antalya in June 2021. The implementation of this Strategy will commence during the upcoming Greek Chairmanship-in-Office of South East European Cooperation Process (SEECP), starting 1 July 2021 until 30 June 2022.

7.4.1.4 Trilateral cooperations

In the Eastern Mediterranean Region and under the overarching umbrella of the Barcelona Convention, two trilateral schemes of technical cooperation and partnership have been initiated, at a high political level, between Greece, Cyprus and Israel and between Greece, Cyprus and Egypt, in 2016 and in 2017, respectively. The ultimate objective of these cooperative schemes is to enhance peace and stability in the region and facilitate the sharing of experiences, knowledge and know-how in order to promote joint projects of mutual interest, find solutions to common concerns and promote interconnectivity and complementarity of actions.

More specifically:

Trilateral Cooperation in the field of Environment between Greece – Cyprus – Israel

The trilateral cooperation was initiated in April 2016 and each year a Summit between the tree Prime Ministers is held in one of the three countries, in rotation, usually with a back-to-back Ministerial Meeting of Environment Ministers. The cooperation is based on the Barcelona Convention and its legal instruments and is intended inter alia to further strengthen their implementation at a sub-regional level.

The thematic areas identified for the trilateral cooperation since the beginning, as issues of common concern, are three, namely:

- protection of the marine environment of the Mediterranean (covering also issues related to satellite monitoring of the coastal and marine environment), led by Cyprus;
- climate change adaptation (with emphasis on developing common set of indicators for climate change adaptation), led by Greece; and
- water and wastewater management with emphasis on olive oil wastewater that will be expanded to cover also issues related to management of sewage sludge, led by Israel.

The three countries have also agreed to exchange best practices and experience gained for capacity building at country level, on processes to adapt and implement the UN Global Sustainable Development Goals (SDGs).

During the 1st Meeting of the three Ministers of Environment (April 2016), a joint trilateral Working Group was established, that agreed that:

- a trilateral Ministerial Meeting on Environment will be held once a year (as stated above),
- the joint trilateral Working Group will meet at technical level, three times a year, on each one of the three above mentioned thematic areas (including on climate change adaptation, depending on needs and progress achieve.

So far, the trilateral Working Group has met three times, at technical level, as follows:

- On 2nd February 2017 in Athens on climate change adaptation
- On 9th February 2017 in Tel Aviv, on water and wastewater management, and,
- On 23 February in Nicosia on the protection of marine environment from pollution and in particular from oil spills.

Further to the above three thematic areas, during the 3rd Meeting of the three Ministers of Environment (June 2017) it was decided that an additional fourth thematic area will be added, on solid and municipal waste management (with emphasis on the utilisation of Refuse Derived Fuel (RDF) / Solid Recovered Fuel (SRF) in the cement industry).

Under the thematic area for the protection of the marine environment, a Sub-regional Marine Oil Pollution Contingency Plan and its accompanying Implementation Agreement pursuant to the Protocol concerning Cooperation in Preventing Pollution from Ships and in Cases of Emergency Combating Pollution of the Mediterranean Sea to the Barcelona Convention, drafted with the support of REMPEC, have been signed between the three Environment Ministers at their Meeting in Nicosia in May 2018. This Contingency Plan provides detailed procedures for the cooperation of the competent authorities from the three countries aiming at coordinating actions for prevention, preparedness and response to major incidents of marine pollution from ships as well as from offshore hydrocarbon exploration and exploitation by defining the scope of action of each partner and the coordination and mutual assistant procedures in case of emergencies. Greece has already started the legal procedures in order to ratify the Implementation Agreement.

Moreover, during the 4th Trilateral Summit in Nicosia (May 2018), the three countries have also agreed at Prime-Ministers' level, to exchange best practices and experience gained for capacity building at country level, on processes to adapt and implement the UN Global Sustainable Development Goals (SDGs). In this context, Greece has informally transferred its national experience to Israel in preparing for its first Voluntary National Review (VNR) presented at the 2019 HLPF in New York.

During the 5th Trilateral Summit in Israel (December 2018), it was agreed that an MoU be signed between the three countries on Education including on Education for Sustainable Development in line with the related SDG (SDG 4) provisions.

Finally, during the most recent Trilateral Summit in Israel (December 2021), the three countries have agreed at the highest level to work closely to reinforce their cooperation in meeting the challenge of climate change, through common projects, in the fields of innovative technology solutions, R&D and renewable energy, to promote energy and electricity connectivity through the Euro-Asia interconnector project including transmission of energy, produced by renewables, in line with the outcomes of the UNFCCC COP26 Summit in Glasgow and in preparation of the COP27 to be held in Egypt. They reaffirmed their commitment to further strengthen cooperation on common environmental challenges, with emphasis on water and wastewater management and protection of the marine and coastal environment. In view of the impacts of climate change on the Eastern Mediterranean and the wider Middle East, the three countries expressed willingness to cooperate in the framework of relevant regional initiatives, including through the Cyprus initiative for Coordinating Climate Change Action in the Eastern Mediterranean and the Middle East, and to strengthen cooperation in the field of preparedness and response for emergency situations

Trilateral Cooperation in the field of Environment between Greece – Cyprus – Egypt

The trilateral cooperation was initiated in October 2016 and each year a Summit between the tree Prime Ministers is held in one of the three countries, in rotation, usually with a back-to-back Ministerial Meeting of Environment Ministers. The cooperation is based on the Barcelona Convention and its legal instruments and is intended inter alia to further strengthen their implementation at a sub-regional level.

The thematic areas identified for the trilateral cooperation in May 2017, as issues of common concern, are five, namely (i) preparedness and response to major marine pollution incidents in the Mediterranean; (ii) combating coastal erosion and coastal zone management; (iii) biological diversity and nature protection; (iv) waste management; and (v) climate change adaptation (with emphasis on the exchange of information on monitoring and observation mechanisms, on best practices and on know-how including on climate adaptation indicators and climate adaptation web applications and tools, aiming to create a solid knowledge-base for adaptation approaches tools/methods that can be compatible to all parts).

With regard to the trilateral cooperation on the thematic area on “waste management”, Greece organized and hosted in Athens, in October 2017, a Workshop regarding the operation of “Extended Producers’ Responsibility” systems in Greece that also included field visits to key advanced-technology recycling sites in the area of Attica, in order to provide to the participants from Egypt and Cyprus a practical hands-on experience on such systems’ operation offering important opportunities for the private sector and businesses.

Finally, during the recent Trilateral Summit held in Crete, Greece, in October 2018, an MoU was signed between the three countries on Education for Sustainable Development also in line with the related SDG (SDG 4) provisions.

7.4.1.5 The H2020 CB/MEP programme of capacity building (capacity building activity)

The "Horizon 2020 Initiative" aims to de-pollute the Mediterranean by the year 2020 by tackling the sources of pollution that account for around 80% of the overall pollution of the Mediterranean Sea: municipal waste, urban waste water and industrial pollution. Horizon 2020 was endorsed during the Environment Ministerial Conference held in Cairo in November 2006 and is one of the key initiatives endorsed by the Union for the Mediterranean (UfM) since its launch in Paris in 2008.

To implement and monitor actions three working groups were created to address:

-Specific Investments for Pollution Reduction (PR);

-Capacity Building (CB) for achieving H2020 objectives;

-Review, Monitoring and Research (RMR).

With the launch of the Union for the Mediterranean the geographic scope of Horizon 2020 was expanded to include focal points from Albania, Bosnia & Herzegovina, Croatia (not an EU Member State at the time) and Montenegro. Greece is a member of the consortium of the Capacity Building component of the Horizon 2020 Initiative for the de-pollution of Mediterranean Sea and participates actively in the process of identification of areas within the scope of H2020 where regional capacity building would add value.

Currently we are running in the 2nd working phase of the programme (years 2015-2020). The current activities of the H2020 Capacity Building Sub Group are supported by the EU-funded Sustainable Water Integrated Management – Horizon 2020 Support Mechanism project (SWIM-Horizon2020 SM).

7.4.1.6 Transnational cooperation activities in the LIFE-IP AdaptInGR project

The Hellenic Ministry of Environment and Energy coordinates the LIFE-IP AdaptInGR project that aims to boost the implementation of adaptation policies in Greece. The project is co-funded by the LIFE Programme of the European Union, the Green Fund of Greece and own funds. The project started on 1 January 2019 and will be concluded on 31 December 2026.

Mediterranean and international cooperation activities are foreseen under Sub-Action E2.6 of the project aiming to replicate the results and share the knowledge and experience acquired regarding monitoring adaptation policy implementation, developing climate projections, mainstreaming adaptation across sectoral policies, implementing concrete adaptation projects, etc.

These capacity building and transfer of know-how activities will be facilitated through workshops organized in the second half of the project (2023-2026). Experience sharing and collaboration between Ministry of Environment and Energy and the national adaptation authorities of Non-EU Mediterranean and Balkan countries, will be sought, in a demand-driven approach, in order to step up climate change adaptation and resilience in neighbouring countries that are less advanced in the adaptation process. The project activities are included the Four-Year Strategy of Greece’s Development Cooperation Strategy for the period 2022-2025.

The project provides flexibility regarding the form and the timeline of its knowledge and results sharing activities. The agenda of the workshops and the countries to be engaged will be shaped based on the projects results and the knowledge gaps and needs of the target-countries themselves,

The LIFE-IP AdaptInGR seeks to organize the workshops/activities concurrently with other major events or initiatives for Mediterranean and Balkan countries to ensure enhanced outreach and impact. With regard to the Balkans in particular, the project aims to organize a capacity building workshop in 2023.

To maximize the workshop’s outreach, synergies and collaboration with other related EU projects is sought. The LIFE-IP AdaptInGR project already cooperates with the TRATOLOW project on «Transition towards low emissions and climate-resilient economy in the Western Balkans and Türkiye» funded by the TAIEX (Technical Assistance and Information Exchange) of the European Union. Up to date, adaptation experts of the Ministry of Environmen and Energy have participated in five (5) adaptation-related TRATOLOW TAIEX workshops for capacity building and know-how transfer:

27&28-09-2021: “Regional workshop on synergies between climate change adaptation and disaster risk reduction (Beneficiaries: Albania, Bosnia and Herzegovina, Kosovo*, Montenegro, North Macedonia, Serbia, Turkey)

29-11-2021: “National Workshop on Climate Change Adaptation Policy Cycle, Capacity Building and Reporting Requirements” (Beneficiary: North Macedonia)

22-02-2022: “Expert Mission on Adaptation Policy Cycle, Capacity Building and Reporting Requirements” (Beneficiary: Montenegro)

12-07-2022: “Domestic workshop on Monitoring and Revision of Adaptation Policy and Measures” (Beneficiary: Kosovo*)

04-10-2022: “Regional workshop on Adaptation Reporting under the Energy Union Governance Regulation – practical training” (Beneficiaries: Albania, Bosnia and Herzegovina, Kosovo*, Montenegro, North Macedonia, Serbia and Türkiye)

** Kosovo: This designation is without prejudice to positions on status, and is in line with UNSCR 1244 and the ICJ opinion on the Kosovo declaration of independence*

7.4.2 Bilateral cooperation (technology transfer activities)

Hellenic Aid finances projects in a number of developing countries, aiming to facilitate the access to, or transfer of environmentally sound technologies and to promote the use of RES in developing countries as well as in countries with economies in transition. A number of such projects are listed, on an indicative basis, in ***Table 7.5***.

Table 7.4 Description of selected projects or programmes that promoted practicable steps to facilitate and/or finance the transfer of, or access to, environmentally-sound technologies

Establishment of a Research Center for Renewable Energy Sources at the Technical University of Mombasa, Kenya The Hellenic Ministry of Environment and Energy has taken the decision to support the establishment of a Research Center for Renewable Energy Sources (RES) at the Technical University of Mombasa, in Kenya. The Center will collaborate with Greek universities and research institutions, aiming at capacity building and transfer of know-how to the students of the University. In this context, an amount of 400,000 Euros will be granted to the Technical University of Mombasa covering the relevant expenses for the construction, equipment and operation of the Center for the first 5 years. The amount will also cover a scholarship programme on RES to be designed by the Technical University of Mombasa for local students as well as training programmes and seminars related to RES provided by Greek technical experts, in Mombasa.
Project title: "SYN-ENERGY" **Recipient countries**: Albania, Bosnia-Herzegovina, Croatia, FYROM, Moldavia, Montenegro, Serbia, Georgia, Ukraine **Total funding**: Hellenic Aid: 4.000.000 €/ USAID: 4.000.000€ **Implementation:** Hellenic Center for Renewable Energy Sources (CRES) / International Resources Group/Alliance to Save Energy (IRG/ASE) **Project description:** ▪ Regional assessment of RES ▪ E.E. in residential and public buildings ▪ Strategic planning for RES and E.E. ▪ Capacity building and institutional network development **Technology transferred**: EE and solar equipment, transfer of knowhow in RES and EE
Project title: Applications of Renewable Energy and Energy Saving methods **Recipient Country:** Lebanon **Total funding:** 700.000 € **Implementation:** Hellenic Center for Renewable Energy Sources (CRES) **Project description**: • **Promotion of the use of RES in households, decrease of energy consumption, protection of the environment and strengthening of the national/local economy.** • **Enhancement of business and scientific co-operation between Greece and Lebanon in the sector of RES Technologies.** **Technology transferred:** Solar systems and energy saving lighting equipment for household use in affected regions of South Lebanon, supply and installation of testing and measurement equipment for solar collectors, aiming at the creation of a permanent centre for solar testing.

Project title: Renewable Energy Sources – Development and Implementation of Solar Energy

Recipient country: Armenia

Total funding: 360.000 €

Implementation: Hellenic Center for Renewable Energy Sources (CRES)

Project description:

- Development of a new solar market and cooperation in the sector of RES and EE with Armenia.
- Promotion of the use of RES in Public Buildings, decrease of energy consumption, protection of the environment and strengthening of the national/local economy.

Technology transferred: combi solar thermal systems

Project title: Action Plan for Cooperation in the Field of Renewable Energy Sources
Recipient country: Turkey
Total funding: 456.666 €
Implementation: Hellenic Center for Renewable Energy Sources (CRES)

Project description:

- Development of co-operation in the fields of Solar Energy and other Renewable Energy Sources with Turkey
- Support to the harmonisation of the Turkish Legal Framework of RES to the E.U *acquis*

Technology transferred: Installation of solar & energy savings systems

Project title: Installation of solar systems for household use in poor households in the region of Monaragala
Recipient country: Sri Lanka
Total funding: 290.000 €

Implementation: Athens Network of Collaborating Experts (ACNE)
Project description:
Facilitate/finance access to electricity supply through solar systems, for poor, agrarian families for which electricity supply through conventional technologies is not possible
Technology transferred: solar systems for household use

Project title: MeetMed - Mitigation Enabling Energy Transition in the Mediterranean Region
Recipient Country: South Eastern Mediterranean Countries (Algeria, Bosnia and Herzegovina, Egypt, France, Greece, Italy, Jordan, Lebanon, Libya, Morocco, Palestine, Portugal and Tunisia)
Targeted area: climate change mitigation
Sector: Energy
Source of funding: EU (85%) – Greece (15%)

Years of implementation: 2018-2020
Implementation: Hellenic Center for Renewable Energy Sources (CRES)
Project description:
The Mitigation Enabling Energy Transition in the Mediterranean region (meetMED) project is a two-years EU-funded project, developed by the Mediterranean Association of the National Agencies for Energy Management (MEDENER) and the Regional Centre for Renewable Energy and Energy Efficiency (RCREEE) to support regional cooperation and build technical capacity for energy transition in Southern and Eastern Mediterranean (SEM) countries. meetMED has been officially launched in May 2018 at the headquarters of the Union for the Mediterranean (UfM) in Barcelona, Spain. Its main goal is to foster energy transition in the SEM countries, by enhancing the share of Renewable Energy

Sources (RES) and Energy Efficiency (EE) in their energy mix. The meetMED secretariat is coordinating the implementation of the project, which articulates in four workstreams: 1) assessing EE and RES strategies and policies; 2) advancing vocational training and public awareness; 3) attracting sustainable investments in RES and EE; 4) supporting the UfM Renewable Energy and Energy Efficiency Platform.

Technology transferred:

Energy efficiency and renewable energy technologies

Project title: EU Technical Assistance Facility for the "Sustainable Energy for All" Initiative (SE4All) - Western and Central Africa
Recipient Country: Western and Central Africa
Targeted area: climate change mitigation
Sector: energy
Source of funding: EU

Implementation: Hellenic Center for Renewable Energy Sources (CRES)
Project description:
The general objective is to support the targeted developing countries to improve their policy and regulatory framework conditions aiming at providing attractive and enabling conditions for increased public and private investment in energy access, energy supplies, renewable energy and energy efficiency.

Technology transferred:

Energy efficiency and renewable energy technologies

Project title: EU Technical Assistance Facility for the "Sustainable Energy for All" Initiative (SE4All) - Eastern and South Africa
Recipient Country: Eastern and South Africa
Targeted area: climate change mitigation
Sector: energy
Source of funding: EU

Implementation: Hellenic Center for Renewable Energy Sources (CRES)
Project description:
The general objective is to support the targeted developing countries to improve their policy and regulatory framework conditions aiming at providing attractive and enabling conditions for increased public and private investment in energy access, energy supplies, renewable energy and energy efficiency.

Technology transferred:

Energy efficiency and renewable energy technologies

CHAPTER 8. RESEARCH AND SYSTEMATIC OBSERVATION

8.1 General policy on and funding of research and systematic observation

8.1.1 Summary information on GCOS activities

Systematic observations of the Greek environment started immediately after the Revolution of 1821 and the foundation of the Modern Greek state in 1829.

In 1842, the **National Observatory of Athens**, the first research Institution, was established to promote the observations of astronomical and other parameters of natural science. Its creation followed by the establishment of the two other oldest institutions of higher learning in the modern Greek state, the National Technical University of Athens (1836) and the University of Athens (1837). The construction of the historic Sina's building on the hill of the Nymphs was financed by the Greek entrepreneur and national benefactor Georgios Sinas who was a successful banker in Vienna and ambassador of Greece to Austria. In its 175 years history, the observatory on top of the Hill of the Nymphs (landmark in Athens, facing the Parthenon) has long been used by Greek and foreign Astronomers as the basis for astronomical, meteorological, geoastrophysical measurements and observations. The hill of the Nymphs, selected as the place to build the Observatory, is one of the seven hills of Athens, a sanctuary of the Nymphs in antiquity. It is also next to the Pnyka hill where one of the early Observatories of the 5th century was located and where Meton's Heliotropion was placed. The hill of the Nymphs is aligned with one of the most celebrated and best preserved meteorological/astronomical observatories, the Tower of the Winds, also the emblem of the Royal Meteorological Society. A rough copy of this Tower was built at the University of Oxford. The National Observatory of Athens with its highly-skilled human resources and important infrastructure plays today an important role in research in the fields of Astronomy, Astrophysics, Space applications, Environment, Energy and Meteorology, Seismology, and Geodynamics, at European and international level. NOA, hosts the **UNESCO Chair** for Natural Disasters and the Greek Focal Point of the **Global Earth Observing System of Systems** (GEOSS), operates the National Seismological Network, participates in the **OPTICON** and other international research networks, etc.

Nowadays, the buildings of NOA at Thission include an Astrogeophysics Museum, housing clocks, telescopes and other instruments of the 19th century, as well as an extensive 19th century library. The activities of the National Observatory of Athens are organized in 3 research Institutes: the **Institute of Astronomy, Astrophysics, Space Applications and Remote Sensing**, the **Institute of Environmental Research and Sustainable Development**, and the **Geodynamics Institute**. Besides basic and applied research and services to the society, these Institutes provide the facilities for graduate student training in collaboration with other Greek and foreign Universities.

- The **Institute for Astronomy, Astrophysics, Space Applications and Remote Sensing (IAASARS)** of the National Observatory of Athens (NOA) was the first research Institution of Greece founded in **1842**. The present structure of Institute for Astronomy, Astrophysics, Space Applications and Remote Sensing (IAASARS) was established in March 2012, by the merging of two independent institutes of the National Observatory of Athens (NOA): The Institute of Astronomy and Astrophysics (IAA) and the Institute for Space Applications and Remote Sensing (ISARS). IAA evolved from the old Astronomical Institute, which was founded as a discrete section of NOA in 1890, together with the Meteorological and Seismological institutes. It carried-on the tradition of ground-based observational astronomy that commenced with the construction of the Observatory of Athens in 1842, but also expanded it to modern research fields such as space observational astrophysics. ISARS had also evolved from the old Ionospheric Institute, which was founded in 1955.

- **Geodynamics Institute** (G.I.) is one of the oldest Institutes in Greece operating continuously since 1893. In 1897 the first seismograph was installed in Athens and in 1899 the first seismic network started to operate. Since then, systematic and detailed seismic observations started for the region extending from 34° to 42° N and 19° to 30° E. The location of the Head Office of I.G is on the hill of Nymphs. It is the main center in Greece, for the continuous monitor of the seismicity of the country and reporting to national and international authorities. Moreover Institute’s aim is the study and research in the fields of: seismology, physics of the earth's interior, geophysics, plate tectonics, volcanology and geothermy, neotectonics, tsunamis, seismotectonics. and Strong Motion and Engineering Seismology
- The **Institute of Environmental Research and Sustainable Development (IERSD)** is one of three Institutes of the National Observatory of Athens, the first Research Centre in Greece and the Balkans. Initially named as Meteorological Institute (MI), it was established in 1846 while the first meteorological observations began in 1858. IERSD holds the longest and most complete climatological records in Greece, spanning a 150-yrs period. It constituted the first official Meteorological Service of Greece, operating almost all meteorological stations of the existing network until 1931, when the National Meteorological Service was founded. Besides climatic records, IERSD holds a historical record of atmospheric ozone data, monitored from 1900 to1940, which is unique for Southeastern Europe. Milestone to the evolution of the Institute was the study of atmospheric pollution, well before its evident appearance in Athens, through the systematic monitoring of classical pollutants with a network of six stations. The network was passed to the Ministry of the Environment in 1984 and formed the basis of the National Network for the Monitoring of Atmospheric Pollution. In 1986, the Institute was renamed as 'Institute of Meteorology and Physics of the Atmospheric Environment' (IMPAE), incorporating in its main activities physics of the atmospheric environment and solar and wind energy, in addition to meteorology and climatology. In parallel, it extended its laboratory and instrumentation facilities, intensified its research efforts with collaboration with numerous Greek and foreign universities and research centers, and continued to provide services to ministries, local authorities and the private sector. In 1999 the Institute was renamed as Institute for Environmental Research and Sustainable Development (IERSD), in response to the modern environmental challenges for a sustainable future. Its activities expanded further towards the study of impacts of development on the environment, climate change, hydrology & natural resources management, air quality and energy saving. Currently, IERSD with its research and consultancy activities has managed to become the national "focal point" for environmental issues and further aims at increasing its competitiveness and added value services in the national economy, environment and society.

NOA established the **first National Network** of meteorological stations in **1894**, deployed over the country. The main infrastructure of NOA distributes as follows:

1. **Meteorological and Actinometric Network**

The extensive meteorological network of almost **260 fully automated meteorological stations**, established by IERSD all over Greece, offers to the public, in almost real-time (data refreshment every 10 min), information about prevailing meteorological conditions. Meteorological parameters that are presented are the following: Air temperature (ºC) and relative humidity (%), Atmospheric pressure (hPa), Wind speed (m/s or Km/h) and wind direction (deg.), Total precipitation (mm) (rainfall, snow, or hail). In selected meteorological stations, the incoming total solar radiation (W/m²) and ultra-violet (UV) radiation (W/m²), incident at a horizontal surface, are also provided to the public.

The expanding network of **radiometric stations** includes **two stations within Attica region**, the historic radiometric station in Thissio and the newest in Penteli, but also **six more stations scattered throughout Greece:** in Klokotos (Trikala), in Larissa (Thessaly), in Methoni (Messinia, South Peloponnese), in Filotas (Florina), in Andros island (Cyclades) and in Antikythira island. Also included is another high altitude station (at 2340 m) in Neraidorahi site of Helmos mountain in Kalavryta (Achaia).

2. **PANGEA-PANhellenic GEophysical observatory of Antikythera**

The PANGEA project sets the baseline for NOA to fulfill its strategic goal for the establishment of the "PANhellenic GEophysical observatory of Antikythera (PANGEA)", following the monitoring standards of the Global Atmosphere Watch of the World Meteorological Organization (GAW/WMO). The island of Antikythera has been selected for PANGEA due to the fact that the geographic area is considered representative of the broader region in the Mediterranean since it is not affected by nearby anthropogenic activities. Furthermore, Antikythera is a significant location for monitoring the Hellenic Subduction Zone, a critical plate-boundary in southeast Mediterranean, along which the African and Eurasian plate converge. All the above make Antikythera an ideal natural laboratory, which at the same time is strategically located in an area that intercepts severe weather phenomena. In terms of temporal characteristics, the extended Mediterranean region around Antikythera underlies a rapidly changing environment, recognized by IPCC as one of the most sensitive and vulnerable to climate change regions on Earth.

The PANGEA Observatory, after the relevant decision of NOA's Board of Directors (BoD), is being directed by a Provisional Committee (development team), led by the Director of NOA (Prof. Manolis Plionis), consisted by the directors of the 3 NOA Institutes (Prof. N. Michalopoulos, deputy director Dr. G. Drakatos and Dr. S. Basilakos) and the Scientific Committee SC which consists of one expert researcher from each of the three relevant to the PANGEA Research Entities (Dr. V. Amiridis – Head of the SC, Dr. C. Evangelidis and Dr. K. Bougatioti). This committee leads the development of the PANGEA Observatory on Antikythera Island, by coordinating the efforts of completion of the building and the procurement of the research equipment.

3. **Accelerometers Network**

The Institute of Geodynamics has been op**erating a permanent strong motion network since 1972**. The main turn points of the history of this network are the beginning of its deployment in 1972 by the installation **of 15 analogue SMA-1 type accelerographs** – the first ever used in Greece -, the increase of the installed instruments to 40 in 1986 and the gradual use of digital instruments of A-800 type since 1995. By the end of 2008 the installed instruments (A800/A900, QDR, ETNA and CMG-5TD) **reached the number of 85** after the financial support of the State or within the frame of scientific projects. At that time, Earthquake Planning and Protection Organization supported financially NOAIG and ITSAK for the deployment and the initial operation of the National Strong Motion Network. Via this project NOAIG **purchased more than 80 modern 24-bits accelerographs of CMG-5TD type**, doubling in such a way the number of the installed instruments. T**he majority of the instruments are located in urban complexes, taking into account the population density and the seismicity of the Greek territory.** Local strong motion arrays are also developed in some cities. The most important of these is the one covering the broader area of Athens. Limited number of instruments are installed at archaeological (Athens' Acropolis) or historical sites. The **telemetric connection** of the installed instruments, which is in progress during the last years, improve the reliability of the network.

4. Seismic Network

The Seismic Network is operated by the Institute of Geodynamics. The service to monitor seismicity in Greece and the adjacent region has started back in 1893 with the first seismic network operating five stations. In 2000, a large upgrade towards digital monitoring with broadband stations was initiated. Today, the Hellenic Unified Seismic Network (HUSN), with Institute of Geodynamics as coordinator and the three University Seismic Networks (Athens, Thessaloniki and Patras) as partners, provides seismological data in near real time from more than 150 stations.

5. Helmos Observatory – "Aristarchos" 2.3m telescope

Helmos Observatory is situated on "Neraidorachi", a mountaintop of the Helmos mountain chain in the Peloponnese. The site is 2340 m above sea level, 220 km southwest of Athens, and is one of the darkest places in continental Europe. Helmos Observatory hosts the "Aristarchos" telescope, an optical telescope designed and manufactured by the german company Carl Zeiss GmbH. The main characteristic of this telescope is its 2.3 m mirror which, combined with the super-sensitive detectors that the telescope is equipped with and the good atmospheric conditions of the site, makes it a very valuable tool for observing astronomical objects, even very faint and very distant objects located in the outskirts of the Universe.

6. Kryoneri Observatory

Kryoneri Observatory (established in 1972) is located in the district of Corinth in the northern Peloponnese at the top of mount Kyllini, close to Kryoneri village. It is equipped with a 1.2 m Cassegrain reflector telescope manufactured and installed in 1975 by the British company Grubb Parsons Co., Newcastle. It is one of the largest telescopes in Greece, with many successful scientific observations during its long operation (scientific observations started in 1975). In 2016, the telescope was upgraded in the framework of the ESA program NELIOTA, to monitor the lunar surface for impacts of near-earth objects.

To that end, several services provided to the public and multiple data are available upon request from NOA.

Weather forecasting: Operational weather forecasting is presented to the public through the popular web page www.meteo.gr (in greek) as well as through the English web page www.noa.gr/forecast. Meteo.gr provides 6-days weather forecasts for 500 cities across Greece, together with UV forecasts. Moreover, interactive map provides detailed wind and wave forecasts for the Greek Seas.

Solar ultraviolet (uv) index forecasting for Greece: The UV index is an internationally defined expression of the risk of solar ultraviolet radiation to humans and the ecosystem. The calculation of the UV index forecast is presented daily from the Institute for Environmental Research and Sustainable Development of the National Observatory of Athens. The methodology used includes a radiation transfer model with input parameters such as the solar zenith angle, cloud cover forecast, total column ozone forecasting (KNMI / ESA), the long-term climatology of aerosols from satellite measurements, ground albedo and altitude for each sub-region of the map below. Website: http://www.meteo.gr/meteoplus/uv.cfm Information related with the effects of UV radiation on health (dermatological effects, melanomas, cataracts, vitamin D), effects on plants (photosynthetic capacity) and marine ecosystems are also provided.

Meteorological observations: The extensive network of almost 260 fully automated meteorological stations, established by IERSD all over Greece, offers to the public, in almost real-time (data refreshment every 10 min), information about prevailing meteorological conditions. Meteorological parameters that are presented are the following: Air temperature (ºC) and relative humidity (%), Atmospheric pressure (hPa), Wind speed (m/s or Km/h) and wind direction (deg.), Total precipitation (mm) (rainfall, snow, or hail). In selected meteorological stations, the incoming total solar radiation (W/m²) and ultra-violet (UV) radiation (W/m²), incident at a horizontal surface, are also provided to the public. Real-time measurements of the above meteorological parameters are widely available to the public through the following WEB links: www.meteo.gr/meteosearch. All meteorological observations and measurements are automatically saved in the database for further statistical analysis.

Actinometric observations: The expanding network of radiometric stations includes two stations within Attica region, the historic radiometric station in Thissio and the newest in Penteli, but also six more stations scattered throughout Greece: in Klokotos (Trikala), in Larissa (Thessaly), in Methoni (Messinia, South Peloponnese), in Filotas (Florina), in Andros island (Cyclades) and in Antikythira island. Also included is another high altitude station (at 2340 m) in Neraidorahi site of Helmos mountain in Kalavryta (Achaia). At all of the above stations, the intensity of the total incoming solar radiation (in W/m2) incident at a horizontal plane is recorded, in five of them the diffuse solar component (in W/m2) is recorded in parallel, while in four of them the duration of sunshine duration (in minutes) is also measured. Both radiometric stations at Thissio and Penteli sites also record the intensity of the incoming Ultra-Violet solar radiation (Total UV, UV-A, UV-B, in W/m2) as well as the intensity of the natural daylight (in Lux) (Total and Diffuse components). Furthermore, all basic meteorological parameters such as air temperature (oC) and relative humidity (%), atmospheric pressure (hPa), wind speed (m/sec) and direction (degrees) and total precipitation (mm) (rainfall, snow, hail) are recorded in parallel. Real-time measurements of the above actinometric and meteorological parameters are widely available to the public through the following WEB link: www.iersd.noa.gr/WeatherOnLine. For each parameter presented, the historic daily fluctuation is also available throughout the WEB-page for a period of 10 days. All meteorological observations and measurements are automatically saved in the database for further statistical analysis.

Severe weather monitoring and nowcasting: The Weather Radar Group operates unique equipment for the in situ measurement and remote sensing of rainfall, which includes a mobile weather radar, a 2D video and a Parsivel disdrometer and a network of rain gauges with data loggers. The system can provide monitoring and nowcasting of localized severe weather events (intense rain and hail storms, tornadoes) for distances up to 100 km.

In view of the **geography of Greece** (18400 km of coastline, 9835 islands), and the historical preoccupation with the sea (fishing, trading and shipping), the **Hellenic Navy Hydrographic Service (HNHS)** which was firstly organized as a Hydrographic Office of the Hellenic Navy, in 1905. Since then, the HNHS continues to provide its products and services to the mariners sailing the Greek Seas and systematic observations of currents, salinity, sea surface temperature and other sea state marine parameters. HNHS is the official hydrographic organization of Greece. It is an independent agency of the Hellenic Navy (HN), based in Attica and accountable directly to the Chief of the Hellenic Navy General Staff. It has its own seal and emblem, which are used in all its publications. HNHS personnell represents the country at the International Hydrographic Organization (IHO), participating in its conferences, committees and working groups, as well as participates in various international civilian and military organizations, on matters related to its work and mission.

The history of the **Hellenic Centre for Marine Research (HCMR)** begins in 1912 when the Greek Government decided to establish an institute that would focus on the study of the marine environment. The Italian Professor D. Vinciguerra, that was invited to offer his services as a consultant, proposed the creation of a Marine Hydrobiological Station, that was finally established in 1914 at Paleo Faliro. In 1915, the Marine Hydrobiological Station begun to conduct fisheries and marine biological studies. In 1948, it changed its name to Fisheries Research Laboratory and placed under the supervision of the Ministry of Agriculture. After the Second World War (1945), the Greek Hydrobiological Institute of the Academy of Athens was founded. This Institute, based in Piraeus, incorporated in 1947 the Hydrobiological Station of Rhodes, which had been founded by the Italians in 1934, as Reale Istituto di Ricerche Biologiche di Rodi. At the same time, a small boat named “GLAFKI” was converted to a research vessel that, in 1946, conducted its first three oceanographic voyages. The “GLAFKI” was replaced, in 1948, by the research vessel “ALCYON”. In 1965, the Hydrobiological Institute of the Academy of Athens, together with the Fisheries Research Laboratory, were incorporated to the newly established Institute of Oceanographic and Fisheries Research (I.ΩK.A.E.), which became operational in 1970. In 1985, under Law 1514, the National Centre for Marine Research (NCMR), the successor of I.ΩK.A.E., was established and placed under the supervision of the General Secretariat for Research and Innovation (GSRI) of the Ministry of Industry, Energy and Technology (currently under the Ministry of Education and Religious Affairs). In 1985, the oceanographic vessel ” Aegean” of NCMR, which was then the main research body for marine science in Greece, was built in the shipyards of Chalkis. In 1987, the Institute of Marine Biology of Crete (IMBIC) was founded in Heraklion, Crete. The IMBIC grew rapidly and, with its research vessel “PHILIA”, contributed significantly to the scientific fields of marine biology, fisheries and aquaculture. In 2003, under Law 2919/2001 “Linking Science and Technology with Production”, the Hellenic Centre for Marine Research (HCMR) was established, through the integration of the National Centre for Marine Research (HCMR) and the Institute of Marine Biology of Crete (IMBIC). HCMR consisted then of five research Institutes, i.e. the Institute of Oceanography (IO), the Institute of Aquaculture (IA), the Institute of Marine Biology and Genetics (IMBG), the Institute of Marine Biological Resources (IMBR) and the Institute of Inland Waters (IIW). In 2012, IMBR and IIW were merged to form the **Institute of Marine Biological Resources and Inland Waters (IMBRIW)**. Dr Economou served as first acting director of the newly founded IMBRIW, while its current director Prof. Stergiou was elected in April 2013 but officially assumed his duties on the 4th of November 2013. **Currently IMBRIW is now Greece’s largest public institution studying marine biological resources and inland water environments.**

NCMR and its parent entities had a long tradition in fisheries research and a small but dynamic organization of fisheries researchers have been working since the beginning of the 20th Century. Research in inland waters was late in coming to Greece, and NCMR’s institute of Inland waters (IIW) was the first such entity in any academic or governmental organization. However, a distinguished group of researchers and associates studied inland water themes at the parent institutions at least since the late ‘70s. The actual establishment of the IIW took place in 1994, when the provisions and procedures dictated by the Law (1514/85) were completed with the election of the Institute’s first director. Both parent institutes of **IMBRIW** focused on fish-related work, aquatic resource management, wider environmental assessments and biodiversity conservation. A remarkable increase in research and development took place after the mid-nineties in both fisheries and inland waters. The policy-relevant research was boosted by major Environmental EU Directives (e.g. work within the framework of the Birds and Habitats Directives- BHD, and slightly later the Water Framework Directive- WFD). IMBRIW also works closely with the other Institutes of HCMR. HCMR’s public outreach capacity increased greatly when in December 2005, the Cretaquarium in Heraklion was opened, one of the largest aquariums in Europe.

Cooperation between **ESA** and the **Hellenic National Space Committee** began in the early 1990s and **in 1994** Greece signed its first cooperation agreement with ESA. This led to regular exchange of information, the award of fellowships, joint symposia, mutual access to databases and laboratories, and studies on joint projects in fields of mutual interest. In **September 2003 Greece formally applied to join ESA**. Subsequent negotiations were followed in the summer of 2004 by the signing of an agreement on accession to the ESA Convention by Jean-Jacques Dordain, ESA Director General on behalf of ESA, and by Dimitris Sioufas, the Minister for Development, on behalf of the Greek Government. Greece already participates in ESA's telecommunication and technology activities, and the Global Monitoring for Environment and Security Initiative (GMES). With the deposition of its instrument of ratification of the Convention for the establishment of ESA with the French Government on 9 March 2005, Greece becomes the 16th ESA Member State. The ESA activities are at present coordinated by the General Secretariat for Research and Innovation (GSRI) of the Ministry of Education and Religious Affairs.

The network of systematic observation of climatic parameters in Greece includes the **Hellenic National Meteorological Service (HNMS), services of the Greek Armed Forces**, the **Ministry of Rural Development and Food**, the **Ministry of the Environment and Energy (MEE)**, **Ministry for Climate Crisis and Civil Protection** as well as a number of national research centers. Furthermore, the **Public Power Corporation of Greece (PPC)** operates a network of meteorological stations in the vicinity of its thermal and hydro power plants and dams for electricity production.

8.1.2 General policy on and funding of research (and systematic observation)

The **General Secretariat for Research and Innovation (GSRI)** of the Ministry of Education and Religious Affairs (*until 10/8/2012 the Secretariat was working under the Ministry of Development, Competitiveness, Infrastructure, Transport and Communications*) is the responsible institution for supporting and promoting research in Greece. In specific, GSRI is a modern public service assigned with the task of defining, as well as coordinating the implementation of, the national policy for Research, Technological Development and Innovation. It supports the activities of research and industry bodies through competitive research programmes highlighting economic performance and a socially fair allocation of outcomes. Furthermore, it supervises research and technology bodies, which provide local communities with the skills necessary for producing knowledge and boosting innovation. GSRI actively follows EU and international developments in the field of RDI and represents the country to the EU and International Organisations within its competence.

In the face of the current economic conjecture, investing in science, research and technology becomes a key strategic priority towards a socially and economically sustainable model of development, based on highly-qualified human resources and novel ideas.

The GSRI mandate consists in:

- Defining and promoting a comprehensive strategy for research, technology and innovation;
- Fully exploiting the highly-qualified research staff to boost economic growth, generate new employment and reverse the current trend of expert Greek scientists migrating abroad;
- Transferring and facilitating the uptake of innovative technologies by the country's industry, through targeted use of research outcomes;
- Supporting initiatives to raise awareness among Greek people in the fields of Research and Technology;
- Supervising and funding Research and Technology Bodies across the country;

- Promoting international S&T cooperation with EU and third countries and making best use of the opportunities to participate in relevant EU, bilateral and international initiatives.
- Evaluating the outcomes of research & innovation projects, with a view to adjusting research policy on an ongoing basis.
- Encourages and promotes the international outreach of Greek R&D entities through bilateral cooperation programmes, establishing strategic partnerships with other countries. In parallel, GSRI also supports R&D cooperation with International Organizations (ESA, CERN, EMBL etc.).
- Represents Greece to the relevant Institutions of the European Union, promoting dialogue and synergies with International R&D activities.
- Supports the national human research potential and develops strategies to confront brain drain through specific programmes for young researchers.
- Promotes creation of jobs in businesses for young, highly qualified scientists aiming to confront unemployment and to boost innovation within the business sector.
- Initiates and supports specific actions aiming to enhance public awareness and understanding of science towards the Greek society and beyond.
- Monitors research policy implementation and organizes evaluation and impact assessment of RTDI policies.
- Compiles Science & Technology indicators at national and regional levels.

GSRI actively involved in both the preparation and implementation of the country's development planning for the 2014-2020 period, as it is responsible for Thematic Objective 1 «Strengthening research, technological development and innovation».

Its role consists mainly in:

✓ Drawing-up the country's comprehensive strategic development plan for the 2014-2020 period, namely the Partnership Agreement (PA), i.e. the «new NSRF» for 2014-2020, in the field of Research, Technological Devenopment and Innovation (RTDI). More specifically, its tasks include:
    - Developing, in the context of the Partnership Agreement, the Research and Innovation Smart Specialisation Strategy (RIS3), which is an ex ante conditionality for receiving ERDF funding for investments in research, technological development and innovation during the 2014-2020 programming period. This strategy is defined simultaneously in both the national and regional levels, through interaction and synergies between the two levels, co-ordinated by the Special Service for Strategy, Planning and Evaluation (EYSSA), with the GSRI bearing scientific responsibility. A key tool for drawing-up the Strategy is the so-called Entrepreneurial Discovery, namely the identification of entrepreneurial opportunities by acknowledging the potential offered by research and innovation and turning this potential into a competitive advantage. The Smart Specialisation Strategy document was approved by the Council for the Smart Specialisation Strategy and the European Commission in August 2015.
    - Developing a Multiannual Financial Plan for Research Infrastructures, which will highlight the country's priorities for long-term investments in large-scale research infrastructures, in alignment with RIS priorities and taking into account the regional impact of these investments.
    - Updating and adapting the above through active and open monitoring and evaluation procedures throughout the 2014-2020 programming period.

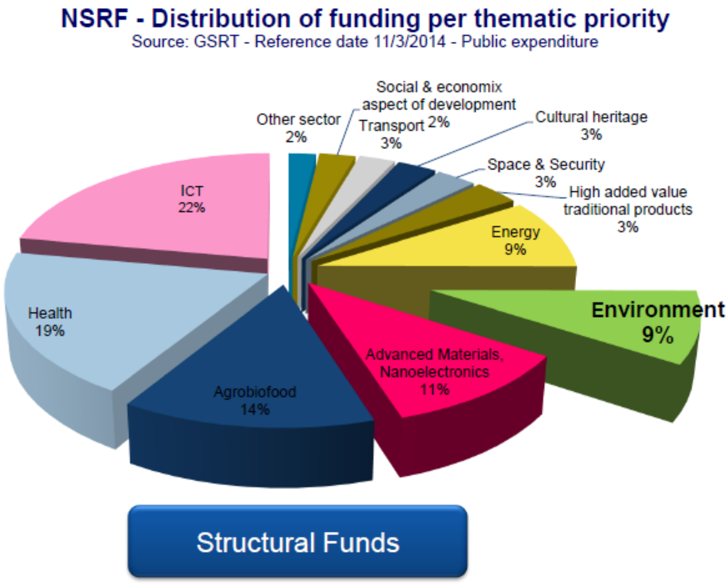
- ✓ Drawing up the Operational Plan(s) in the field of Research, Technological Development and Innovation, intended to be the main financing instrument for RTDI activities during the 2014-2020 period.
- ✓ Implementing and assessing Research, Technological Development and Innovation activities in the context of the various 2014-2020 operational programmes.

The main funding sources in the research sector in Greece include public and private funds. Public funds include the funds provided by the national budget, funds by the Programme of Public Investments, Structural Funds and also the European Commission's funds.

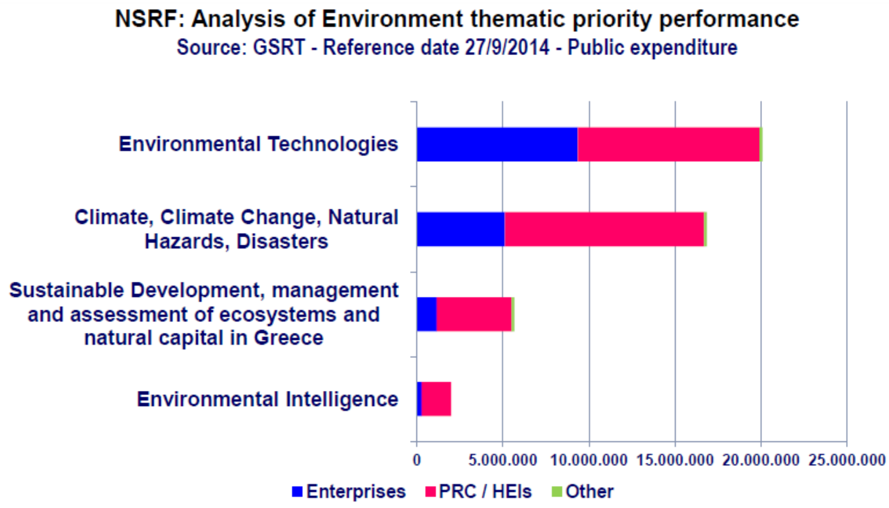
For 2019 the Gross Domestic Expenditure on R&D (percentage of GDP) is estimated at 1.27%, while 41.1% has been funded by the State and the 41.4% by the Business Enterprise sector (EUROSTAT, 2021 / data for 2019, https://ec.europa.eu/eurostat/databrowser/view/sdg_09_10/default/table?lang=en,https://ec.europa.eu/eurostat/statistics-explained/index.php?title=R_%26_D_expenditure#R_.26_D_expenditure_by_source_of_funds).

Funds that derive from the regular national budget, on an annual basis and a more limited range than the ones of the Programme of Public Investments, concern principally the covering of the operational need of Universities and National Research Centres (including the conservation and operation of the GCOS network whenever applicable).

Funding of the last programming period (2014-2020) per sector is summarized in the Figure below.



Programmes that are funded from Structural Funds are included in the European Commission's Support Frameworks and are managed by the Ministry of Finance. The main means of European Funds in the area of Research are the Framework Programmes for the period 2002-2013 was the 6th and 7th Framework Programmes. The 6th Framework Programme (6th FP) started in 2002 and completed in 2006, providing about 419 MEuros to the Greek research. The sector of "Sustainable Development, Global Change and Ecosystems" has been one of the more successful in Greece and received more than 59 MEuros. The 7th Framework Programme for Research and Technological Development (7th FP), has started in 2007 and will be completed by the end of 2013. Until February of 2012 the Greek research organisations have obtained contributions of about 635 MEuros, through the 7th FP. According to data of March 2014 Total Funding of Greek participants was 974 Mio. €, with an SME Funding of 15% and a participation of 3587 Greek participants. The figure below summarises the thematic priorities.



Programming Period 2014-2020:

The Strategy for Smart Specialization constitutes the main guidance for defining and promoting the Research and Innovation Policy for the programming period 2014-2020. It highlights areas where Greece has already achieved, or can achieve, a competitive advantage. Priorities emerge as a result of the so-called entrepreneurial discovery process aimed at identifying new business opportunities to put into use newly-produced knowledge and integrate it into value chains. This process is carried out through continuous and active consultation of all actors involved in the innovation “ecosystem” (including private enterprises, higher education institutions and research centers, ministries, regional authorities, etc.), with private enterprises and the industry at large also playing a central role. All the topics within RIS3 are available at this link (https://www.espa.gr/en/pages/staticRIS3.aspx)

Actions planned by GSRI in each of the RIS3 areas are aimed at developing innovative products and services, transferring knowledge, supporting research staff and further developing and using research infrastructure. The European dimension (synergies and complementarity with the “Horizon 2020” strategy and other activities within the European Research Area) is strongly promoted. Top priorities also include fostering an innovation culture and broadening the participation of social partners in research institutions.

In Greece, one national and 13 regional research and innovation strategies for smart specialization were implemented. The national strategy was drawn up by the General Secretariat for Research and Innovation (GSRI) of the Ministry for Education, Research and Religious Affairs, whilst each Region was responsible for preparing its own strategy. The Special Service for Strategy, Planning and Evaluation (EYSSA) of the Ministry of Economy, Development and Tourism coordinated the entire process. The investigation made during the preparation of the National Strategy resulted in the identification of eight sectors, in which research and innovation could contribute to developing an important competitive edge, whilst the critical mass and excellence of the research potential were also taken into account.

Key research, where Greek research organisations actively participate under the FP7 is described below according to thematic subject:

CLIMATE PROCESSES, OBSERVATIONS AND PROJECTIONS

- ENSEMBLES — Ensemble based Predictions of Climate Changes and their Impacts
- COMBINE — Comprehensive Modelling of the Earth system for better climate prediction and projection
- IS-ENES — InfraStructure for the European Network for Earth System Modelling
- IPY-CARE — Climate of the Arctic and its Rolefor Europe (CARE) — A European component of the International Polar Year

- WATCH — Water and Global Change
- DAMOCLES — Developing Arctic Modelling and Observing Capabilities for Long-term Environmental Studies
- EURO ARGO, Global Ocean Observing Infrastructure

CLIMATE INTERACTIONS WITH STRATOSPHERIC OZONE
- THE MAIN AIM QOS2004 — Quadrennial Ozone Symposium 2004
- SCOUT-O3 — Stratosphere-Climate Links with Emphasis on the UTLS

CLIMATE INTERACTIONS WITH ATMOSPHERIC COMPOSITION CHANGE
- ACCENT — Atmospheric Composition Change: A European Network
- EUCAARI — European Integrated Project on Aerosol Cloud Climate and Air Quality Interactions
- MAP — Secondary Marine Aerosol Production from Natural Sources
- OOMPH — Organics over the Ocean Modifying Particles in both Hemispheres
- CITYZEN — megaCITY — Zoom for the Environment
- MEGAPOLI — Megacities: Emissions, urban, regional and Global Atmospheric POLlution and climate effects, and Integrated tools for assessment and mitigation
- AIR4EU — Air Quality Assessment for Europe from Local to Continental
- GEOMON — Global Earth Observation and Monitoring
- COPAL — Community heavy-payload long endurance instrumented aircraft for tropospheric research in environmental and geo-sciences
- EARLINET ASOS — European Aerosol Research Lidar Network: Advanced Sustainable Observation System
- EUSAAR — European Supersites for Atmospheric Aerosol Research

CLIMATE CHANGE IMPACTS
- EURO-LIMPACS — Integrated Project to Evaluate the Impacts of Global Change on European Freshwater Ecosystems
- GENESIS — Groundwater and Dependent Ecosystems: New Scientific Basis on Climate Change and Land-Use Impacts for the Update of the EU Groundwater Directive
- HERMIONE — Hotspot Ecosystem Research and Man’s Impact on European seas
- ESCAPE — European Study of Cohorts for Air Pollution Effects
- QUANTIFY — Quantifying the Climate Impact of Global and European Transport Systems
- CECILIA — Central and Eastern European Climate Change Impact and Vulnerability Assessment
- CIRCE — Climate Change and Impact Research: the Mediterranean Environment
- EDEN — Emerging diseases in a changing European environment
- CLIMATE FOR CULTURE — Damage Risk Assessment, macroeconomic Impact and Mitigation for Sustainable Preservation of Cultural Heritage in the Times of Climate Change
- MESMA — Monitoring and Evaluation of Spatially Managed Areas

CLIMATE RELEVANT PROJECTS ON NATURAL HAZARDS AND EXTREME EVENTS
- XEROCHORE — An Exercise to Assess Research Needs and Policy Choices in Areas of Drought
- HYDRATE– Hydrometeorological data resources and technologies for effective flash flood forecasting

- SafeLand — Living with landslide risk in Europe: Assessment, effects of global change, and risk management strategies
- ENSURE — Enhancing resilience of communities and territories facing natural hazards.

CLIMATE CHANGE ADAPTATION, MITIGATION AND POLICIES

- ClimateCost — Full Costs of Climate Change
- MEECE — Marine Ecosystem Evolution in a Changing Environment
- ADAGIO — Adaptation of agriculture in the European regions at Environmental risk under climate change
- SERPEC-CC — Sectoral Emission Reduction Potentials and Economic Costs for Climate Change
- SAFEWIND — Forecast with emphasis to extreme weather situations for a secure large-scale wind power integration.

For the running Programming Period 2014-2020, the European Union gives particular emphasis on the great potential of Education, Research & Innovation to increase competitiveness, setting eventually the knowledge triangle as major priority of Europe 2020 strategy (through a knowledge economy for growth and jobs). Thus, for 2014-2020, a considerable part of Structural Funds focuses on Research & Technological Development (RTD) activities (circa €86 billion), while around €80 billion are expected in RTD competitive calls in Horizon 2020.

Research, Technological Development and Innovation (RTDI) as a common system, form one of the five major strategic objectives of the new Cohesion Policy Period 2014-2020.

In this regard it is worth mentioning that GSRI:

- Works closely since its foundation with the relevant Directorates in European Commission, actively participating in shaping the RTDI component of the Framework Programmes that Greece has been part of since the '80s.
- Promotes R&D extraversion representing the country in International Organizations and implementing Bilateral Programmes with border or other countries of strategic importance.
- Participates in various international Committees and Councils, European Union's Competitiveness Council among them, while it is the sole public Authority bearing liability for handling the related dossiers for Research and Space sectors.
- Formulates the new National Strategic Framework for Research and Technology, identifying and analyzing regions' RTDI specific needs and problems.
- Aims at regional development through Smart Specialization, through launching participatory processes involving its own ecosystem, i.e. Research Centers, Universities, high-tech companies, along with Regions and Ministries.
- Develops coherent policies for Research, Technological Development & Innovation that provide the basis for a broader and more permanent cooperation platform amongst all stakeholders thus safeguarding complementarity of activities and avoiding overlaps.
- Supports the creation of critical mass RTDI resources and builds on the specific assets and potentialities of the regions, key prerequisites in essence for the development of innovative technologies and value-added products and services that can compete in global markets.
- Is the Public Authority implementing Thematic Priority 1 (Research & Innovation), appointed by the Ministry of Development & Infrastructures / Secretariat General for Public Investments, the latter being in charge for drafting the Operational Programmes and for managing Structural Funds for Cohesion Policy.

- Has become responsible for the Research & Innovation Strategies for Smart Specialisation (RIS3), an ex-ante conditionality for future Cohesion Policy investments.
- Either as intermediate or as final beneficiary, it manages considerable public funds, especially those related to the National Strategic Reference Framework (NSRF) or to various Operational Programmes (Sectoral & Regional) and European Funds.
- Has managed the total state funding for the period 2007-2013 amounting to 1.7 billion Euros [Regular State budget + Public Investment Programs (PIP) that co-fund Research Technology and Innovation projects under the National Strategic Reference Framework.
- GSRI supervises National Research Centres and Technological Institutions, geographically distributed in Greece:
    - Athena Research & Innovation Center in Information, Communication and Science Technologies
    - Biomedical Research Foundation of the Academy of Athens (BRFAA)
    - Biomedical Sciences Research Center "Alexander Fleming" – BSRC Fleming
    - Centre for Nuclear Research, Demokritos
    - Centre for Research and Technology Hellas / CERTH
    - Foundation for Research and Technology - Hellas (FORTH)
    - Hellenic Centre for Marine Research / HCMR
    - Hellenic Pasteur Institute
    - National Hellenic Research Foundation / NHRF
    - National Observatory of Athens (NOA)
    - National Centre for Social Research (EKKE)

GSRI's role is particularly critical in the current circumstances and its obligations are high. Therefore, capitalizing on its organizational structure and accumulated know-how, as well as strengthening its policy-making and programme management & administration capacities, is absolutely essential.

Programming Period 2021-2027:

The Commission has adopted the first Partnership Agreement for the 2021-2027 programming period for Greece, the first EU country to submit its strategic reference document for deploying more than €21 billion of investments for its economic, social and territorial cohesion. The Partnership Agreement lays out the strategy and investment priorities to be addressed via the Cohesion policy funds and the European Maritime Fisheries and Aquaculture Fund (EMFAF). These funds will support key EU priorities such as the green and digital transition and will contribute to develop a competitive, innovative and export-oriented growth model for the country.

In total, the Partnership Agreement comprises 22 programmes: 13 regional and 9 national. The 13 regional programmes (combine European Regional and Development Fund - ERDF and European Social Fund Plus) and correspond to each administrative region in Greece. Greece is strongly committed to the coordinated use of the Cohesion policy funds with the Recovery and Resilience Facility. **A new Capacity Building programme** will also facilitate the project preparation process and help strengthen the administrative and organisational capacity of beneficiaries and authorities.

Greece has planned significant investments **- 30% of the ERDF and 55% of the Cohesion Fund - in energy efficiency and reduction of carbon emissions, as well as in waste and water management measures.** The **development of sustainable public transport** will be pursued in Attica and Thessaloniki and expanded to further agglomerations throughout the country. Moreover, a new governance mechanism will allow **more investments in the protection of biodiversity**. Greece has also taken a str**ong political commitment of closing**

down all the lignite power plants by 2028, thus contributing significantly to the EU and national climate neutrality targets. **Finally, the Partnership Agreement marks a shift away from the road investments in favour of multi-modal and more sustainable modes of transport**.

8.1.3 International cooperation

European Territorial Cooperation Programmes (ETC) are a key tool for strengthening the territorial cooperation both in the European context and with third countries and constitute one of the main options for the programming period 2014-2020.

The European territorial cooperation at the level of the European Union member states is implemented through cross-border, transnational and interregional cooperation programmes. These programmes are either bilateral or multilateral.

The bilateral ETC programmes aim to tackle common challenges that border regions face, to exploit growth potential and of course to strengthen cooperation in the interests of the harmonious progress of the Union. The bilateral ETC programmes between Greece and neighboring countries are:

- Interreg V-A "Greece - Cyprus 2014-2020" Programme (Total EU contribution: 48,011,092.00 €)
- Interreg V-A "Greece - Bulgaria 2014-2020" Programme (Total EU contribution: 110,241,234 €)
- Interreg V-A "Greece - Italy 2014-2020" Programme (Total EU contribution: 104,700,362 €)
- Interreg IPA CBC "Greece - Albania 2014-2020" Programme (Total EU contribution: 35,965,222.00 €)
- Interreg IPA CBC "Greece - Former Yugoslav Republic of Macedonia (FYROM) 2014-2020" Programme (Total EU contribution: 38,649,552.00 €)

Table 8.1 International cooperation programmes of Greece and top priorities related to climate change

Programme	Sector addressed	Priorities
"Greece – Bulgaria"	Economy - Business - Industry - Tourism Environment Culture Local development Health Spatial Development	A Competitive and Innovative Cross Border Area A Sustainable and Climate adaptable Cross Border Area A Better interconnected Cross Border Area A Socially Inclusive Cross Border Area
"Greece – FYROM"	Social and economic cohesion and cultural development Socio-economic Sciences and Humanities Transportation Economy Environment Local development	Two priorities axes, (excluding technical assistance) which reflect the needs and challenges of the Programme area: PA 1 - Development and Support of Local Economy and PA 2 - Protection of Environment - Transportation.
"Greece – Cyprus"	environment, protection against risks, promotion of the natural and cultural heritage.	Enhancing competitiveness and entrepreneurship in the eligible area. Efficient use of energy and sustainable transport. Conservation and protection of the environment and risk prevention.
"Greece – Italy"	Agro-food industry, blue growth, tourism, cultural heritage, cultural and creative industries	Innovation and competitiveness, with investments in R&I and SMEs contributing to the building of a strong export based economy.
	Environmental protection and risk prevention	Integrated environmental management, promotion of the cultural and natural heritage and fostering shared potentials and responsibilities
	Transport system	Improve the accessibility to transport infrastructures, the coordination of cross-border transport systems and procedures, the promotion of an efficient and environmental-friendly mobility and transport system.
"Greece-Albania"	Employment Energy Engineering Social and economic cohesion and cultural development Transportation Economy Economy - Business - Industry - Tourism Environment Local development	Increase the capacity of cross border infrastructure in transport, water and waste management; increase the effectiveness of environmental protection and energy-efficiency; improve the effectiveness of risk prevention and disaster management with a focus on forest fires. Preserve cultural and natural resources as a prerequisite for tourism development of the cross border area and to improve cross-border capacity to support entrepreneurship, business survival and competitiveness.

Source: Community Initiative INTERREG Website, http://www.interreg.gr/default.aspx?lang=en-GB&page=237

The **multilateral** Territorial Cooperation Programmes, in which Regions of our country participate, are:

- Adriatic - Ionian (interstate)
- MED (interstate)
- MED ENI CBC (cross-border)
- Black Sea basin ENI CBC (cross-border)
- INTERREG EUROPE (interregional)
- Balkan - Mediterranean (interstate)

In the Territorial Cooperation programmes are included the collaboration networks **URBACT** and **ESPON**, as well as **INTERACT**, which provides technical support to all ETC programs in Europe.

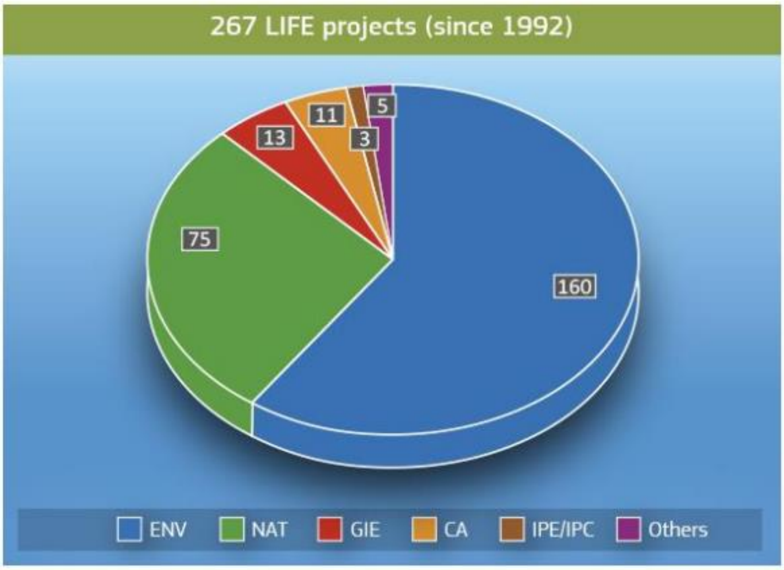
LIFE PROGRAMME

The LIFE programme is the EU's funding instrument for the environment and climate action. It has been running since 1992 and has cofinanced more than 4 500 projects across the EU and in third countries, mobilising over €9 billion and contributing more than €4 billion to the protection of the environment and climate. The budget for the LIFE programme for 2014–2020 is set at €3.4 billion in current prices, with a sub-programme for environment and a sub-programme for climate action.

Types of LIFE project:

- Traditional (Environment and Resource Efficiency; Nature and
- Biodiversity; Environmental Governance and Information; Climate
- Change Mitigation; Climate Change Adaptation; Climate
- Governance and Information).
- Integrated (Environment, Nature or Climate Action)
- Preparatory
- Capacity-building

Other types of LIFE funding: NGO operating grants, Natural Capital Financing Facility (NCFF), Private Finance for Energy Efficiency (PF4EE)



Investment in LIFE projects in Greece (€ million)		
	Total investment	**EU contribution**
ALL LIFE projects	**432**	**237**
Environment and Resource Efficiency (ENV)	226.5	106.5
Nature and Biodiversity (NAT)	112	76
Environmental Governance and Information (GIE)	14	7.5
Climate Action (CA)	28	16.5
Integrated (IPE/IPC)	47	28
Others	4.5	2.5

Figure 8.1 Overview of LIFE in Greece,** https://cinea.ec.europa.eu/system/files/2021-04/Greece_Update_EN_Final_April21.pdf, **(date 08/12/2021)

LIFE Environment and Resource Efficiency

This LIFE priority area is aimed at developing, testing and demonstrating best practices, solutions and integrated approaches to environmental challenges, as well as improving the related knowledge base.

To date, the LIFE Environment and Resource Efficiency strand (formerly the LIFE Environment Policy and Governance component) has cofinanced **160 projects in Greece**, representing a total investment of €226.5 million, of which €106.5 million has been provided by the EU.

Completed projects mainly targeted integrated environmental management; the management of vulnerable coastal areas; industrial and municipal waste, as well as biowaste; waste reduction; green financial products; air quality management and monitoring; the environmental impact of economic activities; water management at the scale of the river basin; sustainable tourism; forest fire safety; hazardous waste (waste oils and petroleum residues); reduction of greenhouse gas emissions (creation of a co-modal journey planning platform); renewable energies; protection of water resources; climate change adaptation (adaptation of the market to the risks and financial impacts of climate change and carbon sequestration in the olive growing sector); integrated management plans for the environmentally-friendly control of invasive mosquito species, preventing their entry, spread and establishment across Europe); air quality management and monitoring; forest management; prevention of natural risks (forest fires and floods); reduction of the carbon footprint in the food industry sector; decontamination and pollution control; implementation of an innovative, patented, environment-friendly and low-cost food attractant

(Biodelear) for the control of med fly on a full scale; risk assessment in health protection; water supply; soil protection and agricultural waste. Almost a third of the projects were implemented by local authorities. The other beneficiaries were mainly development agencies, universities and public enterprises. The projects had average durations of 24 to 48 months.

There are 12 ongoing projects in Greece, covering a wide range of issues, including: waste management and recycling (e.g. transformation of food waste from hotels into animal feed, prevention of WEEE, and specific recycling schemes for remote areas); wastewater treatment (building of a new water purifier to clean effluents from the fruit industry); chemicals (development of a technology and online tools to monitor exposure to engineered nanomaterials in indoor workplaces and urban areas); land-use and planning (promotion of an energyefficient urban freight transport through the introduction of green routing); environmental management (smart exploitation of petroleum sludge produced by the Corinth Refineries of Motor Oil Hellas); demonstration of an innovative, adaptable and affordable smart farming system; air pollution (bringing older heavy-duty vehicles up to Euro VI standard); and energy saving (development of a holistic solution to achieve healthy indoor environments, and to induce energy savings in the building sector, by using new environmentally-friendly technologies).

The project beneficiaries are mainly universities, local, regional and national authorities, research institutes, development agencies, large enterprises, NGOs and SMEs. The projects' expected durations are between 42 and 76 months.

Presented below is an example of a successful LIFE Environment project in Greece

Development & demonstration of management plans against the climate change-enhanced invasive mosquitoes in S. Europe/ (LIFE CONOPS) LIFE12 ENV/GR/000466

http://www.conops.gr/

The LIFE CONOPS project established systematic mosquito surveillance for the first time in Greece, developed and pilot-operated innovative monitoring devices, and implemented innovative mosquito control and management methods in both Greece and Italy. The project beneficiaries established and operated 12 prototype Invasive Mosquito Species Monitoring Devices (IMS MDs): 8 in Greece and 4 in Italy. The first systematic mosquito surveillance system in Greece was created through the deployment of the IMS MDs in combination with an extensive network of ovitraps in 17 locations/ports of entry (e.g. Athens International Airport, Piraeus Containers Terminal). Ovitraps were also deployed in 3 locations in Italy (e.g. Ravenna port) in addition to the IMS MDs. Ovitraps attract pregnant female mosquitoes and enable their eggs to be collected for monitoring purposes. BG sentinel traps were also deployed to catch adult mosquitoes.

LIFE Nature and Biodiversity

This LIFE priority area is aimed at developing, testing and demonstrating best practices, solutions and integrated approaches to contribute to the development and implementation of nature and biodiversity policy and legislation, as well as improving the related knowledge base. To date, the LIFE Nature and Biodiversity component has co-financed 75 projects in Greece. These represent a total investment of €112 million, of which €76 million was contributed by the EU. Completed LIFE Nature projects in Greece have supported actions aimed at stabilising or increasing populations of endangered species (Gypaetus barbatus, Caretta caretta, Falco eleonorae, Monachus monachus, Ursus arctos, Mediterranean shag and Audouin's gull, Fennoscandian population of lesser white-fronted goose, lesser kestrel, Eleonora's falcon and its adaptation to climate change, and the monk seal in the Northern Cyclades), as well as conserving/rehabilitating habitats (e.g. Drana lagoon, Northern Pindos National Park, Agras wetlands, Mediterranean temporary ponds, black pine forests, coastal lagoons, and Juniper wood habitats in Crete, the South Aegean, Prespa National Park). One project aimed at the establishment of a sustainable management and financing system for an important but degraded wetland ecosystem (the Natura 2000 site "Limni Stymfalia"). Another addressed the improvement of human-bear coexistence in four National Parks in southern Europe. The AmiBio Biodiversity project developed a particularly innovative integrated technological system to enable remote, quick and non-obtrusive monitoring of biodiversity. One Biodiversity project aimed to establish integrated planning and management for enhancing biodiversity, whilst also facilitating sustainable economic and social development. Another sought to enhance biodiversity during the restoration of fire-disturbed ecosystems by introducing a new technology, based on pre-cultivation in mini-plugs using a wide range of species. The last Biodiversity project aimed to develop a methodology that can be used to harmonise the needs of wind farm developers with the conservation of EU biodiversity. Project beneficiaries were mostly NGOs, local and national authorities, research institutions and development agencies. Durations ranged from 24 to 60 months. There are 9 ongoing LIFE Nature projects in Greece. These focus on the conservation of habitats (e.g. forest/forest openings in continental Greece Natura 2000 sites on Andros Island, priority habitats in Mediterranean coastal areas) and on the protection of species (e.g. Lake Prespa waterbirds, Bonelli's eagle populations in Greece and Cyprus). Some of the projects have very specific objectives, including: the improvement of conditions for the coexistence of bears and humans in Amyntaio municipality, the management and change of attitude towards Greek caves and bats, improvement of green infrastructure in agroecosystems, and the response to threats of invasive species in northern Greece. The projects have average durations of 49 to 87 months and are being coordinated by universities, NGOs and a consultancy company.

Presented below is an example of a successful LIFE Nature project in Greece, which is nominated for a LIFE Award in June 2021.

Falco eleonorae climate change

Conservation measures to assist the adaptation of Falco eleonorae* to climate change (LIFE ElClimA)/ LIFE13 NAT/GR/000909

http://www.lifefalcoeleonorae.gr/

LIFE ElClimA improved the breeding and foraging habitat of Eleonora's falcon (Falco eleonorae) in Greece, which hosts more than 85% of the species' global breeding population. The project therefore had a significant impact on the species at the global level. The project team eradicated rats in a series of operations to improve the falcons' breeding success, by reducing predation of eggs and chicks. This was done in two island complexes on a total area of over 700 ha, hosting 6% of the species' national breeding population. These were the largest-ever rat eradication attempts in Greece and the Eastern Mediterranean, and used methods with minimal risk to non-target species. Following rat eradication, there were indications of recovery of native plant species and also Chukar partridge populations. By constructing and maintaining more than 1 000 artificial nests for Eleonora's falcon, the project improved the availability and quality of nesting sites on 12 islets at 5 sites, hosting 19% of the species' national breeding population. This large-scale operation focused primarily on colonies in the southern parts of the Aegean Sea, an area most likely to be affected by climate change.

LIFE Environmental Governance and Information

This priority area is aimed at raising awareness of environmental matters, supporting the communication, management and dissemination of environmental information, and promoting better environmental governance by broadening stakeholder involvement. This strand (formerly the LIFE+ Information and Communication component) has co-financed 13 projects in Greece so far. This represents a total investment of €14 million, of which the EU is contributing €7.5 million. The projects are being carried out by universities, NGOs, a national authority (Greek Ministry of Environment and Energy) and a regional authority (Peloponnese). They will have durations of between 21 and 60 months. To date, eight of these projects have been completed. One conducted a widespread awareness-raising campaign to inform fishermen and local inhabitants about the issues of endemic fish, water quality and sustainable fishing practices in the transboundary Prespa Basin. Another helped to change attitudes and behaviour regarding the marine environment and 14 marine mammal species. One project promoted sustainable production and consumption of olive oil. Another developed a series of tools for addressing the issue of coastal litter in Greece. One closed project's overall objective was to minimise the impacts caused by the improper management of waste electrical and electronic equipment (WEEE) in the regions of Thessaly and Epirus, as defined by current Greek and European legislation. Another completed project supported conservation efforts targeting Natura 2000 sites in Crete, by motivating the public to participate in relevant decision-making processes and by highlighting the socio-economic damage that will result from biodiversity loss. The last one developed and implemented an integrated information and awarenessraising campaign for the prevention and reduction of plastic bag pollution in marine waters (detailed information and results can be found in the box below). There are five ongoing projects, focused on the following issues: promoting awareness of wildlife crime prosecution and liability for biodiversity damage in Natura 2000 areas in Crete; building cooperation, developing skills and sharing knowledge for Natura 2000 forests in Greece; supporting the harmonisation of knowledge in order to help enforce EU regulations on the sustainable use of chemicals and expanding the added value of environmental prevention in handling hazardous chemicals; setting up a waste crime prevention mechanism via intelligence-based inspections; and improving financial security provisions for Environment Liability Directive Annex III activities in Greece, through the implementation of environmental risk assessment.

Integrated information and awareness campaign for the reduction of plastic bags in the marine environment (LIFE DEBAG)/ LIFE14 GIE/GR/001127

http://www.lifedebag.eu/

LIFE DEBAG developed and implemented an integrated information and awareness-raising campaign for the reduction of plastic bag pollution in the marine environment on a national (Greece) and a local level (Syros Island). The project reached out to the local community and informed 41 020 visitors and 16 762 inhabitants of Syros regarding the problems created by plastic bags in the marine environment, as well as measures that can be taken to address the issue - including using cotton reusable bags, 12 000 of which were produced by the project and given for free to the local population. Local voluntary agreements to reduce the consumption of plastic bags were signed with 215 local shops in Syros, while public events and educational events at all of its schools were held.

Sub-programme for Climate Action (LIFE 2014-2020)

LIFE Climate Change Mitigation and LIFE Climate Change Adaptation

The Climate Change Mitigation priority area is helping to reduce greenhouse gas emissions, notably by contributing to the implementation and development of related policy and legislation, improving the knowledge base, developing integrated approaches, and developing and demonstrating innovative technologies, systems, methods and instruments. To date, the Climate Change Mitigation strand has co-financed four projects in Greece. One project aims to contribute to the development of a new methodology and provide policymakers with an innovative tool for the quantification of carbon storage in permanent tree crops. The second project aims to demonstrate improvements in climate change mitigation strategies through the production of sustainable biofuel, obtained through an innovative green technology, Green Floating Filters. Another project aims to develop and deliver innovative, reliable, rapid and cost-effective technologies of Tier 3 level for the on-site measurement of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) emissions and soil organic matter from agricultural fields in real time. The most recently-funded project aims to achieve high greenhouse gas emission savings from the substitution of fossil fuels with advanced biofuels, as well as to promote the implementation of a circular economy concept for biomass. The total investment for these projects amounts to nearly €9.5 million, of which the EU will provide €5.5 million. The projects will be carried out by a university and two research institutes, and will have durations of 42 to 54 months. The Climate Change Adaptation priority area is supporting efforts to increase resilience to climate change, in particular by contributing to the implementation and development of related policy and legislation, improving the knowledge base, developing integrated approaches, and developing and demonstrating innovative technologies, systems, methods and instruments. To date, the Climate Change Adaptation strand has co-financed five projects in Greece. Two of them are closed. One aimed to develop an adaptation strategy for agriculture and prepare the sector for climate change by introducing water management adaptation strategies in selected farmer organisations. The second aimed to facilitate the development of adaptation strategies for agriculture by deploying and demonstrating an innovative decision support tool. The ongoing projects aim: to demonstrate, on the Aegean island of Andros, the use of drystone wall terraces as green infrastructures resilient to climate change impacts; to design, implement, pilot and validate a set of Urban Heat Island forecasting systems in Thessaloniki and Rome based on state-of-the-art numerical models; to contribute to the development of strategic and integrated environmental management in Mount Athos. The total investment for these projects amounts to €13 million, of which the EU will provide €8 million. The projects will, respectively, be carried out by an SME, universities, the Holy Community of Mount Athos and a research institute, and will have durations of 36 to 63 months.

Presented below is an example of a successful LIFE Climate Change Adaptation project in Greece.

Adaptation to Climate change Impacts on the Mediterranean islands' Agriculture (LIFE ADAPT2CLIMA)/ LIFE14 CCA/GR/000928

http://www.adapt2clima.eu

The LIFE ADAPT2CLIMA project developed a decision support system (DSS), the ADAPT2CLIMA tool, for demonstrating the impact of climate change on agriculture, in a way that is easy for non-experts to understand. The tool was used, in consultation with policymakers and stakeholders, in the development of the first sectoral strategies for adaptation of agriculture to climate change in Sicily, Crete and Cyprus. Firstly, the project partners explored climate change impacts on the agricultural sectors of each island to 2060, based on two greenhouse gas emission scenarios. It was found that for the three islands, summer crops (olives, grapes and tomatoes in open-field conditions) are more negatively impacted than winter crops, as they grow during peak periods of drought and heat stress. For example, for grapes in Crete and Sicily yield decreases of 11% and 13%, respectively, were predicted; while olive yields were reduced by 5-6% in Crete and Cyprus. Although winter crops overall were less impacted, in some cases, such as barley in Cyprus (12% yield reduction), significant impacts were estimated. Following these estimated reductions in yield, the project team conducted a total impact assessment taking into account socio-economic aspects for each region. This enables farmers and government authorities to target action to increase the resilience of the agricultural sector, for which the project proposed a clear set of adaptation measures to reduce the intensity of impacts. Three adaptation strategies of agriculture to climate change were developed as a first policy outcome of ADAPT2CLIMA: a national strategy in Cyprus with some of its adaptation measures incorporated in the new Rural Development Programme and Climate Adaptation Action Plan; Guidelines for the regional adaptation strategy of agriculture to climate change impacts in Sicily; and the Regional Adaptation Action Plan in Crete.

LIFE Climate Governance and Information

The Climate Governance and Information priority area is promoting awareness-raising on climate matters, supporting the communication, management and dissemination of climate information, promoting more effective compliance with climate legislation, and encouraging better climate governance by broadening stakeholder involvement. To date, the Climate Governance and Information strand has co-financed two projects in Greece. One project aims to promote urban integration of green infrastructure to improve climate governance in cities. It is coordinated by the Hellenic Agricultural Organization “DEMETER”. The goal of the second project is to enable consumers to make informed decisions regarding the purchase of low emission and low fuel-consumption vehicles. It is implemented by the Aristotle University of Thessaloniki. The total investment amounts to €5.5 million, of which the EU will contribute €3 million. The projects are running over an average period of 40 months. More details about the LIFE GrIn project can be found below.

Promoting urban integration of GReen INfrastructure to improve climate governance in cities (LIFE GrIn)/ LIFE17 GIC/GR/000029

http://lifegrin.gr/

The LIFE GrIn project's objectives are to: • Establish an integrated policy framework for the management, monitoring and evaluation of UGAs based on cooperative planning and best practices in urban forestry, satisfying public values and promoting urban adaptation to climate change; • Quantify and multiply the impact of UGAs on urban climate problems, such as heat waves and the heat island effect, increased runoff during heavy rainfalls and increased energy consumption for heating and cooling buildings; • Integrate and promote European climate change adaptation and mitigation policies, as well as sustainable urban planning and design; • Promote the incorporation of sustainable urban forest management for climate change adaptation and mitigation in the Covenant of Mayors and other EU policies; • Improve quality of life through the mitigation of the effects of climate change and the multifunctional planning of UGAs; • Raise awareness among decision-makers regarding the necessity and benefits of taking climate action municipal level and of the public in order to promote their participation; and • Conserve nature and biodiversity and improve habitats for fauna and flora species in cities.

LIFE Integrated Projects for the Environment and Clima

This LIFE priority area is aimed at implementing on a large territorial scale (regional, multi-regional, national, trans-national) environmental or climate plans or strategies required by specific EU environmental or climate legislation, primarily in the areas of nature, water, waste, air and climate change mitigation and adaptation. Integrated Projects ensure the involvement of stakeholders and promote the coordination with and mobilisation of at least one other relevant EU, national or private funding source. To date, three Integrated Projects has been co-financed in Greece (two for environment, IPE, and one for climate, IPC). This represents a total budget of €47 million, of which the EU will contribute €28 million. The first IPE project will demonstrate integrated actions for the conservation and management of Natura 2000 sites, species, habitats and ecosystems in Greece. The project is coordinated by the Ministry of Environment and Energy. Detailed actions of this project can be found in the box below. The objective of the second project is to reduce the amount of municipal waste sent to landfill and to promote waste prevention and re-use, based on circular economy principles. The IPC project will support the implementation of the national adaptation strategy in Greece. To this end it will build national and regional capacity for coordinating, prioritising, monitoring and mainstreaming adaptation policy actions. The three projects are coordinated by the Greek Ministry of Environment and Energy and have durations of 96 to 100 months.

Εδώ Ζούμε
Natura 2000

Integrated actions for the conservation and management of Natura 2000 sites, species, habitats and ecosystems in Greece (LIFE IP 4Natura)/ LIFE16 IPE/GR/000002

https://edozoume.gr

The main objectives of the LIFE-IP 4 NATURA project are to: • Implement concrete conservation measures and apply legal instruments for habitats and species of Community interest that are threatened at the national and multiregional scale; • Formulate, legally approve and implement at least 10 Action Plans for selected habitats and species; • Implement at least 12 Management Plans in the four participating administrative regions, covering Natura 2000 network sites in marine and terrestrial areas; • Enhance the effectiveness of all local, regional and national nature conservation authorities, and develop the necessary means and conditions that will improve their work and results; • Study and acquire the necessary knowledge on ecosystem services and their provisions at national, regional and local level; • Strengthen the coherence between Natura 2000 network sites and improve their connectivity; • Provide a geospatially-oriented database system for the Natura 2000 network and a web-based GIS tool for ecosystem services for governmental, professional and public use; • Improve capacity, knowledge and awareness of key stakeholders (organisations, authorities and the general public) with respect to the implementation of the Birds the Habitats directives, and the Natura 2000 network, as well as their responsibilities and involvement in its conservation; and • Actively disseminate the results of the project and ensure their implementation, transfer and replication by other stakeholders, nationally and at EU level. The complementary actions are to develop (draft and legally adopt) a coherent national action-based plan for the conservation of the whole Greek Natura 2000 network for five years, and to draft the application for measures foreseen in the PAF for Natura 2000 under all seven priority categories.

Table 8.2a Recently closed and ongoing LIFE Environment and Resource Efficiency projects, (European Commission/CINEA (https://cinea.ec.europa.eu/life_en, 31/03/2021)

Project Title	Project Number	Website	Click on the icon to read the project summary	Project duration
Landfill mining pilot application for recovery of invaluable metals, materials, land and energy (LIFE RECLAIM)	LIFE12 ENV/GR/000427	http://www.reclaim.gr/		07/2013--> 06/2016
Development & demonstration of management plans against -the climate change enhanced- invasive mosquitoes in S. Europe (LIFE CONOPS)	LIFE12 ENV/GR/000466	http://www.conops.gr/		07/2013--> 12/2017
Cross-Mediterranean Environment and Health Network (CROME- LIFE)	LIFE12 ENV/GR/001040	http://www.crome-life.eu		07/2013--> 12/2016
Addressing Med fly with an innovative and environment friendly attractant through an Integrated Pest Management Strategy (LIFE BIODELEAR)	LIFE13 ENV/GR/000414	http://www.biodelear.gr		06/2014--> 06/2019
Development of an integrated strategy for reducing the carbon footprint in the food industry sector (LIFE FOODPRINT)	LIFE13 ENV/GR/000958	http://www.foodprint.gr		09/2014--> 10/2017
Life GreenYourMove: Development and promotion of a co-modal journey planning platform to minimize GHG emission in Europe (LIFE GYM)	LIFE14 ENV/GR/000611	http://www.greenyourmove.org/		09/2015--> 08/2018
Demonstrating resource efficiency through innovative, integrated waste recycling schemes for remote areas (LIFE: PAVEtheWAySTE)	LIFE14 ENV/GR/000722	http://pavethewayste.eu		09/2015--> 12/2018
Development and Demonstration of Waste Electrical & Electronic Equipment (WEEE) Prevention and Reuse Paradigms (LIFE RE-WEEE)	LIFE14 ENV/GR/000858	http://www.reweee.gr/el		01/2016--> 06/2019
Food for Feed: An Innovative Process for Transforming Hotels' Food Wastes into Animal Feed (LIFE-F4F (Food for Feed)	LIFE15 ENV/GR/000257	https://life-f4f.gr		09/2016--> 02/2020
New desulfurization technology for SOx reduction with positive net environmental impact based on MgO reagents (LIFEPOSITIVEMgOFGD)	LIFE15 ENV/GR/000338	http://www.betterlife-withmgo.eu		07/2016--> 12/2019
New concept for energy self-sustainable wastewater treatment process and biosolids management (LIFE B2E4sustainable-WWTP)	LIFE16 ENV/GR/000298	http://www.biosolids2energy.eu		09/2017--> 08/2020

Table 8.2b Recently closed and ongoing LIFE Environment and Resource Efficiency projects, (European Commission/CINEA (https://cinea.ec.europa.eu/life_en, 31/03/2021)

Development of a pilot unit for the valorisation of PRS (Petroleum Refinery Sludges) to new added-value raw materials (LIFE DIANA)	LIFE16 ENV/GR/000461	http://www.lifediana.eu/		07/2017–> 06/2020
LIFE GreenYourRoute: A European innovative logistic platform for last mile delivery of goods in urban environment (LIFE GYR)	LIFE17 ENV/GR/000215	https://www.greenyourroute.com		09/2018–> 08/2022
Innovative Smart Farming services supporting Circular Economy in Agriculture (LIFE GAIA Sense)	LIFE17 ENV/GR/000220	http://lifegaiasense.eu/index.php		07/2018–> 06/2022
Integrated approach for exposure and health effects monitoring of engineered nanomaterials in workplaces and urban areas (LIFE NanoEXPLORE)	LIFE17 ENV/GR/000285	https://www.lifenanoexplore.eu/		09/2018–> 02/2022
Nano-CATalysts for HEAVY Duty Applications (LIFE CAT4HEAVY)	LIFE17 ENV/GR/000352	https://www.lifecat4heavy.eu/		07/2018–> 01/2022
Pollutant Photo-NF remediation of Agro-Water (LIFE PureAgroH2O)	LIFE17 ENV/GR/000387	https://lifepureagroh2o.com		07/2018–> 12/2021
Demonstration of an advanced technique for eliminating coal mine wastewater (brines) combined with resource recovery (LIFE BRINE-MINING)	LIFE18 ENV/GR/000019	https://brinemining.eu		09/2019–> 08/2023
InnoVative photocatalytic paintS for healthy envirOnment and eNergy Saving (LIFE VISIONS)	LIFE19 ENV/GR/000100	https://lifevisions.gr/		09/2020–> 09/2023

Table 8.3a Recently closed and ongoing LIFE Nature & Biodiversity projects, (European Commission/CINEA (https://cinea.ec.europa.eu/life_en, 31/03/2021)

Project Title	Project Number	Website	Click on the icon to read the project summary	Project duration
Conservation and Management of the Lesser Kestrel (Falco naumanni") at three Greek SPA sites (Lesser Kestrel Thessaly)	LIFE11 NAT/GR/001011	http://www.lifelesserkestrel.eu		06/2012 –> 05/2016
Conservation of priority forests and forest openings in "Ethnikos Drymos Oitis" and "Oros Kallidromo" of Sterea Ellada (FOROPENFORESTS)	LIFE11 NAT/GR/001014	http://www.foropenforests.org		09/2012 –> 11/2017
Sustainable management and financing of wetland biodiversity – The case of Lake Stymfalia (LIFE-Stymfalia)	LIFE12 NAT/GR/000275	http://www.lifestymfalia.gr		10/2013 –> 09/2017
Restoration and Conservation of the Priority Habitat Type *9562 Grecian Juniper Woods in Prespa National Park, Greece (LIFE JunEx)	LIFE12 NAT/GR/000539	http://www.junex.gr		07/2013 –> 06/2017

Table 8.3b Recently closed and ongoing LIFE Nature & Biodiversity projects, (European Commission/CINEA (https://cinea.ec.europa.eu/life_en, 31/03/2021)

CYCLADES "Integrated monk seal conservation in Northern Cyclades" (CYCLADES Life)	LIFE12 NAT/GR/000688	http://www.cycladeslife.gr/		07/2013 –> 06/2017
Conservation actions for improving conditions of human-bear coexistence in Northern Pindos (LIFE ARCPIN)	LIFE12 NAT/GR/000784	http://www.lifearcpin.gr/		10/2013 –> 06/2017
Conservation measures to assist the adaptation of Falco eleonorae" to climate change (LIFE ElClimA)	LIFE13 NAT/GR/000909	http://www.lifefalcoeleonorae.gr		10/2013 –> 06/2017
Bird conservation in Lesser Prespa Lake: benefiting local communities and building a climate change resilient ecosystem (LIFE Prespa Waterbirds)	LIFE15 NAT/GR/000936	https://www.prespawaterbirds.gr/the-project-weg-11899.html		10/2016 –> 09/2021
Improving Human-Bear Coexistence Conditions in Municipality of Amyntaio (LIFE AMYBEAR)	LIFE15 NAT/GR/001108	http://lifeamybear.eu/		10/2016 –> 07/2020
Improvement of green infrastructure in agroecosystems: reconnecting natural areas by countering habitat fragmentation (LIFE IGIC)	LIFE16 NAT/GR/000575	https://www.lifeigic.eu		09/2017 –> 12/2022
Conservation of priority species and habitats of Andros Island protected area integrating socioeconomic considerations (LIFE Andros Park)	LIFE16 NAT/GR/000606	http://www.androslife.gr		09/2017 –> 09/2021
Restoration, management and valorisation of PRIority habitats of MEDiterranean coastal areas (LIFE PRIMED)	LIFE17 NAT/GR/000511	https://www.lifeprimed.eu		07/2018 –> 06/2023
onservation & Management of the Bonelli's eagle population in east Mediterranean (LIFE Bonelli eastMed)	LIFE17 NAT/GR/000514	http://www.lifebonelli.eu		09/2018 –> 08/2023
Greek Caves and Bats: Management Actions and Change of Attitude (LIFE GRECABAT)	LIFE17 NAT/GR/000522	https://www.lifegrecabat.eu		09/2018 –> 02/2023
Addressing the Threat of Invasive Alien Species in North Greece, using Early Warning and Information systems for mammals (LIFE ATIAS)	LIFE18 NAT/GR/000430	http://lifeatias.gr/		09/2019 –> 09/2022
Improving human-bear coexistence in 4 National Parks of South Europe (LIFE ACRPROM)	LIFE18 NAT/GR/000768	https://lifearcprom.uowm.gr/		09/2018 –> 09/2024
Demonstration of good practices to minimize impacts of wind farms on biodiversity in Greece (LIFE WINDFARMS & WILDLIFE)	LIFE12 BIO/GR/000554	http://www.windfarms-wildlife.gr/		10/2019 –> 09/2017

Table 8.4 Recently closed and ongoing LIFE Environmental Governance and Information projects, (European Commission/CINEA (https://cinea.ec.europa.eu/life_en, 31/03/2021)

Project Title	Project Number	Website	Click on the Icon to read the project summary	Project duration
"The ecological services, social benefits and economic value of the Ecosystem Services in Natura 2000 sites in Crete" (LIFE Natura2000ValueCrete)	LIFE13 INF/GR/000188	http://www.ecovalue-crete.eu/		07/2014 –> 06/2018
Development of a Communication and Training campaign for the recycling of Waste Electrical & Electronic Equipment (WEEE) (LIFE – INFOCYCLE)	LIFE13 INF/GR/001342	http://www.infocycle.gr/		07/2014 –> 06/2016
Promoting awareness on wildlife crime prosecution and EU environmental legislation in NATURA 2000 areas in Crete (LIFE Natura Themis)	LIFE14 GIE/GR/000026	http://www.lifethemis.eu		10/2015 –> 09/2020
Building cooperation, developing skills and sharing knowledge for Natura 2000 forests in Greece (LIFE ForestLife)	LIFE14 GIE/GR/000304	http://www.forestlife.gr		07/2015 –> 07/2019
Integrated information and awareness campaign for the reduction of plastic bags in the marine environment (LIFE DEBAG)	LIFE14 GIE/GR/001127	http://www.lifedebag.eu/		09/2015 –> 0 3/2018
Chemicals Regulations Enforcement & Inspections - Building Authority Capacity for REACH/CLP and SEVESO III Compliance (LIFE CHEREE)	LIFE15 GIE/GR/000943	https://www.reach-cheree.gr/		10/2016 –> 03/2020
PRevent Of Waste crIme by Intelligence Based InspecTions (LIFE PROWhIBIT)	LIFE18 GIE/GR/000899	https://ypen.gov.gr/perivallon/programmata-life/life-prowhibit-prolipsi-perivallontikou-egklima/		10/2019 –> 01/2024
Promote financial instruments for liability on environment (LIFE PROFILE)	LIFE19 GIE/GR/001127	N/A		11/2020 –> 11/2023

Table 8.5a Ongoing LIFE Climate Change Mitigation and LIFE Climate Adaptation projects, (European Commission/CINEA (https://cinea.ec.europa.eu/life_en, 31/03/2021)

Project Title	Project Number	Website	Click on the Icon to read the project summary	Project duration
Promoting water efficiency and supporting the shift towards a climate resilient agriculture in Mediterranean countries (LIFE AgroClimaWater)	LIFE14 CCA/GR/000389	http://www.lifeagroclimawater.eu/		09/2015 –> 08/2020
Adaptation to Climate change Impacts on the Mediterranean islands' Agriculture (LIFE ADAPT2CLIMA)	LIFE14 CCA/GR/000928	http://www.adapt2clima.eu		10/2015 –> 04/2019
EMPLOYING LAND STEWARDSHIP TO TRANSFORM TERRACED LANDSCAPES INTO GREEN INFRASTRUCTURES TO	LIFE16 CCA/GR/000050	http://lifeterracescape.aegean.gr		07/2017 –> 08/2021

Table 8.5b Ongoing LIFE Climate Change Mitigation and LIFE Climate Adaptation projects, (European Commission/CINEA (https://cinea.ec.europa.eu/life_en, 31/03/2021)

BETTER ADAPT TO CLIMATE CHANGE (LIFE TERRACESCAPE)				
Implementation of a forecAsting System for urban heaT Island effect for the development of urban adaptation strategies (LIFE ASTI)	LIFE17 CCA/GR/000108	https://lifeasti.eu/		09/2018 –> 08/2021
Strategic Environmental Management in Mount Athos under Climate Change (LIFE STEMMA ATHOS)	LIFE19 CCA/GR/001185	N/A		10/2020 –> 12/2025
A novel approach for accounting & monitoring carbon sequestration of tree crops and their potential as carbon sink areas (LIFE CLIMATREE)	LIFE14 CCM/GR/000635	http://www.lifeclimatree.eu/		07/2015 –> 06/2019
Low-cost, carbon positive bioethanol production with innovative Green Floating Filters in multiple water bodies (LIFE Biomass C+)	LIFE16 CCM/GR/000044	http://biomasscarbonpositive.eu		09/2017 –> 02/2021
Innovative technologies for climate change mitigation by Mediterranean agricultural sector (LIFE ClimaMed)	LIFE17 CCM/GR/000087	https://life-climamed.eu/		09/2017 –> 02/2021
A circular economy system for multi-source biomass conversion to added value products (LIFE CIRCforBIO)	LIFE18 CCM/GR/001180	https://circforbio.eu/		10/2019 –> 05/2023

Table 8.6 Ongoing LIFE Climate Governance and Information projects, (European Commission/CINEA (https://cinea.ec.europa.eu/life_en, 31/03/2021)

Project Title	Project Number	Website	Click on the Icon to read the project summary	Project duration
Promoting urban integration of GReen INfrastructure to improve climate governance in cities (LIFE GrIn)	LIFE17 GIC/GR/000029	http://lifegrin.gr/		06/2018 –> 12/2021
More Information Less Emissions - Empowering consumers for a greener 21st century (MILE21-LIFE)	LIFE17 GIC/GR/000128	https://www.mile21.eu/		09/2018 –> 08/2021

Table 8.7 Ongoing LIFE Integrated Projects (European Commission/CINEA (https://cinea.ec.europa.eu/life_en, 31/03/2021)

Project Title	Project Number	Website	Click on the icon to read the project summary	Project duration
Integrated actions for the conservation and management of Natura 2000 sites, species, habitats and ecosystems in Greece (LIFE IP 4Natura)	LIFE16 IPE/GR/000002	https://edozoume.gr		12/2017 –> 11/2025
LIFE-IP AdaptInGR - Boosting the implementation of adaptation policy across Greece (LIFE-IP AdaptInGR)	LIFE17 IPC/GR/000006	https://www.adaptivegreece.gr		12/2017 –> 11/2025
Circular Economy Implementation in Greece (LIFE-IP CEI-Greece)	LIFE18 IPE/GR/000013	https://ekpaa.ypeka.gr/en/projects/european/life-ip-cei-greece-life-ip-circular-economy-implementation-in-greece-2		07/2019 –> 10/2027

8.2 Research

The main institutions that perform research in the sector of climate change in Greece are:

- the National Observatory of Athens,
- the Academy of Athens,
- the Hellenic Centre for Marine Research,
- the National Technical University of Athens,
- the National & Kapodistrian University of Athens,
- the Aristotle University of Thessaloniki,
- the University of the Aegean,
- the National Agricultural Research Foundation,
- the Hellenic National Meteorological Service,
- the Atmospheric Modeling and Weather Forecasting group,
- the Hellenic Navy Hydrographic Service
- the Ministry of the Environment and Energy
- the Ministry for Climate Crisis and Civil Protection
- the Public Power Corporation,
- the Institute of Geology and Mineral Exploration.

In addition, there are other institutes in Greece that are working on research areas that are related to climate change (i.e., forest fires, water management, coastal zones, biodiversity new energy technologies), like the Agricultural University of Athens, the University of Patras, the Technical University of Crete, the Greek Biotope/Wetland Centre, the Centre for Renewable Energy Sources and Saving CRES etc.

The National Observatory of Athens (NOA), along with the Hellenic National Meteorological Service (HNMS) and the Aristotle University of Thessaloniki, are the institutes that perform the main analysis of the current climate in Greece.

HNMS (http://www.emy.gr/emy/en/climatology) is currently covering all the meteorological and climatological needs of the country. In the same time, HNMS has established a lot of European and international cooperations in order to improve its services to the customers and also to contribute to the development of the meteorological services at European and international level. HNMS represents Greece in all the following international meteorological organizations: WMO, ECMWF, EUMETSAT, EUMETNET, ECOMET, ICAO, COSMO-Model, NATO. National cooperations have been established between HNMS and Universities, Researsh Institutes or Governmental Bodies, Ministry of Agriculture and Athens Enviromental Agency. By these cooperations HNMS is aiming at improving the services provided to the customers and at promoting the recearch.

In NOA, the Institute of Environmental Research and Sustainable Development (IERSD, https://www.iersd.noa.gr/en/) aims to promote environmental science and engineering, through different activities that include among others meteorology and weather forecast, climatology and climate change and water resources engineering. NOA hosts the UNESCO Chair for Natural Disasters and the Greek Focal Point of GEOSS and IPCC.

The Department of Meteorology – Climatology of Aristotle University of Thessaloniki (AUTH, http://www.geo.auth.gr/en_research.htm#gmc) has also worked on climate change issues, while equally important is the contribution of the University of Athens Climate and Climatic Change Group (https://climate.phys.uoa.gr/).

The Hellenic Centre for Marine Research (HCMR, http://www.hcmr.gr/) is mainly focused on the impacts of climate change on the marine ecosystems, due to the rise of sea level and the rise of temperature. The HCMR is member of the European Global Ocean Observating System (EuroGOOS) and has participated in several operational oceanography R&D projects.

The research areas in the National Technical University of Athens (NTUA) are closely connected to the impacts of climate change in significant sectors, such as water scarcity, desertification and extreme weather events (mainly floods). The Centre for Hydrology and Informatics (CHI) in the School of Civil Engineering (http://www.chi.civil.ntua.gr/) has participated in a number of international and national projects regarding the water scarcity issue and flood risk, while the Environmental & Energy Management research unit in the School of Chemical Engineering (http://environ.chemeng.ntua.gr/en/Default.aspx?t=53) is focused on the mitigation of water stress and the research of needs and policy choices in areas of drought (i.e. AquaNES, EdGeWIsE, WatERP, WASSERMed, etc.).

The Centre for Renewable Energy Sources and Saving (CRES, http://www.cres.gr/kape/index_eng.htm) is the Greek national entity for the promotion of renewable energy sources (RES), rational use of energy (RUE) and energy conservation. In the modern demanding energy sector CRES is dynamically active, in the frame of the national and Community policy and legislation, for the protection of the environment and sustainable development. Working in the state of the art of technology development, CRES implements innovative projects and significant activities for the promotion and market penetration of new energy technologies. The Center, over the years, has participated in more than 600 European, national and international projects. These include applied research projects and development, demonstration projects, energy policy studies, development of energy information systems and energy modelling, investment feasibility studies, technical and economic studies, environmental impact assessments, market research as well as activities for the promotion of RES/RUE/ES. Through these projects, CRES has developed co-operation with numerous public and private organisations, at a national, European and international level. The project GROUNDHIT "Ground Coupled Heat Pumps of High Technology", coordinated by the Greek

Centre for Renewable Energy Sources (CRES), received the Energy Globe Award-one of the most prestigious international environmental awards-as the best environmental project in Greece in 2008. The project GROUNDHIT (http://www.cres.gr/kape/news/deltia/deltio_typoy_groundhit.htm) aims at improving the cost-effectiveness, competitiveness and market penetration of ground coupled heat pumps. The Ground Coupled Heat Pumps are a reliable and environmentally friendly technology that utilises the soil temperature, which is near-constant irrespective of the external weather conditions, and provides buildings with efficient heating, cooling and warm water.

The participation of Greek institutes in indicative international and national research programmes is also presented in ***Table 8.7***.

Table 8.8 Selected projects that are directly or indirectly related to climate change and to which Greece is (or was) a partner

Project	Greek Institute	Source
Development and evaluation of mitigation/adaptation (M/A) policy portfolios (PROMITHEAS-4)	1. National and Kapodistrian University of Athens (NKUA) 2. National Observatory of Athens (NOA) 3. Aristotle University of Thessaloniki (AUTH)	http://cordis.europa.eu/projects/rcn/97951_en.html
Modelling the economics of climate change (CLIMATECOST)	1. University of the Aegean (UAegean) 2. Institute of Communication and Computer Systems	http://cordis.europa.eu/projects/rcn/89308_en.html
Earth system models predict the climate (COMBINE)	Technical University of Crete (TUC)	http://cordis.europa.eu/projects/rcn/92901_en.html
Climate Local Information in the Mediterranean region: Responding to User Needs (CLIM-RUN)	National Observatory of Athens (NOA)	http://cordis.europa.eu/projects/rcn/99345_en.html
Climate change and cultural heritage (CLIMATE FOR CULTURE)	Foundation for Research and Technology (FORTH)	http://cordis.europa.eu/projects/rcn/92906_en.html
Integration and enhancement of key existing European deep-ocean observatories (EuroSITES)	Hellenic Centre for Marine Research (HCMR)	http://cordis.europa.eu/projects/rcn/87797_en.html
Enabling CLimate Information Services for Europe (ECLISE)	Technical University of Crete (TUC)	http://cordis.europa.eu/projects/rcn/97417_en.html
The Pan-European Gas-AeroSOls-climate interaction Study (PEGASOS)	Foundation for Research and Technology (FORTH)	http://cordis.europa.eu/projects/rcn/97270_en.html
Mediterranean sea acidification in a changing climate (MEDSEA)	Hellenic Centre for Marine Research (HCMR)	http://cordis.europa.eu/projects/rcn/97645_en.html
Climatology of Vertical Aerosol Structure for Space-Based Lidar Simulation Studies (Lidar)	IAASARS, (NOA)	http://lidar.space.noa.gr:8080/livas/
Southern European seas: Assessing and Modelling Ecosystems Changes (SESAME Project)	1. Hellenic Centre for Marine Research (HCMR) 2. University of the Aegean (UOA) 3. Athens University of Economics and Business -Research Center (AUEB) 4. University of Crete (UOC)	http://cordis.europa.eu/result/brief/rcn/9811_en.html
Climate Change and Impact Research (CIRCE)	1. Environmental Chemical Processes Laboratory (UOC) 2. Institute of Accelerating Systems and Applications, School of Physics, (NKUA) 3. IERSD (NOA) 4. Dept. Of Hygiene and Epidemiology, Medical School and Laboratory of Climatology and Atmospheric Environment (NKUA) 5. Department of Geography (UAegean) 6. Institute of Oceanography (HCMR) 7. Energy - Economics - Environment Modelling Laboratory Research and Policy Analysis,	http://www.circeproject.eu/index.php?option=com_content&task=view&id=67&Itemid=1

Project	Greek Institute	Source
	(NTUA)	
Monitoring, forecasting and best practices for FLOOD mitigation and prevention in the CADSES region (FLOODMED)	1. Centre for Hydrology and Informatics (CHI/ NTUA) 2. Department of civil protection, Prefecture of Chania 3. Department of Environmental Engineering, Technical University of Crete (TUC)	http://www.floodmed.org/partners.html
Integrated water resources management, development and comparison of common transnational methodologies to combat drought in the MEDOCC regions (MEDDMAN)	1. Centre for Hydrology and Informatics (CHI/ NTUA) 2. Department of Hydraulics, land and agricultural science (AUTH) 3. Prefecture of Pieria	http://www.meddman.org/partners.html
Prevention and restoration actions to combat desertification. An integrated assessment (PRACTICE)	Aristotle University of Thessaloniki (AUTH)	http://cordis.europa.eu/fetch?CALLER=FP7_PROJ_EN&ACTION=D&DOC=2&CAT=PROJ&QUERY=01245f7f4691:3930:76ae2057&RCN=92041
Living with landslide risk in Europe: Assessment, effects of global change, and risk management strategies (SAFELAND)	Aristotle University of Thessaloniki (AUTH)	http://cordis.europa.eu/fetch?CALLER=FP7_PROJ_EN&ACTION=D&DOC=7&CAT=PROJ&QUERY=01245f7f4691:3930:76ae2057&RCN=91248
Marine ecosystem evolution in a changing environment (MEECE)	Hellenic Centre for Marine Research (HCMR)	http://cordis.europa.eu/fetch?CALLER=FP7_PROJ_EN&ACTION=D&DOC=16&CAT=PROJ&QUERY=01245f7f4691:3930:76ae2057&RCN=89307
Develop a framework that will enable water managers to design cost-effective restoration programmes for freshwater ecosystems (REFRESH)	University of Patras (UPAT)	http://www.refresh.ucl.ac.uk/node/245

8.3 Systematic Observation

8.3.1 Atmospheric essential climate variables

8.3.1.1 Overview

The main institutions that contribute to the national oceanic observations are the Hellenic National Meteorological Service (HNMS, http://www.emy.gr/emy/en/), the National Observatory of Athens (NOA, https://www.noa.gr/en/), the National Agricultural Research Foundation (NAGREF, http://www.nagref.gr/), the Laboratory of Atmospheric Physics of the Aristotle University of Thessaloniki (AUTH, http://lap.physics.auth.gr/index.asp?lang=en), the Centre of Renewable Energy Sources (CRES, http://www.cres.gr/kape/index_eng.htm), the Atmospheric Modeling and Weather Forecasting group (AM&WFG, https://forecast.uoa.gr/en/group; http://forecast.uoa.gr/about.php) of the National and Kapodistrian University of Athens (School of Physics, Division of physics of Environment-Meteorology) and the Centre for Hydrology and Informatics (CHI) in the School of Civil Engineering of National Technical University of Athens (School of Civil Engineering/ NTUA, http://www.chi.civil.ntua.gr/).

8.3.1.2 Measurements of meteorological parameters

The **Hellenic National Meteorological Service (HNMS)** operates a network of 178 land surface and 3 upper air measurement stations (http://www.emy.gr/emy/el/services/paroxi-ipiresion-diktio-met-stathmon-protogeni). In addition, all of them are registered to World Meteorological Organization (WMO). The available data time series cover a period of 35-40 years. The majority of the stations have been in operation since 1955.

The **Ministry of Rural Development and Food (MRDF)** has been operating a large network of agrometeorological stations, some of which have been operating for more than 50 years. In the last years, after a complete refurbishment, 40 of these stations are operating under the supervision of the General Directorate of Agriculture and Research of the Ministry, and provide a full and continuous set of data, which are collected and stored centrally. Another 120 agrometeorological stations are operated by two **different Departments of the Ministry of Rural Development and Food** and the Ministry of Environment & Energy (80 of them by the **General Directorate of Agriculture** (of MRDF) with the rest divided between the **General Directorate of Forests and Forest Environment** (of MEEN) (former Department of Forests of MRDF) and the **Directorate of Land Reclamation αnd Water αnd Soil Recourses** (of MRDF). Measurements are taken automatically every minute and averages are recorded every hour (except for precipitation which is recorded every 10 minutes in order to capture intensity).

The **Institute of Mediterranean Forest Ecosystems and Forest Products Technology** is one of the oldest research institutes in Greece. It was established in Athens, Greece, in 1929 as the research arm of the Greek Forest Service. Its title soon changed to Forest Research Institute of Athens (FRIA) In its more than 80 years of operation, the Institute has produced excellent research always focusing on the research needs of the practicing foresters of the Forest Service. In 1989 the Institute was integrated into the **National Agricultural Research Foundation** (NAGREF) and got its current official title. Both the historic name and the official title are currently in use. In 2011 NAGREF was merged with three other organizations of the Ministry of Rural Development and Food forming the Hellenic Agricultural Organization “DEMETER” to which the Institute now belongs. In the Forest Ecology laboratory of the Institute, developed activities related to all terrestrial ecosystems of our country. The staff is occupied with the analysis of biotic and abiotic factors that influence each other in their internal functioning. More specially examined the flora and its composition through phytosociology in order to translate the forms and dynamics of vegetation. The vegetative and floristic data are related to climatic, geographical, geomorphological and soil factors determine the composition and forms of vegetation. The climatic factors are examined in the light of bioclimatology and the restrictions that it sets to the composition of vegetation and its distribution in the space. In addition, in the laboratory keep a computerized database, with meteorological data from the early 1960's, collected from about 30 forest meteorological stations located in mountainous areas of the country covering the conditions of the major forest ecosystems. These data are used to evaluate the climate development of forests and are also available for all public offices, universities and individuals on delivery.

The extensive meteorological network of **National Observatory of Athens (NOA)** consists of almost 500 fully automated meteorological stations(http://stratus.meteo.noa.gr/front) (Figure 8.2), established by IERSD all over Greece, offers to the public, in almost real-time (data refreshment every 10 min), information about prevailing meteorological conditions. Meteorological parameters that are presented are the following: Air temperature (ºC) and relative humidity (%), Atmospheric pressure (hPa), Wind speed (m/s or Km/h) and wind direction (deg.), Total precipitation (mm) (rainfall, snow, or hail). In selected meteorological stations, the incoming total solar radiation (W/m^2) and ultra-violet (UV) radiation (W/m^2), incident at a horizontal surface, are also provided to the public.

The expanding network of radiometric stations includes **two stations within Attica region, the historic radiometric station in Thissio (**1st class meteorological stations in Athens (in Thissio since 1842 and Penteli since 1998)) and the newest in Penteli, but also six more stations scattered throughout Greece: in Klokotos (Trikala), in Larissa (Thessaly), in Methoni (Messinia, South Peloponnese), in Filotas (Florina), in Andros island (Cyclades) and in Antikythira island. Also included is another high altitude station (at 2340 m) in Neraidorahi site of Helmos mountain in Kalavryta (Achaia).

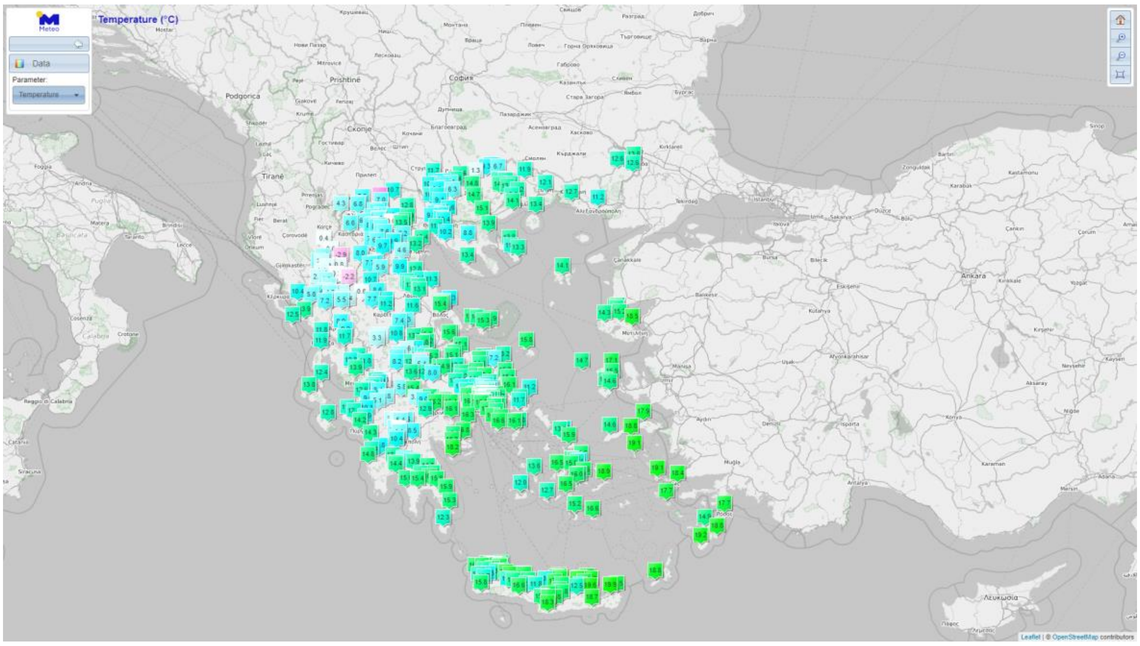


Figure 8.2 Temperature data in different meteorological stations network.
(https://www.meteo.gr/Gmap.cfm, 10/12/2021)

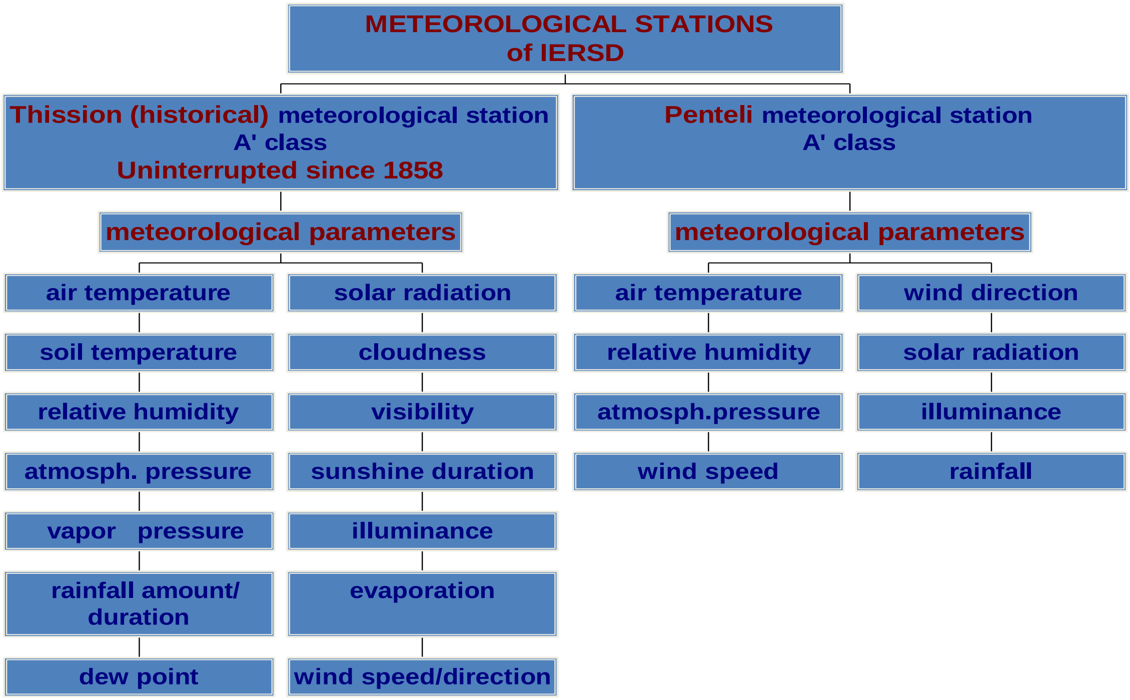
The Institute of Environmental Research and Sustainable Development (IERSD) has been performing continuous meteorological observations for over 150 years at Thissio site. As a result, it has the largest, most complete and reliable climatological records in the country.

These observations include measurements of air & ground temperature, relative humidity, wind speed, wind direction, barometric pressure, evaporation, rainfall, cloudiness, visibility, sunshine duration and miscellaneous phenomena. Solar radiation and more recently daylight measurements are also recorded at the meteorological station at Thissio.

Since 2000, meteorological data are available on a routine base from the IERSD meteorological station at Penteli site. These data include measurements of air temperature, relative humidity, wind speed, wind direction, barometric pressure, rainfall, as well as solar radiation & daylight.

The data are available in a database and they are published every year in the Climatological Bulletin, which is edited by the Institute. Since 1998, Climatological Bulletins are available in CD-ROM as pdf files. From 2000, the CD-ROM contains the meteorological data from the Penteli site. The Bulletin is dispatched to 80 national and 60 foreign organizations (Universities, Research Centers and Libraries).

The availability of data time series varies from 10 to 50 years in relation to the respective station and measured parameter. The historical data and real-time provided by the websites: http://stratus.meteo.noa.gr/front, https://www.meteo.gr/Gmap.cfm, http://meteosearch.meteo.gr/ & http://www.meteo.noa.gr/WeatherOnLine respectively.



A dense network is required for the systematic monitoring of climate change in the country. (Particularly important for Greece, due to its morphology and the existence of a variety of microclimates).

Today

- NOA/IERSD operates a network of **491 automated** surface meteorological stations (Davis) deployed over Greece (Figure 8.2)
- **Solar radiation** data are also available for **134** sites.
- UV radiation data are also available for **66 sites**
- The network is still expanding

A number of national research centres, namely the National Center for Scientific Research 'Demokritos', the Centre of Renewable Energy Sources (CRES) and universities (National

Technical University of Athens, Aristotle University of Thessaloniki, University of Patras, University of Ioannina, University of Athens, University of Crete), also operate meteorological stations. The time series of these stations vary in length from a few years to a few decades, and their data are widely available:

- National Centre of Scientific Research "**DEMOKRITOS**" operates two meteorological stations, one of which measures aerosol parameters.
- In the wider area of Athens (687 km^2), 15 fully automatic telemetric hydrometeorological stations are installed and already operating in the framework of the METEONET network. This network was developed by members of the **Laboratory of Hydrology and Water Resources** and is supported by the Computer Center of the **National Technical University of Athens** (School of Civil Engineering). The measurements performed by the METEONET network concern air temperature and precipitation, wind speed gust and direction, relative humidity, solar radiation, net radiation and sunshine duration, whereas the Zografou station performs also measurements of air pressure and water vapour. All data measurements are publicly available at the webpage of the METEONET project (http://www.chi.civil.ntua.gr/site_gis/html/index.htm). The data are collected every ten minutes and updated (in the webpage) every 8 hours on a daily basis. Historical data, concerning the period of operation of each station (2005-now) are available on demand. These data are not provided to any international data centre and are used for national purposes only at the moment.
- The **University of Patras-Laboratory of Atmospheric Physics** (LAPUP) operates an automatic weather station located at 38° 17’ 31’’ N longitude and 21° 47’ 18’’ E latitude. It consists of an 11-m high weather mast. The instrumentation is positioned at the appropriate height (10 m) via a motorized system, in order to facilitate its regular calibration. The meteorological parameters measured are: wind velocity and direction, air temperature and relative humidity, pressure, global and diffuse solar radiation, rainfall amount and rate. The instruments are calibrated according to current international standards. Data acquisition is performed using a Campbell Scientific data logger. Data are acquired every 30 s and 10 min average values are stored. The averaging period can be modified according to the requirements of specific field experiments. Raw data is stored and checked for inconsistencies, prior to its use, via quality control software developed by the LAPUP. Detailed metadata records are maintained.
- The **Laboratory of Meteorology of the University of Ioannina** (Department of Physics) operating ten meteorological stations and one environmental in several locations: University of Ioannina, Island in the lake of Ioannina, Metsovo in Ioannina, Koronisia in Arta, Vourgareli in Arta, Ammoudia in Preveza, Trapeza in Konitsa, Kalpaki in Ioannina, Lorida Sagiadas in Thesprotia, Paramythia in Thesprotia. The stations measure temperature, humidity, wind, pressure, radiation, rain and temperature/humidity of fuels. The station in the University of Ioannina also measures evaporation, UVA, UVB, infrared, lighting, etc. The environmental station located in the suburbs of Ioannina and measures PM10, PM2.5, NOx, O3, BTX, etc.
- The **Department of Meteorology and Climatology** (DMC) of the **Aristotle University of Thessaloniki** (School of Geology) established the Olympus Meteorological Center which operates a station monitoring atmospheric essential climate variables (Precipitation, Temperature, Atmospheric Pressure, Wind Speed, Wind Direction, Relative Humidity, Radiation, Net Radiation).
- The **Laser Remote Sensing Unit** is located in the **Laboratory of Optoelectronics, Lasers and their Applications** of **National Technical University of Athens**-(Physics Department). The infrastructure currently available at LRSU includes:

- a compact 8-wavelength Raman lidar system, used to perform continuous measurements of suspended aerosol particles, and water vapor in the Planetary Boundary Layer (PBL) and the free troposphere (0.3-15 km asl.),
- a mobile depolarization lidar employed for detecting the polarized and cross polarized backscattered lidar signals at 532 nm, to further characterize the shape of the sampled particles. It provides the aerosol backscatter coefficients at 532 and 1064 nm, as well as the linear particle depolarization ratio (LPDR) at 532 nm, from 0.3-8 km asl. The calibration technique applied in this system is the ±45o calibration method, introduced by Freudenthaler et al. (2009),
- a FURUNO marine radar (9.4 GHz) is used to study heavy clouds,
- a Differential Optical Absorption Spectroscopy (DOAS), which is based on Beer-Lambert’s absorption law, to identify and measure concentrations of different gases. It states the relationship between the quantity of light absorbed and the number of molecules in the light path where travels the optical beam.,
- ustTrak™ I, II Aerosol Monitors 8520 and 8530 are desktop battery-operated, data-logging, light-scattering laser photometer that gives you real-time aerosol mass readings. It uses a sheath air system that isolates the aerosol in the optics chamber to keep the optics clean for improved reliability and low maintenance. They can measure aerosol concentrations corresponding to PM1, PM2.5, Respirable, PM10 or size fractions,
- GRIMM EDM 365 Transportable Outdoor Environmental Dust Monitor simultaneously measures the PM10, PM2.5, PM1 values every sixty seconds and displays them as number concentration (number of particles/m^3). The aerosol spectrometer works at a flow rate of 72 liters/minute. The constant flow rate is maintained by a large external flow controlled pump. Sheath air assures cleaning of the optic which means extended periods of remote operation are assured.

- The **group of Meteorology and Climatology** of the **Department of Environmental Physics-Meteorology** in **University of Athens** (School of Physics) monitoring a Data Base of daily Temperature and Rainfall at 20 surface stations covering Greece.
- The **Environmental Chemical Processes Laboratory** (ECPL) of **University of Crete** (Department of Chemistry) operates a meteorological station at Finokalia (35o 20'N, 25o 40'E) on the north coast of Crete. The meteorological parameters monitoring are: Temperature, Relative Humidity, Solar Radiation, wind speed and direction height of Rain. Data acquisition is performed using a Campbell Scientific data logger. Data are acquired every 5 min.

The Ministry of Rural Development and Food and the Ministry of Environment, Energy & Climate Change operate a large network of rain gages and snow gages. The network consists of more than 250 rain gages and 1000 snow tables.

8.3.1.3 Measurements of atmospheric electricity discharges

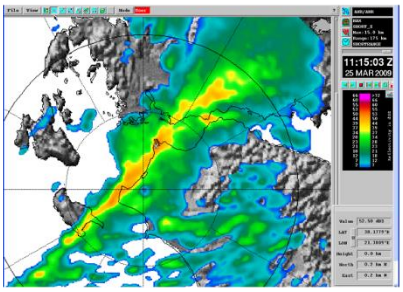
The National Observatory of Athens (NOA) has been operating a network of stations aimed at detecting lightning strikes (https://www.thunderstorm24.com/). The network consists of 6 recording stations, located in the UK, Denmark, Romania, Italy, Cyprus, Portugal and Greece. It has been in operation (detection and recording) since 2005, covering a major part of Europe, whole Mediterranean Sea area and part of northern Africa. The lightning-strike data provide real-time information regarding the location of thunder cells and severe rainstorm activity. This is crucial information for predicting floods and providing more accurate local forecasts. This information is provided to the meteorological community via Internet (https://www.meteo.gr/meteomaps/obs_zeus_eu.cfm).

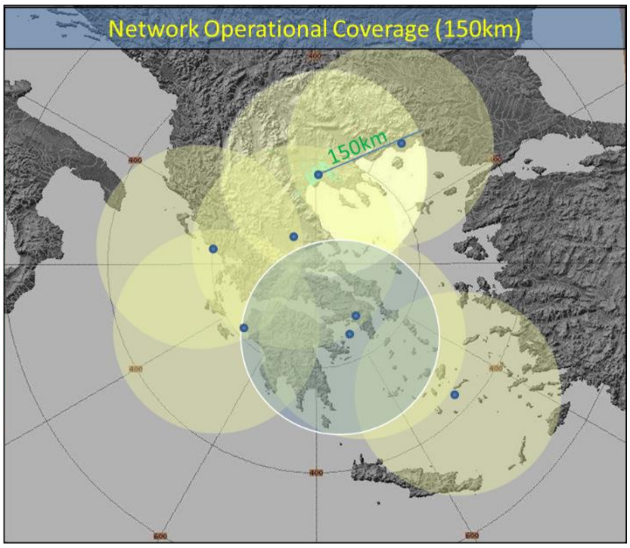
8.3.1.4 Meteorological RADAR

HNMS has a network of meteorological radars

- 4 C-band Doppler
- 2 C-band Doppler / dual polarization
- 2 S-band Doppler

The above-mentioned network is fully automated, covers the major part of the territory of Greece (limited coverage of south west area), carries out two kinds of scanning (short range: 150Km and long range: 250Km/ 400Km for C-bands/ S-bands respectively), with a frequency of 15 min. The network is to operate in full scale as from October 2008. Moreover, NOA operates a mobile X-band/dual polarization meteorological radar. This radar is used for research purposes (http://www.meteo.noa.gr/ENG/iersd_radar.htm).





8.3.1.5 Wind Measurements

The Centre of Renewable Energy Sources (CRES) and several companies have established and operate wind measurement masts, usually of 30m height, for the collection of data to estimate wind energy potential and identify possible locations for the establishment of wind parks. The number of masts varies with the needs of possible wind park developers. CRES has performed wind measurements in more than 30 places, in various regions of Greece (Cyclades, Crete, Ionian Islands, Peloponnese, Attica, Evia, central Greece). Also maintains permanent stations recording wind data in Andros and Agia Marina in Lavrion. Data collected, apart from the ones collected by CRES, are not available free of charge.

8.3.1.6 Ozone and UV-radiation measurements

Aristotle University of Thessaloniki (AUTH) and National Technical University of Athens (NTUA) have been monitoring the total (column) ozone amount at two locations on a continuous basis for more than 30 years. Since 2005 total ozone is derived also at the 9 stations of UVNET (described in this section) from multifilter radiometer data.

The Laboratory of Atmospheric Physics (LAP) in Aristotle University of Thessaloniki hosts the World Ozone Mapping Center, which utilizes measurements from the 100 stations of WMO Global Ozone System (part of GAW) and of TOMS (Total Ozone Mapping Spectrometer) to generate and archive global maps of total ozone column (http://lap.physics.auth.gr/ozonemaps/). Furthermore, the Institute of Mediterranean Forest Ecosystems and Forest Products Technology of NAGREF, also measures (since 2003) average monthly ozone concentration in 3 forest areas (in Vatada near the town of Amfilohia at 350 m height, St Nicolas in the Evrytania province at 1120 m height and on Ossa Mountain at 740 m height) and in Athens (Ano Ilisia).

At the station of Thessaloniki (LAP, AUTH) solar UV radiation is monitored since the beginning of the 1990s with 2 spectroradiometers providing spectral irradiance measurements several times during the day. The UV-A, erythemal irradiance (UV-B) and total solar radiation are measured continuously since 1981, 1991 and 1993 respectively.

However, since 2004 a team effort coordinated by the Laboratory of Atmospheric Physics (LAP) of the Aristotle University of Thessaloniki (AUTH) resulted in the establishment of the National Network for Monitoring of Solar UV Solar Radiation, UVNET (http://www.uvnet.gr/index.php), that aims at the long-term monitoring of solar ultraviolet radiation over Greece and Cyprus, with the following goals:

- Studying of the effects of UV exposure on human beings and the ecosystem, as well as the short-term forecast of UV radiation levels.
- The awareness of the public concerning their protection from the biological effects from their exposure to ultraviolet radiation.
- Providing of continuous and reliable information to all relevant public organizations, national or international organizations, health services and also to any citizen for the actual level and the possible effects from the exposure to the biologically effective UV rays of the sun.

In the framework of this network, 9 stations have been installed at Thessaloniki, Mytilene, Ioannina, Athens, Patras, Heraklion, Nicosia, Rhodes and Xanthi using state of the art instrumentation and technology for obtaining the measurements and the dissemination and exploitation of the results.

The instruments that are used are the NILU-UV multi-filter radiometers, which measure solar irradiance at 5 narrow bands in the UVB (280-315 nm) and UVA (315-400 nm), and the Photosynthetically Active Radiation (PAR, 400-700 nm). The instruments are connected on-line with a central data base maintained at AUTH, enabling immediate recording and display of the measurements. Based on appropriate methodologies and software the following products are derived form the network measurements:

- The solar spectral irradiance at specific wavelengths (305, 312, 320, 340 and 380 nm)
- The total column of ozone.
- The transmittance of the atmosphere in the UV and visible part of the spectrum
- The cloud optical depth
- The photolysis rates of ozone, nitrogen dioxide and formaldehyde
- The UV-B and UV-A irradiance and the PAR
- Biologically relevant doses related to the influence of UV radiation to humans and plants.

The **Laboratory of Atmospheric Physics** (LAP) of the **Aristotle University of Thessaloniki** (AUTH) and the **Laboratory of Atmospheric Physics of the University of Patras** (LAPUP) in the framework of the Cooperation program which has been supported from European Regional Development Fund and National Resources, have been established the "**Greek Network for Solar Energy**" (GNSE) (http://www.helionet.gr/) operating a network of 14 stations monitoring solar ultraviolet radiation over Greece (Argos, Athens, Volos, Finokalia, Thessaloniki, Ioannina, Kozani, Mytilini, Xanthi, Orestiada, Patra, Preveza, Pylos, Rhodes). In collaboration with the Atmospheric Modeling and Weather Forecasting group (AM&WFG) of the National and Kapodistrian University of Athens (School of Physics, Division of physics of Environment-Meteorology) and the National Centers for Environment Prediction in U.S.A. (NCEP), forecasts of the UV index are provided for Greece and Cyprus.

AM&WFG is part of School of Physics and the Institute of Accelerating Systems and Applications (IASA) of National and Kapodistrian University of Athens (NKUA). The research activities of the group are related to atmospheric, air pollution, soil dust cycle, climatic variability and wave modeling and applications related to data assimilation, weather, wave and air quality forecasting, agricultural and wind energy applications. The AM&WFG participated in a number of projects in USA such as the NARSTO project (Ozone study over NE USA) and the Mercury budget over NE USA. National projects like SKIRON, NHREAS, POSEIDON, PYTHAGORAS, etc. These activities brought significant research experience to the members of the groups. The AM&WFG participates in the CESTM/ASRC project on weather and air quality forecasting over NE USA. The SKIRON modeling system is an integrated limited area modeling system developed from the AM&WFG. It is in use in approximately 20 research institutes and weather services worldwide. It is based on the Eta/NCEP model. It is in operational use at NKUA (http://forecast.uoa.gr) with more than 7000 visitors per day. Recently the AM&WFG delivered an upgraded version of SKIRON system at HCMR called POSEIDON II.

Since 2006, aerosol optical properties are monitored with a Cimel sunphotometer which is part of the AERONET. Finally, LAP operates broadband radiometers for the measurement of UV-B, UV-A and total solar radiation, since the beginning of 1990s.

The National Observatory of Athens' station in Thissio (Athens) measure total UV since 1989, UV-B since 1995 and total solar radiation components since 1989, 1995 and 1953, respectively.

The **Laboratory of Process Analysis and Design** (LPAD) of **National Technical University of Athens** (School of Chemical Engineering) operating a station in Attica (Pireaus Region) which measures Ozone, air pollutants (SO_2, NO_x, CO) and aerosols.

Finally, The station monitoring by **ECPL** at Finokalia running measurements concerning Aerosols [EC-OC (EUSAAR 2), ions, metals, PON, P], ions (Cl, NO_3, SO_4, Oxalate, MSA) in PM_1/ OM, SO_4, NO_3, NH_4, PM_1/, PM_{10} concentration, Rd-Th concentration)], Gases (O_3, CO, NO, NO_2) and Greenhouse gases (CO_2, CH_4, N_2O, CO), along with Optical Measurements (ABS 7- PM_{10}, Light Extinction at 530 nm in PM_{10}) and Deposition (ions+metals+PON+P) and Size Distribution (N dist. (10-880 nm)).

8.3.1.7 Ground level air pollutants

The Ministry of Environment & Energy operates local networks for monitoring air pollution in the major urban areas of Greece. In the greater Athens area, the network consists of 20 stations under the supervision of the ministry and 28 under the supervision of respective regions. These srations measure air pollutants and PMs, of which 31 measure ground level ozone. The data are available to the public through the Ministry of Environment and Energy (http://env.ypeka.gr/deltia/e1220400.html) and through the European Environmental Agency (http://cdr.eionet.europa.eu/gr).

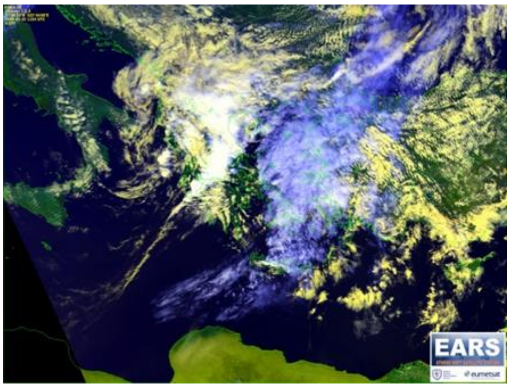
In addition, the Public Power Corporation of Greece operates 35 air quality stations near its power plants that monitor air pollutants (SO_2, NO_x, PM10, PM2,5 and O_3) and meteorological parameters (wind direction and velocity, temperature and relative humidity). All stations are automated, operating continuously. Data are gathered and kept in a centralised database.

Details about on the contribution of Greece in international systems and networks are presented in ***Tables 8.8a***, ***8.8b*** and ***8.8c***. The abbreviations in brackets next to the number of stations correspond to the organization that operates the respective station(s).

8.3.1.8 Satellite observations

Greece is a member of the European organization for the exploitation of Meteorological Satellites (EUMETSAT), the consortium that operates the meteorological observation satellite METEOSAT, and is represented in EUMETSAT by HNMS. For more details it is recommended to visit the EUMETSAT home page (http://www.eumetsat.int). It should be noted that EUMETSAT has a decentralised network of Satellite Application Facilities (SAFs) for the generation of products from EUMETSAT satellite data (EUMETCast (METEOSAT 7, 8, 9) 12-Channels)

In addition, Greece is a member of ESA and participates in basic, as well as in optional, research projects. Greece also participates in several actions of Copernicus (the new name for the Global Monitoring for Environment and Security programme, previously known as GMES) program of ESA (http://www.copernicus.eu/).



NOA - Space Weather Operational Unit

Adverse conditions in space can cause problems in radio telecommunications, navigation problems, electric power failure, satellites failure, danger to astronaut health. Solar Energetic Particles (SEPs) can penetrate the shield of the geomagnetic field and enter the ionosphere. SEPs penetrate more easily via the areas near the poles of the geomagnetic field than via the equator. Satellites on high-gradient LEO orbits can be vulnerable to SEPs as well as the International Space Station. SEPs can also influence the propagation of signals between Earth and satellites. Protons of 1-100 MeV cause increased ionization which absorbs radio waves at HF and VHF frequency bands, resulting in telecommunication problems and navigation errors. In addition, high-energy protons are dangerous to astronauts' health. SEPs reach at aviation heights and pose a threat for human health since the radiation dose received may be increased. This applies in particular to high latitudes and polar routes. For commercial aviation, there is a risk for 'frequent flyers' and the crew. Therefore, it is necessary to forecast the solar storms and their impacts in a timely manner, which is carried out by the NOA Space Weather Operational Unit.

The HESPERIA REleASE tool provides real-time predictions of 30-50 MeV solar energetic protons in the Geospace. It is based on observations of electrons moving at the speed of light crossing the Sun-Earth distance in a few tens of minutes and being collected by the sentinel SOHO/ACE near-Earth spaceships as precursors of protons arriving 30-90 minutes later. This tool provides more complete predictions than others based solely on observations of solar flares in the visible hemisphere of the Sun. The HESPERIA UMASEP-500 tool provides real-time predictions of events detected on the ground by very high-energy protons (> 500 MeV). The tool provides more timely forecasts than neutron monitors on the ground and is based solely on space data. The forecasts are available through the NOA website (http://www.hesperia.astro.noa.gr). The HESPERIA tools were selected by NASA as a top priority internationally to be included in the emulation of manned missions to the Moon and Mars.

The Space Weather Operational Unit consists of Dr. Olga Malandraki, Senior Researcher of Space Physics, Dr. Georgia Tsiropoula, Research Director, Dr Kostas Tziotziou, Director Scientist, Michalis Karavolos, MSc., PhDc., Software and Satellite Communications Engineer, Nikolaos Milas, Special Technical Scientist and Dimitrios Kokkinis, Informatics and Telecommunications Researcher, BSc, MSc student. (https://www.hesperia.astro.noa.gr/index.php/results/real-time-prediction-tools)

BEYOND Center of Excellence

The BEYOND Center of Excellence develops research and provides disaster management services addressing priorities and needs in South Eastern Europe, Mediterranean, N. Africa, Middle East and the Balkans. The Center's creation supported by the competitive framework of EU FP7-REGPOT-2012-2013-1 and costed 2,3 MEuros. It generated unique excellence and EO research infrastructure for the region. It maintains a fully operational and self-sustained activity, through competitive funding from Space research and operational projects supported by EU, ESA and International Funding Organisations (FP7, H2020, ESA EOEP, WB, EIB, etc.). The operational activity of the BEYOND Center serves the Civil Protection and Decision Making Process for disaster management, and the stakeholders acting in Institutional Disaster Management Authorities at International level. The Center in its activity has been validated, and is performing in compliance to European Copernicus and ESA standards (set by the SAFER project – see description below) in the provision of disaster management services. The Center's activity focuses on Emergency Response (during crisis) and Emergency Support (preparedness and recovery) (according to the Copernicus EMS standards), the protection of Sea and Atmospheric environment, as well as advanced topics relating to Agriculture and Food Security, improved Access to Renewable Energy Resources, and Climate Resilience and Adaptation to Climate Change. Many Institutional Authorities and International Organisations have profited from the services offered by the BEYOND Center such as The European Forest Fires Information System/EFFIS, the Global Fire Monitoring Center-GFMC, the European program for disasters Copernicus EMS, a large number of Civil Protection Authorities in countries over EU, Africa, Latin America, and Asia, as well as a number of Fire Brigade authorities, Forestry Departments, Directorates for the Protection of Forests and Natural Ecosystems, Environmental Agencies and Ministerial Bodies, Rehabilitation Services, etc. Indicatively and only over the period of 2016-2018, the BEYOND Center has been activated more than 20 times by the Copernicus EMS for the purposes of civil protection authorities worldwide, in order to address multi-hazard management needs, in cases of devastating earthquakes, volcanic eruptions, landslides, soil and coastal erosion, wildfires, floods, toxic gas emissions, duststorms, industrial accidents.

The activity of the Center is supported by a multidisciplinary team of experts comprising of more than 35 scientists (17 at M.Sc and 7 Ph.D. level). The BEYOND Center is funded from competitive programs (EU, ESA, National Programs), as well as from International Funding Organisations amounting 1.2-1.5 million Euros per year. At the same time, it supports with its infrastructure and research, the activity of other researchers in the country, providing an additional equal inflow of research funds at IAASARS/NOA (http://beyond-eocenter.eu/)

Table 8.9a National contribution to the surface-based atmospheric essential climate variables

Contributing networks specified in the GCOS implementation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2010	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
GCOS Surface Network (GSN)	Air temperature	4 (HNMS)	4 (HNMS)	4 (HNMS)	4 (HNMS)	4 (HNMS)
	Precipitation	4 (HNMS)	4 (HNMS)	4 (HNMS)	4 (HNMS)	4 (HNMS)
Full World Weather Watch/Global Observating System (WWW/GCOS) surface network	Air temperature, air pressure, wind speed and direction, water vapour	178 (HNMS) 13 (NTUA) 2 (NCSR) 6 (NAGREF) 1 (NOA)	178 (HNMS) 13 (NTUA)	178 (HNMS) 13 (NTUA) 2(NCSR) 1 (NOA)	178 (HNMS)	178 (HNMS) 1 (NOA)
	Precipitation	178 (HNMS) 16 (NTUA) 5 (NAGREF) 1 (NOA)	178 (HNMS) 16 (NTUA)	178 (HNMS) 16 (NTUA) 1 (NOA)	178 (HNMS)	178 (HNMS) 1 (NOA)
Baseline Surface Radiation Network (BSRN)	Surface radiation	14 (GNSE)	14 (GNSE)	14 (GNSE)		
Solar radiation and radiation balance data	Surface radiation	12 (NTUA) 1 (NOA) 5 (NAGREF)	12 (NTUA)	12 (NTUA) 1 (NOA)		1 (NOA)
Ocean drifting buoys	Air temperature, air pressure					
Moored buoys	Air temperature, air pressure	11 (HCMR)	11 (HCMR)	11 (HCMR)	11 (HCMR)	11 (HCMR)
Voluntary observing ship climate project (VOSClim)	Air temperature, air pressure, wind speed and direction, water vapour					
Ocean Reference Mooring Network and sites on small isolated islands	Air temperature, wind speed and direction, air pressure					
	Precipitation					

Table 8.9b National contribution to the upper-air atmospheric essential climate variables

Contributing networks specified in the GCOS implementation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2010	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
GCOS Upper Air Network (GUAN)	Upper-air-temperature, upper-air wind speed and direction, upper-air water vapour					
Full WWW/GOS Upper Air Network	Upper-air-temperature, upper-air wind speed and direction, upper-air water vapour	3 (HNMS)	3 (HNMS)	3 (HNMS)	3 (HNMS)	3 (HNMS)

Table 8.9c National contribution to the atmospheric composition

Contributing networks specified in the GCOS implementation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2010	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
World Meteorological organization/Global Atmosphere Watch (WMO/GAW) Global Atmospheric CO_2 and CH_4 Monitoring Network	Carbon dioxide					
	Methane	1 (NOA)		1 (NOA)		
	Other greenhouse gases	1 (NOA)		1 (NOA)		
WMO/GAW ozone sonde network	Ozone	1 (AUTH)		1 (AUTH)	1 (AUTH)	1 (AUTH)
WMO/GAW column ozone network	Ozone	2 (AUTH) 2 (NTUA)	2 (NTUA)	2 (AUTH) 2 (NTUA)	2 (AUTH) 2 (NTUA)	2 (AUTH) 2 (NTUA)
WMO/GAW Aerosol Network	Aerosol optical depth	3 (AUTH)		3 (AUTH)	3 (AUTH)	3 (AUTH)
	Other aerosol properties	1(NCSR) 3 (AUTH)		1 (NCSR) 3 (AUTH)	1 (NCSR) 3 (AUTH)	3 (AUTH)
EARLINET-ASOS Aerosol Network	Aerosol optical depth	2 (NTUA)		3 (NTUA)	2 (NTUA)	
	Other aerosol properties	2 (NTUA)		3 (NTUA)	2 (NTUA)	

8.3.2 Oceanic essential climate variables

8.3.2.1 Overview

The main institutions that contribute to the national oceanic observations are the Hellenic Centre for Marine Research (HCMR, http://www.hcmr.gr/en/) and the Hellenic Navy Hydrographic Service (HNHS, https://www.hnhs.gr/en/).

8.3.2.2 Hellenic Centre for Marine Research (HCMR)

The Hellenic Centre for Marine Research is a governmental research organisation operating under the supervision of the GENERAL SECRETARIAT FOR RESEARCH AND INNOVATION (GSRI) of the MINISTRY OF DEVELOPMENT AND INVESTMENTS. The HCMR comprises three Research Institutes: the Institute of Marine Biology, Biotechnology and Aquaculture (IMBBC), the Institute of Marine Biological Resources and Inland Waters (IMBRIW) and the Institute of Oceanography (IO).

Participating in European Networks of Excellence such as MARBEF, Marine Genomics, Euroceans and Esonet, among others, has provided the HCMR with the ability to strategically place itself among the leading Research Centres in Europe. Furthermore, networks such as COST, ERA-NET, MedCLIVAR and I3 networks build support and strengthen cooperation among the different areas of Europe with the HCMR adequately representing the Mediterranean.

The global scientific community can also access the Mediterranean Marine Science Journal, (https://ejournals.epublishing.ekt.gr/index.php/hcmr-med-mar-sc), HCMR publications, Collected Reprints abstracts, and data-rich projects such as HNODC, IASON and ELNAIS.

The HCMR is member of the European Global Ocean Observating System (EuroGOOS). In the previous years the HCMR has participated in several operational oceanography R&D projects, such as:

- **MFSPP** (1998-2001): Development of multiparametric M3A station, VOS Measurements, High resolution regional and coastal models
- **MFSTEP** (2002-2004): Consolidation of MFS observing system
- **MARSAIS** (2001-2003): Synergy between SAR and buoy data, Validation of Algorithms, Detection and forecasting of oil-spills
- **FerryBox** (2002-2005): Implementation of a European network for FerryBox measurements, Operational phase: 2002-2003
- **MAMA** (2002-2004): Coordination on Mediterranean Scale, Capacity building
- **MERSEA_S1** (2003-2004): GMES Initial phase
- **ROSES** (2003-2004): ESA GSE
- **EPAN/ESPEN** (2003-2005): Improved wave monitoring and forecasting products – oil spill risk assessment
- **MERSEA-IP** (2004-2008): Global monitoring and forecasting. HCMR: Coordination of Mediterranean Observations, M3A system
- **EUROCEANS (2005-2008):** ESA, developing models for assessing and forecasting the impacts of climate and anthropogenic forcing on foodweb dynamics
- **MARCOAST** (2006-2009): ESA GMES service network
- **ESONET-NoE** (2007-2011): ESA GMES
- **SPICOSA** (2007-2011): developing a self-evolving, holistic research approach for integrated assessment of Coastal Systems

- **MYOCEAN** (2009-2012): GMES, setting up infrastructures and services in preparation for the GMES Marine Services
- **OPEC** (2012-2015): research and development to develop Operational Ecology to augment the capabilities of the GMES Marine Service
- **MYOCEAN2 (2012-2014): delivering and operating a rigorous, robust and sustainable Ocean Monitoring and Forecasting system of the GMES Marine Service (OMF/GMS) to users for all marine applications**
- **Climpact – National Network on Climate Change and its Impacts (2019-2022)**

The following paragraphs include the main activities currently run by the HCMR, concerning the observation of ECVs.

- **The POSEIDON System (Long term *(climatic)* variability monitoring):** HCMR established the system and keeps it running. The main monitoring, forecasting and information system (**Moored buoys)** in Greece
- **HCMR participates in EURO-ARGO** network (network of autonomous instruments-drifting buoys). ARGO floats can continuously measure important variables that characterize the ocean (column distribution of temperature, salinity, oxygen etc.) and report it, using satellite connections, to processing centres.
- **HCMR participates in EMSO**, a large-scale European Research Infrastructure in the field of environmental sciences. EMSO is based on a European-scale network of seafloor observatories
- **SESAME project** (FP6 project on Climate Change effects in the Mediterranean and Black Sea: **HCMR coordinator**)

The POSEIDON System

The main monitoring, forecasting and information system is the **POSEIDON System**, developed by HCMR through EEA infrastructure funding:

- POSEIDON-I: 14.1 M€ (1997-2000),
- POSEIDON-II: 9.8 M€ (2005-2009)
- POSEIDON-III: 1.1 M€ (2010-2011),

which is continuously upgraded through collaborative research projects. The system operated by HCMR and supported by the Hellenic National Meteorological Service & the Hellenic Hydrographic Service. By establishing a network of observation buoys and the creation of a specialized operational centre for the processing of the data collected and the production of forecasts, POSEIDON system is an operational monitoring, forecasting and information system for marine environmental conditions in the Eastern Mediterranean. The system targeted to end-user needs such as maritime transport, fisheries, tourism, as well as environment & climate monitoring.

The network of observation 16 buoys records continuously the physical, biological and chemical parameters of the Greek seas. These data are then transmitted to the operational center where they are sorted and fed into forecasting models. POSEIDON system is a unique planning tool in the endeavor for the protection of the marine environment. It also provides a competitive advantage for the development of business activity, the prevention of disaster, and the safeguarding of human life. In the frame of the world-wide trend for the development of operational oceanography, POSEIDON network places Greece among the leading countries in this field. The ten stations (SE of mount Athos, Lesvos, Skyros, Saronikos, Mykonos, Santorini, Kalamata, Cretan sea (E1M3A), Pylos, Zakynthos) providing atmospheric and sea data are presented in table 3.1. Two of them, in Cretan sea (E1M3A), and Pylos, are the reference **deep sites** which operate since 2000 and 2008 respectively. The observation buoys are equipped with sensors that monitor:

- Air-pressure
- Air-temperature
- Wind speed and direction
- Wave height, period and direction
- Sea surface salinity and temperature
- Surface current speed and direction

In two sites additional deep physical and biochemical observations are made:

- Salinity and temperature in depths 20-1000 m
- Chlorophyll-A and light attenuation at 20-100 m
- Dissolved oxygen at 20-100 m
- Current speed and direction at 20-50 m
- Radioactivity
- Radiance - Irradiance

All the stations report data on air temperature and pressure, wind speed (mean and gust) and direction, as well as sea surface temperature, waves (significant and maximum height, direction) and current (speed and direction) data. These data are online available in the POSEIDON webpage (http://www.poseidon.hcmr.gr/) either as time series graphs or as text based format for the latest transmission.

Seven "Seawatch" instrumentation platforms are deployed in areas where the water depth does not exceed 300m and are equipped with sensors for the basic met-ocean parameters recording. Every station can potentially monitor temperature, salinity, pressure and bio-chemical parameters in several depths by adjusting instruments on the mooring line. By now several sensors are attached on the buoy shell measuring sea surface parameters such as salinity, temperature, current speed and direction and a variety of wave parameters. On the top of the platform meteorological parameters are measured such as air pressure, air temperature as well as wind speed and direction. The 3 "Seawatch- Wavescan" buoys are multi-parametric instrumentation platforms and are deployed in deep offshore locations. Due to an inductive mooring cable, ctd instruments are adjusted on the mooring line providing salinity, temperature and pressure data down to 1000m depth. Biochemical parameters such as oxygen and chlorophyll are also measured from the sea surface down to 100m depth. ADCP profilers collect current data every 5m from the sea surface to the depth of 50m. On the upper part of the buoy a variety of sensors record the atmospheric variability. Except the basic meteorological parameters, additional parameters are measured such as rainfall, radioactivity, radiance and irradiance. One of the "Wavescan" multi-parametric instrumentation platform, deployed at southern Ionian Sea, communicates through an acoustic modem with a Deep Sea Module platform which is deployed at 1763 m depth. The main purpose of deploying this instrumentation platform is to record sea pressure and detect anomalies on the sea surface altimetry which could indicate a tsunami incident over the specific sea area. The platform has also adjusted sensors measuring temperature and salinity down to the sea basin.

A new platform with additional sensors (CO_2, CH_4, pH, Passive Acoustics) is now constructed: POSEIDON-3.

The POSEIDON operational center receives, processes and analyzes all the data on an operational basis. Poseidon system uses data from other platforms also integrated (e.g. ARGO floats). These data, which are archived and utilized for forecast and research purposes need management, which means efficient storage, cleaning (pre data mining process), and availability in-source for the production of forecasts and other scientific issues and outsource (other institutes, web generally). The operational center receives the above data on a 3-hourly basis. They are stored in text files and then are transferred to a normalized sql database. The data base has been designed to support fast access to all available parameter values and their metadata. Appropriate links have been established to associate the transmitted data with their metadata and the relevant quality control flags which assigned to the data providing a reliability score of the recorded values. This quality control process is an integral and important part of the operational process. Its significance derives from the fact that ocean data measurements are sparse and often present a variety of dubious and false values. Bio-fouling, sensor failures, anchoring and transmission problems are among the common causes of corrupted data. In terms of operational activities, this analysis must be held in real-time conditions and has to be as reliable as possible.

Concerning the future of the Poseidon system, the main goals are the following:

- The complete upgrade of the existing buoys with next generation atmospheric and oceanographic sensors and state of the art communication devices.
- The extension of the network coverage to the Ionian Sea.

Participation in the Euro-Argo Network

Greek Argo is a component of the Euro Argo research infrastructure. Argo Observe ocean processes and circulation on scales from a few weeks to seasons and inter-annual, integrated observing system: complementarity with satellite observations (altimetry) and ocean models and is an essential component of GMES MCS.

Greece is an active member of the Euro-Argo network. HCMR Contributes to the network with 3 floats per year approved from the Greek Secretary General for R&D. Additionally, HCMR is considering the possibility of developing a DMQC facility for Argo profiles collected within the Eastern Mediterranean region.

The EURO-ARGO network constitutes an important asset of the ARGO network. The ARGO network is a global network of autonomous instruments-drifting buoys- which can continuously measure, throughout their lifetime, important variables that characterize the ocean (column distribution of temperature, salinity, oxygen etc.) and report it, using satellite connections, to data gathering and processing centres. EURO-ARGO is the single most important in-situ observing infrastructure for the GMES (Global Monitoring for Environment and Security) Marine Core Service. It delivers the above mention critical data (especially over the vertical dimension of the oceans) that are strongly complementary to satellite observations for assimilation in ocean analysis and forecasting models.

Euro-Argo aims to establish a long-term global array of in situ measurements integrated with other elements of the climate observing system (in particular satellite observations) to:

- Detect climate variability from seasonal to decadal scales and provide long-term observations of climate change in the oceans. This includes regional and global changes in temperature and ocean heat content, salinity and freshwater content, sea level and large scale ocean circulation.
- Provide data to constrain global and regional ocean analysis and forecasting models, to initialize seasonal and decadal forecasting coupled ocean-atmosphere models and to validate climate models.
- Provide information necessary for the calibration and validation of satellite data

The main goals of the Greek team for next years can be summarized to the following:

- Launch of the Greek Argo infrastructure funded by the National Strategic Reference Framework (NSRF) which will contribute to an enhanced monitoring over Aegean and Ionian seas as well as Eastern Mediterranean region in general. 25 Iridium floats will be deployed during the next 4 years

- By the end of 2013 to deploy 6 floats in total in the Ionian (2 floats), in the Aegean Sea (3 floats) and South of Crete (1 float). One of these floats has been already purchased with PERSEUS funds, two will be purchased with IONIO (Interreg-III) allocated funds, while National Greek Argo programme will contribute with three additional floats

The expected benefits from the implementation of these goals are to:

- Expand the observing capacity of the POSEIDON system
- Increase the forecasting skill of the POSEIDON hydrodynamic models through data assimilation of ARGO T/S profiles
- Contribution to UNFCCC (monitoring of climate variables)

Emso

The Basic scientific objective of Greek EMSO is the Long-term monitoring, of environmental processes and the interaction between geosphere, biosphere, and hydrosphere, including natural hazards and climate change impacts (dense water convection Adriatic vs Aegean). For the implementation of this program in Pylos Deep reference site is used.

Sesame

The scientific objectives of SESAME program are:

- Assess the changes or regime shifts in the SES ecosystems over the last 50 years and assess the potential mechanisms that relate these changes to changes in natural and anthropogenic forcings.
- Assess the current status of the SES ecosystems through analysis of existing and newly collected data and model simulations.
- Predict changes in the SES ecosystem responses to likely changes in climate and anthropogenic forcings during the next five decades.
- To assess and predict changes in the ability of the ecosystems to provide goods and services. Goods: tourism and fisheries/Services: ecosystem stability through conservation of biodiversity, and mitigation of climate change through carbon sequestration

Through the implementation of the project new data have been and will be collected and WOCE-type stations have been already established with various positive consequences as described above. In specific, the gathering of high quality field data, the analysis of samples and the preparation of datasets to feed the SESAME databases are being used to tune and validate the ecological models. Seven WOCE-type stations in the Mediterranean and Black Sea have been established (2 in the Black Sea and 4 in the Mediterranean – 1 in the Greek waters North Aegean). In addition, Long time-series from selected stations in the Mediterranean and the Black Sea will be also collected. SESAME consortium is determined to maintain the operation of these WOCE-type stations beyond the duration of the project. Acquired data will be incorporated into the SESAME databases thus establishing a long-term information in Mediterranean and Black Seas.

Voluntary Observation Ships

As regards to voluntary observing ships, in general there are 18 ships cooperating with the HCMR, although their use is not organized on a regular basis. These ships cooperate with HCMR under the context of various programs. However, in the present there is no such program running.

Forecasting System (HIMOFS)

The Hellenic Integrated Marine Inland water Observing, Forecasting and offshore Technology System (HIMIOFoTS) includes integrated approaches in Marine observation and forecasting systems, coastal monitoring and an innovative Hydro-Environmental Monitoring and information Network. The infrastructure incorporates the following interrelated components:

(a) The Hellenic Integrated Marine Observing and Forecasting System (HIMOFS), a cluster of already-existing and under-implementation marine observing systems coupled with a full range of forecasting operational models. (b) The Open Hydrosystem Information Network, an integrated information infrastructure for the collection, management and free dissemination of hydrological and environmental information related to the inland waters of the country. HIMIOFoTS RI belongs to the Greek national Research Infrastructure Roadmap and aims to create an integrated infrastructure for the management of the Greek national water resources by building synergies and collaborations between the relevant Greek institutes and laboratories. HIMIOFOTS RI is coordinated by the Institute of Oceanography (https://io.hcmr.gr/infrastructure/himiofots/).

CretaCosmos

CretaCosmos, the mesocosm facility of the Oceanography Institute of HCMR in Crete (cretacosmos.hcmr.gr) is an infrastructure of global importance, being surrounded by an extreme oligotrophic marine environment and complemented by a variety of laboratories of 3 HCMR Research Institutes, housed in the same area of Thalassocosmos. The geographic position of Crete makes HCMR the ideal place for experimental hypothesis-testing at the lower end of the productivity gradient. Running mesocosm experiments at CretaCosmos is not only feasible and easy but also pleasant due to a variety of accommodation services (smaller and larger hotels and plenty of restaurants) offered in walking distance during an extended touristic period at the world-known mild climate conditions of Crete. The infrastructure allows for large-scale experiments involving: a) global environmental problems, b) issues regarding the functioning of the marine ecosystem under disturbance and/or pollution, c) trophic relationships that support food webs and supply marine biological resources, d) experimental investigation of changes in goods and services of the marine environment under the pressure of significant changes in physico-chemical and biological characteristics of the marine ecosystem (https://io.hcmr.gr/infrastructure/mesocosms/).

8.3.2.3 Hellenic Navy Hydrographic Service (HNHS)

The Hellenic Navy Hydrographic Service (HNHS) is the official hydrographic organization of Greece. It is an independent agency of the Hellenic Navy (HN), based in Attica and accountable directly to the Chief of the Hellenic Navy General Staff. It has its own seal and emblem, which are used in all its publications. HNHS personnell represents the country at the International Hydrographic Organization (IHO), participating in its conferences, committees and working groups, as well as participates in various international civilian and military organizations, on matters related to its work and mission.

The purpose of HNHS is to study the Greek and the adjacent seas, coasts and ocean, the navigation conditions, to contribute to the development and the promotion of the sciences and arts related to navigation, hydrography, oceanography, shipping and maritime meteorology. The mission of the HNHS includes, among other things, the composition and production of nautical charts and publications, as well as the creation of products that result from studying the parameters of the marine environment, the development of geosciences (hydrography, topography, oceanography, geography) and the science of navigation. More specifically, the HNHS collects, processes and uses information and data to generate products and services related to Hydrography, Naval Cartography, Marine and Military Oceanography in order to:

- support and meet the operational requirements of the HN and National Defense, in general, on matters that fall under its competence;
- contribute to the safety of seafarers in Greek and neighboring seas;
- protect the marine environment;
- contribute to the growth of the economy of the country's islands;

- assist and support, where required, public services, legal and natural persons, and private entities in their work.

The Hellenic Navy Hydrographic Service is a government agency that has exclusive competence and certification to draw up, publish, supplement and correct the official navigational charts of Greece and their updates, as well as to publish, supplement and correct official nautical publications.

Moreover, the HNHS publishes in printed and/or electronic format, navigational aids and instructions, notices, messages and announcements, wave forecasts and oceanographic information, contributing to the promotion and development of shipping and navigation safety.

Lastly, the HNHS is the National Coordinator for the management and operation of NAVTEX Service, in accordance with national and international law and practice.

During the various oceanographic cruises, many types of data are collected, according to the operational and scientific needs.

- Conductivity, Temperature, Depth profilers (CTD) are used for recording the **temperature, salinity, density and sound velocity fields** of the Hellenic Seas.
- Side Scan Sonars and Sea-bottom profilers are used for examining the **geological and geoacoustic properties of the sea bed and the sea-bottom stratification**.
- Bottom corers and samplers are used for collecting **sediment cores and samples of the sea-floor**.
- Current Meter Profilers are used for recording the **sea currents** in areas of specific interest.

All collected data are analyzed, stored in data bases and used in order to understand the physical phenomena and to produce environmental studies.

The Hydrographic Service maintains a network of permanent sea level recorders (tide gauges at ports in Greece’s maritime space to monitor changes to sea level). The stations enable the analog recording of any change to sea level, round the clock. The data are also recorded digitally (through ten-minute or fifteen-minute sampling) at selected stations and in the context of network upgrading, which enables phone transmission of the data in virtually real time. Also, the recordings of four stations (Piraeus, Katakolo, Syros and Kalamata) are directly available on the internet through the HS website. (Figure 8.2):

- A network of **Twenty one (21)** permanent Sea Level (SL) Stations is located in Aegean and Ionian seas Harbours.
- At each station site a combination of sensors, type of recording and transmission of data exists.
- All stations are using analog recording, nine (9) of them also have digital outputs with GSM transmission of data.
- From those nine (9) stations, four (4) transmit data in real time mode, using GPRS.
- Nine (9) stations also have a temperature sensor.

One (1) station has a CGPS system.

In the future, all analog sea level recorders will be gradually replaced by electronic ones, which will be equipped with atmospheric pressure, temperature, salinity sensors and GPS. This is expected to reduce losses and upgrade the quality of observations by extracting direct data indicating how atmospheric (inverse barometer effect), thermosteric (rise of sea temperature), allosteric (changes in salinity) effects, and coastline movements (earthquakes, shifts of the crust of the earth) affect the level of the sea.

Sea level data in the form of hourly values are collected, processed and archived, while statistical information is also drawn about sea level in 23 areas of the Greek maritime space, in the form of monthly and annual statistics. The stations of the existing network provide the statistical data for the period from the 1990's to date. These data have been compiled and issued (together with a local leveling network, area charts, etc.) in the study "Statistical Data of Sea Level at Greek Ports" and are available for activities including:

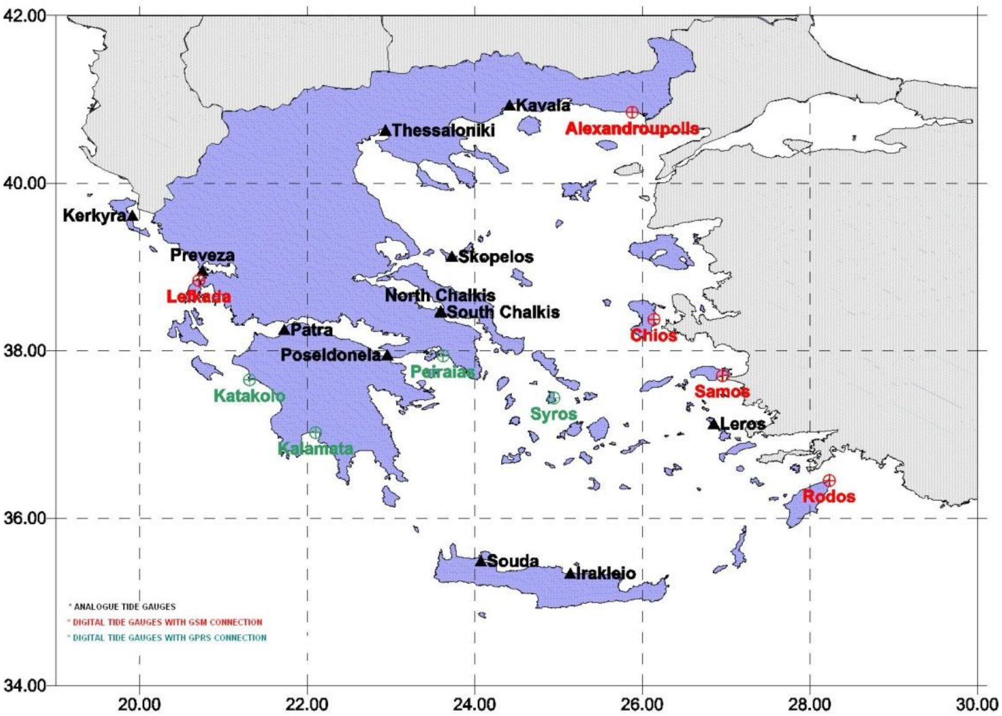


Figure 8.3 Map of Permanent Network of Sea - level and Temperature Monitoring

The Hellenic Navy Hydrographic Service has a continuously cooperation with the following Organizations: **ESEAS** (European Sea level Service), **PSMSL** (Permanent Service for Mean Sea Level), **IOC** (Intergovernmental Oceanographic Commission). In addition it is also partner in the **National Tsunami Warning System** as active member of the Intergovernmental Coordination Group-North Atlantic Mediterranean and connected Seas Tsounami Warning System (ICG/NEAMTWS). In addition, the Hellenic National Tsunami Warning Centre (HL-NTWC) is a particular unit of the Institute of Geodynamics of the **National Observatory of Athens (NOA-IG),** which is the leading earthquake analysis and monitoring Centre in Greece. The HL-NTWC performs tsunami research, education and training, develops monitoring systems and other infrastructures, provides tsunami warning services on a 24/7 basis for Greece and the eastern Mediterranean Sea and participates actively in international communication tests and exercises. The tsunami warning services are provided not only nationally but also at international level given that the HL-NTWC is one out of four accredited Tsunami Service Providers (TSPs) acting in the frame of the North-Eastern Atlantic, the Mediterranean and connected seas Tsunami Warning System (NEAMTWS). The early history of HL-NTWC goes back to 1990's but only in 2010 it was officially established by the state while it declared as operational on August 2012.

In the context of Hellenic Navy Hydrographic Service participation in national and European programs aiming to develop and upgrade the network, the HS has participated or is currently taking part, through the Oceanography Directorate, in:

a) The ESEAS Program (European Sea Level Service- Research Infrastructure), 2002-2005

b) Memorandum of Cooperation between the HS/HN and the Dionysos Satellite Center of the National Technical University of Athens (NTUA), relating to the installation of four (4) sea level recorders and GPS stations in areas of national and surveying interest. In the context of this cooperation, the first integrated metering station was installed on the island of Megisti (Kastelorizo).

c) Climate Cosmos Program (Development of National Infrastructure and a National Web Portal in relation to Climate Change in Greece, following the Scientific and Technical Guidance of the United Nations and the Global Climatic Observation System,2013-2015) with the participation of the National Center for Sustainable Development (NCSD), the Institute of Geology and Mineral Exploration (IGME), the Hellenic National Meteorological Service, the 'Athena' Research and Innovation Center in Information, Communication and Knowledge Technologies

8.3.2.4 National Contribution

In ***Tables 8.9a*** and ***8.9b*** the total national contribution to oceanic essential climate variables are reported. The climate of Greece does not justify the participation in some networks (i.e. global tropical moored buoy network). In this case the relevant cells are shaded grey.

Table 8.10a National Contributions to oceanic essential climate variable-surface

Contributing networks specified in the GCOS implementation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2010	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
Global surface drifting buoy array on 5x5 degree resolution	Sea surface temperature, sea level pressure, position-change-based current	0	N.A.	5	0	0
GLOSS Core sea-level framework	Sea level	22	N.A.	22	3	22
Voluntary observing ships (VOS)	All feasible surface ECVs	25	N.A.	25	0	0
Ship of opportunity programme	All feasible surface ECVs	0	N.A.	1	0	0

N.A. not available.

Table 8.10b National Contribution to the oceanic essential climate variables-water column

Contributing networks specified in the GCOS implementation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2010	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
Global reference mooring network	All feasible surface and subsurface ECVs	10	10	11	10	10
Global tropical moored buoy network	All feasible surface and subsurface ECVs					
Argo network	Temperature, salinity, current					
Carbon inventory survey lines	Temperature, salinity, ocean tracers, biochemistry					

Contributing networks specified in the GCOS implementation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2010	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
	variables					

8.3.2.5 Satellite observations

Using information gathered by the HCMR, and the HNMS, the global products that require satellite observations and are being currently developed are presented in ***Table 8.7***. The launching of a satellite in 2010 has improved the data collection and creates a new climatological database.

Table 8.11 Global products requiring satellite observations-oceans

ECVs/ Global products requiring satellite observations	Fundamental climate data records required for Product generation (from pas, current and future missions)
Sea Level Sea level and variability of its global mean	Altimetry
Sea Surface Temperature Sea surface temperature: assessment of spatial and temporal variability. Use of SST products (Sea Surface Temperature) in the EUMETCAST context of the EUMETSAT organization. For wave height and other sea level measurements, products of satellites JASON 1 & 2 are being used in the context EUMETCAST context of the EUMETSAT organization.	Single and multi-view IR and microwave imagery
Ocean color Examination of the patterns of ocean color (i.e. light intensity) and oceanic chlorophyll-a concentration derived from several sensors (Sea WiFS, MODIS)	Multi-spectral VIS imagery
Ocean salinity Research towards the measurement of changes in sea surface salinity	Microwave radiance

8.3.2.6 Actions taken in response of the recommended actions in the GCOS implementation plan

1. Including sea level objectives in the capacity-building programmes of GOOS, JCOMM, WMO, other related bodies and the system-improvement programme of GCOS: The possibility of including sea level objectives on the gathering of satellite data is under consideration by the HCMR.
2. Implementing a wave measurement component as part of the Surface Reference Mooring Network: The observation buoys of the POSEIDON System are equipped with sensors that monitor wave height period and direction. The offshore wave forecasting model of POSEIDON system uses the outputs of the weather and circulation models to produce 72 hours prediction of wave conditions in the Aegean Sea. The wave forecast consist from the following parameters:
   - Significant wave height
   - Mean wave direction
   - Mean wave period
   - Developing capability for systematic measurement of biochemical and ecological ECVs
3. Supporting data rescue projects and implementing regional, specialized and global data and analysis centres: The Hellenic National Oceanographic Data Centre (HNODC) is part of the institute of Oceanography, one of the five institutes of the Hellenic Centre for Marine Research (HCMR). It operates as a National Agency and is responsible for processing, archiving and distributing marine data. HNODC is also developing techniques for oceanographic data processing and data base maintenance. Furthermore it promotes the International Exchange of Data in the frame of its cooperation with the Intergovernmental Oceanographic Commission (IOC) of UNESCO as it is responsible for the coordination of International Data Exchange (IODE) in Greece. HNODC runs many

projects and European activities. Further information on these projects can be found in the webpage http://hnodc.hcmr.gr/.

8.3.3 Terrestrial Observations

8.3.3.1 Overview

The main institutions that contribute to the national terrestrial observations are the Ministry of Environment & Energy (MEEN, http://www.ypeka.gr/), the National Technical University of Athens (NTUA, http://www.ntua.gr/), the Public Power Corporation (PPC, https://www.dei.gr/en), the Institute of Geology and Mineral Exploration (IGME, https://www.eagme.gr/) and the National Agricultural Research Foundation (NAGREF, http://www.nagref-her.gr/en).

8.3.3.2 Observation System on quantity/quality of surface water

The purpose of the EU Water Framework Directive is to establish a framework for the protection of inland surface waters (rivers and lakes), transitional waters (estuaries), coastal waters and groundwater. In line with the provisions of the Water Framework Directive, Greece has established and recently revised a national monitoring program for the assessment of the status of surface water and ground water, in order to obtain a coherent and comprehensive overview of water status within each river basin district.

The implementation of the Water Framework as well of the related daughter Directives fall within the scope of the activities of the Secretariat. The Secretariat, in collaboration with the Regional Water Authorities, formulates and, upon approval by the National Council for Water, implements the national monitoring program. The Secretariat is composed of four Directorates and is headed by a Special Secretary, appointed by the Ministry of Environment, Energy and Climate Change and the Government.

The revised monitoring program takes, among others, into consideration the analysis of pressures and impacts associated with each water body, and is fully operational from 2011. More than 600 surveillance and operational monitoring stations refer to surface waters (inland, transitional and coastal) and 1400 stations refer to groundwater (Figures 3 & 4). The program monitors biological, general physicochemical, and specific chemical parameters, as well as priority pollutants and morphological and quantitative data (http://www.ypeka.gr/Default.aspx?tabid=249&locale=el-GR&language=en-US). The data and information obtained are stored in electronic data bases, including the National Data Bank of Hydrological and Meteorological Information and the National Environmental Information Network and processed for reporting, and dissemination purposes.

For the implementation of the national monitoring program, the Special Secretariat for Water coordinates the following participating organisations:

- Directorate General of the General Chemical State Laboratory (GCSL, Ministry of Economy and Finance)
- Hellenic Centre for Marine Research (HCMR)
- Institute of Geology & Mineral Exploitation (IGME)
- Greek Biotope/Wetland Centre (EKBY)
- The Municipal Water and Sewerage Company of Larissa (DEYAL)
- Land Reclamation Department, Soil and Water Resources Institute, (Hellenic Agricultural Organization, Department of NAGREF)

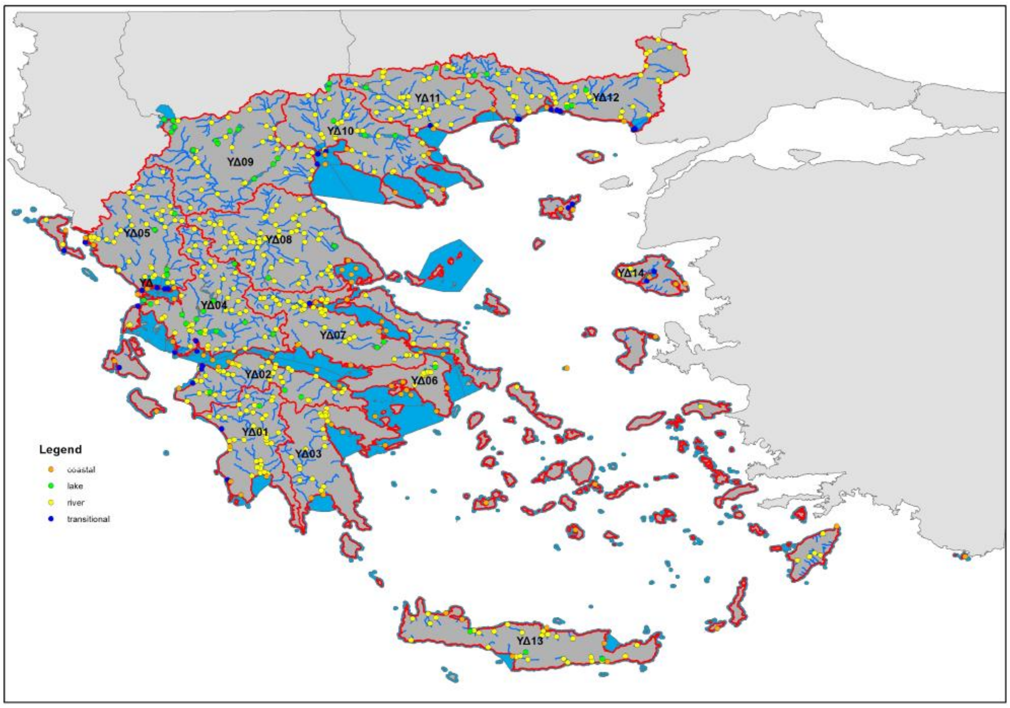


Figure 8.4 Network of surface waters

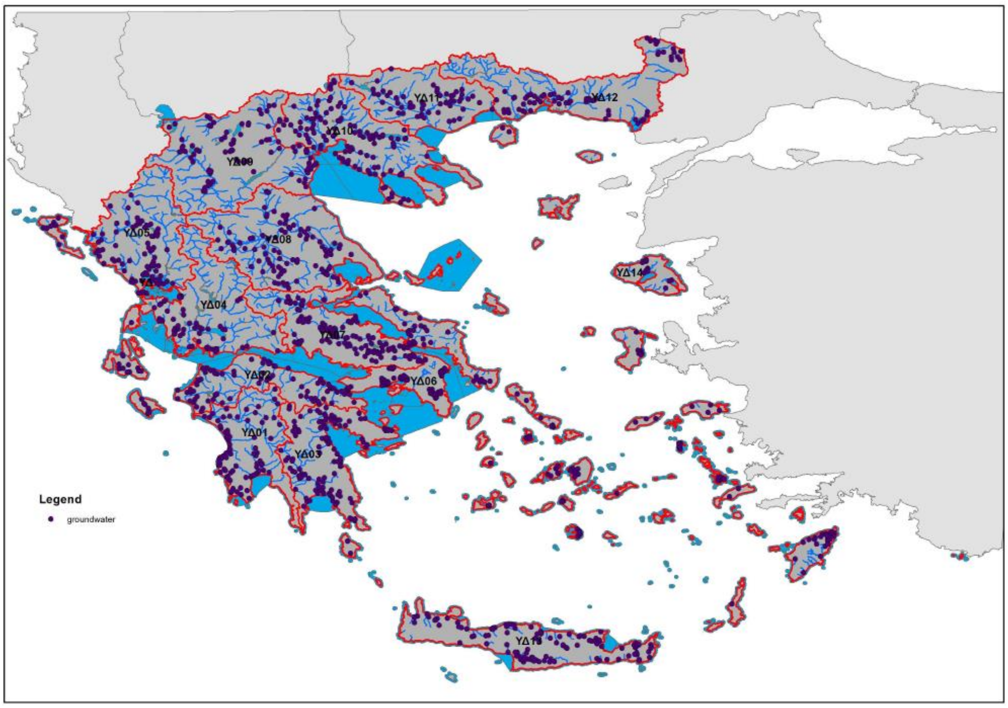


Figure 8.5 Network of ground waters

An effort for gathering all available meteorological and hydrological data in one database is the project of the National Data Bank of Hydrological & Meteorological (NDBHMI) which was assigned to the National Technical University of Athens (Laboratory of Hydrology and Water Resources) by the Ministry of Environment Energy & Climate Change. This project provides the required infrastructure for the implementation of the E.U. Water Framework Directive for the protection, rational management and exploitation of the water resources in the national level.

The core of the project was the development of a Data Bank (http://www.hydroscope.gr/) which will contain the total amount of hydrometeorological and hydrogeological data covering the whole country. The data are acquired from 2500 stations which are distributed in Greece and are placed by the participating organisations:

- The Ministry of Environment & Energy
- The Hellenic National Meteorological Service
- The Public Power Corporation
- The Ministry of Rural Development and Food
- The Ministry of Economy and Development

Various software applications are linked to the central Database of the project supporting the analysis and synthesis of the data and the elaboration of secondary information. The distributed form of the database allows a continuous online operation and exchange of data between the participating organisations.

Furthermore, the Ministry of Rural Development and Food and some of its supervised entities (National Agricultural Research Foundation (NAGREF), Forest Research Institute (FRI) and Greek Agricultural Insurance Organization), the Ministry of Environment & Energy and the Public Power Corporation operate an extended network of rainfall and snowfall gages. The network consists of more than 250 rain gages and more than 1000 tables to measure the height of snow. Furthermore, the Institute of Geology and Mineral Exploration (IGME) operates a large network of surface and ground water measurements.

Among these stations, only 46 hydrometric stations, supervised by PPC, meet international specifications so as to be able to contribute quality controlled data to the corresponding databases. The Ministry of Rural Development and Food also operates 277 (Ministry of Rural Development and Food: 240, Greek Agricultural Insurance Organization: 2, National Agricultural Research Foundation: 26, Forest Research Institute: 9) stations for the measurement of surface water quantities.

8.3.3.3 Observation System on quantity/quality of ground

IGME in corporation with the other Geological Institutes of Europe (www.eurogeosurveys.org) have prepared the «Geochemical Atlas of Europe» (http://weppi.gtk.fi/publ/foregsatlas/) using the Global Geochemical Baselines (a program of International Union of Geological Sciences, IUGS, and International Association of GeoChemistry, IAGC). In the framework of this global reference network, the following stations operate in Greece:

- 41 stations for the observation of residual soil
- 41 stations for the observation of floodplain sediments or alluvial soil of large catchment areas.
- 41 stations for the observation of overbank sediments or alluvial soil of small catchment areas.

Moreover, NAGREF operates four stations for the observation of ground temperature in two depths. The data from these stations are provided to the respective European Union services.

8.3.3.4 Forest ecosystem health observation

The “Institute of Mediterranean Forest Ecosystems and Forest Products Technology” is one of the oldest research institutes in Greece. It was established in Athens, Greece, in 1929 as the research arm of the Greek Forest Service. Its title soon changed to “Forest Research Institute of Athens” (FRIA) In its more than 80 years of operation, the Institute has produced excellent research always focusing on the research needs of the practicing foresters of the Forest Service.

In 1989 the Institute was integrated into the National Agricultural Research Foundation (NAGREF) and got its current official title. Both the historic name and the official title are currently in use. In 2011 NAGREF was merged with three other organizations of the Ministry of Rural Development and Food forming the Hellenic Agricultural Organization “DEMETER” to which the Institute now belongs.
Greece, and in particular the Forest Research Institute (FRIA), is a member of the ICP-Forests Network (International Cooperative Programme on Forests) of the UNECE and of the “FUTMON”, a Life+ and European Union co-financed project for the "Further Development and Implementation of an EU-level Forest Monitoring System". A network of plots (Level I and Level II) has been established in Greece and a number of parameters concerning the growth conditions are monitored on a regular basis. In particular, Greece has ninety one (147) Level I and eight (8) Level II plots, representing important forest ecosystems (Maquis, Oaks, Beech, Fir) and geological types of the country. The following parameters are monitored: crown condition, soil, foliage, increment, deposition, soil solution, meteorology, ground vegetation, phenology, air quality (ozone), and litter fall.

8.3.3.5 CO_2 flux measurements

A station for CO_2 vertical flux measurements has been established and operated for a number of years in Kalamata by NAGREF, in the frame of the research project MEDFLUX of the European Commission.

8.3.3.6 National Contribution

In ***Table 8.11*** the national contribution to the terrestrial domain essential climate variables is reported.

8.3.3.7 Satellite observations

Greece is a member of ESA and participates in basic, as well as in optional, research projects. Greece also participates in three actions of the Global Monitoring for Environment and Stability (GMES) program of ESA. In the framework of this program estimation of forest land change and of forest carbon reserves (GMS-Forest Monitoring) is performed.

Table 8.12 National contributions to the terrestrial domain essential climate variables

Contributing networks specified in the GCOS implementation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2010	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
GCOS baseline river discharge network (GTN-R)	River discharge					
GCOS Baseline Lake Level/ Area/Temperature Network (GTN-L)	Lake level/area/ temperature					
WWW/GOS synoptic network	Snow cover					
GCOS glacier monitoring network (GTN-G)	Glaciers mass balance and length, also ice sheet mass					
GCOS permafrost monitoring network (GTN-P)	Permafrost borehole temperatures and active layer thickness					
Global Terrestrial Network – Hydrology (GTN-H)	Available data from existing global hydrological observation networks	3	3	3	3	3

8.3.4 Cryosphere climate observing systems

Greece as member of ESA is participating in ESA's ice mission "CRYOSAT. ESA's Earth Explorer CryoSat mission is dedicated to measuring the thickness of polar sea ice and monitoring changes in the ice sheets that blanket Greenland and Antarctica. Its main payload is a SAR Interferometric Radar Altimeter, which is designed for ice, measuring changes at the margins of vast ice sheets and floating ice in polar oceans.

8.3.5 Support for developing countries to establish and maintain observing systems and related data and monitoring systems.

GEO-CRADLE is a GEO capacity building program in north africa, middle east, balkans, Black sea, and NOA acts as coordinator of it. The vision of GEO-CRADLE is to pave the way for the sustainable and continuous uptake and exploitation of Earth Observation services in North Africa, Middle East and the Balkans. The different activities undertaken by the GEO-CRADLE have been defined and are pursued in way that ensures appropriate coordination mechanisms and necessary tools are put in place during the lifetime of the project but are also used beyond that. Therefore, through the establishment of the GEO-CRADLE network and the parallel support of networking activities by a dedicated portal, the project aspires to ensure one of the fundamental requirements for coordinated EO activities; that is an attractive and comprehensive platform, named the Regional Networking Platform, where regional stakeholders can be informed on existing capacities, complementary skills and collaboration opportunities.

The GEO-CRADLE Initiative will be governed by key organisations having held leading roles in the implementation of the GEO-CRADLE project, NextGEOSS, ERAPLANET, and the e-SHAPE EuroGEOSS Showcase project. These organisations will be supported by a vibrant GEO-CRADLE Network covering several countries across the NAMEBA region, expanded to Black Sea. The National Observatory of Athens (NOA) will also act as the Coordinator of the GEO-CRADLE Initiative, carrying on its role as Coordinator of the GEO-CRADLE project.

Acronyms

AM&WFG	Atmospheric Modeling and Weather Forecasting group
AUEB	Athens University of Economics and Business
AUTH	Aristotle University of Thessaloniki
BSRN	Baseline Surface Radiation Network
CHI	Centre for Hydrology and Informatics
CRES	Centre of Renewable Energy Sources
DEMETER	Hellenic Agricultural Organization
DEYAL	Municipal Water and Sewerage Company of Larissa
ECVs	Essential Climate Variables
EKBY	Greek Biotope/Wetland Centre
ERDF	European Regional Development Fund
ESA	European Space Agency
ESEAS	European Sea level Service
EUMETSAT	European organization for the exploitation of Meteorological Satellites
FORTH	Foundation for Research and Technology
FP	Framework Programme
FRI	Forest Research Institute
FRIA	Forest Research Institute of Athens
GAW	Global Atmosphere Watch of WMO
GCOS	Global Climate Observing System
GCSL	General Chemical State Laboratory of Greece
GEOSS	Global Earth Observing System of Systems
GEOSS	Global Earth Observing System of Systems
GI	Institute of Geodynamics
GMES	Global Monitoring of Environment and Security
GMS	Geostationary Meteorological Satellite
GOOS	Global Ocean Observing System
GSN	GCOS Surface Network
GSRI	General Secretariat for Research and Innovation
GTN-G	Global Terrestrial Network – Glaciers
GTN-L	Global Terrestrial Network – Lakes
GTN-P	Global Terrestrial Network – Permafrost
GTN-R	Global Terrestrial Network – Rivers
GTOS	Global Terrestrial Observation System
GUAN	GCOS Upper Air Network
HCMR	Hellenic Centre for Marine Research
HNGS	Hellenic Navy General Staff
HNHS	Hellenic Navy Hydrographic Service
HNMS	Hellenic National Meteorological Service
HNODC	Hellenic National Oceanographic Data Centre
IAA	Institute of Astronomy and Astrophysics
IAASARS	Institute for Astronomy, Astrophysics, Space Applications and Remote Sensing
IAGC	International Association of GeoChemistry
IASA	Institute of Accelerating Systems and Applications
ICP-Forests Network	International Cooperative Programme on Forests
ICG/NEAMTWS	Intergovernmental Coordination Group-North Atlantic Mediterranean and connected Seas Tsounami Warning System
IERSD	Institute of Environmental Research and Sustainable Development

IGME	Institute of Geology and Mineral Exploration
IHO	International Hydrographic Organization
IMBC	Institute of Marine Biology of Crete
IOC	Intergovernmental Oceanographic Commission of UNESCO
IODE	International Data Exchange
IOFR	Institute of Oceanographic and Fisheries Research
ISARS	Institute for Space Applications and Remote Sensing
IUGS	International Union of Geological Sciences
LAP	Laboratory of Atmospheric Physics of AUTH
LRI	Land Reclamation Institute
MEECC	Ministry of Environment Energy & Climate Change
MRDF	Ministry of Rural Development and Food
NAGREF	National Agricultural Research Foundation
NCEP	National Centers for Environment Prediction in U.S.A.
NCSR	National Center for Scientific Reasearch, DEMOKRITOS
NDBHMI	National Data Bank of Hydrological & Meteorological
NKUA	National and Kapodistrian University of Athens
NOA	National Observatory of Athens
NSRF	National Strategic Reference Framework
NTUA	National Technical University of Athens
PPC	Public Power Corporation
PSMSL	Permanent Service for Mean Sea Level
RTD	Research & Technological Development
RTDI	Research, Technological Development and Innovation
SAFs	Satellite Application Facilities
SST	Sea Surface Temperature
TOMS	Total Ozone Mapping Spectrometer
TUC	Technical University of Crete
UAegean	University of the Aegean
UNESCO	United Nations Educational, Scientific and Cultural Organization
VOS	Volunteer Observing Ship
UOC	University of Crete
UPAT	University of Patras
VOS	Volunteer Observing Ship
VOSClim	Voluntary observing ship climate project
WMO	World Meteorological Organization

CHAPTER 9 EDUCATION, TRAINING AND PUBLIC AWARENESS

It is generally acknowledged that combating climate change will be a success only if the danger is widely known and understood by the public and especially by those who have to undertake mitigation and adaptation measures. This can be accomplished with intensive education, awareness and training efforts at all levels.

For this purpose, as part of the programme for the implementation of the Convention and the New Delhi Programme, and the relevant provisions of the Kyoto Protocol, Greece has carried out a series of actions, which are presented below, aiming at the integration of climate change issues at all educational levels and disciplines, the dissemination of information and promotion of participation of youth, stakeholders, and public, as well as the enhancement of cooperation and co-ordination at regional and international level to promote capacity building.

9.1 General policy towards education, training and public awareness

According to Law 1982/90 article 11 par 13, the Environmental Education is part of the programs of secondary schools. A year later, the law extends to primary education. The purpose of Environmental Education is to make pupils realise the relationship between man and the natural and social environment, to raise awareness about the problems associated with it and to engage them in specific projects in order to contribute to the overall effort to address these problems. The same law provides for the operation of the institution of the Responsible for environmental education and the establishment of Environmental Education Centers (EEC).

There is also a new strategy for primary and secondary level education, the “New School” (Law 3848/2010 and has been updated with Law 4473/2017) which makes the student the focal point of the educational system. The "New School" policy is based on five key principles: all-day, inclusive, digital, sustainable and innovative school.

The Educational Institute, with the Unified Cross-Thematic Curriculum Framework (DEPPS) (http://www.pi-schools.gr/programs/depps/index_eng.php), introduces the interdisciplinary approach to knowledge, the enrichment of curriculum with environmental issues and the link of the school with society. In the configuration of this framework, the pilot implementation of the "Flexible Zone" programme is included, where the Environmental Education takes its own time to the curricula of schools for teachers and students who want to link Environmental Education with natural, humanitarian and socio-economic sciences through exploratory cross-cutting approaches.

The themes of the Environmental Education stems from the necessity of protecting the natural, historical and social environment, through the enhancement of critical issues in accordance with local, national and global priorities, such as those made at the Summit on Environment and Development (Agenda 21, Rio De Janeiro 1992). As key priorities are proposed:

- Climate change - Protection of the atmosphere
- The air (air pollution in cities, etc.)
- Water (pollution and depletion of surface and groundwater, etc.)
- The soil (desertification, erosion, etc.)
- Energy (depletion of non renewable energy sources, overexploitation of natural resources etc.)
- Forests (protection and sustainable management of forests, etc.)
- Biodiversity / Extinction of species

- Waste management
- Human activities (structured spaces and the functions performed in those in urban and suburban green etc.)
- Human relations (social and economic dimensions of development and environmental issues, gender equality, human values, the problems of minorities, etc.)

Access of environmental information to the public is provided through the websites of the relevant Ministries and other governmental agencies. With the ratification of the Aarhus Convention by Law 3422/2005, Greece has posed legal obligations for the access of information regarding the state of the Environment. In addition, JMD 11764/653/2006 by which Greece incorporated the Directive 2003/4/EC on “public access to environmental information” into national legislation, seeks to increase public access and dissemination of information, contributing to a greater public awareness in decision making and environmental protection. According to this joint ministerial decision, “environmental information” includes information related to climate change such as: state of elements (among others air, atmosphere, water, coastal areas, biological diversity, and the interactions among them), factors (e.g. emissions, energy), policies and measures, reports, cost-benefit analyses.

The Greek Government gives high priority to public consultation and awareness. Draft legislation related to climate change, energy and environmental issues are open to public consultation before their adoption. A circular dated 1-12-2009 (No 7156) by the Minister of Environment and Energy reminds to the Ministry’s services the obligation to conform to the above legislation, and to enhance their actions to ensure the dissemination and easy public access to the information.

9.2 Primary, secondary and higher education

9.2.1 The structure of the education system

Education in Greece is compulsory for all children 6-15 years old; namely, it includes Primary and Lower Secondary Education. The school life of the students, however, can start from the age of 2.5 years (pre-school education) in appropriate institutions (private and public) (creches). In some creches there are also nursery classes which operate along with the kindergartens.

Attendance at Primary Education lasts for six years, and children are admitted at the age of 6. Along with the regular kindergartens and the Primary schools, all-day primary schools are in operation, with an extended timetable and an enriched curriculum.

Post-compulsory Secondary Education, according to the reform of 1997, consists of two school types: Unified Upper Secondary Schools and the Technical Vocational Educational Schools. The duration of studies in the first is three years and two years (a' level) or three years (b' level) in the Technical Vocational Educational Schools (TEE). Mutual student transfer from one type of school to the other is possible.

Along with the mainstream schools of Primary and Secondary Education, Special Kindergartens, Primary, Lower Secondary and Upper Secondary classes are in operation, which admit students with special educational needs. Musical, Ecclesiastical and Physical Education Lower and Higher Secondary education schools are also in operation.

Post-compulsory Secondary Education also includes the Vocational Training Institutes (IEK), which provide formal but unclassified level of education. These Institutes are not classified as an educational level, because they accept both lower secondary school and upper secondary school graduates according to the relevant specializations they provide.

Public higher education is divided into Universities and Technological Education Institutes. Students are admitted to these Institutes according to their performance at national level examinations taking place at the third grade of upper secondary education schools. Additionally, students are admitted to the Hellenic Open University upon the completion of the 22 year of age by drawing lots.

9.2.2 Primary and secondary education

In Greece, Environmental Education has been used as a pilot and preparatory programme in schools from 1976 to 1990 and was then instituted by Law 1892/90. This law was important for the establishment and development of Environmental Education in Greek schools. During the 90s there were three (3) Responsible Care Offices in each Country of Education, one for the Environmental Education, one for Health Education and one for the Cultural. Since the start of the economic crisis, since 2011, three (3) positions have ceased to exist, and now only one (1) has three items in its competence. Today these positions are called School Activities.

In the Greek schools it is implemented in three forms:

(a) Standard environmental education that is included in the school programmes. In the first 4 classes of primary school (ages 6-10) a special course named “Study of the Environment” and later “Environmental education” is focusing on natural and human environment, while environmental issues are also included in the material of other courses of the primary and secondary school (mainly physics, biology and chemistry). In addition, in all the school courses the development of conscious environmental behaviour is set out explicitly as an aim (for instance the Geography book of the 6th grade includes chapters that are dedicated to the climatic zones, the natural disasters and the effect of human activities on the terrestrial surface, while in the 5th grade pupils are well introduced to the natural geography and ecology of the country).

(b) Optional activities include the study of special environmental issues, usually from the school natural or social environment. These activities are on a voluntary basis and do not belong to the obligatory programme of school courses. They might include long-term (i.e. homework) or short-term (i.e. environmental visits) organised studies with the support of central or local educational authorities. The long-term activities (5th grade of Primary School-age of 9) are usually implemented through the formation of environmental teams of students that undertake, under the supervision of one or more teachers, the study of a concrete issue.

(c) Informal activities that reflect the environmental culture of each school and of the school environment.

In recent years, we have seen radical changes and rapid advances in science, knowledge, technology, the wider environment. For these reasons, Environmental Education is now oriented towards sustainable and viable development.

9.2.2.1 Ministry of Education and Religious Affairs (M.E.)

The Ministry of Education and Religious Affairs (M.E.) published in October 2007 and in October 2009 two circulars regarding the Planning and Implementation of School Activities Programmes including, among others, the environmental education. The first circular was mostly focused on forests, an issue that has been considered as a crucial after the catastrophic fires of 2007. The main axes in the school activities programmes were: 1. Forest and terrestrial ecosystems, 2. Forest and water resources, 3. Forest and human activity, 4. Protection of forests, 5. Forest and quality of life, 6. Forest and human health, and 7.Forest and culture.

The most recent circular (this of 2009) includes the following special issues of environmental education: 1. Management of natural resources, 2. Conservation of natural environment, 3.

Environmental degradation, 4. Environmental hazards, 5. Space, spatial management and use, 6. Human environment – parameters and degradation, 7. Quality of life.

The issue of climate change is especially treated in the Environmental Hazards category, while other categories include various aspects of climate change (i.e. forests, energy, renewable energy sources, biodiversity and endangered species etc.).

Both circulars provide the necessary information for supporting the planning of school activities, while all the proposals are submitted to the local Educational Directorates in order to approve their financing.

The Directorate of «Program Support and Sustainability Education» of the Ministry of Education and Religious Affairs coordinates and supports **the realization of environmental education activities** in primary and secondary schools, as well as in through the following educational structures:

- The support of coordinators per administrative structure at a national level: **Teachers Responsible for Environmental Education** per prefecture and educational level who design, co-ordinate and assist teachers in the implementation of the **School Activities Programs** for students of primary and secondary education which is the most wide-spread form of Education for Sustainable Development (ESD). The programs last from two to five months.
- The exploitation of the network of fifty-three (53) **Environmental Education Centers** (EECs) throughout the country. They are visited by school environmental teams and offer ESD programs that last from one to (1) to three (3) days. A current development in this field is the introduction of Law 3879/2010 for the Development of Lifelong Learning which allows for the implementation of programs for adult groups in EECs.

The Ministry of Education and Religious Affairs, in compliance with the UNESCO goals on Climate Change, has set up a program of action for the Decade of Education for Sustainable Development aiming at sensitizing **students** and cultivating attitudes that characterize active citizens as well as promoting **public** awareness through the opening of school to society. The duration of a program of Career Education, Environmental Education, Health Education, Cultural Affairs may be at least 5 months for D / Secondary and 2-6 months for the P / Secondary.

Indicative websites on basic principles and content of education for sustainable development are:

- Website of the UNESCO Education for Sustainable Development www.unesco.org/

- UN Decade of Education for Sustainable Development; final report: https://unesdoc.unesco.org/ark:/48223/pf0000230171

- Environment and Sustainable Development Education Unit: https://elearning.schools.ac.cy/index.php/el/monada-perivallontikis-ekpaidefsis

- Educational Television: https://edutv.minedu.gov.gr/index.php/perivalon-2

- Ministry for climate crisis and Civil protection: https ://www.civilprotection.gr/en including informative videos in the relative YouTube chanel: https://www.youtube.com/channel/UC7cMXhEAsyOdNb_f_3aeMSg

Under the M.E., the Educational Institute of Greece is providing substantial guidance on environmental education to teachers. In the respective website, entitled “Environmental Education”, the Institute suggests specific projects of environmental issues that could be applied by teachers regarding the climate, the forests and the energy forms (http://www.pi-schools.gr/perivalontiki/).

In addition the ministry has published guides addressing to the teachers with regards to environmental education. Some of them are:

- *Melas D, Asonitis G. & Amoiridis B., Climate change – Guide for teachers, Ministry of National Education, Athens 2000*

  The book consists of three main chapters in which guidance is given for the education on the understanding of the climate system (Greenhouse effect, Greenhouse gases etc.), the impacts of climate change (extreme events, sea level rise, water resources, biodiversity etc.) and adaptation to climate change (new circumstances, energy technology and policy, the UN convention on climate change etc.). The book addresses to teachers of both the Primary and the Secondary education.

- *Fermeli G., Roussomoustakaki-Theodoraki M., Chatzikosta Kl., Gaidlich M., Development guide of environmental educational activities, Athens 2008*

  The book consists of two parts. The first part addresses the theoretical approach to the environmental education and includes a section dedicated to "Air, Atmosphere, Climate Change". In the second part of the guide, practical and laboratorial activities are suggested to help the comprehension by the students. Special attention has been given to the measures that have been adopted to reduce GHG emissions and their impacts to the everyday life and to biodiversity.

Other books concerning environmental education are:

- *Troubis G., Troubis A. Flogaiti E., Discover and Understand the Forest, Greek company for environmental awareness & education, 1988*

  This book includes ideas and suggestions for educational activities for teachers, forest group leaders and parents. It consists of 3 Parts of which Part A: Includes theoretical Information, Part B: Educational Activities and Part C: General Information

- *Kalatzidis D., Ozounis K., Environmental education: Theory and action, Spanidis ed., 2000*

  This book describes the efforts of teachers to establish Environmental Awareness to students including Methodological Approaches to Environmental Education, Evaluation in environmental education, Educational games and Educational activities.

- *Liarakou, G. & Flogaiti, E., From Environmental Education to Education for Sustainable Development: Concerns, Trends and Suggestions. Athens: Nisos, 2007*

  At the beginning of the 21st century, education for sustainable development, with the support of international organizations, is claiming its own place in educational events. This new educational proposal, however, also raises a number of issues, which we try to address in this book. The relationships with environmental education, the different trends and interpretations that are formed, the concerns and objections that are expressed are elements through which we try to compose the image of emerging education for sustainable development and to substantiate our own proposals.

- *Flogaiti E., Mercan E., Gavrilakis K. & Liarakou G., Environmental Education in Primary School, WWF, 2008*

  "Environmental Education in Primary School " was published in 1995 by the WWF and the Foundation Bodossaki. The issues addressed are: Soil, Water, Sea, Forest, agroecosystems, Air, and Biodiversity. The material includes informative texts for teachers and 150 educational activities. This report contains the spread of forest land surface , the function of the forest ecosystem and regulatory capabilities available over the air, water and soil.

- *Dimitriou, A., Environmental education: Environment, sustainability, theoretical and pedagogical approaches. Thessaloniki: Epikentro, 2009*

  This book introduces new pedagogical tools such as discussion methods, role-playing games, computer simulations, methods of studying environmental issues outside the classroom, brainstorming, concept mapping. These are methods of encouraging experiential knowledge, necessary for every level of education, especially when the object of analysis is the environment. Thus, the importance of understanding the environment as a whole through the constructive approach of knowledge, collaborative learning, interdisciplinarity, cultivating values and critical thinking is highlighted. At the same time, the pedagogical methods that can contribute to the promotion of the objectives of the environmental education are analyzed and theoretically documented, while examples of applications in school reality are mentioned.
- *Georgopoulos, A., Environmental Education, Identity Issues. Athens: Gutenberg, 2014*

  In the first part of the book, an attempt is made to capture certain parameters of the Environmental Education (EE) that, as it seems in the last decades, concern key points of its identity. Greek education is narrated in order to give the context in which the EE has recently come to take a position and its relationship with the epistemological change in the field of pedagogy and environmental ethics during the post-colonial period is discussed. The second part examines the deficits that characterize the field of EE (especially in Greece) such as that of pedagogical training but also the dominance of behavior and proposes axes in the direction of its deepening and radicalization.
- *Dousi E., Climate change, Papadopoulos ed., 2017*

  Climate change, one of the most difficult and complex problems faced by humanity, is a totally real, a global threat. It is connected with critical sectors of the economy, the way of life and organization of our societies, our own way of life. Energy, food, legislation, business decisions, technology, transport, agricultural and livestock production, fuel selection and much more need to be discussed from the very beginning. Can the new international agreement become the vehicle for the transition to a low-carbon economy? What are the appropriate goals? And how do all this affect Greece? Finally, what are the challenges of the international climate governance system for climate change?

A. Programmes of Environmental Education

Under the Ministry of Education and Religious Affairs and the circular Φ11 / 160010 / Δ7 / 08-12-2021 related to "Design and implementation of School Activities Programs for the school year 2021-22" several environmental Education programs in Secondary Schools are implemented outside the program schedule. Environmental Education programs are implemented within the program schedule only:

- in the context of the Creative Activities in the A 'EPAL and

- in the Special Education School Units

For each environmental program, a two-hour timeline each week is defined, which is specifically appointed to the minutes of the Teachers' Association of the school that approves the program and which accompanies the program’s submission plan. The Environmental Education programs last at least three (3) months and are implemented at any time during the school year and up to ten (10) days before the end of the courses. Each teacher can implement up to three (3) school activity programs, of which one (1) as Coordinator. Each program can be supported by a group of (1-3) teachers (including the coordinator). Each student can participate in up to two (2) school activity programs. The participation of students requires the consent of their parents / guardians.

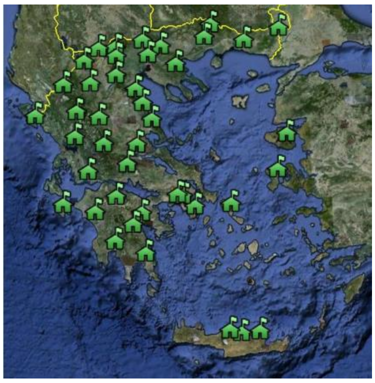
During the school year 2016-2017 only in Athens more than 200 environmental programs were implemented in schools of Secondary Education, in the two out of four “Directorates of Secondary Education”, with the participation of more than 150 teachers of Secondary Education. ***Table 9.1*** summarizes some of the recent Programmes related to climate change.

Table 9.1 Programmes related to climate change in Secondary Education School Units

PROGRAMMES RELATED TO CLIMATE CHANGE														
		Issue												
No	Title	Conventional energy	RES	Natural gas	Energy savings	Energy & transportation means	Pollution	Climate and city	Climate change - education & awareness	Greenhouse effect	Climate change and biodiversity	Desertification	Floods	Fires
1	Our energy choices and their impact on climate change				X									
2	Climate change and every day energy choices					X		X						
3	SOS Planet earth demands for the use of RES – Wind parks		X		X									
4	The bigger world experiment: prediction of climate of the 21st century								X					
5	Effect of forests on climate factors								X	X				
6	National network of environmental education: Climate change & natural disasters												X	X
7	Environmental impacts on Thriassion after the implementation of new investments in the area’s industries						X	X						
8	Energy saving at home, at school, in the city				X									
9	Environment and quality of life at Vilia								X					
10	Becoming and energetic citizen, taking care of the environment								X					
11	Electricity saving				X									
12	The green choice of auto mobility – hybrid cars					X								

Environmental Education Centres (EEC)

The Environmental Education Centres (EEC) are also involved in the implementation of educational programmes and activities. Currently 53 EECs are operating in Greece (https://kpe.inedivim.gr/), that provide educational programmes to scholars, organize training seminars for the educators, produce educational material, develop the thematic networks of schools, promote international cooperation actions for the training of educators, and develop activities in the local communities.



Environmental Education Centres (EEC) active in Greece

The thematic areas they cover are summarised below:

- Economy & Environment
- Natural Resources - Sustainable Management & Sustainability
- Biodiversity & Ecosystems
- Air Pollution & Climate Change

It should be highlighted that several seminars and workshops related to climate change have been developed in the EECs, referring to different aspects of the issue (tourism and climate change, wetland ecosystems, sea life and fisheries, biodiversity etc.).

An example of different projects implemented by EECs can be seen below along with the relevant students attending them.

Table 9.2 Examples of programmes related to climate change organised by EECs

No	Title	School Units			
		Nursery	Primary education	Secondary education	Special education
1	Free spaces and green in the city		X	X	
2	Garbage to throw away? No thanks!	X	X	X	X
3	Consumerism and the environment: Mobile phones in our lives		X	X	
4	Thessaloniki Sustainable city		X	X	
5	The Vertiskos forest	X	X	X	X
6	Energy from nature to society		X	X	
7	The climate is changing! How about us?		X	X	
8	Sustainable water management in the city			X	
9	Water scarcity in Nerochora!	X	X		X
10	Active citizen in my neighborhood		X	X	
11	Thermal springs and baths		X	X	
12	Environment and advertising		X	X	
13	Sheikh Sou: The suburban forest of Thessaloniki	X	X	X	
14	Urban green - Urban crops		X	X	

Also via the "Gate of Environmental Education" teachers get access to various types of educational material (videos, photographs, interactive worksheets) (Website: http://www.env-edu.gr/). There several topics are analysed and books and articles can be found: http://www.env-edu.gr/Packs.aspx

B. Education for sustainable development

In the context of the UN "Decade of Education for Sustainable Development 2005-2014", the Ministry of Education and Religious Affairs has planned various educational actions for the decade 2005-2014, aiming at the development of school activities that support the formation of energetic citizens and at the same time promote the opening of the school to the society.

The above mentioned actions include the following:

1. Institutional Actions

i. Constitution of the National Committee for the Education for Sustainable Development (ESD).

ii. Participation in the UNECE/UNESCO Steering Committee for the ESD.

iii. Identification of the national strategy for ESD, on the basis of international strategies – recording of indexes

iv. Introduction of the "Thematic Years" institution. In specific, each year has been dedicated to a specific issue as follows:

2006: Water – Blue Planet
2007: Consumerism & Environment
2008: Forest – Green Planet
2009: Agriculture, Alimentation & Life Quality
2010: Energy – Renewable Energy Sources & Local Communities
2011: Education over Human Rights
2012: Health and Productive Activities
2013: Human Environment & Sustainable Management

2014: Energetic Citizens

2. National thematic networks linked to climate change

i. Climate Change - Extreme Weather Conditions. The Environmental Education Centre (EEC) of Stylida-Ipati is the founder and coordinator of the National Thematic Network: ‘Climate Change –Extreme Weather Conditions’. The Network was established in 2008 and has been in operation ever since. During the school years from 2011 to 2014, one hundred and ninety –nine (199) schools have taken part in the network, i.e. five thousand four hundred and sixty seven (5467) students and four hundred and forty-seven (447) teachers of both primary and secondary education.

ii. The Laboratory of Life – Biodiversity. Based on the thematic unit ‘**Climate change and its impact on biodiversity**’, the EEC of **Kastoria** founded and coordinates the thematic network ‘**The laboratory of life- biodiversity**’. The network began its activities in 2003 and consisted of 22 EECs. During 2013-2014, forty–three (43) schools have taken part in it, i.e. one thousand five hundred and thirteen (1513) students and ninety-eight (98) teachers of both primary and secondary education.

3. Awareness

i. 6000 school activity programmes per year

ii. National, regional and local thematic networks of school activities (Biodiversity, energy, rivers etc.)

iii. Production of educational material at a regional and a national level.

iv. Pilot regional programmes

v. Cooperation activities with public institutions (ministries, secretariats, Centre for Renewable Energy Sources and Savings etc.), universities, NGOs (Hellenic Association for the Protection of Nature, WWF, Mom etc.), local communities.

4. Horizontal actions

Organization and coordination of school thematic activities and events at a national level (i.e. school competitions for recycling, conjectural laboratories of the thematic year, informational activities for climate change). Especially, in 2013 a competition named "Creation from zero" took place where students from all the high schools through the country participated. The competition aimed to raise awareness through art to students on how to contribute on reducing. The students were asked to create three-dimensional works using recycled materials such as plastic, aluminum, paper, etc.

5. International actions of coordination and Promotion

1 Official opening of the UN Decade for Sustainable Development in the Mediterranean, 2005.

2 International voluntary actions concerning environmental protection, preservation of cultural heritage, promotion of culture and social contribution (under the coordination of NGOs, such as WWF Greece, ELIX etc.).

3 Presentation of the Global Experiment in Greece under the Medies Project presented in 7th World Environmental Education Congress (WEEC, Morocco, 9-14 June 2013).

6. Publication of the Scientific Journal of EECs

Moreover, the Mediterranean Strategy on Education for Sustainable Development (MSESD) was endorsed in 2014 with the aim to promote the integration of the principles, values and practices of sustainable development into all aspects of education and learning. Moreover, it aims to ensure that national frameworks support ESD, promote sustainability through all levels and types of education, develop educators' competencies, and promote materials, research and cooperation on ESD. The MSESD is also included in the Athens Declaration of the Contracting Parties to the Barcelona Convention at COP 19 .Countries should be further supported to formulate and implement technically feasible, socially acceptable and financially viable projects. To this end, Greece has proposed a cooperation with the European Investment Bank with the aim to utilize the existing FEMIP resources in projects as well as the match capacities of the Mediterranean Component of the EU Water Initiative that has been led by the Government of Greece, to support climate change adaptation objectives in the Mediterranean region in the framework of Union for the Mediterranean (UfM). Amongst its achievements the following are included:

- Nine national and regional training sessions took place in Algeria, Cyprus, Egypt, Greece, Jordan, Palestine, Tunisia, supported by European Union, UNEP/MAP and UfM funds.
- 600 administrators and educators were engaged in interactive workshops and dialogue.
- Five national ESD policy frameworks were developed, considering the MSESD.
- 19 countries were technically supported in promoting ESD in their national contexts.
- One Flagship Project of UNESCO/GAP was dedicated to the Action Plan of MSESD.

C. Other Environmental Education Activities

- **School Programmes of Environmental Education**. The project has been implemented in the period 2002-2006 by the University of the Aegean. It involved the application of 4725 "School Programs for Environmental Education" to a substantial sample of school units all over the country with the participation of a large number of educators (approximately 14,000) and pupils (approximately 160,000) of primary and secondary education. The budget was 13.100.000.000 €, with a national contribution of 25%. It is worth mentioning that the project has been included in the Best Practices of the Community Support Framework in Greece (http://www.hellaskps.gr/bestpractices/proj_en.asp?pId=76).

The School Programmes of Environmental Education continue to be implemented in Greece, including the programmes that have been described above (circulars published by the M.E.).

National Thematic Networks of Environmental Education[28]. Their function is primarily aiming to: a. The organized scientific and educational support of Environmental Education program, b. The compilation of educational material, c. The development of communication between all members, d. The exchange of experiences and views between scientists and all members (teaching and student groups participating schools , coordinating bodies), e. Exchange of visits, f. Drawing conclusions and g. The formulation of proposals for actions of students and to mobilize relevant public bodies. Some National Thematic Networks are summarised below:

- National Thematic network EE "Biodiversity - the workshop of life"

[28] https://www.researchgate.net/publication/312371455_Ta_Ethnika_Thematika_Diktya_Periballontikes_Ekpaideuses_ton_Kentron_Dia_Biou_Matheses_gia_to_Periballon_kai_ten_Aeiphoria_os_Plaisio_Anaptyxes_Elektronikon_Koinoteton_Yphistamene_Katastase_Prooptikes

- National thematic network EE "Lakes: sources of inspiration for programs EE"
- Traditional settlements and Nature
- The caves of Greece in the Light
- The seismic arc that unites us …
- Bee Works, Human Goods
- Agriculture and the environment
- The international network on "Golden Green Leaf"

- **REWARDING RECYCLING Pilot programme**. The REWARDING RECYCLE has been considered as a national body aiming to the organization, development and operation of the Overall System of the Rewarding Alternative Management of Recycling Packaging and Waste. In this direction, the rewarding recycling has developed an Integrated Environmental Education Program. The basic components of the program are the following:

  – Installation and Operation of Recycling Centres in schools

  – Environmental Education Workshops using special printed and audiovisual material

  – Recycling Contests, promoting awareness and education about the benefits of recycling

  Only in Piraeus municipality 38.200 packages were recycled during Recycling Contests of 2017.

  Moreover, the "Panhellenic Educational Recycling Competitions" are implemented by the National Collective System REWARDING RECYCLING raising awareness and prompting the active participation of young people and especially students in the recycling process.

  More specifically, Panhellenic Educational Recycling Competitions at Secondary Education Schools and Sports Academies, have been working since 2018. Secondary school classes and sports academies from all over the country can participate. Classes are considered to be all the students (up to 25 students) that make up a school classroom. Sports Academy classes are groups of athletes of up to 25 people, who are enrolled in the same Sports Academy (valid for ages 12-18). Where Integrated Rewarding Recycling Centers and Environmental Education and Recycling Parks operate, students can return plastic, metal and glass items of packaging for recycling. At the end of the packaging recycling process at the high-tech recycling machines, the coupon for the Panhellenic Recycling Competition is automatically printed. Students or athletes collect these coupons, which they have to deliver to a certain place and date, to be announced before the end of the contest at www.antapodotiki.gr .The three (3) Secondary School classes or Sports Academy classes that recycle the most packaging receive three (3) unique gifts.

D. Digital games linked with environmental educational

i. A **digital educational game** designed by the EEC of Kastoria to teach primary and secondary education students about climate change and related issues. Responding to **99 multiple-choice questions** of escalating difficulty, learners get informed about:

- the difference between **weather and climate**
- the **greenhouse** effect
- basic aspects concerning **currently observed climate change and its effects** on natural environment

- **biodiversity** and human societies
- personal and collective actions required to **reduce greenhouse gas emissions**.

The educational material in question **is enriched** by a number of texts providing feedback on topics such as the **process of greenhouse effect** and the **nature of greenhouse gases**, the **impacts of climate change on biodiversity**, common **misconceptions of students** about the greenhouse effect and the **depletion of stratospheric ozone layer** and a brief **glossary** of related terms.

ii. The platform Mathisi 2.0 plus, dedicated to Innovative youth initiatives and good practices for the utilization of Internet Tools and Communities in the field of Education and Lifelong Learning. Under the tag "Tools" (https://mathisi20.gr/tags/t797/) several options are provided for learning in a fun way.

- http://persuasivegames.com/game/windfall
- https://el.watedu.eu/

The aim of the Mathisi 2.0 plus action is to help inform young people, pupils, students as well as teachers, parents and all parties interested in the new online tools and the collaborative opportunities they create, for education and lifelong learning. The overall target is to promote initiatives actively undertaked by young people, for the utilization and innovative use of online tools and digital media in the field of education and lifelong learning and therefore for highlighting the good practices.

E. Comenius: Europe in the classroom

The Comenius Programme focuses on all levels of school education, from pre-school and primary to secondary schools. It is relevant for everyone involved in school education: mainly pupils and teachers but also local authorities, representatives of parents' associations, non-government organisations, teacher training institutes and universities.

E-twinning (http://www.etwinning.gr/) is part of the Comenius Program, through which schools from different European countries, using Information and Communication Technologies (ICT), can cooperate towards educational, social and cultural benefits. The activity encourages students and teachers from European countries to meet each other, exchange ideas and create bonds of friendship and cooperation. The e-Twinning, since 2005, has enhanced the development of cooperative programs between schools and teachers. As part of the 10-year anniversary of e-Twinning, 6,000 eTwinning teachers took part in a survey which investigated how e-Twinning is affecting participating teachers' professional practice and professional development. Over 90% of teachers surveyed declared that their competence in teaching transversal skills such as team work, creativity, problem-solving, and decision taking were improved by eTwinning. Working on projects with teachers from different countries has a significant impact on teachers' project-based teaching skills, as well as foreign language skills for teaching. Similarly, 80% of teachers reported that their skills in teaching in a multilingual/multicultural setting benefited from taking part in eTwinning projects.

F. Digital Library

The **Digital Library**, http://repository.edulll.gr, developed by the National Documentation Center (EKT / ECB), offers easy navigation and simple and complex search, while from the home page the users are able to navigate through all topics of education and lifelong learning. The Digital Library includes the educational material and the studies that have been produced in the framework of the Operational Program 'Education and Initial Vocational Training' (EPEAEK I and II). The library includes useful educational material, studies and reports, books and manuals, as well as videos and presentations from workshops and conferences. The website, therefore, brings together, in a user-friendly way, rich content on intercultural education, pre-school education, lifelong learning, special education and a wide range of related topics, for students, teachers, scientists, researchers, but also to all citizens.

G. Collaborations

Apart from the exploitation and development of the administrative educational structures mentioned above, the Ministry of Education and Relilgious Affairs **co-operates with** the **Ministry of Environment and Energy** as well as with **local authorities** and **Environmental Non-Governmental Organizations** to promote Education for Sustainable Development, encompassing climate change issues. The Department of Environmental Education is committed to **informing schools, educators and the general public** of the educational activities and programs run by NGOs **by approving the upload** of all the necessary information at the Ministry's Official Educational Portal www.e-yliko.gr.

9.2.2.2 Ministry of Environment and Energy

The Ministry of Environment and Energy (https://ypen.gov.gr/), and in particular the Department of Climate Change of the Directorate of Climate change and atmosphere quality, is in close cooperation with the Ministry of Education and Religious Affairs in the context of the education for sustainable development. Since September 2021 a new Ministry was formed titled: ***Ministry for Climate Crisis and Civil Protection***, undertaking activities related to climate change (see Chapter 6).

However, the Ministry Environment and Energy has already published the following printed material that is available to all Greek schools:

- *"50 Simple Things Kids can do to save the Earth"*, Ministry of Environment and Energy, ISBN: 960840294-8.
- *"Kids, let's talk about the Environment"*, Ministry of Environment and Energy & National Centre for the Environment and Sustainable Development, September 2009.

Moreover, the Ministry of Environment and Energy has made great efforts to **maximize public awareness activities** at minimum cost. Their strategy is presented below:

1. Minimize printing
2. Establish sponsorships to provide the required material
3. Cooperate with national and local authorities as well as with a number of Associations and NGOs
4. Using CSR with environmental messages shown on screens on metro platforms and public transport
5. Ensure that all events are covered by National TV channels, radio stations and newspapers all over the country.

Forest Protection: A memorandum has been signed between the Ministry of Environment and Energy and the Scouts of Greece. Actions will be taken to raise awareness among members of the Scouts of Greece on forest protection and the natural environment, as well as on precautionary, forest protection and firefighting issues. The organised camps will be of a temporary nature (maximum 15 days) and after the end of the activity the forest area will be delivered clean and without damage.

Sea protection: Info kiosks were set to 29 popular beaches around the country providing information about water quality and beach protection.

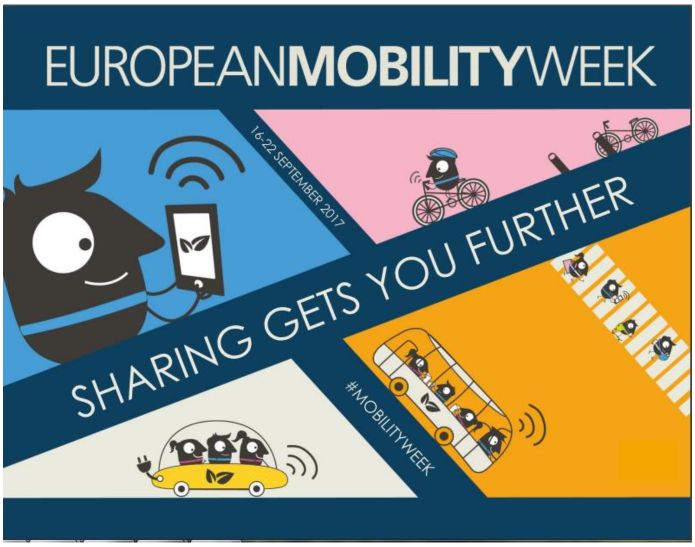
Activities of the Greek Scouts

Info kiosks at popular beaches

Biodiversity: Conference at the Acropolis museum about protection of local varieties.

Recycling: A number of workshops are organised every year in big cities. Activities include: floor games, treasure hunting, paper recycling, origami, seed planting, composting, photo competition, etc.

European mobility week: 87 Participants from Greece participated in the mobility week event. Many activities focused on the annual theme 'Clean, shared and intelligent mobility', some other were more general. As a decentralised campaign, towns and cities are responsible for organising their own events in line with the common guidelines. Input from National Coordinators and local campaigners, as well as the award applications from towns and cities are a very helpful basis for this selection.



Alimos in Greece, was a good example of how a small municipality can easily link their activities to the annual theme ('Clean, shared and intelligent mobility' in 2017). With this aim, the town organised a workshop to promote the new local bike-sharing system and make their citizens know about it.

9.2.2.3 Hellenic Association of Teachers for Environmental Education

The Hellenic Association of Teachers for Environmental Education (HATEE) (http://peekpesite.blogspot.gr/) has been established in 1992, and since then it aims at the mutual support, the exchange of views and the coordination between teachers within the framework of environmental education activities. HATEE is a scientific non-profit organization with a memorandum of association officially recognized by the Court of First Instance of Athens, which foresees the operation of branches in the greater regions of Greece (see also http://peekpeattikis.gr/). Its members are teachers from all educational stages who are involved in environmental education activities. The objectives of HATEE are the following:

- Communication and collaboration between teachers who deal with environmental education
- Exchange of information and experiences between teachers in Greece and abroad

- Promotion and support of environmental education programmes in schools
- Support of the Environmental Education Centres
- Studies, research activities and planning dealing with environmental problems in Greece

There is an increasing specialization of presentations given on issues such as climate change within the framework of HATEE activities, reflecting the intensifying knowledge requirements posed by environmental education on these technical issues. Also, the website of the HATEE provides a special area for further suggestions for school activities, including the climate change issue approach.

HATEE has organized conferences, workshops, meetings and seminars on issues related to environmental education. The conferences are being organized with the participation of Primary and Secondary Education teachers, researchers from Higher Education Institutions, Research Institutes, Higher Technological Educational Institutes, students and representatives of governmental and non-governmental bodies. HATEE has already organized 7 Panhellenic Conferences with great participation (over 500 people).

In 2012 the conference's main topic was "Education for the Environment and the Sustainability in today's reality", aiming to the:

- Valuation of over 20 years' experience on Environmental Education and its impact on our educational system
- Prospects, both in the context of Education for Sustainable Development and under upcoming institutional changes
- The content of the Environmental Education and Education for Sustainability with respect to the current social-economic-cultural and educational reality.

In Rhodes, on October 20, 2017, the 7th International Conference on Disaster Management was held with scientists from 11 countries. Preparing for 'Disaster Risk Reduction Training' has already been integrated by UNESCO into the three most important actions for the second half of the decade for Education for Sustainable Development, United Nations (2010-14), together with the education on climate change and education on biodiversity.

Moreover, the HATEE publishes quarterly the Electronic Magazine "for Environmental Education". All members can send articles and papers for publication to the editorial board of the magazine based in Thessaloniki.

The Attica Branch is the oldest in the country and always has a large number of members that has ranged from 20 to 1000. In 2018 it has about 150 active members. Their actions include:

- workshops and seminars
- programs in schools
- educational material
- environmental excursions
- meetings
- presentaitons
- publication of the booklet "Highly Educational"
- collaborations with Local Government, Universities and other scientific institutions, Associations and NGOs
- dialogue with Regional bodies and Directorates of Education
- distribution of the Union magazine to members

9.2.2.4 “Learning about Wind Energy"

A new information leaflet addressed to students aged 7-11 entitled "Learning about Wind Energy" was published by the Hellenic Wind Energy Scientific Association (ELETAEN), thus wanting to give the opportunity to young children in Greece to learn more about wind energy. The content of the form was initially prepared by the Cyprus Wind Energy Association SAEK, and then updated and reworded by ELETAEN.

The aim of this initiative is to be fun and educational at the same time. Through a series of activities (shapes, pictures, cryptos, paintings and crafts) children are encouraged to play and learn more about wind energy: such as how wind is created and measured, what are Renewable Energy Sources, how it works a wind turbine and so on. either at school with teachers or at home with parents. In the last pages of the form there is a guide for teachers and parents, which contains the solutions of the activities, as well as a series of useful websites from where relevant information on wind energy, information and educational material can be found. https://eletaen.gr/category/wind-energy-kids/ \

9.2.2.5 The MEdIES programme

MEdIES is a Type II Initiative on Education for Sustainable Development (ESD), supported financially by the Hellenic Ministry of Environment and Energy and officially approved by the Hellenic Ministry of Education, Research and Religion. Leading partners are also MIO-ECSDE together with UNEP/MAP and UNESCO. Its confirmed partners include several Ministries of Environment, Universities, IGOs and NGOs as well as schools.

MEdIES is an online network of teachers involved in Environmental Education or Sustainable Development Education (https://medies.net/). The website contains educational material and information in various languages. MEdIES aims to facilitate the educational community - educators and students- of the Mediterranean to contribute in a systematic and concrete way to the implementation of Agenda 21 and the Millennium Development Goals, through the application of innovative Educational Programmes for Environmental Education and ESD, addressing mainly water issues as well as other related aspects such as waste, consumption and production patterns and climate change with emphasis on adaptation (www.medies.net).

Examples of concrete activities, in the field, implemented in the context of MEdIES the last years, that are related to climate change, with funding, *inter alia*, from the Hellenic Ministry of Environment and Energy, include indicatively:

(a) Running Educational Projects

a. 2021 Asterousia Hybrid University: Since 2014, a series of Summer Universities jointly run by MIO-ECSDE and the UNESCO Venice Office have trained a number of young scientists and managers of Biosphere Reserves (BRs) from Europe, Mediterranean and beyond https://medies.net/project/2021-asterousia-hybrid-university/

b. Three projects for marine litter in Crete: The three projects aim to sensitise and motivate local communities in Crete in order to reduce the generation of marine litter and particularly of plastics including single use plastics (SUPs) by improving waste management. In this endeavour many target-groups are involved including fishermen, owners and staff of tourism and leisure businesses, but also the education community. https://medies.net/project/three-projects-for-marine-litter-in-crete/

c. STEAM education for plastic-free school: The project PLASTEAM “STEAM education for plastic-free primary schools” is a 30 months project co-funded by the European Commission under the Programme Erasmus+, Strategic Partnership. It aims to educate pupils from primary schools and their teachers in responsibly using, consuming and recycling plastic items. The project will inform them about the environmental impact of plastics and how to develop didactical activities for reducing the use of single-use plastics. https://medies.net/project/plasteam-steam-education-for-plastic-free-primary-schools/

d. SIDUMEF: SIDUMEF will co-create new open educational resources with the objective of fostering awareness among educators, youth and citizens on the tangible and intangible heritage of the Mediterranean diet. Ultimately it aspires to improve the "perceptions of the other" by exploring the different food cultures as well as the common responsibilities of sustainable consumption and production. https://medies.net/project/sidumef/

e. Plastic waste? Into the blue bin, away from the blue sea! : The project aims to sensitize students, teachers and citizens of selected Greek Islands on marine litter with an emphasis on single-use plastics and to stimulate a behavioural shift away from the single-use mentality, combined with effective daily recycling practices. https://medies.net/project/plastic-waste-into-the-blue-bin-away-from-the-blue-sea/

f. Long lasting projects also include ESD training courses, eligible for Erasmus+ KA1 grant, Summer Universities, Animation4Water: a Mediterranean Campaign on Water, The Mediterranean Strategy on ESD, A mobile exhibition on marine litter and The Mediterranean Universities Network for SD & ESD

(b) **Past Educational projects** in schools on energy and climate change topics based on the MEdIES educational materials:

a. Water for the City (Alexandroupolis) 2017. The programme aims to enhance the city water supply through increasing the capacity of the city's reservoir and promote good practices for sustainable water use in the urban environment, through the education of pupils and teachers, informing citizens and engaging local Operators. The Mediterranean Environment, Culture and Sustainable Development Information Office (MIO-ECSDE) through the MEdIES educational network coordinates the educational actions of the program.

b. Rainwater Harvesting in the Greek Islands 2009 -2016. The purpose is to inform and sensitize students and teachers to the issue of water saving, particularly through the revival of the practice of collecting rainwater in cisterns. It is targeted for late primary and early secondary school level (ages 10-15yrs), but it has been also piloted at younger (kindergarten) as well as older students (16yrs), with very satisfactory results. Only in 2013 activities 451 students and 105 teachers from the Dodecanese participated.

c. Education for Sustainable Development; Training Material. Addressed to trainers, officers of MAB Biosphere Reserves (BRs), Protected Areas (PAs), Environment Centres, Nature Parks, Eco-museums, NGOs, etc. within any "Designated Area" in SE Europe and the Mediterranean.

d. RUCAS-TEMPUS project. The main goal is to support the development of ESD in the Higher Education sector in developing countries (Egypt, Jordan and Lebanon) with the help of developed countries (Greece, France, Ireland, Italy, Sweden). The project is targeted to students, teaching staff and high rank administrators at the partner universities and in curricular sectors such as: educational sciences, applied sciences, social sciences, engineering, agricultural sciences, business and economics. An ESD student competency framework will be developed, validated and surveyed among undergraduate students across these disciplines.

e. HYDRIA Project. The overall objective is to unfold and present a small part of the diverse Mediterranean Cultural Heritage using as vehicle representative cases of past water management works, concepts and techniques. Hydria project was also presented in the Water Museum Conference, in Venice (2-4 May 2017).

f. SWIM H2020. The SWIM-H2020 SM Project (Sustainable Water Integrated Management and Horizon 2020 Support Mechanism 2016-2019) funded by the European Union aims to contribute to reduced marine pollution and a sustainable use of scarce water resources in the countries of North Africa and the Middle East (Algeria, Egypt, Israel, Jordan, Lebanon, Libya, Morocco, Palestine, [Syria] and Tunisia). Greece participates in the consortium with 4 entities.

(c) Some **Experiential Workshops and Conferences** for educators on the theme of climate change are summarized below:

a. "Regional Training on ESD /1st Meeting of the Mediterranean Committee on ESD", 22-24 Nov 2017: 60 representatives of Ministries of Education, Environment, Civil Society Organisations as well as of UNESCO Paris, UNESCO Office in Venice, UN Environment/MAP, UNECE, Secretariat of UfM and League of Arab States, participated in the meeting. 17 countries of the region were represented, namely: Albania, Algeria, Bosnia and Hergegovina, Bulgaria, Cyprus, Egypt, Greece, Israel, Italy, Jordan, Lebanon, Malta, Mauritania, Montenegro, Morocco, Palestine, Tunisia. The meeting successfully ended by identifying common areas of challenges in the application of ESD at national and regional level and proposing ideas for the way forward at the regional level, as regards the promotion and application of the AP/MSESD and its Committee. Additionally the representatives of the International Organisations reconfirmed their will to further support the process of promotion and application of the Mediterranean Strategy on ESD and its Action Plan.

b. "Three teacher trainings on Non-Conventional Water Resources educational material", 9-10 November 2016: All trainings aimed to elaborate on specific educational methods of the educational material "The other water". To this end, apart from the presentations on the overall Programme (by Mariella Antonakopoullou, GWP-Med), the educational material (by Vicky Malotidi, MEdIES) and how the material has been envisaged and used in Cyprus (by Anna Nikolaou and Klio Hadjisimou, Pedagogical Institute of Cyprus) the trainings included two experiential workshops:
(a) on educational drama, applying various drama techniques to revive the water related realities and challenges, some decades ago.
(b) on using models, and demonstrating how to construct and integrate a model in the teaching and learning process.

c. "Project Green Challenge" throughout October 2017: 30 daily green challenges for students around the world: Project Green Challenge (PGC) seeks to inform, inspire and mobilize high school, college, and grad school students globally. This powerful and diverse call to action features 30 days of environmentally–themed challenges. PGC aims to touch lives, shift mindsets, and equip students with knowledge, resources and mentorship to lead change on campuses and communities worldwide.

d. "AQUA 2008 Conference", 18 October 2008: The event was attended by aprox. 60 educators, while this year special emphasis was given to linking water education with climate change issues. A group of students participated also and they delivered a short role-play that they had themselves developed within their EE project, on the theme of water management.

(d) **Lesson Plans** related to climate change topics uploaded in the MEdIES webpage available for educators i.e. "The Greenhouse effect project"; "The climate change game", "MIO-ECSDE and MEdIES e-learning space" etc.

(e) **E-courses and web apps:** https://medies.net/category/resources/e-courses-web-apps/

9.2.3 Education in universities and technical education centres

The establishment of new departments dealing with environmental issues, and the enlargement of the scientific content of many existing ones during the recent years, have created a significant technical knowledge on climate change issues and their causes, both at the level of research as well as - progressively - at the level of higher education. This includes Universities, Technical Universities and Vocational Training Institutes (IEK). In general new thematic issues such as: active and passive systems in buildings, bioclimatic architecture, incorporation of renewable energy sources in energy planning, and investigation and analysis of the relation of the human community with the environment (artificial, social, cultural, natural), emerge, since it is recognized that the effective confrontation of climate change is linked to the provision of a number of services and products – such as accommodation, transport and supply of consumable materials - with new methods presenting lower negative environmental impacts.

Universities:

The Research Centre of Environmental Communication and Education of the Department of Environment of University of Agean is one of them (https://www.env.aegean.gr/research/research-laboratories/research-centre-of-environmental-communication-and-education/). The purpose of the research Centre is to cover under-graduate and postgraduate teaching needs at the Department of the Environment, and other Departments of the University of the Aegean, while promoting research of the theoretical framework and applications in Environmental Education, Communication and Interpretation through interdisciplinary approach. Consequently, research programs that are addressing issues related to the specialist fields of the Centre , such as evaluation, comparison and monitoring of the characteristics and environmental profile (environmental awareness , knowledge, attitude, behavior , action, participation) of the Greeks and generally Europeans citizens are implemented.

The Department of Environment of the University of Thessaly has a curriculum that includes structural sciences for the understanding of processes in the environment (Chemistry, Physics, Biology, Mathematics), as well as courses that will introduce students to the natural and structured Environment, Environmental Engineering and Environmental Geology. In the next 6 semesters students are familiarized with the three main areas (https://www.uth.gr/spoydes/proptychiakes/schools-departments/sholi-tehnologias/tmima-periballontos):

- Biological processes, Ecology and Ecosystem Management

- Economic and Sociological Approaches to the Environmental Sciences and
- Engineering Technologies and Skills in Environmental Sciences

The Department of Environmental Engineering of University of Patras aims to offer a comprehensive program of undergraduate and postgraduate education in the science of Environmental Engineering and to provide a curriculum that will respond to international developments in the field of Environmental Engineering and Environmental Engineering. The offered Curriculum fully satisfies the requirements and needs of the science of Environmental Engineering. (http://www.env.upatras.gr/el)

The Department of Environment of the Ioanian University, is based in Zakynthos, an island area connected with the study and research of the natural environment, and owns modern educational - laboratory equipment and infrastructure. Through the appropriately specialized subjects of its Teaching - Research staff, which cover a wide range of Environmental Sciences, and offers to its students a high quality of studies to acquire a professional level of knowledge and skills. The program of the Department aims at the qualitative and quantitative understanding of Physical, Chemical, Biological processes and their results in the environment and ecosystems, as well as in environmental technologies. The program is regularly harmonized with the international scientific developments, but also with the requirements of the professional, productive, and social axes of the country (https://envi.ionio.gr/gr/).

The Department of Biological Applications & Technology of the University of Ioannina, and the Biodiversity Conservation Lab aims to:

a. increase the biodiversity knowledge base through continuous field data collection and relevant biodiversity databases update

b. provide evidence-based solutions to major conservation problems by linking biodiversity research with policy and practice

c. train, educate and inspire young scientists in the field of conservation biology

d. promote biophilia, by disseminating biodiversity knowledge to the broad public and by engaging society to nature conservation (https://bc.lab.uoi.gr/en/)

It should be noted that many of the particular issues related to climate change are new and evolving. Consequently, the provision of education on these issues requires a permanent link between research and the educational process, with respect to both the content of education, as well as to the wider interdisciplinary approach into which this content is inevitably integrated.

The Department of Natural Resources and Environmental Engineering, TE, focuses the studies on the rational management of Natural Resources & the protection of the Environment through the application of interdisciplinary approaches and technologies. Specifically, the Department aims to provide knowledge and develop research in subjects related to:

- The identification, evaluation and rational management of natural resources,
- Renewable energy management technologies,
- Environmental protection, detection, monitoring and management of environmental pollution,
- Geophysics and natural disaster management, geoinformatics, sustainable development and
- Construction and design technologies

Vocational Training Institutes (IEK):

Technologist of Technological Applications and Installations in Landscape and Environmental Projects: Studies lead to the creation of qualified professionals with qualifications and skills, who will contribute to green development, ensuring the creation of functional and at the same time elegant public spaces.

9.2.4 Continuous education

The aims set for life-long education are the activation of citizens and teams for private and social development, the promotion of active participation and the increase of the social incorporation and occupation potential. The main mean to succeed in this area is the education of adults. Recognizing the rapid development of scientific fields and institutional frameworks related to climate change mitigation and adaptation, an increasing number of Greek scientific and educational institutions extend their activities in the area of continuous education, in order to contribute to the enhancement of scientific knowledge in public administration, private enterprises and the citizens in general.

9.2.4.1 General Secretariat for Youth and Lifelong Learning

The public institution that plans and executes the actions in lifelong education in Greece is the General Secretariat of Youth and Lifelong Learning (http://www.gsae.edu.gr/), that is functioning under the Ministry of Education and Religious Affairs.

Vocational Training Centers (KEK)

Centers of Vocational Training are established throughout Greece aiming to provide the required knowledge and skills to adults. Specific Centers of Vocational Training are specialized in adaptation to climate change and environmental protection, while creating the conditions for the integration and retention of trainees in the labor market (Green Jobs). Namely, during 09/2011 and 03/2013 about 7,500 people attended the training in the vocational centers participating in the program called “HUMAN RESOURCES DEVELOPMENT”. The aim of the project was the growth and creation of work opportunities associated with environmental protection and rational use of natural resources in the context of EU policies promoting environmental sustainability and combating climate change.

In addition, in certain Vocational Training Centres Educational training concerning RES is provided. More specifically, the Centre of Vocational Training of Agioi Anargyroi was founded in 1987, according to the EEC regulation 815/1984, and has been operating since 1994. An annual training programme is implemented in the Centre, entitled “Systems of utilization of Renewable Energy Sources”. In the context of the programme the following specialties are operating:

- Installations of Photovoltaic Systems and Wind Generators (180 instructive hours)
- Energy savings in Buildings and Industrial Areas (180 instructive hours)
- Solar systems for Heating/Refrigeration (160 instructive hours)
- Interior installation of Natural Gas Systems (140 instructive hours)

Lifelong Learning Centers

In order to support new policies and direct educational intervention at the local level the General Secretariat of Lifelong Learning has introduced in April 2012, the Operational Programme "Education and Lifelong Learning" Priority Axes 7 and 8, having a total budget of 65.000.000 €. By September 2012 121 municipalities have applied and during the second phase, which was completed on 14.01.2013, 94 more municipalities applied for membership and participated.

The program "Education and Lifelong Learning" Priority Axes 7 and 8, involve: a) updating and configurating 110 educational material kits, corresponding to 70 national programs and 40 local projects, which will be implemented by the Lifelong Learning Centers (LLC) and b) education of 4,000 adult educators, who will work in the LLC. The start of the project was set at 1.12.2012 and the end of the project is scheduled for 31.5.2014. 200 trainers and 4,000 teachers are anticipated to benefit from the implementation of the project.

These centers, as units and adult education system target to:

- Creating a positive attitude towards learning and promoting equal access to education
- Increasing adaptability in cognitive demands of a constantly evolving socio-economic aspects of action for adult citizens
- Connection or reconnection with the educational process of adults, who have not completed compulsory education
- Enhancing capabilities for accessing the labor market and career development
- Participation in the "society of knowledge and information" and access to new work, economic, social and cultural opportunities
- Upgrade conditions of education, work and social inclusion of vulnerable social groups
- Integration of ICT in adult education.

Currently there is a new era for the Lifelong Learning Centers (https://kentradiaviou.gr/thematikes-enotites/), as now the Municipality has the ability to decide and organize the educational and training programs that would be selected to be implemented in its region. This gives the opportunity to reverse the process of selecting educational programs, since the educational needs of citizens can be investigated first and the needs "translated" into learning programs.

The Program aims at the cooperation of the administrative bodies and the providers of lifelong learning services and aims at the wider implementation of the institutional system of provision of educational services to adults through the operation of Structures (Lifelong Learning Centers) that provide lifelong learning to all citizens. The purpose of the operation and implementation of the Program, among others, is the activation of the National Lifelong Learning Network, within the responsibilities of the General Secretariat for Lifelong Learning as a staff of lifelong learning, as provided in Law 3879/2010.

Second Chance Schools

According to Law 4763/2020, they are in the responsibility of the General Secretariat for Vocational Education and Training, Life Long Learning and Youth/Ministry of Education and Religious Affairs, which forms their educational framework and superintends them. To enroll one must have reached the minimum age of 18 years and at the same time one must have not completed compulsory education, having obtained a primary school certificate.

There are 66 Second Chance Schools (and 22 Branches) and 12 Second Chance Schools located within correctional institutions. Second Chance Schools operate at all Districts. During school year 2020-2021 there were 5.903 learners enrolled at Second Chance Schools (2.349 graduates).

The SCS program, co-funded by the European Social Fund (ESF) and the Greek State, started in Greece in 2000 with the operation of the first SBS in Peristeri, and was based on three basic principles:

- flexible training program tailored to learners' skills and needs, thus ensuring their active participation
- support them in all areas where they have difficulty
- training staff and counseling services capable of responding to the complexity of the tasks they undertake

A large proportion of SCS graduates continue at the next level of education (EPAL, General Lyceum) and some have advanced to the University.

Environmental Education is one of the 8 courses of the SCS and is being instructed for 2 hours per week during both years of attendance. In addition, in the framework of the cross sectional Projects and Laboratories, the participants have the chance to further work on Environmental

Education Issues. The course is supported by the elaboration of specific educational material that aims at:

- The awareness of participants over environmental issues
- The acquisition of variable experiences and basic knowledge on environmental issues
- The modulation of principles and the development of interest on the environment, further enhancing the participation in environmental protection and improvement actions
- The acquisition of the appropriate capacities to identify and solve environmental issues
- The acquisition of the capacity to take action and participate to all the available levels of prevention of environmental issues.

9.2.4.2 Summer schools

Several summer schools are being implemented in the recent years in the Greek territory with reference to environmental issues. Some of them are presented below.

12th Summer School for the Training of Young Scientists, organized by the European Center for Environmental Research and Training of the Panteion University in Agia Pelagia, Kythira (30/9 - 6/10/2016): At this year's 10-year anniversary event in Kythira entitled "Environment and Sustainable Development. Blue Economy and Energy Planning" 25 participants participated (PhDs, doctoral candidates and postgraduate students) from universities in Greece and abroad. The purpose of this year's seminar was to explore the prospects of the Blue Economy as a driver of Sustainable Development at national, European and global level as well as to examine the role of Energy Planning as a prerequisite for energy security with low environmental impact. The targeting of the program was based on four pillars: pluralism, interdisciplinarity, awareness and training, and the group of teachers was composed of experienced and young scientists with interdisciplinary backgrounds as well as professionals from energy production and management (https://greenagenda.gr/).

2nd Summer School organized by the Hellenic Society for the Protection of Nature (HSPN), Skiathos, July 2016. The Summer School was organized by the HSPN, in collaboration with the Cultural Association "Skiathos", the Ministry of Education and the Primary Education Directorate of Athens, within the framework of the International Thematic Network for Environmental Education "Learning about Forests". During the Summer School, thirty-five teachers of all levels from across the country were invited to reflect, sensitize and introduce new learning processes focusing on the students and having as a point of reference the love for the forest. Experiential workshops and teaching methods presented by experienced teachers in the field of environmental education had the ultimate goal of highlighting the importance of environmental education in the early formulation and raising environmental awareness among students. According to the announcement, the environmental games that took place in the forest, such as the important habitat of Koukounaries (NATURA 2000), invited the participants to use all their senses and filled them with satisfaction, especially to those who had participated in the planting of 1,000 pine trees last November in the area, after finding that almost all the seedlings "grew up" along with the students who planted them.

Summer School entitled: "Clean Energy - Clean Environment: Technological Solutions and Prospects", Kozani, June 23 - l July 7, 2016: The Department of Mechanical Engineering of the University of Western Macedonia organizes the 4th Summer School entitled: "Clean Energy - Clean Environment: Technological Solutions and Prospects". Some of the covered topics include:

- Environmental Challenges of the Energy Sector
- Anti-pollution technologies in Energy Generation Units (Particulate Gases)
- Examples of Design of Antifouling Technologies

- Biomass, potential energy recovery
- Synthetic Fuels
- Hydrogen technologies
- Examples of Biomass and Hydrogen Process Designs
- Introduction to Mild Energy Forms & Applications
- RES systems for building applications

1st Summer School entitled "The Journey to Sustainability", organized by the Hellenic Society for the Protection of Nature, within the framework of the International Environmental Thematic Network "**Ecological Schools**", July 2017: Experiential workshops were attended by 30 teachers from 40 schools across the country, who experienced the transition to a sustainable school and had the opportunity to follow the good practices of implementing the program in schools. Through the diffusion of good environmental education practices the Summer School passes a resounding message of action to:

- Involve citizens in the protection of the environment.
- Make more environmental education programs in schools.
- Raise awareness among environmental education teachers.
- Raise awareness among students about environmental protection.
- Sensitize more entrepreneurs to the protection of the environment.
- Make more actions for the environment in Crete and all over Greece.

EcoDAR-2017, Ecological Data Analysis, Mitilini, 10-15 July, 2017: Within the framework of the Summer School, a wide range of classical and modern statistical methods were presented, through their application towards facing modern ecological issues. The widely used and extensively evolving programming language R was used as a data analysis tool. This initiative taught internationally distinguished scientists in ecological data analysis and statistical ecology. Twenty-four scientists from Greece, Cyprus, Svolvah, England, Israel and Germany participated. The Summer School was under the auspices of the Hellenic Ecological Society.

Summer School 2019 - Clean Energy and Sustainability. This Summer School is the first of a series which is organized in the frame of the strategic cooperation between the Karlsruhe Institute of Technology (KIT) and the Aristotle University of Thessaloniki (AUTh). The Summer School is organized and hosted by the AUTh. It is mainly intended for doctoral students and open to applicants from all research institutions. The Summer School consists of plenary lectures on Circular Economy, Climate Change, Energy Transition and Environmental Observation as well as extended courses organized in parallel streams. The following topics will be covered:

- Climate Change – Climate Impacts – Clean Energy
- Clean Air in Cities
- Bioenergy and Clean Combustion
- Sustainable Use of Water Resources

The **9th Summer School in Environmental Journalism** is organized by the Department of Journalism & Mass Media of the Aristotle University of Thessaloniki, in collaboration with the Laboratory of Journalism Studies and Communication Applications of the Department of Communication and Mass Media of the National and Kapodistrian University of Athens. The Summer School will take place at the premises of the Provincial Press Institute (host organization) in Chania, Crete, from 17 to 26 July 2020. Within the framework of the program, educational excursions and workshops will be held, in collaboration with local bodies, while special creative writing workshops will be developed with the aim of producing and publishing a leaflet on environmental issues.

"SUMMER ACADEMY OF ENVIRONMENTAL TRAINERS 2020" was organised on the island of Skyros from 6 to 12 July 2020 aiming to promote a new way of practical environmental communication and education, where the participating trainees act as educators to health.

9.2.4.3 Centre for Renewable Energy Sources and Saving

The Centre for Renewable Energy Sources and Saving (CRES) is the Greek organisation for Renewable Energy Sources (RES), Rational Use of Energy (RUE) and Energy Saving (ES). CRES has been appointed as the national co-ordination centre in its areas of activity, and its main goal is the research and promotion of RES/RUE/ES applications at a national and international level, as well as the support of related activities taking into consideration the principles of sustainable development.

In this frame, CRES systematically undertakes educational and training activities addressed both to professionals who are active in these thematic fields, as well as to pupils and students in all educational stages. The educational activities include inter alia the production of printed, electronic and audiovisual material, which is distinguished in training material and educational material (http://www.cres.gr/kape/education.htm):

- Education and Training System for Clean Carbon Technologies - CleanCOALtech
- Energy Control and Industrial Logging Guide
- Combustion and Kiln Combustion Guide
- Energy Saving Guide to HVAC Systems
- Energy Saving Guide through Thermal Insulation
- Energy Saving Guide at Industrial Cooling
- Book: Energy and its Sources (for teachers and students)
- Renewable Energy Handbook for High School Students
- Guide for Students of Thermal Solar Systems.

Apart from that, CRES has developed the Park of Energy Awareness (PENA), in order to present RES technologies through real small scale energy systems and to offer its guests the opportunity to be informed about the potentialities and the benefits of the environmental friendly energy technologies. PENA (http://www.penaproject.gr/) was developed in the 3.01 MW Demonstration Wind Farm that CRES operates since 1998. The project was co-funded by the O. P. “Competitiveness” of the Greek Ministry of Development and the Greek State.

The boundary of the park is marked by a wooden pathway lit by photovoltaic cells. Along the route, visitors encounter educational displays and energy demonstration displays on the various forms of renewable energy. Two electric vehicles are also available for the use of visitors with special needs. PENA is the first integrated installation in Greece that offers a successful combination of informational, demonstrative and educational activities in RES.

9.2.4.4 Hellenic Manpower Employment Organization (OAED)

OAED is organising training activities of beneficiaries in the framework of the act: "Promotion of employment through Public Benefit Programs for 36,500 people in Municipalities, Regions, Social Welfare Centers of Regions (KKPP) / related bodies, Services of Ministries and other bodies". The action includes:

- Placement in a specific employment position for 8 months in Municipalities, Regions, Regional Social Welfare Centers (KKPP) / related bodies and Services of Ministries and other bodies.

- A theoretical training program of up to 150 hours which will lead to the certification of the knowledge and skills that will be acquired within the training program.
- Training subjects: Participation in the training will be mandatory for beneficiaries up to the age of 54. In particular, the programs are included in the following priority areas:

- Upgrading the services provided to the citizens by the Local Government bodies, such as the upgrading and maintenance of municipal infrastructures, the upgrading of the operation of the municipal services with emphasis on the promotion of the use of information and communication technologies (ICT),
- Support and improvement of education services,
- Improving the provided social services and public benefit services of the Public Administration to the citizens who are in need due to the consequences of the financial crisis,
- Ecological actions for the protection of the biodiversity of protected areas with the aim of developing and preserving sustainable populations and ecosystems,
- Landscaping / maintenance services,
- Transition to the circular economy,
- Prevention of natural disasters,
- First aid,
- Senior care skills,
- Construction work.

9.2.4.5 Environmental Education Centers (KPE)

Environmental Education Centers (KPE) count 30 years of presence, with the first K.PE. Klitoria Achaia that started operating in 1993. The network of K.P.E. was consolidated and further developed thanks to the development programs of Greece (B’ and C’ Community Support Framework). The number of K.P.E. increased to 53 centers operating today throughout Greece. The Environmental Education Centers are a network of decentralized sustainable public educational structures of the Ministry of Education and Religious Affairs, with the object of environmental education and its support at local, national and international level. The ultimate goal of environmental education is to cultivate environmental awareness and sensitize students to understand the environment holistically but also to approach it interdisciplinary. Through the action of KPE, standard training methods are developed, promoted and implemented based on the preservation of the Environment and Sustainable Development.
The field of activities of K.P.E. defined by:

- The implementation of Environmental Education programs (EP) for all levels of education and the support of the respective school programs, in collaboration with the Heads of the Directorates of Education
- The production of educational - support material
- The organization of events and actions for the environment and sustainability
- The promotion of research in the field of Environmental Education
- The diffusion of the course and the results of the action of K.P.E. (communication strategy)
- The thematic units in which the actions implemented in the respective Environmental Education Center fall are related to the peculiarities of the natural environment of the area in which it is located in order to promote the characteristics and the identity of the place.

Indicatively, the topics concern:

- Natural environment (Ecosystems, biodiversity) - Conservation & Degradation
- Sustainable Development
- Waste management
- Human intervention - consequences

- Natural resources (water resources, forests, land uses)
- Climate change
- Urban & suburban green - Utilization, conservation & protection
- Energy sources
- Ecological footprint
- Recycling
- Composting
- Air pollution
- Sustainability Education (EA)
- Extension of existing thematic units focusing on their social, environmental and economic status

9.2.5 Non governmental organisations and educational activities

A substantial number of environmental non-governmental organisations (NGOs) are active on environmental education issues, promoting at the same time awareness on specific environmental issues.

The **Hellenic Society for the Protection of Nature (HSPN)** is the oldest national environmental NGO in Greece, operating continuously since 1951 throughout the country for the protection of nature. From its very inception it has been at the forefront of efforts to establish national parks, to protect habitats and threatened species of fauna and flora, and to modernise and implement environmental legislation. For many years the HSPN functioned as a kind of nursery, mainly through the encouragement Antipas gave to young Greeks to promote nature protection: from it developed other more specialised organizations such as the Hellenic Ornithological Society, the Sea Turtle Protection Society of Greece, and the Hellenic Society for the Study and Protection of the Monk seal (Mom). The HSPN is a member of important environmental organizations such as the International Union for the Conservation of Nature (IUCN). It also represents the Foundation for Environmental Education (FEE), a worldwide educational organisation, and it operates all five of FEE's international programmes for environmental education and sustainable management. Today the HSPN is active in 4 main areas:

- 1. Environmental Intervention. The HSPN intervenes with the public services and with various governmental agencies regarding violations of national or European environmental regulations and laws, or serious threats to the environment. This is done through direct contact, letters or press releases, or, in cases of serious infringement of laws, through legal action usually in the Council of State, the Supreme Administrative Court of Greece. Examples of this latter form of intervention are the cases against the State over the illegalities in the water-diversion project of the Acheloos and Nestos rivers, and the non-compliance with EU regulations requiring the creation of a forest registry, controlling illegal use of poisoned baits, effective protection of specific Natura 2000 sites, etc. These important cases are often undertaken in cooperation with other national environmental NGOs.

- 2. Nature conservation projects. The HSPN has implemented, alone or in cooperation with other NGOs, a variety of conservation projects. The most recent include:

  – Promotion of the Natura 2000 network in Greece (2004)

  – Creation of the "Otter Trail" along the Arachthos River (2008-2009)

  – Programme for the Protection and Management of the Oak Forest of Foloi in the Peloponnese (2008-2011)

– Re-planting of the Communal Land of Arachamita, in the Peloponnese (2008-2012)

– Project LIFE11 NAT/GR/001014 ”ForOpenForests” (ongoing since 2012)

– Biodiversity assessments in Macedonia and Milos (2014-2015)

– Project ICON (2015-2017): This 15-month project is implemented as part of the “Civil Society Dialogue between EU and Turkey - IV Environment Grant Scheme (CSD-IV/ENV)”.

– Project LIFE14 GIE/GR/000026 ”Natura THEMIS” (ongoing since 2015)

– Project INTERREG MED ”POSBEMED” (ongoing since 2016)

Ongoing projects include (https://www.eepf.gr/en/project/actions/works-in-progress):

- The project "WaysTUP!" has a duration of 42 months and is funded by the Horizon 2020 Programme. The project is about turning urban biowaste into biobased products.

- The project “POSBEMED2 – Governance and management of Posidonia beach-dune systems across the Mediterranean” is conducted under the programme InterregMED, has a duration of 32 months, started in November 2019 and it is co-financed by the European Regional Development Fund.

- The project "Ecological Understanding of Risks of the Environment through a deeper Knowledge and Awareness - EUREKA", has a duration of 24 months, is funded by the Programme Erasmus+ and is implemented in Greece, France, Italy and Turkey.

- The Project LIFE17 GIE/GR/000511 ”LIFE PRIMED” is co-financed by the European Union Life Financial Instrument. The HSPN is the coordinating beneficiary of this 5-year LIFE+ project for the protection of priority habitats and species in two Natura 2000 sites, one in northern Greece (Nestos Delta), and another in central Italy (Palo Laziale).

- 3. Environmental Education

  – Eco-Schools” (FEE international programme). Each school studies problems that have to do with energy, water, waste management, resource conservation, etc., and comes up with practical solutions. This FEE international Programme started in Greece in 1995. It involves schools of all educational levels. When a school has completed its Action Plan, it is evaluated by the appropriate committee and if the results are favourable it is awarded with a Green Flag. (see www.ecoschools.global, http://ecoschools.gr/).

    – “Young Reporters for the Environment” (FEE international programme). The students analyze a serious environmental problem, most often one which concerns their local community, frequently in cooperation with students from other European countries. The students have to write up and present these themes, like reporters, and communicate them from one school to the other using the Internet. The network is part of an international Programme, and started in Greece in 1993. It is addressed to secondary level students.Groups of students, in collaboration with other schools that participate internationally in the Programme, address various common environmental problems as journalists, and using the Internet as a communication tool. Hellenic Industry of Aluminium has supported the Network during the year 2019-2020 and especially the Action “Circular Economy – Society ; the voice of the youth”. (see www.yre.global).

- “Learning about Forests” (FEE international programme). This FEE international Programme started in Greece in 2001. Its goal is to encourage schools and teachers at all levels to include forests in their educational activities, providing them with the necessary tools and incentives to reach forests and learn from them. The students receive information about forests, their biological functioning and their uses, and practical applications of this knowledge are demonstrated. Students are then called on to implement what they have learnt, frequently in the forest itself (www.leaf.global). MYTILINEOS S.A is the new sponsor for 2019-2020 and suports the new action of the network "Information and sensibilitization of the school community, regarding the prevention and management of forest fires and forest conservation".

  - “Nature without Garbage” (National programme). Teams of students work with local authorities to make public opinion in their areas more sensitive to better ways of handling waste and combating all forms of pollution. The Programme was designed by the HSPN and started in 1996, initially with the help of a volunteer group. Its aim originally was the collection of waste, but it has since expanded to include awareness-raising of students, and through them of the public, about waste management issues and the need for a clean, tidy environment. ALPHA BANK had supported the Network from 2004-2019. (http://eepf.gr/el/drasi/fysi-xwris-skoupidia).

- “Green Corners” (National programme). Students (6-16 y.o.) are given educational material about nature and wildlife within urban environments, and then are called upon to observe and interact with nature in the field, in all its little refuges in their towns and cities (http://eepf.gr/el/drasi/prasinesgonies). The Programme was and started by the HSPN in 1999, and is aimed at schools of all education levels. Students chose some small green corner of their urban area and their environmental awareness and study its fauna and flora of the urban environment. 4. Raising awareness among the public on environmental issues.

  - “Blue Flag”. Since 1992 the HSPN has been the national operator of the Blue Flag, a programme which aims at the ecological management of beaches, marinas and tourist boats.

  - “Green Key”. The HSPN has operated this programme in Greece since 2009. It awards the “Green Key” eco-label to those hotels, restaurants and conference centres that successfully meet the required strict environmental criteria.

Arcturos protects the Brown Bear, Wolves, Greek shepherd dogs, Chamois, European otters, Red deers, Red deer, Lynx, Golden jackal and flora (http://www.arcturos.gr). Arcturos’ actions on environmental education are addressed to children aged 8 to 15 years. Through these actions students are informed about the prospects for survival of the bear and the importance of the environment in areas such as Grammos and the Rhodope region defined by mountains and Verno and Varnounta (“Forest, home of the Bear”, “The Cartographers of Verno and Varnounta” and “Grammos, Rodopi - Maps of my country”)

The **Hellenic Society for the Study and Protection of the Monk Seal Mom** (https://www.mom.gr/home) MOm carries out environmental education activities throughout Greece with a special focus on coastal and insular areas. The goal is to educate school children, our future generation, about the critically endangered status of the Mediterranean monk seal and its habitat and how they can become active in their protection. This is done by challenging their learning process and their critical thinking. The environmental education programs of MOm have been officially approved by the Hellenic Ministry of Education and have been attended so far by more than 250,000 school children in the country. Furthermore, each year MOm carries out during the summer months the environmental program “The school of the monk seal”. At the Information Center of MOm at the island of Alonissos young children learn about environmental protection through a variety of interactive activities, such as theatrical plays, treasure hunts etc. The Environmental Center has also a children’s library with more than 1,300 different books.

Acknowledging the increasing role of the internet in the education process, MOm has also developed several educational websites:

• www.monachoulis.gr. This is the main environmental education website of MOm, containing information about the Mediterranean monk seal and the environmental education material of MOm. The target group of the site are school children but also teachers seeking to enrich their curriculum with information regarding the protection of the Mediterranean monk seal and the marine environment in general.

• www.thalassapedia.gr/en/. This website was created within the framework of the European program Life “Thalassa” and contains information regarding the marine mammals in Greece, the threats they face and ways to help save them.

• http://mofi.mom.gr/ekpaideysi.htm: This is the educational outlet of the project MOFI that was carried out by MOm in 2006 - 2009 throughout coastal and insular Greece with the aim of mitigating monk seal – fishery conflicts. This website contains a link to a book on sustainable fisheries.

Kallisto (https://www.callisto.gr/en/organization) offers Environmental education for pupils since 2004. Kallisto's programs aim at understanding the necessity of preserving wildlife and nature and, on the other hand, cultivating volunteering in actions to protect Greek forests.
The environmental education program focus on:
- Designing, developing and implementing environmental education programs aimed at students and teachers of all levels of education. We emphasize experiential learning activities and our goal is for children to participate in the process of their environmental awareness, through modern activities and games.
- Participating in events and festivals with organized environmental education activities for all ages.
- Organising activities and training courses for adults (eg training of protected area management staff, farmers and stockbreeders on environmental issues, scientists from Greece and other Balkan countries in techniques and methods of protection and management of the natural environment, etc.).
- Collaborating with schools, either by providing support material to environmental group programs, or by implementing a program with our environmental education team in your classroom.

Only over the last five years, more than 6,700 students have attended the environmental education program.

Educational material

- Poisoned baits: first aid for our dog
- Educational brochure for younger ages
- The Path of Coexistence: Exploration Guide

- Combining a walk in Rodopi with Environmental Education
- Exploring and Protecting our Forest Ecosystems
- Learning about the animals of the forest
- Researching and Protecting our Environment
- Poisoned baits: educational brochure
- Thematic educational paths
- The Path of Coexistence: A Guide for Teachers

Games

- The game of bioaccumulation
- The woodcutters

WWF has created more than 100 environmental education programs, covering the topics of: "Lifestyle", "Forests", "Island wetlands", "Sea", "Protected areas", "Biodiversity", "Climate/Energy" and "Sustainable economy". Namely, programs like "Climate: it's up to you" or the "Schools for the Climate" and the "Climate Chaos" suggest particular activities via computerised material, workshops and even interactive games (https://www.wwf.gr/ti_mporeis_na_kaneis/paikse_kai_mathe/). Seminars are also organised by the organization aiming at the training of educators over the above mentioned programmes. A list of the available school material can be found in the website of the organisation (http://www.wwf.gr). The topics are very broad: ecological footprint, city life, responsible consumption, climate change, ecosystems, threatened species. The material is designed to be used easily in the classroom and in any learning environment; Worksheets, electronic and floor games, presentations, posters, work plans. Specific campaigns can also be found here: https://www.wwf.gr/en/get_involved/campaigns/.

Arcturos protects the Brown Bear, Wolves, Greek shepherd dogs, Chamois, European otters, Red deers, Red deer, Lynx, Golden jackal and flora (http://www.arcturos.gr). Activities are summarised below: a. HABITAT- Nature in Our Yard, b. Forests, c.Reintegration in Natural Habitat, d. Environmental Education, e. Circus without Animals, f. Scientific research, g.Greek Sheperd Dogs, h. Animals in Captivity, i. Life Against Poison, j. Operations in Construction Projects, k. Emergency Response & Veterinary Centre Emergency Response Team and l. Protection of flora. Arcturos' actions on environmental education are addressed to children aged 8 to 15 years. Since 1995, ARCTUROS has been successfully carrying out activities about environmental education in institutions of primary and secondary education, with the approval of the Ministry of Education. Each year, 100.000 students of either elementary schools, or junior and senior high schools are being educated and trained by the specialized educational team of ARCTUROS, which carries out the projects in the regions of Attica and Thessaloniki as well as other nearby regions. Apart from school classes, these educational projects also take part both in the facilities of ARCTUROS and in nature! Through these actions students are informed about the prospects for survival of the bear and the importance of the environment in areas such as Grammos and the Rhodope region defined by mountains and Verno and Varnounta ("Forest, home of the Bear", "The Cartographers of Verno and Varnounta" and "Grammos, Rodopi - Maps of my country").


(source: http://www.archelon.gr/)

The **Sea Turtle Protection Society of Greece ARCHELON** (http://www.archelon.gr/) is studying, protecting sea turtles and their habitats and managing coastal ecosystems at the most important beaches of Caretta turtles in our country also aiming to treat injured sea turtles. The Sea Turtle Rescue Center at the 3rd Marina of Glyfada also has a major role to play in raising public awareness of environmental protection. The center provides integrated infrastructure for turtle care, hospitality of Center volunteers, as well as student reception areas, projections and activities for organized groups visitors. Each school year, a large number of students visit the center on a daily basis, where they take part in awareness raising programs. These programs are aimed at pupils from pre-school to high school graduates.

The **SOS Mediterranean Network** provides educational presentations to schoolchildren about the environmental issues in which it operates. Presentations are conducted by SOS Mediterranean Network Specialists using modern supervisory tools and adapted to the learners' age. They are accompanied by a creative conversation with the students for the purpose of exchange of views and reflection on the environmental issue in question. Particular emphasis is placed on encouraging action by students themselves, both within and outside school.

Mediterranean SOS Network has established Environmental Education and Sensitization actions that address the main environmental issues in which the organization operates, climate change - energy, water saving and shore-sea. Presentations are being made to students of all levels of learning, during which pupils discuss and try to find ways to contribute themselves, with personal minor changes in their behaviour, to improving the state of the environment. Educational material is also available and support is provided to teachers who implement Environmental Education programs (http://medsos.gr/medsos/component/content/article/1025.html). Environmental games and activities for various actions organized by the Mediterranean SOS Network are being designed and implemented.

1. Educational material
2. Raising awareness and raising awareness among students
3. Student competitions / events
4. Training of teachers / adults
5. Volunteers in Environmental Education
6. Environmental education

Currently the thematic areas covered by the Mediterranean Network SOS are:

- Water resources
- Coasts - Sea
- Climate Change - Energy
- Sustainable cities
- Biodiversity
- Green economyCivil society
- Dialogue of cultures

9.2.6 Other initiatives

Non-educational institutions play an important role in producing educational material and in organizing activities of continuous education on issues related to climate change. In many cases, due to the specialization of these institutions, the educational material produced represents a reference material for other scientific activities.

The activities of such institutions are briefly presented below by means of indicative examples of their activities.

9.2.6.1 Interdisciplinary Institute for Environmental Research (INIER)

The Interdisciplinary Institute for Environmental Research (INIER) is a non-profit organization for the environment. Its objectives are the elaboration of policies and the development of tools for the promotion of sustainable development, the provision of information and stimulation of public awareness on environmental issues and the contribution to the development of an institutional framework for environmental protection (http://www.dipe.gr/). Since 1998 the INIER is organizing cycles of training seminars that are entitled "Summer Ecological University" and address to adults with regard to ecology and environmental sciences.

9.2.6.2 Hellenic Association for the Protection of Environment and Cultural Heritage

The Hellenic Association for the Protection of Environment and Cultural Heritage (http://www.ellinikietairia.gr/) is a non-profit organization aiming at highlighting the value of the Greek cultural heritage, the importance of the protection of ecosystems and ecological balance in Greece, as well as the aesthetic value of landscape and the importance of the natural environment of the country. Furthermore, it aims at promoting the concept and practices of sustainable development so that human activities coexist harmoniously with the natural and cultural heritage.

Mission and Objectives:

To raise awareness on the values of the natural and cultural environment and promote the protection and rehabilitation of our heritage in both fields of nature and culture within the framework of sustainable development.

Main Projects / Activities:

- Restoration of Byzantine monuments
- Protection of historical city centres (e.g. Plaka)
- Actions for protection of free spaces, parks and recreational areas in or outside cities (e.g. National Garden in Athens, Tatoi)
- Promotion of sustainable development in the Aegean Islands
- Participation in Management Agencies of Protected areas
- Environmental education programmes (e.g. "The river", "The Nestos environmental train")
- Biennial congresses on Environmental Education
- Series of lectures for the public (e.g. Water Framework Directive, protection of historical city centres)

9.2.6.3 Global Environmental Education Partnership (GEEP)

The mission of the GEEP is to create a vibrant and inclusive learning network designed to build capacity in countries around the world to strengthen environmental education leading to a more sustainable future. To accomplish the mission, the GEEP is striving to:

- Connect and build bridges among practitioners, researchers, policy makers, institutions, providers, and international networks to elevate effective practice, scale impact, share global resources, and catalyze collaboration

- Demonstrate the value and impact of environmental education as a tool for achieving the UN Sustainable Development Goals
- Support, mentor, and empower a new generation of innovative and inspirational leaders to shape the future
- Build a global fund to sustain the field and advance our collective work
- Promote Innovation through a Global Environmental Education Think Tank

Greece is part of this initiavite (https://thegeep.org/learn/countries/greece) and through the dedicated activities aims to:

- Strengthen Networks: to connect the people and organizations working to strengthen environmental education around the world.
- Build Leadership: to enable environmental education change makers to develop and succeed, trough awards, professional development opportunities, bringing the brightest environmental education minds together.
- Champion Effective Practice: to highlight good practices so that knowledge is replicated and shared, continueing to advance our collective work in environmental education.

Moreover, an online community is built, eePRO, aiming to connect environmental education professionals from around the world to each other and to the most effective professional development resources available in our field. Anyone can join eePRO, and by joining, one can gain access to job opportunities, webinars, online courses, workshops, and a variety of resources. You can also post resources, events, jobs, and other opportunities. The eePRO Global group is designed to curate resources geared towards a global audiences. In the eePRO Global portal: https://naaee.org/eepro/learning, all planned learning activities, are summarised.

9.2.6.4 Action for a better world

The initiative in action is developed by the QualityNet Foundation in collaboration with international and European bodies, such as Project Everyone, Unicef and Unesco, the German Council for Sustainable Development (RNE) and the European Sustainable Development Network (ESDN). (https://inactionforabetterworld.com/to-programma/)

It is implemented at the national level with the approval of the Educational Policy Institute of the Ministry of Education and with the support of Organizations that want to connect with the Global Goals and contribute to the creation of the Greek SDGs Library and the development of local actions. through festivals in action -We create a better world.

The aim is:

- To inform and raise awareness of all of us - the responsible organizations and the active citizens of today - with the aim of adopting responsible practices that contribute to the improvement of the quality of life.
- To educate the student community, aiming at the creation of the active citizens of tomorrow, those who will take action to bring change to our planet by 2030.
- To awaken & activate the local community for the development of cooperation & intervention actions, in order to address the local challenges.

The results of the pilot implementation of the program (2018) were impressive. 650 schools with a total of 100,000 students participated in the educational process and, through the active participation in Bravo Schools, 32,000 students from 202 school units with 545 participants, submitted their own views on creating a better world. The development of the initiative at the national level with the participation of schools from 13 regions, 43 prefectures and 109 municipalities, allowed the creation of the first in action SDGs Schools & Cities Clubs. Also, the activation of the local community resulted in the active participation of 8,420 active citizens and the information and awakening of a total of 240,000 people.

9.2.6.5 GeoEducation

The GeoEducation team is active in the field of environment in order to promote and protect it. It is a large scientific team, with many years of professional experience, consisting of

environmentalists, geologists, biologists, oceanographers, foresters, archaeologists and educators. GeoEducation plans, organizes and implements a number of excursions with activities in nature with experiential environmental education, in areas of great ecological value, with accompanying scientists and educators.
For the school year 2018-2019, it proposes the educational environmental programs adapted to the particularities and learning needs of each age .:

- "A puzzle of nature", for kindergarten and elementary school
- "Pine guards" for kindergarten and elementary school
- "The hill and the dune" for high school,

They are implemented outside school units, in the area of Rafina and use elements of theatrical play and group games-activities. They follow the needs of children, give space and time to express themselves, to discover and finally to study in different ways and means, the elements of the environment. The purpose of the programs is the environmental awareness of the students and consequently the promotion and protection of the environment.

9.3 Environmental information and awareness

9.3.1 Governmental Initiatives and Public information campaigns

9.3.1.1 Hellenic Parliament

The Permanent Special Committee on Environmental Protection of the Parliament has been founded in 2004 and comprises representatives from all the parliamentary parties (http://www.hellenicparliament.gr/en/Koinovouleftikes-Epitropes/Katigories). The activities of Committee are focused on the observance and evaluation of the status of the environment status of the country, and of the impacts derived from various actions over it. The Committee is also providing consulting services in the designation of national strategies regarding the environmental protection and has a subcommittee on water resources.

The committee has set three independent meetings regarding issues related to:

- Addressing the marine pollution in Saronic from the sinking of the tanker "Agia Zoni II".
- Decreasing the use of plastic bags.
- From Environmental Education to Sustainable Education.
- Protecting the Geo-environment: The situation today, problems and prospects.
- Protection of the Corinthian Gulf.
- The contribution of Forestry in the field of Energy.
- Recycling and composting. The role of the National Recycling Organization

In October 2012 more than 120 members of the parliament, with the initiation of the Special Committee on Environmental Protection and the cooperation of NGOs and journalists from countries from all over the Mediterranean, attended a two-day workshop in Athens and exchanged views and proposals for tackling environmental degradation and promoting sustainable development of the Mediterranean.

The Committee has various meetings with representatives from NGOs (WWF, Greenpeace, etc.) targeting to issues related to climate change and energy. Various objectives have been set out including the elaboration of an adaptation plan, the promotion of RES and energy savings etc. The issue of environmental awareness has also been considered as very important, and meetings have been dedicated to discuss the results of a study regarding the public opinion over the environmental consciousness of Greeks conducted by the Hellenic Association for the Protection of Environment and Cultural Heritage.

Finally, to enhance public awareness, the Parliament is periodically publishing the "Environmental Bulletin of the Parliament", where all its actions are explicitly mentioned.

9.3.1.2 Ministry of Environment and Energy and Ministry for Climate Crisis and Civil Protection

The Ministry of Environment and Energy, has been established in order to confront the continuous environmental problems and to adopt a new development model – the model of Green Development- that will secure a better quality of life for every citizen (http://www.ypeka.gr/Default.aspx?tabid=230&language=en-US). The Ministry works to achieve the protection of the natural environment and resources, the improvement of quality of life, the mitigation and adjustment to the implications of climate change and the enhancement of mechanisms and institutions for environmental governance.

In particular, MoEE takes an active part in all UNECE activities like the "Environment for Europe" process and the implementation of the "Strategy of Education for Sustainable Development". Moreover, MoEE participates actively in the activities of the Organisation of Black Sea Economic Cooperation (BSEC) (http://www.internationaldemocracywatch.org/index.php/organization-of-the-black-sea-economic-cooperation), of the UNEP/MAP, of the Adriatic - Ionian Initiative and of the "Mediterranean Component of the EU Water Initiative (MED EUWI)". In the context of these organisations and initiatives, Greece/MoEE aims to promote strong transboundary links and cooperation for sustainable development. Furthermore, MoEE contributes considerably to all environmental activities in the context of the "Union for the Mediterranean", like for instance the implementation of "Horizon 2020" Initiative for the depollution of the Mediterranean Sea by 2020 as well as the development and implementation of a "Mediterranean Strategy for Water".

Since September 2021 responsibilities of the Ministry of Environment and Energy are transferred to the newly formed Ministry for Climate Crisis and Civil Protection. The Ministry will lead activities related with Self Protection Guidelines, Earthquakes, Landslides/Mudslides, Forest Fires, Severe Weather Phenomena, Floods, Volcanic Eruptions, Industrial Accidents and Accidents.

On bilateral level, strategic objectives are defined in accordance to the requirements of the Development Assistance Committee (DAC) of OECD and in particular of the Paris Declaration on Aid Effectiveness (2005) so that Greek official development assistance at bilateral level improves, in time, in quality, coherence and volumes so as to better meet partner countries environmental needs. To this end, together with other competent Ministries like the Ministry of Foreign Affairs, the increase of cohesion between national policies for development is being systematically promoted, mainly in the fields of environmental protection, climate change development assistance. Finally Greece has signed and ratified numerous "Memoranda of Understanding" with neighboring countries, like Turkey, Albania and Bulgaria, for cooperation in the field of environment and sustainable development, giving particular emphasis on the integrated management of shared waters.

Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters of the UNECE, signed in Aarhus, Denmark on 25 June 1998 (and as the Aarhus Convention) was ratified, in accordance with Article 28 (1) of the Constitution, by Law 3422 / 12.12.2005 (Government Gazette A 303 / 13.12.2005). In Greece, the Convention entered into force on 30 October 2001 and is undoubtedly the most elaborate and elaborated international text regulating this subject, it contains 22 articles and two annexes and consists of three pillars each of which contains provisions conferring different rights:

- The first pillar refers to the right of citizens to access environmental information and can be divided into 2 parts. The first part concerns the right of the public to request information from public authorities and the obligation on the public authorities to provide this information (Article 4). The second part concerns the right of the public to receive information and the obligation for public authorities to collect and disseminate information without the need for a specific request on the part of the public and covered by Article 5. Various exceptions such as national defense and public security, intellectual property protection, etc. are provided for in the above public service obligations.

- The second pillar refers to public participation in decision-making and is divided into 3 parts. The first part concerns public participation, which concerns or focuses on a specific activity (Article 6). The second part concerns public participation in the preparation of environmental plans, programs and policies (Article 7). Finally, the third part concerns public participation in the preparation of laws, regulations and legally binding rules (Article 8).
- The third pillar refers to access to justice. It essentially puts the two previous pillars into effect in national legislation and strengthens the implementation of national environmental legislation (Article 9).

The Ministry of Environment and Energy has participated in various actions to help the access of the public to environmental information. Some of these actions are included in the following:

1. Creation of "Centres for Environmental Information" for environmental protection and administration Institutions in Balkan countries, on issues of environmental politics and administration (DAC/OECD)

The Programme has been approved by the Ministry in the framework of DAC/OECD and aimed at the creation of the necessary requirements for a broad and systematic collaboration of the institutions which are concerned with the environmental problems of Balkan countries. The programme's main objectives were the creation of a database – its content will be further analysed in the following paragraphs – and the creation of the "Centres for Environmental Information; plural Esties" (we shall call them Estia) in Greece, Yugoslavia and Rumania. During the programme's implementation Cyprus was also included (without this being a conventional requirement of the collaborating institutions).

The principal aim is that Esties will function as coordinating and intermediate centres among the Non-Governmental Ecological-Environmental Organisations (NGOs), private and public institutions and scientific research teams with similar interests. Each country's data base will be the mean of achieving or fulfilling a broader information and dissemination of the programme's results.

The creation of each country's database in unified structure was based in the former experience of the Environmental Team of the Institute of Urban and Rural Sociology (IURS) of the National Centre for Social Research (EKKE). Data base content is divided into two basic units:

(a) *Database of the Non-Governmental Ecological - Environmental Organisations (NGO's):* The data concern all the activities, the relations and the way environmental organizations function, from their establishment until present.

(b) *Database of the Institutions that are related to the Environment:* The Institutions include Ministries, research centres, public organizations and enterprises, prefectures, municipalities, municipal enterprises and other environmental institutions.

All the collected information is available to the public via the webpage of the project: http://www.ekke.gr/estia/eng_pages/eng_index.htm. Also, data can be given, under demand, to the public in printed and electronic format.

2. National Centre for Viable and Sustainable Development – NCVSD

The National Centre for Viable and Sustainable Development (NCVSD) was formed in 2011 after the merge of National Centre for Environment and Sustainable Development (NCESD) with the Institute of Geological and Mineral Research (http://www.igme.gr), under the supervision of the Ministry for the Environment, Physical Planning and Public Works.

The National Centre for the Environment and Sustainable Development (NCVSD) was founded to provide a scientific contribution to the elaboration, application and assessment of policies, programmes and measures related to the environment and sustainable development in Greece, taking into account national commitments within the international and European framework. Its objectives also include the collection and processing of environmental data, the provision of reliable environmental information to public and private users, and the training of public officers and the staff of local/regional authorities on issues relevant to the environment and sustainable development. NCVSD contributes to the compilation of the National Strategy on Sustainable Development; compiles the regular National Report on the State of the Environment; proposes measures of a precautionary character aimed at preserving environmental quality; supports the Ministry of Environment, Energy and Climate Change in fulfilling national commitments related to climate change and other environmental issues.

3. Funding Programs concerning Environmental Awareness

Under the supervision of the Ministry of Environment and Energy many Environmental Projects have been implemented during the ten years. Namely, “Life+ Program” is the financial instrument of the European Union and its main goal is to contribute to the implementation, updating and development of Community environmental policy and legislation, including the integration of the environment into other policies, thereby contributing to the promotion of sustainable development. In particular, the integrated project «LIFE-IP AdaptInGR - Boosting the implementation of adaptation policy across Greece» is the most important project for adapting Greece to climate change. The project aims to catalyse the implementation of the Greek National Adaptation Strategy and of the 13 Regional Adaptation Action Plans at the current 1st adaptation policy cycle (2016-2025) and to prepare the passage to the 2nd adaptation policy cycle (2026+), through appropriate action at national, regional and local levels.

Public awareness:The public can have access to LIFE-IP AdaptInGR information material, and can subscribe to the LIFE-IP AdaptInGR newsletter. Access to the audiovisual material of project is provided, sharing information on the level of public awareness on climate change adaptation, on the 13 informational events (regional info-days) in the Regions of Greece, on climate change adaptation information and on social networking opportunities. The projects owns a YouTube Chanel (https://www.youtube.com/channel/UCLiBZ9NmwrcySBBJqJJrszQ) where informational material can be found.

Schools: LIFE-IP AdaptInGR providesaccess to information material to students and teachers and aims to organise 16 seminars for teachers in all regions of Greece. The seminars aimed at raising the awareness of teachers regarding the effects of climate change and the necessity of adapting to it and, on the other hand, promoting ways of integrating this knowledge into the daily life in schools. Smeinars started in 2020 and due to COVID-19, they continued online, via the zoom platform addressing deferent regions.

Information about the "Youth Adapts" campaign and several school competitions, as well as climate change adaptation information can be found in the relevant section of the project’s portal.

In particular, regarding “Youth Adapts”, as part of the LIFE-IP AdaptInGR project, educational material was developed for students aged 7 to 17, which is distributed to selected schools in Greece. The campaign is monitored for its performance and effectiveness so that its overall design and implementation can be refined. Over time, material aimed at older age groups will be adapted to form part of adult programs for lifelong environmental education. Educators will be able to keep up to date with all developments regarding Youth Adapts and download the material that will be developed, from the "News" and "Library" sections of the aforementioned website.

The first of the two pan-Hellenic school competitions that were organized concerned the academic year 2020-2021. The competition entitled: "The climate is changing... I am changing my life!" was addressed to students of Primary & Secondary Education and aims to highlight projects on the effects of climate change and adaptation to it. The organization in charge of the competition is the HELLENIC SOCIETY OF ENVIRONMENT AND CULTURE (ELLET).

More information can be found here: https://www.adaptivegreece.gr/el-gr/%CE%B5%CE%BD%CE%B7%CE%BC%CE%B5%CF%81%CF%89%CF%83%CE%BF%CF%85/%CF%83%CF%87%CE%BF%CE%BB%CE%B5%CE%B9%CE%BF.

9.3.1.3 Ministry of Foreign Affairs

Sustainable development, climate change, conservation of biodiversity, protection of the ozone layer, desertification, environmental pollution and sustainable water management are important environmental issues that the international community is addressing given their social and economic dimensions. Some of these issues, in particular climate change and water management, have also implications to the international security.

Greece, within the framework of the relevant international organizations, participates in multilateral environmental meetings as well as in efforts to improve the global environmental governance. Moreover, as a European Union member, Greece works towards the formulation of a leading-edge framework for the protection of the environment.

Furthermore, Greece is working together with other countries on environmental protection, by implementing joint programs and sharing best practices in order to develop effective responses to the current environmental challenges, particularly in the Mediterranean region. The trilateral cooperation between Greece, Cyprus and Israel on climate change adaptation is an example, which aims to enhance the effectiveness of their adaptation policies and actions to the future climate conditions, expected to be shaped in the region by the effects of a changing climate (https://www.mfa.gr/en/foreign-policy/global-issues/environment-climate-change.html).

Topics interlinked between the Ministry of Environment and Energy and Ministry of Foreign Affairs are:

- Sustainable development
- Climate Change
- Biodiversity
- Barcelona Convention
- Circular Economy
- EU Green Diplomacy Network

Greece is actively involved in the ongoing international climate change negotiations and supports the ambitious EU efforts to lead the struggle to deal with this phenomenon. The Green Diplomacy Network promotes coordinated action to achieve the international objectives of EU policy on the environment and climate change and facilitates the exchange of information and views on environmental issues between the Ministries of Foreign Affairs of the Member States and best practices on the integration of these issues into foreign policy.

A series of events, highlighting the issue of climate change impact on climate change, were organized by the Ministry of Foreign Affairs, in co-operation with the Ministry of Environment and Energy, International Organisations and other members of the H.S. Network.

9.3.1.4 Ministry of Infrastructure and Transport

The Ministry has adopted some actions regarding the change of attitude towards the GHG emissions. The main elements are the introduction of the ecological driving perception in the training of new drivers and the introduction of cycling in the Greek cities.

- *Ecological driving*:

  In 1996-1997 and in the specialty of driving educators of the Institutes of Professional Training (IEK), the introduction of the course “Environmental protection and energy saving” has been performed, in order to develop the ecological consciousness, the respect towards the environment during the use of vehicles, and the training of new drivers in the ecological driving. In 2003-2004 several seminars took place for the education of older drivers on the same subjects. Also, new additions regarding ecological driving have been introduced in 2009 in the questionnaires of the formal examination for driving licence.

- *Green traffic ring:*

  According to the regulations of the Ministry of Environment and Energy (MoEE) with the collaboration of the Ministry of Transport and Communications for the green traffic ring:

  - The entrance of private vehicles in the small traffic ring is permitted according to the so-called "Odd/Even" system.
  - Moreover, private cars and trucks under 2.2 tonnes are authorized in the small traffic ring, if their technology is Euro5 or later - either normal or hybrid – with the restriction that they emit less than 140g/km of carbon dioxide. Especially for hybrid and fuel gas vehicles, Euro 4 technology vehicles are also authorized when the emitted carbon dioxide is less than 140g/km.
  - Buses and trucks over 2.2 tonnes, when the movement permit in Greece is prior to January 1 1990, are not permitted in the large ring. For a transitional period of one year (from 1.1.12. - 1.1.13). This prohibition does not include the New National Road Athens-Lamia, Kifisou Avenue and a part of Athenon Avenue.
  - The date of January 1, 1990 shall be increased by one year each new calendar year, so that vehicles that are older than 22 years will be prohibited.

- *Cycling in the city:*

  According to the decision 33523/7564/10-6-2002 of the Ministry, the project “Introduction of bicycle in the Greek cities” has been included in the National Programme of Road Safety. The project has been focused on the materialization of interventions for the safe use of bicycles and the construction of bicycle paths (road marking, parking positions, interventions in the road network including widening of roads and sidewalks etc.). In this framework, the Ministry has assigned the NTUA’s school of Rural and Surveying Engineering the elaboration of research over the introduction of bicycle in the Greek cities and the structure of policy for the motor bicycle. Studies have been performed for 17 Greek cities, while about 80 cities have been interested in the project. Three joint ministerial decisions have been approved for the construction of bicycle paths in the Municipalities of Karditsa, Larissa, Mesologgi, N. Psychiko, Thessaloniki, Heraklion (Crete), Patra, Athens and Bolos, with the financing of the Ministry.
  In addition to the above, the NTUA has compiled the “Guidance for Studies regarding bicycles”, that is at the disposal of local governments and constitutes the first guide that giving specific instructions on how to plan the bicycle infrastructure under the Greek circumstances.

The Ministry of Transport and Communications was also actively involved in the “Earth Hour” and the WWF's Climate Change and Climate Change Campaign.

9.3.1.5 Municipalities

In the recent years many municipalities are becoming more interested in the climate change issue, and relative local activities and events are becoming much more often than in the past. Examples of such initiatives are the following:

- Actions to raise public awareness of recycling. Municipality of Alimos. The purpose of the actions is to inform the residents about the usefulness and benefits of recycling in our lives, as well as the necessity of managing the urban waste management, with the ultimate hope of developing environmental consciousness and culture. The actions included the creation of a web site (http://www.alimosrecycle.gr) where information material on waste management, the recycling program of the Municipality, the benefits of recycling, as well as useful information for the public will be posted.

- The Municipality Of Anatoliki (Eastern) Mani, in response to the need to tackle climate change and the introduction of energy policies for sustainable development both at the national and the local community levels has signed the Covenant of Mayors on 23 November 2015 and began to implement the resulting commitments. Moreover the municipality participated in the “Action plan of sustainable energy and climate” related to: municipal buildings, industry and households, municipal lighting, vehicles & transport, renewable energy etc.

- The City of Athens, in the context of environmental initiatives and actions and on the occasion of the World Environment Day (June 5th, 2021), organized a discussion entitled, “Our world after the pandemic: Confronting climate change.” The president opened the conversation discussing the changes necessitated by the environmental crisis before distinguished guests, including the director of the National Observatoy in Athens and a Professor at the University of Athens, shared their insight.

- The environmental awareness park "Antonis Tritsis" is one of the few open green spaces in Athens and one of the last lands of wildlife in the basin, as in the extent of 1100 acres 170 species of birds are hosted. The park is on top of unique green space and recreation for the entire West and Northwest Athens and receives daily visitors from the neighbouring municipalities (Athens, Ag. Anargiroi, Ilion, Peristeri, New Philadelphia, New Chalcedon, Axarnes, Petroupoli, Agaleo). At the same time environmental education programs for schools also take place in the Park under the supervision of the Ornithological Society.

- Creation of Thematic RES Park and Environmental Observatory at the Municipality of Portaria, aiming at:

  - The presentation of energy saving means in the infrastructure, the bioclimatic architecture and the techniques of energy efficiency of the buildings using RES
  - The observation and archiving of the microclimate of the area and of the RES use
  - The raising of public awareness in environmental protection and RES use issues
  - The elaboration of an educational software entitled “e-Energy School” that can be used by all levels of interested citizens (students, professionals, institutional bodies).

9.3.2 Non-governmental organization and involvement of the public

Several 'thematic' NGOs exist in Greece, such as the Hellenic Society for the Protection of Nature (HSPN) (www.eepf.gr/), Sea Turtle Protection Society of Greece ARCHELON (http://www.archelon.gr/), Arcturos (http://www.arcturos.gr/el/main.php), Hellenic Centre for Marine Research "Poseidon" (http://poseidon.hcmr.gr/index.php), Greenpeace (http://www.greenpeace.org/greece/el/), WWF, "Clean-up Greece" (http://www.cleanupgreece.org.gr/), Kallisto (https://www.callisto.gr/en/organization), Hellenic Ornithology Society (http://www.ornithologiki.gr/), Forest Research Institute (http://www.fri.gr/), the Hellenic Society for the Study and Protection of the Monk Seal Mom. Moreover, 'inter-sectoral' NGOs such as the Greek Association for the Protection of the Environment and Cultural Heritage (EEPECH), as well as institutions of international cooperation between NGOs, such as the Mediterranean Information Office for the Environment, Culture and Sustainable Development (MIO-ECSDE) and the Mediterranean Network SOS are active in Greece. The full list of active NGO in Greece is summarised in the following link: https://www.ekke.gr/projects/estia/gr_pages/mko_po/euretir_02.htm. These NGOs aim to raise awareness related to environmental concepts, and as reported above also organise in many cases relevant workshops, educational activities and events.

9.3.2.1 Hellenic Society for the Protection of Nature (HSPN) (www.eepf.gr/)\

The Hellenic Society for the Protection of Nature (EEPF) is the oldest environmental NGO of national scope, active since 1951. Its mission is to protect the Greek nature and to sensitize those who love Greece for the natural heritage of our country . Since its inception, it has been leading the creation of National Forests and the protection of endangered species of fauna and flora, as well as habitats. Indicatively, the then Secretary-General of Byron Antipas signed on behalf of Greece, in 1971, the Ramsar Convention on Wetlands of International Importance. Today, its actions focus on five main axes: environmental interventions, nature conservation projects and programs , environmental education with five Pan-Hellenic Networks approved by the Ministry of Environment , sustainable tourism management , and public awareness. To carry out its mission, it is based on an extensive network of scientists, members and volunteers, as well as teachers involved in environmental education programs.

9.3.2.2 Arcturos

Among other activities of ARCTUROS, priority has been given to scientific research as well as to providing environmental education and raising public awareness on matters such as biodiversity and viability, while practicing political pressure based on complete programs and solutions.

Each year ARCTUROS develops more activities, covering a broad spectrum of actions that support and promote the protection of wildlife, most important being that of reproduction and perpetuation of the greek shepherd dog along with its free distribution to farmers of the hill country, contributing thus in the harmonious co-existence of humans and wildlife. In general, the protected species by ARCTUROS include: Wolf, Bear, Sheperd Dog, Chamois, Otter, Deer, Roe Deer and Jackal.

9.3.2.3 WWF Hellas

The WWF Hellas organisation is part of the global WWF Network. The organisation is aiming at the conservation of the Greek biodiversity as part of the Mediterranean and at the constrain - or even overturn in the long term - of the environmental degradation, in order to achieve the harmonic coexistence of human and nature. Currently there are 12.000 active supporters, as well as the global WWF network, that provides the power to intervene at the political level to promote policies that enhance nature conservation. At the same time, we environmental legislation is monitored to prevent policies that degrade it, while submitting proposals for better shielding of our natural heritage and sustainable development. The four areas that WWF's actions are targeting are:

- Climate crisis and Energy
- Nature
- Human
- Economy

The main means that are currently used by the organisation in order to achieve its objectives are:

- Implementation of scientific actions and promotion/enforcement of such indispensable actions that are being implemented by other bodies.
- Implementation of projects of natural environment management.
- Cooperation with NGOs, operators of the public sector, local government and academic environment
- Cooperation with companies
- Elaboration and publication of opinions relative to environmental policy
- Contribution in corporate consultation bodies and committees/working groups of experts
- Criticism of the practices in the public and/or private sector
- Materialization of campaigns aiming at imposing pressure and mobilizing the public
- Communication and public awareness actions
- Training and scientific knowledge distribution actions
- Environmental education actions
- Actions aiming at the public participation, voluntarism and reinforcement of the Civil Society

Corporate partnerships

- As part of WWF's Greece "Responsible Fishery" programme, the organization and AB Vassilopoulos, in collaboration with the fishermen purse in Kavala, fish company "Manios" and the Fisheries Research Institute (FRI), started for the first time in Greece and the Mediterranean a fleet sustainability improvement programme. The aim of this innovative synergy is to achieve sustainability of the purse seine fleet of Kavala fishing anchovy and sardine, according to the standards of ecological Marine Stewardship Council Fisheries Certification (MSC).
- In April 2016 WWF Greece, in collaboration with the Association of Volunteer Firefighting of Andros and other state bodies of the island, began a pilot regional campaign to prevent forest fires and to raise awareness of the local community and the involvement of local stakeholders, through information and dissemination activities. The programme is implemented with the generous support of the maritime company Andriaki Shipping.
- By spreading the statement "*A natural alliance*" and its financial contribution, Vlachakis Eggs assists WWF Greece since 2004 in raising public awareness and informing about the organic practices followed in their production.

- Since 2011, with the support of the Network of Coca-Cola in Greece (Coca-Cola HBC and Coca-Cola Hellas) within the framework of environmental programme “Mission: Water”, WWF Greece initiated the creation of a dynamic volunteer network in Crete , Paros, Lesvos, helping to raise awareness and mobilize stakeholders and citizens on the ecological, social and economic importance of wetlands.
- In 2015, WWF Greece started an ambitious collaboration in 11 European countries in order to raise awareness of consumers to the global ecological and social impacts of overfishing and the responsible consumption of fish. The main pillars of the programme focus to: inform consumers on the benefits of responsible consumption of fish for society, the bond between sea and man and to promote solutions to the enterprises for sustainable seafood available in local markets.

Running actions:

- Fight for the climate
- Fight for your world
- Blue panda
- Prevention for the forests
- Voice for the planet
- Houe of the Earth
-

Former actions:

- TOGETHER FOR THE FORESTS! We now have a unique opportunity to tackle deforestation. We want the European Commission to protect our forests and our future, NOW!
- SAY NO TO MINING. The cosmogenic changes brought about by technological and scientific developments bring us one step closer to the end of the oil age.
- WWF & OUR PLANET. Our Planet is an original documentary series and a groundbreaking global collaboration between Netflix, Silverback Films and WWF. A series that explores the unique wonders of nature, the emblematic and majestic creatures of our planet and the wildlife that takes our breath away and still endures, while at the same time revealing what threatens this life with extinction.
- COP21: We are changing the climate. After much agony and upheaval, the final result of the World Climate Conference in Paris in December 2015 filled us with relief and joy! We finally have a binding global climate agreement, which in fact adopts a more ambitious goal of limiting the temperature rise to 1.5 oC, instead of 2 oC.
- Living Land. Europe's food and agriculture production system is problematic. It destroys the climate and the environment, phases out wildlife, harms public health, and harms small and medium-sized producers and rural communities. The key driver behind all this is the Common Agricultural Policy (CAP) - one of the oldest, strongest, most debated and costly policies in the EU. Europe leaders need to understand that a growing number of organizations and individuals from diverse sectors communities are calling for fundamental changes in this policy. Through the public consultation started by the European Commission and remained open until May 2, 2017, 258,708 signatures were collected.
- Embrace the "ugly" vegetables. Millions of tons of fresh fruits and vegetables are thrown away every year because they are not… beautiful or because they are too much! More than 1/3 of world food production is wasted in fields and supermarkets, households and restaurants.
- Strengthen the voice of nature. 61,806 songs we created with sounds of nature managed to strengthen her voice and demand the necessary protection. The "Strengthen the voice of nature" campaign was completed with great success, fulfilling its goal, while ensuring the best implementation of European laws that protect nature.

9.3.2.4 Greenpeace

For more than thirty years, Greenpeace has given a multi-faceted struggle to prevent and tackle the world's biggest environmental problems. At international level, Greenpeace is striving for the definitive cessation of nuclear tests and the use of weapons of mass destruction, the rescue of primordial forests, the implementation of the ban on whaling and the protection of the oceans, the preservation of biodiversity and the ban on the release of genetically modified organisms in food and the environment, the banning of dangerous toxic substances, the prevention of climate change and the promotion of renewable energy sources.
Within this framework, Greenpeace has undertaken a number of initiatives which address four main directions:

1. Climate and Energy (https://www.greenpeace.org/greece/ekserevnise/klima/). Vision: A planet with 100% clean energy from the sun, wind and other RES until the middle of the century. To aim to break free from coal and oil and ensure a socially equitable energy transition.

2. Plastics (https://www.greenpeace.org/greece/ekserevnise/plastika/). Vision: Working hard to tackle the root of the plastic pollution problem: the culture of single use and rejection. Becoming part of the global alliance and pushing businesses to stop using disposable plastics and politicians to take immediate drastic measures to limit its use, also ensuring we also take on our responsibilities, change habits and reduce the use of disposable plastic in our daily lives.

3. Sea (https://www.greenpeace.org/greece/ekserevnise/thalassa/) An alliance is built with coastal fishermen and coastal communities, creating a fair fisheries market based on respect for marine life and human relations. These actions aim to oppose to destructive and illegal fishing methods and push for the creation of marine sanctuaries, also demanding stricter policies, which protect the marine environment and put a limit on its exploitation.

4. Nutrition (https://www.greenpeace.org/greece/ekserevnise/diatrofi/). To protect the planet and public health, and support publics health, aiming for an agricultural model that supports local communities and adapts to local needs.

9.3.2.5 Hellenic Centre for Marine Research "Poseidon"

The Hellenic Centre for Marine Research "Poseidon" (http://poseidon.hcmr.gr/index.php) focuses on the monitoring, forecasting and information system for the greek seas. The POSEIDON general aims are: (a) to establish a sustainable marine observing network in the Eastern Mediterranean, (b) to provide quality and validated forecasts of the marine environment, (c) to provide scientific knowledge and support on the study of the ocean mechanisms and their variability, as well as to address the sensitivity of marine ecosystem and biodiversity to combined natural forcing factors and anthropogenic pressures, and (d) to provide a technology test bed and services to marine policy-makers and the society. The system is being developed in accordance to the policy frameworks suggested by IOC/GOOS, EuroGOOS, MonGOOS and GEO while it maintains a balance between the operational and research character of the infrastructure through the integration of methodologies and tools developed in relevant EU initiatives and projects. Relative projects can be found here: https://poseidon.hcmr.gr/about-us/projects.

9.3.2.6 Hellenic Ornithology Society – HOS (http://www.ornithologiki.gr/),

Since 1982, HOS is working to ensure a sustainable environment for both birds and humans, through protection and study, information and education, as well as interventions on critical natural environment issues. They are forefront of local, national and international campaigns to raise awareness among stakeholders and citizens about the major threats to wildlife and threats to biodiversity in the country, one of the last biodiversity refuges in Europe and a hub for global migratory birds. In particular, they are leading Conservation & Scientific Research actions covering the following areas:

- Species conservation
- Site conservation
- Combating Wildlife Crime
- Projects
- Important Bird Areas of Greece
- Bird monitoring

Moreover, they are organising Environmental Education programs focusing on i. Teachers, ii. Families and iii. Kids education.

9.3.2.7 Forest Research Institute (http://www.fri.gr/),

The Forest Research Institute (FRI) was established in 1961 by the Ministry of Agriculture as Forest Research Station of Macedonia and Thrace. In the course of time it has developed into the present Forest Research Institute. In 1989 the Institute was integrated into National Agricultural Research Foundation (NAGREF) under the same official title. FRI brings together many disciplines to develop a better understanding of forests, rangelands and environment and society's interactions and impacts on it.

- FRI to accomplish this mission:
- Conducts innovative research that promotes the healthy ecosystems upon which human communities depend
- Provides relevant information for policy and decision making in national organization responsible for forest sector and in Ministry of Rural Development & Food
- Develops research methods and know-how
- Organises and participates in scientific meetings
- Publishes research results and reports
- Organises and participates in forest research training
- Supports public awareness activities

The mission of the Forest Research Institute is to contribute through research to the understanding, restoration, and sustainable management of terrestrial ecosystems such as forests and rangelands and to maintain and enhance plant and wildlife resources for the benefit of people and the nature. Some past and running projects include: “Safeguarding the lesser white-fronted goose fennoscandian population in key wintering and staging sites within the European flyway” and “Understanding of interactions among bioactive rangeland plants and small ruminants to enhance and maintain the welfare and animal production (BIOPLANT)”, among others.

9.3.2.8 Hellenic Society for the Study and Protection of the Monk Seal Mom

https://www.mom.gr/home

MOM focuses on SCIENTIFIC RESEARCH, CONSERVATION, PUBLIC AWARENESS and ENVIRONMENTAL EDUCATION.

Related to Public awareness since 1990, MOm has been operating Information Centers in areas that are important for the Mediterranean monk seal in Greece within the framework of its Summer Awareness and Sensitization Campaigns. More than 500,000 people have visited these Information Centers on the islands of Alonissos, Skopelos, Skiathos, Kimolos, Milos, Karpathos, Syros, Fournous and Keratea in the Prefecture of Attica, and have been informed on the critically endangered status of the Mediterranean monk seal and the actions of MOm to

protect it. Our outreach and awareness activities are always carried out with the help of MOm's dedicated team of volunteers, which is comprised of more than 1,000 individuals who have participated so far in our summer campaigns!
MOm's Rescue Team frequently conducts training seminars to teach people how to respond in emergency cases when seals are in distress or are found dead. The participants are trained on the established reporting protocols in place to quickly notify the Rescue Team about emergency situations, which can help facilitate rescue efforts to save an animal in distress. In addition, MOm's Rescue Team has prepared a special instruction manual titled "Rescuing a monk seal. Now I can help as well!", which provides step-by-step guidelines on what to do when a sick or injured monk seal is found until MOm's Rescue Team arrives.
Through e-newsletters, information leaflets, manuals, posters and social media tools (facebook and youtube), the public can be informed directly for the Mediterranean monk seal in Greece, the marine environment as well as MOm's actions.
Moreover, the 2021 research season for the Northern Aegean Dolphin Project is off to an awesome start! The students from Anatolia College together with MOm's research team got the opportunity to observe three species of dolphins in small and large groups, to collect valuable data on the occurrence of mixed-species groups of Common and Bottlenose dolphins, to participate enthusiastically in lectures and in the clean-up of remote beaches on the island of Peristera organized by the Thalassa Foundation with a massive impact on nature conservation in the National Marine Park of Alonissos, Northern Sporades. With this being the fourth year of a wonderful cooperation, we would like to thank Anatolia College for their continued support and the opportunity to work with its exemplary students! Along the framework of the project "Conservation of the Mediterranean monk seal in the wider area of the National Marine Park of Alonissos Northern Sporades", MOm's researchers installed automatic infrared cameras in reproduction sites in the area of the project to monitor their use by the animals and record the number of births. The project is funded by the Monk Seal Alliance, the Thalassa Foundation and the Prince Albert of Monaco Foundation.

9.3.2.9 Mediterranean SOS Network

MEDITERRANEAN SOS Network (http://medsos.gr) is a non-profitable, non-governmental organization active since 1990, that comprises of 120 'Full Members' who form its annual General Assembly and approximately 3000 'Supporting Members'. The main aims of the Network include:

1. Raising public awareness and encouraging changes in citizens' -especially youth- everyday behaviour that impact on the environment
2. Advocating, lobbying and promoting cooperation among social partners, stakeholders and policy-makers at local, national, regional level
3. Promoting active public participation in sustainable development strategies and demonstrating alternative solutions in local communities
4. Promoting intercultural exchanges and balanced international cooperation among European - Mediterranean partners.

These goals are achieved through:

- information campaigns at the local, national and regional level
- networks with NGOs and public agencies at local, national, regional and Euro-Med level
- Environmental education projects in schools(training packages, creative games / competitions)
- volunteer summer camps, field work, voluntary clean-ups
- youth groups exchange and training projects
- Implementation of conferences, seminars, workshops

- Collaboration with national and local media
- production of print, audiovisual and multimedia material

9.3.2.10 Sea Turtle Protection Society of Greece ARCHELON

Sea Turtle Protection Society of Greece ARCHELON (http://www.archelon.gr/): Since its establishment in 1983, ARCHELON- the Sea Turtle Protection Society of Greece aims at the protection of sea turtles and their habitats. A number of activities with regard to sea turtle conservation have been tested and developed through the years. At the same time, activities are bringing the initiative close to small and big environmental and societal issues aiming to support conservation in action and the data we are collecting aim to contribute to the solution of problems that constitute threats to sea turtles. For example:

- protection on nesting beaches is linked directly to problems of coastal management in relation to tourism
- housing and tourist developments on the coast, marine recreation, beach furniture and infrastructure, waste management etc. are important for local societies, visitors AND sea turtles.
- Sea turtle rescue and rehabilitation efforts have shown the big problem with plastic in the sea and the issue of sea turtles entanglements in fishing gear.
- Volunteering for conservation is a very important component of our activities, as it brings people in the forefront; many people from all over the world have the opportunity to get involved

Through our information, public awareness and environmental education activities, we create opportunities for everyone, and especially young people, to understand that beaches and the sea are here for all of us including nature.

9.3.2.11 Institute of Energy for South East Europe (IENE)

The Institute of Energy of South East Europe (IENE, http://www.iene.gr/) is a non-profit organization whose main activity is the study of energy matters and the provision of quality information to professionals and to the public in general. IENE aspires to become the focus around which energy matters can be discussed, analysed, compiled and presented to the scientific-technical communities and to the representatives of social, business and economic life in Greece and SE Europe. The Institute also aspires to playing a significant role in providing factual and unbiased information in Greece and internationally on matters concerning energy, the environment and sustainable development. At the same time, the Institute hopes to provide a suitable platform for discussion and analysis on the critical subjects of energy and the environment which are of a broader concern to society.

The means for achieving its goals include the following:

1. Information/publicity: One of the basic activities of the IENE is the provision of the necessary information and updating on the energy situation and related activities in Greece as well as in the South East Europe. This information is provided on a regular basis through the publication of articles, research papers, conference proceedings studies and books as well as via the specialist internet sites supported and controlled by the Institute. In the field of communication the Institute organizes frequent conferences, meetings, educational seminars, workshops and public discussions on the subjects of energy, environment and sustainable development relative to Greece and to the adjacent area of S.E. Europe.

   One of the more known events of the IENE is the annual national conference "Energy and Development" organized every autumn in Athens with the participation of both Greek and foreign speakers and participants from all over the world. Another important event is the "Oil and the Economy" conference first organized in April 2003, and now scheduled in as a regular Institute activity. IENE’s plans include the organizing of meetings on a wide range of energy related subjects including natural gas, solid fuels, the electricity market, renewable every sources, energy conservation and new energy technologies such as hydrogen. Also, among the plans of IENE is the organisation of a regional conference, at S.E. European level, that will cover the activities of the various countries in the area and be directed at senior government and business executives responsible for the laying-down of economic and energy policies.

The IENE participates actively in the promotion and diffusion of new energy technologies, the transfer of "know-how" and the implementation of E.U. policies and directives. Within this framework, the IENE co-operates with corresponding bodies, both domestic and foreign, in promoting these goals and activities. The Institute aims at organising on a regular basis specialist events, as well as meetings of a more general nature for the public at large.

2. Seminars/Workshops are summarised yearly following this link: https://www.iene.gr/category.asp?cid=11&lng=1 . Some of them can be found below:

- "Energy Efficiency: Business, Industry and Public Buildings", Tuesday 12 January 2021 (via live streaming)
- "Green Liquid Fuels of the Future", Thursday -Friday 11/12 February 2021 (via live streaming)
- Webinar "The Road to Depoliticization: Challenges and Opportunities", Thursday, March 18, 2021 (15:00 -18: 00)
- Webinar "The Role of Energy Storage in Advancing Large Scale RES Penetration", Tuesday 27 April 2021 (14:00 - 18:30)
- Webinar "Gas Markets in Transition in SEE", Thursday 8 June 2021 (14:00 -18: 00)
- Workshop "Electric Mobility and Smart Cities", online, Wednesday 22 September 2021 (13:00 - 17:00)
- Presentation of “SEE Energy Outlook 2021”, Thursday, October 7, 2021, (14:00 - 16:00), hybrid with live streaming) with details to be announced later
- Greek-Bulgarian Energy Forum, in collaboration with the Energy Management Institute (EMI), Sofia, Thursday, October 14, 2021 (hybrid event)

3. Co-operation with the Institutional Organisms of the European Union and other National and International Institutions: The Institute, in accordance with its Articles of Association, may submit proposals to the European Commission and other International Organisations (e.g. UN bodies, World Bank) participate in the management of EU programmes, resources and initiatives, co-operate with the European Parliament, the Regional Commission and other national or international bodies and organisations. Also, it aims to co-ordinate activities with other Institutes and organizations, national and foreign universities, take part in common programmes, research oriented or not, and also participate in dissemination/briefing and other associated activities. IENE will maintain a pool of scientists ready to offer consultancy services and also to act as evaluators in the E.U projects.

4. Co-operation with S.E. Europe: Particular emphasis has been given to networking and co-operation with energy companies, institutional bodies and organizations, research centres and scientific institutions active in the field of energy and the environment in

the countries of S.E. Europe. The Institute is prepared to contribute to the elaboration of policies normally required as part of international obligations and transitional phases. The IENE aspires to act as a bridge of communication and promotion on the energy issue between Greece and the countries of S.E. Europe. (http://www.iene.gr/page.asp?pid=9&lng=1)

An extended list of the IENE's activities can be found in the website of the organization (http://www.iene.gr/page.asp?pid=7&lng=2).

9.3.2.12 Callisto

"CALLISTO" is an Environmental NGO (a civil, not-for-profit society), which was founded in Thessaloniki, Greece, in July 2004.

Main activities of CALLISTO include:

- Conservation of biodiversity and of areas of high natural and aesthetic value, with emphasis on mountainous ecosystems and forests in Greece, the Balkans and other neighbouring countries.
- Study, conservation and management of wild fauna populations, especially of large carnivores (bear, wolf, lynx, jackal) that inhabit the above areas.
- Elaboration and implementation of projects for the protection and management of wildlife and the natural environment.
- Information, awareness-raising, and activation of the public for imposing control on the decision-making centres regarding environmental issues.
- Development of environmental education and training programs.
- Development of voluntarism to serve conservation actions.
- Support for the establishment and operation of Protected Areas and Ecological Networks, in order to preserve biodiversity, as well as the natural and cultural heritage.
- Development of scientific research and its applications as well as building national, trans-Balkan and international cooperation and networking for the above purposes

CALLISTO also designs, implements and supports information and awareness-raising campaigns aiming at "translating" tangible environmental, political, economic and scientific developments into understandable concepts for the general public and on the other, aiming at the active participation of citizens in efforts to preserve the environment.

- Organizes and participates in Meetings - Conferences on topical environmental issues related to our field of activity.
- Organizes photo exhibitions on the natural environment and the emergence of the artistic value of nature.
- Participates in events for the environment with specially designed kiosks.
- Designs and implements targeted public awareness campaigns
- Issues brochures to raise public awareness
- Organizes events to inform a special portion of the population involved in the conservation of large carnivores (farmers, breeders, beekeepers, etc.) and, more generally, of rural residents)

9.3.3 Environmental information-awareness and a civil society

Apart for the NGOs, a number of institutions of the civil society show an increasing interest on energy, climate change and environmental issues. These institutions can contribute to the awareness and promotion of good practices, either due to their large membership (Greek General Confederation of Labour - GSEE, Technical Chamber of Greece - TEE), or due to their sectoral representation (Hellenic Association of Photovoltaic Companies - Helapco, Greek Association of RES Electricity Producers), or finally, due to the specialization of their members in issues critical for the application of solutions for climate change mitigation (Alumni Association of Greek Environmental Scientists, Hellenic Environmental Law Society).

9.3.4 Impact of environmental education and public awareness on climate change

Through the presented initiatives and activities the following benefits have been reported:

- partnerships have been developed with citizens and local actors, with willingness responded
- the students came in contact with each other, exchanging ideas on environmental issues of their country, making suggestions to protect the environment and the development of the site.
- they compiled and distributed brochures aiming at raising awareness among citizens, interviewed by competent officials or specialists
- published the programs in the local press, at the local radio, released posters for each program, and organized presentations in the local community resulted in dissemination of results, evaluation and feedback.
- theatrical events with children's protagonists were presented, photo and school exhibitions, DVD screenings, fairy tales were created by children.
- the involvement of parents and collaborators has sensitized the local community to environmental issues and has enabled initiatives to be taken on local environmental issues.

9.3.5 Training programmes

i. Training in EECs

<u>Education/Training of teachers</u>

For each thematic year training seminars are taking place in the EECs. The seminars are referring to the particular subject of the year. At national level, additional training of the teachers included:

a. Organisation of "Seminars" that addressed to the pedagogic units of the EECs and to the responsible for environmental education: The seminars referred to the training over sustainability and environmental education, the methodological issues and teaching approaches, suggestive educational material and co operational actions as well as to the environmental education at a local level. http://kpe-drapets.att.sch.gr/seminars-for-teachers

b. Training of teachers on issues of education and sustainable development. (Three-day-long training seminar entitled 'Human activities in times of crisis and Climate change', Two-day-long training seminar entitled 'Natural Disasters and Climate Change: their prevention – challenge for the aware citizen', Workshop entitled 'Climate change and geo-mythology in education)

c. Training videos by the EECs (http://www.kpe.gr/new/index.php/ekpaideftika-vinteo)

<u>Training for the public</u>

Seven-hour workshop entitled 'Climate change and renewable sources of energy', Five-hour workshop entitled 'Energy for all – cooperative models of production, energy and development', Workshop entitled 'Meteorology: weather forecast', Workshop entitled 'Consumption and energy saving for home heating'

ii. Training through the LIFE-IP AdaptInGR project

- The LIFE AdaptInGR has developed a detailed guide for teachers, including Training Material related to Climate Change Adaptation.
- 13 regional and 2 national capacity building workshops organised across Greece by the LIFE-IP AdaptInGR project;
- Production of guidebooks for CCA actions at regional & local level, building on the experience acquired through the LIFE-IP's pilot applications;
- Provision of guidance by the Educational Institute of Greece to teachers for implementing environmental education programmes. The Educational Centers for Sustainability are also involved in the implementation of educational programmes & activities.
- LIFE-IP AdaptInGR awareness raising activities, e.g., info-days, conferences, audiovisual, social media & information material.

iii. Other trainings

- The Hellenic Ornithology Society is organising adult training through different projects namely: MEDITERAVES Project, SeaEnvTraining Project and BIRDTOURISE Project
- Development of e-learning programmes: An online library is available with educational material i.e. books and articles that can be downloaded (http://repository.edulll.gr/edulll/)
- Workshop on "Circular Economy Transition in Smart Specialization Strategy", Ministry of Environment and Energy (http://unsdsn.gr/workshop-on-circular-economy-transition-in-smart-s)
- MedSOS: Training material is summarised here including LIFE DEBAG project, LIFE AMMOS, Watersave among others http://medsos.gr/medsos/component/content/article/1025.html

9.3.6 Participation in international activities

The United Nations (UN) is an association of states aimed at securing global peace and supporting cooperation in international law, security, economic development and political equality. It was founded in 1945 by the winning countries of the Second World War, in the position of the League of Nations (League of Nations), which was set up in 1919, after World War I, with similar purposes. The Economic and Social Council (ECOSOC) draws its jurisdiction from the UN General Assembly and includes:

- Nine (9) Thematic Committees, one of which is the UN Sustainable Development Committee. (U.N.C.S.D.)
- Five (5) Regional Committees, including the United Nations Economic Commission for Europe. (U.E.E.E.)
- Other UN programs and agencies related to environmental issues:
- UN Environment Program - U.N.E.P.
- Mediterranean Action Program - MAP U.N.E.P.

- United Nations Development Program (U.N.D.P.)
- United Nations Industrial Development Organization (U.N.I.D.O.)
- United Nations Educational, Scientific and Cultural Organization (UNESCO)

Other initiative include [29],[30]:

- European Civil Protection Legislation
- NATO
- Council of Europe - EUR-OPA
- Organization of the Black Sea Economic Cooperation
- Adriatic & Ionian Initiative
- Hellenic-French Joint Working Group
- FIRE 5
- The Process of offering and Receiving International Assistance in Civil Protection Emergencies
- Bilateral Agreements and Cooperation Protocols in Force
- UN Sustainable Development Goals (SDGs)
- Environmental Performance Report of Greece by the Organization for Economic Cooperation and Development (OECD)
- International Energy Organization
- OHE Environment Program (UNEP) - United Nations Environment Assembly (UNEA)
- International Organization for Renewable Energy (IRENA)
- Energy Map
- International Conventions and Protocols

9.3.6.1 Activities-Responsibilities on International level

Greece as a Member State of the UN and the OECD actively participates in related International Conferences and Meetings, which address, inter alia, climate change issues.

- Achievement of MDGs (2000)
- Johannesburg/WSSD targets (2002)
- Rio+20 / "The Future We Want" (2012)
- OWG on Sustainable Development Goals (2013-2014)
- IEC on Sustainable Development Financing (2013-2014)

Active participation in the Rio+20 preparation and follow-up processes, which are very relevant to the fight against climate change and to the work of the UNFCCC. Special note has to be made to the work of the Open Working Group on the Sustainable Development Goals, whose report was recently adopted by the UN General Assembly (A/RES/68/309).

The Ministry for Climate Crisis and Civil Protection oversees all annual financial contributions to Environmental multilateral Funds and Conventions' Secretariats (e.g. UNEP, UNFCCC, CBD, CCD, UNECE, UNESCO, HABITAT, IUCN, etc.) through national funds and budget. https://www.civilprotection.gr/en/international-cooperation

9.3.6.2 Activities-Responsibilities on Regional level

The aim is to achieve effective trans-boundary cooperation, using cooperation on environmental issues as a catalyst, in the areas of the Mediterranean, Southeast Europe, Black

[29] https://www.civilprotection.gr/en/international-cooperation
[30] https://ypen.gov.gr/diethneis_synergasies/

Sea and sub-regions (e.g. Adriatic Ionian). Climate change is included in their agendas, especially in relation to capacity building.

Greece (MoEE) is active in several regional organisations and initiatives:

UNEP/MAP (Secretariat of the Barcelona Convention). Hosted in Athens since 1981.

Greece is a Member of the Bureau for the current biennium. COP (40 years of UNEP/MAP) was organised in Athens in 2015.

- → Protocols (e.g. ICZM Protocol (2008) prioritizes adaptation to climate change)
- → Five-Year Programme of Work 2010-2014: ***Climate Change*** is one of the six themes
- → Mediterranean Strategy for Sustainable Development (2005).

Union for the Mediterranean (UfM)

Greece hosted on 13 May 2014 the first Ministerial Meeting on Environment and Climate Change in the framework of the Union for Mediterranean. During the meeting the Ministers discussed the environmental and climate-related challenges facing the region and defined the future strategic directions to reduce pollution and increase resource efficiency.

Climate Change: the Ministers agreed on the creation of the "UfM Climate Change Expert Group" to advance discussion on climate change priority actions.

Mediterranean Strategy on Education for Sustainable Development (MSESD): Greece proposed the endorsement of MSESD with the aim to encourage countries of the Mediterranean to develop and incorporate Education for Sustainable Development (ESD) into their formal education systems, in all relevant subjects, as well as in non-formal and informal education.

UNECE:

'Environment for Europe' process, UNECE Strategy on Education for Sustainable Development (incl. chairing the UNECE Steering Group on Education for Sustainable Development since 2005)

Organisation of Black Sea Economic Cooperation (BSEC):

International training seminars are organized on Climate Change policies. For more details please refer to paragraph 7.6.1.2.

Drin Dialogue Process and Western Balkans:

The Drin Dialogue Process aims at developing a Shared Vision for the sustainable management of the Drin basin and enhancing Transboundary cooperation, including on climate change adaptation in relation to management of water and natural resources. In this regard, the Hellenic Ministry of Environment, Energy and Climate Change as well as the ministries of the riparian countries of the extended Drin Basin with competence on water resources management signed in Tirana on 25 November 2011 the Memorandum of Understanding for the Management of the Extended Transboundary Drin Basin.

Adriatic-Ionian Initiative & EU Strategy of the Adriatic-Ionian

The main focus is the impact of climate change on Marine biodiversity & Integrated Coastal Zone Management.

9.3.6.3 Activities-Responsibilities on Bilateral level

The main focus is to increase the cohesion between national environmental & climate change policy goals and development assistance & cooperation objectives. Greece (MoEE) has signed and ratified "Memoranda of Understanding" and "Agreements" with neighbouring countries, like Turkey, Cyprus, Albania, Bulgaria and Cyprus, for cooperation in the field of environment and sustainable development with an emphasis on capacity building and sharing of experiences, covering, inter alia, climate change mitigation and adaptation . More information can be found here: https://www.civilprotection.gr/en/bilateral-agreements-and-cooperation-protocols-force

9.3.6.4 Governmental initiatives: The case of the Countries of the Africa Region

Greece's long-standing cooperation with countries of the African region is channeled through a number of different processes and is especially characterized by the social, economic, commercial, cultural and environmental links induced by sharing the Mediterranean Sea. The different levels of cooperation between Greece and the African countries can be summarized as cooperation at international level, cooperation at regional level, with emphasis on the Mediterranean region, and cooperation at bilateral level. It should be noted that there also exists cooperation between the European Union (EU) and African countries, especially at the international level but also at the regional level, where Greece, as a Member State of the EU, is also actively involved.

Cooperation on environmental issues: Climate change

Africa is a region particularly vulnerable to environmental changes. A fundamental issue related to environmental changes is currently climate change and its related consequences in terms of water scarcity, land degradation and desertification. The capacity of Africa to deal with the consequences of environmental changes is to a large extent limited. Within a globalised world, international cooperation should put emphasis in assisting African countries to meet their special needs and emerging global challenges, particularly within the context of achieving the MDGs.

Collaboration with Africa is of increased importance in relation to the issues of climate change and water. Especially regarding climate change, it is necessary for the developed states to provide sufficient support to Africa in order to prevent further damage, which can lead to human and environmental crises with far reaching consequences. Africa is expected to be substantially affected by climate change, but its own ability to adapt to climate change consequences is insufficient. It is imperative that appropriate tools for Africa's adaptation to climate change are set up and put into operation.

i. Global Environment Facility (GEF):

GEF is an independent financial mechanism, which provides developing countries with grants for programs aiming at the improvement of the environment globally and promotes sustainability to local communities. The vast majority of GEF's projects concern African countries. GEF's programs deal with 6 complicate environmental subjects: Biodiversity, Climate Change, International Waters, Land Degradation, Ozone Depletion and Persistent Organic Pollutants (POPs). Greece participates to the GEF's budget since its First Replenishment. For the Fourth Replenishment, Greek contribution for the time period 2007-2010 amounts up to EURO 5.73 millions. Contributions to GEF are voluntary and the Greek contribution is paid in four equal yearly instalments.

ii. Mediterranean Commission on Sustainable Development (MCSD)

The MCSD, created in 1996 by the Contracting Parties of the Barcelona Convention, is made up of 46 members. The UNEP/MAP Coordination Unit, based in Athens, ensures the role of MCSD Secretariat and coordinates the different working groups on a permanent basis. In addition to the recommendations presented to the Contracting Parties on specific Mediterranean challenges (e.g. energy and climate change; information and communication; integrated coastal zone management; management of water demand, marine pollution; sustainable development indicators; sustainable tourism; trade agreements; urban development; etc.) the MCSD has provided major inputs to the formulation of the Mediterranean Strategy for Sustainable Development (MSSD) and spearheads its implementation at the country level. Greece is actively involved in the work of the MCSD and the development and implementation of the MSSD.

iii. EU Water Initiative – Mediterranean Component

In the framework of the MED EUWI, Country Dialogues are organised in selected Mediterranean countries, involving water stakeholders which include government authorities and agencies, local authorities, water users associations, civil society, academia, the private sector as well as international and national donors.

iv. The "Euro-Mediterranean Water and Poverty Facility"

This initiative involves cooperation between Mediterranean countries, mainly Greece and Egypt, with Global Water Partnership-Mediterranean acting as implementation actor and financing from the Hellenic Ministry of Environment.

v. "Mediterranean Education Initiative for Environment and Sustainability with Emphasis on Water and Waste (MEDIES - http://www.medies.net)"

This initiative involves cooperation between Mediterranean countries with the Mediterranean Information Office (MIO-ECSDE) acting as implementation actor and financing from the Hellenic Ministry of Environment. This action is being effectively promoted in Mediterranean countries and has been included as a sub-programme in the framework of the National Strategy for Education on Sustainable Development of Greece, which is implemented through the Hellenic Ministry of Education, Research and Religion (http://www.minedu.gov.gr/), as it has already been mentioned in the previous sections.

vi. "Initiative on the assessment of climate change impacts in African developing countries"

This initiative involves cooperation with Egypt during the first stage of the initiative and with Ghana and Senegal during the second stage of the initiative, with the National Observatory of Athens acting as an implementation actor and EURO 125,000 financing from the Hellenic Ministry of Environment.

vii. "Sustainable Water Management in the Balkan and Southeast Mediterranean area"

This initiative involves cooperation with countries of North Africa/Mediterranean, with the Region of Crete acting as an implementation actor and financing from the Hellenic Ministry of Environment.

Greece is currently further intensifying its efforts regarding ODA focusing at climate change adaptation. For example, Greece is currently financing programmes for adaptation to climate change in Least Developed Countries and in regions that, due to their geographical location, are under severe danger from climate change which mainly include Africa and Small Island States. In order to ensure the best possible utilisation of funds and distribution to programmes according to the most significant needs of the threatened regions, the Hellenic development assistance plan is implemented in coordination with regional organisations of the areas under consideration, such as the African Union.

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ANNEXES

A.I 5th Biennial Report

A.I.1 Introduction

This Annex I to the Greek 8th National Communication (NC) under the UNFCCC is the 5th Biennial Report (BR) of Greece under decision 2/CP.17 of the Conference of the Parties under the UNFCCC.

As defined in the UNFCCC biennial reporting guidelines for developed country Parties, the information is structured into:

- ✓ information on greenhouse gases (GHG) emissions and trends and the GHG inventory including in-formation on national inventory system (section A.I.2);
- ✓ quantified economy-wide emission reduction target (section A.I.3);
- ✓ progress in achievement of the quantified economy-wide emission reduction targets (section A.I.4);
- ✓ projections (section A.I.5);
- ✓ provision of financial, technological and capacity building support to developing countries (section A.I.6).

Tabular information as defined in the common tabular format (CTF) for the UNFCCC biennial reporting guidelines for developed country Parties (UNFCCC decision 19/CP.18) is also submitted. For the CTF submission to the UNFCCC, the electronic reporting facility provided by the UNFCCC Secretariat has been used as required by UNFCCC decision 19/CP.18.

A.I.2 Information on GHG emissions and trends

Information about the national GHG emissions and trends is provided in Chapter 3.1, 3.2 Annex A.II and CTF Tables 1. Information about Greek national inventory arrangements is provided in Chapter 3.3.

Thre were no changes of the national inventory arrangemnts of Greece since the 4th BR.

A.I.3 Quantified economy-wide emission reduction target (QEERT)

A.I.3.1 Description of the 2020 EU pledge (QEERT)

Greece, as a Member State of EU, is under the joint quantified economy-wide emission reduction target of EU and its Member States. This section explains this target and the target compliance architecture set up within the EU in order to meet that target.

Under the UNFCCC, the EU and its Member States committed to achieving a joint quantified economy wide greenhouse gas emission reduction target of 20 per cent below the 1990 level by 2020 (“the Cancun pledge”) It is therefore a joint pledge with no separate targets for Member States under the Convention The UK remains part of the joint EU 2020 target together with the 27 EU Member States

In 2010, the EU submitted a pledge to reduce its GHG emissions by 2020 by 20 % compared to 1990 levels, in order to contribute to achieving the ultimate objective of the UNFCCC: 'to stabilize GHG concentrations at a level that would prevent dangerous anthropogenic (human-induced) interference with the climate system', or, in other words, to limit the global temperature increase to less than 2°C compared to temperature levels before industrialization (FCCC/CP/2010/7/Add.1). The EU is also committed to raising this target to a 30 % emission reduction by 2020 compared with 1990 levels, provided that other developed countries also commit to achieving comparable emission reductions, and that developing countries contribute adequately, according to their responsibilities and respective capabilities. This offer was reiterated in the submission to the UNFCCC by the EU-28 and Iceland on 30 April 2014[31].

The definition of the Convention target for 2020 (QEERT) is documented in the revised note provided by the UNFCCC Secretariat on the 'Compilation of economy-wide emission reduction targets to be implemented by Parties included in Annex I to the Convention' (FCCC/SB/2011/INF.1/Rev.1 of 7 June 2011). In addition, the EU provided additional information relating to its quantified economy-wide emission reduction target in a submission as part of the process of clarifying the developed country Parties' targets in 2012 (FCCC/AWGLCA/2012/MISC.1).

The EU clarified that the accounting rules for the target under the UNFCCC are more ambitious than the current rules under the Kyoto Protocol, for example, including international aviation, adding an annual compliance cycle for emissions under the Effort Sharing Decision or higher Clean Development Mechanism (CDM) quality standards under the EU Emissions Trading System (EU ETS) (FCCC/TP/2013/7). Accordingly, the following assumptions and conditions apply to the EU's 20 % target under the UNFCCC (QEERT):

- ✓ The EU Convention pledge does not include emissions/removals from Land Use, Land Use Change and Forestry, but it is estimated to be a net sink over the relevant period. EU inventories also include information on emissions and removals from LULUCF in accordance with relevant reporting commitments under the UNFCCC. Accounting for LULUCF activities only takes place under the Kyoto Protocol.
- ✓ The target covers the gases CO2, CH4, N2O, HFCs, PFCs and SF6.
- ✓ The target refers to 1990 as a single base year for all covered gases and all Member States.
- ✓ Emissions from international aviation to the extent it is included in the EU ETS are included in the target.
- ✓ A limited number of CERs, ERUs and units from new market-based mechanisms may be used to achieve the target: in the ETS, the use of international credits is capped (up to 50 % of the reduction required from EU ETS sectors by 2020). Quality standards also apply to the use of international credits in the EU ETS, including a ban on credits from LULUCF projects and certain industrial gas projects. In the ESD sectors, the annual use of international credits is limited to up to 3 % of each Member State's ESD emissions in 2005, with a limited number of Member States being permitted to use an additional 1 % from projects in Least Developed Countries (LDCs) or Small Island Developing States (SIDS), subject to conditions.
- ✓ The Global Warming Potentials (GWPs) used to aggregate GHG emissions up to 2020 under EU legislation were those based on the Second Assessment Report of the IPCC when the target was submitted. In accordance with the CMP Decision to revise the GWPs to those from the IPCC Fourth Assessment Report (AR4) revised GWPs from AR4 were adopted for the EU ETS. The revised GWPs were taken into account for the revision of the ESD target. For the implementation until 2020, GWPs from AR4 will be used consistently with the UNFCCC reporting guidelines for GHG inventories.

The QEERT target is also described in **CTF Tables 2(a-f)**.

Table A.I.1 Key facts of the Convention target of the EU-28

Parameters	Target
Base Year	1990

[31] European Union, its Member States and Iceland submission pursuant to par 9 of decision 1/CMP.8' http://ec.europa.eu/clima/policies/international/negotiations/docs/eu_submission_20140430_en.pdf

Target Year	2020
Emission Reduction target	-20% in 2020 compared to 1990
Gases covered	CO_2, CH_4, N_2O, HFCs, PFCs, SF_6
Global Warming Potential	AR4
Sectors Covered	All IPCC sources and sectors, as measured by the full annual inventory and international aviation to the extent it is included in the EU ETS.
Land Use, Land-Use Change, and Forests (LULUCF)	Not included in the target under Convention. Accounted under KP, reported in EU inventories under the Convention. Assumed to produce net removals
Use of international credits (JI and CDM)	Possible subject to quantitative and qualitative limits.
Other	Conditional offer to move to a 30% reduction by 2020 compared to 1990 levels as part of a global and comprehensive agreement for the period beyond 2012, provided that other developed countries commit themselves to comparable emission reductions and that developing countries contribute adequately according to their responsibilities and respective capabilities.

The QEERT target is also described in **CTF Tables 2(a-f)**.

A.I.3.2 The EU target compliance architecture

A.I.3.2.1 The 2020 climate and energy package

•

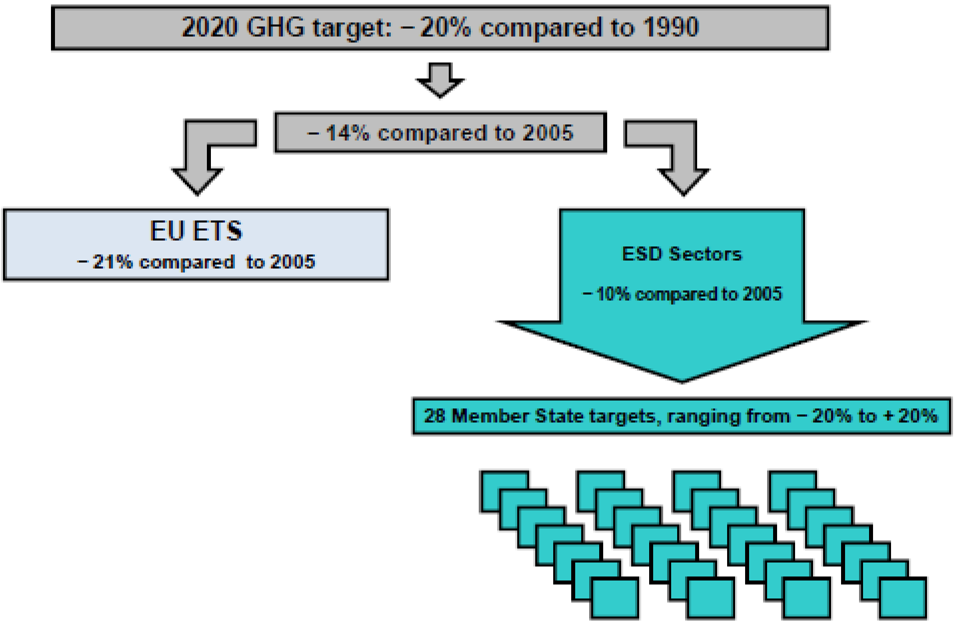
The EU has jointly committed to its UNFCCC target and implemented it internally through EU legislation in the 2020 EU Climate and Energy Package In this package, the EU introduced a clear approach to achieving the 20 reduction in total GHG emissions from 1990 levels, by dividing the effort between the sectors covered by the EU Emissions Trading System (EU ETS) and the sectors under the Effort Sharing Decision (Binding national targets were set for Member States under the Effort Sharing Decision The achievement of EU internal compliance under the 2020 Climate and Energy Package including the national targets under the ESD is not subject to the UNFCCC assessment of the EU's joint commitment under the Convention

In 2009 the EU established internal rules under its "2020 climate and energy package"[32] – these underpin the EU implementation of the target under the Convention. The package introduced a clear approach to achieving the 20 % reduction of total GHG emissions from 1990 levels, which is equivalent to a 14 % reduction compared to 2005 levels. This 14 % reduction objective is divided between the ETS and ESD sectors. These two sub-targets are:

- ✓ a 21 % reduction target compared to 2005 for emissions covered by the ETS (including domestic and international aviation);
- ✓ a 10 % reduction target compared to 2005 for ESD sectors, shared between the 28 Member States (MS) through individual national GHG targets.

The distribution of the total target across the ETS and ESD is shown in ***Figure A.I.1***.

[32] http://ec.europa.eu/clima/policies/package/index_en.htm



Source: European Commission

Figure A.I.1 ***GHG targets under the 2020 climate and energy package***

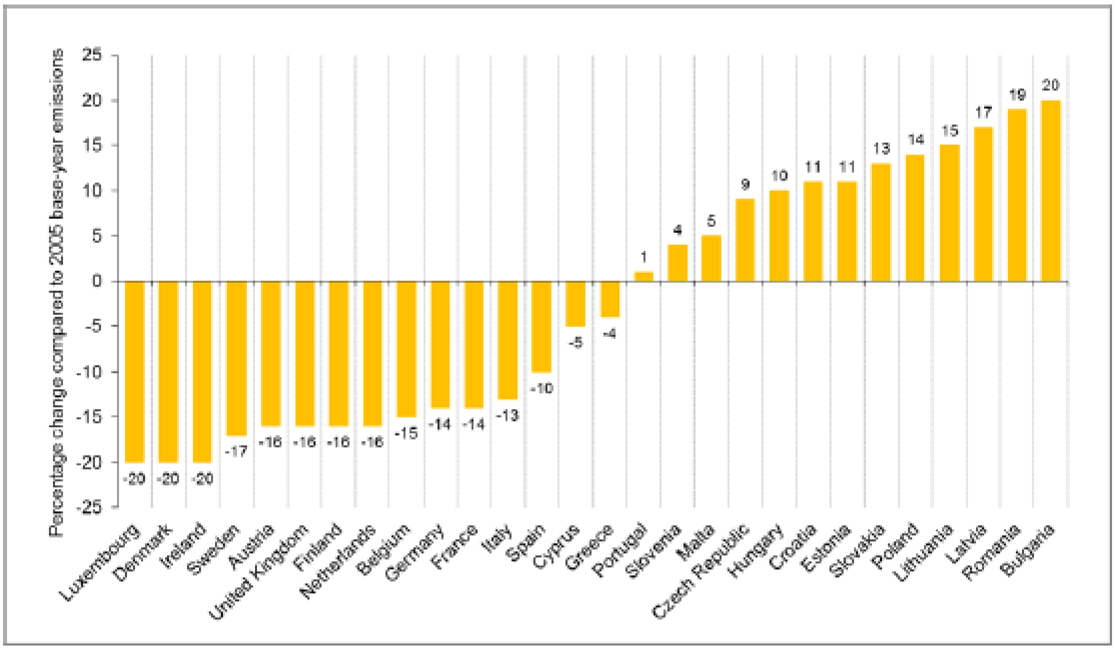
Under the revised EU ETS Directive (Directive 2009/29/EC), a single ETS cap covers the EU Member States and three participating non-EU countries (Norway, Iceland and Liechtenstein), i.e. there are no further individual caps by country. Allowances allocated in the EU ETS from 2013 to 2020 decrease by 1.74 % annually, starting from the average level of allowances issued by Member States for the second trading period (2008–2012).

The three non-EU countries participating in EU ETS (Norway, Iceland and Liechtenstein) are also subject to a similarly defined cap and the same annual decrease in allowance allocation. For further additional information on recent changes in the EU ETS see chapter 4 of the NC7.

The vast majority of emissions within the EU which fall outside the scope of the EU ETS are addressed under the Effort Sharing Decision (ESD) (Decision No 406/2009/EC). The ESD covers emissions from all sources outside the EU ETS, except for emissions from domestic and international aviation (which were included in the EU ETS from 1 January 2012), international maritime, and emissions and removals from land use, land-use change and forestry (LULUCF). It thus includes a diverse range of small-scale emitters in a wide range of sectors: transport (cars, trucks), buildings (in particular heating), services, small industrial installations, fugitive emissions from the energy sector, emissions of fluorinated gases from appliances and other sources, agriculture and waste. Such sources currently account for about 60 % of total GHG emissions in the EU.

While the EU ETS target is to be achieved by the EU as a whole, the ESD target was divided into national targets to be achieved individually by each Member State. Under the Effort Sharing Decision, national emission targets for 2020 are set, expressed as percentage changes from 2005 levels. These changes have been transferred into binding quantified annual reduction targets for the period from 2013 to 2020 (Commission Decision 2013/162/EU as amended by 2017/147/EU and Commission Decision 2013/634/EU), denominated in Annual Emission Allocations (AEAs). At country level, 2020 targets under the ESD range from -20 % to +20 %, compared to 2005 levels. ESD targets for 2020 for each EU Member State are shown in ***Figure A.I.2***.

The target levels have been set on the basis of Member States' relative Gross Domestic Product per capita. In addition, different levels of development in the EU-28 are taken into account by the provision of several flexibility options. Up to certain limitations, the ESD allows Member States to make use of flexibility provisions for meeting their annual targets: carry-over of over-achievements to subsequent years within each Member State, transfers of AEAs between Member States and the use of international credits (credits from Joint Implementation and the Clean Development Mechanism). Nevertheless ESD targets are designed in a strict manner: Every year, once MS emissions are reviewed according to strict criteria (described in Chapter III of the Commission Implementing Regulation 749/2014), the European Commission issues an implementing decision on MS ESD emissions in the given year. MS exceeding their annual AEA, even after taking into account the flexibility provisions and the use of JI/CDM credits, will face inter alia a penalty – a deduction from their emission allocation of the following year (excess emissions, multiplied by 1.08).



Source: EU Decision No 406/2009/EC, Annex 2

Figure A.I.2 National 2020 GHG emission limits under the ESD, relative to 2005 emissions levels

The 2020 ESD target of Greece is to reduce emissions by 4% compared to 2005 levels. The binding quantified annual reduction targets for the period from 2013 to 2020, or the Annual Emission Allocations (AEAs) of Greece are presented in Table A.I.2.

Table A.I.2 Annual Emission Allocations (AEAs) of Greece for the year 2013 to 2020 calculated applying global warming potential values from the fourth IPCC assessment report

Year	AEAs (t CO2eq)
2013	58,955,025
2014	59,281,845
2015	59,608,666
2016	59,935,486
2017	59,131,332
2018	59,437,285
2019	59,743,238
2020	60,049,191

Table A.I.3 Overview of EU targets

	International commitments				EU domestic legislation				
	Kyoto Protocol		UNFCCC	Paris Agreement	2020 Climate and Energy Package		2030 Climate and Energy Framework (subject to revision in light of the enhanced target.)		
					EU ETS	ESD	EU ETS	ESR	LULUCF
Target year of period	First commitment period (2008-2012)	Second commitment period (2013-2020)	2020	2030	2013-2020		2021 – 2030		
Emission reduction target	-8 %	-20 %	-20 %	At least -55% in net emissions compared to 1990	-21 % compared to 2005 for ETS emissions	Annual targets by MS. In 2020 -10 % compared to 2005 for non-ETS emissions	-43% for EU ETS sectors Proposed new target: -61%	-30% for ESR sectors (translated into individual binding targets for MSs) Proposed new target: -40%	No-debit target based on accounting rules Proposed new targets: - For 2030 the EU target is -310 MT CO_2-eq - For 2035 the EU target is a climate neutral land sector (combining LULUCF and emission from agriculture non-CO_2)

	International commitments				EU domestic legislation				
	Kyoto Protocol		UNFCCC	Paris Agreement	2020 Climate and Energy Package		2030 Climate and Energy Framework (subject to revision in light of the enhanced target.)		
					EU ETS	ESD	EU ETS	ESR	LULUCF
					Overall target: -20% GHG emission reduction vs 1990		Overall target: at least -55% net domestic GHG emission reduction vs 1990		
Further targets	-	-	Conditional target of -30 % if other Parties take on adequate commitments	-	Renewable Energy Directive: 20 % share of renewable energy of gross final energy consumption; Energy Efficiency Directive : Increase energy efficiency by 20 %		A binding renewable energy target for the EU for 2030 of at least 32% of final energy consumption, including a review clause by 2023 for an upward revision of the EU level target. A headline target of at least 32.5% for energy efficiency to be achieved collectively by the EU in 2030, with an upward revision clause by 2023.		
Base year	1990 KP Flexibility rules (Art 3(5)) regarding F-Gases and Economies in Transition	1990, but subject to flexibility rules. 1995 or 2000 may be used as the base year for NF_3	1990	1990	1990 for overall emission reduction target; 2005 for renewable energy and energy efficiency target; as well as for targets broken down into ETS and non-ETS emissions		2005		Subject to accounting rules

	International commitments				EU domestic legislation				
	Kyoto Protocol		UNFCCC	Paris Agreement	2020 Climate and Energy Package		2030 Climate and Energy Framework (subject to revision in light of the enhanced target.)		
					EU ETS	ESD	EU ETS	ESR	LULUCF
Aviation	Domestic aviation included. International aviation excluded	Domestic aviation included. International aviation excluded	Aviation in the scope of the EU ETS included	Aviation in the scope of the EU ETS included.	Aviation in the scope of the EU ETS included.	Excluded	Domestic and intra-EEA international aviation and departing flights to UK and CH included.	CO2 from domestic aviation excluded. Aviation generally excluded.	Not applicable
Use of international credits	Use of KP flexible mechanisms subject to KP rules	Use of KP flexible mechanisms subject to KP rules	Subject to quantitative and qualitative limits	No contribution from international credits	Upper limit for credit use for period 2008-2020 at a maximum of 50% of the reduction effort below 2005 levels	Annual use of carbon credits is limited to up to 3% of each Member State's ESD emissions in 2005	No contribution from international credits		
Carry-over of units from preceding periods	Not applicable	Subject to KP rules including those agreed in the Doha Amendment	Not applicable	Not applicable	EU ETS allowances can be banked into subsequent ETS trading periods since the second trading period	No carry-over from previous period	Indefinite validity of allowances not limited to trading periods, no need to carry over.	No	No

	International commitments				EU domestic legislation				
	Kyoto Protocol		UNFCCC	Paris Agreement	2020 Climate and Energy Package		2030 Climate and Energy Framework (subject to revision in light of the enhanced target.)		
					EU ETS	ESD	EU ETS	ESR	LULUCF
Gases covered	CO_2, CH_4, N_2O, HFCs, PFCs, SF_6	CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, NF_3	CO_2, CH_4, N_2O, HFCs, PFCs, SF_6	CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, NF_3	CO_2, N_2O, CF_4 and C_2F_6	CO_2, CH_4, N_2O, HFCs, PFCs, SF_6	CO_2, N_2O, PFCs	CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, NF3	CO_2, CH_4, N_2O
Sectors included	Annex A of KP (Energy, IPPU, agriculture, waste), LULUCF according to KP accounting rules for CP1	Annex A of KP (Energy, IPPU, agriculture, waste), LULUCF according to KP accounting rules for CP2	Energy, IPPU, agriculture, waste, aviation in the scope of the EU ETS	Energy, IPPU, Agriculture, Waste, LULUCF	Power & heat generation, energy-intensive industry sectors, aviation (Annex 1 of ETS directive)	Transport (except aviation), buildings, non-ETS industry, agriculture (except forestry) and waste	Power & heat generation, energy-intensive industry sectors, aviation	Transport (except aviation), buildings, non-ETS industry, agriculture (non- CO2) and waste [33]	Land-use, land-use change and forestry
GWPs used	IPCC SAR	IPCC AR4	IPCC AR4	IPCC AR5	IPCC AR4	IPCC AR4	IPCC AR5	IPCC AR5	IPCC AR5
Sectors included	Annex A of KP (Energy, IPPU, agriculture, waste), LULUCF according to KP accounting rules for CP1	Annex A of KP (Energy, IPPU, agriculture, waste), LULUCF according to KP accounting rules for CP2	Energy, IPPU, agriculture, waste, aviation in the scope of the EU ETS	Energy, IPPU, Agriculture, Waste, LULUCF	Power & heat generation, energy-intensive industry sectors, aviation (Annex 1 of ETS directive)	Transport (except aviation), buildings, non-ETS industry, agriculture (except forestry) and waste	As under Climate and Energy Package	As under Climate and Energy Package. [34]	Land-use, land-use change and forestry

[33] The ESR allows the use of land-use credits under certain conditions and up to a total limit over the period 2021-2030 as a flexibility option.
[34] The ESR allows the use of land-use credits under certain conditions and up to a total limit over the period 2021-2030 as a flexibility option.

	International commitments			EU domestic legislation				
	Kyoto Protocol	UNFCCC	Paris Agreement	2020 Climate and Energy Package		2030 Climate and Energy Framework (subject to revision in light of the enhanced target.)		
				EU ETS	ESD	EU ETS	ESR	LULUCF

	International commitments			EU domestic legislation	
	Kyoto Protocol		UNFCCC	Climate and Energy Package	
				EU ETS	ESD
Use of international credits	Use of KP flexible mechanisms subject to KP rules	Use of KP flexible mechanisms subject to KP rules	Subject to quantitative and qualitative limits	Subject to quantitative and qualitative limits	Subject to quantitative and qualitative limits
Carry-over of units from preceding periods	Not applicable	Subject to KP rules including those agreed in the Doha Amendment	Not applicable	EU ETS allowances can be banked into subsequent ETS trading periods since the second trading period	No carry-over from previous period
Gases covered	CO_2, CH_4, N_2O, HFCs, PFCs, SF_6	CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, NF_3	CO_2, CH_4, N_2O, HFCs, PFCs, SF_6	CO_2, CH_4, N_2O, HFCs, PFCs, SF_6[35]	
Sectors included	Annex A of KP (Energy, IPPU, agriculture, waste), LULUCF according to KP accounting rules for CP1	Annex A of KP (Energy, IPPU, agriculture, waste), LULUCF according to KP accounting rules for CP2	Energy, IPPU, agriculture, waste, aviation in the scope of the EU ETS	Power & heat generation, energy-intensive industry sectors, aviation (Annex 1 of ETS directive)	Transport (except aviation), buildings, non-ETS industry, agriculture (except forestry) and waste
GWPs used	IPCC SAR	IPCC AR4	IPCC AR4	IPCC AR5	

[35] In its third trading period, the EU ETS however only covers the gases CO_2, N_2O, CF_4 and C_2F_6.

A.I.3.2.2 Accounting for Market-based Mechanisms under the 2020 QEERT target

In general, in the EU the use of flexible mechanisms can take place on the one hand by operators in the EU ETS, on the other hand by governments for the achievement of ESD targets.

The amended EU ETS Directive 2009/29/EC (Article 11a(8)) sets the upper limit for credit use for the period from 2008 to 2020 at a maximum of 50 % of the reduction effort below 2005 levels. This is further specified into installation-level limits in the Commission Regulation on international credit entitlements (RICE) (EU No 1123/2013). Since some entitlements are expressed as a percentage of verified emissions over the entire period, the exact overall maximum amount will only be known at the end of the third trading period (2013-2020). For example, the majority of EU ETS emissions in Greece comes from operators of a stationary installation which have received a free allocation or an entitlement to use international credits in the period from 2008 to 2012. These operators (in case that they have not implement a significant capacity extension) shall be entitled to use international credits during the period 2008 to 2020 up to an amount corresponding to a maximum of 11 % of their allocation in the period from 2008 to 2012. Therefore, these operators are permitted to use up to about 34.7 million carbon credits during the period 2008 to 2020.

Since 2013, it is no longer possible to track the use of flexible mechanisms in the EU ETS directly via information on EUTL public website because CERs and ERUs are no longer surrendered directly but are exchanged into EUAs. These exchanges will become public on an installation level after three years ; however aggregated data at EU-level are available at the BR CTF Table 4 of EU.

The ESD allows Member States to make use of flexibility provisions for meeting their annual targets, with certain limitations. In the ESD sectors, the annual use of carbon credits is limited to up to 3 % of each Member State's ESD emissions in 2005. Member States that do not use their 3 % limit for the use of international credits in any specific year can transfer the unused part of their limit to another Member State or bank it for their own use until 2020. Member States fulfilling additional criteria (Austria, Belgium, Cyprus, Denmark, Finland, Ireland, Italy, Luxembourg, Portugal, Slovenia, Spain and Sweden) may use credits from projects in Least Developed Countries (LDCs) and Small Island Developing States (SIDS) up to an additional 1 % of their verified emissions in 2005. These credits are not bankable and transferable. Approximately 750 Mt of international credits can be used during the period from 2013 to 2020 in the ESD.

Moreover, higher CDM quality standards apply to the use of CERs for compliance with the EU's target under the Convention.

> According to the latest official GHG emission projections of Greece, Greece is expected to meet its annual ESD target without the use of international carbon credits, on the basis of the domestic policies and measures.

A.I.3.2.3 Other EU emission reduction targets

In addition to the EU target under the Convention, the EU also committed to a legally binding quantified emission limitation reduction commitment for the second commitment period of the Kyoto Protocol (2013 - 2020). In ***Table A.I.3*** all relevant GHG reduction targets for the EU and their key facts are displayed in an overview. On the left, the table includes the international commitments under the Kyoto Protocol and the UNFCCC. On the right, the EU commitments under the Climate and Energy Package are included.

A further target has been pledged to the Convention through the EU's Nationally Determined Contribution submitted under the Paris Agreement, and has been adopted by the EU under the

2030 Climate and Energy Framework. The emission reduction target is a pledge to reduce emissions by at least 40% (compared to 1990 levels) by 2030, enabling the EU to move towards a low-carbon economy and implement its commitments under the Paris Agreement.

In December 2019, the European Council (heads of state or government of the EU Member States, the European Council President and the President of the European Commission) endorsed the objective of achieving a climate-neutral EU by 2050, in line with the Paris Agreement1. On 5 March 2020, the Council of the European Union adopted a long-term low greenhouse gas emission development strategy of the EU and its Member States, reflecting this climate neutrality objective and submitted this to the UNFCCC Secretariat.

In July 2020, the European Council agreed that "the exceptional nature of the economic and social situation due to the COVID-19 crisis requires exceptional measures to support the recovery and resilience of the economies of the Member States. The plan for European recovery will need massive public and private investment at European level to set the Union firmly on the path to a sustainable and resilient recovery, creating jobs and repairing the immediate damage caused by the COVID-19 pandemic whilst supporting the Union's green and digital priorities.

At the same meeting, EU leaders agreed that the EU budget (the Multiannual Financial Framework for 2021-2027 (MFF)), reinforced by a European Union recovery instrument referred to as the Next Generation EU (NGEU), will be the main European tool for this effort. "Climate action will be mainstreamed in policies and programmes financed under the MFF and NGEU. An overall climate target of 30% will apply to the total amount of expenditure from the MFF and NGEU and be reflected in appropriate targets in sectoral legislation. They shall comply with the objective of EU climate neutrality by 2050 and contribute to achieving the Union's new 2030 climate targets, which will be updated by the end of the year. As a general principle, all EU expenditure should be consistent with Paris Agreement objectives."

EU leaders agreed further that "EU expenditure should be consistent with [...] the "do no harm" principle of the European Green Deal. An effective methodology for monitoring climate-spending and its performance, including reporting and relevant measures in case of insufficient progress, should ensure that the next MFF as a whole contributes to the implementation of the Paris Agreement. The Commission shall report annually on climate expenditure."

EU leaders agreed further that "[i]n order to address the social and economic consequences of the objective of reaching climate neutrality by 2050 and the Union's new 2030 climate target, a Just Transition Mechanism, including a Just Transition Fund, will be created."

In this context, on 11 December 2020 the European Council endorsed a new, significantly more ambitious EU climate target for 2030. The EU and its Member States, acting jointly, are committed to a binding target of a net domestic reduction of at least 55% in greenhouse gas emissions by 2030 compared to 1990.

Following the Withdrawal Agreement between the EU and the UK, and the Transition Period that will end on 31 December 2020, the United Kingdom will no longer be part of the European Union NDC from that date. Whereas the EU's original NDC submission was applicable also to the United Kingdom, this update is applicable to the EU and its 27 Member States.

A.I.4 Progress in achievement of quantified economy-wide emission reduction targets and relevant information

A.I.4.1 Assessment of progress and achievement of EU joint 2020 target under the UNFCCC

Under the UNFCCC, the EU and its Member States committed to achieving a joint quantified economy-wide greenhouse gas emission reduction target of 20 per cent below the 1990 level by 2020 ("the Cancun pledge"). It is a joint pledge with no separate targets for Member States under the Convention. The UK remains part of the joint EU 2020 target together with the 27 EU Member States. The LULUCF sector is excluded from the target under the Convention, while emissions from outgoing international flights are included (covered by EU-ETS).

The EU has jointly fulfilled its UNFCCC target and implemented it internally through EU legislation in the 2020 EU Climate and Energy Package that was adopted in 2009. In the package, the EU introduced a clear approach to achieving the 20% reduction in total GHG emissions from 1990 levels, by dividing the effort between the sectors covered by the EU Emissions Trading System (EU ETS) and the sectors under the Effort Sharing Decision (ESD), where national targets for Member States apply. The achievement of EU internal compliance under the 2020 Climate and Energy Package is not subject to the UNFCCC assessment of the EU's joint commitment under the Convention.

The EU has substantially overachieved its reduction target under the Convention, which means that also its Member States and the UK have fulfilled their emission reduction obligations. Greenhouse gas emissions within the scope of the target under the Convention amounted to around 3771 Mt CO2 eq in 2020 which is around 34.0 below the 1990 level of 5710 Mt CO2 eq The emissions of the United Kingdom are included here because it was part of the EU at the time of target setting, and EU legislation applied in the United Kingdom until 31 December 2020 Hence, the EU target under the Convention for 2020 has been overachieved by the EU, its Member States and the United Kingdom.

A.I.4.2 Mitigation actions and their effects

Information about the mitigation actions and their effects is provided in Chapter 4.3, and CTF Table 3. Information about the Greek institutional arrangements, including institutional, legal, administrative and procedural arrangements used for compliance, monitoring, reporting, archiving of information and evaluation of the progress towards the economy-wide emission reduction target is provided in Chapter 4.1, 4.2 and 5.1.

There were no changes in domestic institutional arrangements, including institutional, legal, administrative and procedural arrangements used for domestic compliance, monitoring, reporting, archiving of information and evaluation of the progress towards its economy-wide emission reduction target since the BR4.

A.I.4.2.1 Assessment of the economic and social consequences of response measures

The formulation of climate policy in Greece follows EU policy. To ensure that all relevant possible impacts are taken into account, the EU has established processes that assess the economic and social consequences of climate policy measures.

For the development of new policy initiatives through legislative proposals by the European Commission, an impact assessment system has been established in which all proposals are examined before any legislation is passed. It is based on an integrated approach which analyses both benefits and costs, and addresses all significant economic, social and environmental impacts of possible new initiatives (for details please refer to the EU BR as well as chapter 15 of the EU National Inventory Report).

Beyond this internal impact assessment system, procedures for assessing the impacts of EU (climate change) policies on external countries have also been established. Even though there is no explicit dialogue on response measures, the impacts of policy measures implemented by the EU are naturally being discussed within the framework of bilateral and regional cooperation. Such processes are included in various EU cooperation policies and agreements with third countries on a sectoral level, such as for trade agreements, as well as on an overarching political level in regional cooperation with Africa, Asia and Latin America as well as in bilateral relations. This way, it is ensured that the effects of such policies on non-EU countries are taken into account.

The free Trade Agreements that have been concluded between the EU and third countries provide pertinent examples. For instance, the Deep and Comprehensive Free Trade Area (DCFTA) signed between the EU and Ukraine on 27 June 2014, which came into force on 1 September 2017, sets out various processes which enable concerned stakeholders to get in contact with the EU on potential impacts of policies and regulations under the Trade Agreement.[36] These include provisions that allow interested parties to comment on proposed regulations under the agreement. Furthermore, enquiry or contact points are established to respond to questions arising from the application of regulations included in the agreement. Negotiations of similar agreements are taking place between the EU and Morocco, Tunisia and Jordan, among others.

Furthermore, dialogues on impacts of EU policies on third countries take place in the context of the European Neighbourhood Policy (ENP). As the basis for cooperation between the EU and a neighbouring country an Association Agreement is negotiated bilaterally between the two partners. In such an agreement, specific political priorities are set for the country concerned. Following the agreement, actions plans are negotiated between the EU and the respective neighbouring country which include priority areas for cooperation and a specific focus of action for each of these areas for three to five years. In the negotiations of an action plan, the country is able to raise specific issues of concern with the EU. Additionally, in technical discussions within sub-committees established through the Association Agreement (particularly on energy, transport and the environment), targeted exchanges on policy issues and directions for future cooperation at bilateral level take place. Partner countries can ask questions about planned EU initiatives and legislatives at such meetings to technical experts.[37]

The EU is also supporting third countries to effectively implement the Paris Agreement in a manner that unlocks socio-economic opportunities and supports climate objectives, by providing capacity building for partner countries across all regions. For examples, the Africa LEDS project is supporting Low Emissions Development in nine African countries in the context of socio-economic development priorities as stipulated in countries' development visions and strategies. One of the two components of the project focuses on technical capacity building for a strong analytical framework, including modelling, for long-term policy decision making.[38]

A.I.4.3 Estimates of emission reductions and removals and the use of units from the market-based mechanisms and land use, land-use change and forestry activities

Quantitative information is included in CTF Tables 4, 4(a)I, 4(a)II and 4(b).

Emissions / removals from LULUCF sector are not part of the 2020 target under UNFCCC (QEERT).

[36] For more information see http://ec.europa.eu/trade/policy/countries-and-regions/countries/ukraine/.
[37] For further information on the ENP see http://eeas.europa.eu/enp/.
[38] See http://ufmsecretariat.org/informal-ufm-high-level-conference-on-climate-change/.

Greece will not use any units from market-based mechanisms in relation to its ESD target. The use of units from market-based mechanisms from EU-ETS operators is described in section A.I.3.2.2 of this report.

A.I.4.3.1 LULUCF under the Kyoto Protocol

CTF Table 4(a)II presents quantitative information based on the most updated data reported with the 2017 national greenhouse gas inventory submission under the KP.

For the second commitment period of the Kyoto Protocol Greece has not elected any of the elective activities under Article 3, para 4 of the Kyoto Protocol. Therefore, Greece will account for the mandatory activities Afforestation/Reforestation and Deforestation (Article 3, para 3) and Forest Management (Article 3, para 4). Furthermore Greece has decided to account for Article 3.3 and 3.4 of the Kyoto Protocol activities at the end of the commitment period.

The forest management reference level for Greece is inscribed in the appendix to the annex to decision 2/CMP.7, which is equal to -1.830 Mt CO_2 per year assuming instantaneous oxidation of HWP. Greece submitted its second Technical Correction of the Forest Management Reference Level, both assuming instantaneous oxidation, and applying the First Order Decay Function for Harvested Wood Products with the latest national GHG inventory submission, providing also all the necessary information. In the table below the relevant quantitative information on the FMRL technical correction is presented.

Table A.I.4 Summary information on the Forest Management Reference Level Technical Correction

Summary Table Forest Management Reference Level Technical Correction		
	Instantaneous oxidation	FOD
	kt CO_2 eq/yr	
FMRL	-1,830	0
$FMRL_{corr}$	-1,742	-1,738
Difference in per cent	-5%	-5%
Technical Correction	88	92
Projected HWP contribution	-	4

With regard to the activity of Afforestation/Reforestation under article 3.3 this includes only cropland areas that have been planting in the context of EEC Regulations.

In Article 3.4 Forest Management activity, only those forests that are managed with a forest management plan started in 1990 or later are included. These forests cover approximately 36% of the total forest land of Greece.

Greece intends to apply the provision to exclude emissions from natural disturbances for the accounting for afforestation/reforestation under Article 3, paragraph 3, and forest management under Article 3, paragraph 4 of the Kyoto Protocol during the second commitment period in accordance with decision 2/CMP.7, annex, paragraph 33, and any relevant supplementary methodological guidance developed by the Intergovernmental Panel on Climate Change and adopted by the CMP and the COP. To that end, all the necessary information on the background level, the margin and the type of disturbances (i.e. wildfires) has been provided with the latest national GHG inventory submission (2017) in accordance with decision 2/CMP.7. All the necessary information can be found in sections 9.4.4 and 9.5.2.1 of the 2017 NIR and the relevant CRF tables.

As far as Article 3.3 activities of KP (Afforestation, Reforestation and Deforestation) are concerned, the net removal potential of Greece is expected to be around 0.5-1.0 Mt CO_2 during the years 2013-2020. For forest management activity, it is estimated that under the current forest management practices in Greece, the sink potential during the second commitment period will be approximately 1.7 – 2.2 Mt CO_2 per year.

A.I.5 Projections

The projections for years 2020, 2030 and 2040 consistent with the UNFCCC Annex I reporting guidelines on national communications are reported in Chapter 5 and CTF Tables 5 and 6. No changes since the 4th BR in the model or methodologies used for the preparation of projections have occurred.

A.I.6 Provision of financial, technological and capacity-building support to developing country Parties

This chapter should be read in conjunction with the chapter on provision of financial support (chapter 7) of the 8th National Communication. Together, they present a comprehensive description of the Greece’s climate support.

This chapter covers the quantitative information for 2019 and 2020, using the required table formats.

The CTF tables with detailed data on the support provided in 2019 and 2020 are included in the CTF tables[39].

A.I.6.1 Finance

The provision of financial support by Greece to non-Annex I Parties is presented in chapter 7 of the 8th NC and CTF Tables 7, 7(a) and 7(b).

A.I.6.2 Technology development and transfer

The provision of technology development and transfer support by Greece to non-Annex I Parties is presented in chapter 7 of the 8th NC and CTF Table 8.

A.I.6.3 Capacity-building

The provision of capacity-building support by Greece to non-Annex I Parties is presented in chapter 7 of the 8th NC and CTF Table 9.

[39] These tables will be submitted to the UNFCCC using the official upload software.

A.II Summary tables on emission trends

Table A.II.1a Evaluation of CO_2 emissions for the period 1990 – 1999 (in kt)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(kt CO_2 eq)										
Total (net emissions)[2]	101181.55	101181.55	101039.15	102199.58	101339.66	104388.52	106438.51	110161.82	115410.90	121196.52	120573.90
1. Energy	77026.71	77026.71	77145.94	79136.52	78787.37	81025.24	81090.93	83307.38	87849.36	92575.73	92015.85
A. Fuel combustion (sectoral approach)	75817.41	75817.41	75920.07	77869.41	77538.65	79742.70	79791.15	81955.74	86517.46	91192.75	90623.28
1. Energy industries	43252.76	43252.76	42086.81	44375.84	44274.60	46259.01	45022.01	44198.66	47647.17	50176.93	50474.98
2. Manufacturing industries and construction	9404.85	9404.85	9454.27	9110.42	8824.82	8674.68	9553.42	10169.30	10278.31	10232.23	9212.49
3. Transport	14506.99	14506.99	15324.56	15717.99	15919.79	16234.93	16584.24	17029.69	17765.40	19607.98	19939.66
4. Other sectors	8652.81	8652.81	9054.43	8665.15	8519.45	8574.09	8631.48	10558.09	10826.58	11175.61	10996.16
5. Other	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE
B. Fugitive emissions from fuels	1209.31	1209.31	1225.87	1267.11	1248.71	1282.54	1299.78	1351.64	1331.90	1382.98	1392.57
1. Solid fuels	1130.04	1130.04	1147.43	1198.74	1193.64	1234.03	1255.59	1301.73	1281.33	1325.75	1351.16
2. Oil and natural gas and other emissions from energy production	79.27	79.27	78.44	68.38	55.07	48.51	44.19	49.91	50.57	57.23	41.41
C. CO_2 transport and storage	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Industrial Processes	11277.14	11277.14	11213.59	10644.27	11095.23	11686.78	13603.11	14371.56	14852.33	15569.50	16406.07
A. Mineral industry	6775.43	6775.43	6696.57	6775.95	6730.23	6702.72	7186.10	7176.80	7255.63	7294.80	7285.27
B. Chemical industry	2930.71	2930.71	2929.94	2317.40	3076.45	3592.31	4992.84	5738.10	5974.04	6595.58	7431.47
C. Metal industry	1202.56	1202.56	1241.34	1187.26	927.70	1050.40	1069.99	1068.37	1164.40	1137.54	1016.87
D. Non-energy products from fuels and solvent use	129.78	129.78	102.66	120.57	119.39	102.66	78.27	74.14	64.49	47.98	55.05
E. Electronic industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes	NO	NO	NO	NO	0.10	0.16	42.38	81.21	159.01	256.88	374.27
G. Other product manufacture and use	238.66	238.66	243.08	243.09	241.36	238.53	233.53	232.96	234.76	236.74	243.13
H. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Agriculture	10120.79	10120.79	10144.10	9868.57	9314.84	9119.26	9465.84	9527.57	9443.03	9418.75	9346.04
A. Enteric fermentation	4023.81	4023.81	4027.72	3970.09	3933.47	3858.39	3975.12	3984.12	3986.26	3987.07	4026.67
B. Manure management	1098.30	1098.30	1097.67	1092.72	1096.92	1070.11	1085.53	1082.85	1088.92	1087.49	1081.29
C. Rice cultivation	82.26	82.26	73.80	73.48	101.13	118.40	130.53	143.05	145.42	131.25	116.71
D. Agricultural soils	4811.45	4811.45	4824.98	4626.15	4091.02	3978.94	4180.34	4222.81	4129.31	4123.00	4034.22
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field burning of agricultural residues	44.57	44.57	61.80	50.58	48.56	52.66	49.29	48.72	49.38	46.05	45.40
G. Liming	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
H. Urea application	60.41	60.41	58.13	55.57	43.74	40.75	45.02	46.02	43.74	43.88	41.75
I. Other carbon-containing fertilizers	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
J. Other											
4. Land use, land-use change and forestry[2]	-2107.91	-2107.91	-2305.10	-2388.77	-2848.77	-2586.52	-2872.37	-2295.07	-1946.29	-1758.29	-2538.91
A. Forest land	-1091.56	-1091.56	-1257.76	-1508.37	-1557.50	-1298.46	-1553.79	-1620.05	-1262.78	-1138.45	-1577.01
B. Cropland	-754.87	-754.87	-799.15	-795.29	-1031.57	-957.18	-1034.78	-393.82	-979.39	-824.26	-1008.41
C. Grassland	17.21	17.21	14.58	45.06	85.74	-12.33	-28.84	-33.27	-25.41	-21.47	-83.13
D. Wetlands	NO,NE	NO,NE	NO,NE	0.04	0.71	0.26	0.08	0.21	0.58	2.19	0.36
E. Settlements	50.12	50.12	55.47	56.08	60.11	64.51	66.14	80.18	75.06	78.34	85.09
F. Other land	20.21	20.21	13.30	31.08	24.93	27.99	29.64	41.61	47.58	49.32	55.05
G. Harvested wood products	-349.00	-349.00	-331.55	-217.37	-431.18	-411.32	-350.83	-369.93	198.06	96.05	-10.87
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Waste	4864.81	4864.81	4840.61	4938.99	4990.99	5143.76	5151.00	5250.38	5212.48	5390.82	5344.85
A. Solid waste disposal	2243.04	2243.04	2311.41	2385.09	2462.58	2545.25	2632.58	2724.26	2821.32	2922.43	3026.56
B. Biological treatment of solid waste	0.47	0.47	0.47	0.69	0.74	0.79	0.74	0.67	6.10	5.65	5.70
C. Incineration and open burning of waste	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
D. Waste water treatment and discharge	2620.95	2620.95	2528.38	2552.85	2527.31	2597.36	2517.32	2525.10	2384.71	2462.40	2312.24
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other *(as specified in summary 1.A)*	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Memo items:											
International bunkers	10855.29	10855.29	9835.77	11088.56	12696.30	13794.52	14466.58	12914.38	12858.38	14157.02	13191.89
Aviation	2496.15	2496.15	2152.12	2244.74	2391.05	2836.75	2658.59	2547.12	2464.30	2585.34	2903.64
Navigation	8359.14	8359.14	7683.65	8843.82	10305.25	10957.77	11807.99	10367.26	10394.08	11571.68	10288.25
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 emissions from biomass	4016.56	4016.56	4033.22	4040.84	4044.50	4018.39	4035.04	4083.60	4096.18	4081.99	4097.43
CO_2 captured	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE
Long-term storage of C in waste disposal sites	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Indirect N_2O	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
Indirect CO_2 [3]	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
Total CO_2 equivalent emissions without land use, land-use change and forestry	103289.46	103289.46	103344.25	104588.35	104188.43	106975.03	109310.88	112456.89	117357.20	122954.80	123112.81
Total CO_2 equivalent emissions with land use, land-use change and forestry	101181.55	101181.55	101039.15	102199.58	101339.66	104388.52	106438.51	110161.82	115410.90	121196.52	120573.90
Total CO_2 equivalent emissions, including indirect CO2, without land use, land-use change and forestry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total CO_2 equivalent emissions, including indirect CO2, with land use, land-use change and forestry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table A.II.1b Evaluation of CO_2 emissions for the period 2000 – 2010 (in kt)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
	(kt)										
1. Energy	94040.42	96392.70	96133.09	100038.52	100509.58	104309.84	103081.26	105297.67	102481.14	97677.64	90725.79
A. Fuel combustion (sectoral approach)	94026.45	96382.87	96123.46	100031.49	100502.73	104304.25	103075.64	105293.10	102477.59	97673.20	90719.82
1. Energy industries	54739.01	55254.97	54678.66	55921.54	57238.34	58058.17	55895.54	59371.47	58019.05	54480.47	52036.60
2. Manufacturing industries and construction	9847.74	9971.73	9426.05	9102.77	8618.35	10134.37	10369.07	9959.13	9325.77	7436.78	6813.24
3. Transport	18390.10	19251.76	19573.78	20651.49	21086.30	21375.01	22057.52	22686.15	21983.51	24831.54	22052.80
4. Other sectors	11049.60	11904.42	12444.96	14355.70	13559.75	14214.11	14104.93	12729.20	12453.05	10674.72	9574.70
5. Other	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	522.59	648.58	547.15	696.21	249.69	242.49
B. Fugitive emissions from fuels	13.97	9.83	9.63	7.03	6.85	5.59	5.62	4.57	3.55	4.44	5.97
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	13.97	9.83	9.63	7.03	6.85	5.59	5.62	4.57	3.55	4.44	5.97
C. CO_2 transport and storage	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Industrial processes	8919.92	8955.73	8851.34	9015.19	8999.79	9587.23	9358.85	9257.87	8611.78	6639.75	6598.93
A. Mineral industry	7492.72	7549.59	7312.47	7348.96	7357.02	7926.76	7635.81	7471.57	6957.92	5321.32	4920.64
B. Chemical industry	281.96	135.77	165.68	286.61	304.52	296.92	313.93	317.94	338.06	453.25	632.88
C. Metal industry	1000.97	1111.55	1239.96	1239.99	1182.25	1215.54	1233.61	1301.47	1167.74	732.64	909.45
D. Non-energy products from fuels and solvent use	50.34	63.90	41.73	44.54	58.59	53.23	79.72	70.18	53.86	41.91	42.60
E. Electronic industry											
F. Product uses as ODS substitutes											
G. Other product manufacture and use	93.93	94.93	91.49	95.09	97.41	94.77	95.78	96.70	94.20	90.62	93.36
H. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Agriculture	38.47	37.04	36.05	35.19	36.33	31.91	29.92	33.62	28.64	24.93	30.35
A. Enteric fermentation											
B. Manure management											
C. Rice cultivation											
D. Agricultural soils											
E. Prescribed burning of savannas											
F. Field burning of agricultural residues											
G. Liming	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
H. Urea application	38.47	37.04	36.05	35.19	36.33	31.91	29.92	33.62	28.64	24.93	30.35
I. Other carbon-containing fertilizers	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
J. Other											
4. Land use, land-use change and forestry (2)	-2175.92	-2453.21	-2787.65	-2522.61	-2489.12	-3308.21	-3338.38	-1826.78	-3019.05	-3103.80	-3076.99
A. Forest land	-1124.24	-1798.06	-1875.04	-1888.18	-1879.53	-2293.70	-2245.60	-1463.54	-2051.62	-2057.50	-2148.78
B. Cropland	-859.14	-618.88	-757.48	-421.28	-494.47	-631.48	-614.14	253.21	-669.81	-512.05	-310.04
C. Grassland	-109.12	-109.13	-91.20	-106.83	-59.52	-287.22	-375.40	-378.79	-444.78	-457.88	-464.69
D. Wetlands	2.51	0.74	2.37	1.37	26.30	3.10	4.23	3.58	2.82	2.82	2.61
E. Settlements	89.96	89.58	94.25	111.79	106.05	115.06	115.37	119.25	121.08	122.24	121.34
F. Other land	59.15	64.23	69.89	69.09	77.69	69.91	82.51	107.50	99.33	89.72	86.45
G. Harvested wood products	-235.05	-81.70	-230.45	-288.58	-265.64	-283.87	-305.35	-468.00	-76.06	-291.14	-363.89
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Waste	0.22	0.22	0.48	0.85	1.05	1.98	2.41	3.17	3.68	12.43	6.36
A. Solid waste disposal	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
B. Biological treatment of solid waste											
C. Incineration and open burning of waste	0.22	0.22	0.48	0.85	1.05	1.98	2.41	3.17	3.68	12.43	6.36
D. Waste water treatment and discharge											
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other *(as specified in summary 1.A)*	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Memo items:											
International bunkers	14018.48	13513.65	12342.00	13304.19	13474.19	11815.09	12727.53	13103.79	12862.32	11147.83	11373.02
Aviation	2525.76	2347.31	2347.39	3055.51	3140.94	2600.48	2779.42	2948.31	2930.90	2717.91	2584.15
Navigation	11492.72	11166.34	9994.61	10248.68	10333.25	9214.61	9948.11	10155.48	9931.42	8429.92	8788.87
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 emissions from biomass	4248.96	4288.78	4368.53	4153.54	4196.30	4380.80	4403.94	4802.39	4273.15	3944.68	4190.40
CO_2 captured	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE		NO,IE	NO,IE	NO,IE	NO,IE	NO,IE
Long-term storage of C in waste disposal sites	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Indirect N_2O											
Indirect CO_2 (3)	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
Total CO_2 equivalent emissions without land use, land-use change and forestry	102999.03	105385.70	105020.96	109089.75	109546.75	113930.97	112472.44	114592.34	111125.24	104354.75	97361.43
Total CO_2 equivalent emissions with land use, land-use change and forestry	100823.11	102932.49	102233.31	106567.14	107057.63	110622.76	109134.06	112765.56	108106.20	101250.95	94284.43
Total CO_2 equivalent emissions, including indirect CO2, without land use, land-use change and forestry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total CO_2 equivalent emissions, including indirect CO2, with land use, land-use change and forestry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table A.II.1c Evaluation of CO_2 emissions for the period 2011 – 2019 (in kt)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2011	2012	2013	2014	2015	2016	2017	2018	2019	Change from base to latest reported year
					(kt)					%
1. Energy	89559.15	85903.15	75823.30	72455.54	69220.33	65355.02	68490.59	65581.80	59759.89	-19.96
A. Fuel combustion (sectoral approach)	89553.91	85898.19	75819.23	72451.79	69216.70	65345.65	68482.88	65570.83	59750.84	-19.93
1. Energy industries	53838.38	54507.26	49205.02	45784.63	40776.46	36,909.61	39,817.11	38,149.03	31,885.66	-26.01
2. Manufacturing industries and construction	4917.03	5457.78	5229.16	5397.33	5166.28	5,291.92	5,715.97	5,048.80	4,568.50	-51.08
3. Transport	19779.97	16465.15	16246.67	16270.48	16804.68	17,132.32	16,902.97	17,130.03	17,517.02	24.02
4. Other sectors	10802.99	9257.07	4903.11	4810.77	6262.95	5,812.76	5,864.53	5,119.81	5,645.59	-30.00
5. Other	215.53	210.93	235.28	188.58	206.32	199.05	182.30	123.17	134.07	100.00
B. Fugitive emissions from fuels	5.24	4.95	4.07	3.75	3.64	9.37	7.71	10.97	9.04	-78.82
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
2. Oil and natural gas and other emissions from energy production	5.24	4.95	4.07	3.75	3.64	9.37	7.71	10.97	9.04	-78.82
C. CO_2 transport and storage	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
2. Industrial processes	4958.96	5498.93	5882.99	6178.45	5711.86	5986.70	6326.09	6189.05	5937.88	-31.75
A. Mineral industry	3108.57	3738.18	4170.20	4359.38	3956.73	4,271.66	4,246.72	4,007.64	3,931.48	-41.97
B. Chemical industry	584.38	502.02	516.91	569.38	495.05	461.93	804.62	951.19	877.74	28.96
C. Metal industry	1137.50	1139.16	1073.79	1126.00	1143.27	1,134.82	1,155.86	1,108.15	1,005.64	-0.63
D. Non-energy products from fuels and solvent use	40.37	34.31	35.93	40.34	33.00	34.29	34.18	35.29	35.87	-72.36
E. Electronic industry										
F. Product uses as ODS substitutes										
G. Other product manufacture and use	88.13	85.27	86.16	83.33	83.81	84.00	84.72	86.78	87.14	-14.96
H. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
3. Agriculture	25.84	25.00	26.01	23.64	23.41	26.36	34.14	32.91	34.80	-42.39
A. Enteric fermentation										
B. Manure management										
C. Rice cultivation										
D. Agricultural soils										
E. Prescribed burning of savannas										
F. Field burning of agricultural residues										
G. Liming	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
H. Urea application	25.84	25.00	26.01	23.64	23.41	26.36	34.14	32.91	34.80	-42.39
I. Other carbon-containing fertilizers	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
J. Other										
4. Land use, land-use change and forestry (2)	-3166.00	-3149.19	-1614.72	-150.80	-3745.52	-3521.90	-3282.72	-4127.33	-3626.22	66.57
A. Forest land	-2161.17	-2107.11	-2188.77	-2201.58	-2169.48	-2,159.11	-2,121.43	-2,206.19	-1,709.01	49.60
B. Cropland	-554.14	-567.07	974.06	2294.54	-591.79	-249.26	-123.96	-388.90	-363.26	-51.91
C. Grassland	-333.55	-773.60	-670.40	-512.62	-1250.63	-1,392.83	-1,276.18	-1,711.81	-1,723.76	-801136.83
D. Wetlands	2.59	2.85	2.52	0.09	0.07	0.03	0.01	0.21	0.25	100.00
E. Settlements	119.89	131.89	121.00	118.99	120.37	133.56	131.49	131.75	128.81	158.98
F. Other land	84.33	128.23	82.43	82.47	80.15	81.38	83.76	79.75	71.47	261.19
G. Harvested wood products	-323.96	35.61	64.44	67.31	65.78	64.33	23.59	-32.13	-30.72	-91.20
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
5. Waste	5.61	3.48	3.83	4.48	5.48	4.66	4.26	3.78	3.36	1426.40
A. Solid waste disposal	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00
B. Biological treatment of solid waste										
C. Incineration and open burning of waste	5.61	3.48	3.83	4.48	5.48	4.66	4.26	3.78	3.36	1426.40
D. Waste water treatment and discharge										
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
6. Other *(as specified in summary 1.A)*	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Memo items:										
International bunkers	11652.07	9727.87	9382.76	8878.27	8657.31	8664.95	10401.28	10994.61	12238.89	15.67
Aviation	2696.04	2386.98	2466.45	2829.92	2869.09	3,079.15	3,434.50	3,858.08	3,988.58	61.17
Navigation	8956.03	7340.89	6916.31	6048.35	5788.21	5,585.80	6,966.77	7,136.53	8,250.31	1.78
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
CO_2 emissions from biomass	5142.30	5708.36	4710.18	4757.38	5202.20	4,545.61	4,741.12	4,678.49	4,669.14	16.25
CO_2 captured	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	0.00
Long-term storage of C in waste disposal sites	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.00
Indirect N_2O										
Indirect CO_2 (3)	NE,NO	NE,NO	NE,NO	NE,NO	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	0.00
Total CO_2 equivalent emissions without land use, land-use change and forestry	94549.57	91430.55	81736.13	78662.11	74961.09	71372.74	74855.08	71807.55	65735.92	-21.20
Total CO_2 equivalent emissions with land use, land-use change and forestry	91383.57	88281.36	80121.41	78511.31	71215.57	67850.85	71572.36	67680.22	62109.70	-23.56
Total CO_2 equivalent emissions, including indirect CO2, without land use, land-use change and forestry	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
Total CO_2 equivalent emissions, including indirect CO2, with land use, land-use change and forestry	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00

Table A.II.2a Evaluation of CH_4 emissions for the period 1990 – 1999 (in kt)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(kt)										
1. Energy	61.67	61.67	62.48	64.34	63.91	65.39	66.26	68.33	67.78	70.20	71.17
A. Fuel combustion (sectoral approach)	15.01	15.01	15.18	15.11	15.14	15.13	15.17	15.26	15.42	15.51	15.50
1. Energy industries	0.57	0.57	0.57	0.58	0.59	0.60	0.61	0.60	0.63	0.65	0.66
2. Manufacturing industries and construction	0.49	0.49	0.48	0.48	0.46	0.45	0.48	0.51	0.51	0.49	0.47
3. Transport	4.42	4.42	4.46	4.41	4.46	4.45	4.50	4.52	4.60	4.76	4.89
4. Other sectors	9.54	9.54	9.67	9.64	9.63	9.62	9.59	9.64	9.68	9.60	9.47
5. Other	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE
B. Fugitive emissions from fuels	46.66	46.66	47.30	49.23	48.77	50.27	51.09	53.06	52.37	54.69	55.67
1. Solid fuels	45.20	45.20	45.90	47.95	47.75	49.36	50.22	52.07	51.25	53.03	54.05
2. Oil and natural gas and other emissions from energy production	1.46	1.46	1.40	1.28	1.02	0.90	0.86	0.99	1.11	1.66	1.62
C. CO_2 transport and storage											
2. Industrial processes	0.06	0.06	0.06	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.03
A. Mineral industry											
B. Chemical industry	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.05	0.05	0.02
C. Metal industry	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
D. Non-energy products from fuels and solvent use	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
E. Electronic industry											
F. Product uses as ODS substitutes											
G. Other product manufacture and use	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
H. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Agriculture	196.58	196.58	196.84	194.23	194.02	191.44	196.63	197.35	197.73	197.10	197.71
A. Enteric fermentation	160.95	160.95	161.11	158.80	157.34	154.34	159.00	159.36	159.45	159.48	161.07
B. Manure management	30.97	30.97	30.86	30.93	31.14	30.74	30.88	30.77	30.95	30.94	30.58
C. Rice cultivation	3.29	3.29	2.95	2.94	4.05	4.74	5.22	5.72	5.82	5.25	4.67
D. Agricultural soils	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field burning of agricultural residues	1.37	1.37	1.91	1.56	1.49	1.63	1.52	1.50	1.52	1.42	1.40
G. Liming											
H. Urea application											
I. Other carbon-containing fertilizers											
J. Other											
4. Land use, land-use change and forestry	2.51	2.51	1.24	3.67	3.28	3.06	1.74	1.05	2.31	6.31	0.48
A. Forest land	1.88	1.88	0.71	2.06	2.15	1.88	1.24	0.51	1.50	4.72	0.30
B. Cropland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Grassland	0.63	0.63	0.53	1.61	1.13	1.18	0.50	0.54	0.81	1.59	0.18
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Other land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Harvested wood products											
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Waste	183.39	183.39	182.26	186.05	188.08	193.96	194.15	198.07	196.36	203.53	201.21
A. Solid waste disposal	89.72	89.72	92.46	95.40	98.50	101.81	105.30	108.97	112.85	116.90	121.06
B. Biological treatment of solid waste	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.15	0.14	0.14
C. Incineration and open burning of waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Waste water treatment and discharge	93.65	93.65	89.79	90.62	89.54	92.11	88.81	89.07	83.35	86.49	80.01
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other *(as specified in summary 1.A)*	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total CH_4 emissions without CH_4 from LULUCF	441.69	441.69	441.64	444.68	446.06	450.85	457.10	463.81	461.94	470.88	470.12
Total CH_4 emissions with CH_4 from LULUCF	444.20	444.20	442.88	448.35	449.34	453.91	458.84	464.85	464.25	477.19	470.60
Memo items:											
International bunkers	0.68	0.68	0.61	0.70	0.82	0.87	0.92	0.82	0.82	0.93	0.83
Aviation	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Navigation	0.66	0.66	0.60	0.68	0.80	0.85	0.90	0.80	0.80	0.91	0.81
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 emissions from biomass											
CO_2 captured											
Long-term storage of C in waste disposal sites											
Indirect N_2O											
Indirect CO_2[3]											

Table A.II.2b Evaluation of CH_4 emissions for the period 2000 – 2010 (in kt)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
	(kt)										
1. Energy	73.63	75.75	79.29	77.54	79.33	79.00	74.99	77.56	75.09	72.84	66.26
A. Fuel combustion (sectoral approach)	15.71	15.79	15.62	15.56	15.62	15.65	15.50	16.01	13.98	12.67	13.08
1. Energy industries	0.73	0.72	0.72	0.75	0.74	0.77	0.77	0.82	0.82	0.72	0.66
2. Manufacturing industries and construction	0.53	0.52	0.53	0.47	0.47	0.57	0.54	0.52	0.56	0.49	0.47
3. Transport	4.92	5.05	4.98	4.95	4.99	4.88	4.80	4.58	4.30	4.10	4.33
4. Other sectors	9.52	9.50	9.39	9.40	9.41	9.42	9.39	10.08	8.29	7.37	7.62
5. Other	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	0.00	0.00	0.00	0.00	0.00	0.00
B. Fugitive emissions from fuels	57.93	59.96	63.67	61.98	63.71	63.35	59.48	61.55	61.11	60.16	53.18
1. Solid fuels	55.65	57.79	61.38	59.49	61.01	60.45	56.20	57.89	57.24	56.52	49.23
2. Oil and natural gas and other emissions from energy production	2.28	2.18	2.29	2.50	2.70	2.91	3.29	3.66	3.87	3.64	3.95
C. CO_2 transport and storage											
2. Industrial processes	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.02
A. Mineral industry											
B. Chemical industry	0.01	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C. Metal industry	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.02
D. Non-energy products from fuels and solvent use	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
E. Electronic industry											
F. Product uses as ODS substitutes											
G. Other product manufacture and use	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
H. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Agriculture	194.67	196.00	198.49	199.59	198.57	198.61	199.08	198.51	196.27	195.30	198.83
A. Enteric fermentation	158.78	160.31	162.44	163.66	162.46	162.27	163.68	162.76	160.70	159.60	162.93
B. Manure management	30.43	29.95	30.11	30.05	30.04	30.19	29.53	29.38	28.93	28.53	28.47
C. Rice cultivation	3.98	4.22	4.48	4.52	4.55	4.62	4.46	5.00	5.00	5.60	6.01
D. Agricultural soils	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field burning of agricultural residues	1.48	1.51	1.46	1.36	1.51	1.53	1.40	1.37	1.65	1.57	1.41
G. Liming											
H. Urea application											
I. Other carbon-containing fertilizers											
J. Other											
4. Land use, land-use change and forestry	8.32	1.12	0.15	0.21	0.54	0.42	0.84	12.85	1.74	1.85	0.66
A. Forest land	5.84	0.62	0.06	0.09	0.23	0.20	0.58	7.71	1.20	1.31	0.55
B. Cropland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Grassland	2.48	0.50	0.09	0.13	0.31	0.23	0.25	5.14	0.54	0.54	0.10
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Other land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Harvested wood products											
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Waste	201.11	170.46	168.78	173.31	173.59	177.66	184.31	176.97	177.81	166.30	177.62
A. Solid waste disposal	126.02	109.26	114.19	122.39	124.57	132.78	138.33	135.99	140.17	130.07	137.78
B. Biological treatment of solid waste	0.14	0.03	0.03	0.02	0.02	0.07	0.33	0.36	0.37	0.12	0.55
C. Incineration and open burning of waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Waste water treatment and discharge	74.96	61.17	54.55	50.90	49.00	44.80	45.64	40.62	37.27	36.11	39.28
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other *(as specified in summary 1.A)*	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total CH_4 emissions without CH_4 from LULUCF	469.44	442.23	446.57	450.46	451.50	455.29	458.40	453.06	449.19	434.46	442.73
Total CH_4 emissions with CH_4 from LULUCF	477.76	443.34	446.73	450.67	452.04	455.71	459.23	465.91	450.93	436.31	443.38
Memo items:											
International bunkers	0.96	0.94	0.85	0.88	0.89	0.80	0.86	0.88	0.87	0.73	0.76
Aviation	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Navigation	0.94	0.92	0.83	0.86	0.87	0.78	0.84	0.86	0.85	0.72	0.74
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 emissions from biomass											
CO_2 captured											
Long-term storage of C in waste disposal sites											
Indirect N_2O											
Indirect CO_2 (3)											

Table A.II.2c Evaluation of CH_4 emissions for the period 2011 – 2019 (in kt)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2011	2012	2013	2014	2015	2016	2017	2018	2019	Change from base to latest reported year
	(kt)									%
1. Energy	70.71	75.64	65.40	61.76	58.58	45.50	51.10	49.13	41.00	-33.52
A. Fuel combustion (sectoral approach)	14.92	16.39	14.39	13.94	14.49	12.81	13.12	12.53	12.18	-18.87
1. Energy industries	0.67	0.67	0.63	0.59	0.55	0.54	0.58	0.55	0.51	-10.55
2. Manufacturing industries and construction	0.45	0.37	0.26	0.31	0.35	0.29	0.32	0.36	0.37	-24.07
3. Transport	3.77	2.85	3.21	3.15	3.19	2.92	2.94	2.84	2.77	-37.32
4. Other sectors	10.02	12.50	10.28	9.90	10.40	9.06	9.28	8.77	8.53	-10.58
5. Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
B. Fugitive emissions from fuels	55.79	59.25	51.01	47.82	44.09	32.69	37.98	36.60	28.82	-38.23
1. Solid fuels	51.10	54.83	46.97	44.29	40.28	28.43	32.86	31.78	23.84	-47.25
2. Oil and natural gas and other emissions from energy production	4.70	4.41	4.04	3.53	3.81	4.26	5.11	4.82	4.98	241.79
C. CO_2 transport and storage										
2. Industrial processes	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	-75.60
A. Mineral industry										
B. Chemical industry	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	
C. Metal industry	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	35.11
D. Non-energy products from fuels and solvent use	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00
E. Electronic industry										
F. Product uses as ODS substitutes										
G. Other product manufacture and use	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
H. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
3. Agriculture	197.98	195.45	192.11	184.89	181.79	178.48	177.75	179.12	178.73	-9.08
A. Enteric fermentation	162.30	160.34	158.22	152.30	149.21	145.72	145.01	146.78	145.83	-9.39
B. Manure management	28.06	27.53	26.84	25.92	25.58	25.17	25.01	25.68	25.70	-17.02
C. Rice cultivation	6.18	6.16	5.62	5.42	5.81	6.43	6.56	5.67	6.12	85.90
D. Agricultural soils	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.00
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
F. Field burning of agricultural residues	1.44	1.41	1.44	1.25	1.19	1.16	1.17	0.98	1.08	-21.29
G. Liming										
H. Urea application										
I. Other carbon-containing fertilizers										
J. Other										
4. Land use, land-use change and forestry	0.71	1.75	0.64	0.38	0.43	1.27	0.74	0.78	4.86	93.70
A. Forest land	0.24	0.88	0.07	0.04	0.17	0.49	0.22	0.16	2.58	37.35
B. Cropland	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C. Grassland	0.48	0.87	0.57	0.33	0.26	0.78	0.52	0.62	2.28	262.26
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
F. Other land	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
G. Harvested wood products										
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
5. Waste	168.72	159.80	163.80	166.28	165.63	168.04	174.84	179.29	180.91	-1.35
A. Solid waste disposal	129.09	120.85	124.35	126.71	125.91	125.79	129.74	132.38	132.98	48.22
B. Biological treatment of solid waste	0.72	0.94	0.91	0.80	0.77	1.25	1.82	2.42	2.71	14272.77
C. Incineration and open burning of waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	59.88
D. Waste water treatment and discharge	38.90	38.01	38.54	38.77	38.95	40.99	43.28	44.49	45.22	-51.71
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
6. Other *(as specified in summary 1.A)*	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Total CH_4 emissions without CH_4 from LULUCF	437.43	430.90	421.31	412.94	406.00	392.03	403.70	407.55	400.65	-9.29
Total CH_4 emissions with CH_4 from LULUCF	438.14	432.65	421.95	413.32	406.44	393.30	404.44	408.33	405.50	-8.71
Memo items:										
International bunkers	0.78	0.64	0.60	0.53	0.50	0.48	0.60	0.62	0.72	4.88
Aviation	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	39.60
Navigation	0.76	0.62	0.59	0.51	0.48	0.46	0.58	0.60	0.69	3.83
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
CO_2 emissions from biomass										
CO_2 captured										
Long-term storage of C in waste disposal sites										
Indirect N_2O										
Indirect CO_2 [(3)]										

Table A.II.3a Evaluation of N_2O emissions for the period 1990 – 1999 (in kt)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(kt)										
1. Energy	2.75	2.75	2.84	2.85	2.93	3.03	3.00	3.02	3.17	3.44	3.45
A. Fuel combustion (sectoral approach)	2.75	2.75	2.84	2.85	2.93	3.02	3.00	3.02	3.17	3.44	3.45
1. Energy industries	0.49	0.49	0.47	0.50	0.50	0.52	0.50	0.49	0.53	0.56	0.55
2. Manufacturing industries and construction	0.18	0.18	0.18	0.18	0.18	0.18	0.20	0.23	0.24	0.23	0.20
3. Transport	0.91	0.91	0.96	1.03	1.13	1.20	1.24	1.22	1.32	1.58	1.62
4. Other sectors	1.17	1.17	1.22	1.14	1.13	1.12	1.05	1.08	1.08	1.08	1.08
5. Other	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE
B. Fugitive emissions from fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1. Solid fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
2. Oil and natural gas and other emissions from energy production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. CO_2 transport and storage											
2. Industrial processes	4.02	4.02	3.40	3.54	3.39	3.31	3.30	3.71	3.32	2.82	2.91
A. Mineral industry											
B. Chemical industry	3.58	3.58	2.95	3.08	2.93	2.85	2.83	3.24	2.84	2.34	2.43
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
E. Electronic industry											
F. Product uses as ODS substitutes											
G. Other product manufacture and use	0.45	0.45	0.45	0.46	0.46	0.47	0.47	0.47	0.47	0.48	0.48
H. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Agriculture	17.27	17.27	17.33	16.64	14.83	14.40	15.12	15.26	14.95	14.92	14.64
A. Enteric fermentation											
B. Manure management	1.09	1.09	1.09	1.07	1.07	1.01	1.05	1.05	1.06	1.05	1.06
C. Rice cultivation											
D. Agricultural soils	16.15	16.15	16.19	15.52	13.73	13.35	14.03	14.17	13.86	13.84	13.54
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field burning of agricultural residues	0.03	0.03	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
G. Liming											
H. Urea application											
I. Other carbon containing fertlizers											
J. Other											
4. Land use, land-use change and forestry	0.02	0.02	0.02	0.04	0.04	0.04	0.03	0.03	0.04	0.07	0.03
A. Forest land	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00	0.01	0.03	0.00
B. Cropland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Grassland	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.00
D. Wetlands	NO	NO	NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Settlements	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
F. Other land	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
G. Harvested wood products											
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Waste	0.94	0.94	0.95	0.96	0.97	0.99	1.00	1.00	1.02	1.01	1.05
A. Solid waste disposal											
B. Biological treatment of solid waste	NO	NO	NO	NO	NO	NO	NO	NO	0.01	0.01	0.01
C. Incineration and open burning of waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Waste water treatment and discharge	0.94	0.94	0.95	0.96	0.97	0.99	1.00	1.00	1.01	1.01	1.05
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other *(as specified in summary 1.A)*	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total direct N_2O emissions without N_2O from LULUCF	24.99	24.99	24.52	23.99	22.12	21.73	22.42	22.99	22.46	22.20	22.05
Total direct N_2O emissions with N_2O from LULUCF	25.01	25.01	24.54	24.03	22.16	21.77	22.45	23.02	22.50	22.27	22.08
Memo items:											
International bunkers	0.86	0.86	0.84	1.04	1.15	1.27	1.47	1.22	1.21	1.23	1.15
Aviation	0.07	0.07	0.06	0.06	0.07	0.08	0.07	0.07	0.07	0.07	0.08
Navigation	0.79	0.79	0.78	0.98	1.08	1.19	1.40	1.15	1.14	1.16	1.07
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 emissions from biomass											
CO_2 captured											
Long-term storage of C in waste disposal sites											
Indirect N_2O	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
Indirect CO_2 [3]											

Table A.II.3b Evaluation of N_2O emissions for the period 2000 – 2010 (in kt)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
	(kt)										
1. Energy	3.07	3.23	3.31	3.39	3.28	3.40	3.51	3.37	3.30	2.90	2.59
A. Fuel combustion (sectoral approach)	3.07	3.23	3.31	3.39	3.28	3.40	3.51	3.37	3.30	2.90	2.59
1. Energy industries	0.59	0.60	0.59	0.60	0.61	0.62	0.58	0.60	0.59	0.57	0.53
2. Manufacturing industries and construction	0.24	0.24	0.24	0.22	0.22	0.29	0.31	0.30	0.32	0.29	0.25
3. Transport	1.16	1.30	1.29	1.27	1.32	1.33	1.41	1.37	1.34	1.21	1.06
4. Other sectors	1.08	1.10	1.20	1.30	1.13	1.15	1.19	1.08	1.03	0.83	0.75
5. Other	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	0.01	0.02	0.02	0.02	0.01	0.01
B. Fugitive emissions from fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1. Solid fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
2. Oil and natural gas and other emissions from energy production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. CO_2 transport and storage											
2. Industrial processes	2.97	2.57	2.50	2.34	2.25	2.24	1.91	1.90	1.85	1.67	1.87
A. Mineral industry											
B. Chemical industry	2.49	2.09	2.01	1.86	1.77	1.76	1.43	1.42	1.36	1.19	1.38
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
E. Electronic industry											
F. Product uses as ODS substitutes											
G. Other product manufacture and use	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.49	0.49	0.49	0.49
H. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Agriculture	14.16	14.00	13.87	13.67	13.89	13.22	12.86	13.34	12.68	12.05	12.80
A. Enteric fermentation											
B. Manure management	1.04	1.03	1.05	1.06	1.08	1.09	1.09	1.08	1.04	1.02	1.06
C. Rice cultivation											
D. Agricultural soils	13.08	12.93	12.78	12.57	12.77	12.09	11.74	12.22	11.60	10.98	11.70
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field burning of agricultural residues	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
G. Liming											
H. Urea application											
I. Other carbon containing fertlizers											
J. Other											
4. Land use, land-use change and forestry	0.09	0.04	0.04	0.04	0.05	0.05	0.06	0.14	0.07	0.07	0.06
A. Forest land	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.01	0.01	0.00
B. Cropland	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C. Grassland	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.04	0.01	0.01	0.00
D. Wetlands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Settlements	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
F. Other land	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
G. Harvested wood products											
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Waste	1.10	1.05	1.04	1.07	1.07	1.06	1.07	1.09	1.07	1.07	1.08
A. Solid waste disposal											
B. Biological treatment of solid waste	0.01	NO	NO	NO	0.00	0.00	0.02	0.02	0.02	0.01	0.03
C. Incineration and open burning of waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Waste water treatment and discharge	1.09	1.05	1.04	1.07	1.07	1.05	1.05	1.07	1.04	1.06	1.05
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other ***(as specified in summary 1.A)***	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total direct N_2O emissions without N_2O from LULUCF	21.30	20.85	20.71	20.47	20.49	19.92	19.35	19.70	18.90	17.69	18.35
Total direct N_2O emissions with N_2O from LULUCF	21.39	20.90	20.75	20.52	20.54	19.96	19.41	19.84	18.97	17.76	18.41
Memo items:											
International bunkers	1.23	1.06	0.96	0.92	0.90	0.75	0.79	0.76	0.73	0.66	0.69
Aviation	0.07	0.07	0.07	0.09	0.09	0.07	0.08	0.08	0.08	0.08	0.07
Navigation	1.16	0.99	0.89	0.83	0.81	0.68	0.71	0.68	0.64	0.58	0.62
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 emissions from biomass											
CO_2 captured											
Long-term storage of C in waste disposal sites											
Indirect N_2O	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
Indirect CO_2 [(3)]											

Table A.II.3c Evaluation of N_2O emissions for the period 2011 – 2019 (in kt)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2011	2012	2013	2014	2015	2016	2017	2018	2019	Change from base to latest reported year
					(kt)					%
1. Energy	2.38	1.71	1.57	1.65	1.69	1.59	1.64	1.66	1.49	-45.95
A. Fuel combustion (sectoral approach)	2.38	1.71	1.57	1.65	1.69	1.59	1.64	1.66	1.49	-45.94
1. Energy industries	0.54	0.55	0.49	0.46	0.41	0.33	0.37	0.35	0.27	-45.03
2. Manufacturing industries and construction	0.19	0.20	0.17	0.23	0.25	0.21	0.21	0.23	0.14	-23.19
3. Transport	0.82	0.67	0.63	0.66	0.72	0.78	0.80	0.82	0.83	-9.47
4. Other sectors	0.83	0.28	0.27	0.29	0.31	0.26	0.26	0.26	0.25	-78.66
5. Other	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	100.00
B. Fugitive emissions from fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-77.99
1. Solid fuels	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00
2. Oil and natural gas and other emissions from energy production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-77.99
C. CO_2 transport and storage										
2. Industrial processes	2.02	1.48	0.55	0.57	0.54	0.52	0.54	0.54	0.54	-86.61
A. Mineral industry										
B. Chemical industry	1.53	0.99	0.07	0.09	0.07	0.05	0.07	0.08	0.07	-98.00
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
D. Non-energy products from fuels and solvent use	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00
E. Electronic industry										
F. Product uses as ODS substitutes										
G. Other product manufacture and use	0.48	0.48	0.48	0.48	0.47	0.47	0.47	0.47	0.47	4.57
H. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
3. Agriculture	12.08	11.86	11.93	11.15	10.94	11.24	11.36	11.06	11.32	-34.47
A. Enteric fermentation										
B. Manure management	1.04	1.05	1.04	1.02	0.96	0.96	0.95	0.96	0.96	-11.39
C. Rice cultivation										
D. Agricultural soils	11.00	10.78	10.85	10.10	9.94	10.25	10.39	10.07	10.33	-36.05
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
F. Field burning of agricultural residues	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.02	0.03	-22.39
G. Liming										
H. Urea application										
I. Other carbon containing fertlizers										
J. Other										
4. Land use, land-use change and forestry	0.06	0.06	0.06	0.05	0.05	0.06	0.05	0.05	0.08	270.44
A. Forest land	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	37.35
B. Cropland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	159.82
C. Grassland	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.02	266.19
D. Wetlands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
E. Settlements	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	1689.40
F. Other land	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	1256.05
G. Harvested wood products										
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
5. Waste	1.05	1.04	1.04	1.03	1.02	1.02	1.04	1.05	1.05	11.98
A. Solid waste disposal										
B. Biological treatment of solid waste	0.04	0.05	0.04	0.04	0.03	0.04	0.05	0.07	0.07	100.00
C. Incineration and open burning of waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	59.88
D. Waste water treatment and discharge	1.01	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	4.73
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
6. Other ***(as specified in summary 1.A)***	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Total direct N_2O emissions without N_2O from LULUCF	17.53	16.09	15.09	14.39	14.19	14.38	14.58	14.31	14.39	-42.39
Total direct N_2O emissions with N_2O from LULUCF	17.59	16.16	15.14	14.45	14.24	14.43	14.63	14.36	14.48	-42.12
Memo items:										
International bunkers	0.66	0.56	0.58	0.54	0.58	0.59	0.67	0.66	0.76	-11.70
Aviation	0.08	0.07	0.07	0.08	0.08	0.09	0.10	0.11	0.11	59.54
Navigation	0.58	0.50	0.51	0.46	0.50	0.50	0.57	0.55	0.65	-17.98
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
CO_2 emissions from biomass										
CO_2 captured										
Long-term storage of C in waste disposal sites										
Indirect N_2O	NE,NO	NE,NO	NE,NO	NE,NO	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	0.00
Indirect CO_2 (3)										

Table A.II.4a Evaluation of F-gases emissions per gas (in kt) and in total (in kt CO_2 eq) for the period 1990 – 1999

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(kt)										
Emissions of HFCs and PFCs - (kt CO_2 equivalent)	1373.08	1373.08	1591.27	1336.81	2145.38	2782.42	4220.23	4873.89	5292.13	5922.99	6826.44
Emissions of HFCs - (kt CO_2 equivalent)	1182.82	1182.82	1400.08	1149.07	2032.44	2712.11	4157.38	4820.17	5166.49	5767.51	6721.13
HFC-23	0.08	0.08	0.09	0.08	0.14	0.18	0.28	0.32	0.34	0.37	0.43
HFC-32	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00	0.00	0.00	0.00	0.00
HFC-41	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-43-10mee	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-125	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00	0.00	0.01	0.01	0.02
HFC-134	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-134a	NA,NO	NA,NO	NA,NO	NA,NO	0.00	0.00	0.02	0.04	0.07	0.10	0.15
HFC-143	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-143a	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00	0.00	0.01	0.01	0.01
HFC-152	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-152a	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-161	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-227ea	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00
HFC-236cb	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-236ea	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-236fa	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-245ca	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-245fa	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-365mfc	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Unspecified mix of HFCs[4] - (kt CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Emissions of PFCs - (kt CO_2 equivalent)	190.26	190.26	191.19	187.74	112.94	70.31	62.85	53.73	125.64	155.48	105.31
CF_4	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.01
C_2F_6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C_3F_8	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_4F_{10}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
$c\text{-}C_4F_8$	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_5F_{12}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_6F_{14}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
$C_{10}F_{18}$	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
$c\text{-}C_3F_6$	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Unspecified mix of PFCs[4] - (kt CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Unspecified mix of HFCs and PFCs - (kt CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Emissions of SF_6 - (kt CO_2 equivalent)	2.93	2.93	3.02	3.11	3.20	3.29	3.42	3.51	3.56	3.60	3.69
SF_6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Emissions of NF_3 - (kt CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
NF_3	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO

Table A.II.4b ***Evaluation of F-gases emissions per gas (in kt) and in total (in kt CO_2 eq) for the period 2000 – 2010***

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
	(kt)										
Emissions of HFCs and PFCs - (kt CO_2 equivalent)	5384.12	4865.62	5178.62	4822.93	5016.12	5169.54	2810.84	3349.68	3831.30	4127.36	4597.20
Emissions of HFCs - (kt CO_2 equivalent)	5261.86	4781.52	5090.33	4733.65	4928.27	5078.03	2723.63	3246.63	3712.35	4036.02	4467.76
HFC-23	0.32	0.28	0.28	0.23	0.22	0.19	0.01	0.01	0.01	0.01	0.01
HFC-32	0.01	0.01	0.02	0.04	0.05	0.07	0.09	0.12	0.14	0.16	0.20
HFC-41	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-43-10mee	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-125	0.03	0.04	0.06	0.08	0.11	0.15	0.18	0.23	0.27	0.31	0.37
HFC-134	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-134a	0.21	0.30	0.38	0.47	0.58	0.82	0.94	1.07	1.22	1.27	1.30
HFC-143	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-143a	0.02	0.03	0.04	0.05	0.06	0.08	0.09	0.11	0.13	0.13	0.16
HFC-152	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-152a	NA,NO	0.02	0.41	0.66	0.72	0.85	1.08	1.14	1.23	1.25	1.29
HFC-161	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-227ea	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.03	0.03
HFC-236cb	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-236ea	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-236fa	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-245ca	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-245fa	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-365mfc	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Unspecified mix of HFCs[(4)] - (kt CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Emissions of PFCs - (kt CO_2 equivalent)	122.26	84.10	88.29	89.28	87.86	91.51	87.21	103.04	118.95	91.35	129.44
CF_4	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.00	0.00
C_2F_6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
C_3F_8	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_4F_{10}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
c-C_4F_8	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_5F_{12}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_6F_{14}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
$C_{10}F_{18}$	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
c-C_3F_6	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Unspecified mix of PFCs[(4)] - (kt CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Unspecified mix of HFCs and PFCs - (kt CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Emissions of SF_6 - (kt CO_2 equivalent)	3.81	3.88	4.06	4.06	4.26	6.16	7.98	9.46	7.18	5.02	5.86
SF_6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Emissions of NF_3 - (kt CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
NF_3	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO

Table A.II.4c Evaluation of F-gases emissions per gas (in kt) and in total (in kt CO_2 eq) for the period 2011 – 2019

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2011	2012	2013	2014	2015	2016	2017	2018	2019	Change from base to latest reported year
	(kt)									%
Emissions of HFCs and PFCs - (kt CO_2 equivalent)	4857.75	5301.70	5914.04	5977.58	6119.37	6359.03	6303.73	6042.90	5584.27	306.70
Emissions of HFCs - (kt CO_2 equivalent)	4747.22	5153.93	5741.48	5842.95	5999.84	6223.86	6177.93	5907.58	5447.17	360.53
HFC-23	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	-91.08
HFC-32	0.24	0.31	0.41	0.45	0.46	0.51	0.49	0.50	0.46	100.00
HFC-41	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00
HFC-43-10mee	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00
HFC-125	0.43	0.51	0.63	0.68	0.72	0.81	0.84	0.84	0.78	100.00
HFC-134	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00
HFC-134a	1.32	1.29	1.37	1.31	1.33	1.28	1.18	1.06	0.94	100.00
HFC-143	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00
HFC-143a	0.16	0.18	0.18	0.18	0.17	0.17	0.17	0.15	0.14	100.00
HFC-152	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00
HFC-152a	1.31	1.35	1.28	1.28	1.29	1.30	1.30	1.31	1.32	100.00
HFC-161	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00
HFC-227ea	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	100.00
HFC-236cb	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00
HFC-236ea	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00
HFC-236fa	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00
HFC-245ca	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00
HFC-245fa	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00
HFC-365mfc	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00
Unspecified mix of HFCs(4) - (kt CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	0.00	0.00	0.01	0.01	0.01	100.00
Emissions of PFCs - (kt CO_2 equivalent)	110.53	147.77	172.56	134.63	119.52	135.17	125.79	135.31	137.10	-27.94
CF_4	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-44.85
C_2F_6	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	56.71
C_3F_8	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00
C_4F_{10}	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00
$c\text{-}C_4F_8$	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00
C_5F_{12}	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00
C_6F_{14}	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00
$C_{10}F_{18}$	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00
$c\text{-}C_3F_6$	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00
Unspecified mix of PFCs(4) - (kt CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00
Unspecified mix of HFCs and PFCs - (kt CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00
Emissions of SF_6 - (kt CO_2 equivalent)	5.13	5.05	5.15	4.92	5.06	5.20	5.01	4.94	4.92	68.00
SF_6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	68.00
Emissions of NF_3 - (kt CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00
NF_3	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00

Table A.II.5a Evaluation of GHG emissions / removals per gas and per sector for the period 1990 – 1999 (kt CO_2 eq)

GREENHOUSE GAS EMISSIONS	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (kt)										
CO_2 emissions without net CO_2 from LULUCF	83425.55	83425.55	83401.12	84982.71	84296.37	86442.18	86979.10	89132.01	93820.93	98641.50	97958.38
CO_2 emissions with net CO_2 from LULUCF	81248.51	81248.51	81060.01	82491.46	81354.92	83768.40	84054.65	86802.66	91805.35	96705.18	95398.27
CH_4 emissions without CH_4 from LULUCF	11042.24	11042.24	11040.95	11116.92	11151.49	11271.24	11427.51	11595.16	11548.54	11772.09	11753.05
CH_4 emissions with CH_4 from LULUCF	11104.92	11104.92	11072.05	11208.73	11233.43	11347.66	11470.89	11621.37	11606.33	11929.72	11765.05
N_2O emissions without N_2O from LULUCF	7445.66	7445.66	7307.88	7148.80	6592.01	6475.91	6680.62	6852.32	6692.04	6614.62	6571.25
N_2O emissions with N_2O from LULUCF	7452.12	7452.12	7312.80	7159.47	6602.73	6486.74	6689.32	6860.38	6703.54	6635.02	6580.45
HFCs	1182.82	1182.82	1400.08	1149.07	2032.44	2712.11	4157.38	4820.17	5166.49	5767.51	6721.13
PFCs	190.26	190.26	191.19	187.74	112.94	70.31	62.85	53.73	125.64	155.48	105.31
Unspecified mix of HFCs and PFCs	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
SF_6	2.93	2.93	3.02	3.11	3.20	3.29	3.42	3.51	3.56	3.60	3.69
NF_3	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Total (without LULUCF)	103289.46	103289.46	103344.25	104588.35	104188.43	106975.03	109310.88	112456.89	117357.20	122954.80	123112.81
Total (with LULUCF)	101181.55	101181.55	101039.15	102199.58	101339.66	104388.52	106438.51	110161.82	115410.90	121196.52	120573.90
Total (without LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (with LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (kt)										
1. Energy	77026.71	77026.71	77145.94	79136.52	78787.37	81025.24	81090.93	83307.38	87849.36	92575.73	92015.85
2. Industrial processes and product use	11277.14	11277.14	11213.59	10644.27	11095.23	11686.78	13603.11	14371.56	14852.33	15569.50	16406.07
3. Agriculture	10120.79	10120.79	10144.10	9868.57	9314.84	9119.26	9465.84	9527.57	9443.03	9418.75	9346.04
4. Land use, land-use change and forestry[5]	-2107.91	-2107.91	-2305.10	-2388.77	-2848.77	-2586.52	-2872.37	-2295.07	-1946.29	-1758.29	-2538.91
5. Waste	4864.81	4864.81	4840.61	4938.99	4990.99	5143.76	5151.00	5250.38	5212.48	5390.82	5344.85
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total (including LULUCF)[5]	101181.55	101181.55	101039.15	102199.58	101339.66	104388.52	106438.51	110161.82	115410.90	121196.52	120573.90

Table A.II.5b Evaluation of GHG emissions / removals per gas and per sector for the period 2000 – 2010 (kt CO_2 eq)

GREENHOUSE GAS EMISSIONS	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
	CO_2 equivalent (kt)										
CO_2 emissions without net CO_2 from LULUCF	102999.03	105385.70	105020.96	109089.75	109546.75	113930.97	112472.44	114592.34	111125.24	104354.75	97361.43
CO_2 emissions with net CO_2 from LULUCF	100823.11	102932.49	102233.31	106567.14	107057.63	110622.76	109134.06	112765.56	108106.20	101250.95	94284.43
CH_4 emissions without CH_4 from LULUCF	11735.94	11055.63	11164.36	11261.48	11287.54	11382.32	11459.91	11326.60	11229.80	10861.59	11068.19
CH_4 emissions with CH_4 from LULUCF	11943.97	11083.57	11168.17	11266.83	11301.07	11392.86	11480.87	11647.87	11273.35	10907.75	11084.60
N_2O emissions without N_2O from LULUCF	6347.98	6213.83	6172.11	6101.41	6106.01	5934.71	5766.82	5870.93	5631.65	5270.36	5467.36
N_2O emissions with N_2O from LULUCF	6374.52	6226.99	6184.06	6114.27	6120.48	5949.47	5783.26	5913.04	5651.77	5291.17	5484.86
HFCs	5261.86	4781.52	5090.33	4733.65	4928.27	5078.03	2723.63	3246.63	3712.35	4036.02	4467.76
PFCs	122.26	84.10	88.29	89.28	87.86	91.51	87.21	103.04	118.95	91.35	129.44
Unspecified mix of HFCs and PFCs	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
SF_6	3.81	3.88	4.06	4.06	4.26	6.16	7.98	9.46	7.18	5.02	5.86
NF_3	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Total (without LULUCF)	126470.88	127524.66	127540.10	131279.63	131960.69	136423.69	132517.99	135149.01	131825.16	124619.09	118500.04
Total (with LULUCF)	124529.53	125112.55	124768.21	128775.22	129499.57	133140.78	129217.01	133685.61	128869.79	121582.25	115456.96
Total (without LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (with LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
	CO_2 equivalent (kt)										
1. Energy	96797.04	99249.24	99100.26	102987.53	103470.46	107296.89	106000.70	108239.67	105341.15	100362.88	93155.42
2. Industrial processes and product use	15193.13	14592.36	14778.45	14539.11	14690.42	15432.05	12748.21	13184.95	13002.12	11271.23	11759.57
3. Agriculture	9124.74	9109.03	9132.75	9099.06	9139.04	8936.41	8839.92	8971.78	8715.16	8497.16	8815.94
4. Land use, land-use change and forestry[(5)]	-1941.35	-2412.11	-2771.89	-2504.41	-2461.12	-3282.91	-3300.98	-1463.40	-2955.37	-3036.83	-3043.08
5. Waste	5355.96	4574.03	4528.64	4653.92	4660.76	4758.33	4929.16	4752.61	4766.73	4487.82	4769.11
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total (including LULUCF)[(5)]	124529.53	125112.55	124768.21	128775.22	129499.57	133140.78	129217.01	133685.61	128869.79	121582.25	115456.96

Table A.II.5c Evaluation of GHG emissions / removals per gas and per sector for the period 2011 – 2019 (kt CO_2 eq)

GREENHOUSE GAS EMISSIONS	2011	2012	2013	2014	2015	2016	2017	2018	2019	Change from base to latest reported year
	CO2 equivalent (kt)									(%)
CO_2 emissions without net CO_2 from LULUCF	94549.57	91430.55	81736.13	78662.11	74961.09	71372.74	74855.08	71807.55	65735.92	-21.20
CO_2 emissions with net CO_2 from LULUCF	91383.57	88281.36	80121.41	78511.31	71215.57	67850.85	71572.36	67680.22	62109.70	-23.56
CH_4 emissions without CH_4 from LULUCF	10935.66	10772.42	10532.86	10323.58	10150.12	9800.77	10092.48	10188.81	10016.15	-9.29
CH_4 emissions with CH_4 from LULUCF	10953.47	10816.13	10548.86	10332.97	10160.93	9832.44	10111.03	10208.23	10137.56	-8.71
N_2O emissions without N_2O from LULUCF	5223.62	4795.80	4496.20	4289.62	4228.34	4284.09	4344.70	4264.15	4289.68	-42.39
N_2O emissions with N_2O from LULUCF	5240.56	4815.15	4512.76	4305.24	4243.86	4301.05	4360.42	4280.10	4313.61	-42.12
HFCs	4747.22	5153.93	5741.48	5842.95	5999.84	6223.86	6177.93	5907.58	5447.17	360.53
PFCs	110.53	147.77	172.56	134.63	119.52	135.17	125.79	135.31	137.10	-27.94
Unspecified mix of HFCs and PFCs	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00
SF_6	5.13	5.05	5.15	4.92	5.06	5.20	5.01	4.94	4.92	68.00
NF_3	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00
Total (without LULUCF)	115571.73	112305.52	102684.38	99257.81	95463.98	91821.84	95600.99	92308.35	85630.94	-17.10
Total (with LULUCF)	112440.47	109219.39	101102.22	99132.03	91744.79	88348.57	92352.55	88216.39	82150.06	-18.81
Total (without LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
Total (with LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2011	2012	2013	2014	2015	2016	2017	2018	2019	Change from base to latest reported year
	CO2 equivalent (kt)									(%)
1. Energy	92035.90	88303.64	77926.18	74490.73	71189.39	66966.41	70257.48	67303.33	61228.32	-20.51
2. Industrial processes and product use	10423.91	11245.63	11966.80	12329.99	11998.07	12506.82	12795.12	12399.23	11688.04	3.64
3. Agriculture	8574.71	8446.56	8382.83	7968.54	7826.86	7837.72	7864.47	7806.02	7875.00	-22.19
4. Land use, land-use change and forestry[(5)]	-3131.25	-3086.12	-1582.16	-125.78	-3719.19	-3473.26	-3248.44	-4091.96	-3480.88	65.13
5. Waste	4537.20	4309.69	4408.57	4468.55	4449.66	4510.88	4683.92	4799.76	4839.58	-0.52
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Total (including LULUCF)[(5)]	112440.47	109219.39	101102.22	99132.03	91744.79	88348.57	92352.55	88216.39	82150.06	-18.81

A.III Inventory preparation details

Table A.III.1 Overview of methods applied for the calculation of GHG emissions / removals

	CO2		CH4		N2O		F-gases	
	Method	Emission factor	Method	Emission factor	Method	Emission factor	Method	Emission factor
1. Energy								
A. Fuel combustion								
1. Energy industries	T1,T2	D,PS	T1	D	T1	D		
2. Manufacturing industries and Construction	T1,T2	CS,D,PS	T1	D	T1	D		
3. Transport	T1,T2,T3	CS,D	M,T1,T2,T3	CR,D,M	M,T1,T2,T3	CR,D,M		
4. Other sectors	T1,T2	CS,D,NO	T1	D,NO	T1	D,NO		
5. Other	T1	D	T1	D	T1	D		
B. Fugitive emissions from fuels								
1. Solid fuels			T1	D				
2. Oil and Natural gas	T1	D	T1	D	T1	D		
2. Industrial processes								
A. Mineral products	CS,T1	CS,D,PS						
B. Chemical industry	T1,T1a	CS			CS	CS		
C. Metal production	CS,T1	CS,D,PS	CR	CR	NA	NA	T3	PS
D. Non-energy products from fuels and solvent use	D,T1	D						
E. Production of halocarbons and SF_6							T1, NA	D, NA
F. Consumption of halocarbons and SF_6							CS,T2	D,CS
G. Other product manufacture and use	T1	D			OTH	OTH	CS	CS
3. Agriculture								
A. Enteric fermentation			T1,T2	CS,D				
B. Manure management			T1,T2	CS,D	D	D		

	CO2		CH4		N2O		F-gases	
	Method	Emission factor	Method	Emission factor	Method	Emission factor	Method	Emission factor
C. Rice cultivation			T1	D				
D. Agricultural soils					T1	D		
F. Field burning of agricultural residues			T1	D	T1	D		
5. Land Use, Land Use Change and Forestry								
A. Forest land	OTH,T1,T2	CS,D,OTH	T1	D	T1	D		
B. Cropland	T1,T2	CS,D	NA	NA	T1	D		
C. Grassland	T1,T2	CS,D	T1	D	T1	D		
D. Wetlands	T1,T2	CS,D	NA	NA	T1	D		
E. Settlements	T1,T2	CS,D	NA	NA	T1	D		
F. Other Land	T1,T2	CS,D	NA	NA	T1	D		
G. HWP	T2	D	NA	NA	NA	NA		
6. Waste								
A. Solid waste disposal on land			T2	CS,D				
B. Wastewater handling			D	D	D	D		
C. Waste incineration	D	D, CS	D	CS	D	CS		
D. Waste water treatment and discharge			D	D	D	CS		
KP-LULUCF								
KP.A.1. Afforestation - Reforestation	OTH	OTH	T1	D	T1	D		
KP.A.2. Deforestation	T1,T2	CS,D	NA	NA	T1	D		
KP.B.1. Forest Management	T2	CS,D	T1	D	T1	D		

CR = CORINAIR, CS = Country Specific, PS = Plant Specific

NE = Not Estimated, NA= Not Applicable, NO= Not Observed, OTH= Other

T1, T1a, T1b, T2, T2a, T3b = IPCC T1, T1a, T1b, T2, T2a, T3b methodology respectively

D = Default IPCC methodology and emission factor

IE = Included Elsewhere

M = Copert IV model

Table A.III.2 Global Warming Potential (in t of CO_2 eq) for the 100-year horizon

Gas	GWP
Carbon dioxide (CO_2)	1
Methane (CH_4)	25
Nitrous oxide (N_2O)	298
Hydrofluorocarbons (HFC)	
HFC-23	Please refer to 24/CP.19
HFC-32	
HFC-125	
HFC-134a	
HFC-143a	
HFC-152a	
HFC-227ea	
HFC-236fa	
HFC-4310mee	
Perfluorocarbons (PFC)	
CF_4	
C_2F_6	
C_4F_{10}	
C_6F_{14}	
Sulphur hexafluoride (SF_6)	

Table A.III.3 Key categories for the Greek inventory system without LULUCF

IPCC source categories	GHG	Criteria for identification	
		Level	Trend
ENERGY SECTOR			
Fuel combustion - Energy Industries - Gaseous Fuels	CO_2	X	X
Fuel combustion - Energy Industries - Liquid Fuels	CO_2	X	X
Fuel combustion - Energy Industries - Solid Fuels	CO_2	X	X
Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO_2	X	X
Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO_2	X	X
Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO_2		X
Domestic Aviation	CO_2	X	
Road Transportation	CO_2	X	X
Domestic Navigation - Liquid Fuels	CO_2	X	X
Other Sectors - Gaseous Fuels	CO_2	X	X
Other Sectors - Liquid Fuels	CO_2	X	X
Fugitive emissions from Solid Fuels	CH_4	X	X
INDUSTRIAL PROCESSES SECTOR			
Cement Production	CO_2	X	X
Other Process Uses of Carbonates	CO_2	X	
Ammonia Production	CO_2		X
Other	CO_2	X	X
Nitric Acid Production	N_2O		X
Fluorochemical Production	Aggregate F-gases		X
Ferroalloys Production	CO_2	X	
Refrigeration and Air conditioning	Aggregate F-gases	X	X
AGRICULTURE			
Enteric Fermentation	CH_4	X	X
Manure Management	CH_4	X	
Direct N_2O Emissions From Managed Soils	N_2O	X	X
Indirect N_2O Emissions From Managed Soils	N_2O	X	
WASTE			
Solid Waste Disposal	CH_4	X	X
Wastewater Treatment and Discharge	CH_4	X	X

Table A.III.4 Key categories for the Greek inventory system with LULUCF

IPCC source categories	GHG	Criteria for identification	
		Level	Trend
ENERGY SECTOR			
Fuel combustion - Energy Industries - Gaseous Fuels	CO2	X	X
Fuel combustion - Energy Industries - Liquid Fuels	CO2	X	X
Fuel combustion - Energy Industries - Solid Fuels	CO2	X	X
Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO2	X	X
Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO2	X	X
Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO2	X	X
Domestic Aviation	CO2	X	
Road Transportation	CO2	X	X
Domestic Navigation - Liquid Fuels	CO2	X	X
Other Sectors - Gaseous Fuels	CO2	X	X
Other Sectors - Liquid Fuels	CO2	X	X
Other Sectors - Liquid Fuels	N2O		X
Fugitive emissions from Solid Fuels	CH4	X	X
INDUSTRIAL PROCESSES SECTOR			
Cement Production	CO_2	X	X
Other Process Uses of Carbonates	CO_2	X	
Ammonia Production	CO_2		X
Other	CO_2	X	X
Nitric Acid Production	N_2O		X
Fluorochemical Production	Aggregate F-gases		X
Ferroalloys Production	CO_2	X	
Refrigeration and Air conditioning	Aggregate F-gases	X	X
Foam Blowing Agents	Aggregate F-gases		X
AGRICULTURE			
Enteric Fermentation	CH_4	X	X
Manure Management	CH_4	X	
Direct N2O Emissions From Managed Soils	N_2O	X	X
Indirect N2O Emissions From Managed Soils	N_2O	X	X
WASTE			
Solid Waste Disposal	CH_4	X	X
Wastewater Treatment and Discharge	CH_4	X	X
Wastewater Treatment and Discharge	N2O	X	
LULUCF			
Forest Land Remaining Forest Land	CO2	X	X
Land Converted to Forest Land	CO2	X	X
Cropland Remaining Cropland	CO2	X	X
Grassland Remaining Grassland	CO2	X	
Land Converted to Grassland	CO2		
Harvested Wood Products	CO2		X

A.IV Summary of reporting of the Supplementary information under Article 7, paragraph 2, of the Kyoto Protocol in the NC8

Table A.IV.1 Summary of reporting of the Supplementary information under Article 7, paragraph 2, of the Kyoto Protocol in the NC8

Information reported under Article 7, paragraph 2		NC7 section
National systems in accordance with Article 5, paragraph 1		3.3
National registries		3.4
Supplementarity relating to the mechanisms pursuant to Articles 6, 12 and 17		5.3
Policies and measures in accordance with Article 2		4.3
Domestic and regional programmes and/or legislative arrangements and enforcement and administrative procedures		4.1 & 4.2
Information under Article 10		
	Art 10a	3.3
	Art 10b	4.1 & 4.2
	Art 10c	7.5
	Art 10d	8
	Art 10e	9
Financial resources (Annex II only)		7.2, 7.3 & 7.4

A.V National Communication Preparation Process

Overall responsibility: Ministry of Environment and Energy/Division of Climate Change and Air Quality
Technical assistance: NTUA, Ioannis Sempos, Athina Progiou, Leonidas Kallinikos, Ioanna Katsavou, Panagiota Maria Eleni, Despoina Maria Vlachaki.

Data providers:

- Ministry of Environment and Energy.
- Ministry of Finance.
- Ministry of Development and Investments.
- Ministry of Foreign Affairs.
- Center for Renewable Energy Sources / Division for Energy Policy and Planning.
- Hellenic Statistical Authority.
- Ministry of Rural Development and Food.
- Ministry of Infrastructure and Transport.
- Ministry of Education and Religious Affairs.
- The Central Union of Municipalities and Communities of Greece.
- The Union of Prefectural Authorities of Greece.
- The Hellenic Navy Hydrographic Service.
- The Hellenic National Meteorological Service.
- The National Observatory of Athens.
- National Technical University of Athens.
- Ministry of Tourism- Greek National Tourism Organisation.
- Hellenic Centre for Marine Research.
- National Committee for Combatting Desertification.
- Global Water Partnership.