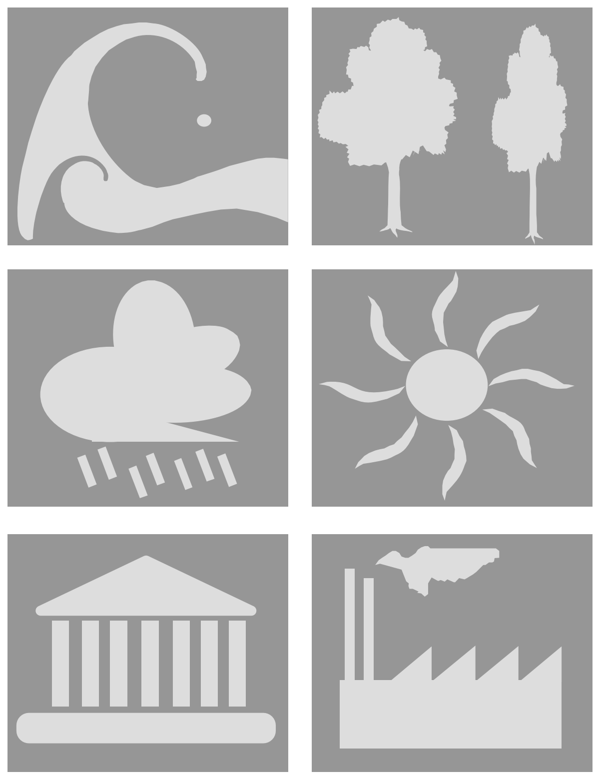
HELLENIC REPUBLIC

MINISTRY OF ENVIRONMENT AND ENERGY



7th NATIONAL COMMUNICATION AND 3rd BIENNIAL REPORT UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

JANUARY 2018

CHAPTER 1. EXECUTIVE SUMMARY

1.1 National Circumstances

1.1.1 Government structure

The Constitution of 1975, as revised in 1986, 2001 and in 2008, 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.

1.1.2 Population

In 2011, the total permanent population of Greece was 10.815 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. For 2016, total permanent population of Greece is estimated equal to 10.78 milion inhabitants, slightly lower than this for 2011. 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 Geographic and climate 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.

Forest land, divided into Forests (high and coppice forests) and Other Wooded Lands (branchy dwarf trees and scrubs), covers 26.2% of the total area of the country. Grassland, rangeland and pasture with vegetation that falls below the threshold of forest definition, covers 40.3% of the total area of the country. Agricultural land, including fallow land, account for 25.1% of the total area. Settlements, developed land including transportation infrastructure and human settlements of any size, account for 4.1% 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.

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 24°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 – 2015, 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.

1.1.4 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 experiences its most-severe economic crisis recording six consecutive year recession up to 2013. In 2014 about 0.7% growth was noted while for years 2015 and 2016 a small recession was shown from 0.2 to 0.3%. Positive number of growth is projected for 2017.

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 is expected to be completed by the August of 2018.

1.1.5 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. 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.

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 2015 amounted to approximately 940 PJ. The consumption of solid fuels and oil products accounts for 75.4% of total consumption, while the contribution of biomass and of the rest renewable energy sources (mostly hydropower, solar, wind energy and geothermal) are 3.1% and 6.5% respectively. Finally, the share of natural gas in gross inland consumption is 10.8%, while the rest of gross inland consumption is covered by electricity (net imports – exports). In 2015, gross inland consumption increased by approximately 1.8% compared to 1990, presenting a 0.2% average annual rate of increase. It should be mentioned that up to 1996 supply of natural gas was exclusively in 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. Furthermore, from 2007 to 2015 a decrease in gross inland consumption is observed, presenting an about 4.7% average annual rate of decrease.

1.2 Greenhouse gas inventory information

1.2.1 Emissions / Removals of GHG in Greece for the period 1990 – 2015

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 1990–2015 is presented in ***Table 1.1a*** and ***Table 1.1b***, while emissions/removals per sector are presented in ***Table 1.2a*** and ***Table 1.2.b***.

In 2015, GHG emissions (without LULUCF) amounted to 95.7 Mt CO_2 eq showing a decrease of 9.64% compared to base year emissions and of 7.15% compared to 1990 levels. If emissions / removals from LULUCF were to be included then the decrease would be 8.25 % (from 100.9 Mt CO2 eq in 1990 to 92.6 Mt CO_2 eq in 2015).

Carbon dioxide emissions accounted for 78.32% of total GHG emissions in 2015 (without LULUCF) and decreased by approximately 10.09% from 1990. Methane emissions accounted for 10.68% of total GHG emissions in 2015 and decreased by 6.31% from 1990, while nitrous oxide emissions accounted for 4.71% of the total GHG emissions in 2015 and decreased by 39.29% from 1990. Finally, f-gases emissions (from production and consumption) that accounted for 6.17% of total GHG emissions in 2015 were increased by 42.70% from 1995 (base year for F-gases).

Table 1.1a Total GHG emissions in Greece (in kt CO_2 eq) for the period 1990-2002

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
A. GHG emissions per gas (excluding LULUCF)													
CO_2	83,375.36	83,350.94	84,915.80	84,229.45	86,391.99	86,945.64	89,098.55	93,804.20	98,624.77	97,941.65	102,982.30	105,368.98	105,011.40
CH_4	10,906.61	10,919.21	11,013.98	11,038.71	11,148.72	11,303.20	11,471.76	11,419.64	11,640.53	11,634.36	11,628.86	10,937.64	11,023.64
N_2O	7,423.22	7,289.30	7,134.00	6,575.73	6,458.52	6,662.98	6,835.07	6,675.00	6,602.04	6,560.21	6,328.64	6,204.93	6,161.18
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	6,721.15	5,261.83	4,781.39	5,090.07
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
SF_6	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
Total	**103,081.19**	**103,153.73**	**104,403.70**	**103,992.47**	**106,784.94**	**109,135.47**	**112,282.79**	**117,194.53**	**122,793.94**	**122,966.37**	**126,327.70**	**127,380.92**	**127,378.64**
B. GHG emissions/removals from LULUCF													
CO_2	-2,245.82	-2,418.51	-2,513.10	-2,979.19	-2,721.86	-2,975.06	-2,389.37	-2,082.05	-2,016.03	-2,647.14	-2,339.38	-2,630.66	-2,903.34
CH_4	62.18	30.91	91.27	81.38	75.92	43.05	26.07	57.40	156.40	11.92	206.51	27.78	3.79
N_2O	5.62	3.30	8.73	8.52	8.35	5.94	5.04	8.18	16.73	5.34	21.65	7.41	5.93
Total	**-2,178.02**	**-2,384.30**	**-2,413.10**	**-2,889.29**	**-2,637.59**	**-2,926.07**	**-2,358.25**	**-2,016.48**	**-1,842.91**	**-2,629.89**	**-2,111.21**	**-2,595.48**	**-2,893.62**
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
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
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
Total	**10,855.29**	**9,835.77**	**11,088.56**	**12,696.30**	**13,794.52**	**14,466.58**	**12,914.38**	**12,858.38**	**14,157.02**	**13,191.89**	**14,408.32**	**13,853.28**	**12,648.64**

Table 1.1b Total GHG emissions in Greece (in kt CO2 eq) for the period 2003-2015

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
A. GHG emissions per gas (excluding LULUCF)													
CO_2	109,083.18	109,530.03	113,925.07	112,464.91	114,582.59	111,112.52	104,340.56	97,342.98	94,531.70	91,417.80	81,722.58	78,657.96	74,962.94
CH_4	11,118.17	11,154.41	11,235.08	11,295.52	11,144.59	11,092.07	10,746.91	10,972.53	10,793.89	10,595.13	10,387.06	10,312.84	10,218.43
N_2O	6,085.75	6,088.43	5,924.21	5,763.70	5,864.10	5,632.82	5,267.02	5,469.46	5,228.73	4,796.77	4,499.27	4,485.00	4,506.46
HFC	4,733.36	4,927.91	5,077.45	2,722.45	3,245.14	3,710.35	3,964.12	4,388.67	4,661.66	5,061.78	5,650.22	5,758.13	5,902.68
PFC	89.28	87.86	91.51	87.21	103.04	118.95	91.35	129.44	110.53	147.77	172.56	134.63	119.52
SF_6	4.06	4.26	6.16	7.98	9.46	7.18	5.02	5.86	5.13	5.05	5.15	4.92	5.06
Total	**131,113.78**	**131,792.90**	**136,259.48**	**132,341.78**	**134,948.92**	**131,673.90**	**124,414.97**	**118,308.93**	**115,331.64**	**112,024.30**	**102,436.85**	**99,353.49**	**95,715.10**
B. GHG emissions/removals from LULUCF													
CO_2	-2,632.47	-2,609.09	-3,388.93	-3,463.86	-2,086.45	-3,310.91	-3,377.93	-3,351.26	-3,440.73	-3,431.62	-1,890.55	-461.70	-3,159.71
CH_4	5.32	13.47	10.49	20.81	319.28	43.24	45.82	16.27	17.75	43.48	15.99	9.39	10.77
N_2O	6.54	7.87	7.87	9.26	34.49	12.36	12.75	9.98	9.94	12.34	9.56	8.62	8.51
Total	**-2,620.60**	**-2,587.75**	**-3,370.57**	**-3,433.79**	**-1,732.67**	**-3,255.30**	**-3,319.36**	**-3,325.00**	**-3,413.04**	**-3,375.80**	**-1,865.00**	**-443.69**	**-3,140.44**
C. GHG Emissions from International Transport													
CO_2	13,304.19	13,474.19	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
CH_4	21.91	22.17	19.89	21.52	22.09	21.68	18.35	19.06	19.56	16.00	15.09	13.22	12.52
N_2O	275.48	267.53	223.68	235.55	227.13	216.42	196.01	206.56	195.71	167.63	171.56	160.30	172.75
Total	**13,601.58**	**13,763.90**	**12,058.66**	**12,984.61**	**13,353.01**	**13,100.42**	**11,362.19**	**11,598.64**	**11,867.34**	**9,911.50**	**9,569.40**	**9,051.78**	**8,842.57**

Table 1.2a Total GHG emissions in Greece (in kt CO_2 eq) for the period 1990-2002

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Energy	76,869.62	77,006.70	79,019.75	78,659.44	80,886.43	80,949.77	83,167.51	87,703.96	92,427.63	91,883.56	96,678.36	99,120.02	98,946.99
IPPU	11,226.96	11,163.40	10,577.36	11,028.32	11,636.59	13,569.65	14,338.11	14,835.60	15,552.78	16,389.35	15,176.38	14,575.50	14,768.63
Agriculture	10,120.79	10,144.10	9,868.57	9,314.84	9,119.26	9,465.84	9,527.64	9,443.03	9,418.75	9,346.04	9,124.74	9,109.03	9,132.75
Waste	4,863.82	4,839.52	4,938.02	4,989.87	5,142.66	5,150.20	5,249.53	5,211.94	5,394.79	5,347.42	5,348.23	4,576.37	4,530.27
Total [1)]	**103,081.19**	**103,153.73**	**104,403.70**	**103,992.47**	**106,784.94**	**109,135.47**	**112,282.79**	**117,194.53**	**122,793.94**	**122,966.37**	**126,327.70**	**127,380.92**	**127,378.64**
LULUCF	**-2,178.02**	**-2,384.30**	**-2,413.10**	**-2,889.29**	**-2,637.59**	**-2,926.07**	**-2,358.25**	**-2,016.48**	**-1,842.91**	**-2,629.89**	**-2,111.21**	**-2,595.48**	**-2,893.62**
Index per sector													
Energy	100.00	100.18	102.80	102.33	105.23	105.31	108.19	114.09	120.24	119.53	125.77	128.95	128.72
IPPU	100.00	99.43	94.21	98.23	103.65	120.87	127.71	132.14	138.53	145.98	135.18	129.83	131.55
Agriculture	100.00	100.23	97.51	92.04	90.10	93.53	94.14	93.30	93.06	92.34	90.16	90.00	90.24
Waste	100.00	99.50	101.53	102.59	105.73	105.89	107.93	107.16	110.92	109.94	109.96	94.09	93.14
Total [2)]	**100.00**	**100.07**	**101.28**	**100.88**	**103.59**	**105.87**	**108.93**	**113.69**	**119.12**	**119.29**	**122.55**	**123.57**	**123.57**

[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 1.2b Total GHG emissions in Greece (in kt CO_2 eq) for the period 2002-2015

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Energy	102,830.84	103,324.48	107,136.64	105,852.07	108,071.31	105,227.91	100,268.60	93,080.53	91,901.25	88,118.94	77,766.86	74,323.39	71,022.38
IPPU	14,532.25	14,673.33	15,425.62	12,739.51	13,173.76	12,987.41	11,185.12	11,662.02	10,320.48	11,140.73	11,861.99	12,232.95	11,896.29
Agriculture	9,099.06	9,139.04	8,936.41	8,839.92	8,971.78	8,715.16	8,497.16	8,815.94	8,574.71	8,446.56	8,380.53	8,294.91	8,309.97
Waste	4,651.63	4,656.04	4,760.81	4,910.28	4,732.08	4,743.41	4,464.09	4,750.44	4,535.19	4,318.07	4,427.47	4,502.23	4,486.46
Total [1)]	**131,113.78**	**131,792.90**	**136,259.48**	**132,341.78**	**134,948.92**	**131,673.90**	**124,414.97**	**118,308.93**	**115,331.64**	**112,024.30**	**102,436.85**	**99,353.49**	**95,715.10**
LULUCF	**-2,620.60**	**-2,587.75**	**-3,370.57**	**-3,433.79**	**-1,732.67**	**-3,255.30**	**-3,319.36**	**-3,325.00**	**-3,413.04**	**-3,375.80**	**-1,865.00**	**-443.69**	**-3,140.44**
Index per sector													
Energy	133.77	134.42	139.37	137.70	140.59	136.89	130.44	121.09	119.55	114.63	101.17	96.69	92.39
IPPU	129.44	130.70	137.40	113.47	117.34	115.68	99.63	103.88	91.93	99.23	105.66	108.96	105.96
Agriculture	89.90	90.30	88.30	87.34	88.65	86.11	83.96	87.11	84.72	83.46	82.81	81.96	82.11
Waste	95.64	95.73	97.88	100.96	97.29	97.52	91.78	97.67	93.24	88.78	91.03	92.57	92.24
Total [2)]	**127.19**	**127.85**	**132.19**	**128.39**	**130.92**	**127.74**	**120.70**	**114.77**	**111.88**	**108.68**	**99.37**	**96.38**	**92.85**

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 1.1***, 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 2008-2015 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.

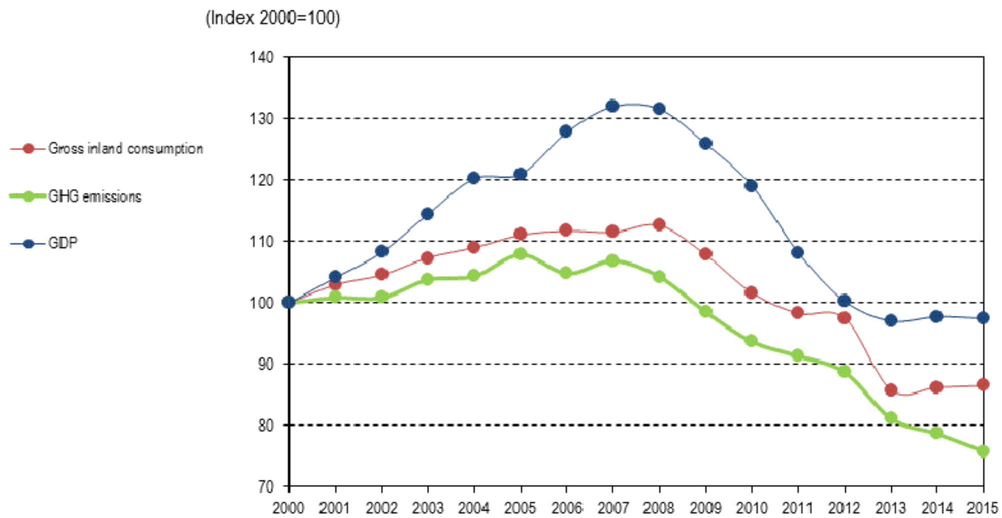


Figure 1.1 Factors underlying GHG emissions trends

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).

The main entities participating in the National Inventory System 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 except LULUCF sector has been assigned to **National Technical University of Athens (NTUA) / School of Chemical Engineering**, on a contract basis by MEEN. The inventory of LULUCF sector has been assigned, on a contract basis, to an independent consultant 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.

Climate change mitigation is one of the main targets identified in the Greek strategy 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.

Policies and measures, as well as all other issues and actions regarding mitigation are 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 rests with the Council of Ministers.

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.

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

1.3.2 Results of policies and measures

The most important supporting policies related with the implementation of measures for the restriction of GHG emissions in Greece are:

- The **2nd National Climate Change Programme**, that was elaborated and adopted in 2002 (Act of the Ministerial Council 5/27.02.2003, Official Journal of the Hellenic Republic A' 58 – 05.03.2003) defines the additional policies and measures necessary for Greece to meet its Kyoto target, i.e., restricting the increase of GHG emissions to 25% over the time period 2008–2012, compared to base year emissions.
- The **European common and coordinated policies and measures (CCPM)**, that constitute a legislative framework that supports and set the targets of a number of the respective national policies for the restriction of GHG emissions. Part of the CCPM is the 'climate and energy package', which was agreed by the European Parliament and Council in December 2008 and became law in June 2009. The climate and energy package serves three key objectives for 2020, known as the "20-20-20" targets:
    - ✓ A 20% reduction in EU greenhouse gas emissions from 1990 levels. The EU is also offering to increase its emissions reduction to 30% by 2020 if other major economies in the developed and developing worlds commit to undertake their fair share of a global emissions reduction effort;

  - ✓ Raising the share of EU energy consumption produced from renewable resources to 20%;
  - ✓ A 20% improvement in the EU's energy efficiency.

- ➢ The **European emissions trading scheme** (Directive 2003/87/EC) the operation of which started in 2005. 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 were allocated to installations included in the EU-ETS 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 CO2 emissions of ETS installations for the period 2008-2012. In 2013, the EU ETS is now 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 **financing mechanisms** for the funding for the support of policies that either straightforward or inter alia contributes in the restriction of GHG emissions have been developed in a big extent under the frame of the Community Support Frameworks.
- ➢ The **fiscal measures** that support policies and measures that reduce GHG emissions, such as the tax regime of energy products, the registration tax of vehicles, the Motor vehicle circulation fee (road tax), the income taxation – relief and exemptions.

The total realistic quantifiable GHG emissions reduction potential from the implemented and adopted policies and measures was estimated to be 34.8Mt CO2eq for 2020. 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.

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 minimization of adverse effects of climate change on other Parties and especially developing countries. The Protocol is seeking 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 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 2014.

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.[1]
- ✓ 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.

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 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.

[1] In the EU, the sum of emissions covered by category 1.A.3.a 'domestic aviation' and memo item 'international bunkers - aviation' go beyond the scope of the EU target, as emissions from international aviation are included in the EU Climate and Energy Package and the EU target under the UNFCCC **to the extent to which aviation is part of the EU ETS**.

1.4.2 Projections

The projections of GHG emissions in the "with measures" scenario disaggregated by sector and by gas are presented in ***CTF Table 6(a)***, ***Tables 5.1*** and ***5.2.*** 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 target of Greece are presented. In ***Tables 5.3*** a split of the projections of the GHG emissions is presented between the sectors covered and not covered by the EU ETS.

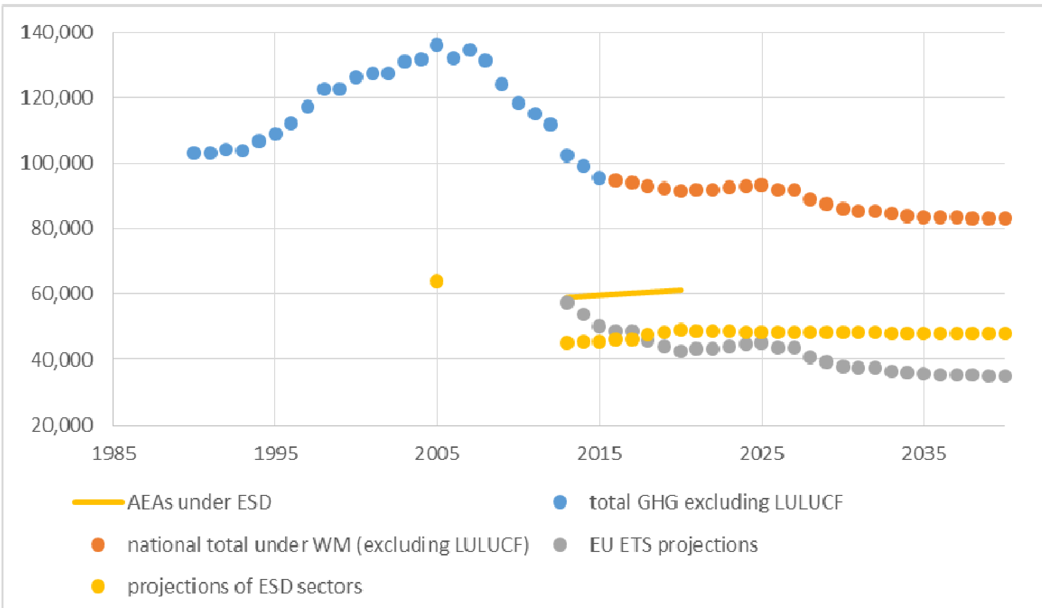


Figure 1.2 Projections of total national GHG emissions (excluding LULUCF), EU ETS and ESD sectors (in ktCO2eq)

Greece has fulfilled its Kyoto Protocol target (1st commitment period). For more information please refer to 6th National Communication. 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. It should be mentioned that this 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.

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 ***Tables 1.4*** 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 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	23211	31155	32641	36890
Transport sector (CO2)	8	401	501	1007	824	972
Industrial processes (HFC, PFC)	NA	NA	NA	460	1400	2300
Agriculture (CH4 30%, N2O 70%)	NE	NE	800	905	1050	1250
Waste Sector (only CH4)	NE	NE	800	1300	1500	1700
Total Effect	**7529**	**24470**	**25312**	**34827**	**37415**	**43112**

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 (projections of energy production and consumption data) 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 2015 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 BR2, updated to:

- ✓ include improvements in inventory reporting;
- ✓ include emissions for 2015, 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

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 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.

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, 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 (at constant prices of 2008).

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 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

While the international crisis was raging, Greece continued in 2017 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.

Despite these developments, Greece will continue to strive, according to its capabilities, for the implementation of the Millennium Development Goals (MDGs), that compose a policy framework for economic stability and prosperity, mainly via intensifying efforts to achieve the quality objectives of development assistance for which Greece has been committed internationally by the “Monterrey Consensus on Financing for Development” (2002), the “Paris Declaration on Aid Effectiveness” (2005), the “European Consensus on Development” (2005), the “Accra Agenda for Action” (2008) and recently the “Busan Partnership for Effective Development Co-operation” (2011).

Due to the difficult fiscal circumstances that it faces Greece's net bilateral and multilateral Official Development Assistance (ODA) disbursements have indicated decreasing trends since 2008 both in absolute terms and as a percentage of GNI.

Total (bilateral and multilateral) ODA granted by Greece in 2016 reached 368.53 MUSD, that is 0.19% of GNI of which about 30% was channelled bilaterally to developing countries, while 57% through International Organisations. Multilateral ODA reached 209.38 MUSD, while bilateral ODA amounted to 159.15 MUSD. In relation to 2008, total ODA has a decreasing trend, due to the difficult fiscal circumstances (approximately 48%), while ODA/GNI ratio dropped respectively from 0.21% in 2008 to 0.19% in 2016. However, an increasing trend of bilateral and multilateral ODA is observed in past few years (since 2013).

1.7 Research and Systematic Observation

1.7.1 Research

The General Secretariat of Research and Technology (GSRT) of the Ministry of Education and Religious Affairs, Sport and Culture (*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.

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 Environment, Energy and Climate Change, the School of Civil Engineering in the NTUA, as well as a number of national research centres (National Observatory of Athens, Hellenic Centre for Marine Research, etc.). 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 Observating 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. The environmental education has been considered a priority in the Greek educational system as early as the beginning of 1980's. 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 47 EECs are operating in Greece. In the context of the UN "Decade of Education for Sustainable Development 2005-2014", the Ministry of Education 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 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 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.

2.1 Government structure

The Constitution of 1975, as revised in 1986, 2001 and in 2008, 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.

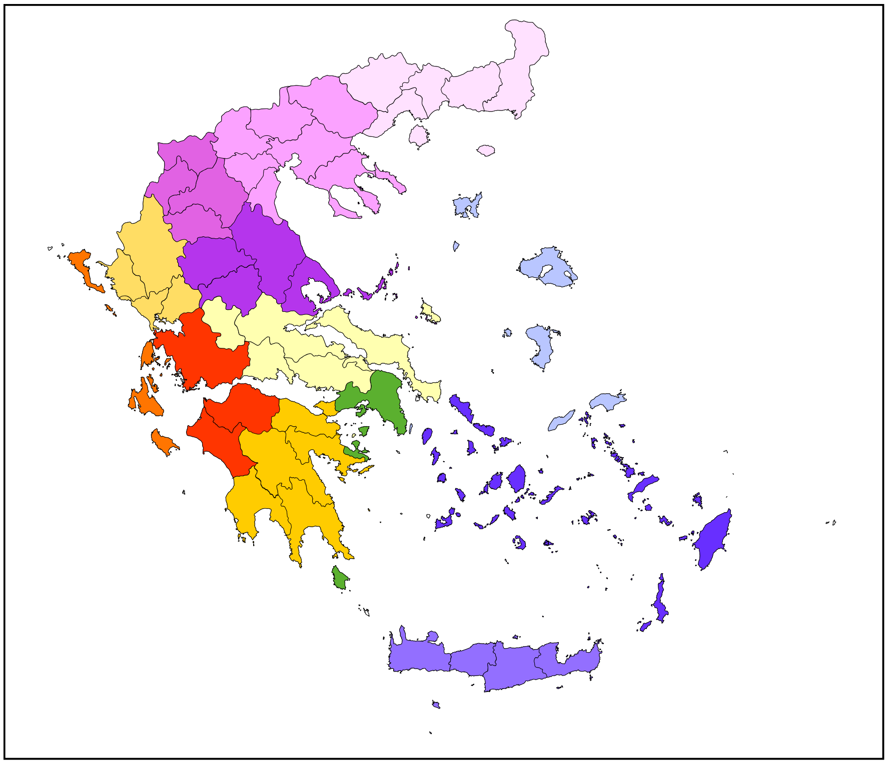

Figure 2.1 Major administrative divisions of Greece

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.

With regard to the parts pertaining to the LULUCF sector, the compilation of the national communications has been assigned, on a contract basis, to an independent LULUCF cosultant.

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 10.815 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 2016, total permanent population of Greece is estimated equal to 10.78 million inhabitants, slightly lower than this for 2011.

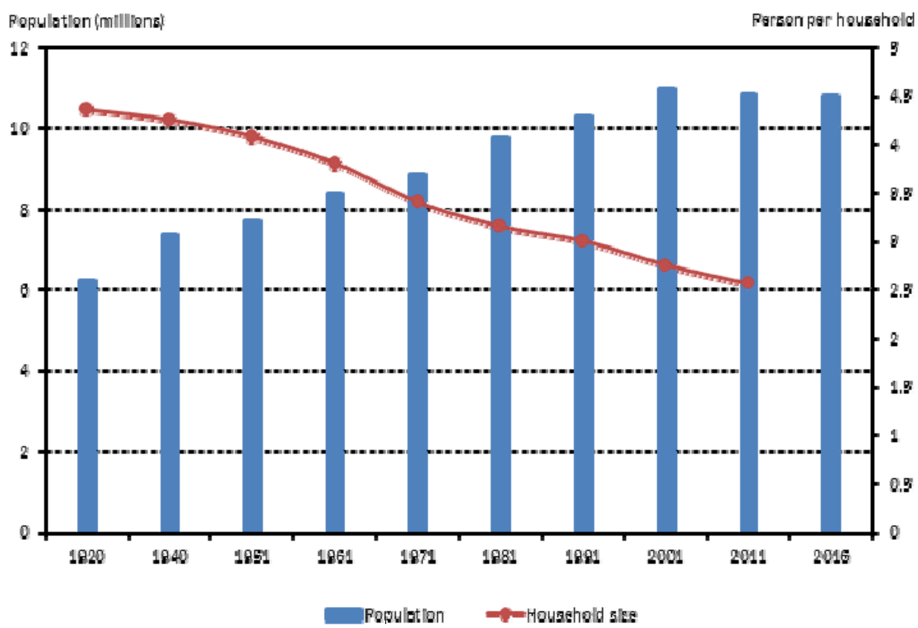

Figure 2.2 Population of Greece and average household size

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 2015 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);
- 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.

Forest land, divided into Forests (high and coppice forests) and Other Wooded Lands (branchy dwarf trees and scrubs), covers 26.2% of the total area of the country. Grassland, rangeland and pasture with vegetation that falls below the threshold of forest definition, covers 40.3% of the total area of the country. Agricultural land, including fallow land, account for 25.1% of the total area. Settlements, developed land including transportation infrastructure and human settlements of any size, account for 4.1% 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.

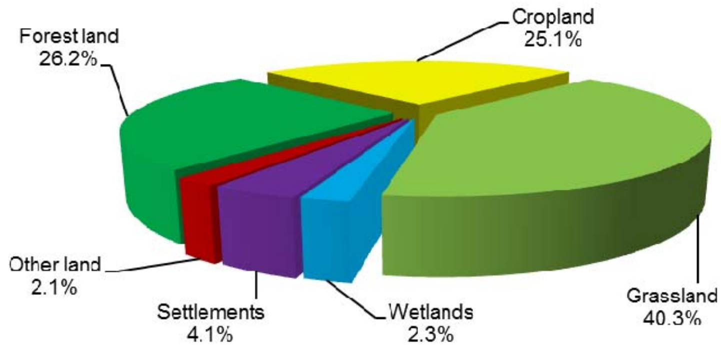

Figure 2.3 Distribution of the area of Greece in 2015 by land-use category

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 24°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 – 2015, 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 13°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 and 2015, as measured at selected meteorological stations of Greece.

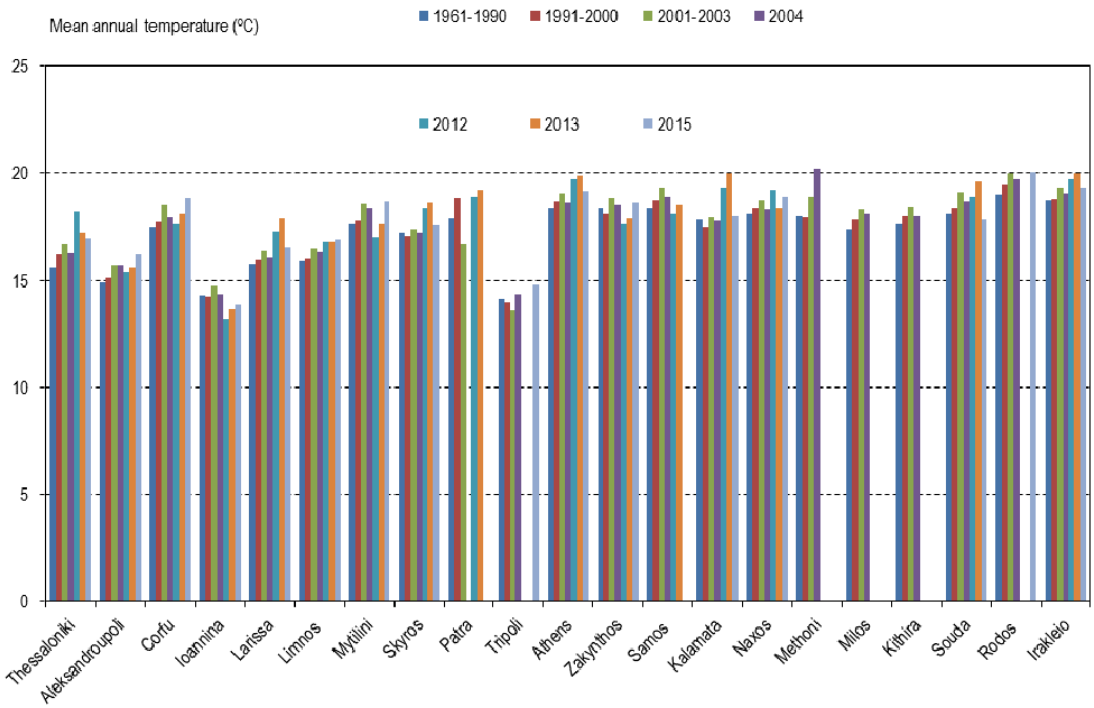

Figure 2.4 Mean annual temperature (in ˚C) at selected meteorological stations for the periods 1961 – 1990 and 1991 – 2000, 2001-2003 and for the years 2004, 2012, 2013 and 2015

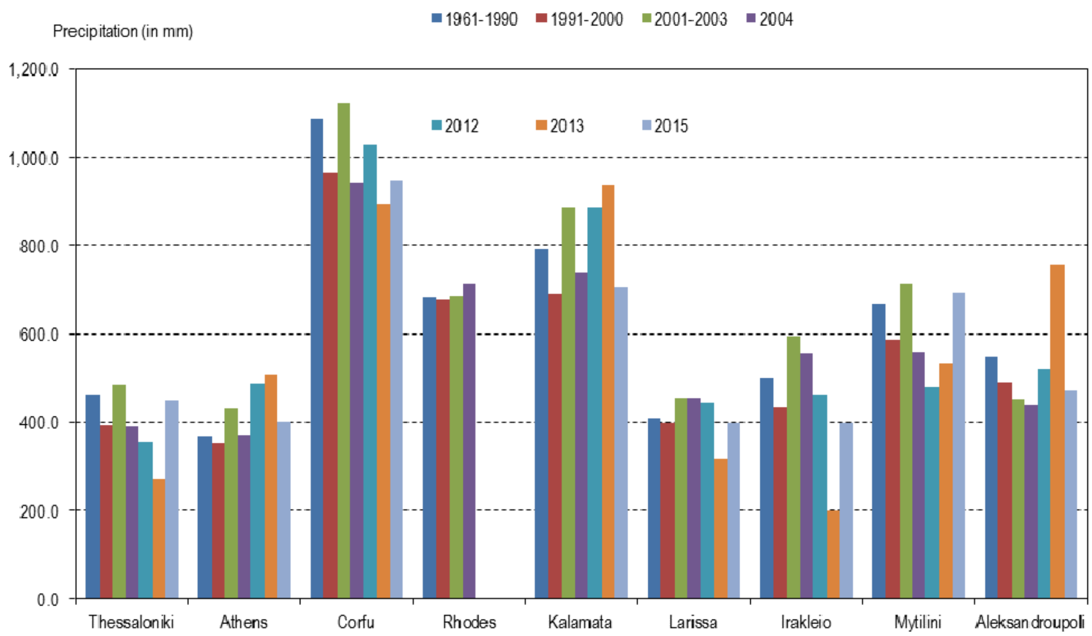

Figure 2.5 Precipitation height (in mm) at selected meteorological stations for the periods 1961 – 1990 and 1991 – 2000, 2001-2003 and for the years 2004, 2012, 2013 and 2015

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 experiences its most-severe economic crisis recording six consecutive year recession up to 2013. In 2014 about 0.7% growth was noted while for years 2015 and 2016 a small recession was shown from 0.2 to 0.3%. Positive number of growth is projected for 2017.

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 is expected to be completed by the August of 2018.

2.6.1 General

Over the last nine years Greek economy faced its most-severe crisis since it experienced a significant recession having recorded a cumulative decline in real terms exceeding 30% (by the end of 2016 compared to GDP at the end of 2007). Growth for 2016 was at -0.2%, while a recovery is expected for followed by a gradual acceleration of growth. The repercussions from the international financial crisis are 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.

Before this nine years period, 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.

As a result of economic crisis, unemployment in Greece has 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.

Inflation followed a downward trend from 2.7 in to -1.4 in 2014. In 2015 inflation was measured equal to -1.3 while for 2016 it was measured -0.4.

The general government deflection was substantial reduced from a peak of 14.3% of GDP in 1990 to around 3% in 1999. After the entrance of the country in the EMU, the fiscal deflection increased again above the 3% of GDP, but up to 2003 it was coupled with primary surpluses contributing to the debt reduction. Consolidation efforts reduced again the gov's deflect to 2.9% in 2006, but adverse international economic conditions coupled with specific deficiencies, mostly of structural nature in the budgetary management and control, led to a budget deflect of 10.2% of GDP in 2008.

2009 was the year with 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.

The extent of the economic crisis is also observed in other macroeconomic indicators as the private consumption and the gross value added (**Figure 2.6**). The average annual growth rate of gross value added for the period 2000 – 2007 is estimated at 3.70% and for the period 2008-2013 at -4.9%. For period 2014 to 2016 a small decrease in the range of -0.46% is observed. The average annual increase of the private consumption is estimated at 3.80% for the 2000-2007, -4.7 for the period 2008 – 2013 and -0.24 for the period 2014-2016.

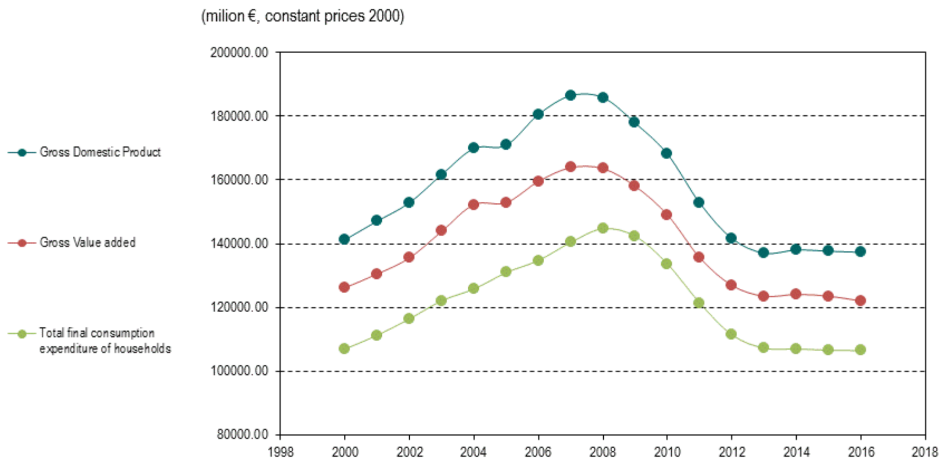

Figure 2.6 Basic macroeconomic indicators of the Greek economy for the period 2000 - 2016

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

In 2016, the tertiary sector accounted for 77.9% of the total gross value added (72.9% in 2000). The contribution of the primary sector decreased during the period 2000-2016 (5% in 2016 compared to 5% in 2000), while the contribution of industry (including energy industry) decreased from 14% in 2000 to 12.5% in 2016. On the contrary, the contribution of the construction sector decreased from 7.0 in 2000 to 4.3.

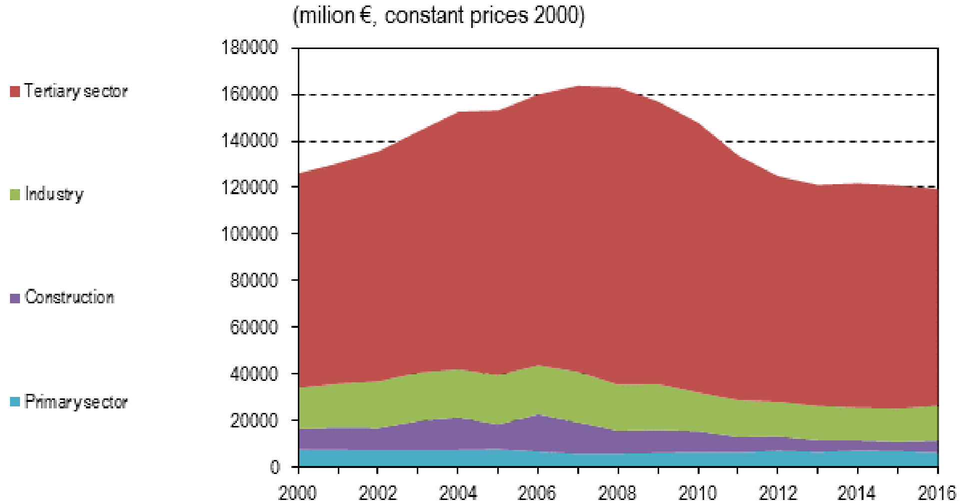

Figure 2.7 Gross value added (in constant prices 2000) per economic sector for the period 2000 – 2016

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. The construction sector presented the highest average annual decrease rate (approximately 38%).

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 decreased by 0.77% from 2000 to 2016. During the same period employment in the sector decreased by 29.3% and as a result employment in the primary sector accounts for 11.3% of total employment in 2016. The corresponding figure in 2000 was approximately 16%.

2.6.2.1 Agriculture

In 2016, the total area of agricultural land in Greece was approximately 3.3 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 19% in 2015 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 37.6% in 2015.

- 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.

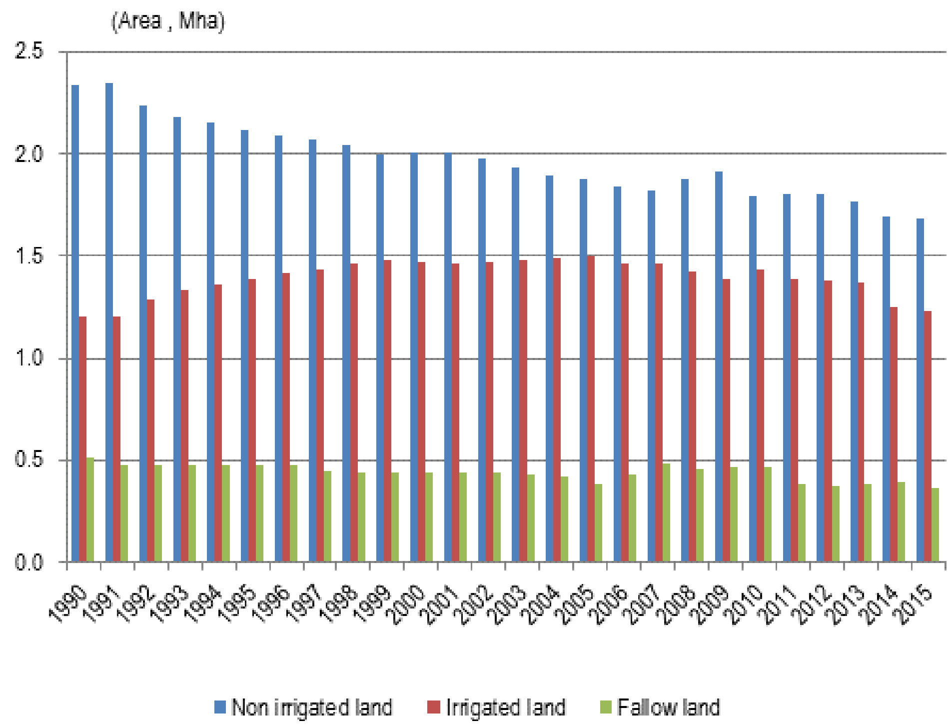

Figure 2.8 Distribution of agricultural land in irrigated and non-irrigated and fallow land (in Mha) for the period 1990 – 2016

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.

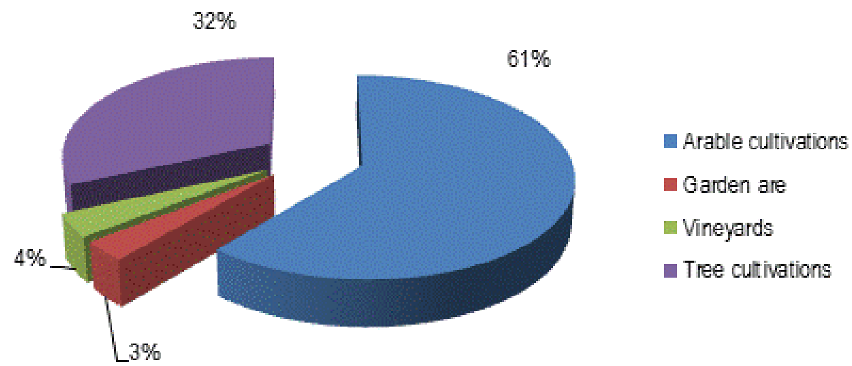

Figure 2.9 Agricultural land by cultivation type for the year 2009

The use of synthetic nitrogen fertilizers in 2015 decreased by approximately 56% 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 2015, livestock population amounted to approximately 46.3 million animals, of which: cattle 1.5%, sheep 18.3%, goats 10.3%, pigs 1.6% and poultry 68.2%. Livestock population increased by approximately 4.9% compared to 1990 levels because poultry population increased. However, a decrease is observed in the number of Mules and asses, Horses and swine (79.2%, 26.3% and 25.1% 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 1990–2015

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	0.7	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	1.11	1.29	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
Dairy cattle	132	130	130	133
Other Cattle	553	542	550	544
Sheep	8778	8611	8481	8473
Buffalo	2.167	2.343	2.503	2.606
Swine	793	761	753	746
Horses	31	32	33	33
Mules and Ashes	47	43	39	39
Goats	4895	4782	4777	4772
Poultry	30804	31078	31579	31611

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 16.8 in 2016. 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 1.6%, of Construction 25.5%, of Energy industries 14.0% and of Manufacture about 59% in 2016.

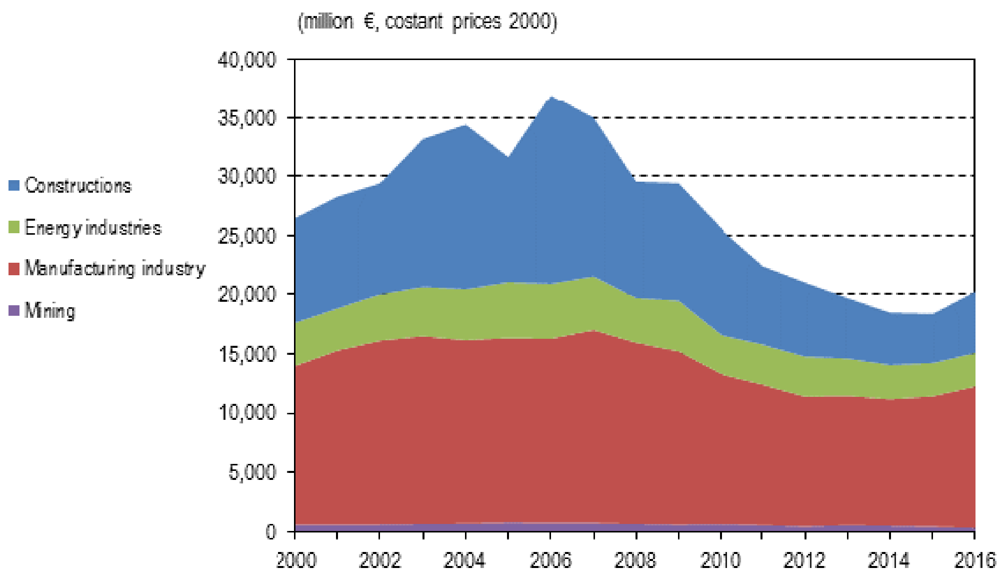

Figure 2.10 The structure of gross value added in the secondary sector for the period 2000 – 2016

Employment in the sector (***Table 2.3***) presents a similar to the gross value added trend. The total number of employees has decreased by 29.5% during the period 2000 – 2016, while the share of the secondary sector in total employment is about 14% 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 2016, the gross value added of the mining sector decreased by 43.2% compared to 2000.
- Employment in the mining sector decreased by 24% compared to 2000.

Table 2.3 Employment in the secondary sector for the period 2000 – 2016 (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	2013	2014	2015	2016
Mines	12	11	10	10	11	10	11	12
Manufacture	431	392	359	336	326	330	324	431
Energy Industry	51	50	46	43	43	42	43	51
Construction	314	241	207	203	205	197	199	314

2.6.3.2 Manufacture

The contribution of Manufacture to the gross value added of the secondary sector increases from 51% in 2000 to 59% in 2016. The structure of gross value added of Manufacture is presented in ***Figure 2.11***.

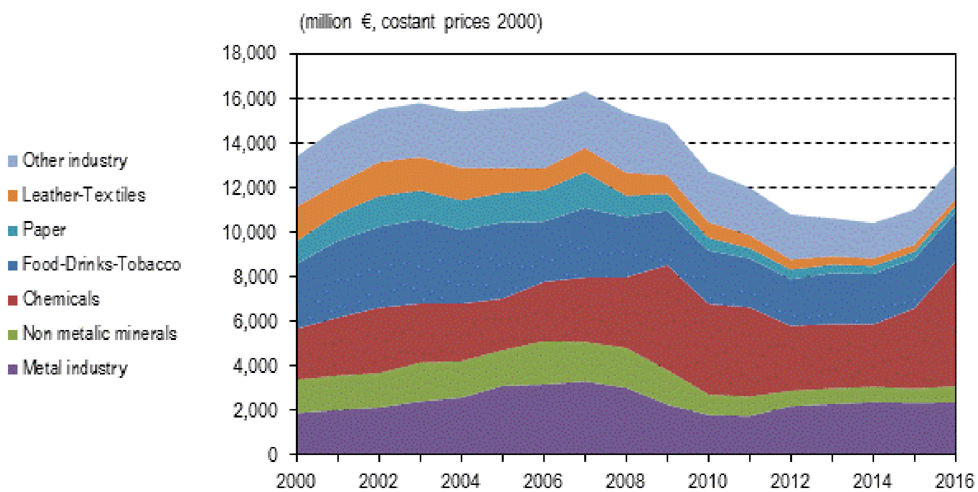

Figure 2.11 ***The structure of gross value added in Manufacture for the period 2000 – 2016***

- In 2016, Chemicals (Mainly of Manufacture of coke and refined petroleum products) presented the highest contribution to the gross value added of Manufacture (43%), followed by the Metal industry (18%) and the Food, Beverages and Tobacco (17%).
- The industrial branches that presented a significant increase of their gross value added during the period 2000-2016, were those of Chemicals (increase by 145% from 2000 to 2016) and Metal industry (increase by 26% from 2000 to 2016).
- The total industrial production index (base year 2010) for the period 2000-2016 is shown in ***Table 2.4***.

Table 2.4 Industrial production index for the period 2000-2016 (base year, 2010)

Branches	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Food	80.4	77.2	80.4	81.8	87.6	88.7	94.9	95.6	101.6	100.1	100.0	103.1	104.4	106.4	106.6	106.7	106.3
Beverages	77.7	75.3	77.7	80.9	85.0	86.6	89.2	91.4	96.3	99.4	100.0	101.5	102.8	104.3	104.0	102.1	103.7
Tobacco	90.0	85.8	90.0	91.6	93.1	93.7	96.3	100.4	101.2	106.7	100.0	95.0	98.3	95.4	96.9	103.3	103.4
Textiles	95.3	95.7	95.3	96.0	98.3	96.4	97.9	98.8	100.2	99.3	100.0	105.7	105.4	105.7	105.1	107.6	108.7
Clothing	91.0	89.5	91.0	93.4	96.4	96.7	96.8	97.5	98.6	99.5	100.0	100.9	100.8	102.0	101.8	101.2	100.2
Leather & footwear	88.2	85.9	88.2	90.3	92.0	92.0	92.6	95.3	96.4	98.1	100.0	104.2	105.2	105.2	105.3	107.6	106.1
Wood & cork	78.5	78.0	78.5	79.1	82.6	85.4	88.7	93.4	97.6	98.5	100.0	100.5	101.6	101.0	99.9	98.1	97.3
Paper & paper products	89.9	89.9	89.9	89.1	87.6	87.3	88.9	91.8	98.7	98.7	100.0	103.6	102.7	102.5	102.3	101.2	99.6
Printing & publishing	85.0	80.7	85.0	88.3	89.3	90.4	91.6	93.0	99.5	100.9	100.0	101.2	102.3	102.0	102.2	103.1	103.1
Petroleum & coal products	53.0	53.7	53.0	52.9	58.9	73.2	82.6	86.9	105.3	75.8	100.0	127.3	142.1	132.4	121.9	86.5	72.1
Chemicals	85.6	84.2	85.6	87.3	85.8	89.0	91.6	93.5	103.2	104.7	100.0	103.9	106.9	108.7	107.8	108.5	106.9
Plastics & rubber	81.4	80.7	81.4	83.4	83.0	87.6	90.9	93.0	97.7	98.9	100.0	103.9	105.0	105.5	104.9	104.1	103.0
Non-metallic minerals	78.4	75.7	78.4	78.4	80.8	82.7	86.2	91.3	97.0	99.0	100.0	100.2	101.1	100.4	100.2	99.9	99.4
Basic metals	70.9	72.1	70.9	71.0	74.3	78.2	84.3	89.5	93.4	91.2	100.0	107.7	108.9	104.7	101.2	100.3	95.0
Final metallic products	74.7	74.8	74.7	73.9	78.9	82.3	85.9	91.9	97.5	98.5	100.0	100.3	100.6	100.4	99.9	100.0	100.1
Machinery	93.7	92.8	93.7	94.2	93.6	94.1	96.5	97.9	99.4	99.7	100.0	100.1	100.7	100.9	100.5	100.0	99.5
Office & computing equipment	54.1	53.2	54.1	55.3	59.2	64.0	78.3	81.7	88.1	86.9	100.0	106.9	104.6	99.7	97.4	98.6	93.6
Electrical machines	91.8	90.5	91.8	90.0	90.2	90.6	92.1	96.7	98.8	99.8	100.0	100.2	99.8	99.9	98.9	98.5	98.4
Transport equipment	86.0	85.9	86.0	88.6	90.5	91.4	93.2	95.2	98.3	99.3	100.0	100.9	102.4	102.6	103.5	104.1	104.5
Other transport equipment	81.1	76.3	81.1	83.7	84.8	85.9	87.8	89.9	94.5	98.8	100.0	101.3	105.6	107.4	108.7	107.3	107.3
Furniture & other industries	82.8	81.6	82.8	83.6	85.7	88.3	91.0	94.3	96.6	99.3	100.0	99.2	98.3	98.2	98.1	98.8	98.6

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 26.5% in 2016 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 2.6%

for the period 2000 – 2016. As a result, employment decreased by approximately 32% during the period 2000-2016 and by 49% during the period 2007-2016.

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 14.0% in 2016. 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 2016, and in 2016 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 12, 15, 13, 32 and 28 % respectively.

Employment in the tertiary sector (***Table 2.5***) increased by 10% from 2000 until 2016. The share of the tertiary sector in the total employment increased from 65% of the economic active population in 2000 to 65% in 2016.

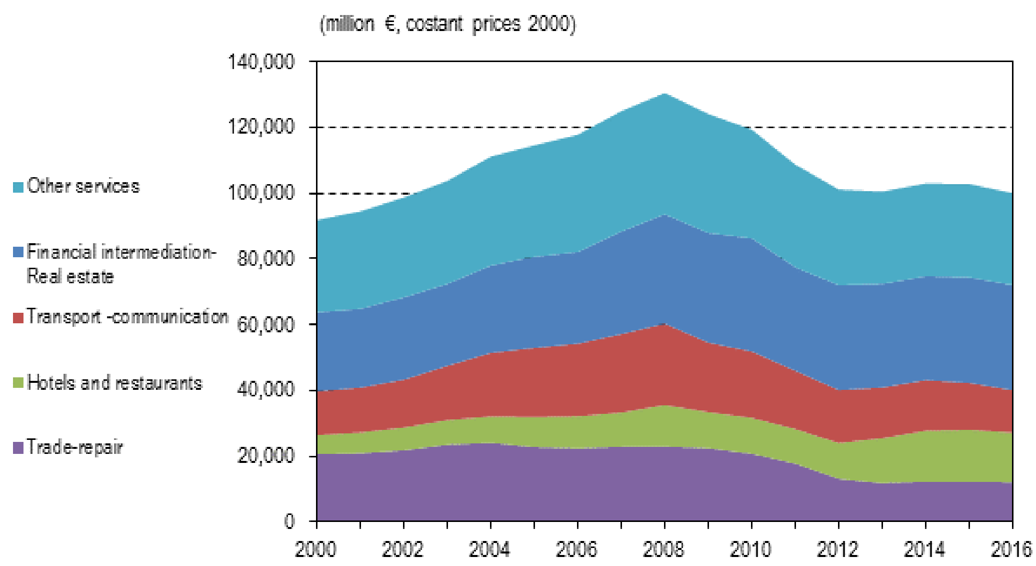

Figure 2.12 Structure of gross value added in the tertiary sector for the period 2000 – 2016

Table 2.5 Employment in the tertiary sector for the period 2000 – 2016 (thousands employees)

	2000	2001	2002	2003	2004	2005	2006	2007	2008
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
Information and communication	27	27	30	30	30	33	30	28	30
Financial and insurance activities	110	107	105	110	115	116	119	118	122
Real estate activities	6	7	8	10	13	13	12	12	14
Professional, scientific and technical activities; administrative and support service activities	167	182	200	203	225	230	242	243	257
Public administration and defence; compulsory social security; education; human health and social work activities	808	813	840	851	942	926	966	990	982
Arts, entertainment and recreation, repair of household goods and other services	171	175	198	212	215	214	218	222	234

	2009	2010	2011	2012	2013	2014	2015	2016
Wholesale and retail trade; repair of motor vehicles and motorcycles; transportation and storage; accommodation and food service activities	1739	1697	1600	1490	1444	1497	1538	1563
Information and communication	28	29	28	28	27	25	23	22
Financial and insurance activities	117	113	109	105	100	92	89	90
Real estate activities	13	14	14	13	12	13	14	12
Professional, scientific and technical activities; administrative and support service activities	261	259	248	246	241	244	250	250
Public administration and defence; compulsory social security; education; human health and social work activities	978	984	945	890	871	867	876	887
Arts, entertainment and recreation, repair of household goods and other services	243	267	245	222	222	221	222	219

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 18.6% to the G.D.P., creates approximately 850,000 jobs and is a main tool of regional development. Tourist arrivals range around 30,000,000 and the nights spent in tourist accommodations rise to about 68,000,000 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 2015, about 24% 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 –2015 is presented in the ***Figure 2.13***.

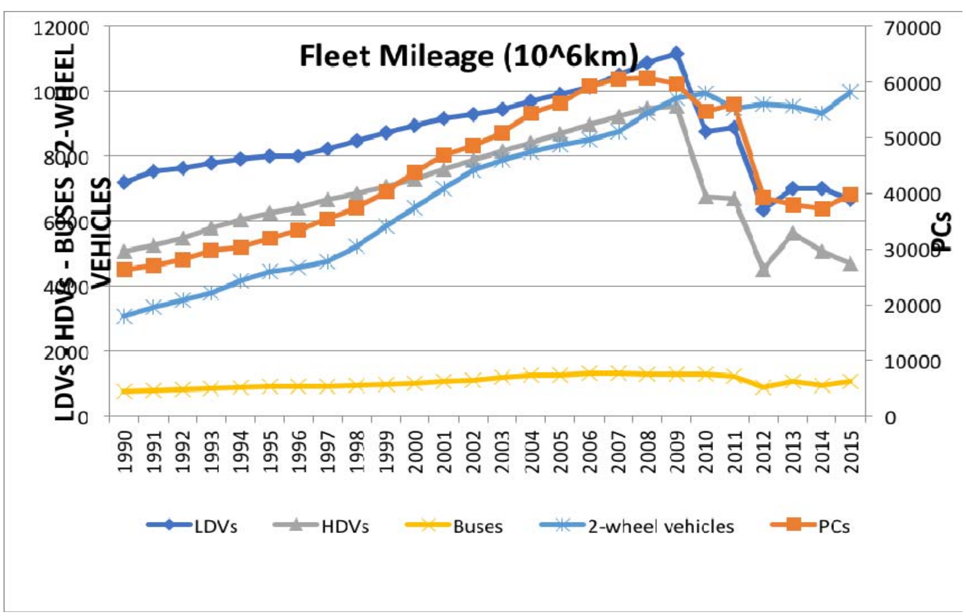

Figure 2.13 Annual mileage driven by all vehicles categories during the whole time period 1990 – 2015

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.

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 2,812.5 km. Greece was the last European country to develop a railway system, which dates only from the 1880s. Over the last 25 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 (the connection to Corinthos is in operation, while the connections to Livadia and Chalkida are expected to operate in the near future). 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 expected to increase. In 2016, the Railways Organisation had approximately 637 employees.

In 2016, a total of 15.6 million passengers were transported, of which 10.1 million used the suburban lines and 5.5 million the national network. A total of 1.1 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 92% compared to 1990 data, reaching a number of Landing and Take-off (LTO) cycles of approximately 235000 (compared to 122000 in 1990). Passengers that embark and disembark in the airports of the country, mounted approximately at 53.0 millions in 2016. Since 2000 air traffic presents an average annual decrease by 10% and the number of passengers increased by approximately 5.3% annually. Air transport of goods in 2016 decreased by 37% compared to 2000 levels.

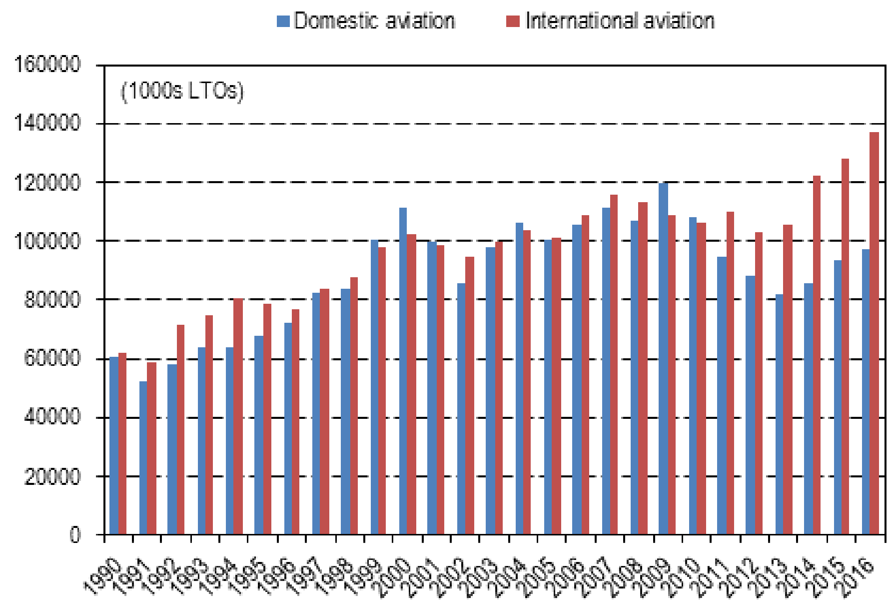

Figure 2.14 Domestic and international air traffic for the period 1990 – 2016

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 2015 amounted to approximately 940 PJ. The consumption of solid fuels and oil products accounts for 75.4% of total consumption, while the contribution of biomass and of the rest renewable energy sources (mostly hydropower, solar, wind energy and geothermal) are 3.1% and 6.5% respectively. Finally, the share of natural gas in gross inland consumption is 10.8%, while the rest of gross inland consumption is covered by electricity (net imports – exports). In 2015, gross inland consumption increased by approximately 1.8% compared to 1990, presenting a 0.2% average annual rate of increase. It should be mentioned that up to 1996 supply of natural gas was exclusively in 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. Furthermore, from 2007 to 2015 a decrease in gross inland consumption is observed, presenting an about 4.7% average annual rate of decrease.

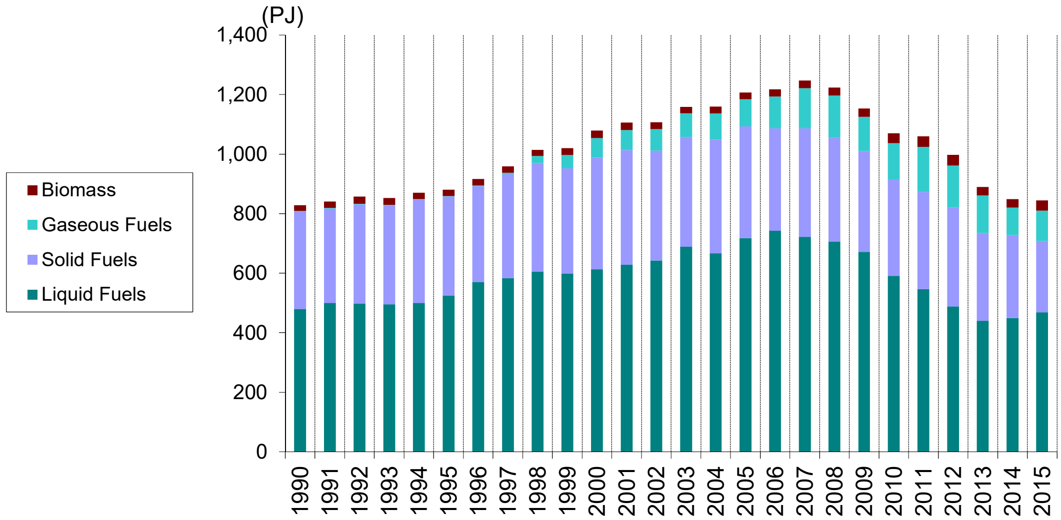

Figure 2.15 Gross inland consumption (in PJ) in Greece for the period 1990 - 2015

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 65% in 2015, 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 the only significant domestic energy source. It is a key strategic fuel and accounts for 31.6% of electricity production (in 2016). The lignite annual consumption was 34.2 million tonnes for 2016.

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 15 TWh in 2016, because of growth in renewable power sources and a lower overall electricity demand.

Lignite production decreased by 50% between 2012 and 2016, 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 2015, 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 30.2 Mt in 2016.

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 28% in power generation and 15% in the total primary energy supply (TPES) in 2016, and more than doubling its share in total final consumption over the last decade.

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.

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, 952 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 130,000 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 four major Greek cities (Athens, Thessalonica, Larissa and Volos) 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 9.0%. Electricity production in 2015 increased by 2.8% compared to 2014. Gross electricity production in 2015 (51.9 TWh) was approximately 48.2% higher compared to 1990 levels (***Figure 2.16***).

Electricity generation from the use of fossil fuels is approximately 70% of electricity production in 2015. Specifically, 42.6% 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 9.4% and 17.5% respectively. The rest of electricity production, i.e. around 30.5%, derives from renewable energy sources as hydropower, wind energy, PVs and biogas.

The calculation of GHG emissions from this sector was performed as described in section 3.2.4.2. The allocation of energy consumption by technology was made on the basis of Public Power Corporation (PPC) verified 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 18942 MW in 2015 (4302 MW lignite, 3972 MW NG, 2503 MW oil, 78MW biogas/biomass, 3392 MW hydro, 2091 wind, 2596 solar PV).

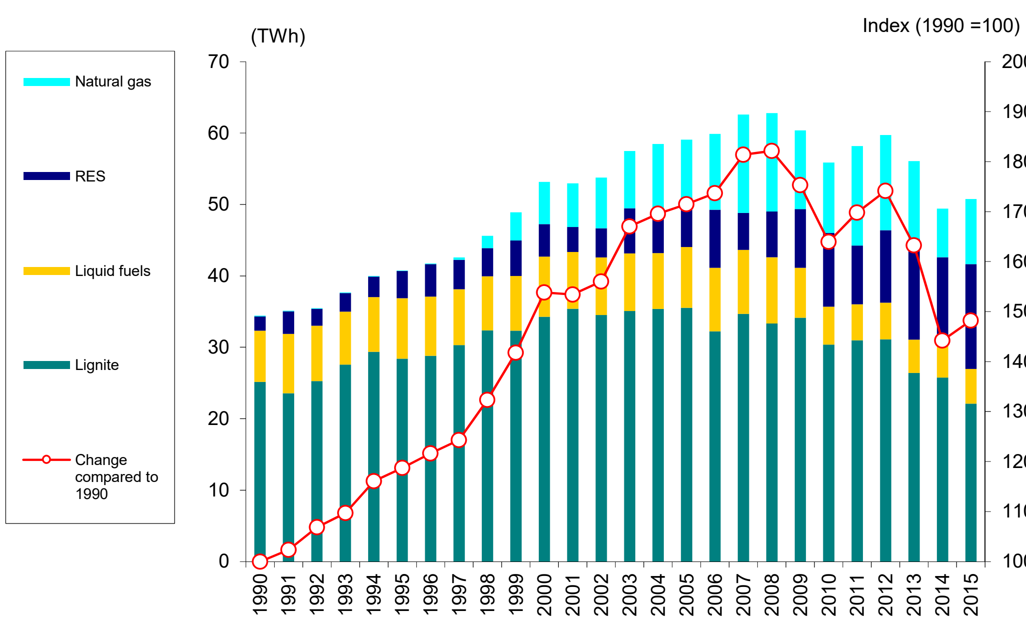

Figure 2.16 Gross electricity generation (in TWh) in Greece for the period 1990 – 2015

2.8.2 Final energy consumption

In 2015, final energy consumption in Greece totalled 16.4 Mtoe. The share of industry in final energy consumption is estimated at 19% in 2015, of transport at 40% while the share of residential and tertiary sector was 41.0%. The average annual rate of increase for the period 1990-2011 is estimated at 0.5%.

Residential and tertiary sector and transportation increased their energy use from 1990 to 2015 (***Figure 2.17***), 41% and 13% respectively, while industry sector decreased by 12%. This resulted in a total increase of 28% between 1990 and 2015.

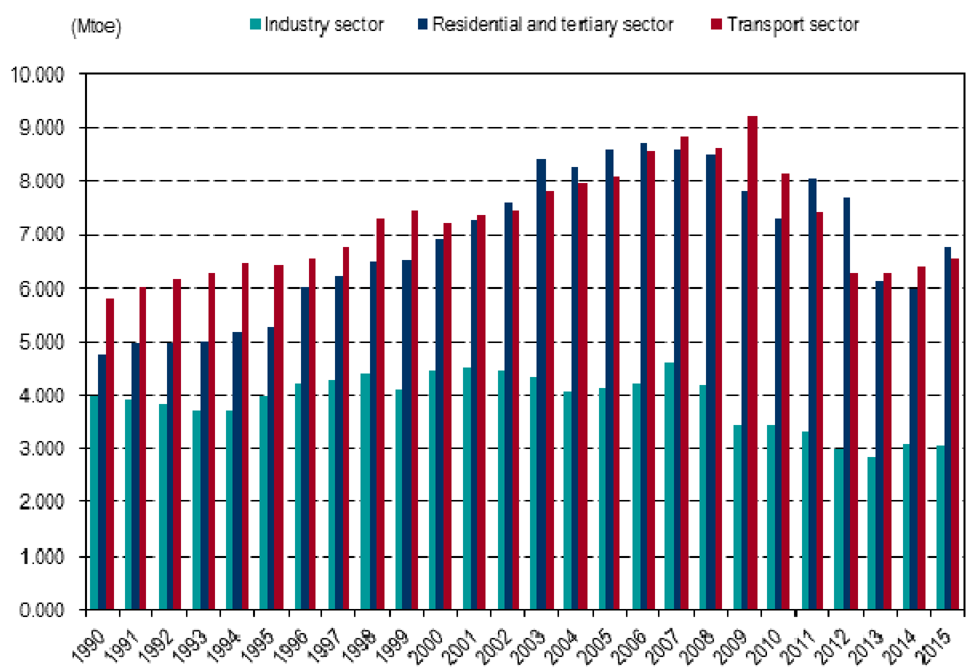

Figure 2.17 Final energy consumption (in Mtoe) by economic sector for the period 1990 – 2015

2.8.2.1 Industry

In 2015, the total energy consumption in industry totalled 3.1 Mtoe (***Figure 2.18***), accounted for 19.0% 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 2015, oil products accounted for approximately 37% 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 2015 it reached a total of approximately 1.1 Mtoe or 36% 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 – 2015.

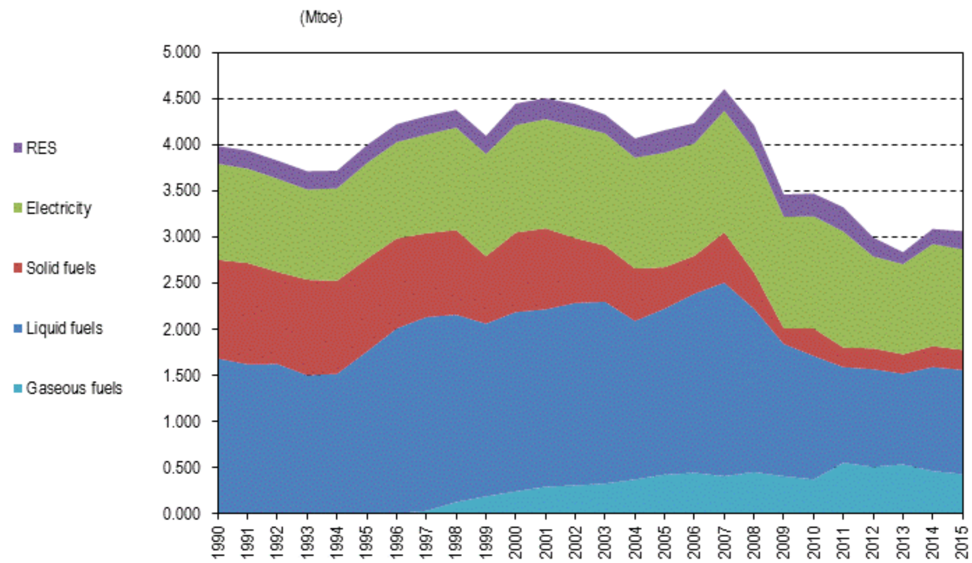

Figure 2.18 Energy consumption (in Mtoe) in industry for the period 1990 – 2015

2.8.2.2 Residential, tertiary sector and agriculture

In 2015, the energy use in the sector totalled 6.7 Mtoe or 41% of the total energy demand in Greece, compared to 4.97 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 2015, consumption of oil products accounted for 28% (1.9 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 16% in 2011 (1.1 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.

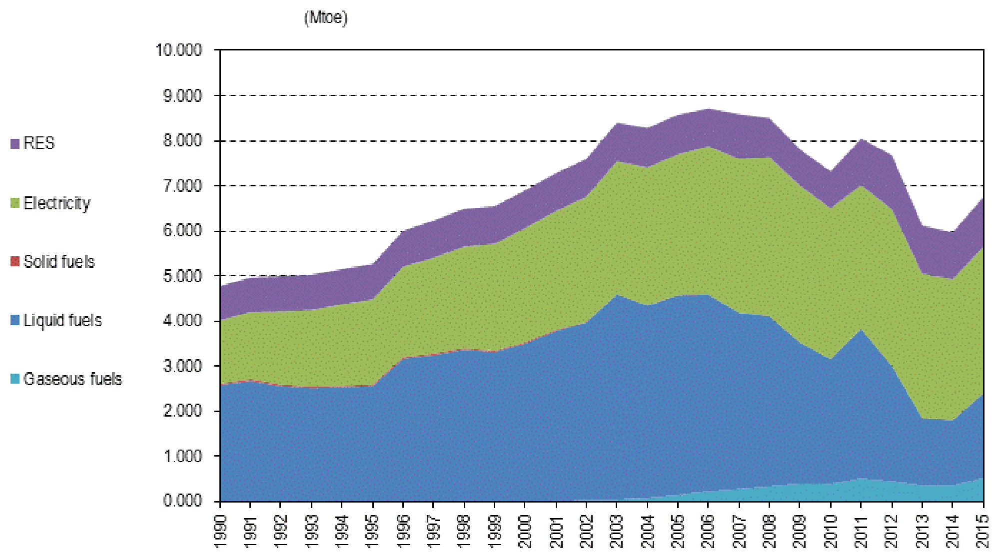

Figure 2.19 Final energy consumption (in Mtoe) in the residential, tertiary sector and in agriculture for the period 1990 - 2015

2.8.2.3 Transport

The energy use in transport has increased during the 1980–1995 period. In 2015, energy consumption for transportation accounted for 6.6 Mtoe (6.0 Mtoe in 1990) or 40% of the total final energy demand in Greece. Oil products accounted for more than 97% 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 – 2015, waste generation presented a continuous increase. Municipal solid waste generated quantities increased from 3.1 Mt in 1990 to 5.3 Mt in 2015, while the per capita solid waste generation increased from 0.82 kg/person/day in 1990 to 1.23 kg/person/day in 2015, remaining however below the EU average (EU-15). 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 41.6%, followed by paper 23.6%, plastic 12.1%, glass 4.14%, Textiles 3.25%, metal 2.7%, garden (yard) waste 1.5%, Wood 1% and Rest waste (Soils 3.0% and Other Inorganic 7.05%).

The amount of recycled wastes present a remarkable increase during the last years from 8% in 2000 to **14% in 2016** 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 2015 about 100 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 110 kt annually, until 2015.

The hospitals in Greece have the obligation to dispose clinical wastes in incineration units In 2015 it is estimated that these units accepted approximately 11 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 2015, 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 1990–2015 as reported in the National Inventory Report submitted to the UNFCCC in 2017 (MEEN, 2017).

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 1990–2015 is presented in ***Table 3.1a*** and ***Table 3.1b***. The detailed CRF trend tables are presented in Annex II.

Total uncertainty for the 2015 emissions is estimated at 12.5% (including Land Use, Land Use Change and Forestry - LULUCF), while the uncertainty carried over into the GHG emissions trend is approximately 11.7% (MEEN, 2017). The uncertainty for GHG emissions per gas (including LULUCF), in 2015, was estimated at:

- 2.9% for CO_2 emissions,
- 36.7% for CH_4 emissions,
- 106.5% for N_2O emissions
- 282.4% 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 105.9 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 2015, GHG emissions (without LULUCF) amounted to 95.7 Mt CO_2 eq showing a decrease of 9.64% compared to base year emissions and of 7.15% compared to 1990 levels. If emissions / removals from LULUCF were to be included then the decrease would be 8.25 % (from 100.9 Mt CO2 eq in 1990 to 92.6 Mt CO_2 eq in 2015).

Carbon dioxide emissions accounted for 78.32% of total GHG emissions in 2015 (without LULUCF) and decreased by approximately 10.09% from 1990. Methane emissions accounted for 10.68% of total GHG emissions in 2015 and decreased by 6.31% from 1990, while nitrous oxide emissions accounted for 4.71% of the total GHG emissions in 2015 and decreased by 39.29% from 1990. Finally, f-gases emissions (from production and consumption) that accounted for 6.17% of total GHG emissions in 2015 were increased by 42.70% from 1995 (base year for F-gases).

Table 3.1a Total GHG emissions in Greece (in kt CO_2 eq) for the period 1990-2002

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
A. GHG emissions per gas (excluding LULUCF)													
CO_2	83,375.36	83,350.94	84,915.80	84,229.45	86,391.99	86,945.64	89,098.55	93,804.20	98,624.77	97,941.65	102,982.30	105,368.98	105,011.40
CH_4	10,906.61	10,919.21	11,013.98	11,038.71	11,148.72	11,303.20	11,471.76	11,419.64	11,640.53	11,634.36	11,628.86	10,937.64	11,023.64
N_2O	7,423.22	7,289.30	7,134.00	6,575.73	6,458.52	6,662.98	6,835.07	6,675.00	6,602.04	6,560.21	6,328.64	6,204.93	6,161.18
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	6,721.15	5,261.83	4,781.39	5,090.07
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
SF_6	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
Total	**103,081.19**	**103,153.73**	**104,403.70**	**103,992.47**	**106,784.94**	**109,135.47**	**112,282.79**	**117,194.53**	**122,793.94**	**122,966.37**	**126,327.70**	**127,380.92**	**127,378.64**
B. GHG emissions/removals from LULUCF													
CO_2	-2,245.82	-2,418.51	-2,513.10	-2,979.19	-2,721.86	-2,975.06	-2,389.37	-2,082.05	-2,016.03	-2,647.14	-2,339.38	-2,630.66	-2,903.34
CH_4	62.18	30.91	91.27	81.38	75.92	43.05	26.07	57.40	156.40	11.92	206.51	27.78	3.79
N_2O	5.62	3.30	8.73	8.52	8.35	5.94	5.04	8.18	16.73	5.34	21.65	7.41	5.93
Total	**-2,178.02**	**-2,384.30**	**-2,413.10**	**-2,889.29**	**-2,637.59**	**-2,926.07**	**-2,358.25**	**-2,016.48**	**-1,842.91**	**-2,629.89**	**-2,111.21**	**-2,595.48**	**-2,893.62**
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
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
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
Total	**10,855.29**	**9,835.77**	**11,088.56**	**12,696.30**	**13,794.52**	**14,466.58**	**12,914.38**	**12,858.38**	**14,157.02**	**13,191.89**	**14,408.32**	**13,853.28**	**12,648.64**

Table 3.1b Total GHG emissions in Greece (in kt CO2 eq) for the period 2003-2015

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
A. GHG emissions per gas (excluding LULUCF)													
CO_2	109,083.18	109,530.03	113,925.07	112,464.91	114,582.59	111,112.52	104,340.56	97,342.98	94,531.70	91,417.80	81,722.58	78,657.96	74,962.94
CH_4	11,118.17	11,154.41	11,235.08	11,295.52	11,144.59	11,092.07	10,746.91	10,972.53	10,793.89	10,595.13	10,387.06	10,312.84	10,218.43
N_2O	6,085.75	6,088.43	5,924.21	5,763.70	5,864.10	5,632.82	5,267.02	5,469.46	5,228.73	4,796.77	4,499.27	4,485.00	4,506.46
HFC	4,733.36	4,927.91	5,077.45	2,722.45	3,245.14	3,710.35	3,964.12	4,388.67	4,661.66	5,061.78	5,650.22	5,758.13	5,902.68
PFC	89.28	87.86	91.51	87.21	103.04	118.95	91.35	129.44	110.53	147.77	172.56	134.63	119.52
SF_6	4.06	4.26	6.16	7.98	9.46	7.18	5.02	5.86	5.13	5.05	5.15	4.92	5.06
Total	**131,113.78**	**131,792.90**	**136,259.48**	**132,341.78**	**134,948.92**	**131,673.90**	**124,414.97**	**118,308.93**	**115,331.64**	**112,024.30**	**102,436.85**	**99,353.49**	**95,715.10**
B. GHG emissions/removals from LULUCF													
CO_2	-2,632.47	-2,609.09	-3,388.93	-3,463.86	-2,086.45	-3,310.91	-3,377.93	-3,351.26	-3,440.73	-3,431.62	-1,890.55	-461.70	-3,159.71
CH_4	5.32	13.47	10.49	20.81	319.28	43.24	45.82	16.27	17.75	43.48	15.99	9.39	10.77
N_2O	6.54	7.87	7.87	9.26	34.49	12.36	12.75	9.98	9.94	12.34	9.56	8.62	8.51
Total	**-2,620.60**	**-2,587.75**	**-3,370.57**	**-3,433.79**	**-1,732.67**	**-3,255.30**	**-3,319.36**	**-3,325.00**	**-3,413.04**	**-3,375.80**	**-1,865.00**	**-443.69**	**-3,140.44**
C. GHG Emissions from International Transport													
CO_2	13,304.19	13,474.19	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
CH_4	21.91	22.17	19.89	21.52	22.09	21.68	18.35	19.06	19.56	16.00	15.09	13.22	12.52
N_2O	275.48	267.53	223.68	235.55	227.13	216.42	196.01	206.56	195.71	167.63	171.56	160.30	172.75
Total	**13,601.58**	**13,763.90**	**12,058.66**	**12,984.61**	**13,353.01**	**13,100.42**	**11,362.19**	**11,598.64**	**11,867.34**	**9,911.50**	**9,569.40**	**9,051.78**	**8,842.57**

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 2008-2015 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.

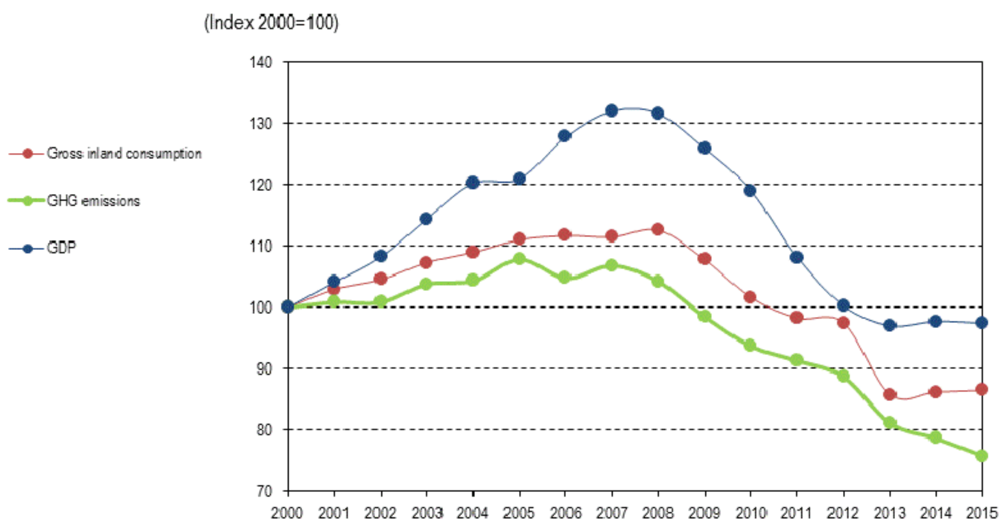

Figure 3.1 Factors underlying GHG emissions trends

3.2 GHG emissions trends

3.2.1 GHG emissions trends per sector

GHG emissions by sector for the period 1990 - 2015 are presented in ***Table 3.2a*** and ***Table 3.2b***, while the sectoral contribution to GHG emissions for 2015 (excluding LULUCF) is presented in ***Figure 3.2***.

Table 3.2a Total GHG emissions in Greece (in kt CO_2 eq) for the period 1990-2002

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Energy	76,869.62	77,006.70	79,019.75	78,659.44	80,886.43	80,949.77	83,167.51	87,703.96	92,427.63	91,883.56	96,678.36	99,120.02	98,946.99
IPPU	11,226.96	11,163.40	10,577.36	11,028.32	11,636.59	13,569.65	14,338.11	14,835.60	15,552.78	16,389.35	15,176.38	14,575.50	14,768.63
Agriculture	10,120.79	10,144.10	9,868.57	9,314.84	9,119.26	9,465.84	9,527.64	9,443.03	9,418.75	9,346.04	9,124.74	9,109.03	9,132.75
Waste	4,863.82	4,839.52	4,938.02	4,989.87	5,142.66	5,150.20	5,249.53	5,211.94	5,394.79	5,347.42	5,348.23	4,576.37	4,530.27
Total [1)]	**103,081.19**	**103,153.73**	**104,403.70**	**103,992.47**	**106,784.94**	**109,135.47**	**112,282.79**	**117,194.53**	**122,793.94**	**122,966.37**	**126,327.70**	**127,380.92**	**127,378.64**
LULUCF	**-2,178.02**	**-2,384.30**	**-2,413.10**	**-2,889.29**	**-2,637.59**	**-2,926.07**	**-2,358.25**	**-2,016.48**	**-1,842.91**	**-2,629.89**	**-2,111.21**	**-2,595.48**	**-2,893.62**
Index per sector													
Energy	100.00	100.18	102.80	102.33	105.23	105.31	108.19	114.09	120.24	119.53	125.77	128.95	128.72
IPPU	100.00	99.43	94.21	98.23	103.65	120.87	127.71	132.14	138.53	145.98	135.18	129.83	131.55
Agriculture	100.00	100.23	97.51	92.04	90.10	93.53	94.14	93.30	93.06	92.34	90.16	90.00	90.24
Waste	100.00	99.50	101.53	102.59	105.73	105.89	107.93	107.16	110.92	109.94	109.96	94.09	93.14
Total [2)]	**100.00**	**100.07**	**101.28**	**100.88**	**103.59**	**105.87**	**108.93**	**113.69**	**119.12**	**119.29**	**122.55**	**123.57**	**123.57**

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 2002-2015

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Energy	102,830.84	103,324.48	107,136.64	105,852.07	108,071.31	105,227.91	100,268.60	93,080.53	91,901.25	88,118.94	77,766.86	74,323.39	71,022.38
IPPU	14,532.25	14,673.33	15,425.62	12,739.51	13,173.76	12,987.41	11,185.12	11,662.02	10,320.48	11,140.73	11,861.99	12,232.95	11,896.29
Agriculture	9,099.06	9,139.04	8,936.41	8,839.92	8,971.78	8,715.16	8,497.16	8,815.94	8,574.71	8,446.56	8,380.53	8,294.91	8,309.97
Waste	4,651.63	4,656.04	4,760.81	4,910.28	4,732.08	4,743.41	4,464.09	4,750.44	4,535.19	4,318.07	4,427.47	4,502.23	4,486.46
Total [1)]	**131,113.78**	**131,792.90**	**136,259.48**	**132,341.78**	**134,948.92**	**131,673.90**	**124,414.97**	**118,308.93**	**115,331.64**	**112,024.30**	**102,436.85**	**99,353.49**	**95,715.10**
LULUCF	**-2,620.60**	**-2,587.75**	**-3,370.57**	**-3,433.79**	**-1,732.67**	**-3,255.30**	**-3,319.36**	**-3,325.00**	**-3,413.04**	**-3,375.80**	**-1,865.00**	**-443.69**	**-3,140.44**
Index per sector													
Energy	133.77	134.42	139.37	137.70	140.59	136.89	130.44	121.09	119.55	114.63	101.17	96.69	92.39
IPPU	129.44	130.70	137.40	113.47	117.34	115.68	99.63	103.88	91.93	99.23	105.66	108.96	105.96
Agriculture	89.90	90.30	88.30	87.34	88.65	86.11	83.96	87.11	84.72	83.46	82.81	81.96	82.11
Waste	95.64	95.73	97.88	100.96	97.29	97.52	91.78	97.67	93.24	88.78	91.03	92.57	92.24
Total [2)]	**127.19**	**127.85**	**132.19**	**128.39**	**130.92**	**127.74**	**120.70**	**114.77**	**111.88**	**108.68**	**99.37**	**96.38**	**92.85**

[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

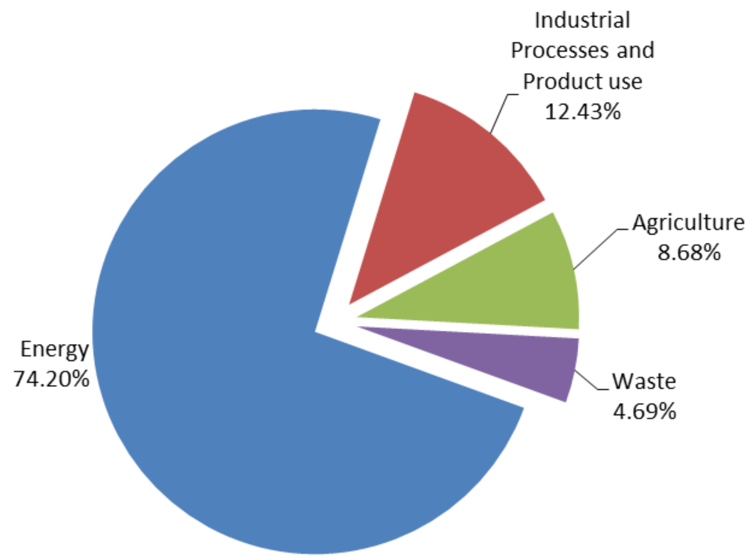

Figure 3.2 Contribution of activity sectors to total GHG emissions (without LULUCF) in 2015

- Emissions from Energy in 2015 (***Figure 3.2***) accounted for 74.20% of total GHG emissions (without LULUCF) and decreased by approximately 7.61% 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. For the period 2008 – 2015, the emissions have a decreasing trend.
- 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 CO_2 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 decreasing trend of emissions of energy of the years 2008-2015 is attributed mainly to the economic recession that the country is facing, but also to the effect of mitigation actions (i.e. RES, energy efficiency measures, road infrastructure and public transportation improvements, etc.
- The majority of GHG emissions (57.6%) in 2015 derived from energy industries, while the contribution of transport, manufacturing industries and construction

and other sectors is estimated at 24.1%, 7.4% and 9.1% respectively. The rest 1.6% of total GHG emissions from Energy derived from fugitive emissions from fuels. Within the fuel combustion activities, the sector with the greatest increase of emissions since 1990 is transport, showing an increase of 17.9% compared to 1990. Emissions from manufacturing industries and construction emissions and other sectors (i.e. residential, tertiary and agriculture sectors) had decreased by around 44.18% and 24.10%, respectively, compared to 1990. The decrease in the other sectors is noticeable during the recent years. Finally, fugitive emissions from fuels decreased by 8.56% for the period 1990 – 2015.

- Emissions from Industrial Processes and Product use in 2015 accounted for 12.43% of the total emissions (excluding LULUCF) and increased by 5.96% compared to 1990 levels. In 2015 mineral products production has continued the decreasing trend of the previous years, following the decrease of all the subcategories of the sector, mainly due to the effects of the economic recession. There is an increase in emissions since 2011 (27.28%), which followed the intense decrease of 2011. Emissions from chemical industry have decreased by 82.41% since 1990. Emissions from metal industry slightly increased with regards to 2011 by 2.18%, due to the increased production of aluminium and nickel.
- Emissions from Agriculture that accounted for 8.68% of total emissions in 2015 (without LULUCF), decreased by approximately 17.89% compared to 1990 levels. Emissions reduction is mainly due to the reduction of N_2O emissions from agricultural soils, because of the reduction in the use of synthetic nitrogen fertilizers. 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. animal population, crops production etc.) have a minor effect on GHG emissions trend.
- Emissions from the Waste Sector (4.69% of the total emissions, without LULUCF), decreased by approximately 7.76% from 1990. Living standards improvement resulted in an increase of the generated waste and thus of emissions. 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 − 2015. The sink capacity of the LULUCF sector fluctuates between 0.44 Mt CO2 eq. and 3.43 Mt CO2 eq., showing an increasing 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 CO_2 emissions decreased from 83.4 Mt in 1990 to 74.97 Mt in 2015 (without LULUCF). The decrease of 10.09% from 1990 to 2015 is mainly attributed to the economic crisis. Other reasons are the increased share of natural gas in energy mix and RES technologies.

CO_2 emissions from Energy decreased, from 74.66 Mt in 1990 to 69.22 Mt in 2015, presenting a total decrease of 7.29% from 1990 to 2015. Carbon dioxide emissions from Industrial processes and product use in 2015 decreased by 28.72% compared to 1990 levels. Finally, emissions from Waste in 2009 show a continuous increase from 1990 (***Figure 3.3***).

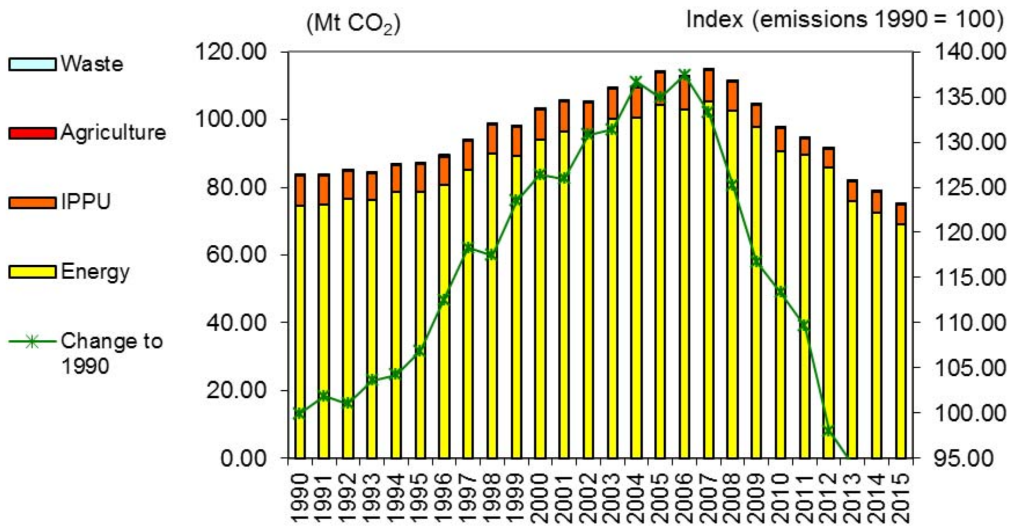

Figure 3.3 CO_2 emissions by sector (in Mt) for the years 1990 – 2015 (without LULUCF)

3.2.2.2 Methane

The trend of methane emissions from 1990 to 2015 by source category is presented in ***Figure 3.4***. Emissions present an abrupt decrease in 2001 mainly due to Waste Sector, while in 2015 emissions are slightly lower than 2014.

Waste represents the largest anthropogenic source of methane emissions in Greece accounting for 40.52% of total methane emissions in 2015 (without LULUCF). Methane emissions from Waste decreased by 9.67% since 1990 and are mainly attributed to Solid Waste Disposal on Land and Wastewater Handling.

Methane emissions from Agriculture in 2015 decreased by 3.26% compared to 1990 levels. Methane emissions from Agriculture, with enteric fermentation being the main source category in the sector, in 2015 accounted for 46.53% 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 12.95% of the total methane emissions. Finally, the contribution of CH4 emissions from Iron and Steel Production can be considered negligible (0.002%).

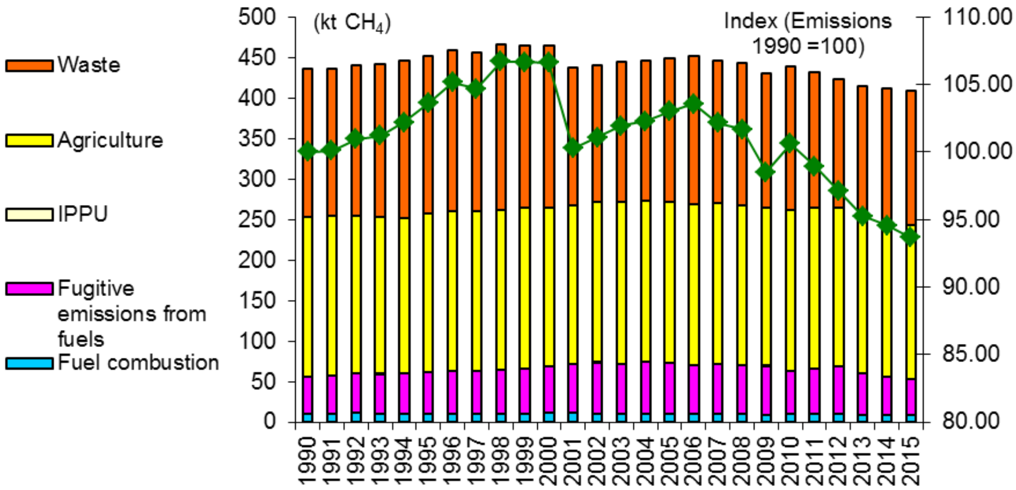

Figure 3.4 CH_4 emissions by sector (kt) for the years 1990 – 2015 (without LULUCF)

3.2.2.3 Nitrous oxide

The trend of nitrous oxide emissions from 1990 to 2015 by source category is presented in ***Figure 3.5***.

Agriculture represents the largest anthropogenic source of nitrous oxide emissions in Greece (78.31% approximately of the total nitrous oxide emissions in 2015, without LULUCF). Emissions from this sector decreased by 31.42% 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 10.63% of total nitrous oxide emissions in 2015) decreased by 39.98% from 1990.

Production of nitric acid is the major source of N2O emissions from Industrial processes and product use and accounts for 3.58% of total N2O emissions in 2015. Nitrous oxide emissions from this source decreased by 86.53% from 1990, due to the reduction of nitric acid production in Greece. However, it should be mentioned that the high decrease between 2011 and 2012, which was attributed to the economic recession, is 26.91%. N2O emissions from Waste in 2015 (7.47% of total emissions without LULUCF) increased by 20.48% compared to 1990 levels.

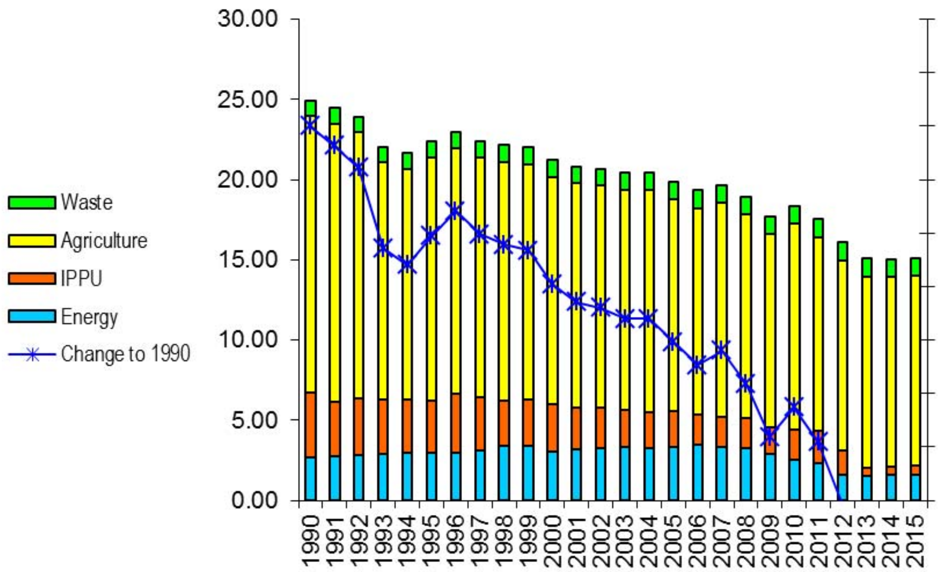

Figure 3.5 N_2O emissions by sector (kt) for the years 1990 – 2015 (without LULUCF)

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 2008-2015 show fluctuations 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.

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 1990-2015 (in kt CO2 eq)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
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**	**6,721.15**	**5,261.83**	**4,781.39**	**5,090.07**
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
HFC-32						0.03	0.22	0.73	1.45	2.45	4.78	9.23	15.15
HFC-125						6.10	12.12	24.10	39.46	57.46	90.44	137.29	198.05
HFC-134a				0.10	0.16	27.34	52.43	95.30	149.77	215.02	305.89	427.11	547.39
HFC-152a												2.78	51.22
HFC-143a						8.92	16.44	30.21	47.21	65.88	95.11	127.57	168.30
HFC-227ea										3.17	4.37	5.89	7.57
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**
SF_6	**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**
Total	**1,376.00**	**1,594.29**	**1,339.93**	**2,148.58**	**2,785.71**	**4,223.65**	**4,877.41**	**5,295.68**	**5,926.60**	**6,830.15**	**5,387.90**	**4,869.37**	**5,182.41**

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
HFC	**4,733.36**	**4,927.91**	**5,077.45**	**2,722.45**	**3,245.14**	**3,710.35**	**3,964.12**	**4,388.67**	**4,661.66**	**5,061.78**	**5,650.22**	**5,758.13**	**5,902.68**
HFC-23	3,444.78	3,317.29	2,832.99	114.65	171.78	186.46	190.76	221.65	196.32	220.06	222.78	180.55	175.92
HFC-32	24.38	36.24	48.77	63.42	79.69	95.41	110.41	133.11	164.13	206.95	279.77	306.06	310.21
HFC-125	280.48	381.28	529.08	639.15	804.19	946.15	1,070.21	1,283.25	1,495.19	1,791.55	2,194.69	2,373.39	2,535.72
HFC-134a	677.57	825.17	1,166.96	1,343.16	1,525.19	1,741.52	1,809.97	1,864.24	1,884.16	1,847.38	1,960.28	1,877.90	1,898.95
HFC-152a	81.63	88.67	105.66	133.60	141.14	152.37	155.26	159.96	162.36	167.08	158.40	159.04	160.07
HFC-143a	214.72	266.35	377.70	409.08	500.06	561.97	597.83	693.47	723.09	790.29	793.33	818.00	774.80
HFC-227ea	9.80	12.91	16.29	19.40	23.08	26.47	29.69	32.99	36.40	38.47	40.97	43.19	47.01
PFC	**89.28**	**87.86**	**91.51**	**87.21**	**103.04**	**118.95**	**91.35**	**129.44**	**110.53**	**147.77**	**172.56**	**134.63**	**119.52**
SF_6	**4.06**	**4.26**	**6.16**	**7.98**	**9.46**	**7.18**	**5.02**	**5.86**	**5.13**	**5.05**	**5.15**	**4.92**	**5.06**
Total	**4,826.69**	**5,020.03**	**5,175.12**	**2,817.64**	**3,357.65**	**3,836.48**	**4,060.49**	**4,523.97**	**4,777.31**	**5,214.60**	**5,827.93**	**5,897.68**	**6,027.27**

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 34.25 kha, land areas deforested were 5.21 kha and land areas under forest management were 1,234.49 kha. In 2015 net removals from ARD activities were 79.51 kt CO_2 eq and from Forest Management activities 2028.15 kt CO_2 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 of the NIR.

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 3.6 emissions from these subcategories during the period 1990-2015 are summed up in order to illustrate the effect of deforestation.

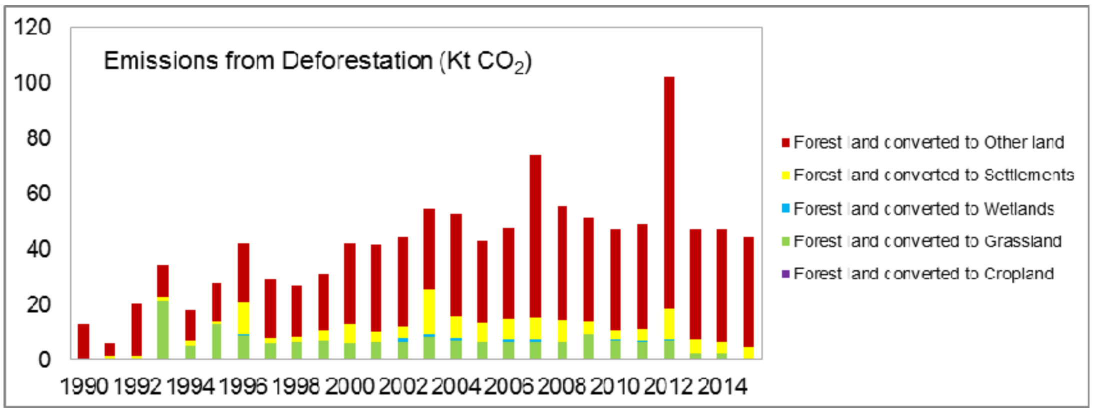

Figure 3.6 CO2 emissions (in kt) from deforestation for the period 1990 – 2015

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 3.7 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 except LULUCF sector has been assigned to **National Technical University of Athens (NTUA) / School of Chemical Engineering**, on a contract basis by MEEN. The inventory of LULUCF sector has been assigned, on a contract basis, to an independent consultant 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.

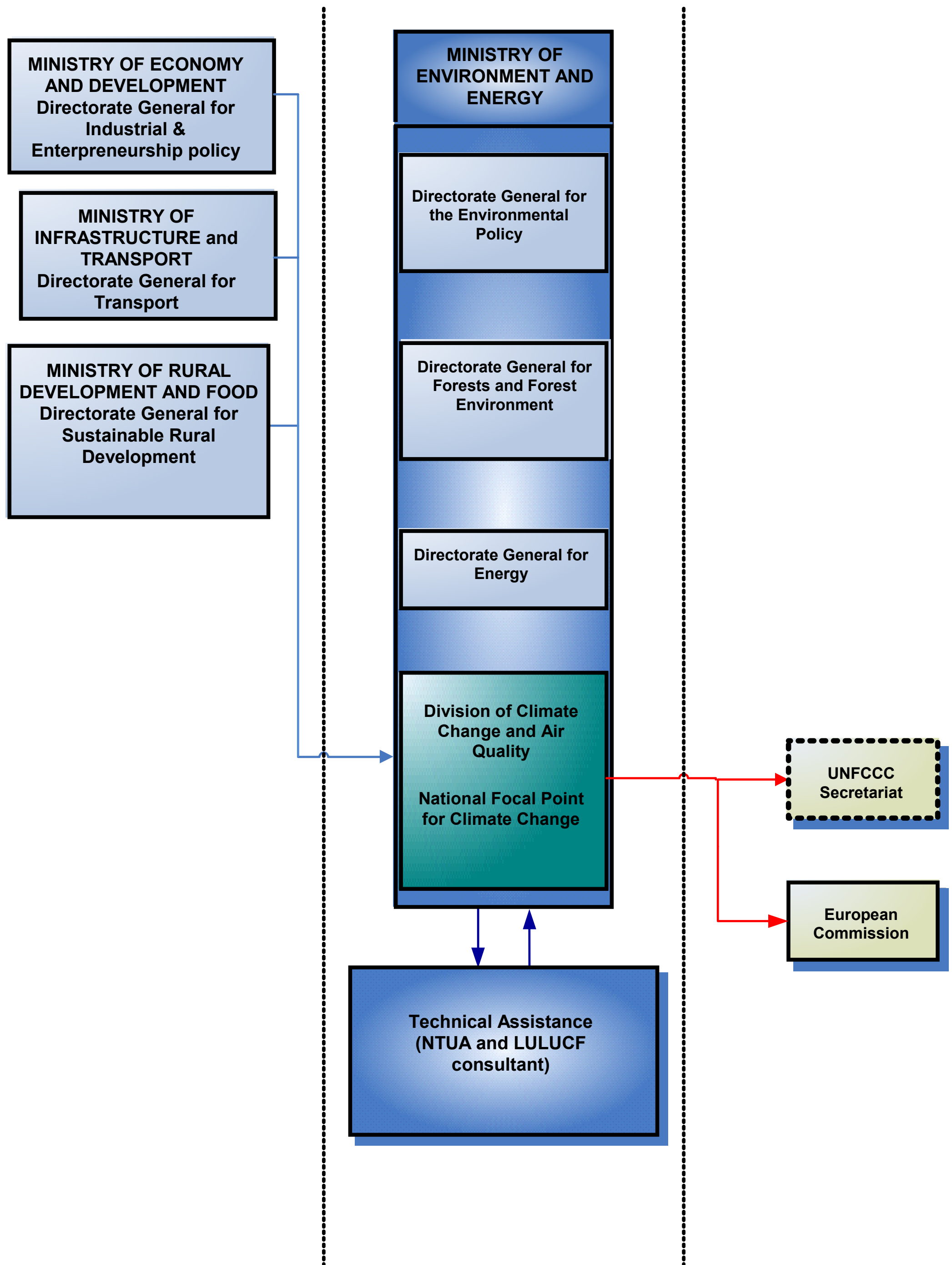

Figure 3.7 Organizational Structure of the National Inventory System

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 consultants (NTUA and LULUCF consultant), who have 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 and LULUCF consultant) 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 Assistants (NTUA and LULUCF consultant). 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 Assistants (NTUA and LULUCF consultant) 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 except LULUCF. With regard to the LULUCF sector the respective responsibilities have been assigned by the MEEN, to an independent consultant, also on a contract basis. In this framework, NTUA and LULUCF consultant have 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
   - ✓ the comparison of the same or similar data from alternative data sources and
   - ✓ time-series assessment in order to identify changes that cannot be explained.
3. 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.
4. Data processing and archiving.
5. Assessment of the consistency of the methodologies applied, inventory improvement – recalculations.
6. Reliability check of results.
7. Key categories analysis.
8. Uncertainty assessment.
9. Preparation of Common Reporting Format (CRF) tables.
10. Preparation of National Inventory Report (NIR).
11. Reporting of the required information according to Regulation 525/2013 of the European Parliament and of the Council and its implementing acts.
12. 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 and LULUCF consultant at the beginning of the next inventory cycle.
13. Development of QA/QC procedures.
14. Implementing the QA/QC procedures under the supervision of MEEN.
15. Training the representatives of data providing agencies on inventory issues.

The NTUA and LULUCF consultant 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 consultants (NTUA and LULUCF Consultant) are responsible for the final decision concerning methodological issues.

The names and contact details of the NTUA inventory team follows:

1. Prof. Ioannis Ziomas, Scientific responsible

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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.

With regard to the LULUCF Consultant, his name and contact details are the following:

1. Iordanis Tzamtzis

Forester, MSc

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FAX: +30 210 7242305

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, included in the above mentioned circular:

- 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 Economy and Development 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 2005-2015 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 consultants) check. The official approval procedure follows for one month period of interactions between the technical consultants (NTUA and LULUCF consultant) 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 consultants 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 consultants (NTUA and LULUCF consultant) 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 (http://www.ypeka.gr/Default.aspx?tabid=470&language=el-GR).

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 and the

LULUCF consultant 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 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***.

Eleven key source categories are found in the energy sector, seven in the IPPU sector, seven in agriculture and two in waste sector in 2015 (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 2015 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 fluctuation 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 fluctuation 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. 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 and LULUCF consultant are 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 3.8*** 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.

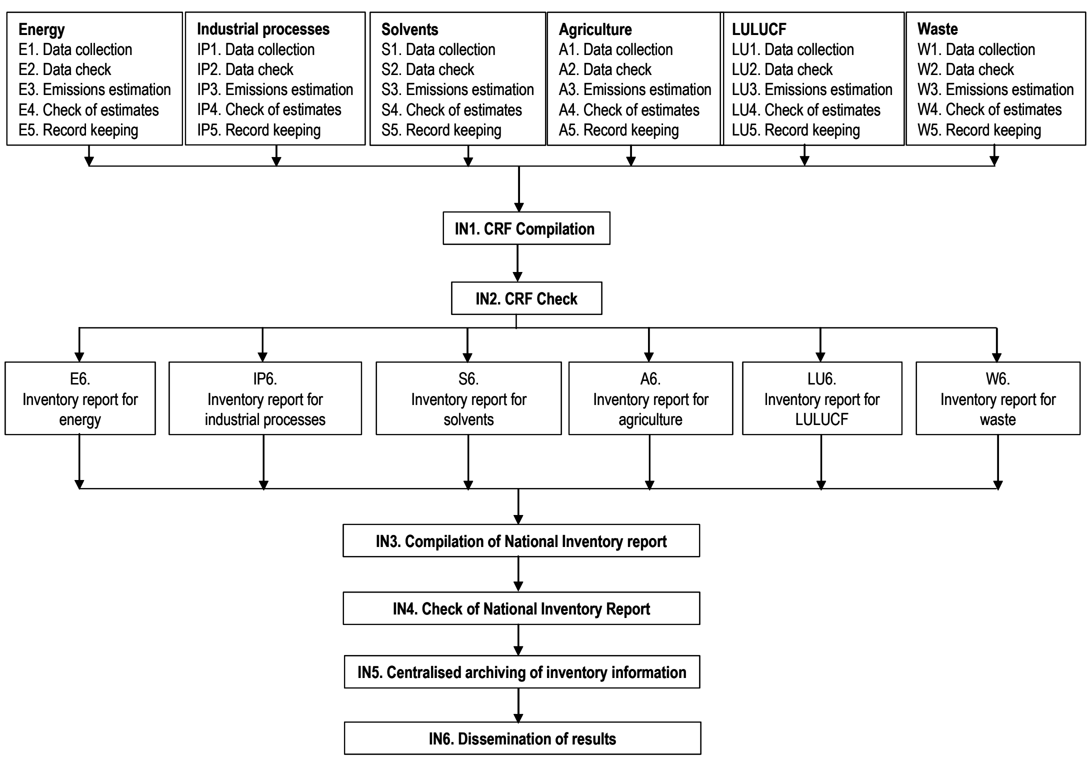


Figure 3.8 Flow chart activities concerning the GHG emissions inventory

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 the MEEN and the NTUA and LULUCF consultant. 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/LULUCF consultant between January and March of each year and audits by independent local experts are planned and implemented.

Each year the EU performs QA/QC checks (called initial checks) to its member states as a part of EU QA/QC system. These tests are performed 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; I 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. Two comprehensive reviews of the Greek inventory (all sectors except LULUCF) have been performed by EU, i.e. in 2012 and 2016.

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 of the inventory holds for one month period of interactions between the technical consultants (NTUA, LULUCF expert) and the Climate Team (MEEN), starting on the 1st of February of the year of submission. During this period, the Technical Assistance has 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 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 I. Markoudakis j. markoudakis@prv.ypeka.gr)

Address: Patission 147

11251 Athens

Greece

Tel: +30.210.86.47.008

(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.

Table 3.5 Changes to the EU national registry in 2015

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	In 2016 new tables were added to the database for the implementation of the CP2 functionality. Versions of the Union registry released after 6.1.6 (the production version at the time of the last NC submission) introduced other minor changes in the structure of the database. These changes were limited and only affected EU ETS functionality. No change was required to the database and 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	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 were successfully carried out prior to each release of a new version in Production. Annex H testing is carried out every year. 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	The mandatory use of hardware tokens for authentication and signature was introduced for registry administrators.
15/CMP.1 Annex II.E paragraph 32.(g) Change to list of publicly available information	Publicly available information is provided via the Union registry homepage for each registry e.g. https://ets-registry.webgate.ec.europa.eu/euregistry/XX/public/reports/publicReports.xhtml
15/CMP.1 Annex II.E paragraph 32.(h) Change of Internet address	No change of the registry internet address occurred during the reporting period.
15/CMP.1 Annex II.E paragraph 32.(i) Change regarding data integrity measures	No change of data integrity measures occurred during the reporting period.
15/CMP.1 Annex II.E paragraph 32.(j) Change regarding test results	Both regression testing and tests on the new functionality are carried out prior to release of the new versions in Production. The site acceptance tests are carried out by quality assurance consultants on behalf of and assisted by the European Commission. Annex H testing is carried out on an annual basis.

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 Economy and Development,	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, Social Security and Social Solidarity and Welfare	Safety in the environment of work – Risk management in professional places
Ministry of the Interior	Natural and technological disasters
Ministry of Finance	Support of environmental investments - – Energy and Environmental taxation
Ministry of Education, Research and Religion Affairs, ,	Environmental education and research
Ministry of Tourism	Touristic 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 are 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 rests with the Council of Ministers.

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 CO_2 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 CO_2, CH_4 and N_2O emissions – 1995 for F - gases). Since the base year emissions of Greece were 106,987,169 t CO_2 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.

As already mentioned, MEEN is responsible 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 over time is 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, re-pealing Decision No 280/2004/EC (Monitoring Mechanism Decision, MMD). The main aims of the new regulation are 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.

A reporting template provided by DG CLIMA / EC (developed by the EEA's European Topic Centre on Air and Climate Change) is used for the monitoring and evaluation of policies and measures, along with additional working files in spreadsheet format. The reporting template is in a spreadsheet format and is organized in working sheets related to information and data about: GHG projections, projection parameters and indicators, policies and measures, summary of results, consistency checks, graphs, etc., as required under Articles 13 and 14 of the MMR and UNFCCC reporting guidelines for national communications (FCCC/CP/1999/7).

Apart from the MMR, the European common and coordinated policies and measures (CCPM) have provisions requiring each member state of the EU to monitor and evaluate the GHG mitigation policies that they cover. For example, pursuant to Energy Efficiency Directive (2012/27/EU), Greece has to report annually on the progress achieved towards national energy efficiency targets. Moreover, by 30 April 2014, and every three years thereafter, Greece has to prepare and submit a National Energy Efficiency Action Plan, which covers significant energy efficiency improvement measures and expected and/ or achieved energy savings, including those in the supply, transmission and distribution of energy as well as energy end-use. Till now, pursuant to 2012/27/EU, but also to End-use Efficiency & Energy Services Directive (2006/32/EC), Greece has submitted three National Energy Efficiency Action Plans in 2007, 2011 and 2014.

As concerns renewable energy sources, pursuant to Directive 2009/28/EC, Greece has to submit a report to the Commission on progress in the promotion and use of energy from renewable sources by 31 December 2011, and every two years thereafter. Pursuant to the same directive, Greece has prepared and submitted to EC in 2010 the National Renewable Energy Action Plan, which sets out Greece' national targets for the share of energy from renewable sources consumed in transport, electricity and heating and cooling in 2020, taking into account the effects of other policy measures relating to energy efficiency on final consumption of energy, and adequate measures to be taken to achieve those national overall targets.

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[2] 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. http://www.ypeka.gr/Default.aspx?tabid=226&language=el-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. http://www.ypeka.gr/Default.aspx?tabid=225&language=el-GR (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. http://www.ypeka.gr/Default.aspx?tabid=775&locale=en-US&language=el-GR (official website of Greek Registry (Union Registry), available in Greek and English).

[2] SEC(2009) 92 Impact Assessment Guidelines: http://ec.europa.eu/smart-regulation/impact/commission_guidelines/docs/iag_2009_en.pdf

4. http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/7383.php (UNFCCC website, containing GHG inventories and NC).

5. Information provided through EU's websites as

   http://cdr.eionet.europa.eu/gr/eu/ghgmm
   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 European Common and Coordinated policies and measures framework, 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.

4.3.1.1 2nd National Climate Change Program

The 2nd National Climate Change Programme, that was elaborated and adopted in 2002 (approved by Act of the Ministerial Council 5/27.02.2003, Official Journal of the Hellenic Republic A' 58 – 05.03.2003) defines the additional policies and measures necessary for Greece to meet its Kyoto target, i.e., restricting the increase of GHG emissions to 25% over the time period 2008–2012, compared to base year emissions. Further information was included in the Greek 6th National Communication.

4.3.1.2 European common and coordinated policies and measures

The European common and coordinated policies and measures (CCPM) constitute a legislative framework that supports and set the targets of the respective national policies for the restriction of GHG emissions. A list of CCPM is presented in ***Table 4.2***.

2020 Climate and Energy Package

In January 2008 the European Commission proposed binding legislation to implement the 20-20-20 targets. These targets, known as the "20-20-20" targets, set three key objectives for 2020:

- A 20% reduction in EU greenhouse gas emissions from 1990 levels. The EU is also offering to increase its emissions reduction to 30% by 2020 if other major economies in the developed and developing worlds commit to undertake their fair share of a global emissions reduction effort;
- Raising the share of EU energy consumption produced from renewable resources to 20%;
- A 20% improvement in the EU's energy efficiency.

This '2020 climate and energy package' was agreed by the European Parliament and Council in December 2008 and became law in June 2009. The core of the package comprises four pieces of complementary legislation:

1. A revision and strengthening of the Emissions Trading System (ETS), the EU's key tool for cutting emissions cost-effectively. A single EU-wide cap on emission allowances will apply from 2013 and will be cut annually, reducing the number of

allowances available to businesses to 21% below the 2005 level in 2020. The free allocation of allowances will be progressively replaced by auctioning, and the sectors and gases covered by the system will be somewhat expanded.

2. An 'Effort Sharing Decision' governing emissions from sectors not covered by the EU ETS, such as transport, housing, agriculture and waste. Under the Decision each Member State has agreed to a binding national emissions limitation target for 2020 which reflects its relative wealth. The targets range from an emissions reduction of 20% by the richest Member States to an increase in emissions of 20% by the poorest. These national targets will cut the EU's overall emissions from the non-ETS sectors by 10% by 2020 compared with 2005 levels.

3. Binding national targets for renewable energy which collectively will lift the average renewable share across the EU to 20% by 2020 (more than double the 2006 level of 9.2%). The national targets range from a renewables share of 10% in Malta to 49% in Sweden. The targets will contribute to decreasing the EU's dependence on imported energy and to reducing greenhouse gas emissions.

4. A legal framework to promote the development and safe use of carbon capture and storage (CCS). CCS is a promising family of technologies that capture the carbon dioxide emitted by industrial processes and store it in underground geological formations where it cannot contribute to global warming. Although the different components of CCS are already deployed at commercial scale, the technical and economic viability of its use as an integrated system has yet to be shown. The EU therefore plans to set up a network of CCS demonstration plants by 2015 to test its viability, with the aim of commercial update of CCS by around 2020. Revised EU guidelines on state aid for environmental protection, issued at the same time as the legislative package was proposed, enable governments to provide financial support for CCS pilot plants.

The climate and energy package does not address the energy efficiency target directly. This is being done through the 2011 Energy Efficiency Plan and the Energy Efficiency Directive. On 25 October 2012, the EU adopted the Directive 2012/27/EU on energy efficiency. This Directive establishes a common framework of measures for the promotion of energy efficiency within the Union in order to ensure the achievement of the Union's 2020 20 % headline target on energy efficiency and to pave the way for further energy efficiency improvements beyond that date. It lays down rules designed to remove barriers in the energy market and overcome market failures that impede efficiency in the supply and use of energy, and provides for the establishment of indicative national energy efficiency targets for 2020.

Greece has to report annually on the progress achieved towards national energy efficiency targets. Moreover, by 30 April 2014, and every three years thereafter, Greece has to prepare and submit a National Energy Efficiency Action Plan, which covers significant energy efficiency improvement measures and expected and/ or achieved energy savings, including those in the supply, transmission and distribution of energy as well as energy end-use. Till now, pursuant to 2012/27/EU, but also to End-use Efficiency & Energy Services Directive (2006/32/EC), Greece has submitted three National Energy Efficiency Action Plan in 2007, 2011 and 2014.

Greek action plans are comprised of horizontal and measures focusing to the residential, tertiary (public and private), non-ETS industry and transport sector. These measures are presented in ***Table 4.3***.

As a member of the European Union, in compliance with the Directive 2012/27/EU, Greece was required to set a TFC (total final consumption) target for 2020. This target established the basis for energy efficiency policies and measures across the Greek economy. The target set by Greece was 18.4 million tonnes of oil equivalent (Mtoe), which represented a 12% reduction on energy consumption levels in 2005. However, due to the financial and economic crisis, TFC fell to 16.4 Mtoe in 2015, 11% below the 2020 reduction target. It is unlikely that energy use in Greece will increase to a point where it will not be able meet its 2020 target, even under optimistic economic growth forecasts.

A key component of Greece's compliance with the Energy Efficiency Directive is Article 7, in which EU member states are required to ensure that energy savings of 1.5% per year are achieved by energy suppliers and distributors due to the implementation of targeted policy measures. Greece has to achieve cumulative energy savings of 3,332.7 thousand tonnes of oil equivalent (ktoe) by 2020 through the implementation of energy efficiency policy measures, as part of its compliance with the above article. These savings are separate to the economy-wide TFC target.

2030 Climate and Energy Framework

This framework was agreed by EU leaders in October 2014 and builds on the 2020 climate and energy package mentioned above. It sets three key targets for the year 2030:

- ✓ At least 40 % cuts in greenhouse gas emissions (from 1990 levels). To achieve this, EU ETS sectors would have to cut emissions by 43 % (compared to 2005), and the ETS will be reformed and strengthened to achieve this. Non-ETS sectors would need to cut emissions by 30 % (compared to 2005), and this will need to be translated into individual binding targets for Member States
- ✓ At least 27 % share of EU energy consumption for renewable energy
- ✓ At least 27 % improvement in energy efficiency.

The framework is in line with the longer-term perspective set out in the Roadmap for moving to a competitive low carbon economy in 2050, the Energy Roadmap 2050 and the Transport White Paper.

The framework will be underpinned by a new and transparent governance process that will ensure the targets outlined above to be met in an effective and coherent manner. This governance process will be based on national plans for competitive, secure, and sustainable energy but will follow a common EU approach.

The European Commission has proposed a number of actions to help deliver the framework and the 2030 targets, including a reformed EU ETS, a new Effort Sharing Regulation, and a proposal to integrate greenhouse gas emissions and removals from land use, land use-change and forestry (LULUCF) into the 2030 climate and energy framework. At the time of the preparation of the NC7, the decision-making procedure related to these regulations in the council and Parliament was ongoing.

Table 4.2 European common and coordinated policies and measures (CCPM)

CCPM
Cross Cutting Polices and Measures • The EU Emissions Trading System (2003/87/EC amended by 2009/29/EC) • The Effort Sharing Decision (Decision No 406/2009/EC) • Carbon Capture and Storage Directive (2009/31/EC) • Monitoring Mechanism Regulation (Regulation No 525/2013) • Energy Taxation Directive (2003/96/EC) • Horizon 2020 • European Structural and Investment Funds (ESIF) • National Emissions Ceilings Directive (2016/2284/EU) • Covenant of Mayors for climate and energy

- Proposal for a revision to Directive 2003/87/EC to enhance cost-effective emission reductions and low-carbon investments (COM (2015) 337 final)
- Proposed Regulation on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 for a resilient Energy Union (COM(2016) 482 final)

Sectoral policies and measures: Energy

- Directive 2009/28/EC on the promotion of the use of energy from renewable sources
- Directive 2010/31/EU on the energy performance of buildings
- Directive 2012/27/EU on energy efficiency
- Directive 2009/125/EC establishing a framework for the setting of eco-design requirements for energy- related products
- Directive 2010/30/EU on the indication by labelling and standard product information of the consumption of energy and other resources by energy- related products
- Proposal for a Regulation setting a framework for energy efficiency labelling and repealing Directive 2010/30/EU
- Green Public Procurement
- Energy Star Programme
- EU Project Development Assistance (PDA) Facilities
- European Energy Efficiency Fund (EEEF)
- European Regional Development Fund (ERDF)
- MotorChallenge Programme
- Strategic Energy Technology Plan (COM(2007) 723)
- Energy Union Strategy (COM(2015) 80 final)
- Biomass Action Plan
- Communication on Accelerating Clean Energy Innovation (COM(2016) 763 final)
- Communication on Ecodesign Working Plan (COM(2016) 773 final)
- Proposals for revised Energy Efficiency Directive (COM/2016/0761 final)
- Proposal for revised Energy Performance of Buildings Directive (COM/2016/0765 final)
- Proposal for revised Renewable Energy Directive (COM(2016) 767 final/2)
- Commission Implementing Decision on energy labelling, in support of and as regards: Commission Delegated Regulation (EU) 2015/1186, Commission Regulation (EU) 2015/1188, Commission Regulation (EU) 2015/1185
- EU heating and cooling strategy (COM(2016) 51 final)

Sectoral policies and measures: Transport

- CO2 and Cars Regulation (EC 443/2009)
- CO2 and Vans Regulation (EC 510/2011)
- Strategy for reducing Heavy-Duty Vehicles' fuel consumption and CO2 emissions
- Car and tyre labelling Directives (1999/94/EC and EC 1222/2009 respectively)
- Regulation of Safe motor vehicles and trailers (EC 661/2009)
- Renewable Energy Directive (2009/28/EC)
- Fuel Quality Directive (2009/30/EC)
- Infrastructure charging for heavy goods vehicles (1999/62//EC, amended by 2006/38/EC and 2011/76/EU)
- Directive 2014/94/EU on Deployment of Alternative Fuels Infrastructure
- Clean Vehicles Directive (2009/33/EC)
- Integrating maritime transport emissions in the EU's greenhouse gas reduction policies (COM(2013) 479 final and Regulation (EU) 2015/757)
- White Paper: Roadmap to a Single European Transport Area COM(2011) 144 final
- A European Strategy for Low-Emission Mobility (COM(2016) 501 final)
- Electromobility initiative, Green eMotion
- Fuel Cells and Hydrogen Joint Undertaking (JU)

Sectoral policies and measures: Industry / industrial processes

- Mobile Air Conditioning Systems (MAC) Directive (Directive 2006/40/EC)
- Fluorinated greenhouse gases regulation (Regulation (EU) No 517/2014)
- Industrial Emissions Directive 2010/75/EU (IED)

Sectoral policies and measures: Agriculture

- Agricultural Market and Income support (1st pillar of Common Agricultural Policy / CAP)
- Rural Development Policy (2nd pillar of CAP)
- Soil Thematic Strategy (COM(2006) 231)
- Nitrates Directive (91/676/EEC)

Sectoral policies and measures: Waste

- Directive on Waste (2008/98/EC)
- Landfill Directive (1999/31/EC)
- Management of biodegradable waste (COM/2008/0811 final)
- Urban Waste Water Directive (91/271/EEC)
- Directives on end-of-life vehicles (2000/53/EC)
- EU action plan for the Circular Economy (COM(2015) 614 final)
- Motor Vehicles Directive (2005/64/EC)
- Directive on batteries and accumulators and waste batteries and accumulators (2006/66/EC)
- Directive on waste electrical and electronic equipment (2012/19/EU)
- Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment (Directive 2011/65/EU)
- Packaging and Packaging Waste Directive ((EU) 2015/720 regarding 94/62/EC)
- A legislative proposal on online sales of goods (December 2015)
- A legislative proposal on fertilisers (March 2016)
- Launch of the Innovation Deals for a circular economy (May 2016)
- Ecodesign Working Plan 2016-2019 (COM(2016) 773 final)
- Establishment of the EU Platform on Food Losses and Food Waste (August 2016)
- A Communication on waste-to-energy processes and their role in the circular economy (January 2017).

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 CO2 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 CO2 emissions that are to be allocated to installations included in the EU-ETS (including the reserve) were fixed to 341.547.710 t CO2, 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 CO2 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 presented in July 2015 a legislative proposal 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 new ETS package aims to further develop predictable, robust and fair rules to address the risk of carbon leakage; provide support mechanisms to help the industry and the power sector meet the innovation and investment challenges of the transition to a low-carbon economy. At the time of the preparation of the NC7, the decision-making about ETS package was ongoing in the EU Council and Parliament.

Table 4.3 Energy Efficiency National Action Plan Measures

Horizontal Measures
H1. Information system for monitoring energy efficiency improvement and achieved energy savings
H2. Programmes to provide financial support for investment in energy-saving technologies and research
H3. Tax exemptions of energy savings interventions
H4. Implementation of an energy management system (EMS) in the tertiary and public sectors
H5. Bioclimatic upgrades of public open spaces
H6. Green rural and island communities - New development model
Residential and Tertiary Private Sector Buildings
R1. Regulation on the Energy Performance of Buildings
R2. 'Saving Energy at Home'
R3. Mandatory installation of solar thermal systems in new residential buildings.
R4. Energy upgrading of social housing buildings- 'Green Pilot Urban Neighbourhood' programme
R5. Compulsory installation of solar thermal systems in tertiary sector buildings
R6. Strengthening SMEs active in manufacturing, tourism and trade - services'.
Tertiary Public Sector
PS1. Integrated energy planning by local authorities and Covenant of Mayors
PS2. Energy saving interventions in public buildings
PS3. Interventions for improving energy efficiency in school buildings
PS4. Green flat roofs in public buildings
PS5. Compulsory installation of central solar thermal systems to meet hot water requirements
PS6. Compulsory replacement of all low energy efficiency light fittings in the public sector and the wider public sector
PS7. Intelligent Nearly Zero Energy Theme Museums

	PS8. Energy managers in public sector and general government buildings
Industry	
	I1. Relocation of enterprises to industrial-business zones and business parks
	I2. Innovative Entrepreneurship, Supply Chain, Food, Beverages
	I3. Green Enterprise
	I4. Support for improving energy efficiency in manufacturing enterprises
Transport Sector	
	T1. Reshaping of the public transport system
	T2. Transport infrastructure projects
	T3. Development of urban mobility plans
	T4. Promotion of economical, safe and eco-driving.
	T5. Incentives for the replacement of private vehicles and to promote the use of energy-efficient vehicles (vehicles fuelled by natural gas and biofuels and hybrid vehicles)
	T6. Eco-labelling – Energy label for cars
	T7. Compulsory quotas of vehicles with greater energy efficiency in the fleets of the public services and of public bodies
	T8. Linking of vehicle taxation to energy efficiency and CO2 emissions
	T9. Replacing old public and private light trucks
	T10. Replacing old private passenger vehicles
	T11. Promotion of CNG and LPG-powered passenger vehicles
	T12. Introduction of electric vehicles and electric vehicle recharging points
Efficient heating and cooling systems	
	H1. Installation of high-efficiency cogeneration of heat and power (CHP) systems with natural gas in hospitals
	H2. Installation of CHP systems

Aviation

CO2 emissions from aviation have been included in the EU emissions trading system (EU ETS) since 2012. Under the EU ETS, all airlines operating in Europe, European and non-European alike, are required to monitor, report and verify their emissions, and to surrender allowances against those emissions. They receive tradeable allowances covering a certain level of emissions from their flights per year. The system has so far contributed to reducing the carbon footprint of the aviation sector by more than 17 million tonnes per year, with compliance covering over 99.5% of emissions.

In addition to market-based measures like the ETS, operational measures – such as modernising and improving air traffic management technologies, procedures and systems – also contribute to reducing aviation emissions.

The EU legislation, adopted in 2008, was designed to apply to emissions from flights from, to and within the European Economic Area (EEA) – the 28 EU Member States, plus Iceland, Liechtenstein and Norway. The European Court of Justice has confirmed that this approach is compatible with international law. The EU has, however, decided to limit the scope of the EU ETS to flights within the EEA until 2016 to support the development of a global measure by the International Civil Aviation Organization (ICAO).

In light of the progress on the global measure (see below), the European Commission has proposed to continue the current approach beyond 2016. This proposal will now be considered by the European Parliament and the Council of the European Union.

In October 2016, the International Civil Aviation Organization (ICAO) agreed on a Resolution for a global market-based measure to address CO2 emissions from international aviation as of 2021. The agreed Resolution sets out the objective and key design elements of the global scheme, as well as a roadmap for the completion of the work on implementing modalities. The Carbon Offsetting and Reduction Scheme for International Aviation, or CORSIA, aims to stabilise CO2 emissions at 2020 levels by requiring airlines to offset the growth of their emissions after 2020.

Airlines will be required to monitor emissions on all international routes; offset emissions from routes included in the scheme by purchasing eligible emission units generated by projects that reduce emissions in other sectors (e.g. renewable energy).

During the period 2021-2035, and based on expected participation, the scheme is estimated to offset around 80% of the emissions above 2020 levels. This is because participation in the first phases is voluntary for states, and there are exemptions for those with low aviation activity. All EU countries will join the scheme from the start.

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

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 Program Guide in October 2011 and the total commitments-absorptions in 2011 amounted to EUR 60 million, while funding programs 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 + program consists of two subprogrammes, one for Environment and one for Climate Action.

Since the launch of the LIFE programme by the European Commission in 1992, a total of 240 projects have been cofinanced in Greece. Of these, 153 focus on environmental innovation, 70 on nature conservation and 11 on information and communication. Within the framework of the new LIFE programme, one capacity-building project has been funded, as well as three on Climate Change Adaptation and two on Climate Change Mitigation. All these projects since 1992 represent a total investment of over €327 million, of which over €175 million has been contributed by the European Union.

Except for the traditional projects, the LIFE programme includes several new types of projects e.g.integrated, technical assistance, capacity-building and preparatory. 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.

According to the **PA (Partnership Agreement for the Development Framework) 2014-2020**, which constitutes the main strategic plan for growth in Greece with the contribution of significant resources originating from the European Structural and Investment Funds (ESIF) of the European Union, the following financing priorities have been identified:

1. Enhancing business competitiveness and extroversion, shifting to qualitative entrepreneurship spearheaded by innovation and higher domestic added value
   - ➢ Transition to high added value activities
   - ➢ Creation of a business friendly environment to attract investments
   - ➢ Capitalising on research and innovation to strengthen the competitiveness of new and existing businesses
2. Development and utilisation of human resource abilities – active social inclusion
   - ➢ Education and life-long learning
   - ➢ Development of human resources and access to employment focusing on the creation of jobs, especially for young people
   - ➢ Promotion of social inclusion and combating poverty
3. Protection of the environment – Transition to a more environmentally friendly economy
   - ➢ Protection of the environment
   - ➢ <u>Fostering climate change adaptation and risk prevention</u>
   - ➢ <u>Shift to a low carbon economy</u>
4. Development – modernisation – completion of infrastructures for economic and social growth
   - ➢ Transport networks focusing on the completion of the Trans-European Transport Networks, with vertical axes and multi-modal transport
   - ➢ Energy networks
   - ➢ Broadband networks
5. Improvement of the institutional capacity and the efficiency of public administration and local government

The **Operational Programme for “Transport Infrastructure, Environment and Sustainable Development”** encompasses more than one sector and fund (ERDF and CF) and through these Funds mainly finances core transport and environment infrastructures. A part of the budget pertains to the environment and specifically the Cohesion Fund and is assigned to 13 ROPs, in order to be managed by the Regions for the implementation of mainly liquid waste management projects. The objectives of the Transport Infrastructure, Environment and Sustainable Development 2014-2020 OP with respect to transport consist of promoting the completion of the infrastructure of the core TEN-T (road, rail, ports, airports), promoting combined transport and modernization of the transport system, enhanced road safety, as well as the development of sustainable and ecological urban transport (fixed trajectory urban transport) to enhance sustainable urban mobility. With respect to the environment, it aims to implement important environmental projects and provides compliance to the European Environmental acquis mainly in the sectors of solid waste, waters and waste waters and biodiversity; it focuses on the tackling of climate change and flood risk prevention and management; it undertakes focused actions in reducing environmental pollution and in particular air pollution and noise; and it promotes sustainable urban development and promotes smart energy efficiency projects in public buildings and broader use of teleheating.

The expected impacts of the OP in relation to transport:

- an additional double railway of 161km on the PATHE-P axis, smaller travel times by road between Athens, Thessaloniki and Patra as well as numerous other road trajectories
- the reduction of pollution and greenhouse effects via transportation in the major urban areas (Athens: minus more than 95,000 tons of CO2 equivalent, Thessaloniki: minus 67,000 tonnes of CO2 equivalent)
- a significant increase in the additional serviced population by electrified fixed trajectory public transportation (719,000 in Athens and 580,000 in Thessaloniki)
- serious reductions in the risk of fatal road accidents
- a yearly reduction of greenhouse gases due to Metro works by 67,126 tonnes of CO2 equivalent; 14.40km of new lines of Metro in Thessaloniki alone.

Relating to environment:

- integrated solid waste management throughout the whole waste cycle by increasing the recycling of approximately 650 thousand tonnes per year
- an increase in the population served by waste water treatment facilities by 661,000 p.e
- an increase in the protected Natura 2000 areas by 80%
- a decrease in the annual primary energy consumption of public buildings by 49m kWh/year
- covering all Greece with flood risk management plans.

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.

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

Table 4.4 Excise duty rates for specified products

Excise duties (euro)		
Energy products	**2017**	**Imposition Unit**
Leaded Petrol	681	1000 lt
Unleaded Petrol	700	1000 lt
Gasoil[3]	410	1000 lt
Kerosene[4]	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[5]	60	1000 kg
Natural gas for propellant use	0	GJ
Natural gas heating fuel for business use[6]	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 voltage	2.5	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, Article 121 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 (***Table 4.5a***), CO2 emissions per km (***Table 4.5b***) and the anti-pollutant technology of the vehicle. Concerning the antipollution technology of the motor vehicle:

- if it meets the requirements of the preceded by the current valid European Emission Standard (EURO), the registration tax rates of Table 4.5a are increase by 50%;

- if it does not meet the requirements of both the current and preceded European Emission Standard (EURO), the registration tax rates of Table 4.5a are increase by 200%;

- if it does not meet the requirements of European Emission Standard (EURO) and there is no legal proof of the emissions of carbon dioxide, the registration tax rates of Table 4.5a are increase by 500%.

[3] 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.

[4] 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.

[5] Industrial/Commercial use / stationary motors: 120 EURO / 1000kg

[6] 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

Hybrid cars are subject to 50% of the registration tax, while electric cars are not subject to registration tax.

Table 4.5a Registration tax rates

Taxable price (Euros)	Registration tax rate
Up to 14,000	5%
14,000-17,000	8%
17,000-20,000	16%
20,000-25,000	24%
25,000 and above	32%

Table 4.5b Modification of registration tax rates according to CO2 emissions

CO2 emissions (g/km)	Modification of rate
Up to 100	decrease by 5%
120-140	increase by 10%
140-160	increase by 20%
160-180	increase by 30%
180-200	increase by 40%
200-250	increase by 60%
250 and above	increase by 100%

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 4.6a Road tax for cars registered till 2000

Category	Engine size (cc)	Annual road tax (euros)
Α	Up to 300	22
Β	301-785	55
Γ	786-1071	120
Δ	1072-1357	135
Ε	1358-1548	225
ΣΤ	1549-1738	250
Ζ	1739-1928	280
Η	1929-2357	615
Θ	2358-3000	820
Ι	3001-4000	1025
Κ	4001 and above	1230

Table 4.6b 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
ΣT	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 4.6c 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
ΣT	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 4.6d Road tax for cars registered after 1.11.2010

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

Hybrid cars 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 100 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 Policies and Measures and their effects

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 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. ***Tables 4.13*** present estimates of the expected effects of these policies and measures in the time horizon of the years up to 2035. An ex-post estimation of the effect of policies for year 2005, 2010 and 2015 is also included.

The total realistic quantifiable GHG emissions reduction potential from the implemented and adopted policies and measures was estimated to be 34.8Mt CO2eq for 2020. 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 paragraph 5.1).

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 NC6 and/or BR2 has been followed for the estimation of the mitigation effect of the policies. Any change of the mitigation effect of the policies compared to NC6 and/or BR2 is attributed to a change of the WM scenario.

4.3.2.2 Sectoral policies and measures: Energy

4.3.2.2.1 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 28% in power generation and 15% in the total primary energy supply (TPES) in 2016, 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 half of the total gas consumption in 2015. This share has fallen from levels of around 70% a decade earlier. The decline in natural gas consumption is mainly due to reduced gas power generation, which fell by over half from a peak at 13.9 terawatt hours (TWh) in 2011 to 6.8 TWh in 2014, but increased to 9.1 TWh in 2015, representing 18% of the total power generation. The fall in total electricity generation (12% from 2011 to 2015) and the growth in renewable energy sources (81% from 2011 to 2015), which have replaced natural gas in the power mix, have resulted in a reduction in gas power generation.

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 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.

Natural gas (0.7 PJ in 2015) is also consumed in the transport sector, where natural gas moving buses have already been placed in the public transportation system of Athens.

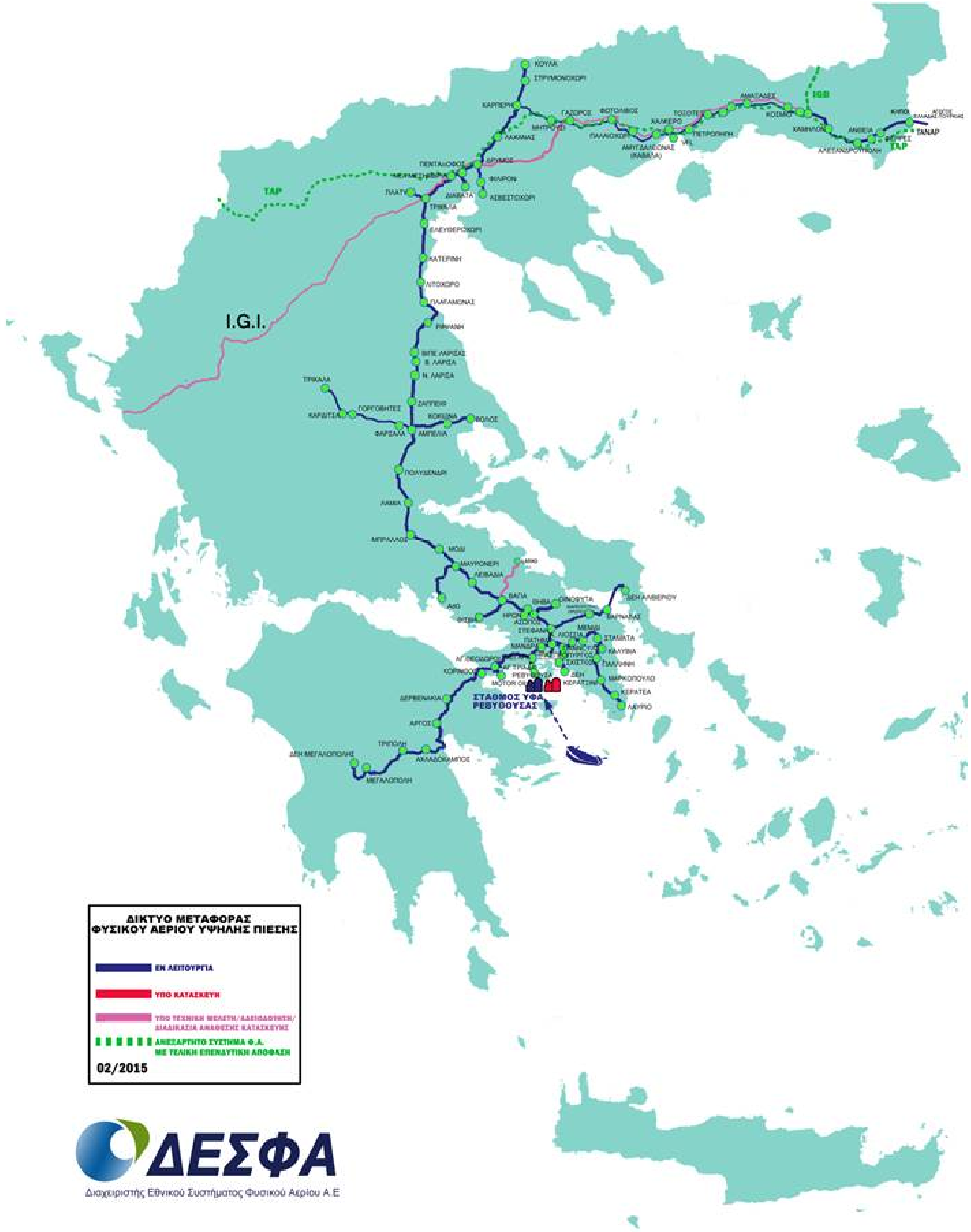


Figure 4.1 Greek National Natural Gas System

In ***Table 4.7*** the achieved (2010 and 2015) and the anticipated (2020, 2030 and 2040) penetration of natural gas in the national energy system is presented. The 2010 and 2015 figures are obtained from the national energy balance and the 2020-2040 are according to the "with measures" projections scenario. In 2015 the installed capacity for electricity production from natural gas was 3,972 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 and projections according to WM scenario

Sector	2010	2015	2020	2030	2040
Power sector	86.3	55.1	89.9	55.7	48.4
Road transport	0.6	0.6	0.6	0.7	1.6
Industry	15.6	18.1	24.5	40.3	57.1
Commercial	5.8	6.9	14.1	24.0	30.6
Residential	10.7	14.9	17.0	20.4	23.9

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	2035
Industry	Implemented / adopted	671	861	1094	1375
Residential	Implemented / adopted	304	330	366	400
Tertiary	Implemented / adopted	250	350	430	490
Road	Implemented / adopted	17	20	22	24

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%).

4.3.2.2.2 Improvements in the conventional power generation system

Electricity demand (in terms of production plus net imports) decreased by 16% from 2008 to 2016 due to the economic crisis. Lignite is the dominant fuel in the generation mix, followed by natural gas and renewable energy sources (solar and wind). The largest electricity consuming sector is the commercial sector, followed by the residential 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 19% of the total generation in 2016.

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. 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 11.7 Mt CO2eq in 2020; 5.5 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%).

4.3.2.2.3 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) and 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%.

The progress that Greece has made per sector target is presented in ***Table 4.9*** and ***Figure 4.2***. Greece is on track to achieve its target for gross final energy consumption for 2020. As concerns the indicative sector targets, the targets for renewable heating and cooling with shares of around 26% are above 2020 expected shares, while renewable transport is lagging with 1.4% against the 10% target.

Table 4.9 Progress made towards 2020 RES targets (%)

Sector	2011	2012	2013	2014	2015
RES – heating and cooling	20.23	24.43	24.43	26.85	25.90
RES – electricity	13.82	16.48	16.48	21.92	22.09
RES - transport	0.74	1.06	1.04	1.37	1.43
RES - total	11.03	13.83	14.99	15.32	15.44

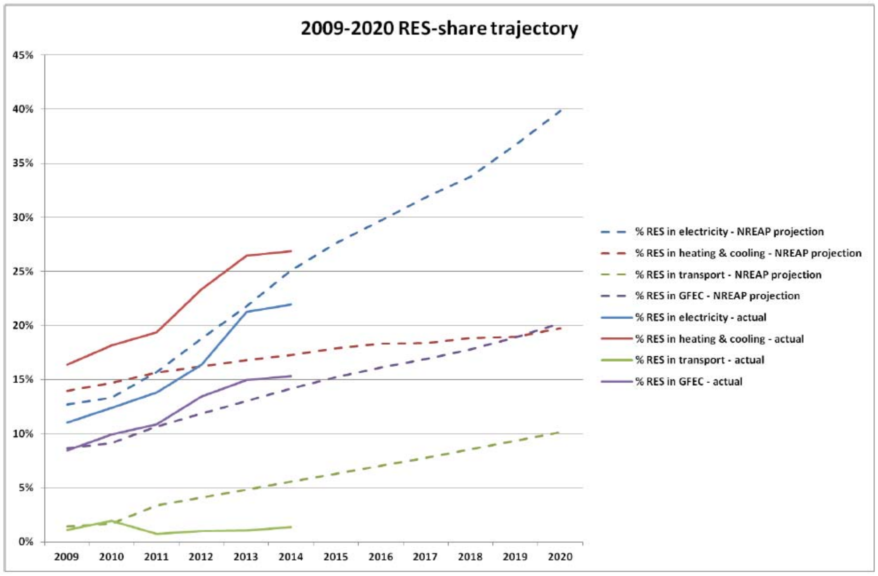


Figure 4.2 RES share trajectory from 2009 to 2020

Electricity

Renewable energy sources reached a share of 31% of electricity generation in 2016. 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 62.9 terawatt hours (TWh) in 2008 and has fallen by 22% since then.

Wind power generation increased from negligible levels in the late 1990s to 5.1 TWh in 2016, equal to 10.5% of the total electricity generation. Solar power has had an even more impressive growth, experiencing a nearly twenty-five-fold increase from 0.16 TWh in 2010 to 3.9 TWh in 2016. Hydro power has consistently accounted for the largest share of renewable electricity, but with substantial annual fluctuations. Hydro power production was 5.5 TWh in 2016, equal to 11.4% 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.

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 3 gigawatts (GW) thermal capacity of 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 1.6 TWh). Greece has installed 2 MW electrical from biomass, with seven plants.

Transport

Only a small share of biofuels is used for transport (11%), while the largest share (58%) is used by the residential sector. Biofuels accounted for 2.5% of the final energy consumption in the transport sector in 2015.

Total consumption of biofuels in the transportation sector amounted to 161 thousand tonnes in 2015. Biofuels are mainly first-generation biodiesels produced from raw materials such as oil seeds, mainly sunflower, used cooking oils, and cottonseed. Six thousand tonnes were produced from waste and residues. There are 16 biodiesel producers (125 600 kilolitres (kL)) and six importers (6 400 kL).

Law 3851/2010 set a binding target for renewable energy sources to provide 10% of the final energy in transport by 2020. Greece issued legislation in 2016 to align the Greek biofuels sustainability certification with other EU member states. The share of certified biofuels is expected to rise significantly when all biodiesel quantities distributed in the Greek market will be verified as sustainable as of 1 October 2016 when the new system became effective.

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 new 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 15 Mt CO2eq in 2020 and 25 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 960 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%).

4.3.2.2.4 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 300 kt CO2 eq in 2020. The affected GHG from this policy is mainly CO2 (more than 99%).

4.3.2.2.5 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 ***Tables 4.10 and 4.11***, the energy efficiency measures related to residential and tertiary sector are presented. It is estimated that the mitigated GHG emissions from the implemented and adopted policies and measures of the Energy Efficiency National Action Plan that are related to the residential and tertiary sector are estimated at 2.9 Mt CO2eq for 2020. The affected GHG from the measures described in this section is mainly CO2 (more than 99%).

Table 4.10 Energy efficiency measures in the residential and tertiary sector buildings (source: 3rd National Energy Efficiency Action Plan)

Title of measure	End-use targeted	Duration	Brief description
Regulation on the Energy Performance of Buildings	Specifications on the design, envelope and electromechanical installations of buildings	Start: 2010	The regulation on the energy performance of buildings (KENAK) introduced an integrated energy design in the sector of buildings to improve the energy efficiency of buildings, energy savings and environmental protection through specific actions: 1. Preparation of a study on the Energy Performance of Buildings 2. Establishing of minimum requirements for energy efficiency in buildings 3. Energy Rating of Buildings (Energy Performance Certificate) 4. Energy inspections to buildings, boilers and heating and air conditioning systems The Study on the Energy Performance of Buildings replaces the study on heat insulation and is be prepared for every new or existing building (over 50m2), which undergoes a complete renovation and is be based on a specific methodology covering: (a) the requirement to meet minimum standards on the design, envelope and electromechanical installations of buildings and (b) its comparison with the reference building. Reference building means a building with the same geometry, position, orientation, use and operating characteristics as the building concerned, which also meets minimum standards and has specific technical characteristics. The Energy Performance Certificate is valid for ten years and applies to all buildings with a surface area of more than 50m2, either new or existing, which undergo complete renovation, existing buildings with a surface area of more than 50m2 or parts thereof, when they are sold or leased, and all public sector buildings. The requirement for an Energy Performance Certificate in case of purchase, sale and lease of buildings, applies as of 9 January 2011. The Energy Performance Certificate includes, among other things, the results of the evaluation by the energy inspector and recommendations for improving the energy efficiency of the building, so that consumers are able to compare and evaluate their actual consumption and any opportunities for improving energy performance. The issue of certificate is mandatory. Energy inspection is an important tool for identifying the energy condition of existing buildings and its potential for improvement, as well as for verifying the implementation of legislation on energy efficiency of new buildings. A private energy inspector, who is in the MEEN Energy Inspectors Register, must inspect the building and place it in an energy category based on the ratio of the building's consumption to the reference building's consumption.

Title of measure	End-use targeted	Duration	Brief description
'Saving Energy at Home'	Energy consumption for domestic hot water, heating-cooling	Start: 2011	The 'Saving Energy at Home' programme aims at providing financial incentives for energy-saving interventions in the residential building sector with a view to reducing energy needs. The types of housing that can be subsidised by the programme are: • Single-family houses • Apartment blocks - for the part of the block which relates to all the apartments in the building • Individual apartments The types of apartments must meet the following criteria: • must be located in areas with a price band lower or equal to EUR 2 100/m2, as this has been designated until 31 December 2009; • must have a building permit; • must be included under the Energy Performance Certificate (EPC) in class D or lower; • must not have been scheduled to be demolished. The proposal (combination of interventions) for energy upgrade which is submitted with the application should cover the following requirement which is the minimum energy objective of the Programme: it must upgrade by at least one energy class or, alternatively, provide an annual primary energy savings greater than 30% of the reference building consumption (kWh/m2). The eligible categories of interventions for improving energy efficiency are: 1. Replacing window frames / glass panes and installing shading systems 2. Installing thermal insulation in the building envelope, including the roof and pilotis (open parking space in place of the ground floor) 3. Upgrading the heating and domestic hot water system
Mandatory installation of solar thermal systems in new residential buildings.	Energy consumption for domestic hot water	Start: 2011	Solar thermal systems will replace 50-100% of conventional fuels and electricity, depending on the climatic conditions in each area, the load and the position of the building.
Energy upgrading of social housing buildings- 'Green	Total energy consumption	Start: 2011	The objective of the programme is to upgrade four industrial buildings to nearly zero energy buildings and optimise the local microclimate. The programme will present the pilot-demonstration and innovative implementation of

Title of measure	End-use targeted	Duration	Brief description
Pilot Urban Neighbourhood' programme			integrated development and implementation of green and sustainable urban housing units, which are occupied by low-income citizens, and are part of an optimized urban environment. Main criteria for the selection of neighbourhoods was the economic level of residents, the potential energy savings in the buildings and the prospects for significant improvement of the local microclimate.
Compulsory installation of solar thermal systems in tertiary sector buildings	Energy consumption for domestic hot water	Start: 2011	Solar thermal systems will replace 50-100% of conventional fuels and electricity, depending on the climatic conditions in each area, the load and the position of the building.
Strengthening SMEs active in manufacturing, tourism and trade - services'	Total energy consumption	Start: 2013	The programme 'Strengthening SMEs active in manufacturing, tourism and trade - services' aims to provide support to micro-enterprises, small and medium-sized enterprises, whether they are existing, new or in the process of being established, which are making investments which are oriented towards innovations, the environment and information technology.
Energy labelling of appliances and minimum energy efficiency requirements	Energy consumption of electrical and electronics appliances	Start: 2008	Energy labelling of appliances is aimed at informing consumers about the electricity consumption and the energy efficiency rating of these appliances, and the requirement for a minimum energy efficiency of appliances ensures a significant reduction of both energy and environmental costs incurred by consumers.
"Changing my old air-conditioner" action	Energy consumption for cooling	Start: 10/6/2009 End: 22/8/2009	The "Changing my old air-conditioner" action involves the provision of subsidies for replacing and recycling of old, energy-intensive household air conditioners. The action is addressed to all citizens/consumers who have old household air conditioners in operation and wish to replace them. Devices which may be replaced include all types of old air conditioners (regardless of year of construction). Every consumer may replace up to two (2) air-conditioners and buy new ones, of inverter-type and high energy class, from any air conditioner store participating in the action.

Table 4.11 Energy efficiency measures in the public tertiary building sector (source: 3rd National Energy Efficiency Action Plan)

Title of measure	End-use targeted	Duration	Brief description
Integrated energy planning by local authorities	Total energy consumption of the target group Fuel consumption in transport	Start: 2009	The ‘ENERGY EFFICIENCY’ programme is made up of the following selected priority axes: Axis 1: Interventions to existing municipal buildings • Energy upgrade of the building envelope (exterior insulation, replacement of glazing and window frames, installing roofing, awnings and special coatings to provide protection from the sun) • Energy upgrade of electro-mechanical heating and cooling installations • Upgrade of the natural/ artificial lighting system • Installing an energy management system Axis 2: Interventions to public areas of the urban environment • Integrated energy saving and management interventions in municipal lighting • Bioclimatic interventions to improve microclimate and energy efficiency in urban areas. Axis 3: Interventions in urban transport • Interventions in municipal fleet vehicles to improve their energy efficiency • Urban mobility studies • Transport studies Axis 4: Interventions in municipal technical infrastructure Axis 5: Dissemination, networking and information actions The following actions are financed by the ‘ENERGY EFFICIENCY’ programme: (1) Energy upgrade of the building envelope, including all relevant operations • Installing thermal insulation (building envelope, bearing structure, flat roof, roof, floor, walls) • Replacing old windows, doors, window frames and glass panes • Use of special coatings (cool materials) on roofs and facades • Installing external shading • Natural/night ventilation • Installing/integrating passive solar systems (2) Energy upgrade of electro-mechanical installations, including all relevant operations • Upgrade of the central heating system, including compensation systems in the burner-boiler in combination with pipe insulation • Upgrade of the air-conditioning system

Title of measure	End-use targeted	Duration	Brief description
			• Upgrade of pumps-motors • Mechanical ventilation • Hybrid ventilation with ceiling fans • Installation of renewable energy systems to cover heat loads (solar thermal systems, shallow geothermal energy, etc.) (3) Upgrade of the natural/ artificial lighting system (4) Installation of an energy management system, including all relevant operations • Measuring, monitoring, recording, processing, control and viewing systems –on site and online - for the operating data and results of the building energy management systems (BEMS) • Data visualisation systems (5) Interventions in the energy upgrade of technical infrastructure/ other facilities of LAs, including all relevant operations • Energy upgrade of open sports grounds • Energy upgrade of sewage treatment plants, pumping stations, etc.
Energy saving interventions in public buildings	Final energy consumption of the buildings in the target group	Start: 2010	Implementation of energy interventions in public buildings to improve energy efficiency. Projects involving heating and/or cooling energy generation from RES and energy saving will be financed under the programme 'Standard demonstration projects on the use of Renewable Energy Sources (RES) and/or Energy Saving (ES) in public buildings' to reduce energy requirements for heating, cooling, lighting and domestic hot water. The programme aims at achieving energy savings in the central and the general government, encouraging and increasing the use of RES through standard demonstration projects, reducing air pollution and reducing emissions of gases that cause climate change. The actions to be funded include: • applying heat insulation • replacing window frames and glass panels • passive solar systems • natural lighting and ventilation systems, external shading systems for the openings of the building

Title of measure	End-use targeted	Duration	Brief description
			• mechanical cooling-ventilation systems • extensive roof planting • replacing burner systems/boilers with a RES, natural gas, LPG system • replacing old air conditioning systems with new central high-efficiency ones • interventions for a compensation system in the burner/boiler and insulation of pipes • installation of measuring, data recording and monitoring systems for the energy installations in buildings.
Interventions for improving energy efficiency in school buildings	Final energy consumption in new or under construction school buildings	Start: 2011	Implementation of projects in existing and new or under construction school buildings to improve energy efficiency. The ‘Bioclimatic Demonstration Schools’ programme promotes bioclimatic design interventions in new or under construction primary and secondary education schools aimed at achieving energy savings. The actions funded include: (a) constructing school buildings having fully integrated the principles of bioclimatic design, (b) supplying and installing passive and active solar systems, hybrid systems and renewable energy systems, including natural lighting and ventilation systems, solar chimneys, solar protection and shading systems and green roofs, (c) various support systems and network connections, including data metering, recording and monitoring systems for the energy systems of buildings, as well as control and operational management systems for electromechanical installations, (d) studies and other actions. The programme ‘Standard demonstration projects on the use of RES and/or ES measures in existing public primary and secondary education school buildings’ includes projects to be implemented in existing primary and secondary education school buildings to increase heating and/or cooling energy generated from RES and energy saving by reducing energy by reducing energy requirements for heating, cooling, lighting and hot water. Actions to improve energy efficiency and rational energy management funded include: (a) installing heat insulation to building envelopes, shading, sun protection systems and other elements to improve the energy efficiency of the building envelope, (b) using special coatings, cool materials, on roofs (c) replacing window frames and glass panes with new certified, energy-efficient ones (d) passive solar heating systems (e) natural and artificial lighting systems

Title of measure	End-use targeted	Duration	Brief description
			(f) natural and/or hybrid ventilation and cooling systems and techniques (g) roof planting (h) bioclimatic interventions in the surrounding area (i) upgrading and modifying existing central heating and/or conditioning installations, premises and installations of Domestic Hot Water (DHW), (j) connections to the natural gas distribution network An essential condition of the programme is that the building will be upgraded by at least one energy class.
Green flat roofs in public buildings	Energy consumption for cooling-heating	Start: 2011	The programme 'Green roofs on public buildings' aims to improve the thermal, optical and environmental conditions of the users of public buildings, to familiarize citizens with the techniques, advantages and features of green roofs, to reduce energy consumption and emission of greenhouse gases and therefore, to help slowing down and reversing climate change.
Compulsory installation of central solar thermal systems to meet hot water requirements	Energy consumption for domestic hot water, heating-cooling	Start: 2011	Solar thermal systems will replace 50-100% of conventional fuels and electricity, depending on the climatic conditions in each area, the load and the position of the building.
Compulsory replacement of all low energy efficiency light fittings in the public sector and the wider public sector	Energy consumption for lighting	Start: 2006	The replacement of filament lamps by compact fluorescent lamps or by other low-consumption lamps which use 80% less energy and have a lifespan which is almost ten times longer will produce immediate substantial results. For this purpose, the following are mandatory: • replacing all low energy efficiency lighting units with high efficiency units (lamps, ballasts, reflectors, etc.). • annual recording / reporting of energy interventions and redetermination of the target for further improvement.
Intelligent Nearly Zero Energy Theme Museums	Total energy consumption	Start: 2012	The programme 'Intelligent Nearly Zero Energy Theme Museums' aims to implement interventions which result in each building, after the proposed interventions, ideally having been converted into a Nearly Zero Energy Building, i.e. its maximum permissible primary energy consumption should not exceed 60 kWh/m2/year. More specifically, the programme aims to promote energy savings in central and general government, encouraging and increasing the use of RES through standard demonstration projects, reducing air pollution and reducing emissions of gases that cause climate change.
Energy managers in	Total energy	Start:	Designation of an energy manager in central and general government buildings to improve energy

Title of measure	End-use targeted	Duration	Brief description
public sector and general government buildings	consumption	2014	efficiency. The institution of energy manager in central and general government was introduced by JMD Δ6/B/14826 (Government Gazette, Series II, No 1122, 17-06-2008) 'Measures to improve energy efficiency and energy savings in the central and general government' which described the competences of energy managers and allocated responsibility for implementing the measure to specific competent public bodies. The energy manager may be responsible for one or several buildings of each body, in accordance with operational needs and the total staff capacity, usable area and volume of the body's buildings. The energy manager may be an engineer with a university degree in a subject related to their specialty, or with a technical education if there is no comparable university education, and is designated by the Secretary General of the competent Ministry or the Region or the management board of said body. The responsibilities of the energy manager include: (1) collecting data on the energy consumption of buildings, (2) keeping a mandatory file or database on the energy consumption of the building, (3)preparing an annual summary report on energy-saving tracking and monitoring in accordance with the procedures, requirements and guidelines for conducting energy inspections required by Joint Ministerial Decision Δ6/B/oik. 11038/1999 (Government Gazette, Series II, No 1526, 08-07-1999), (4) verifying the proper operation of central heating and cooling installations and conducting periodic maintenance of boilers-burners and air conditioning units, (5) monitoring maintenance or repair works to improve energy efficiency.

4.3.2.3 Sectoral policies and measures: Transport

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 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. The operation of suburban railway in the wider area of Athens has already started, the connection to Corinthos and Chalkida are completed, while the connection with Livadia is expected to operate in the near future. 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.

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.

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.

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[7].

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 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,

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

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 460 kt CO2eq for 2020 and 2.3 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 [8], 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.

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

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 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	125	150	200
Organic farming (N_2O)	330	350	400	450
Reduction of the rate of intensity of agricultural land use and improvement of management of animal waste. (CH4, N2O)	370	430	500	600
Total	**800**	**905**	**1050**	**1250**

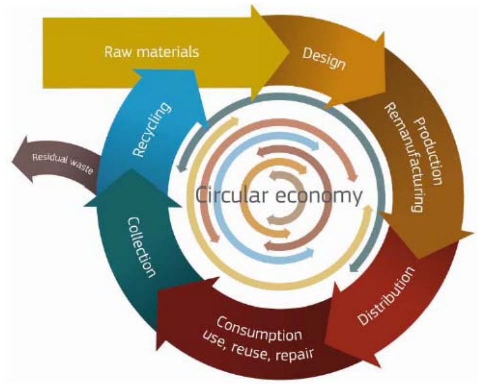
4.3.2.6 Sectoral policies and measures: Waste

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 CH_4 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 (CH_4) at approximately 0.8 Mt CO_2eq, 0.9 Mt CO_2eq and 1.0 Mt CO_2eq 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 500 kt CO2eq, 600 kt CO2eq, and 700 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 targets of the Greek policy regarding the “Land Use, Land Use Change and Forestry” sector are the conservation and the protection of existing forest land, its gradual increase, as well as the improvement of the degraded forest lands. The sustainable management of the forest land was early legislated (Presidential Decree 19-11-1928) while the sustainability of the significant multi-functioning role of forests (e.g. erosion protection, regulation of the water budget, conservation of biodiversity) has been ensured through the Administrative Regulation No 10223/958/1953.

Forests, apart from products, provide numerous environmental and social services and the aim should be to preserve and strengthen those services, such as maintaining and enhancing biodiversity, to increase their contribution to the mitigation of climate change, along with strengthening their resilience to the impacts of climate change, to increase their contribution to the protection of water and soil and air purification etc.

The measures for the LULUCF sector arise from rural development actions and other financial mechanisms. In the overall Greek fiscal deficiency, policies already implemented, adopted and measures taken aim for the above mentioned targets achievement. In particular, for the period 2013-2020, the relevant measures, being implemented aim primarily at protecting forest lands, their sustainable management, preserving and strengthening their multifunctional role, contributing also to the mitigation of the climate change and the development of forestry sector. Those policies and measures are presented divided into the following broad categories:

➢ Public Investment Program – Forest Sector:

1. Collective Project Decision (SAE) 084

In the year 2016 appropriations of 255,520.00 € were allocated for the following two projects:

- 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).
- Reforestations for the restoration of a damaged natural landscape in the Lambia - Astra - Kryovrisi - Tsipiana Municipality of Ancient Olympia.

2. SAE 584

In 2016 appropriations of 3.680.000,00 € were allocated for the following forestry activities – registered projects:

- 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;
- Poplar cultivation and other fast-growing species;
- Effective implementation of the Timber Regulation (Regulation (EC) No 995/2010) and of the Flegt Regulation (Regulation (EC) No 2173/2005);
- 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;

3. SAE 0842 (This SAE includes projects approved under the LIFE Regulation 1293/2013 of the European Parliament and of the Council of 11 December 2013 and in which the Forest Service (Central and/or local Forest Services) participates).

In the year 2016 appropriations of 157,800.00 € were allocated to the following projects:

- Safeguarding the lesser white-fronted goose fennoscandian population in key wintering and staging sites within the European flyway (Safeguard LWfG);
- Addressing Challenges in Sustainable and Multifunctional Forestry through Enhanced and Co-ordinated Research for policy-making decisions (SUMFOREST);
- Enhancing Forest Research in the Mediterranean through improved coordination and integration (FORESTERRA);
- The ecological services, social benefits and economic value of the Ecosystem Services in Natura 2000 sites in Crete (LIFE 13 INF/GR/000188);
- Building cooperation, developing skills and sharing knowledge for Natura 2000 forests in Greece (LIFE 14/GIE/GR/000304);

➢ Regular Budget of the Ministry of Environment and Energy – Special Body Φ 31-130 "Forest Services"

Indicative actions covered are:

- Operational and salary costs of seasonal staff for the operation of the White Mountain National Park (Samaria) (approximately € 500,000.00 per year);
- Expenditure on the implementation of the annual Forest Protection Program, prepared each year by the competent Directorate for the Protection of Forests and Natural Environment (3,550,000.00 € in 2016);
- Financial Aid of Agricultural Character (1,000,000.00 in 2016);
- Expenses for the implementation of the program for the fight against Thaumetopoea pityocampa in the area under the responsibility of the Forest Service of Thessaloniki (100.000,00 € in 2016);
- Strengthening the Expenditure Code No 0878 with the approximately 905.000,00 € for the individual needs of the residents in mountainous areas;
- Expenses for the rent, preparation and operation of the Forest Pavilion at the Internationl Exhibition in Thessaloniki;
- Continuation of production of timber constructions and prefabricated houses of the State Wood Industry of Kalampaka (50,000.00 in 2016);
- Expenditure for the use of an CH-47 D AP of the Army Air Force for the transport of of water, in an open tank in Antimilos island for the survival of the protected wild goat (45,085.00 €); etc.

➢ Special Body of Forests/SBF (Green Fund)

Each year the Forest Service develops the forestry funding program with appropriations from the SBF which is submitted for approval by the "Green Fund". This program finances mainly the regional and local Forest Services to take appropriate measures and actions for the sustainable management and protection of forest ecosystems and which are described, analyzed and specified on priority axes. The measures and actions implemented, aim at the protection of forests and wooded lands from any danger from which they are threatened, and in particular from fires, the combat chestnut ulcer (vaccinations), the protection of wild fauna and its habitats, the monitoring for the compliance with hunting rules, the improvement of ecological and social value with the organization of all day accommodation spaces and outdoor recreation and in general facilitating forest recreation, the restoration of forestry productive potential damaged by natural disasters, etc. During the year 2016 the approved financial plan amounted to 11,300,000.00 €

Indicative actions for which appropriation were allocated in the context of the 2016 program are:

- Preventive measures for the fire protection of public forests and wooded lands;
- Improvement of infrastructures, prevention of illegal logging;
- Biological fight of chestnut ulcer;
- Anti-erosion and flood protection of the watersheds of burnt forests and wooded lands;
- Supply of vehicles;
- Operational costs of the CITES Scientific Committee;
- Expenditure of the Scientific Committee and Prefectural Committees and direct-response Teams for measures managing approaching/interaction incidents of Bear (Ursus arctos) in residential areas;
- 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;

➢ Actions - projects under the Operational Program "Transport infrastructure, environment & sustainable development" 2014-2020.

- Priority Axis 11: Implementation of adaptation to climate change strategy, prevention and risk management. 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;
- Priority Axis 12: Strategies and actions to promote the integration of the European Environmental acquis. 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; In this axis, the following have been included:

✓ Forest and natural environment protection and public awareness actions;

✓ Implementation of Regulations 995/2010 and 2173/2005 (FLEGT);

✓ National and Regional Systems and Records, in particular under Regulation (EU) 995/2010;

✓ Networking actions of bodies and public awareness with regard to issues related to fire protection and security;

➢ Actions - projects under the Rural Development Program 2014-2020.

✓ Sub-measure 4.3.3 «Opening and improvement of forest road network, with budget 45,307,545.14€.

- Measure 8 «Investing in the development of forest areas and the improvement of forest sustainability».

- ✓ Sub-measure 8.1 «support for afforestation/creation of forested areas», with budget 119,333,333.33 €;
- ✓ Sub-measure 8.2. «Aid for agroforestry systems», with budget 21,333,333.33 €;
- ✓ Sub-measure 8.3 «Support for the prevention of damages to forests from forest fires, natural disasters and catastrophic events», with budget 68,669,881.62 €;
- ✓ Sub-measure 8.4 «Support forest restoration caused by forest fires, natural disasters and catastrophic events», with budget 103,025,652.13 €. The sub-measure includes reforestation actions for restoring forest potential damaged by fires, natural disasters and catastrophic events or degradation from other causes such as soil erosion. It also comprises the mountainous corrosion and flood protection projects. Restoration of forestry infrastructures or forestry investments from damages as a result of other than the above mentioned causes may be implemented according to the specifics of the forest area or the management regime.
- ✓ Sub-measure 8.6 «support for investment in forestry technologies and in processing, distribution and marketing of forest products», with budget 27,181,342.54 €.

- Measure 12 «Aid under the Natura 2000 framework and the framework directive on water».

- ✓ Sub-measure 12.2 «compensation for forest areas of Natura 2000 network», with budget 10,000,000.00 €.

➢ Other projects

- 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.
- There is also a number of projects under implementation in the context of the LIFE Regulation, in which various Greek bodies are participating and the results of which are expected to provide valuable information in relation to LULUCF aspects and the climate change combat:

- ✓ 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);
- ✓ Climatree (LIFE14 CCM/GR/000635): The objectives are to define an accounting and monitoring framework for tree-crops CO2 sequestration; to develop a software application for the accounting of carbon sequestration by tree crops; to promote its adoption by EU and National Authorities; to delineate mitigation practices in the agricultural sector (duration 16.07.2015-28.06.2019);
- ✓ Foresmit (LIFE14 CCM/IT/000905): The objectives are to define guidelines of good silvicultural practices for the restoration of per-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 CO2 and other

greenhouse gas emissions, thus giving a complete picture of mitigation potential of management practices (duration 01.09.2015-31.08.2019);

It should be also noted here that Greece is actively engaged in the EU's internal consultation processes with regard to the new European Commission's legislative proposal on how the LULUCF sector will be treated within the 2030 climate and energy framework.

On 20 July 2016 the European Commission presented a legislative proposal to integrate greenhouse gas emissions and removals from land use, land use-change and forestry into the 2030 climate and energy framework. The proposal follows the agreement with EU leaders in October 2014 that all sectors should contribute to the EU's 2030 emission reduction target, including the land use sector. The European Council specifically acknowledged "the multiple objectives of the agriculture and land use sector, with their lower mitigation potential, and the need to ensure coherence between the EU's food security and climate change objectives". The European Council's guidance on including LULUCF into the EU's 2030 climate and energy framework is also reflected in the EU's INDC. This proposal is also in line with the Paris Agreement, which points out to the critical role of the land use sector in reaching long-term climate mitigation objectives.

The proposal sets a binding commitment for each Member State to ensure that accounted emissions from land use are entirely compensated by an equivalent removal of CO_2 from the atmosphere through action in the sector. Although Member States undertook this commitment under the Kyoto Protocol up to 2020, the proposal enshrines the commitment in EU law for the period 2021-2030. The new rules will provide Member States with a framework to incentivise more climate-friendly land use, without imposing new restrictions or red tape on individual actors.

The different stakeholders were involved at various stages in the development of this proposal. Consultations were carried out in 2015, including a written consultation on the Green Paper: A 2030 climate & energy framework, and a written consultation on addressing greenhouse gas emissions from agriculture and LULUCF in the context of the 2030 EU climate and energy framework. Following these consultations and the analysis of EU climate policy targets for 2030, the Commission carried out an impact assessment.

The legislative proposal has been submitted to the European Parliament, the Council, the Economic and Social Committee and the Committee of the Regions for further consideration under the ordinary legislative procedure.

More information on the legislative proposal can be found at the link below:

https://ec.europa.eu/clima/policies/forests/lulucf_en.

Table 4.13a 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 2020	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	11,700	8,200	5,500
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	304	330	366
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	250	350	430
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	671	861	1,094
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	17	20	22
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) ;	14,700	15,000	19,000	25,000

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 2020	Mitigation impact (ktCO2 eq) Year 2020	Mitigation impact (ktCO2 eq) Year 2025	Mitigation impact (ktCO2 eq) Year 2030
								Regulatory Authority for Energy (Other)				
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	810	960
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	300	400	500
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 consumption)	Economic, Fiscal, Regulatory, Information	Implemented	2008	Ministry of Environment and Energy (Government)	93	2,930	3500	4000
10	Road transport measures	Transport	CO2, CH4, N2O	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)	NE	340	500	600
11	Recovery of	Waste	CH4	Reduced landfilling (Waste);	Regulatory,	Implemented	2002	Ministry of	200	800	900	1000

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 2020	Mitigation impact (ktCO2 eq) Year 2020	Mitigation impact (ktCO2 eq) Year 2025	Mitigation impact (ktCO2 eq) Year 2030
	organic waste	management/waste		Enhanced recycling (Waste); Improved landfill management (Waste)	Other (Other (Planning)			Environment and Energy (Government)				
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)	770	500	600	700
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	460	1400	2300
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.	Agriculture	CH_4, N_2O	Other activities improving cropland management (Agriculture); Improved 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)	Other (Other (Planning), Regulatory, Economic	Implemented	2007	Ministry of Rural Development and Food (Government)	370	430	500	600
15	Rural Development Programme (RDP): Increase of organic farming.	Agriculture	N_2O	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)	330	350	400	450
16	Common Agricultural Policy (CAP) – Green	Agriculture	N_2O	Reduction of fertilizer/manure use on cropland (Agriculture)	Other (Other (Planning),	Implemented	2007	Ministry of Rural Development	100	125	150	200

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 2020	Mitigation impact (ktCO2 eq) Year 2020	Mitigation impact (ktCO2 eq) Year 2025	Mitigation impact (ktCO2 eq) Year 2030
	Direct Payments: Reduction in fertilizers use				Regulatory, Economic			and Food (Government)				
17	Measures in the LULUCF sector	Forestry/LULUCF	CO_2, CH_4, N_2O	Measures for LULUCF sector arisen from Public Investment Program, Regular Budget (Special Body Φ 31-130 "Forest Services"), Special Body of Forests (Green Fund), Operational Program "Transport infrastructure, environment & sustainable development" 2014-2020, Rural Development Program 2014-2020 and other financial mechanisms.	Other (Other (Planning)	Implemented		Ministry of Environment and Energy	NE	NE	NE	NE

Table 4.13b 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

P&M No	Name of mitigation action	Brief description
		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 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 chose to raise its ambitions to a 20% overall share for 2020 (Law 3851/2010) and 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

P&M No	Name of mitigation action	Brief description
		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).
8	Implementation of energy efficiency measures in Industry (National Energy Efficiency Action Plan)	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.
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. Promotion of measures for separate collection of biowaste, recycling, energy recovery and use of sludge in agriculture as fertilizer/compost.
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.

P&M No	Name of mitigation action	Brief description
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.	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. 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 contribute to the reduction of GHGs.
15	Rural Development Programme (RDP): Increase of organic farming.	Organic production and decrease of the use of synthetic nitrogen fertilizers result 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	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. The observance of cross compliance will result in reduction in fertilizer use, and consequently to a decrease of N2O emissions.
17	Measures in the LULUCF sector	Forest protection, Forest management, Ecosystem health, Research, Restoration – increase of forest lands, Adaptation.

4.4 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.

4.5 Policies and measures no longer in place

There are no policies and measures listed in previous national communications that are no longer in place.

4.6 Effect of policies and measures on the modification of long-term trends

In 2011, the European Commission launched three roadmaps to promote the discussion on the long-term framework of climate and energy policies in Europe: a) the 'Roadmap for Moving to a Competitive Low Carbon Economy in 2050'[9] b) the 'Roadmap to a Single European Transport Area - Towards a Competitive and Resource Efficient Transport System'[10] and c) the 'Energy Roadmap 2050.'[11] The European Council reconfirmed in February 2011 that the objective of the European Union (EU) is to reduce Europe's greenhouse gas emissions (GHGs) by 80 to 95 % below 1990 levels by 2050 as part of efforts by developed countries as a group to reduce their emissions by a similar degree. Although the EU is already committed to GHG emission reductions of at least 20 % below 1990 levels by 2020 as part of the Energy and Climate Package, longer-term policies are now required to ensure that the ambitious reduction target for 2050 is achieved. The European Commission has therefore published the communication entitled 'Roadmap for moving to a competitive low-carbon economy in 2050', providing guidance on how the EU can decarbonise its economy.

In March 2012, Greece has presented the Greek Energy Roadmap to 2050 in accordance to the targets of the EU 2050 roadmap. As concerns the effect of policies and measures on the modification of longer-term trends in anthropogenic GHG emissions and removals and bearing into consideration the EC guidelines for the period 2020-2050, as well as the development of a core set of parameters (economic activity per sector, international fuel prices, CO2 prices, lignite use level, etc.) three scenarios were examined in order to specify and evaluate alternative measures and policies for the fulfillment of national and European targets.

The Scenario "Existing Policies" (Scenario EP) assumes a conservative implementation of environmental and energy policies, anticipating on the one hand a moderate level of CO2 emissions reduction by 2050 (40% compared to 2005), and on the other moderate penetration of RES and energy saving.

The Scenario "Measures Maximization RES" (Scenario MEAP) assumes maximization of RES penetration (100% in electricity generation), so as to reduce CO2 emissions by 60% -70% with simultaneous energy saving in buildings and transport. The same scenario is examined under the hypothesis of imported electricity which will result in cost savings in electricity sector (Scenario MEAP-a).

The Scenario "Minimum Cost of Environmental Measures" (Scenario PEK) has the same assumptions as the Scenario MEAP relating to CO2 emissions but estimates the share of

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9 COM (2011) 112 final
10 COM (2011) 144 final
11 COM(2011) 885/2

renewables in the energy mix so as to ensure the minimum cost. A variation of this scenario, considering the inclusion of CCS is also considered (Scenario PEK-a).

The picture of the future energy system as indicated by the two basic energy policy scenarios (Scenarios MEAP and PEK) can be summarized in the following 10 points:

1. Reduce greenhouse gas emissions by 60%-70% by 2050 in relation to 2005.
2. 85%-100% electricity generation from RES, using all commercially mature technologies.
3. Total penetration of renewables in gross final energy consumption by 2050 at a rate of 60%-70%.
4. Stabilization of energy consumption due to energy saving measures.
5. Relative increase in electricity consumption due to electrification of transport and greater use of heat pumps in the residential and tertiary sectors.
6. Significant reduction of oil consumption.
7. Increased use of biofuels in transportation sector at the level of 31% to 34% by 2050.
8. Dominant share of electricity in short-distance passenger transport (45) and significant increase in the share of stable track public transport.
9. Significantly improved energy efficiency for the entire building stock and a large penetration of RES in buildings.
10. Development of decentralized production units and smart grids.

Policies, measures and interventions in energy consumption are taking into consideration the potential for energy saving and energy efficiency improving that exist in all final energy consumption sectors. The sectors with the greatest potential for energy saving are buildings, transport and industry.

- ✓ Measures planned to be implemented concerning inter alia:
- ✓ energy certification of buildings;
- ✓ energy upgrade of existing buildings;
- ✓ coverage of all energy requirements of new buildings by RES;
- ✓ development of market mechanisms, such as energy services companies and white certificates;
- ✓ electrification of transport.

In industry, the savings will result from the reduction in electrical consumption and thermal uses and the implementation of CHP (Combined Heat & Power).

The energy policy measures in the electricity sector are related to ensuring the energy supply and functional electricity market, reducing greenhouse gas emissions, and concern in:

- ✓ infrastructure (network expansions and connections);
- ✓ the appropriate modification of the energy mix;
- ✓ flexible and decentralized energy production;
- ✓ the expansion of smart grids;
- ✓ the rationalization and acceleration of licensing process covering RES;

- ✓ the availability of appropriate support mechanisms for RES investments and long-term integration into the competitive market.

The first critical finding of this analysis is that the prospect of existing policies (Scenario EP) does not lead to the achievement of objectives (i.e. reducing CO2 emissions by 2050, more economical development of the energy sector). Instead, the new energy policy scenarios (Scenarios MEAP and PEK), where the high penetration of renewables in gross final energy consumption dominates, achieve deep CO2 emission cuts (by 60% to 70% compared with 2005) while imported energy and country's energy dependence from imported fossil fuels is reduced.

Electricity generation cost follows a declining trend after 2030 while the increased use of renewables and the limited use of fossil fuels ensure further cost reductions by 2050.

At the same time the attraction of investment capital and capital leverage, so that the proposed technical changes to the Greek energy system be implemented, is a particularly important opportunity for local economic development in various sectors of economic activity (e.g. the energy sector, construction sector, commercial sector, etc.).

4.7 Policies and Measures Related to Bunker Fuels (Art. 2 (2) Kyoto Protocol)

Please refer to section 4.3.1.3.

4.8 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 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. A “with additional measures” (WAM) scenario is not reported, since, as it is presented in the next sections of this chapter, the national mitigation commitments will be met without the need of additional policies compared to the policies reflected in the WM scenario.

The projections of GHG emissions in the “with measures” scenario disaggregated by sector and by gas are presented in ***CTF Table 6(a)***, ***Tables 5.1*** and ***5.2.*** 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 target of Greece are presented. In ***Tables 5.3*** a split of the projections of the GHG emissions is presented between the sectors covered and not covered by the EU ETS.

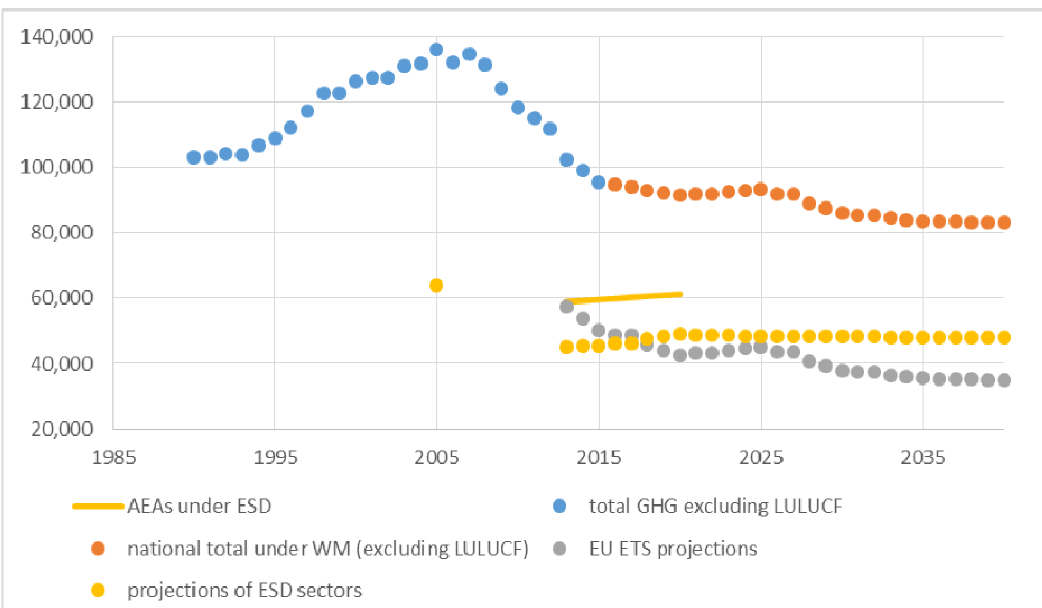


Figure 5.1 Projections of total national GHG emissions (excluding LULUCF), EU ETS and ESD sectors (in ktCO2eq)

Table 5.1 Projection of GHG emissions in the "with measures" scenario, disaggregated by sector (kt CO_2 eq)

		GHG emissions and removals							With measures projections				
GHG emissions projections	Unit	Base year (1990)	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Sector													
Energy	kt CO_2 eq	62,362.64	62,362.64	64,365.53	77,818.40	85,242.63	70,603.69	53,924.29	47,253.37	49,357.98	41,432.51	38,665.28	37,880.01
Transport	kt CO_2 eq	14,506.98	14,506.98	16,584.24	18,859.96	21,894.01	22,476.85	17,098.09	19,197.16	18,650.98	18,183.27	17,785.42	17,657.95
Industrial processes	kt CO_2 eq	11,226.96	11,226.96	13,569.65	15,176.38	15,425.62	11,662.02	11,896.29	11,159.47	11,391.38	12,213.01	12,768.39	13,001.06
Agriculture	kt CO_2 eq	10,120.79	10,120.79	9,465.84	9,124.74	8,936.41	8,815.94	8,309.97	9,172.28	9,403.26	9,640.08	9,882.87	10,131.80
Forestry/LULUCF	kt CO_2 eq	-2,178.02	-2,178.02	-2,926.07	-2,111.21	-3,370.57	-3,325.00	-3,140.44	-1,714.10	-1,152.13	-745.59	-267.37	-851.95
Waste management/waste	kt CO_2 eq	4,863.82	4,863.82	5,150.20	5,348.23	4,760.81	4,750.44	4,486.46	4,733.01	4,572.85	4,567.62	4,467.36	4,374.69
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	2,777.93	2,873.33	2,972.02	3,055.74	3,122.97
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	8,671.66	9,435.50	10,266.63	11,005.06	11,620.36
National Total													
Total with LULUCF	kt CO_2 eq	100,903.18	100,903.18	106,209.40	124,216.49	132,888.91	114,983.93	92,574.66	89,801.20	92,224.32	85,290.90	83,301.96	82,193.54
Total without LULUCF	kt CO_2 eq	103,081.19	103,081.19	109,135.47	126,327.70	136,259.48	118,308.93	95,715.10	91,515.30	93,376.45	86,036.49	83,569.32	83,045.49

Table 5.2 Projections of GHG emissions (excluding LULUCF) in the "with measures" scenario, disaggregated by gas (kt CO_2 eq)

		GHG emissions and removals							With measures projections				
GHG emissions projections	Unit	Base year (1990)	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Gases													
CO_2 emissions including net CO_2 from LULUCF	kt CO_2 eq	81,129.55	81,129.55	83,970.58	100,642.92	110,536.14	93,991.72	71,803.23	68,877.63	71,597.49	64,606.54	62,425.19	61,001.77
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	113,925.07	97,342.98	74,962.94	70,657.40	72,815.29	65,417.81	62,758.23	61,919.39
CH_4 emissions including CH_4 from LULUCF	kt CO_2 eq	10,968.79	10,968.79	11,346.25	11,835.38	11,245.57	10,988.80	10,229.20	10,730.97	10,828.31	10,676.86	10,655.54	10,751.31
CH_4 emissions excluding CH_4 from LULUCF	kt CO_2 eq	10,906.61	10,906.61	11,303.20	11,628.86	11,235.08	10,972.53	10,218.43	10,675.33	10,772.67	10,621.22	10,599.90	10,695.67
N_2O emissions including N_2O from LULUCF	kt CO_2 eq	7,428.84	7,428.84	6,668.92	6,350.30	5,932.09	5,479.44	4,514.97	5,114.48	5,264.03	5,356.91	5,469.87	5,587,34
N_2O emissions excluding N_2O from LULUCF	kt CO_2 eq	7,423.22	7,423.22	6,662.98	6,328.64	5,924.21	5,469.46	4,506.46	5,104.45	5,254.00	5,346.88	5,459.84	5,577.31
HFCs	kt CO_2 eq	1,182.82	1,182.82	4,157.38	5,261.83	5,077.45	4,388.67	5,902.68	4,946.90	4,399.08	4,506.29	4,600.00	4,700.00
PFCs	kt CO_2 eq	190.26	190.26	62.85	122.26	91.51	129.44	119.52	126.09	130.19	138.97	145.91	147.61
SF_6	kt CO_2 eq	2.93	2.93	3.42	3.81	6.16	5.86	5.06	5.12	5.22	5.32	5.45	5.51
NF_3	kt CO_2 eq	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
National Total													
Total with LULUCF	kt CO_2 eq	100,903.18	100,903.18	106,209.40	124,216.49	132,888.91	114,983.93	92,574.66	89,801.20	92,224.32	85,290.90	83,301.96	82,193.54
Total without LULUCF	kt CO_2 eq	103,081.19	103,081.19	109,135.47	126,327.70	136,259.48	118,308.93	95,715.10	91,515.30	93,376.45	86,036.49	83,569.32	83,045.49

Table 5.3 GHG emissions (in kt CO2eq) of the sectors not covered by the EU ETS according to WM scenario

Year	National emissions excl. LULUCF	EU ETS	ESD
2015	95,715	50,266	45,449
2020	91,515	42,589	48,926
2025	93,376	45,090	48,286
2030	86,036	37,772	48,265
2035	83,569	35,554	48,015
2040	83,045	34,897	48,149

Greece has fulfilled its Kyoto Protocol target (1st commitment period). For more information please refer to 6th National Communication.

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 A.I.2***) 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 this 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.

5.2 Assessment of aggregate effects of policies and measures

In this chapter the estimated and expected total effect of implemented and adopted policies and measures is presented. No planned policies were reported, since the national mitigation commitments (ESD target) will be met without the need of additional policies compared to the policies reflected in the WM scenario. 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 5.4*** 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 5.4 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	23211	31155	32641	36890
Transport sector (CO2)	8	401	501	1007	824	972
Industrial processes (HFC, PFC)	NA	NA	NA	460	1400	2300
Agriculture (CH4 30%, N2O 70%)	NE	NE	800	905	1050	1250
Waste Sector (only CH4)	NE	NE	800	1300	1500	1700
Total Effect	**7529**	**24470**	**25312**	**34827**	**37415**	**43112**

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 (projections of energy production and consumption data) 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 2015 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 BR2, updated to:

- ✓ include improvements in inventory reporting;
- ✓ include emissions for 2015, 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)[12] in combination with PropSim[13] 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.

The level of emissions estimated in WM 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 4, are incorporated in the “with measures” scenario. The main assumptions made for the

[12] http://www.iea-etsap.org/web/Times.asp
[13] Probabilistic Production Simulation:
http://www.sciencedirect.com/science/article/pii/S1364032114008247

projection of GHG emissions in WM scenario are presented in **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. It assumes an emissions allowance cost and the international fuel prices reported in **CTF Table 5**, while RES penetration and measures for energy efficiency according to the current rate. Electricity demand is estimated to be 58.5 TWh in 2020. Decommissioning of old public electricity plants and commissioning of new ones is taken into account and the operation of interconnections of the islands to the mainland grid is simulated. The use of lignite is simulated according to the operation schedule of the Public Power Corporation (PPC). The installed power of lignite plants will be decreased from 4.7GW in year 2010 to 3.9GW in year 2020 and 2.0GW in 2030. In 2020, it is anticipated that natural gas plants will be about 5.2GW and RES are being exploited as follows: 3.6 GW of wind farms, 2.9 GW of hydros, 0.1 GW of biogas/biomass and 3.8 GW of photovoltaics. The following national targets will be achieved by the WM scenario:

- ✓ 20% RES target (instead of 18% from the Renewable Energy Directive)
- ✓ Simulation of ETS operation assuming a cost of CO2 emissions for ETS industries indicated in CTF Table 5.
- ✓ 10% Biofuels in transport.
- ✓ Non ETS sectors reduction target -4% (from 2005 level)
- ✓ Energy Efficiency targets according to Directive 2006/32/EC (national final energy savings 9% by 2016). Additionally, the energy conservation of primary energy will evolve according to European target of 20%, as it is defined in Directive 2012/27/EU (primary energy consumption in 2020 will be 24.7 Mtoe / final energy consumption in 2020 will be 18.4 Mtoe).

Concerning energy efficiency, the WM scenario contains the mitigation effect of the energy saving measures from National Energy Efficiency Action Plans included in ***Table 5.5***.

Table 5.5 Energy efficiency measures according to the submitted National Energy Efficiency Action Plans (Scenario: With Measures)

Title of measure	Implementation
High efficient appliances and minimum energy efficiency requirements The measure targets to the promotion of high efficient electrical and electronics appliances either through the provision of the appropriate financial incentives or through the imposition of minimum energy efficiency requirements contributing to the significant reduction of both energy and environmental costs incurred by consumers. Moreover, energy labeling will increase the effectiveness of the specific measure informing the consumers about the electricity consumption and the energy efficiency rating of the appliances.	Residential and tertiary sectors
Promotion of high efficient CHP and district heating units in order to cover the increased heating demand from district heating in 2020 in comparison with 2011 in specific areas The measure foresees the installation of new high efficiency CHP and district heating systems in order to satisfy the increased electricity and thermal demand for heating, domestic hot water and thermal processes in residential, tertiary and industrial sectors resulting in primary energy savings. Moreover, the modernization and the extension of the existing CHP and district heating systems can also be implemented within the framework of the specific measure contributing to the achievement of energy savings.	Tertiary, industrial and residential sectors
Compulsory replacement of all low energy efficiency light fittings in the public sector and the wider public sector until 2020 The measure focuses on the replacement of filament lamps with compact fluorescent lamps or other low-consumption lamps, which consume 80% less energy and have a lifespan almost ten	Public sector

times longer. Moreover, the replacement of low energy efficiency lighting units with high efficiency units (such as ballasts, reflectors, etc.), the annual recording/reporting of energy interventions and redetermination of the target for further improvement are considered crucial actions increasing the effectiveness of the measure.	
Replacing old public and private light and heavy trucks with new high efficient The measure aims at the replacement of old public and private light and heavy trucks fulfilling EURO III standards with new vehicles fulfilling EURO V standards through the partial or full exemption from the specific registration fee.	Transport sector
Replacement of private vehicles and to promote the use of energy-efficient vehicles (vehicles fuelled by biofuels and hybrid vehicles) The measure provides specific financial and tax incentives for the replacement of the old energy-intensive vehicles with new high energy efficient vehicles. The provision of the incentives can facilitate the market penetration of private passenger vehicles fuelled by alternative fuels such as biofuels, compressed natural gas or liquefied petroleum gas. Moreover, the replacement of public and private old passenger vehicles fulfilling EURO III standards with new vehicles fulfilling EURO V standards will be promoted through the partial or full exemption from the specific registration fee.	Transport sector
Energy upgrade of building in residential and tertiary sector The measure focuses on the provision of energy-saving interventions in buildings in order to reduce the heating and cooling demand. Indicatively, the proposed interventions, which can be implemented in buildings of the residential and tertiary and public sector, includes the energy upgrade of the building envelope through interventions, such as the installation of exterior and interior insulation including the roof and the pilotis, the replacement of glazing and window frames, the installation of shadow systems including roofing, awnings and special coatings etc.	Residential, tertiary and public sectors
Energy upgrade of electro-mechanical heating and cooling installations The measure promotes the implementation of energy-saving interventions in the installed electro-mechanical equipment of the building sector so as to meet the heating and cooling demand. Indicatively, the proposed interventions, which can be implemented in buildings of the residential and tertiary and public sector, includes the installation of new high efficient thermal and cooling systems, the modernization of the existing heating and cooling systems including the relative distribution systems and the installation of heating and cooling systems utilizing alternative systems such as biomass, natural gas, solar energy etc.	Residential, tertiary and public sectors
Installation of solar thermal systems to cover part of hot water demand. The measure foresees the further penetration of solar thermal energy in order to satisfy part of hot water demand in new and existing buildings of the residential, tertiary and public sectors. Specifically, the solar thermal systems will replace 50%-100% of the conventional fuels and electricity, depending on the climatic conditions in each area, the load and the position of the building.	Residential, tertiary and public sectors
Implementation of the Regulation on the Energy Performance of Buildings in order to result in lower thermal and cooling demand of the new buildings in comparison with the existing The measure aims at the implementation of the regulation on the energy performance of buildings, which introduces an integrated energy design in the sector of buildings for the improvement of the energy efficiency of buildings, energy savings and environmental protection through specific actions such as the preparation of a study on the Energy Performance of Buildings, the establishment of minimum requirements for energy efficiency in buildings and the Energy Rating of Buildings through the Energy Performance Certificate. The measure will be implemented either during the construction of new buildings or during the upgrade of existing buildings regardless of the sector.	Cross-sectoral

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 5.6*** includes the projections of emissions from the energy sector for the 'with measures' scenario.

Table 5.6 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	32,707	34,325	25,853	22,997	22,223
Fugitives emissions	1,106	772	898	653	578	595
Man. Industry and Construction	5,250	5,871	6,283	6,883	7,219	7,322
Transport	17,098	19,197	18,651	18,183	17,785	17,658
Tertiary	714	1,205	1,431	1,661	1,822	1,988
Residential	5,181	4,731	4,411	4,335	3,979	3,673
Agriculture	554	1,716	1,758	1,796	1,819	1,828
Other	208	252	252	252	252	252
TOTAL	71,022	66,451	68,009	59,616	56,451	55,538

5.4.1.2 Identification of national targets

According to the EU climate and energy package (20-20-20) Greece has the following targets:

- RES: 18% of final energy consumption mandatory until 2020 (Directive 2009/28/EC).
- Mandatory target 10% until 2020 for biofuels.
- Primary energy saving of 20% until 2020.
- Focus on auctioning – Electric Power will not be granted any free emission allowances (after 2013).
- For sectors not falling under 2003/87/EC (non-ETS sectors, 4% reduction of 2005 emissions by 2020).
- For sectors falling under 2003/87/EK, 1.74% emissions reduction yearly (after 2013).

The national target for the reduction of emissions by 2020 is determined by the sum of the partial demanded decrease of emissions in and out of the ETS context.

The allowed GHG emissions will start by the mean value of the period 2008-2010 for industries that are included in the ETS and will be decreased by 1.74 % annually until 2020. By this way, in 2020, emissions from sectors covered by the EU ETS will be 21% lower than in 2005.

Electricity generation plants will have to buy their allowances to emit from auctions, whereas the rest of industries included in the ETS will be able to receive free allowances, which will be decreased in the period 2013-2020. Plants that participate in the ETS will be also able to obtain allowances to emit from their activity in the Clean Development Mechanism and Joint Implementation.

In the same time, the Effort Sharing Decision (406/2009/EC) establishes binding annual greenhouse gas emission targets for Member States for the period 2013–2020 from sectors not included in the EU Emissions Trading System (EU ETS), such as transport (except aviation and international maritime shipping), buildings, agriculture and waste. The Effort Sharing Decision sets national emission targets for 2020, expressed as percentage changes from 2005 levels. It also lays down how the annual emission allocations[14] (AEAs) in tonnes for each year from 2013 to 2020 are to be calculated. The national target

[14] the annual maximum allowed greenhouse gas emissions in the years 2013 to 2020 pursuant to European legislation

for emissions not included in the ETS (non-ETS) is a 4% reduction of emissions by 2020 compared to 2005. The AEAs for Greece for the years 2013-2020 are presented in ***Table A.I.2***.

As regards to the Renewable Energy Sources (RES), assessment of their penetration will be implemented in final consumption (not in primary energy). The national target was increased from the 18% set out in EU regulation Directive 2009/28/EC to 20% penetration in the final consumption by 2020, by L3851/2010 (OG A/85/4th June 2010) "Accelerating the development of Renewable Energy Sources to deal with climate change and other regulations in topics under the authority of MEECC".

As far as the energy end use efficiency is concerned, pursuant to Law 3855/2010 (Directive 2006/32?EC has been transposed to Greek Legislation by this Law), the national final energy savings target was set at 9% by 2016 (16.46 TWh), as compared to average final energy consumption for the period 2001-2005 (the ETS industries are excluded). This objective remains in place and progress towards it is being monitored through the National Energy Efficiency Action Plans (EEAP). However, in order to ensure that the target of 20% primary energy savings in the EU by 2020 is met, the European Commission adopted Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC. The indicative national target of Greece for 2020 under Directive 2012/27/EU is 27.1 Mtoe primary energy consumption[15] and 18.4 Mtoe final energy consumption.

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 4, are incorporated in the "with measures" scenario. The main assumptions made for the projection of GHG emissions, which were also reported in **CTF Table 5**, are analysed as follows:

International fuel prices: They are presented in ***Table 5.7*** below.

Table 5.7 International fuel prices according to IEA

Fuel	2020	2025	2030	2035	2040
Crude oil [€/GJ]	11.61	13.18	14.52	15.14	16.04
Natural Gas [€/GJ]	7.47	8.08	8.79	9.38	9.70
Coal [€/GJ]	2.06	2.24	2.42	2.47	2.52

Demographic characteristics: the population during the period 2010-2040 is presented in ***Table 5.8***.

Table 5.8 Population evolution 2010-2030

Year	2020	2025	2030	2035	2040
Population [mil]	11.00	10.90	10.80	10.70	10.60

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 5.9*** the projected macroeconomic data till 2040 are presented. In ***Table 5.10***, the CO2 emission allowances prices

[15] means gross inland consumption, excluding non-energy uses

considered were also added. The projections of main macroeconomic indexes were provided by the Ministry of Finance.

Table 5.9 Gross domestic product growth (Average Annual)

	2020-2025	2025-2030	2030-2035	2035-2040
Gross domestic product growth (Average Annual)	2.2%	2.0%	1.5%	1.5%

Table 5.10 CO2 emission allowances price

	2020	2025	2030	2035	2040
CO2 emission allowances €/tCO2	8.0	13.0	20.0	22.5	27.0

<u>*Energy demand:*</u> The gross inland consumption and the final energy consumption according to the "with measures" scenario are presented in ***Tables 5.11 and 5.12.***

Table 5.11 Gross inland consumption according to "with measures scenario" (ktoe)

	2020	2025	2030	2035	2040
Solid fuels	4,117	4,815	3,289	2,742	2,765
Liquid fuels	12,718	12,163	12,030	11,688	11,199
Natural Gas	3,751	3,596	3,627	3,939	4,246
RES	3,362	4,449	5,546	6,449	7,024
Electricity	559	475	496	506	507
Total	24,506	25,499	24,988	25,324	25,742

Table 5.12 Final energy consumption according to "with measures scenario" (ktoe)

	2020	2025	2030	2035	2040
Industry	3,569	3,856	4,239	4,484	4,566
Transport	7,327	7,256	7,205	7,097	7,071
Residential	4,205	4,188	4,164	4,158	4,187
Agriculture/Forestry	765	807	847	881	910
Services	2,104	2,305	2,549	2,650	2,715
Total	17,970	18,412	19,005	19,269	19,448

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.

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 5.13***. 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 5.13.

Table 5.13 Main assumptions for the "with measures" scenario in IPPU sector.

Process	Projections
Mineral products (Mt)	The energy projected to be consumed in cement plants by Times model was used as a driver for the estimation of emissions of the whole category.
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 emissions of the whole category.
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 5.14***) 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 decrease with a rate of about 3.2% per annum for the period 2015 – 2020. 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 5.14 Projections of GHG emissions from the IPPU sector (in kt CO_2eq)

Year	2015	2020	2025	2030	2035	2040
Mineral products	3,957	4,028	4,112	4,447	4,693	4,806
Chemical industry	516	532	567	593	611	633
Metal production	1,210	1,327	1,948	2,276	2,449	2,433
Other product manufacture and use	258	271	306	326	345	354
Product uses as substitutes for ODS	5,956	5,002	4,459	4,571	4,670	4,775
Total	11,896	11,159	11,391	12,213	12,768	13,001

5.4.2.3 Waste

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 5.15***, based on the analysis of the trends observed in the previous decade and data provided by MEEN.

In order to estimate the composition of MSW generated on an annual basis, the assumptions presented in the last National Inventory Report (2017) 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.

Finally, the quantities of the solid waste end out at disposal sites were estimated on the bases of historical data as well as on the implementation of implemented/adopted policies and measures. 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. The generation rate per capita, the quantities of biodegradable waste disposed in managed and unmanaged sites (SWDS) and the fraction of biodegradable waste landfilled are presented in ***Table 5.15***.

Table 5.15 Main assumptions of projections scenarios for solid waste disposal on land

	2015	2020	2025	2030	2035	2040
Generation rate (kg / cap / day)	1.242	1.366	1.469	1.578	1.617	1.658
Biodegradable landfill in managed sites (kt)	2785	1137	1168	1201	1208	1214
Biodegradable landfill in unmanaged sites (kt)	173	0	0	0	0	0
Fraction of biodegrable landfill (%)	79	28	27	26	26	25

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) and (b) the Directive on Packaging and Packaging Waste (94/62/EC) concerning the Paper and Cardboard recycling.

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 5.16***.

Table 5.16 GHG emissions from the waste sector (kt CO_2eq)

Year	2015	2020	2025	2030	2035	2040
Solid Waste Disposal on Land	3157	3067	2847	2780	2632	2489
Emissions Doms	483	489	490	491	492	492
Emissions Com	815	857	900	946	995	1045
Waste Incineration	10	14	19	23	27	32
Compost	21	306	317	327	322	316
Total	**4486**	**4733**	**4573**	**4568**	**4467**	**4375**

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 5.18***) increases continuously with a mean annual rate of 0.9% 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 1990-2015 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 1990-2015.

Table 5.17 Animal population (thousands) per species (3-year average)

Animal population (thousands)	Projection					
	2015	2020	2025	2030	2035	2040
Dairy cattle	133	146	150	154	158	162
Non dairy cattle	544	600	616	631	647	663
Buffalos	3	3	3	3	3	3
Sheep	8473	9354	9591	9833	10081	10336
Goats	4772	5269	5402	5539	5678	5822
Horses	33	37	38	39	40	41
Asses & mules	39	43	44	45	46	48
Swine	746	824	844	866	888	910
Poultry	31611	34901	35782	36686	37612	38562

Table 5.18 Projection of nitrogen inputs in soils (in kt) from synthetic fertilizers

	Projection					
	2015	2020	2025	2030	2035	2040
Synthetic fertilizers (kt N)	185	204	210	215	220	226

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 5.19***, 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 5.19 Projection of agricultural crops production

Production (ktn)	Projection					
	2015	2020	2025	2030	2035	2040
Wheat	1558	1720	1763	1808	1853	1900
Barley	425	469	481	493	506	518
Oats	101	112	115	118	121	124
Rye	25	28	29	29	30	31
Maize	2132	2354	2413	2474	2537	2601
Rice	222	245	251	258	264	271
Beans	18	20	21	21	22	23
Peas	1	1	1	1	1	1
Potatoes	622	687	705	722	741	759
Sugarbeet	392	433	444	455	467	478

Total GHG emissions from agriculture are presented in ***Table 5.20***.

Table 5.20 GHG emissions from agriculture in the "with measures" scenario (kt CO_2eq)

Year	2015	2020	2025	2030	2035	2040
Enteric Fermentation	3919	4327	4436	4548	4663	4781
Manure Management	971	1072	1099	1127	1155	1185
Rice Cultivation	142	156	160	164	169	173
Agricultural Soils	3209	3540	3629	3720	3813	3909
Urea application	26	29	30	31	31	32
Field Burning of Agricultural Residues	43	47	49	50	51	52
Total	**8310**	**9172**	**9403**	**9640**	**9883**	**10132**

In general, a declining trend in emissions from the agriculture sector is expected for the period up to the middle of the period 2015-2020. Except of the citified way of life which has been adopted and the abandonment of rural areas, the declining 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 absent.

5.4.2.5 Land Use, Land Use Change and Forestry

Projections of GHG emissions and removals from the LULUCF sector were based on methods and assumptions used for the estimation of emissions and removals during 1990 – 2015. Emission factors applied are the ones used in the preparation of the last submitted inventory. 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:

- According to the forest definition used in the inventory, the area of managed and harvested forest land will remain constant, equal to 2015 levels.
- The annual biomass uptake in these lands, as well as the annual losses as a result of the fellings, 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.
- Area under deforestation activities will remain constant and equal to the average area deforested during the period 1990 – 2015.
- Carbon stock changes in areas under conversion to forest land will remain constant and equal to the average estimated during the period 2000 – 2015.
- Areas affected by wildfires each year will be equal to the average area burnt in the period 1990 – 2015 (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 – 2015).
- N_2O 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 – 2015.

Table 5.21 presents emissions (with positive sign) and removals (with negative sign) of the three GHG from this sector until 2040.

Table 5.21 Net emissions / removals of GHG from Land Use, Land Use Changes and Forestry per gas (kt CO2 eq)

	2015	2020	2025	2030	2035	2040
Carbon dioxide	-3160	-1780	-1218	-811	-333	-918
Methane	11	56	56	56	56	56
Nitrous oxide	9	10	10	10	10	10
Total	-3140	-1714	-1152	-746	-267	-852

As depicted in table above the sink capacity of the LULUCF sector is projected to decrease in the future, from -3.14 Mt CO_2 eq in 2015 to -0.85 Mt CO_2 eq. in 2040.

In LULUCF sector CO_2 is the main greenhouse gas emitted to and removed from the atmosphere following carbon stocks changes in different carbon pools. Non-CO_2 greenhouse gases (CH_4 and N_2O) and indirect GHG are released in relatively small quantities mainly when biomass is burnt.

During the period 1990–2015 forest land category acts as net carbon sink. Emissions/removals from forest land are the result of the balance mainly in biomass increment from forest growth and biomass loss due to fellings and wildfires. Net removals from forest land show an upward trend in the same period that is attributed mainly to the reduction in fellings and the afforestation programmes started in 1994. The upward trend is projected to continue until 2040, with a lower rate however.

Wildfires constitute a common disturbance in Mediterranean basin and in Greece in particular. Their occurrence is difficult to predict, consequently any projection for emissions as a result of the wildfires involves higher uncertainties. For this reason, the average of emissions during the period 1990–2015 was used for the projection of emissions from wildfires. CO_2 and non-CO_2 emissions are projected to represent approximately 1% of the total emissions/removals.

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.

Given that no county specific policies and information about future harvested wood products (HWP) from domestic forests are available, projections of emissions/removals from this pool are based on the trend observed from 2000 onwards. HWP pool is projected to represent a source of emissions during the period 2020-2040.

During the period 1990-2015 removals from cropland, fluctuate between 0.3-1.0 Mt CO_2 eq yr-1 (except 2007, 2013, 2014, 2015 where the category acts as a source). Following the trend observed during the inventory period, cropland category is projected to represent a source of emissions in the period 2020-2040, as a result of the eradication and establishment of new of perennial woody crops (change to a different crop type).

Grassland category is projected to act as a sink in the period 2020-2040 mainly due to conversion of cropland to grassland. Emissions from that category are primarily the result of conversion of forest land to grassland and changes in vegetation type, as well as, the result of wildfires.

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. Greece has not elected to account for any of the elective activities under Article 3, para 4 of the Kyoto Protocol for the second commitment period. 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 – 2.8 Mt CO_2 per year.

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.

In this chapter two additional scenarios of GHG emissions projections are presented for sensitivity analysis purposes. In the next table, the main assumptions and the deviation of key input variables comparing to the examined “with measures” scenario are illustrated.

Apart for the energy sector, no other sector is included in sensitivity analysis, since the energy sector accounts for more than 80% of GHG emissions.

Table 5.22 Main assumptions of Sensitivity Analysis Scenarios

Scenario No	Main assumptions
SensSc1	WM scenario
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

In ***Figure 5.2***, the evolution of GHG emission projections of the scenarios listed in ***Table 5.22*** is illustrated. As it can be concluded from the 2 sensitivity scenarios examined, the deviation of key input variables from the WM scenario is projected to have effect on total GHG emissions practically after year 2025. For all scenarios, the total emissions are estimated to have a decreasing trend. The total GHG emissions of SenSc2 are projected to be 4.7% and 6.8% lower than WM in 2030 and 2040, respectively; and total GHG emissions of SenSc3 1.1% and 2.3% lower in 2030 and 2040, respectively.

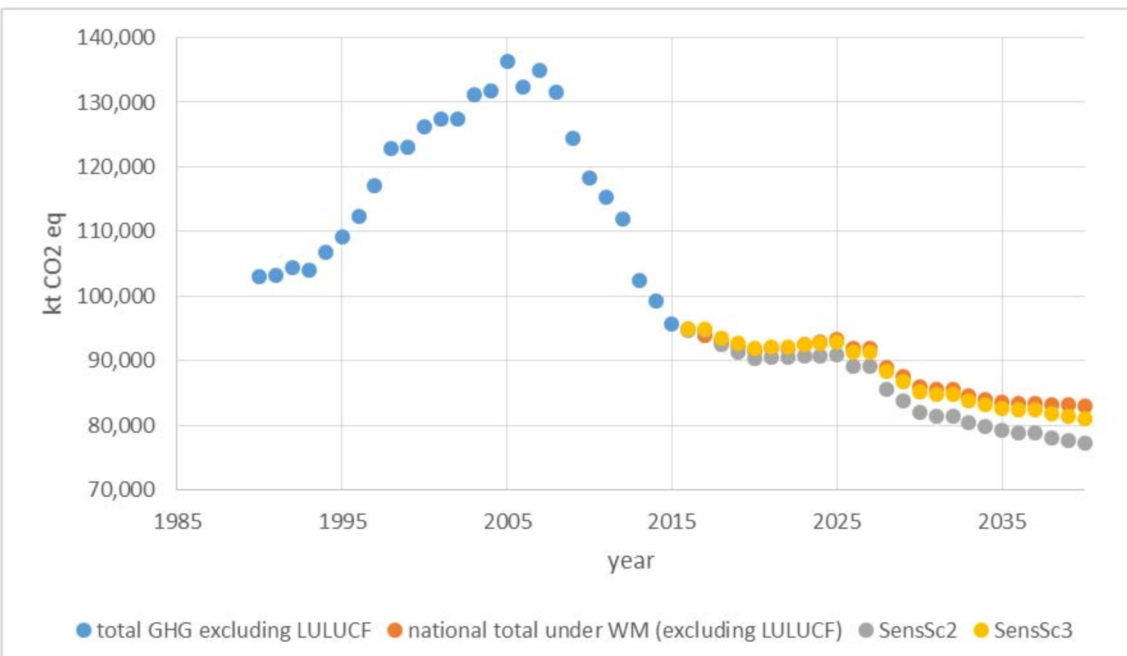


Figure 5.2 Evolution of GHG emission projections corresponding to the sensitivity analysis scenarios examined

5.6 Projections of indirect GHGs

In ***Table 5.23***, 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 measure" scenario of the projections of GHG emissions.

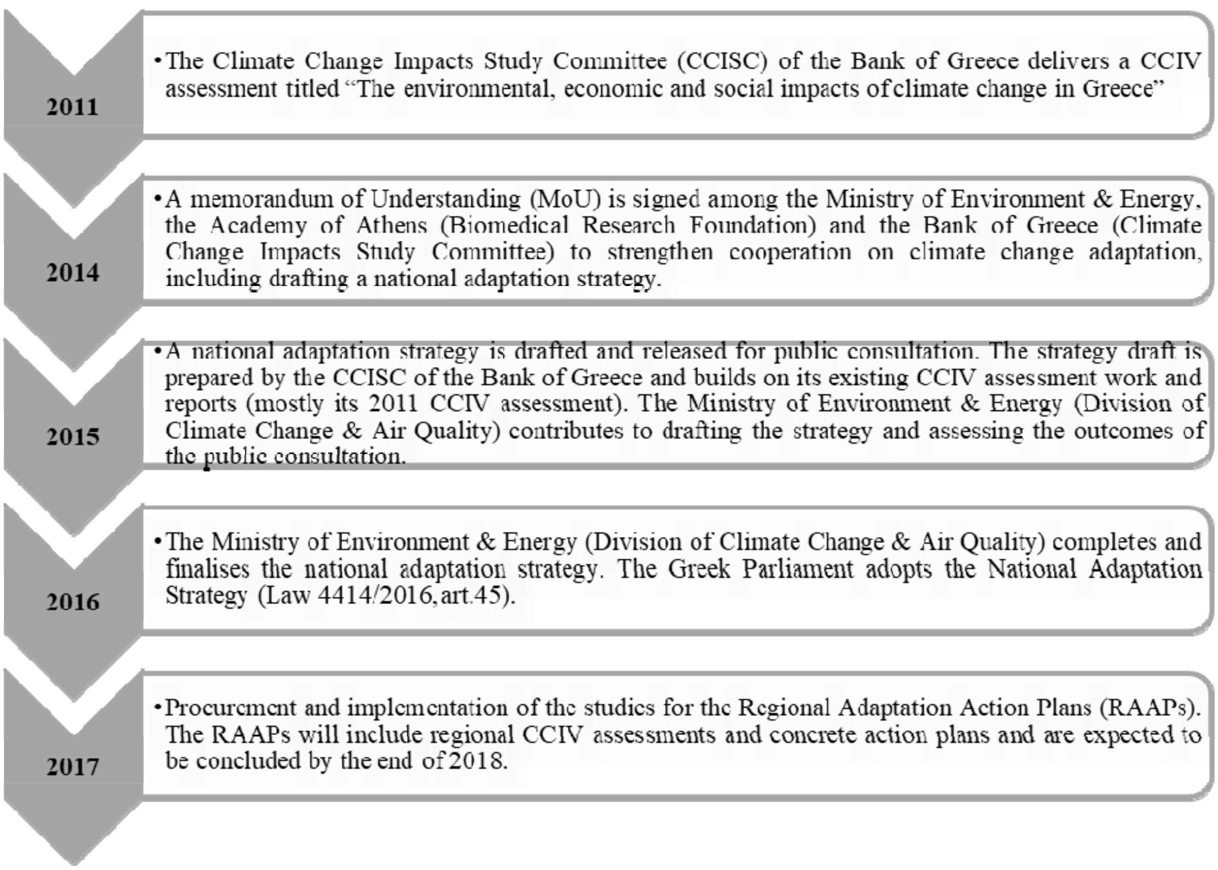
Table 5.23 Emission projections for years 2020 till 2040

Pollutant	2017 Emission Inventory				Projections WM scenario			
(kt)	1990	2005	2010	2015	2020	2025	2030	2040
NOx	377.09	440.29	342.95	252.97	250.03	234.16	226.48	203.42
NMVOC	331.23	305.93	252.36	205.54	187.81	186.94	181.62	172.36
SOx	487.15	570.44	219.13	99.15	89.16	90.00	81.93	75.68
NH3	78.24	65.09	63.59	60.33	60.27	61.42	62.70	65.22
PM2.5	54.70	57.58	45.69	34.68	35.90	36.86	36.76	36.13
BC	8.85	8.40	7.28	5.36	6.48	6.38	6.38	6.00

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) and started developing Regional Adaptation Action 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 (6.1-6.4). The major milestones of the Greek adaptation policy can also been seen at the chart below.



6.1 Climate Change impact

The Bank of Greece report (CCISC) (Bank of Greece 2011) on the impacts of climate change has highlighted 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 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 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 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

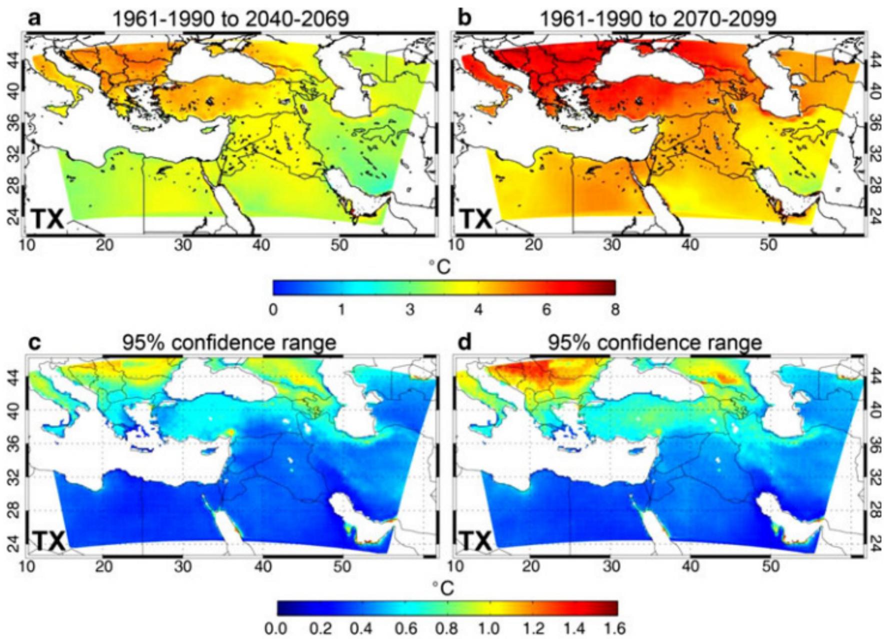
The climate in Greece is typical of the Mediterranean climate: mild and rainy winters, relatively warm and dry summers with, generally, long sunshine duration almost all the year. A great variety of climate subtypes, always in the Mediterranean climate frame, are encountered in several regions, due to 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).

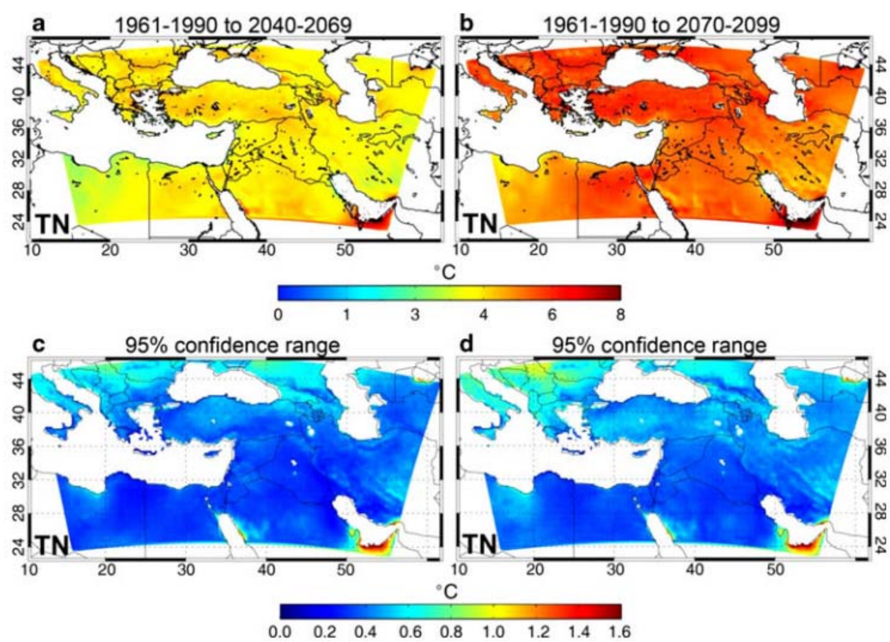
In ***Figure 6.1*** and ***Figure 6.2*** model projections of daytime maximum (TX) and nighttime maximum (TN) temperature during summer by the middle and the end of the twenty-first century are presented, concerning the Eastern Mediterranean and Middle East region (EMME). They also show the 95-percentile 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).



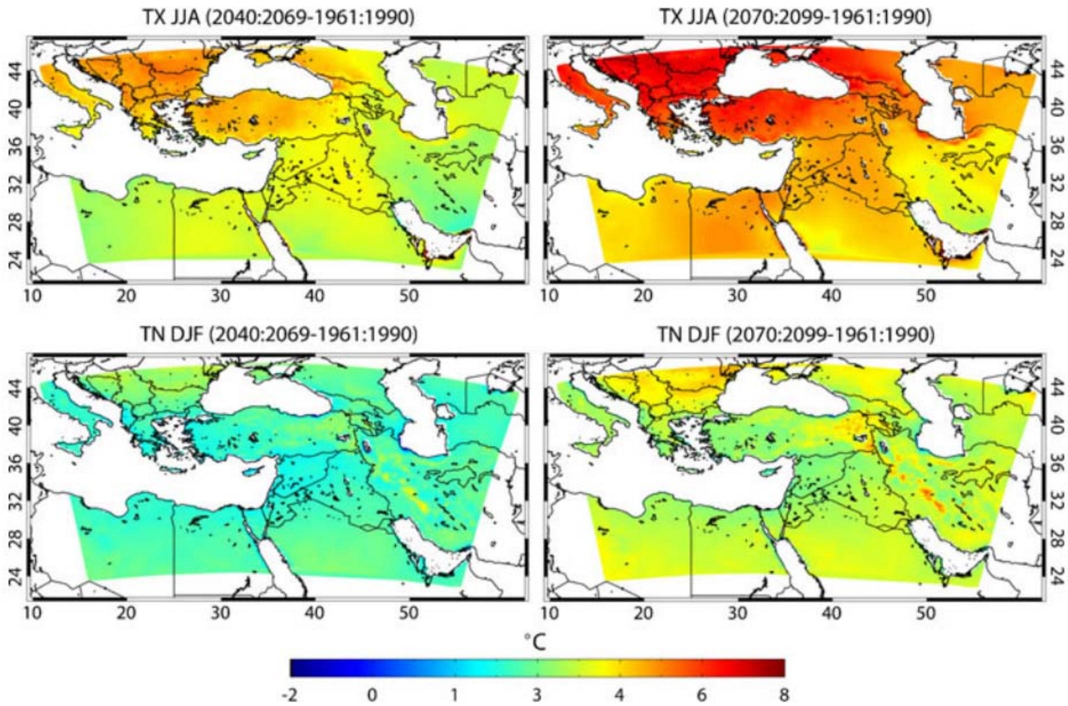
Source: (Lelieveld, Hadjinicolaou et al. 2013). Model projected heat extremes and air pollution in the eastern Mediterranean and Middle East in the twenty-first century, 2013.

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.

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

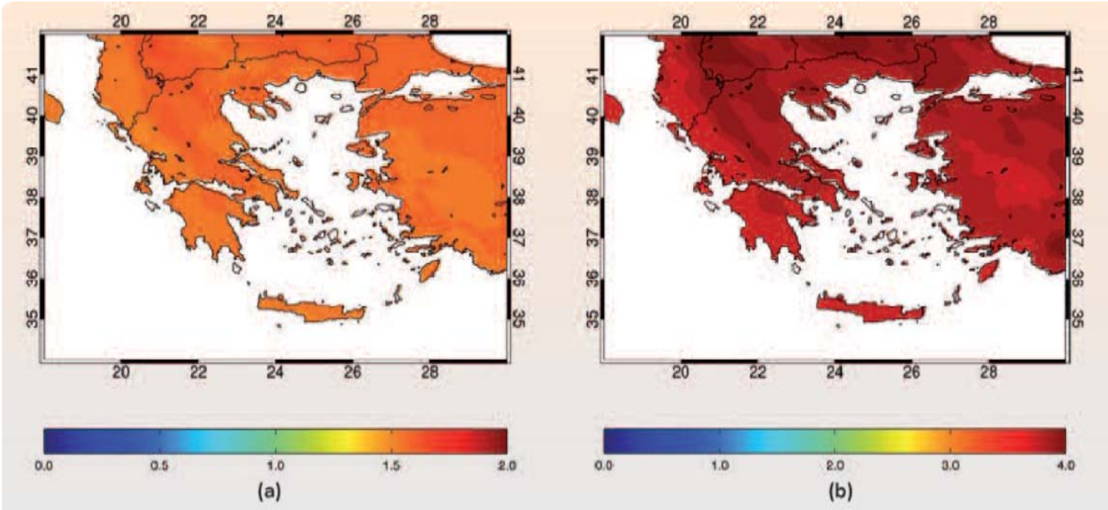
Source: Hellenic National Meteorological Service, 2012.

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).

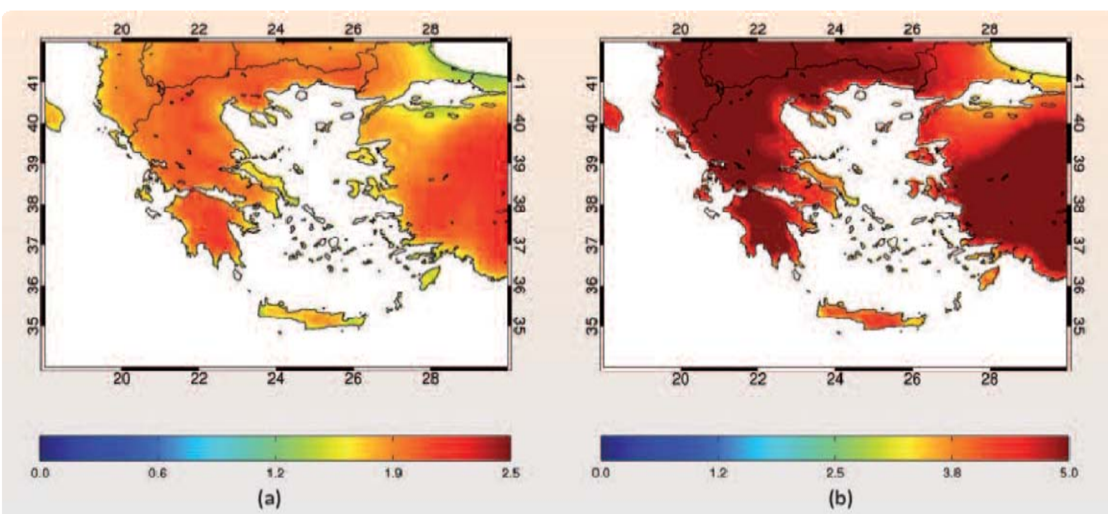
The increase in this parameter is likely to have an impact on forests, presently adapted to colder weather conditions. If the conditions become prohibitive, certain categories of forests (e.g. fir) would have to shift to higher altitudes.



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.

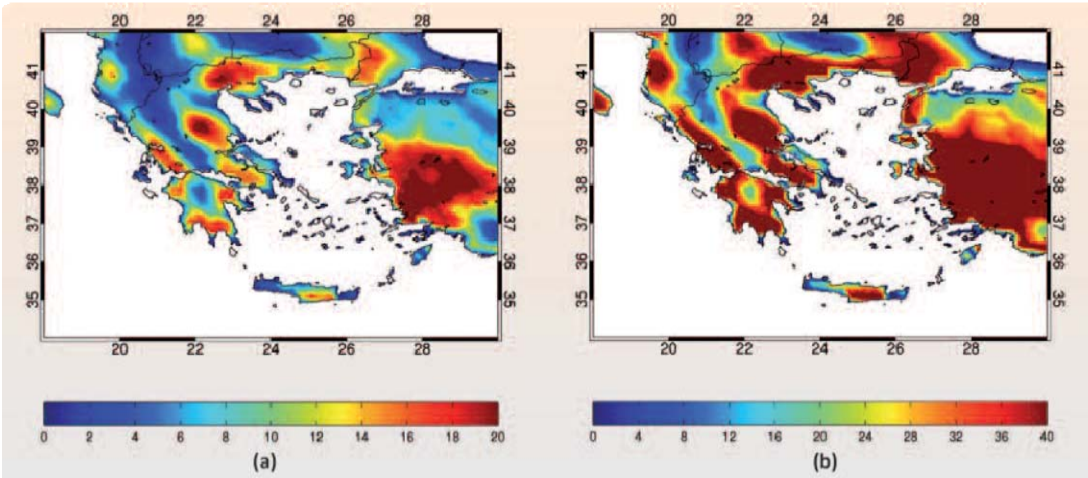


Source: (Bank.of.Greece 2011) "The environmental, economic and social impacts of climate change in Greece"

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.



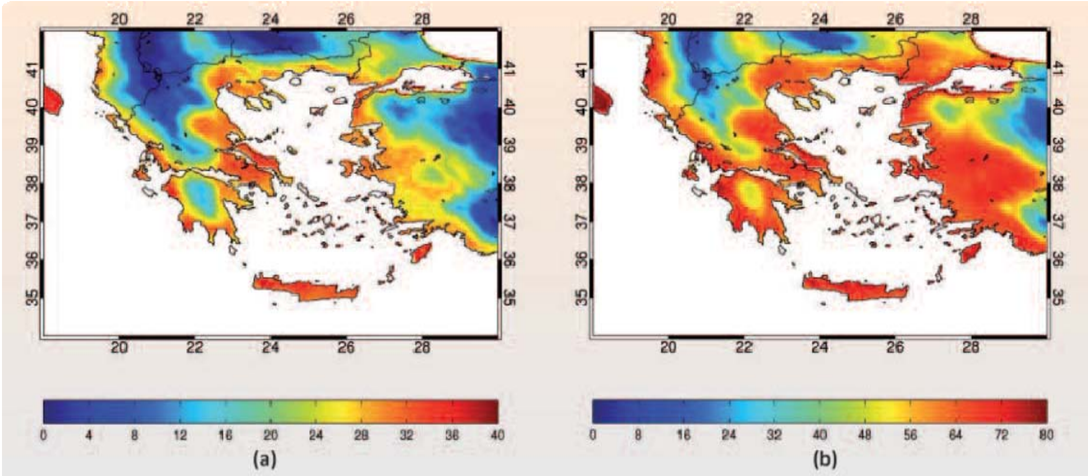
Source: (Bank.of.Greece 2011) "The environmental, economic and social impacts of climate change in Greece"

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.

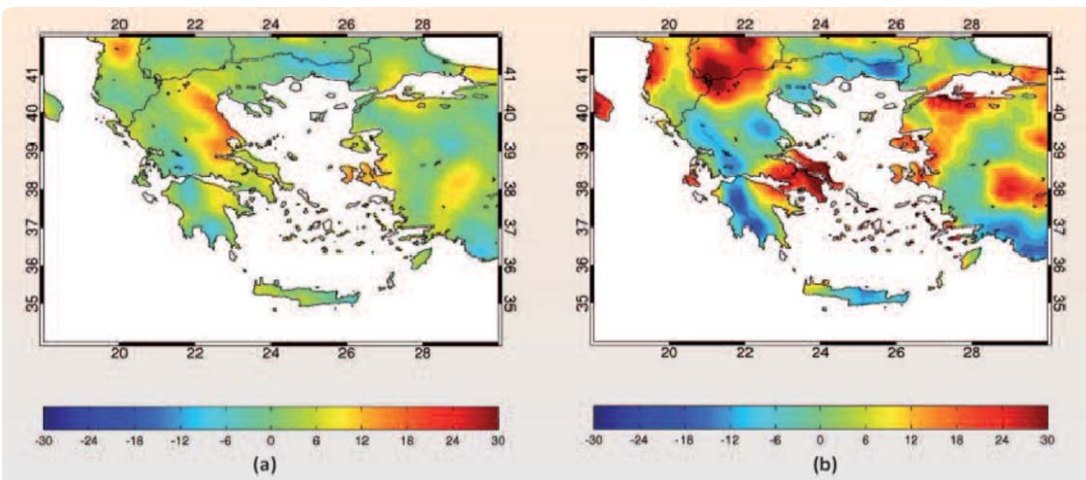
Region	Days	Place	High °C	Millimetres
Aegean Islands	8	Mytilini	25.5	648
Crete	92	Heraklion	19.0	483
Peloponnese	77	Kalamata	30.7	780
Western Greece	112	Agrinio	36.7	931
	86	Patras	26.1	663
Central Greece	98	Athens	14.4	365
	110	Lamia	22.6	574
	117	Larissa	16.7	423
Northern Greece	114	Thessaloniki	17.7	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.

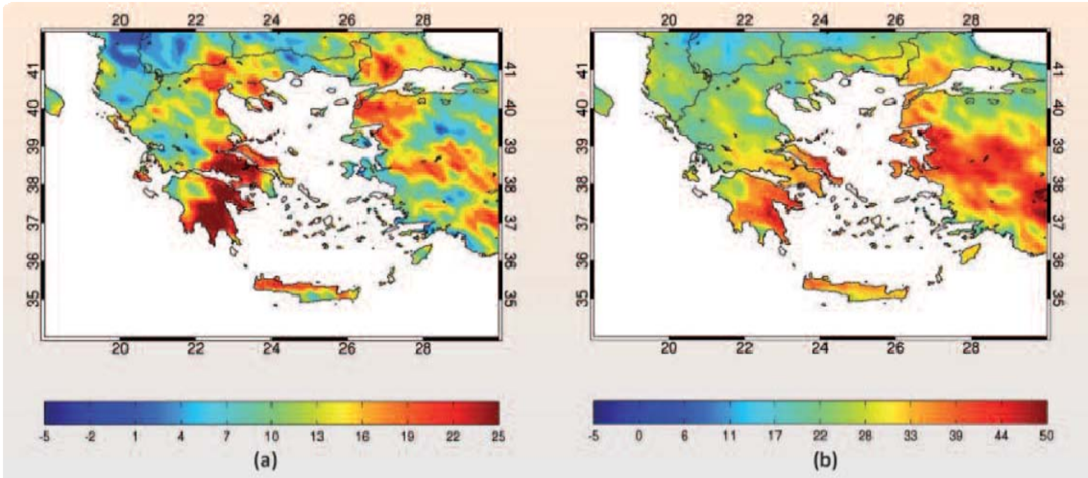
In the eastern continental regions, in particular, maximum consecutive 3-day precipitation is projected to increase by 20%. These contrasts become even more pronounced toward the end of the 21st century, with the amount of extreme rainfall projected to decrease by 10-20% in regions of Western Greece 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.



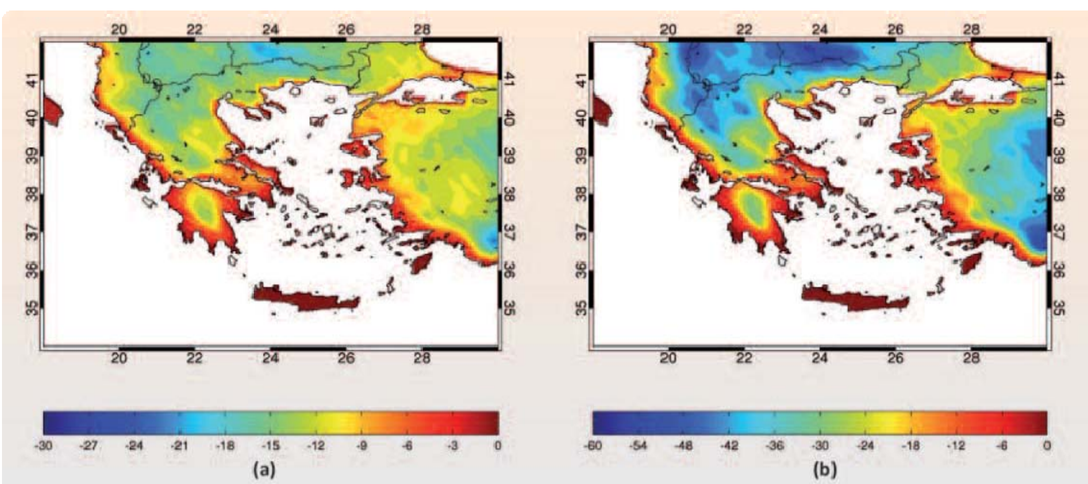
Source: (Bank.of.Greece 2011) "The environmental, economic and social impacts of climate change in Greece"

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

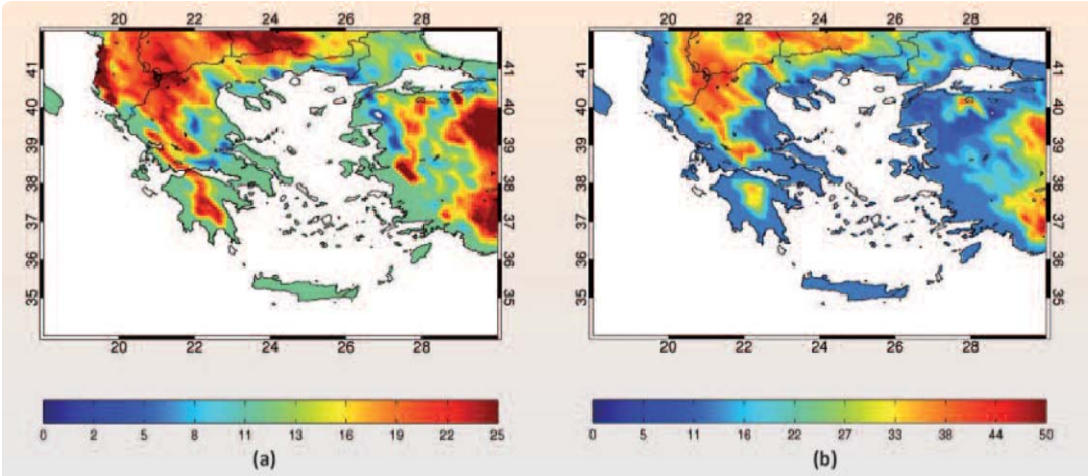
The projected changes in the number of frost days per year are represented in ***Figure 6.10***.

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).

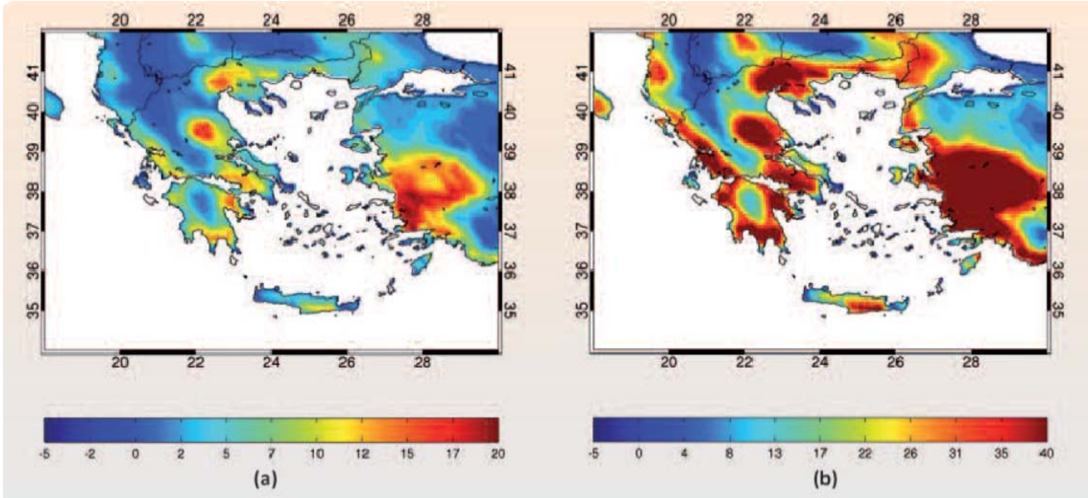
Energy demand for heating and cooling

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.***

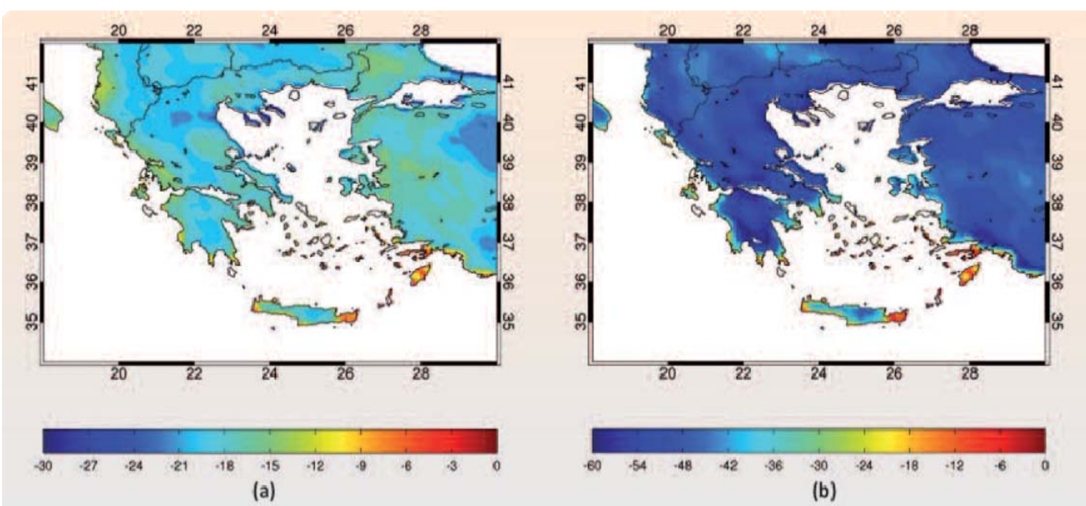


Source: (Bank.of.Greece 2011) "The environmental, economic and social impacts of climate change in Greece"

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.



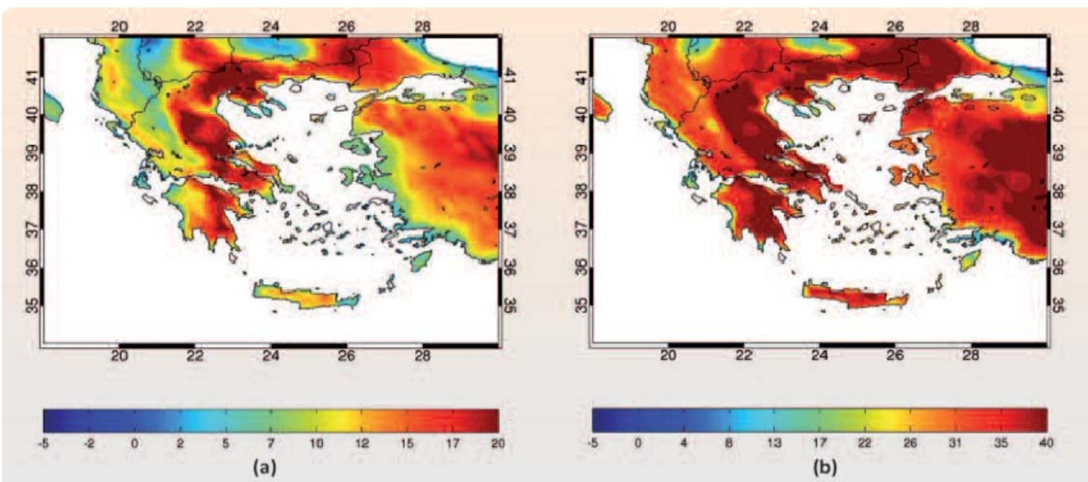
Source: (Bank.of.Greece 2011) "The environmental, economic and social impacts of climate change in Greece"

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).



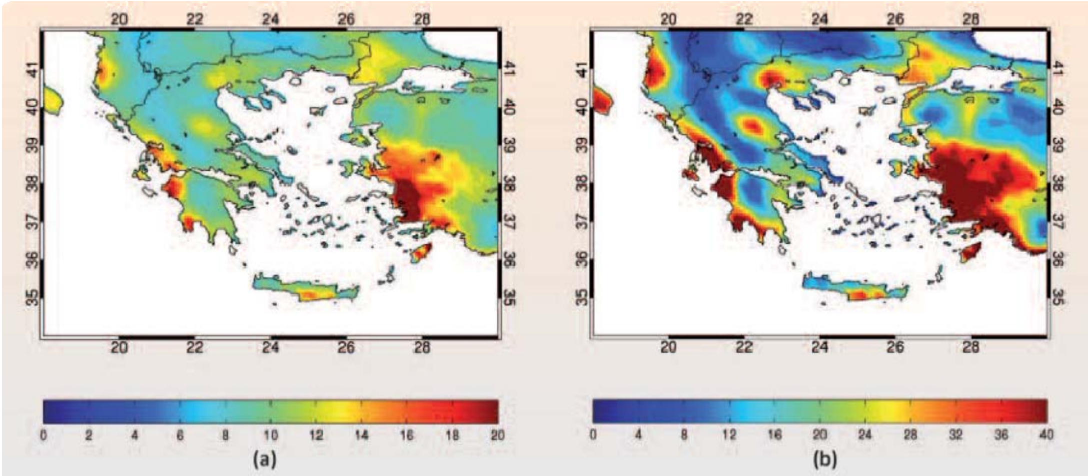
Source: (Bank.of.Greece 2011) "The environmental, economic and social impacts of climate change in Greece"

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 > 38ºC) in (a) 2021-2050 and (b) 2071-2100, relative to 1961-1990

Humidex (equivalent to dry temperature in ºC) is computed with the following formula:

$$T\,(\mathrm{h}) = T_{\max} + 5/9^{*}\,(e - 10)$$

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 (ºC) 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:

- <29ºC: no discomfort
- 30-34ºC: some discomfort
- 35-39ºC: discomfort; avoid intense exertion
- 40-45ºC: great discomfort; avoid exertion
- 46-53ºC: significant danger; avoid any activity
- >54ºC: imminent danger; heatstroke

The projected changes in the number of consecutive days during summer with a humidex value above 38ºC 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>38ºC 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.

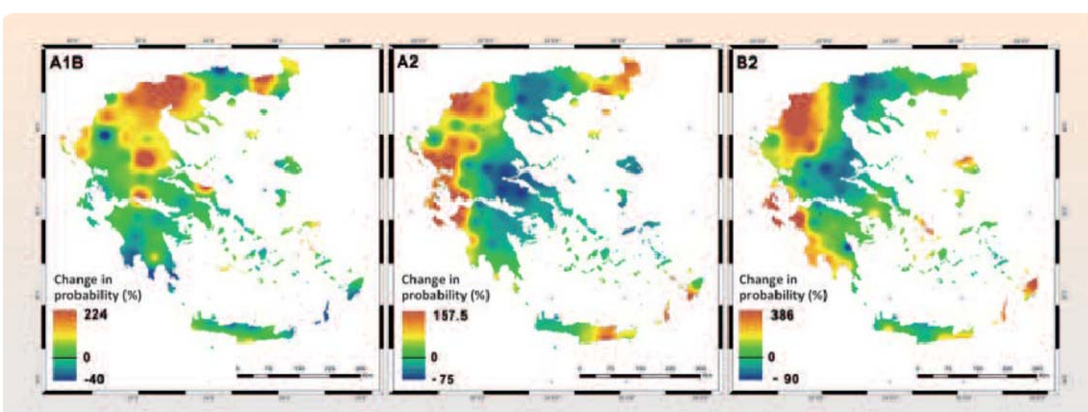
The temporal distribution of flood events in Greece between 1880 and 2010 presents a significant increase during the last decades. This is not a trend in natural processes (i.e. climate change) but is due to:

- 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.

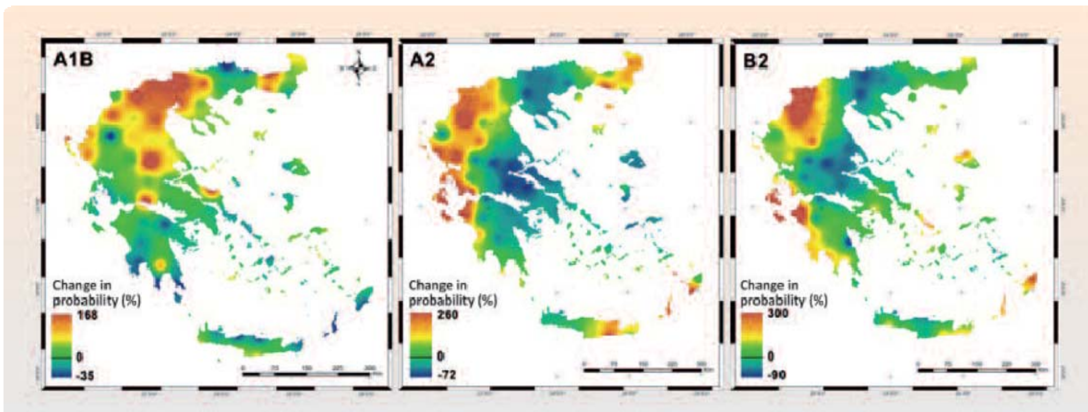
The final results were obtained by calculating the percentage change in probability of rainfall exceeding the thresholds between the reference period (1960-1990) and the periods 2071-2100 (for Scenarios A2 and B2) and 2090-2099 (for Scenario A1B). The results present similar spatial distributions with 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.

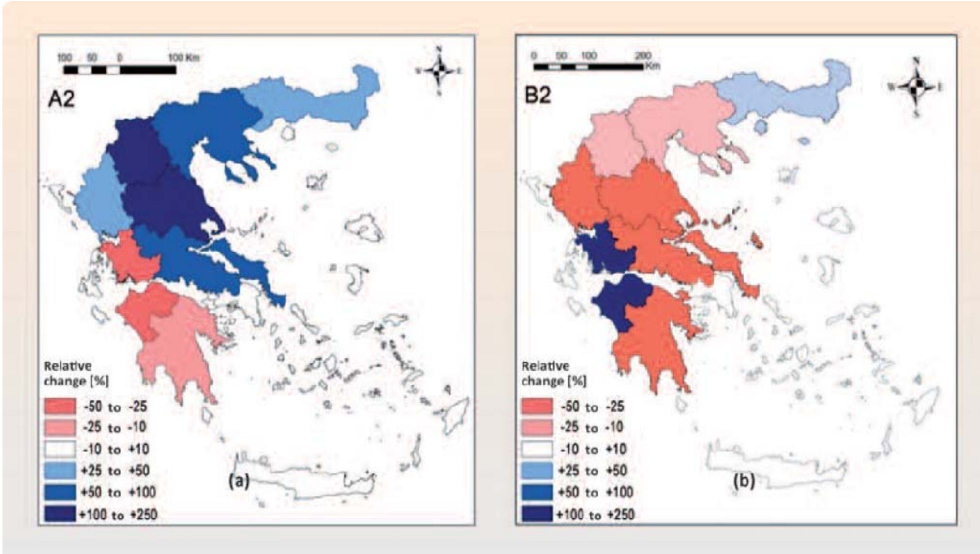


Source: (Bank.of.Greece 2011) “The environmental, economic and social impacts of climate change in Greece”

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.

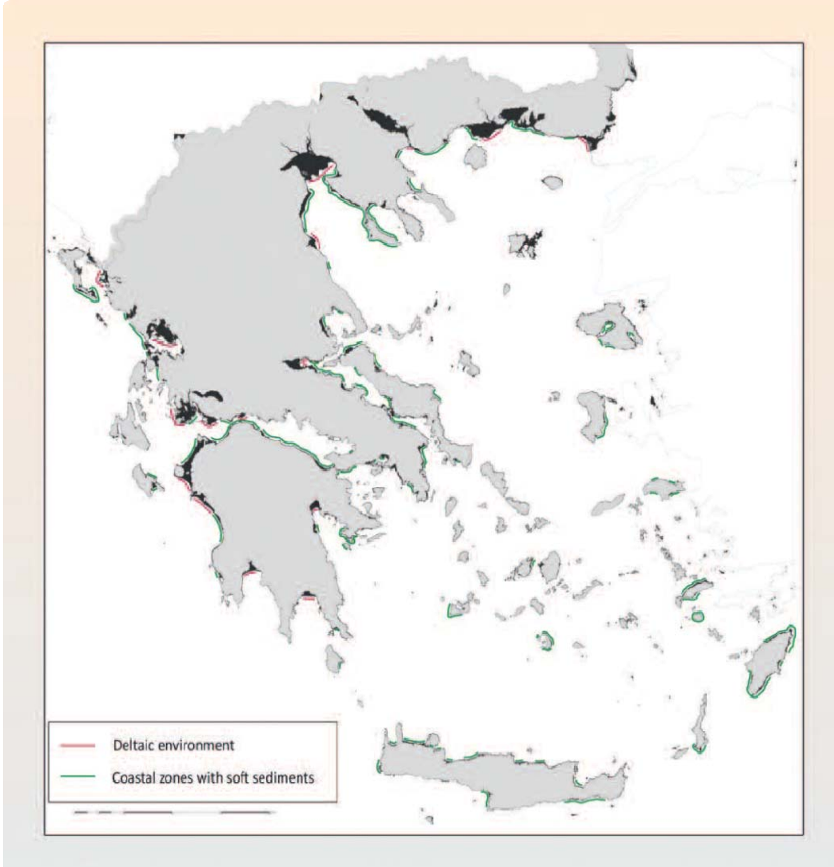
A change (i.e. increase) in **sediment discharge and deposition** in large river delta-front estuaries can cause the delta front to advance and locally offset the sea level rise. Conversely, a decrease in river sediment discharge could reinforce the incursion of the sea following a sea level rise.

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

6.1.5 Impact of climate change in each sector

6.1.5.1 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. 4a 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. 4b Assessment of possible impacts of climate change in different climate zones in Greece (continued)

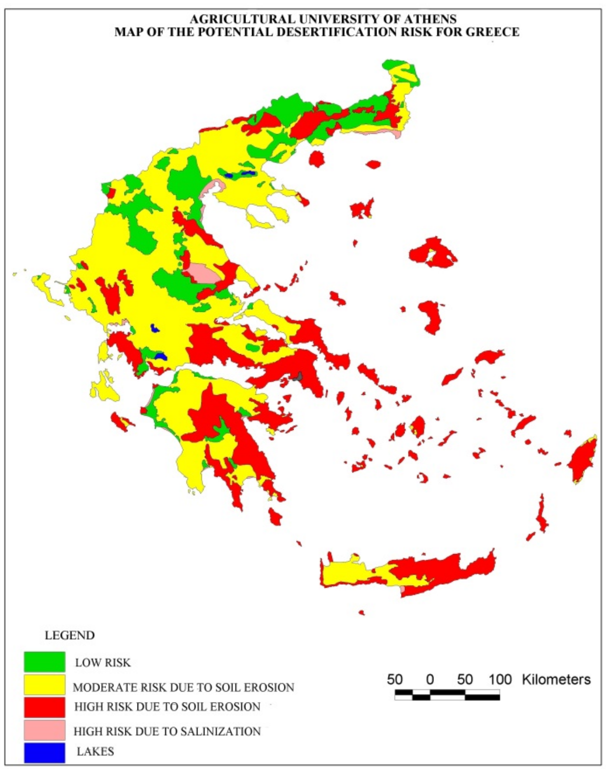
	Scenarios	A1B		A2		B2	
Climate zones	Periods	2041-2050	2091-2100	2041-2050	2091-2100	2041-2050	2091-2100
Eastern Peloponnese	Cotton						
	Wheat						
	Maize						
	Nuts & fruits						
	Olives						
	Vines						
	Vegetables						
Cyclades	Cotton						
	Wheat						
	Maize						
	Nuts & fruits						
	Olives						
	Vines						
	Vegetables						
North-Eastern Aegean	Cotton						
	Wheat						
	Maize						
	Nuts & fruits						
	Olives						
	Vines						
	Vegetables						
Dodecanese	Cotton						
	Wheat						
	Maize						
	Nuts & fruits						
	Olives						
	Vines						
	Vegetables						
Crete	Cotton						
	Wheat						
	Maize						
	Nuts & fruits						
	Olives						
	Vines						
	Vegetables						
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.



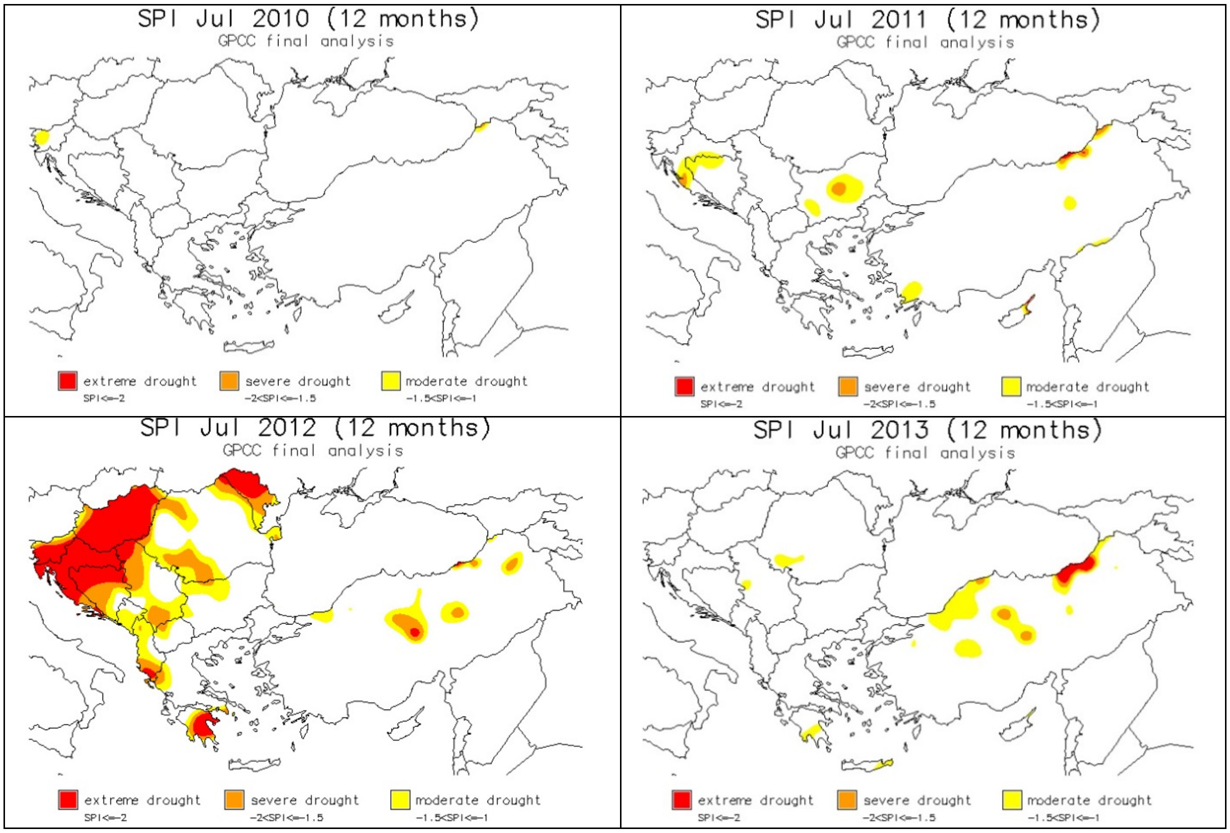
Source: National Committee for Combating Desertification, 2009 (Available on the website http://www.gnccd.com)

Figure 6.20 Map of the potential desertification risk for Greece.

In the Standardized Precipitation Index (SPI)[16] is presented for Greece and for the years 2005-2008, according to data collected from the Drought Management Centre of Southeastern Europe

[16] 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

(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.



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.

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).

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. 5 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. 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. 6 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**

6.1.5.2 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.

6.1.5.3 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. 7 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. 7 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).

6.1.5.4 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. 8 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).

6.1.5.5 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. 9 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. 10 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. 11 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 20^{th} 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.

6.1.5.6 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.

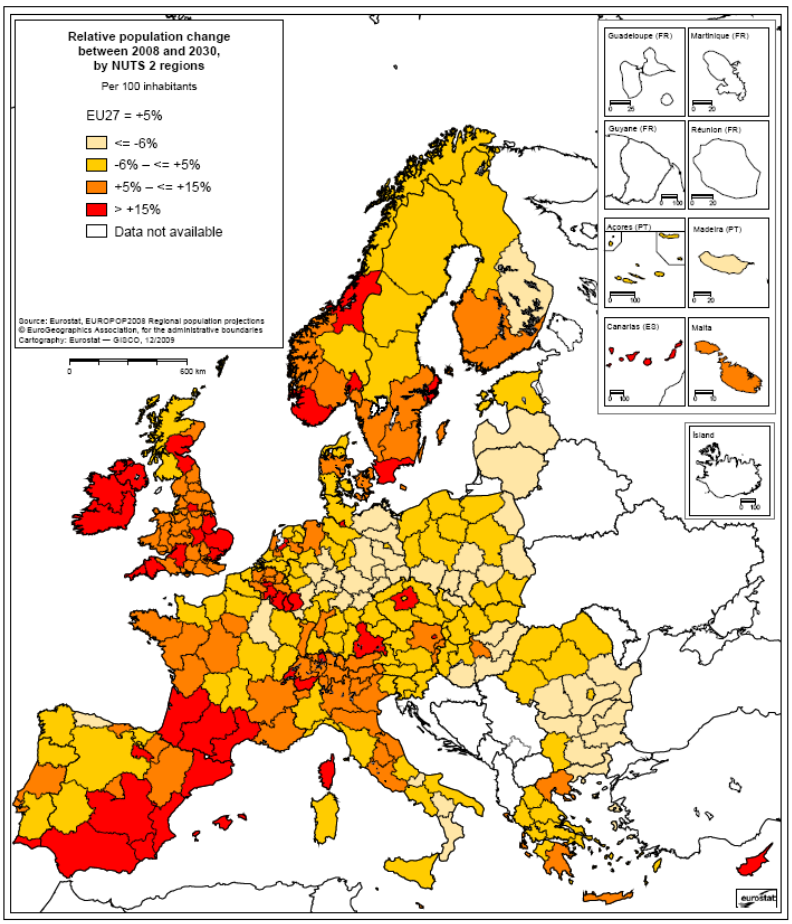
Coastal areas help generate and preserve microclimates. The presence of coastal forests and wetlands ensures the minimization of floods, erosion and other natural disasters, and offers valuable regulating and supporting ecosystem services. The last 20 years have seen a boom in the construction of summer 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.

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. 12 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).

6.1.2.7 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. 13***, 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. 13***, 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. 13,*** 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. 13,*** 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. 13 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.

6.2.5.8 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:

- <u>*Reference scenario:*</u> 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%.

- <u>*Extreme scenario:*</u> 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%.

- <u>*Mild scenario:*</u> 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).

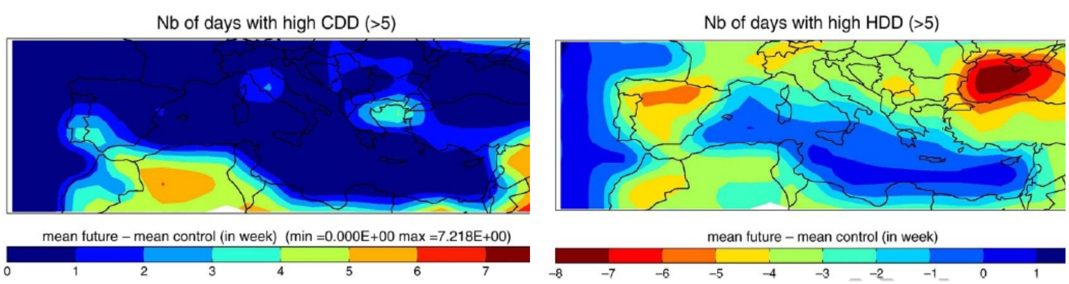


Figure 6.24 Change in the number of days with (a) large cooling demand and (b) large heating demand between the future and the control period (1961-1990)

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***.

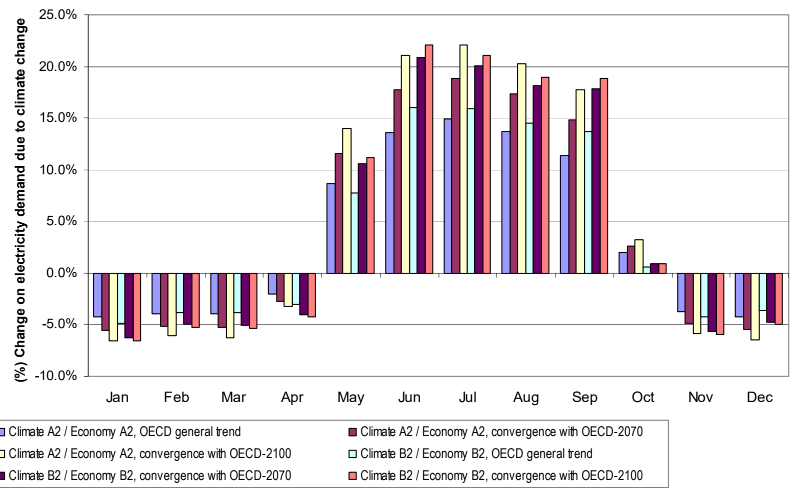


Figure 6.25 Change of the monthly electricity demand in Greece during the period 2071-2100 exclusively as a result of climate change under the A2 and B2 IPCC scenarios.

6.1.5.9 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. 14 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. 15 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. 16 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.

6.1.5.10 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. 17***. 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. 17 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 $\mu g/m^3$ 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 $\mu g/m^3$ – corresponding to a decrease in concentration from 97.5 $\mu g/m^3$ in 2000 to 81.5 $\mu g/m^3$ 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).

6.1.5.11 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.

6.1.5.12 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).

6.1.5.13 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).

6.1.5.14 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%.

6.2 Risk & Vulnerability assessment

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.

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) art.45 and is available on the Ministry's website (for the time being it is available only in Greek).

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 $s_{ij} = \frac{Y_{ij}}{Y_j}$ 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. 18 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 MACEDONIA	33.845	1.205	0.275	348.744	3.496	1.078	1.021	24.133	1.226	415.023	4021.00	0.103214
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. 19 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. 20 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 Adaptation measures 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.

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.

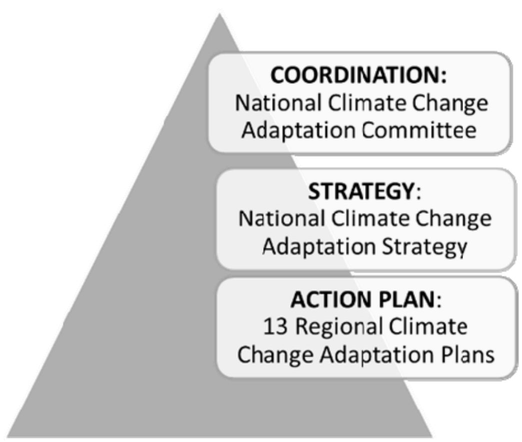


Figure 6.26 The Greek Climate Change Adaptation Framework

6.3.1 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.

Key objectives of the NAS are to:

1. establish and enhance the (short-term and long-term) decision-making procedure regarding adaptation issues;
2. link adaptation with the promotion of a sustainable growth model through the implementation of regional/local action plans;
3. promote adaptation actions and policies in all sectors of the Greek economy, with emphasis on the most vulnerable ones;
4. create a monitoring, evaluation and update mechanism for adaptation actions and policies; and
5. build adaptation capacity and raise public awareness.

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.

6.3.3.1 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.

6.3.3.2 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.

6.3.3.3 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.

6.3.3.4 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.

6.3.3.5 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.

6.3.3.6 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.

6.3.3.7 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).

6.3.3.8 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.

6.3.3.9 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.

6.3.3.10 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.

6.3.3.11 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

6.3.3.12 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.

6.3.3.13 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.

6.3.3.14 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.

6.3.3.15 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).

6.3.2 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.

6.3.3 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.

NASAdditionally 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' (http://www.actlife.eu/EN/deliverables.xhtml) 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.).

6.3.4 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.

6.3.4.1 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. 21 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*[17] and *Mediterranean monk seal*[18] 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

[17] 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.

[18] 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.

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.

6.3.4.2 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 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.

6.3.4.3 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[19], 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.

6.3.4.4 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.

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,

[19] 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).

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):

<u>Insurance aquaculture</u>: 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.

<u>Technology transfer and research</u>: 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.

<u>Diversification of crop species</u>: 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.

<u>Adoption of selection systems for the installation and monitoring of aquacultures</u>: 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.

6.3.4.5 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.

6.3.4.6 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).

6.3.4.7 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).

6.3.4.8 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.

6.3.4.9 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.

6.3.4.10 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. 22 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

Vulnerable Area	Vulnerability / Adaptation
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)

CHAPTER 7. FINANCIAL RESOURCES AND TRANSFER OF TECHNOLOGY

7.1 Introduction

This chapter contains information related to measures taken by Greece to give effect to its commitments under Article 4, paragraph 3 (financial resources), paragraph 4 (assistance in meeting costs of adaptation), and paragraph 5 (transfer of technologies). Paragraphs 2 to 4 contain information related to:

A. Provision of "new and additional" financial resources.

B. Assistance to developing country Parties that are particularly vulnerable to climate change.

C. Provision of financial resources, including financial resources under Article 11 of the Kyoto Protocol.

while paragraph 5 contains information related to:

D. Activities related to transfer of technology.

E. Information under Article 10 of the Kyoto Protocol (related to transfer of technology issues).

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 Millennium Development Goals (MDGs). 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 for all countries irrespectively of their development status as well as to the adoption of Sustainable Development Goals (SDGs) for the period 2015-2030 and a view towards 2050.

Through its bilateral and multilateral development cooperation, Greece provides financial resources to support national development initiatives and to address global developmental issues in the fields of sustainable development, health, environment, etc. A part of Greece's ODA is channeled directly to institutions and/or policies aiming to address environmental issues at the global or regional level, while environmental sustainability is a cross-cutting objective of the programmes, projects and policies financed.

Overall responsibility for development cooperation lies with the Ministry of Foreign Affairs, where the General Directorate for International Development Cooperation (Hellenic Aid /"YDAS") has systems in place to track, measure and record climate change related assistance provided to developing countries. Specifically, the Hellenic Aid programme coordinates programming, allocation and monitoring of development cooperation, multilateral and bilateral funding. The Ministry of Economy is responsible for Greece's contributions to multilateral institutions, such as the Global Environmental Facility, the World Bank, the European Bank for Reconstruction and Development and the United Nations Development Programme. The Ministry of Environment and Energy is responsible for the allocation of annual official and multilateral contributions to international organizations, United Nations convention secretariats including the United Nations Environment Programme and the UNFCCC, trust funds and agencies related to environmental issues.

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. At the moment, there are no other national measures in place to facilitate the above mentioned objectives.

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).

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 ODA general trends

While the international crisis was raging, Greece continued in 2017 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.

Despite these developments, Greece will continue to strive, according to its capabilities, for the implementation of the Millennium Development Goals (MDGs), that compose a policy framework for economic stability and prosperity, mainly via intensifying efforts to achieve the quality objectives of development assistance for which Greece has been committed internationally by the “Monterrey Consensus on Financing for Development” (2002), the “Paris Declaration on Aid Effectiveness” (2005), the “European Consensus on Development” (2005), the “Accra Agenda for Action” (2008) and recently the “Busan Partnership for Effective Development Co-operation” (2011).

Due to the difficult fiscal circumstances that it faces Greece’s net bilateral and multilateral Official Development Assistance (ODA) disbursements have indicated decreasing trends since 2008 both in absolute terms and as a percentage of GNI (cf ***Table 7.1***).

Table 7.1 ODA Volumes 2008-2016

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**

Source: "ANNUAL REPORT OF THE GREEK BILATERAL AND MULTILATERAL OFFICIAL DEVELOPMENT CO-OPERATION AND ASSISTANCE", MINISTRY OF FOREIGN AFFAIRS, HELLENIC INTERNATIONAL DEVELOPMENT CO-OPERATION DEPARTMENT, Y.D.A.S, December 2016

Total (bilateral and multilateral) ODA granted by Greece in 2016 reached 368.53 MUSD, that is 0.19% of GNI of which about 30% was channelled bilaterally to developing countries, while 57% through International Organisations. Multilateral ODA reached 209.38 MUSD, while bilateral ODA amounted to 159.15 MUSD. In relation to 2008, total ODA has a decreasing trend, due to the difficult fiscal circumstances (approximately 48%), while ODA/GNI ratio dropped respectively from 0.21% in 2008 to 0.19% in 2016. However, an increasing trend of bilateral and multilateral ODA is observed in past few years (since 2013).

7.4 Bilateral cooperation

Total bilateral ODA granted by Greece **in 2016** amounted to 159.15 MUSD. Bilateral assistance was granted mainly for refugees in Greek territory (146.61 MUSD) and 1.78 MUSD in scholarships for foreign students in Greece.

Total bilateral ODA granted by Greece **in 2015** amounted to 71.88 MUSD. Bilateral assistance was granted mainly for development projects in the sectors of education (including tertiary scholarships), health, water supply, peacekeeping, social services, road transport, informatics and aid to refugees in Greece. Categorizations of bilateral aid according to OECD/DAC statistical directives:

1. Aid Allocation by Geographical Region:
   - Europe: 6.12 MUSD,
   - Africa: 2.24 MUSD,
   - America: 0.26 MUSD,
   - Asia: 3.45 MUSD,
   - Oceania: -
   - Unallocated: 59.81 MUSD (including, inter alia, aid to refugees in Greece).

2. Aid Allocation by Main Recipient Countries:

- Ukraine: 1.92 m. USD,
- Albania: 1.59 m. USD,
- West Bank and Gaza Strip: 0.712 m. USD,
- Democratic Rep. Congo: 0.60 m. USD,
- Syria: 0.59 m. USD,
- Iran: 0.49 m. USD,
- Egypt: 0.49 m. USD,
- Turkey: 0.46 m. USD,
- Moldova: 0.44 m. USD,
- Belarus: 0.36 m. USD,
- Georgia: 0.33 m. USD.

3. Aid Allocation by Type of Aid:
   - contributions to specific programmes and funds managed by International Organizations: 0.35 m. USD,
   - projects: 0.91 m. USD,
   - experts and other technical co-operation: 1.25 m. USD,
   - scholarships and imputed costs of students from developing countries studying at Greek Universities: 9.86 m. USD,
   - refugees in the donor country: 59.43 m. USD.

4. Aid Allocation by Sector of Aid:
   - Social Infrastructure and Services: 10.24 m.USD
     - Education: 9.16 m. USD,
     - Health: 0.21 m. USD,
     - Government and civil society: 0.72 m. USD,
     - Other social infrastructure and services: 0.15 m. USD
   - Crosscutting: 2.07 m USD
     - Water supply and Sanitation: 0.15 m. USD
     - General environmental protection: 0.19 m. USD
     - Tertiary Scholarships: 1.97 m. USD,
   - Humanitarian assistance: 0.07 m. USD,
   - Costs of refugees: 59.43 m. USD.

Total bilateral ODA granted by Greece **in 2014** amounted to 46.10 MUSD. It was allocated to the following sectors of aid:

- Social Infrastructure and Services: 12.52 MUSD

  - Education: 10.92 MUSD,
  - Health: 0.46 MUSD,
  - Water supply and Sanitation: 0.05 MUSD,
  - Government and civil society: 0.65 MUSD,
  - Other social infrastructure and services: 0.45 MUSD,
- Economic Infrastructure and Services: 0.02 MUSD
  - Transport & storage: 0.02 MUSD,
- Crosscutting: 3.75 MUSD,
  - General environmental protection: 0.21 MUSD,
  - Tertiary Scholarships: 3,54 MUSD,
- Humanitarian assistance: 1.15 MUSD,
- Costs of refugees: 21.29 MUSD.

Total bilateral ODA granted by Greece **in 2013** amounted to 43.61 MUSD. It was allocated to the following sectors of aid:

- Social Infrastructure and Services: 11.78 MUSD
  - Education: 10.81 MUSD,
  - Health: 0.44 MUSD,
  - Water supply and Sanitation: 0.04 MUSD,
  - Government and civil society: 0.50 MUSD,
- Economic Infrastructure and Services: 0.07 MUSD
  - Transport & storage: 0.05 MUSD,
  - Communications: 0.02 MUSD,
- Crosscutting: 2.04 MUSD,
  - General environmental protection: 0.09 MUSD,
  - Tertiary Scholarships: 1.95 MUSD,
- Humanitarian assistance: 0.22 MUSD,
- Administrative costs: 7.08 MUSD.
- Refugees in donor countries: 21.36 MUSD.

In the years 2008-2012, Greece provided grants to partner countries aiming to support national development programmes in sectors related to climate change adaptation / mitigation, such as energy, transport, agriculture, capacity building, water management etc., environmental sustainability remaining a cross-cutting objective of the aid provided (cf ***Table 7.2***).

Table 7.2 Bilateral development cooperation – Aid per sector per year (Flows in MUSD)

Sector of aid		2008	2009	2010	2011	2012	Total
Mitigation (i.e. assistance for reduction of emissions from	Energy	0.14	2.84	0.06	0.00	0.00	3.04
	Transport	5.65	6.96	17.78	19.90	0.07	50.36
	Forestry	0.00	0.00	0.00	0.00	0.00	0.00
	Agriculture	2.19	3.83	1.18	0.36	0.00	7.56
	Waste management	0.00	0.00	0.00	0.00	0.00	0.00
	Industry	0.08	0.21	0.00	0.00	0.00	0.29
Adaptation (i.e. adapting to climate change for various sectors)	Capacity-building	0.37	3.49	5.83	0.00	0.00	9.69
	Water management	0.76	2.90	0.12	0.00	0.00	3.78
	Coastal zone management	1.97	0.78	0.23	0.00	0.54	3.52
	Land use and Planning	0.24	0.00	0.00	0.00	0.00	0.24
	Other vulnerability assessments	0.00	0.00	0.00	0.00	0.00	0.00
	Total	**11.40**	**21.01**	**25.20**	**20.29**	**0.61**	**78.48**

Source: MFA/Hellenic Aid, Directorate 3, November 2013

7.5 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 ODA subscriptions of Greece to International Organizations in the year **2016** amounted to 209.38 MUSD (0.11% of GNI), a fall by about 46% in relation to 2008 (391 MUSD).

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.

As of July 2017, the EU as a collective is the largest contributor to the Green Climate Fund (GCF) with a total of US$4.66 billion committed (or “signed”), accounting for almost half of the USD 10.3 billion already raised. In 2015, the EU and member states contributed up to €17.6 billion (approximately USD 20.7 billion), which was channelled into climate change mitigation and adaptation initiatives in developing countries. This figure includes climate finance sources from public budgets and other development finance institutions, €1.5 billion from the EU budget and €2.2 billion from the EIB[20].

Total flows granted by Greece in **2016** to EU institutions for foreign development assistance amounted to 191.45 MUSD, of which 102.46 MUSD accounted for Greece’s share to the EU budget for development cooperation, while 55.44 MUSD was the country's contribution to the European Development Fund (EDF).

[20] http://www.consilium.europa.eu/en/press/press-releases/2016/10/25-climate-change-finance/

Total flows granted by Greece in **2016** to EU institutions for foreign development assistance amounted to 191.45 MUSD, of which 61.42 MUSD was the country's contribution to the European Development Fund (EDF).

ODA amounting to 12.98 MUSD was also granted in 2016 through the United Nations system mainly to UNDPKO (4.52 MUSD), WHO (2.21 MUSD), UN (2.08 MUSD), FAO (1.59 MUSD), UNESCO (0.87 MUSD), UNFCCC (0.14 MUSD), UNECE (0.07 MUSD), while the amount of 4.94 MUSD was granted to other International Organizations to implement development projects, mainly to CIHEAM and ISTA.

ODA amounting to 7.64 MUSD was also granted in 2015 through the United Nations system mainly to UNESCO, UNIDO, UNEP, UNDPKO, UNFCCC, FAO, WHO, WMO, while the amount of 1.27 m. USD was granted to other International Organizations to implement development projects, mainly to CIHEAM and ISTA.

In **2014**, total multilateral ODA contributions to International Organizations amounted to 201.34 MUSD or 151.75 MEURO (0.09% of GNI). Total flows granted by Greece to EU institutions for foreign development assistance amounted to 181.23 MUSD or 136.59 MEURO of which 89.05 MEURO accounted for Greece’s share to the EU budget for development cooperation, while 47.54 MEURO was the country's contribution to the European Development Fund (EDF). ODA amounting to 14.43 MUSD was also granted through the United Nations system mainly to UNESCO, UNIDO, UNEP, UNDPKO, UNFCCC, FAO, WHO, WMO, while the amount of 5.68 MUSD was granted to other International Organizations to implement development projects, mainly to CIHEAM, ICAC, IOM, ISTA, OIF (Francophonie).

In **2013**, total multilateral ODA contributions of Greece to International Organizations amounted to 195.45 MUSD or 147.21 MEURO (0.08% of GNI). In 2013 total resources granted by Greece to EU institutions for foreign development assistance amounted to 135.44 MEURO or 179.82 MUSD, of which, 88.95 MEURO accounted to Greece's share to EU budget for development co-operation, while 46.49 MEURO was the country's contribution to the European Development Fund. In 2013 Greece also provided ODA amounting to 13.38 MUSD via the United Nations system. Funding was provided mainly through UNESCO, UNECE, UNIDO, UNEP, UNDPKO, UNFCCC, FAO, WHO, WMO. Finally, the amount of 2.26 MUSD was granted to other International Organizations such as, BSEC, CIHEAM, ICAC, IOM, ISTA, OECD.

Greece’s overall ODA-eligible financial contributions towards Multilateral Organizations and programmes over the years 2008-2015 are listed in ***Table 7.4 (a)***.

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 development initiatives, including capacity-building activities related to technology transfer for limiting/reducing GHG emissions, implementation of the UNFCC 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 7.3***. 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 7.3. Greece has not committed to participate in subsequent replenishments after GEF4. Contributions to United Nations Conventions and their Secretariats are channelled through other line Ministries, like MEEN. MEEN’s multilateral and multi-bilateral economic contributions to UN environmental related Organisations, Secretariats and Funds during the last years are detailed in ***Table 7.4(b)***.

Table 7.3 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 7.4(a) ODA eligible financial contributions to multilateral institutions and programmes (2008-2015)

Multilateral institutions and programmes	(in MUSD)								
	2008	2009	2010	2011	2012	2013	2014	2015	2016
United Nations	14.19	13.75	12.85	12.15	10.15	13.38	14.43	7.64	12.99
European Union	238.87	286.06	277.60	256.36	204.05	135.44	181.23	157.90	191.45
World Bank Group	79.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Regional Banks	44.27	0.72	1.01	0.00	0.69	0.00	0.00	0.00	0.00
Other Agencies	14.15	9.80	4.44	2.36	5.22	2.26	5.68	1.27	4.94
TOTAL	**390.99**	**310.33**	**295.90**	**270.87**	**220.11**	**195.45**	**201.34**	**166.82**	**209.45**

Source: MFA/Hellenic Aid, Directorate 3, December 2017

Table 7.4(b) Contributions to UN Environmental related Organizations, Secretariats and Funds (Source: MEEN)

Receiving Organization / Foundation / Entity	2005	2006	2007	2008	2009	2010	2011	2012	2013*	2014	2015	2016
UNEP-Coordinating Unit for MAP	400.000 USD	400.000 USD	400.000 USD	400.000 USD	400.000 USD	400.000 USD	400.000 USD	400.000 USD	400.000 USD	310.000 USD	400.000 USD	400,000 USD
UNECE/EMEP	26.890 USD	29.151 USD	27.400 USD	4.510 USD	31.910 USD	31.910 USD	36.530 USD		73.050 USD			71,060 USD
UNEP-Vienna Convention for the Protection of the Ozone Layer	5.597 USD	2.693 USD	3.108 USD	3.178 USD	3.297 USD	3.867 USD	3.582 USD		8.320 USD			7,994 USD
UNEP-Trust Fund for the Protection of the Mediterranean Sea	155.653 EUR	155.653 EUR	155.653 EUR	155.653 EUR	155.653 EUR	155.653 EUR	155.653 EUR		311.306 EUR	155,653 EUR	183,561 EUR	189,412 EUR
Trust Fund for the Convention on the Conservation of Migratory Species (CMS) of Wild Animals	21.858 USD	21.694 EUR	22.973 EUR	29.177 EUR	23.653 EUR	26.447 EUR	31.917 EUR		61.832 EUR			69,078 EUR
UNEP-Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal	22.051 USD	26.267 USD	27.243 USD	26.051 USD	31.235 USD	32.802 USD	34.897 USD		77.631 USD			77488 USD
UNEP-Trust Fund for the Montreal Protocol on Substances that Deplete the Ozone Layer (MP)	18.435 USD	21.567 USD	22.543 USD	25.404 USD	25.404 USD	25.404 USD	29.505 USD		59.010 USD	238.900 USD		54,394 USD
UNFCCC-Climate change (Core Budget)	85.207 USD	70.175 USD	90.425 USD	91.928 USD	91.806 USD	88.846 EUR	86.888 EUR		206.050 EUR		95,704 EUR	114,232 EUR
UNEP-Trust Fund for the Convention on Biological Diversity (BY)	52.440 USD	55.319 USD	55.847 USD	58.319 USD	77.056 USD	83.991 USD	93.710 USD		205.472 USD			204,028 USD
UNEP-Core Programme budget for the Cartagena Protocol on Biosafety (BG)		33.803 USD	18.533 USD	13.881 USD	16.530 USD	20.155 USD	19.208 USD		49.201 USD			48.911 USD
HABITAT FOUNDATION	30.000 USD	30.000 USD	30.000 USD	30.000 USD	30.000 USD	30.000 USD	--					
Multilateral Fund for the Implementation of the Montreal Protocol	623.621 EUR	1.096.622 EUR	1.270.000 EUR	1.370.158 EUR	1.300.000 EUR	887.216 EUR	828.238 EUR			80,000 USD		
UNEP Fund (Environment Fund)	175.000 USD	200.000 USD	200.000 USD	250.000 USD	250.000 USD	250.000 USD	250.000 USD		50.000 USD			
UNESCO	29.347 EUR	30.000 EUR	30.000 EUR	30.000 EUR	30.000 EUR	30.000 EUR	1.000 EUR		2.000 EUR			

Receiving Organization / Foundation / Entity	2005	2006	2007	2008	2009	2010	2011	2012	2013*	2014	2015	2016
UNFCCC-Kyoto Protocol	35.596 USD	65.631 USD	69.582 USD	70.698 USD	68.952 USD	65.172 EUR	64.385 EUR		127.135 EUR		58,577 EUR	61,612 EUR
UNFCC-Kyoto Protocol (ITL)			23.461 USD	47.205 USD	96.276 USD	30.544 EUR	55.849,76 EUR[21]		29.398 EUR	35,011 EUR	29,000 EUR	28,505 EUR
Stockholm Convention on Persistent Organic Pollutants			0 USD	58.481 USD	34.215 USD	34.048 USD	34.346 USD		80.202 USD			
Aarhus Convention			10.000 USD	10.000 USD	10.000 USD	10.000 USD	1.000 USD		2.000 USD			2,000 USD
Espoo Convention on Environmental Impact Assessment In A Transboundary Context					5.000 USD	5.000 USD	1.000 USD		2.000 USD			2,000 USD
MED-WET (Mediterranean Wetlands)	160.000 EUR	170.000 EUR	170.000 EUR	170.000 EUR	170.000 EUR	170.000 EUR						
UNECE CONVENTION ON THE TRANSBOUNDARY EFFECTS OF INDUSTRIAL ACCIDENTS											1.000 EUR	1.000 EUR
Bureau Europeen De l' Environnement	10.000 EUR		10.000 EUR	10.000 EUR	10.000 EUR	10.000 EUR						
MIO-ECSDE (Mediterranean Information Office)	60.000 EUR	20.033 EUR	20.000 EUR	20.000 EUR	20.000 EUR	20.000 EUR	10.000 EUR					
GWP / MED	114.165 EUR	90.000 EUR	90.000 EUR	90.000 EUR	90.000 EUR	100.000 EUR	90.000 EUR			35,060 EUR		
IUCN (World Conservation Union)	31.483 CHF	140.000 CHF	150.000 CHF	400.762 CHF	195.000 CHF	343.183 CHF	280.000 CHF				187.000 CHF	172.312 CHF
Ramsar Bureau/IUCN	15.738 CHF	20.218 CHF	24.109 CHF	25.048 CHF	24.941 CHF	31.529 CHF	32.318 CHF		67.412 CHF			59.784 CHF
Ramsar Convention / MedWet Coordination Unit		4.685 CHF	5.252 CHF	5.222 CHF	5.222 CHF	5.222 CHF	5.222 CHF					20.888CHF
IMPEL						3.000 EUR	1.000 EUR		2.000 EUR			6.000 EUR

Receiving Organization / Foundation / Entity	2005	2006	2007	2008	2009	2010	2011	2012	2013*	2014	2015	2016
OECD						3.079 EUR						
TRUST FUND FOR THE AGREEMENT ON THE CONSERVATION OF CETACEANS OF THE BLACK SEA, MEDITERRANEAN SEA AND CONTIGUOUS ATLANTIC AREA (ACCOBAM)											54.632 EUR	

* Some amounts for 2011 and most flows of 2012 have been transmitted/deposited in 2013 due to budgetary constrains

7.6 Environmental cooperation and transfer of technology

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 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 programmes, and impact assessment and monitoring (when appropriate).

7.6.1 Multilateral/Regional cooperation

7.6.1.1 Mediterranean Component of the EU’s Initiative ‘Water for Life’ (MED EUWI) (capacity building activity)

In the follow up of the World Summit for Sustainable Development (WSSD), the Greek Government (Hellenic Ministry of Environment, Energy and Climate Change – MoE - and Hellenic Ministry of Foreign Affairs – MoFA), supported by the ‘Global Water Partnership-Mediterranean’ (GWP-Med) Secretariat, has undertaken responsibility of leading the Mediterranean Component of the EU’s Initiative ‘Water for Life’ (MED EUWI), launched in Johannesburg, in 2002.

MED EUWI represents a strategic partnership among stakeholders (national, regional and international) in the Mediterranean region. It seeks to make significant progress in poverty eradication and health and the enhancement of sustainable livelihoods and socio-economic prosperity and growth in the developing countries of the Mediterranean and South-Eastern Europe. Through its work, MED EUWI aspires to provide a catalyst for peace and security in a region that is particularly vulnerable and susceptible not only to environmental, but also to political distress.

Its main aim is to assist the design of better, demand-driven and output-oriented water programmes in the region, and to facilitate the effective coordination of water programmes and projects, targeting more effective use of existing funds, through identification of gaps.

MED EUWI develops its activities through annual work programmes, supported through the participation of a variety of institutions and stakeholders. According to MED EUWI’s precedence, national activities up until 2015 focus on:

i. prioritisation of national needs for the water sector in order to meet national development targets;
ii. assistance to national water planning activities including assistance to countries for the elaboration, implementation and monitoring of IWRM plans and linking them with national climate change adaptation strategies and other water-related sectoral plans;
iii. development of sustainable financing strategies for the water sector;
iv. improved donor coordination, harmonisation and alignment on the ground.

In this respect, synergies and complementarity are systematically sought and ensured between MED EUWI and any other related Initiative and Programme active in the Mediterranean including the Horizon 2020 Initiative to "De-pollute the Mediterranean by 2020", the EU-supported "Sustainable Water Integrated Management (SWIM)" Programme (2011-2014), the GEF MAP UNEP Strategic Partnership for the Mediterranean Large Marine Ecosystems (2007-2014), etc.

Over its 10 years of operation, the MED EUWI has managed to receive a very wide acceptance as it is acknowledged by all Mediterranean partners as a key "platform" in the region aiming to assist meeting the international commitments on water contributing at the same time towards aid effectiveness. In the period 2010-2012, Country Dialogue activities were implemented in Lebanon and Tunisia comprising National Assessments on Private Sector Participation in Water Infrastructure, including those related to climate change adaptation, based on extensive consultation with involved stakeholders. Furthermore, support was provided to Lebanon in preparing its National Water Sector Strategy and advancing elements of its National IWRM Plan.

In terms of funding, MEECC has been supporting the MED EUWI with a core annual budget reaching approximately 90.000 € so far until 2011 to cover "horizontal" activities. In 2006, a co-funding by the EU Commission (EuropeAid Cooperation Office) was activated to financially support selected MED EUWI activities, for 2 years (2006-2008), with the amount of approximately 1,070 million €. Moreover, in 2010, a new co-funding by the EU Commission (DG DEVCO) was again activated to financially support selected MED EUWI activities, for 3 years (2010-2012), with the amount of approximately 1 million €. Furthermore, the MED EUWI has managed to mobilize and coordinate considerable additional funding for the region. Key contributors in the process include, apart from the EC, bilateral EU ODA, the GEF, Development Banks, etc.

In the context of the MED EUWI, increasing emphasis is being given to assisting the efforts of Mediterranean countries to build their adaptation capacities to the changing climate conditions in the Region. More specifically, Greece/MEECC, through the MED EUWI, has:

- Prepared a Position Paper on "Climate Change Adaptation and Integrated Water Resources Management in the Mediterranean" in December 2007 that has been widely distributed and discussed among Med partners aiming to provide a background of the current condition regarding impacts of climate change in the Mediterranean with emphasis on water resources, to assist Med countries with a systematic framework for developing national adaptation strategies linked with national IWRM plans as well as to promote a harmonised regional approach to address adaptation to climate change, under the MED EUWI umbrella.

- Organised, together with the European Commission, the Mediterranean Action Plan/United Nations Environment Programme, the Global Water Partnership – Mediterranean (GWP-Med) and the Mediterranean Information Office for Environment, Culture and Sustainable Development (MIO-ECSDE), a Side-Event on "Addressing Climate Change Adaptation Challenges in the Mediterranean" during the 16th Session of the UN Commission for Sustainable Development, in May 2008. The Side-Event, that was attended by more than 40 participants, aimed at addressing issues pertaining to the specificities of the Mediterranean which, already a water-scarce region, is expected to face even more challenges with regard to its water resources in the near future due to the looming climate crisis (e.g. increasing frequency and severity of droughts, floods and other extreme weather conditions that lead to increased water supply-demand gap, desertification, infrastructure damage, loss of land due to landslides, saltwater intrusion due to sea-level rise, health issues, etc.), jeopardising the region's overall well-being.

- Organised, in the context of MED EUWI, an International Workshop on "Water and Climate Change in Southeastern Europe: Understanding Impacts & Planning for Adaptation" in June 2008, in Tirana, Albania, targeting SE European Countries.

- Prepared a detailed Technical Background paper on "Climate Change Adaptation and Integrated Water Resources Management in the Mediterranean" that was presented to and discussed with Water Directors of "Union for the Mediterranean" (UfM) countries during their Meeting organised by Greece/MED EUWI in Athens in July 2008. Consequently this Technical paper was presented and adopted by UfM Water Ministers at their Ministerial Conference on Water, in Jordan (Dead Sea), in 22 December 2008. This UfM Ministerial Conference on Water decided to elaborate a "Mediterranean Strategy on Water" to be adopted by the next UfM Ministerial Conference on Water to take place in 2010. The Strategy was decided to comprise four main themes, i.e. water governance, water demand management, water financing and adaptation of water resources to climate change. The Chapters on water governance and on adaptation of water resources to climate change have been compiled with the MEECC as their main author. Moreover, MED EUWI has provided overall technical and administrative assistance to the Union for the Mediterranean for the overall process of the elaboration of the Strategy. Unfortunately, to date, the draft Strategy on Water in the Mediterranean is still pending official adoption due to political reasons.

- Actively participated, during the 5th World Water Forum in Istanbul (16-22.3.09) at the Ministerial Roundtables on "Water and Climate" and "Integrated Management of Coastal Strips in relation with IWRM" where it made several practical proposals for achieving adaptation to climate change by operationally linking integrated water resources management with national adaptation strategies using as a catalyst education, public awareness and changes in consumption patterns.

- Aiming to additionally contribute to the elaboration of the above mentioned Strategy for Water in the Mediterranean as well as to produce a "Mediterranean Statement" that will be fed and submitted to the UNFCCC COP15 in Copenhagen, December 2009, Greece/MED EUWI technically assists the organisation of the Joint Egyptian-Dutch Water Conference entitled "Towards the new Long Term Strategy for Water in the Mediterranean", that will be held 2-3 November 2009, in Cairo, Egypt. The Conference, inter alia, will address the four themes of the Strategy, i.e. short water governance, water and climate change, water financing, and water demand management.

- Elaborated, in 2012, a brief overview of regional initiatives and programmes on climate change adaptation in the Mediterranean which has been used as background for regional institutions (e.g. UfM, EC) and Programmes (e.g. SWIM, GEF MAP UNEP Climate Variability and Change, etc.).

- Moreover, in 2012, established synergies with the GEF MAP/UNEP Climate Variability and Change Project (2012-2014) and with the AMCOW/GWP Water, Climate and Development Programme (2012-2016).

- Elaborated, in 2013, an assessment of capacity building needs on climate change adaptation in North Africa.

7.6.1.2 Regional cooperation on environmental protection within the Black Sea Economic Cooperation (BSEC) Organisation (technology transfer activity and capacity building)

Greece, as a member of the Black Sea Economic Cooperation Organization (BSEC), is actively engaged in efforts initiated by the Permanent International Secretariat of BSEC (PERMIS) to promote cooperation and exchange of best practices for mitigation and adaptation of climate change, energy efficiency and green energy investments issues.

These 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*".

More specifically in the first document the Ministers agree to "*explore possibilities for improvement of investment opportunities in the energy sector of the BSEC Member States for upgrading infrastructure and promoting energy efficiency in the BSEC Region*". In the second, they have expressed their determination "*to enhance cooperation among the BSEC Member States on promotion of policies and actions aimed at combating climate change*" and to "*encourage the Member States to develop their national green economy pathways and low carbon policies and enhance appropriate measures*". In the last one they plan to focus on: *"I. Exchange of information on legislation in energy sector and national programs; II. Sustainable energy development; and the III. Development and improvement of energy infrastructure in the Black Sea region".*

Under this framework the Hellenic contribution aims to assist, through the BSEC, the other Member State governments and non-state actors to fulfil the aforementioned commitments and to deliver increased ambition for the achievement of the Paris Agreement.

To that aim the Hellenic government, mainly through the Energy Policy and Development Centre (KEPA) of the National and Kapodistrian University of Athens (NKUA), endorses actions, that:

- ✓ support mainly the regional policy dialogue for green energy investments and the 2020 revision of the Nationally Determined Contributions (NDCs) for identifying opportunities to close the 2030 emissions gap;
- ✓ concluded with and promote further the development of the "BSEC – Green Energy Network", as a knowledge and green investment hub for the BSEC region;
- ✓ result to the organization of "Green Investment Forum" in Greece and to the other BSEC Member States.
- ✓ facilitate "knowledge transfer" and "capacity building" on Climate Change Policy issues;
- ✓ 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 tools for facilitating the development of their forward-looking scenarios and evaluating the effectiveness of their policy mixtures towards their commitments on climate change issues.

The BSEC Green Energy Network

Establishment

The "BSEC – Green Energy Network" was launched as the consequence of an initiative undertaken by the Hellenic Government to establish a "Task Force on Green Energy Development". This led PERMIS to invite KEPA for the development of the "BSEC – Green Energy Network" between administrative bodies and/or Centres and organizations mandated to promote renewable energy sources and energy efficiency measures and policies

(BS/EN/WG/TF/R(2014)2). The network is coordinated by KEPA under the supervision of PERMIS.

This activity started after the decision of the Ministers of Energy of the Black Sea Economic Cooperation Organization (BSEC), during their meeting at Nafplion (Greece, 12 Oct. 2010)[22], to set up a Task Force with the aim to identify relevant issues within which regional cooperation can be most effective, and also to explore ways to promote green energy investments and innovative green energy projects (Declaration concerning "Green Energy Development Initiative" - BS/EN/WG/R(2010)2). In accordance with the Declaration of the Ministerial Meeting in Nafplion (Greece) on 12 October 2010, a "Task Force on Green Energy Development" was set-up within the BSEC Working Group on Energy, with the aim to identify relevant issues within which regional cooperation can be most effective, and also to explore ways to promote green energy investments and innovative green energy projects.

The Task Force started working in April 2012; agreed on the creation of the aforementioned Network and decided to elaborate a BSEC Green Energy Strategy Paper (BS/EN/WG/TF/R(2012)1). In fact, the BSEC Economic Agenda 2012 provides for taking gradual steps to materialize the vision of transforming the BSEC Region into a model for clean energy by the year 2050.

During its meeting in Thessaloniki in December 2014, the Council of the Ministers of Foreign Affairs decided to transfer the activities and functions of the Green Energy Development Task Force to the BSEC Working Group on Energy (BS/FM/R(2014)2 and Annex VII to BS/FM/R(2014)2). The Working Group on Energy decided to continue the work on the development of a Green Energy Strategy Paper (BS/EN/WG/TF/R(2014)2). Member States were invited to continue to contribute to the development of the document and assure the presence of their experts at the forthcoming meetings of the Working Group.

Furthermore, the BSEC Green Energy Network was established by the decision of the Council of Ministers of Foreign Affairs taken on 12 December 2014. The mandate of the Network is to facilitate exchanging information and sharing experience and know-how among national administrative bodies and/or centres and organizations mandated to promote renewable energy sources and energy efficiency measures and policies in the BSEC Region. In accordance with the agreements reached in the Task Force on Green Energy Development and in the Working Group on Energy, the BSEC PERMIS invited the Energy Policy and Development Centre (KEPA) of the National and Kapodistrian University of Athens to develop the Network, under the supervision of the BSEC Permanent International Secretariat, in terms of both partners and activities to be undertaken (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.

Members of the Network are expected to organize and participate in regional/international activities, such as workshops, seminars and conferences. They can take advantage of the existing communication infrastructure of KEPA – scientific journals, periodical editions, newsletters – 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.

[22] The ministerial conference was held in Nafplio, Peloponnese, in the framework of the Greek presidency of the BSEC, with the focal message being "The Black Sea turns Green." At: http://www.bsec-organization.org/bsecnews/BSECinMedia/Downloads/EMG%20(13.10.2010).pdf

It is expected that the Network will contribute, 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” programs.

Finally, members of the Network will be facilitated through brokerage events to participate in internationally financed programs, like those of H2020 of the European Union, or to develop ad hoc “tailor made” consortia upon requests from the BSEC Member States.

Recent activities

October 2016

BSEC PERMIS and the BSEC Green Energy Network, coordinated by KEPA, organized the 1st Green Energy Investment Forum as part of the 9th International Scientific Conference on “Energy and Climate Change” that took place at the History Museum of the National and Kapodistrian University of Athens during 12-14 October 2016, in Athens, Greece.

The Forum aimed to the promotion of green energy investments (policies, advanced technologies, finance, current trends and the considered in the market investment opportunities); this was the main content of the policy statements of the speakers.

Speakers were from the Ministry of Interior and Administrative Reconstruction, the United Nations Academic Impact (UNAI), BSEC-PERMIS, the Embassies of Romania and Ukraine, the Parliamentary Assembly of BSEC-PABSEC, the Hellenic Ministry Foreign Affairs, the Hellenic-Russian Chamber of Commerce; the Hellenic Association of Computer Engineers; the Hellenic Petroleum; the Bank of Greece; the Central Union of Municipalities (K.E.D.E.); the Enterprise Greece; the Institute of Energy for SE Europe (IENE); and AppArt.

The next two days were devoted to presentations of scientific papers and to the brokerage session of the event. The Conference was under the aegis of the Black Sea Economic Cooperation (BSEC) and the United Nations Academic Impact (UNAI).

December 2016

During its meeting on 1st December 2016, the BSEC Working Group on Energy invited the Member States to nominate national governmental bodies, academia, research institutions, companies active in the area of Green Energy to participate in the BSEC Green Energy Network. It also invited Member States to express (if they had not done so already), their agreement with the inclusion in the Network of research institutes and universities which were interested to participate and to directly contact with KEPA (BS/WG/EN/R(2016)2).

The Working Group also: i) took note of the project proposals prepared by the BSEC Green Energy Network, under the coordination of KEPA, in consultation with the BSEC PERMIS, to be further elaborated and finalized, so as to be submitted for funding by international financial institutions and other donors. ii) welcomed the organization of the BSEC Green Energy Investment Forum on in Athens, by the BSEC Green Energy Network, and expressed its support for having an Investment Forum bi-annually, bringing together government officials responsible with the promotion of Green Energy, representatives of the banking sector, the business communities and NGOs. iii) took note of the intention of the KEPA to examine the development of a BSEC Green Energy Investment Fund, with the possible cooperation of the Black Sea Trade and Development Bank (BSTDB) and the BSEC PERMIS, to be supported by the Green Climate Fund (GCF) and Green Environment Facility (GEF) funds.

June 2017

During the meeting of the BSEC Working Group on Energy (15 June 2017) (BS/WG/EN/R(2017)1) the delegation of the Republic of Azerbaijan presented the list of organizations to be included in the BSEC Green Energy Network of Cooperation.

October 2017

BSEC PERMIS and the BSEC Green Energy Network, coordinated by KEPA, organized the 2nd Green Energy Investment Forum as part of the 10th International Scientific Conference on "Energy and Climate Change" that took place at the cultural center of NKUA "Kostis Palamas" building during October 11-13, 2017 in Athens, Greece.

The Forum again aimed to the promotion of green energy investments (policies, advanced technologies, finance, current trends and the considered in the market investment opportunities); this was the main content of the policy statements of the speakers.

Speakers were from UNAI, BSEC-PERMIS, the Embassies of Ukraine, Romania, Moldova, the Parliamentary Assembly of BSEC-PABSEC, the European Bank of Reconstruction and Development (EBRD); the Black Sea Trade and Development Bank (BSTDB); Minister of Economy and Development-Hellas; Hellenic Petroleum; the Public Natural gas Supply Corporation (DEPA); Network of Sustainable Greek Islands (DAFNI); the Institute of Energy for S.E. Europe (IENE); the Hellenic Association for Cogeneration of HEAT & Power; and the Renewable Energy Development Pro Consultants – Hellas.

The whole event is part of the PROMITHEASnet activities and is organized annually by the KEPA. The Conference was under the aegis of the Black Sea Economic Cooperation (BSEC) and the United Nations Academic Impact (UNAI).

November 2017

BSEC PERMIS and the BSEC Green Energy Network, coordinated by KEPA, organized a Green Energy Investment Forum at the BSEC PERMIS Headquarters in Istanbul on the 24th of November 2017. Representatives of BSEC Member States, Related Bodies and Observers, of international organizations and financial institutions participated in the event (BS/INFO.2017.0550).

Representatives of the Black Sea Trade and Development Bank, the Delegation of the European Union to the Republic of Turkey, the European Bank for Reconstruction and Development and the United Nations Development Program presented their Green Investment policies on Energy Efficiency in the BSEC Member States.

Experts from KEPA made presentations under the session "Overcoming Behavioral Barriers in Energy Efficiency Policies - the HERON Project" about effective Energy Efficiency policies and optimum Energy Efficiency scenarios in three BSEC Member States.

Finally, the case of developing project proposals, in the frame of the Network activities, relevant to "smart Nearly Zero Energy Building (NZEB)" in three BSEC – Member States was considered in the perspective of encouraging them to benefit from the GCF funding capacities.

Knowledge transfer and capacity building activities in the region

During the last five years BSEC governments and non-state actors have been offered assistance on knowledge transfer and capacity building regarding climate change issues through the following activities:

1. **Projects** facilitated BSEC institutes in developing scenarios, designing policies and using new tools. More specifically:

a. *PROMITHEAS-4: Knowledge transfer and research needs for preparing mitigation/adaptation policy portfolios* (Implementation period: 2011 – 2013) – **Funding source:** EU FP7. **Amount:** 1.000.000€. **Type:** Coordination and support. **Aim:** The development and evaluation of Mitigation/Adaptation (M/A) policy portfolios and the prioritization of research needs and gaps for twelve (12) countries (Albania, Armenia, Azerbaijan, Bulgaria, Estonia, Kazakhstan, Moldova, Romania, Russian Federation, Serbia, Turkey and Ukraine) characterized as emerging economies. Sixteen (16) institutions from fourteen (14) countries (the twelve aforementioned ones plus Austria and Hellas) participated at the consortium with NKUA-KEPA as the coordinator.

In the framework of the PROMITHEAS-4 activities an *International case Study Seminar about Mitigation/Adaptation policy portfolios* was held during 3 – 7 December 2012 at the KEPA premises in Athens. It was a case study seminar for the countries of BSEC, Estonia and Kazakhstan, following the four months teleteaching courses of PROMITHEAS - 4. PROMITHEAS - 4 covered travel and accommodation expenses for 2 persons coming from beneficiary countries and with passing grades in these tele-teaching courses. Available information at: http://www.promitheasnet.kepa.uoa.gr.

b. *HERON: Forward-looking socio-economic research on Energy Efficiency in EU countries (2015-2017)* – **Funding source:** EU HORIZON 2020. **Amount:** 958.750€. **Type:** Research and innovation project. **Aim:** Facilitate policy makers of multi-level governance in EU, to develop and monitor energy efficiency policies in building and transport sectors, through forward-looking socio-economic research in seven EU (Belgium, Bulgaria, Estonia, Germany, Hellas, Italy, and United Kingdom) and one candidate (Serbia) countries. NKUA-KEPA was the coordinator of the project (Available information at: http://heron-project.eu/).

HERON – Decision Support Tool (methodology/software) developed by NKUA-KEPA in cooperation with App-Art for the software part, provides the policy makers with a user's-friendly software that facilitates them in the selection of the optimum combination of technologies and practices minimizing the negative impact of end-users behavior in the implementation of Energy Efficiency scenarios. HERON - DST outcomes were used as inputs to LEAP for developing scenarios and their respective policy mixtures for seven countries (six EU Member States and one candidate one). *The software was disseminated free of charge to all BSEC – MS through the BSEC – PERMIS while a special presentation was made during the "Green Energy Investment Forum" in Istanbul (Nov. 2017).*

2. **Editions** allowed the dissemination of information about green energy investments per BSEC Member State and presented the efforts of these countries towards climate change issues. More specifically, these editions are:

   a. *"Energy View of BSEC Countries 2008*», biennial, published since 2009.

   b. "*Special edition on Climate Change policies: Energy View of BSEC Countries 2012*", published in 2012 under the framework of the PROMITHEAS-4 activities.

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 26,000 recipients in 170 countries for the last ten years.

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.

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. A number of **events** are organized for reinforcing the skills of the scientific and research potential of the BSEC region. These are:

   a. *Annual International Conference on Energy and Climate Change* (Implementation period: 2008-2017) – **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). KEPA is member of UNAI since year 2011.

   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. The last two 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 2020 calls and finally to increase the cross-interaction on innovative ideas and cooperation on common importance topics.

Proceedings receive ISBN numbers for printed and electronic version.

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.

b. *International Training Seminar on Climate Change Policies* (Implementation period: 2013) – **Funding source:** self-funded/registration fees from attendees. **Aim:** Organised by NKUA-KEPA in cooperation with the US center of Stockholm Environment Institute in Massachusetts and developer of LEAP (Long-range Energy Alternatives Planning system), the "International Training Seminar on Climate Change policies" was an one-week training activity aiming to offer to policy makers a holistic approach in designing climate change policy strategies through the development and evaluation of policy mixtures. Trainees got updated on global policy trends, reliable data collection, scenarios development and selection of policy mixtures with the use of LEAP and their evaluation with the use of AMS method. The training seminar was attended by policy and decision makers (employees of ministries and agencies, consultants), economists, engineers, project managers, researchers on energy and climate change policy from Albania, Azerbaijan, Greece, India, Kuwait, Portugal, Romania, and South Africa and took place in the premises of University of Athens on the second week of November 2013. Both LEAP and AMS have been used for the development and evaluation of M/A policy portfolios for twelve (12) countries of Black Sea and Central Asia. Available information at: http://www.promitheasnet.kepa.uoa.gr

7.6.1.3 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).

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.

7.6.2 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 7.5 Description of selected projects or programmes that promoted practicable steps to facilitate and/or finance the transfer of, or access to, environmentally-sound technologies

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

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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

CHAPTER 8. RESEARCH AND SYSTEMATIC OBSERVATION

8.1 General policy on 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 1846, the National Observatory of Athens (NOA) was established, aiming at promoting the observations of astronomical and other parameters of natural science. In its 170 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. Nowadays, NOA hosts the UNESCO Chair for Natural Disasters and operates the National Seismological Network and it is participating in the OPTICON and other international research networks, hosting the Greek Focal Point on the Global Earth Observing System of Systems (GEOSS).

In 1896 NOA was expanded with the addition to the Astronomical Department of two new, the Meteorological and the Seismological. In 1942 the Departments were named Institutes and in 1955 the Ionosphere Institute, was added. In 1999 the names of the institutes of NOA were updated and five Research Institutes was operating: Institute of Astronomy and Astrophysics (IAA), Institute for Space Applications and Remote Sensing (ISARS), Institute of Geodynamics (GI), Institute of Environmental Research and Sustainable Development (IERSD) and finally in 2003 the Institute of Astroparticle Physics "NESTOR" became the fifth institute of NOA. After a major reform in the structure of all research institutes in Greece in 2012, two of the institutes of NOA were merged (Institute of Astronomy and Astrophysics (IAA) and the Institute for Space Applications and Remote Sensing (ISARS) merged to form the Institute for Astronomy, Astrophysics, Space Applications and Remote Sensing) and one (NESTOR) moved under another administrative unit (Institute of Nuclear and Particle Physics, National Center for Scientific Research, DEMOKRITOS).

NOA established the **first National Network** of meteorological stations in **1894,** deployed over the country

The network included

- 40 B' Class meteorological stations
- 57 precipitation stations

In **1931** the network of NOA was **transferred to** the newly established Hellenic National Meteorological Service (**HNMS**). NOA operates two A΄ Class meteorological stations (and Actinometric stations).

Currently NOA has the following three institutes:

- Institute for Astronomy, Astrophysics, Space Applications and Remote Sensing (IAASARS)
- Institute for Environmental Research and Sustainable Development (IERSD)
- Institute of Geodynamics (GI)

IAASARS, besides the research and educational activities, is evolved in carrying out other activities and providing services to the scientific community and for public outreach. The activities of the Institute encompass a wide area in Space Research and Applications. Its main objective is to carry out R&D projects in these fields, which include Space and Ionospheric Physics, Remote Sensing, and Wireless Communications. Additional activities include: systematic collection and processing of data derived from observations made in space or from the surface of the earth, performance of autonomous studies in other specific subjects of space research and applications, etc.

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. There are also a number of research teams in IERSD active in the following thematic areas: Air Pollution/Quality, Energy Conservation, Atmospheric Research, Energy Planning & Sustainable Development, Environmental Impact and Health Assessment, Climate, Weather, Water & Sustainability, Radar Meteorology / Remote Sensing and Instrumentation Servicing.

Since 1858, the IERSD has been operating a complete first-class meteorological station. Up until 1931, the IERSD was the main meteorological establishment in the country, operating almost all the existing network of meteorological stations. In 1932, the operation of all stations was undertaken by the newly founded Hellenic National Meteorological Service (HNMS). The operation of HNMS comprised part of the Meteorological Institute in NOA until 1934, when it is transferred to the Ministry of Aviation and its mission was to cover all the meteorological and climatological needs of the country. It is based at the former Athens International Airport at Elliniko, and operates under the auspices of the Hellenic Air Force, staffed by both military and civilian personnel.

In 1954, NOA starts the first program to measure solar radiation parameters, and in 1965 establishes an air pollution monitoring network for Athens, which continued operation till 1975 when it was transferred to the newly founded air pollution directorate of the Ministry for the Environment, Physical Planning and Public Works (now the Ministry of Environment Energy & Climate Change (MEECC)).

Greece is among the countries with very high earthquake activity because of its location at the confluence of 3 tectonic major plates. GI 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 GI is on the hill of Nymphs, opposite to Acropolis, at the center of Athens. It is the main center in Greece, for the continuous monitor of the seismicity of the country and reporting to national and international authorities.

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 Institute of Hydrographic Office is founded in 1905, under the Hellenic Navy General Staff, which begins systematic observations of currents, salinity, sea surface temperature and other sea state marine parameters. In 1945, the Hellenic Hydrobiological Institute of the Academy of Athens was founded in Piraeus, incorporating the Hydrobiological Station in Rhodes (Reale Istituto di Ricerche Biologiche) which had been set up by the Italians during their occupation of the Dodecanese. In 1965 the Hydrobiological Institute of the Academy of Athens was amalgamated with the Laboratory of Fisheries Studies, forming a new body, the Institute of Oceanographic and Fisheries Research (IOFR), which became fully functional in 1970. Fifteen years later, in 1985, as a result of new research legislation (law 1514), the National Centre for Marine Research (NCMR) was established. The latter organisation had evolved from the previous one (IOFR) although it was now a public sector organisation under the jurisdiction of the General Secretariat of Research and Technology, part of the Ministry of Industry, Energy and Technology (now the Ministry of Development). The NCMR thus became the main vehicle of marine research in Greece. In 1987, further progress was made with the establishment of the Institute of Marine Biology of Crete (IMBC) in Heraklion, Crete. IMBC rapidly developed and played an important role in the areas of marine biology, fishing and aquaculture. The integration of NCMR and IMBC took place on June 3, 2003, consequent upon enactment of Presidential decree (law 2919/25.6.2001). The new organisation, a public sector body operating under public sector regulations, is called the Hellenic Centre for Marine Research (HCMR).

In 2001, Greece became associated and then, in 2005, full member of the European Space Agency (ESA), participating in all the core activities of the Agency, including those of Global Monitoring of Environment and Security (GMES). The ESA activities are at present coordinated by the General Secretariat for Research and Technology (GSRT) of the Ministry of Education and Religious Affairs, Culture and Sports.

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 for the Environment, Physical Planning and Public Works, 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 of Research and Technology (GSRT) of the Ministry of Education and Religious Affairs, Sport and Culture (*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 mission of the GSRT and the main areas of responsibility are summarized below:

- Designs the national policy for Research, Technological Development and Innovation that is implemented through competitive R&D programs, supporting initiatives from the research & industrial sectors in areas of national strategic importance, crucial for the Greek economy and the citizen's quality of life.
- Ensures the coherence of Education, Research and Innovation pillars, supporting the contribution of science and culture in the knowledge economy.
- Supports research infrastructures promoting excellence within Research Centers (through state funding to the Research Centers). In parallel, GSRT has recently initiated the drafting of a National Roadmap of Large Scale Research Infrastructures, identifying and promoting synergies with the relevant European ones and opening access to national research infrastructures.
- Initiates and supports the development of specific organizational instruments and infrastructures (innovation clusters, innovation poles, incubators, technology parks) aiming to facilitate knowledge-based entrepreneurship and boost research creativity and innovation.
- Promotes dissemination of research results and technology transfer to the country's productive sector, while encouraging the "translation" of research results to high added-value products and services.
- Encourages and promotes the international outreach of Greek R&D entities through bilateral cooperation programmes, establishing strategic partnerships with other countries. In parallel, GSRT 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.

The GSRT policy framework for Research and Technological Development covers all the main phases of the innovation cycle (from basic and applied research to the creation of favorable tax framework for research in the private sector). The design of support actions, financial instruments and legal interventions currently focuses towards the optimal use of research results, boosting of entrepreneurship through new innovative start-up businesses and their support during their starting steps, crucial for their survival, that may be at stake due to lack of capital investment ("death valley phase").

IDENTIFY KEY SECTORS AND THEIR ACTIVITIES

Step 1: Stakeholders' involvement

- Information Day for RIS3 in Athens (Regional authorities, Academic and research organizations, Ministries)
- Working group with the Hellenic Federation of Enterprises
- Working group with National Council for Research and Technology and representatives from the industry.
- Working group with representatives from various ICT sectors
- Questionnaires to the Regional Authorities
- Questionnaires to research organizations Meetings with the Regional Authorities (More than 30 meetings with the regions)

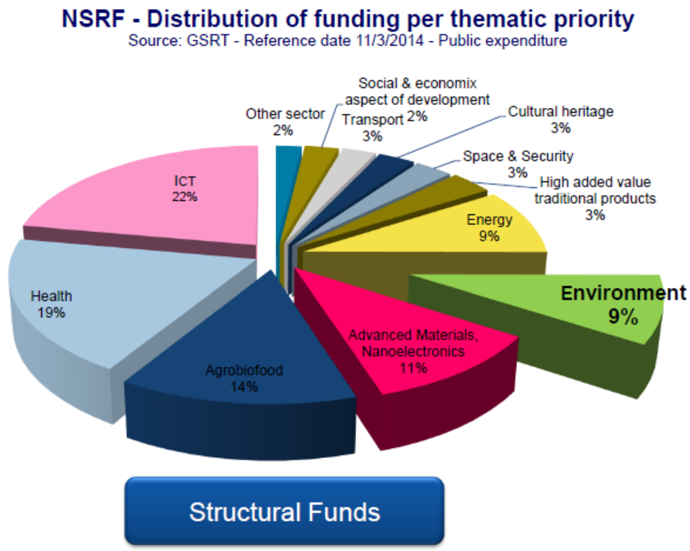
Step 2: Analyze economic studies & policy documents

- McKinsey & Company, Greece 10 Years Ahead: Defining the new National Development Model
- EC Position Paper
- SEV «Research in Business Forecasting of Changes in Regional Production Systems and Local Labor Markets
- SEV/: RECONSTRUCTION AND MANUFACTURING TECHNOLOGY PRIORITIES
- IOBE "Proposed areas of national interest in the context of 'smart specialization' 2014-2020"
- SMART SPECIALISATION strategies in GREECE - expert team review for DGREGIO (Sectoral / technological priorities 2014-2020)
- GSRT, Investigation of priority areas for the promotion of Research & Technology during the programming period 2007-2013

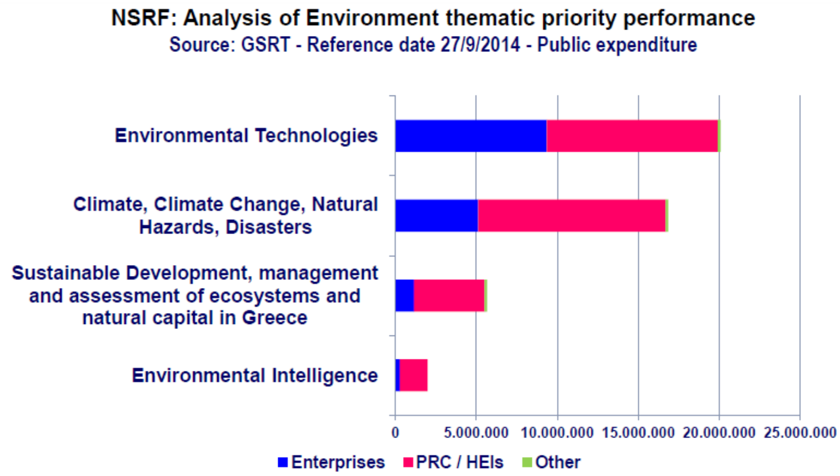
The main funding sources in the research sector in Greece include public and private funds. Public funds include the funds provided by the national budget, funds by the Programme of Public Investments, Structural Funds and also the European Commission's funds. For 2012 the Gross Domestic Expenditure on R&D (percentage of GDP) is estimated at 0.69%, while 50.4% has been funded by the State and the 31% by the Business Enterprise sector (EUROSTAT, 2013, http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=t2020_20, http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=tsc00031).

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 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 GSRT 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 Technology (GSRT) 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 next 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 GSRT:

- 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.
- GSRT supervises National Research Centres and Technological Institutions, geographically distributed in Greece (Attiki: 15, Central Macedonia: 4, Crete: 5, Eastern Macedonia and Thrace: 1, Epirus: 1, Peloponnese: 1, Thessalia: 1 Western Greece: 2, Western Macedonia: 1)

GSRT'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.

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.

<u>Life + programme</u>

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.

Since the launch of the LIFE programme by the European Commission in 1992, a total of 240 projects have been co-financed in Greece. Of these, 153 focus on environmental innovation, 70 on nature conservation and 11 on information and communication. Within the framework of the new LIFE programme, one capacity-building project has been funded, as well as three on Climate Change Adaptation and two on Climate Change Mitigation. These projects represent a total investment of over €327 million, of which over €175 million has been contributed by the European Union.

Since 2014, the traditional LIFE projects have been accompanied by a new sub-programme for Climate Action (focusing on Climate Change Mitigation, Climate Change Adaptation, and Climate Governance and Information). The LIFE programme has also been expanded to include several new types of projects - integrated, technical assistance, capacity-building and preparatory projects, and operating grants - as well as 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).

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 70 projects in Greece. These represent a total investment of €100 million, of which €68 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), as well as rehabilitating habitats (e.g. Drana lagoon, Northern Pindos National Park, Agras wetlands, Mediterranean temporary ponds, black pine forests, juniperus habitats in Crete, the South Agean and Prespa National Park). The AmiBio Biodiversity project developed a particularly innovative integrated technological system to enable remote, quick and non-obtrusive monitoring of biodiversity. Project beneficiaries were mostly NGOs, local and national authorities, research institutions and development agencies. Durations ranged from 24 to 60 months. There are 13 ongoing LIFE Nature projects in Greece. Four of these focus on the conservation of habitats (coastal lagoons, forest/forest openings, and Natura 2000 sites on Andros Island) and species (Fennoscandian population of lesser white-fronted goose; significant avifauna species; the lesser kestrel; Grecian juniper woods in the Prespa National

Park; and the monk seal in the Northern Cyclades). The other projects have very specific objectives, including: the improvement of conditions for the coexistence of bears and humans in Kastoria Prefecture and Northern Pindos; the establishment of a sustainable management and financing system for an important but degraded wetland ecosystem (the Natura 2000 site "Limni Stymfalia"); the management of the Andros Island SPA site to achieve a favourable conservation status for its priority species; and the adaptation of Eleonora's falcon to ongoing and future climate change. There are also three biodiversity projects. One aims to establish integrated planning and management for enhancing biodiversity, whilst also facilitating sustainable economic and social development. Another seeks 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 third project aims to develop a methodology that can be used to harmonise the needs of wind farm developers with the conservation of EU biodiversity. The projects have average durations of 48 to 63 months and are being coordinated by NGOs, local and regional authorities, universities and research institutes.

Some ongoing LIFE Nature & Biodiversity projects are summarised below.

Table 8.2 Ongoing LIFE Nature & Biodiversity projects

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-weq-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	N/A		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	N/A		09/2017 -> 09/2021
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/		10/2013 -> 09/2017

Source:http://ec.europa.eu/environment/life/countries/documents/greece_en_oct17.pdf

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 co-financed 153 projects in Greece, representing a total investment of €205.5 million, of which €95 million has been provided by the EU. Completed projects mainly targeted integrated environmental management, the management of vulnerable coastal areas, municipal, industrial and 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, renewable energies, protection of water resources, and climate change adaptation (adaptation of the market to the risks and financial impacts of climate change). 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 18 ongoing projects in Greece, covering a wide range of issues, including: air quality management and monitoring; forest management; prevention of natural risks (forest fires and floods); waste management and recycling (for example, transformation of food waste from hotels into animal feed); industrial, municipal and agricultural waste; risk assessment (notably related to human health); decontamination and pollution control; climate change (reducing emissions of greenhouse gases and energy saving); wastewater treatment; water supply; and soil protection. 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 24 and 72 months. Presented in the box below is an example of a successful LIFE Environment project in Greece.

Some ongoing LIFE Environment and Resource Efficiency projects are summarised below.

Table 8.3 Ongoing LIFE Environment and Resource Efficiency projects

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

Source:http://ec.europa.eu/environment/life/countries/documents/greece_en_oct17.pdf

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 11 projects in Greece so far. This represents a total investment of €11.5 million, of which the EU is contributing €6 million. The projects are being carried out by the universities of Crete (3 projects) and Patras (one project), three NGOs, a national authority and a regional authority (Peloponnese). They will have durations of between 21 and 60 months. To date, five 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. The second succeeded in raising levels of awareness among its target audiences, and helped to change attitudes and behaviour, regarding the marine environment and the 14 marine mammal species living in Greek waters (detailed information and the results can be found in the box below). This project was selected as one of the Best of the Best LIFE Information & Communication projects in 2015. The third project promoted sustainable production and consumption of olive oil. The fourth developed a series of tools for addressing the issue of coastal littering in Greece. The last closed project's overall objective was to confront and 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 the current Greek and European legislation. There are five ongoing projects, focused on the following issues: supporting conservation efforts targeting Natura 2000 sites in Crete by motivating the public to participate in relevant decision-making processes and by highlighting the socioeconomic damage that will result from biodiversity loss; 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; developing and implementing an integrated information and awareness-raising campaign for the prevention and reduction of plastic bag pollution in the marine environment; and 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. An example is presented below.

Thalassa Campaign: Learn, Act, Protect/Awareness, Educational and Participation Campaign for Marine Mammals in Greece (Thalassa) LIFE09 INF/GR/000320

The LIFE Thalassa project raised awareness among its target audiences, and helped to change attitudes and behaviour, about the marine environment and the 14 marine mammal species living in Greek waters. In the context of the communication strategy developed by the project, the Thalassa campaign produced a diverse range of high-quality awareness-raising, educational and capacity-building tools. These included leaflets, print advertisements, TV and radio spots, a documentary, nine information videos, posters and banners, a project website, eight issues of an e-newsletter, T-shirts, and two open events for the public.

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 two projects in Greece. One project aims to contribute to the development of a new methodology and provide policy-makers 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. The total investment for these projects amounts to €4 million, of which the EU will provide €2 million. The projects will be carried out by a university and a research institute, and will have durations of 42 to 47 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 three projects in Greece. One aims 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 aims to facilitate the development of adaptation strategies for agriculture by deploying and demonstrating an innovative decision support tool. The third project aims to demonstrate, on the Aegean island of Andros, the use of drystone terraces as green infrastructures resilient to climate change impacts. The total investment for these three projects amounts to €6.5 million, of which the EU will provide €4 million. The projects will, respectively, be carried out by an SME, a university and a research institute, and will have durations of 43 to 60 months. More details about one project can be found in the box below. Its results will be added in due course. An example is presented below.

Adaptation to Climate change Impacts on the Mediterranean islands' Agriculture (LIFE ADAPT2CLIMA) LIFE14 CCA/GR/000928: The LIFE ADAPT2CLIMA project aims to facilitate the development of adaptation strategies for agriculture by deploying and demonstrating an innovative decision support tool. The ADAPT2CLIMA tool will make it possible to simulate the impacts of climate change on crop production and the effectiveness of selected adaptation options in decreasing vulnerability to climate change of three Mediterranean islands, namely Crete (Greece), Sicily (Italy), and Cyprus. In particular, the tool will provide: i) climate change projections; ii) hydrological conditions related to agriculture: iii) a vulnerability assessment of selected crops; and iv) an evaluation of the adaptation options identified.

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 Environment Energy & Climate Change,
- 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.hnms.gr/hnms/greek/index_html) is currently covering all the meteorological and climatological needs of the country. In the same time, the Service participates in international networks and represents Greece in the following meteorological organisations: WMO, ECMWF, EUMETSAT, EUMETNET, COSMO-Model, ECOMET, ICAO, NATO.

In NOA, the Institute of Environmental Research and Sustainable Development (IERSD, http://www.meteo.noa.gr/) 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) has also worked on climate change issues, while equally important is the contribution of the University of Athens Climate Research Group (http://env.mg.uoa.gr/index.php?option=com_content&view=article&id=57&Itemid=72&lang=en).

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 Observing 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 Laboratory of Hydrology and Water Resources Management of 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. Aquastress project, the Xerochore project etc.).

The Centre for Renewable Energy Sources and Saving (CRES, http://www.cres.gr/kape/index_eng.htm) 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 area of activity. 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 8.4***.

Table 8.4 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)	11. National and Kapodistrian University of Athens (NKUA) 12. National Observatory of Athens (NOA) 13. 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, (NTUA)	http://www.circeproject.eu/index.php?option=com_content&task=view&id=67&Itemid=1
Monitoring, forecasting and best practices for FLOOD mitigation and prevention in the CADSES region (FLOODMED)	1. Laboratory of Hydrology and Water Resources Management (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. Laboratory of Hydrology and Water Resources Management (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	Aristotle University of Thessaloniki (AUTH)	http://cordis.europa.eu/fetch?CALLER=FP7

Project	Greek Institute	Source
combat desertification. An integrated assessment (PRACTICE)		_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.hnms.gr/hnms/greek/index_html), the National Observatory of Athens (NOA, http://www.noa.gr), the National Agricultural Research Foundation (NAGREF, http://www.nagref.gr/), the Atmospheric Physics Laboratory of the Aristotle University of Thessaloniki (AUTH, http://lap.physics.auth.gr/), the Centre of Renewable Energy Sources (CRES, http://www.cres.gr/kape/index.htm), the Atmospheric Modeling and Weather Forecasting group (AM&WFG, 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 Laboratory of Hydrology and Water Resources of National Technical University of Athens (School of Civil Engineering/ NTUA, http://hoa.ntua.gr/).

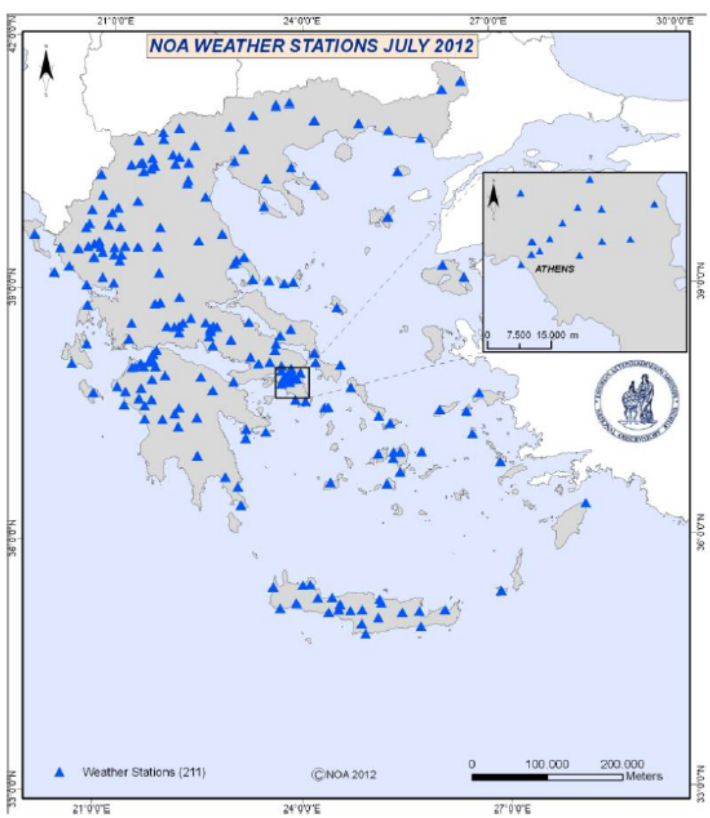
8.3.1.2 Measurements of meteorological parameters

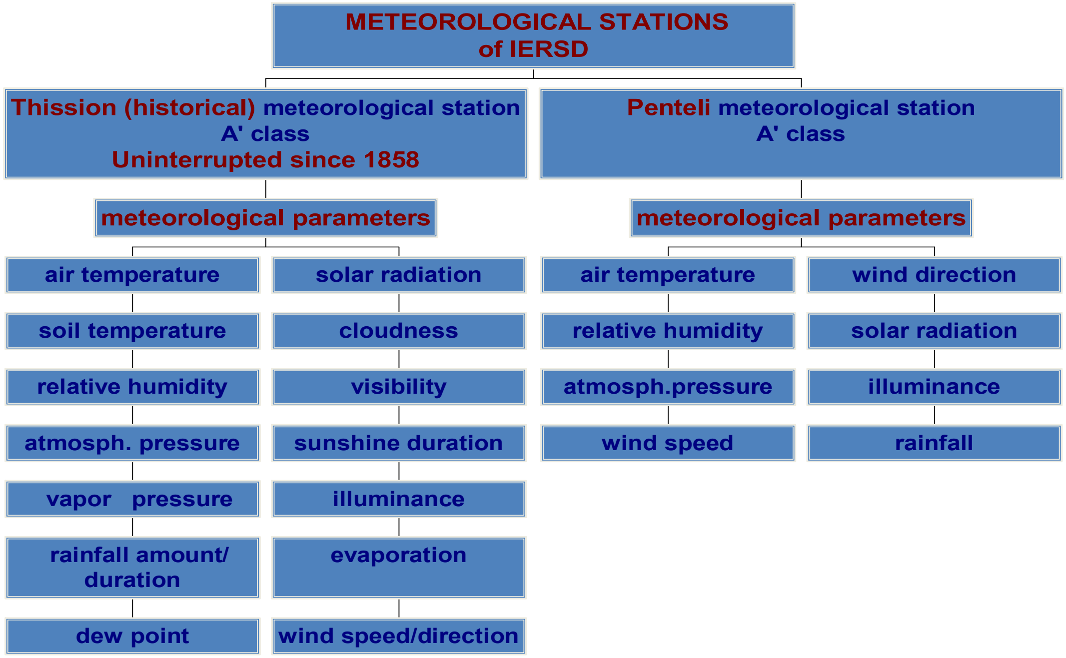
The Hellenic National Meteorological Service (HNMS) operates a network of 79 land surface and 3 upper air measurement stations. In addition, all of them are registered to World Meteorological Organization (WMO). The available data time series cover a period of 35-40 years. The majority of the stations 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 Directorate of Agricultural Research and Applications 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 & Climate Change (80 of them by the General Directorate of Plant Production (of MRDF) with the rest divided between the Special Secretariat for Forests (of MEECC) (former Department of Forests of MRDF) and the Department of Land Reclamation (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 part of the National Agricultural Research Foundation (NAGREF), which in 2011 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. The Institute operates a network of 21 additional meteorological stations in forest area since 1960, which was refurbished in 1994 so as to become fully automated. The stations cover mostly forest areas, while the data are fed into a database of meteorological information that covers a period of 40 years.

The National Observatory of Athens (NOA) also operates two 1st class meteorological stations in Athens (in Thissio since 1842 and Penteli since 1998). These stations measure, on a continuous basis, air temperature, barometric pressure, rainfall, relative humidity, wind direction and velocity, along with a full set of solar radiation parameters. The availability of data time series varies from 10 to 50 years in relation to the respective station and measured parameter. Since early 2006, NOA has started the installation of automated meteorological stations along the country. Till July 2012, have been installed more than 240 stations (Figure 8.1). These stations measure and record every 10 minutes temperature, relative humidity, pressure, rainfall, wind direction and velocity, while 4 of them measure and record every 1 minute. The historical data and real-time provided by the websites: http://penteli.meteo.gr/meteosearch/, http://www.meteo.gr/observations.asp & 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 **280 automated** surface meteorological stations (Davis) deployed over Greece (see also figure below)
- **Solar radiation** data are also available for **60** sites.
- UV radiation data are also available for 20 sites
- The network is still expanding
- Climatic archives from the network of automated stations are available at www.meteo.gr/meteosearch
- A CD-ROM with all weather data from the two A Class stations is distributed for free every year to more than 80 recipients in Greece and abroad (Public organizations, Universities, Libraries etc.).

Figure 8.1 NOA Meteorological stations network.

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://hoa.ntua.gr/). 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 Laser Development and their Applications** of **National Technical University of Athens**-(Physics Department). The infrastructure currently available at LRSU includes: 1) a 6-wavelength (elastic and Raman) aerosol/water vapor lidar system operating at 355-387-407-532-607-1064 nm (0.5-14 km), 2) a mobile single-wavelength elastic backscatter lidar system, equipped with a 532 nm polarization detection channel, 3) a 4-wavelength (266-289-299-316 nm) DIAL system for ozone monitoring in the lower troposphere (0.5-6 km), 4) a fully equipped meteorological station for in situ P,T,U, rainfall and wind measurements, 5) total ozone and aerosol optical depth (IR) measurements capabilities using the Micro-TOPS II technology.
- 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

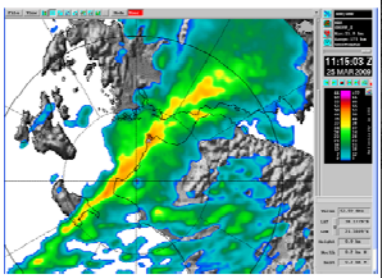
The National Observatory of Athens (NOA) has been operating a network of stations aimed at detecting lightning strikes. The network consists of 6 recording stations, located in the UK, Denmark, Romania, Italy, Cyprus, Portugal and Greece. It has been in operation (detection and recording) since 2005, 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 (http://www.noa.gr/forecast/lightning.gif).

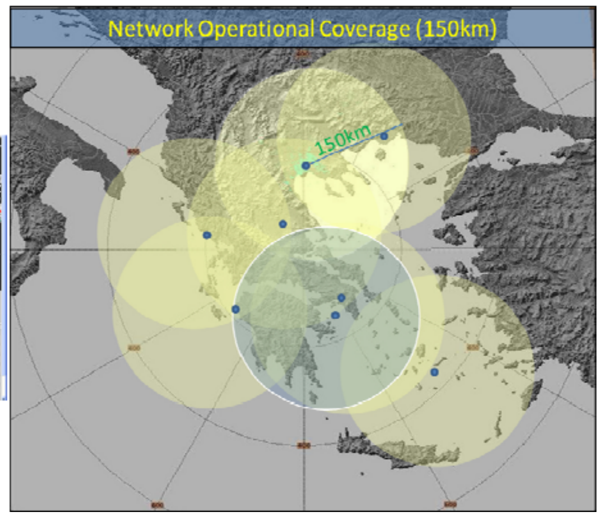
8.3.1.4 Meteorological RADAR

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 (www.uvnet.gr), 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 and Climate Change operates local networks for monitoring air pollution in the major urban areas of Greece. In the greater Athens area, the network consists of 18 stations that measure air pollutants of which 16 measure ground level ozone. In Voiotia two stations consists in Oinofita and Aliartos under the framework of the Program of Trans boundary Transport of Pollution. The greater Thessalonica area network consists of 8 stations. Thirteen additional stations, all of which measure ozone, are located in other cities. The data are available to the public through the National Environmental Data Center of Ministry of Environment, Energy and Climate Change (http://www.e-per.gr, 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 34 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 8.2a***, ***8.2b*** and ***8.2c***. 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/).

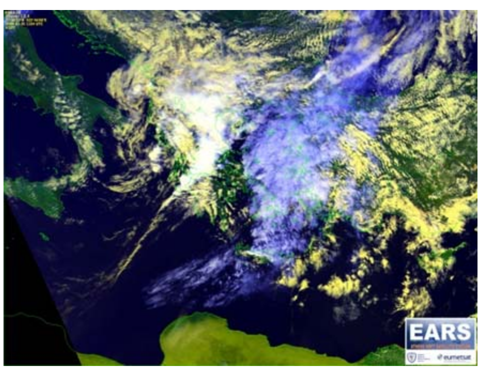


Table 8.5a National contribution to the surface-based atmospheric essential climate variables

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	79 (HNMS) 13 (NTUA) 2 (NCSR) 6 (NAGREF) 1 (NOA)	79 (HNMS) 13 (NTUA)	79 (HNMS) 13 (NTUA) 2(NCSR) 1 (NOA)	79 (HNMS)	79 (HNMS) 1 (NOA)
	Precipitation	79 (HNMS) 16 (NTUA) 5 (NAGREF) 1 (NOA)	79 (HNMS) 16 (NTUA)	79 (HNMS) 16 (NTUA) 1 (NOA)	79 (HNMS)	79 (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 8.5b 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 8.5c 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 Technology (GSRT) of the Ministry of Education, Research and Religious Affairs. 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**

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.

8.3.2.3 Hellenic Navy Hydrographic Service (HNHS)

The Hellenic Navy Hydrographic Service consists of 7 divisions: Digital Cartography Division, Hydrography Operations Division, Cartography Division, Safety of Navigation Division, Oceanography Division, Administrative and Logistics Division and Computing Center Division.

The mission of the of the Hellenic Navy Hydrographic Service is the collection, analysis and use of data and information of the Hellenic sea waters in the fields of Hydrography, Oceanography, Cartography and Navigation in order to:

- Support the relevant operational requirements of the Hellenic Navy and the Hellenic Armed Forces, generally.
- Contribute to the safety of navigation and to promote the subjects of Hydrography, Oceanography and Cartography.
- Support, in case of request, of public services and the private sector

The Hellenic Navy Hydrographic Service is responsible for:

- Storing data and information of the marine environment in order to cover the operational requirements of the Hellenic Navy and the Hellenic Forces in general.
- Carried out Hydrographic and Oceanographic surveying, maritime works and studies using the best available tools and technics.
- Publication and distribution of nautical charts, special naval charts and nautical publications.
- National coordinator in the international NAVTEX service for promulgation of Maritime Safety Information. Issue of Notices to Mariners
- Definition of channels, safety anchorages, restricted areas, dangers to navigation as well as the way of their marking.
- Maritime study on the installation of lighted or not lighted buoys, landmarks, mooring buoys and navigational radio-aids.
- Definition of shore boundaries, terrestrial port zones, port works and installations of aquacultures (sea farms).
- Installation of networks of permanent measuring stations for the collection of hydrographic, oceanographic and navigational information.

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:

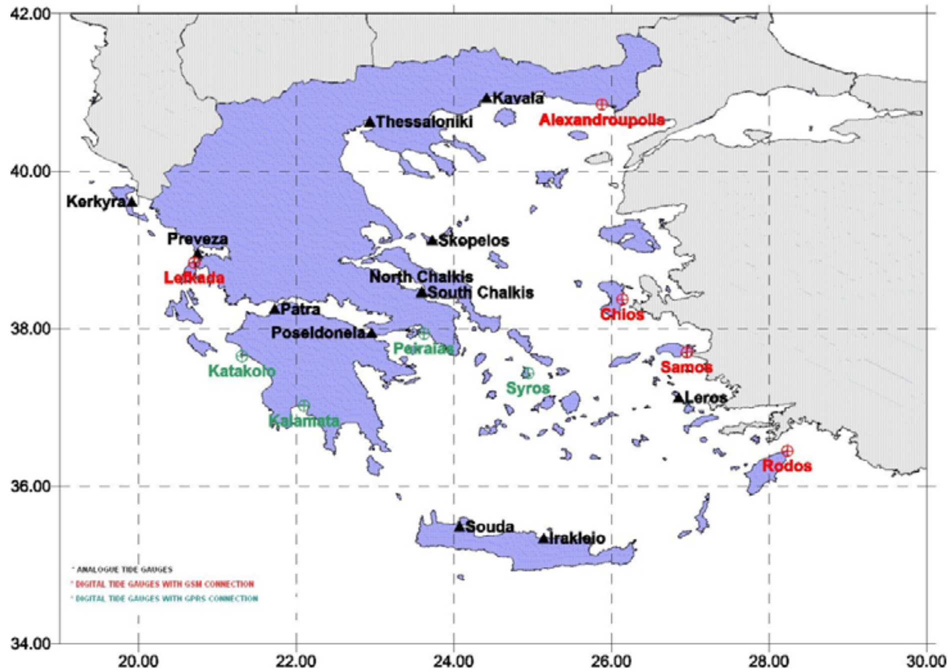


Figure 8.2 Map of Permanent Network of Sea - level and Temperature Monitoring

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 (ICS-NERAMTWS).

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 8.6a*** and ***8.6b*** 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 8.6a 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 8.6b 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 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 8.7 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 & Climate Change (MEECC, http://www.ypeka.gr/), the National Technical University of Athens (NTUA, http://www.ntua.gr/), the Public Power Corporation (PPC, http://www.dei.gr/?lang=2), the Institute of Geology and Mineral Exploration (IGME, http://www.igme.gr/portal/page?_pageid=33,56803&_dad=portal&_schema=PORTAL) and the National Agricultural Research Foundation (NAGREF, http://www.nagref.gr/index_uk.htm).

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:

- General Chemical State Laboratory of Greece (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 Institute (LRI), (Hellenic Agricultural Organization, Department of NAGREF)

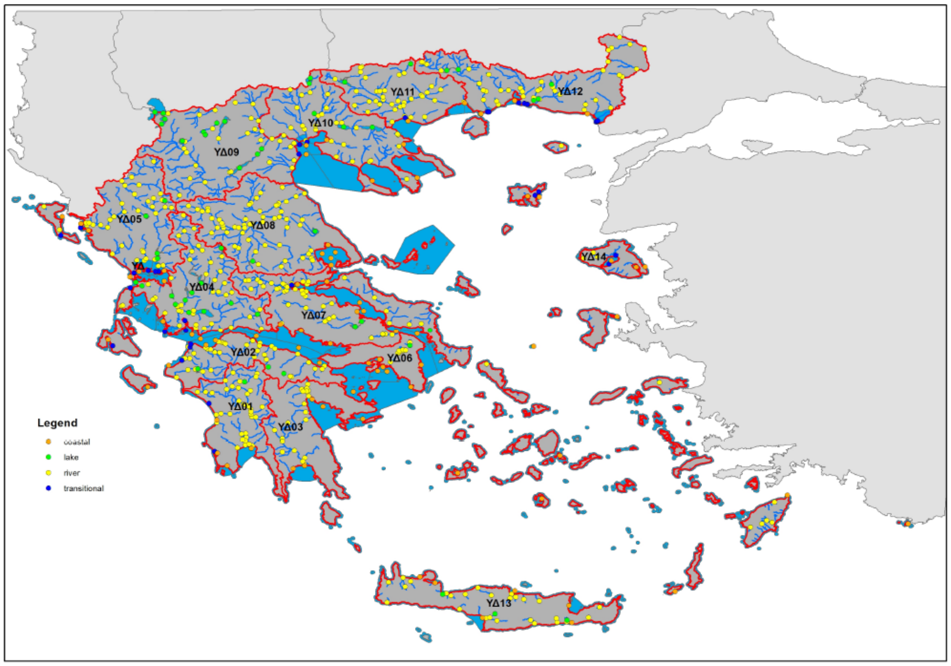


Figure 8.3 Network of surface waters

(http://www.ypeka.gr/LinkClick.aspx?fileticket=hgp1EfmS32k%3d&tabid=249&language=el-GR)

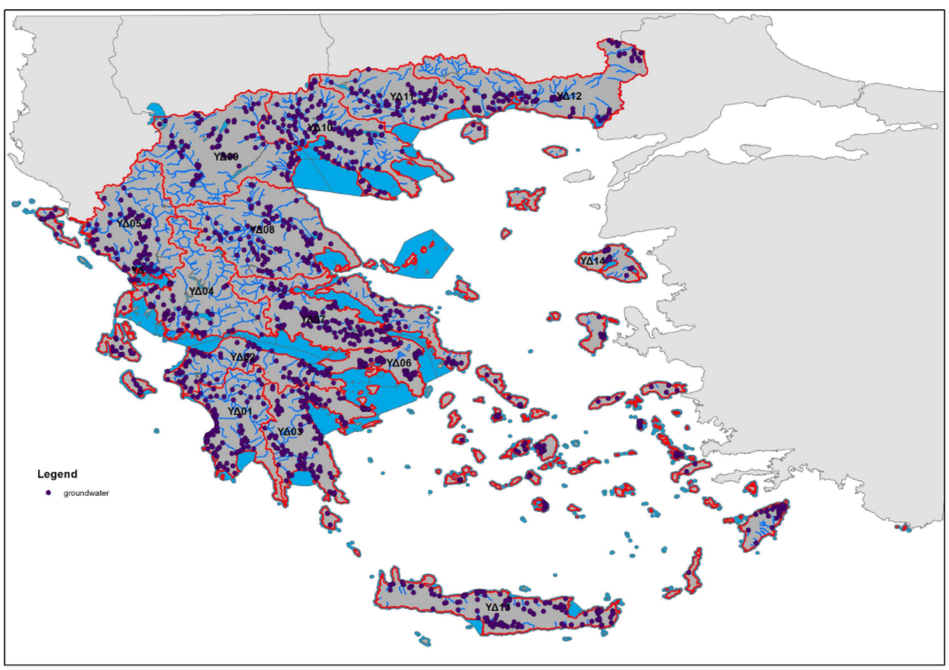


Figure 8.4 Network of ground waters

(http://www.ypeka.gr/LinkClick.aspx?fileticket=67Patn%2fdMdk%3d&tabid=249&language=el-GR)

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 & Climate Change
- The Hellenic National Meteorological Service
- The Public Power Corporation
- The Ministry of Rural Development and Food
- The Ministry of Development & Competitiveness

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 & Climate Change 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. http://www.ypeka.gr/Default.aspx?tabid=543&language=el-GR

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 (http://www.ypeka.gr/Default.aspx?tabid=232).

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 8.8*** 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 8.8 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

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
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
GSRT	General Secretariat for Research and Technology
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
ICS-NERAMTWS	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) 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 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 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 School 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" is focused 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 10) 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, Research and Religion (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 Department of Environmental and Health Education of the Division of Vocational School Guidance and Innovative Actions of the Ministry of Education coordinates and supports **the realization of environmental education activities** in primary and secondary schools 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 ESD. The programs last from two to five months.
- The exploitation of the network of fifty-two (52) **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, 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.

Consistent with 106553/G7/13-10-2006 "The framework of reference for Sustainability Education and school activities", the **year 2013** was dedicated to the human environment and sustainable management. In this context, according to the relevant circular published by the Ministry of Education, Research and Religion (M.E.) in October 2013 the extended concept of environment, as a reservoir and aspect of human activity (cities, buildings, museums, parks, sports facilities and organized art, social groups, etc.), the holistic health perceptions (rather than absence of disease but as overall quality of life with multiple parameters) and Culture course, operate as interrelated fields of study and action (http://dipe.ima.sch.gr/gray/?cat=16).

Indicative websites on basic principles and content of education for sustainable development are:

- The Millennium Declaration: http://www.unric.org/el/human-rights-greek
- Website of the UNESCO Education for Sustainable Development www.unesco.org/

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.

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:

- *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.

- *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?

- *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

- *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.

A. Programmes of Environmental Education

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								

The Environmental Education Centres (EEC) are also involved in the implementation of educational programmes and activities. Currently 52 EECs are operating in Greece (http://kpe-kastor.kas.sch.gr/kpe/pe/kpe.htm), 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

Also via the "Gate of Environmental Education" teachers get access to various types of educational material (videos, photographs, interactive worksheets) (Website: http://www.kpe.gr/index.php). Finally, it's worth mentioning 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.).

B. Education for sustainable development

In the context of the UN "Decade of Education for Sustainable Development 2005-2014", the Ministry of Education, Research and Religion 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. It consists of 14 EECs which cooperate in equal terms and share the following responsibilities.

- To plan and conduct environmental educational programs based on the thematic units of the network (including Climate change **in the past** and methods of **tracing** it, Climate change and **energy**, Climate change and **agriculture,** Climate change and **water,** Climate change and **desertification etc.)**
- To **support the members** of the network with educational material on climate change
- To **co-operate with the teachers** responsible for Environmental education in each prefecture so as to design programs on climate change that will be implemented in schools
- To **co-ordinate and assist schools** to carry out programs on climate change
- To **produce educational material** on climate change
- To **publicize the outcomes** of the educational procedures in the local community

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 consists 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. Training

i. Education/Training of teachers

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 an action entitled “Seminars 2016-2017” that addressed to the pedagogic units of the EECs and to the responsible for environmental education: More specifically, thirty nine (39) centralized seminars were organized. 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.

b. Training for the public. (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’)

c. 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)

ii. 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/)

4. 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.

5. 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.

6. 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).

7. Publication of the Scientific Journal of EECs

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. Their function is primarily aiming to:
  - The organized scientific and educational support of Environmental Education program
  - The compilation of educational material
  - The development of communication between all members
  - The exchange of experiences and views between scientists and all members (teaching and student groups participating schools , coordinating bodies)
  - Exchange of visits
  - Drawing conclusions and
  - The formulation of proposals for actions of students and to mobilize relevant public bodies.

- 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.

D. Educational material linked to climate change

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 (http://kpe-kastor.kas.sch.gr/climate_change/index.htm)

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. Collaborations

Apart from the exploitation and development of the administrative educational structures mentioned above, the Department of Environmental and Health Education **co-operates with** other departments or Divisions of the Ministry, 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 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, and especially the Department of International Relations and EU Affairs, is cooperating closely with the Ministry of Education, Research and Religion in the context of the education for sustainable development. The Ministry has 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 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.

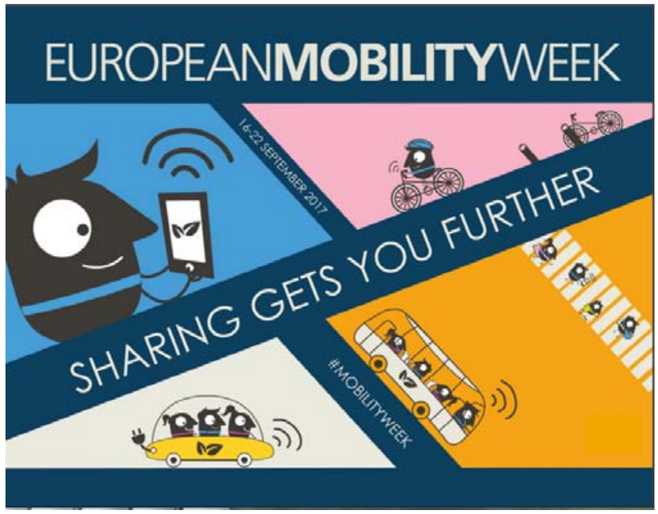
Activities of the Greek Scouts

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://www.peekpe.gr/katastatiko.htm). 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 (http://www.peekpe.gr).

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.

9.2.2.4 Non-governmental organizations

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. For instance, there are 'thematic' NGOs 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/), Arktouros (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/), 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 and the, '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.

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. These important cases are often undertaken in cooperation with other national environmental NGOs "Natura 2000". Presentation of habitat types and important species of fauna and flora in 270 protected Natura areas in the country. Financial support: Ministry of Environment.

- 2. Conservation and Nature-Protection. 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):

- 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 (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. (see www.yre.global).

  – "Learning about Forests" (FEE international programme). 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).

- “Litter-free Nature” (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. (http://eepf.gr/el/drasi/fysi-xwris-skoupidia).

- “Green Neighbourhoods” (National programme). Students 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).

- 4. Sustainable Management and Public Awareness Raising
  - “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.

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

Kallisto offers Environmental education for pupils for the sixth consecutive year. 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 2017-2018 environmental education program includes four themes: "Forest animals go to school", "Mammals at risk" and "Man and carnivorous animals: conflict and coexistence", "The issue of poisoned baits". The program is implemented in cooperation with primary and secondary schools in Athens and Thessaloniki. The initiative began in 2008 under the Corporate Responsibility Program. Environmental actions aim at minimizing the environmental impact of the company's activities, developing and delivering products and services to increase productivity and protect the environment, as well as environmental awareness. 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 (CD Roms), workshops and even interactive games. 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.

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 **Mediterranean Network SOS** (http://medsos.gr/medsos/medsos-network.html) is also active on the environmental education area. The school programmes performed aim at the information and awareness of students, the organisation of student competitions and exhibitions and the training of educators and teachers, with various activities being concentrated on the climate change issue. Currently the thematic areas covered by the Mediterranean Network SOS are:

- Water resources
- Coasts - Sea
- Climate Change - Energy
- Sustainable cities
- Biodiversity
- Green economy
- Civil society
- Dialogue of cultures

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 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. 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, include indicatively:

(a) **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.

(b) 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.

(c) **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.

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.

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.

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.

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/, available in greek only), that is functioning under the Ministry of Education, Research and Religion.

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.

Second Chance Schools

The General Secretariat of Lifelong Learning, through the Institute of Continuous Training of Adults, has the responsibility for the operation of 62 Second Chance Schools (SCS), since 2000, 8 of which are located in penitentiaries.

Second Chance Schools enable adults aged over 18 years old who have not completed their nine year compulsory education to continue their studies and obtain a qualification equivalent to the high school certificate (Law 2525/97). The duration of the course is 18 months (two school years) and teaching hours 25 per week. The lessons take place in the afternoon hours from Monday to Friday.

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.

4th Summer School entitled: "Clean Energy - Clean Environment: Technological Solutions and Prospects", Kozani, June 23 - 1 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". (http://mech.uowm.gr/index.php/2014-06-21-12-13-51/news-reg/689-2016-05-27-12-28-52). 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.

Open GIS Symposium and Summer School 2015 - opengis2015, Aegean University, Crete, 20 Jul 2015 to 24 Jul 2015: This summer school offered an introduction to the concepts behind GIS, the types of data used, the manner in which they are structured and analysed, projection and geographic coordinate systems and data representation, as well as basic data analysis. These theoretical concepts are followed by specific applications focusing on topics such as agriculture, forestry, water and coastal zone management. In addition to the theoretical background, the course focuses strongly on hands-on practical applications, employing open source software.

Nutrition and Biodiversity as tools of Well Being - NuBioEYZHN2015, University of Aegean, Lesvos, 24 Aug 2015 to 29 Aug 2015: The present Summer School aims at presenting, analyzing and evaluating the crucial role of Nutrition and Biodiversity in improving the quality of human life, as well as highlighting the necessity of a synergistic interdependence between the two so that Well Being is achieved (https://summerschools.pns.aegean.gr/).

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.

9.2.5 Other organizations

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.

9.2.5.1 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.

9.2.5.2 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)

9.3 Environmental information and awareness

9.3.1 Governmental Initiatives

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.

Only in October 2017 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

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”.

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 "Life+ Information and Communication" aims to disseminate information and raise awareness on environmental issues, including the prevention of forest fires.

In addition, the "Program for the Development of Interventions", for the period 2010 to 2015 under the pillar "Strengthening of mechanisms and principles of environmental governance" attempts to strengthen the environmental governance through a set of actions which are key pillars to promote the mechanisms and principles of environmental governance, institutional interventions and investments to enhance physical and human resources.

At the same time, public access to environmental information is promoted in the context of the relevant European Directive (INSPIRE), as well as the principle of volunteering is supported through awareness-raising actions and through organizing volunteer and financial assistance actions.

9.3.1.3 Ministry of Foreign Affairs

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:

- "**Special event towards achieving the millennium development goals**", New York, (September 25, 2013). The international landscape is rapidly changing. There are many economic, social and environmental challenges, such as extreme poverty, climate change and financial crises, strong inequalities, demographic and migration problems, regional and local conflicts and security issues. Consequently, the post-2015 agenda should build on the lessons learned and take into account the new global challenges. The new development goals must focus on poverty eradication, be universally applicable, simple and measurable, promoting democracy, human rights, the rule of law, citizens' security, social cohesion and environmental sustainability. They should also take into consideration the particular characteristics, economic and social conditions and needs of every developing country, and the differences among social groups therein, with the view to reinforcing policies already applied at a national level.
- Workshop with the collaboration of the International Centre for Black Sea Studies (ICBSS) and the Center for Strategic Studies of Azerbaijan on "**Energy Cooperation**

and Environmental Protection in the wider Black Sea" (29 November 2011). The main axis of the discussions was to promote Greek-Azerbaijani relations in energy and environmental protection, in order to promote environmentally friendly practices and the adoption of a model of clean energy for the region of the Black Sea. In addition, on the 25 November 2013 senior Officials from the Hellenic Ministry of Interior and the Ministry of Foreign Affairs, Ambassadors of the Black Sea countries to Athens have been invited to the event "**15 years ICBSS: Promoting Synergies in a Dynamic Region**". Maintaining the flagship of promoting sustainable development that ICBSS has been fostering over the years, the event will put emphasis on the significant role of local, regional and international players, civil society and NGOs, as key elements to achieve multilateral cooperation among the Black Sea countries, regional and international actors, aiming to build a sustainable future for the Black Sea area and its peoples.

- "**The Politico-Military Dimension of European Security: Proposals and Perspectives**" (May 17, 2011). The conference was held under the auspices of the Ministries for Foreign Affairs of the Russian Federation and the Hellenic Republic focusing on: 1. The Dialogue on European Security, 2. Arms Control and Confidence and Security Building Measures, and 3. International Organizations and Cooperative Security

9.3.1.4 Ministry of Transport and Communications

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, November 2016. 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, 2015), organizes a two-day workshop on "Planning the Transition to Energy Efficient Cities - Energy Saving at Level Municipalities and Municipalities ".

- 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 Organisations Initiatives

9.3.2.1 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 two main directions:

1. Climate changes. The Energy Revolution is Greenpeace's vision for the future power generation system across the globe and of course Greece. It is Greenpeace's suggestion to prevent the devastating effects of climate change.

2. Marine ecology The Greenpeace campaign aims to protect the world's oceans through the creation of a global network of marine shelters, covering 40% of the seas.

3. Sustainable agriculture. It benefits our country and people and produces safe and healthy food without harming the environment. It is safe, feasible and is already in place in many parts of the world.

9.3.2.2 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

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.

The main thematic axes are:

- Climate change - energy
- Save water
- Coasts – Sea

9.3.2.3 Sea Turtle Protection Society of Greece ARCHELON

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, *(source: http://www.archelon.gr/)*

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.

9.3.2.4 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.

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.

9.3.2.5 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:

- IENE Regional Energy Efficiency Workshop and Role of LNG in Southeast Cyprus, Nicosia, Hilton Cyprus, 1 November 2017
- 22nd National Energy Conference IENE "Energy & Development 2017", Eugenides Foundation, Athens, 23-24 November 2017
- 2nd Energy Tech Forum, www.energia.gr, under the auspices of IENE, Eugenides Foundation, Athens 25 November 2017;
- 3rd IENE Energy and Shipping Seminar in collaboration with the University of Piraeus, Eugenides Foundation, Athens, Wednesday, April 20, 2016,
- 9th SE Europe Energy Dialogue, Thessaloniki, 29/30 June 2016
- "Global Oil & Gas - Black Sea and Mediterranean", Exhibition and Conference organization FORTH Group PLC and ROTA SA, in collaboration with IENE, Athens, September 28-29, 2016
- Presentation of the IENE Study, "SEE Energy Outlook 2016/2017", Ministry of Foreign Affairs, Athens, 14 December 2016
- IENE Regional Conference Energy Security and Gas Supply in SE Europe, Vienna, March 12, 2015
- IENE Regional Conference on "The Nuclear Option for SE Europe", Bucharest, Romania, May 6, 2015
- Open Forum on Hydrocarbon Research and Production in Greece and the Eastern Mediterranean, Athens, June 10, 2015

3. Co-operation with the Institutional Organs 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).

9.3.2.6 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 International cooperation

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)

9.3.5.1 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).

Regarding ODA, MEECC 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.

→ 2004-2013: around EUR 21 million disbursed overall, around USD 1 million to UNFCCC

→ 2005-2013: around USD 750,000 to the Kyoto Protocol Fund

9.3.5.2 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 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. 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 UfM.

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.

9.3.5.3 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, 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 (e.g. MoU with Cyprus-Sept. 2010, Joint Declaration with Turkey-May 2010).

9.3.5.4 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 3rd BIENNIAL REPORT

A.I.1 Introduction

This Annex I to the Greek 7th National Communication (NC) under the UNFCCC is the 3rd 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 2nd 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.

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.[23]

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.[24]
- ✓ 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.

[23] 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

[24] In the EU, the sum of emissions covered by category 1.A.3.a 'domestic aviation' and memo item 'international bunkers - aviation' go beyond the scope of the EU target, as emissions from international aviation are included in the EU Climate and Energy Package and the EU target under the UNFCCC **to the extent to which aviation is part of the EU ETS**.

Table A.I.1 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 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

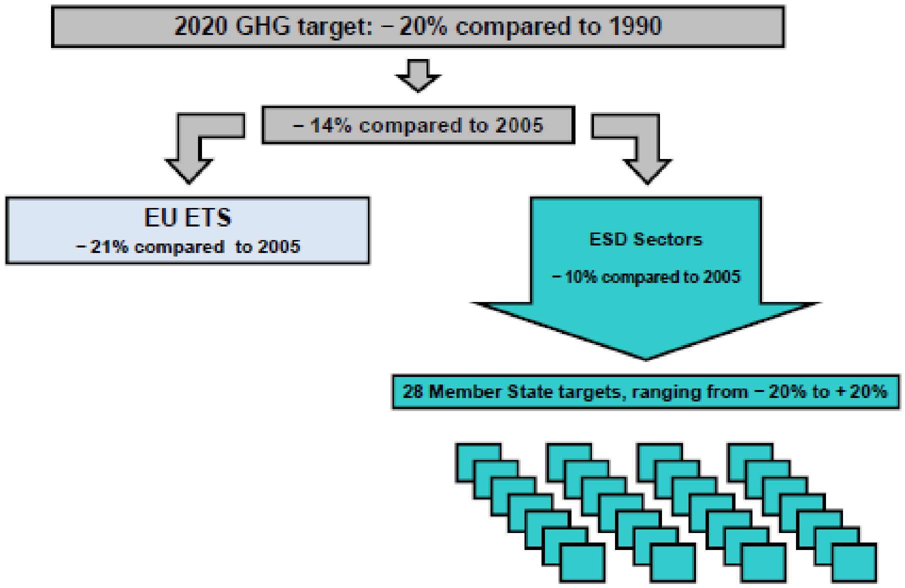
A.I.3.2.1 The 2020 climate and energy package

In 2009 the EU established internal rules under its “2020 climate and energy package”25 – 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***.

[25] http://ec.europa.eu/clima/policies/package/index_en.htm



Source: European Commission

Figure A.I.1GHG targets under the 2020 climate and energy package

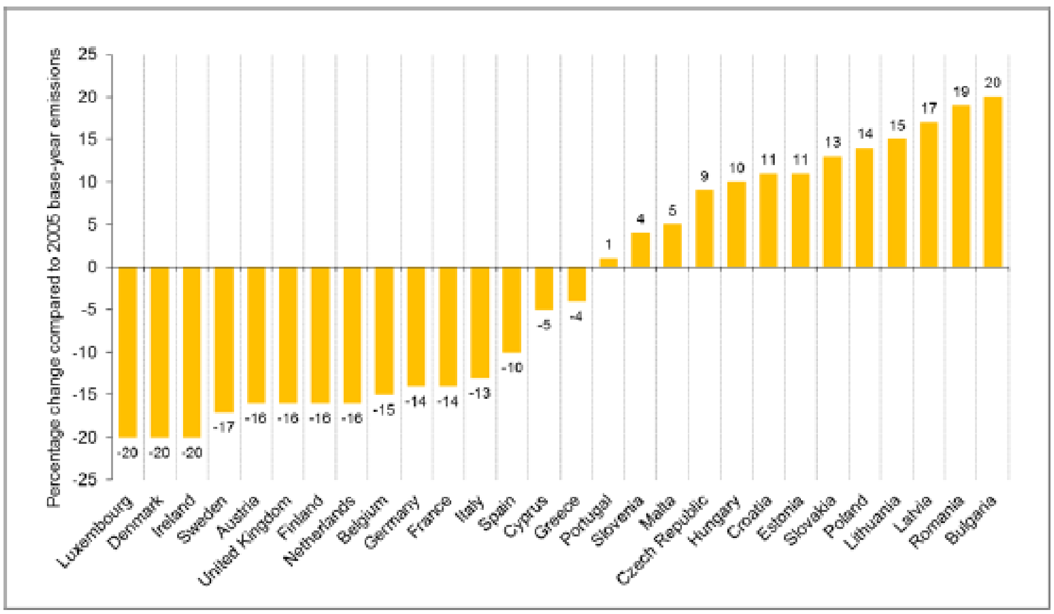
Under the revised EU ETS Directive (Directive 2009/29/EC), a single ETS cap covers the EU Member States and three participating non-EU countries (Norway, Iceland and Liechtenstein), i.e. there are no further individual caps by country. Allowances allocated in the EU ETS from 2013 to 2020 decrease by 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.2National 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	Climate and Energy Package	
				EU ETS	ESD
Target year of period	First commitment period (2008-2012)	Second commitment period (2013-2020)	2020	2013-2020	2013-2020
Emission reduction target	-8 %	-20 %	-20 %	-21 % compared to 2005 for ETS emissions	Annual targets by MS. In 2020 -10 % compared to 2005 for non-ETS emissions
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 %	
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 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	
LULUCF	Included ARD and other activities if elected	Includes ARD and forest management, other activities if elected (new accounting rules)	Excluded	Excluded	
Aviation	Domestic aviation included. International aviation excluded	Domestic aviation included. International aviation excluded	Aviation in the scope of the EU ETS included. In practice total aviation emissions considered	Domestic and international aviation included, as in the scope of EU ETS	Aviation generally excluded, some domestic aviation included(operators below ETS de minimis thresholds)

	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[26]	
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 AR4	

[26] 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[27]; however aggregated data at EU-level is available earlier.

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.

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

[27] Annex XIV of European Commission. Commission Regulation (EU) No 389/2013. 2013. http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32013R0389

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.I.4 Progress in achievement of quantified economy-wide emission reduction targets and relevant information

A.I.4.1 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 BR2.

A.I.4.1.1 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 section 4.10 of the EU BR1 as well as chapter 15 of the EU National Inventory Report 2017).

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.[28] These include provisions that allow interested parties to comment on proposed

[28] For more information see http://ec.europa.eu/trade/policy/countries-and-regions/countries/ukraine/.

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.[29]

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.

A.I.4.2 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).

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.4.2.1 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

[29] For further information on the ENP see http://eeas.europa.eu/enp/.

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 2nd 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 7th National Communication. Together, they present a comprehensive description of the Greece's climate support.

This chapter covers the quantitative information for 2015 and 2016, using the required table formats.

The CTF tables with detailed data on the support provided in 2015 and 2016 are included in the CTF tables[30].

A.I.6.1 Finance

The provision of financial support by Greece to non-Annex I Parties is presented in chapter 7 of the 7th 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 7th 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 7th NC and CTF Table 9.

[30] 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)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)
1. Energy	74664,53	74664,53	74738,27	76679,19	76317,40	78488,87	78540,00	80697,98	85210,36	89795,33	89207,94
A. Fuel combustion (sectoral approach)	74621,84	74621,84	74695,11	76642,89	76287,93	78463,10	78517,44	80673,03	85187,71	89779,72	89207,09
1. Energy industries	43093,70	43093,70	41932,61	44212,55	44111,98	46089,07	44857,20	44037,52	47473,14	49995,24	50294,82
2. Manufacturing industries and construction	9338,49	9338,49	9387,80	9044,66	8760,33	8610,16	9481,90	10087,60	10194,95	10152,18	9139,77
3. Transport	14124,13	14124,13	14925,71	15301,18	15472,29	15765,06	16100,88	16552,11	17256,23	19018,48	19334,68
4. Other sectors	8065,52	8065,52	8449,00	8084,51	7943,33	7998,81	8077,46	9995,79	10263,39	10613,82	10437,82
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	42,70	42,70	43,16	36,30	29,47	25,77	22,55	24,96	22,65	15,61	0,85
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	42,70	42,70	43,16	36,30	29,47	25,77	22,55	24,96	22,65	15,61	0,85
C. CO_2 transport and storage	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Industrial processes	8650,20	8650,20	8554,31	8180,83	7868,10	7862,15	8360,40	8354,33	8549,88	8785,34	8691,74
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	680,65	680,65	649,65	248,00	170,01	30,43	32,03	33,38	116,18	382,22	353,33
C. Metal industry	1012,05	1012,05	1049,91	999,29	814,52	979,88	1006,91	1014,44	1040,53	986,22	918,40
D. Non-energy products from fuels and solvent use	79,60	79,60	52,47	53,65	52,47	52,47	44,81	40,68	47,76	31,25	38,32
E. Electronic industry											
F. Product uses as ODS substitutes											
G. Other product manufacture and use	102,47	102,47	105,72	103,93	100,86	96,65	90,56	89,04	89,77	90,86	96,42
H. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Agriculture	60,41	60,41	58,13	55,57	43,74	40,75	45,02	46,02	43,74	43,88	41,75
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	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]	-2245,82	-2245,82	-2418,51	-2513,10	-2979,19	-2721,86	-2975,06	-2389,37	-2082,05	-2016,03	-2647,14
A. Forest land	-1139,35	-1139,35	-1273,02	-1561,26	-1616,95	-1350,42	-1580,84	-1626,89	-1297,26	-1262,49	-1577,30
B. Cropland	-807,61	-807,61	-858,46	-808,55	-1044,83	-970,43	-1048,04	-407,08	-992,66	-837,52	-1021,67
C. Grassland	0,22	0,22	0,20	5,74	53,00	-52,48	-56,87	-68,48	-74,07	-97,33	-127,02
D. Wetlands	NE,NO	NE,NO	NE,NO	0,04	0,70	0,26	0,08	0,20	0,57	2,16	0,33
E. Settlements	6,08	6,08	7,80	4,79	5,22	6,01	4,03	14,44	5,72	5,39	8,52
F. Other land	19,79	19,79	12,68	29,99	23,60	26,41	27,89	39,44	44,87	46,20	51,52
G. Harvested wood products	-324,95	-324,95	-307,72	-183,86	-399,92	-381,21	-321,32	-341,01	230,78	127,56	18,48
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Waste	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22
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	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22
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	10580,51	10580,51	9569,44	10762,45	12332,40	13393,29	14004,40	12530,32	12475,75	13767,30	12829,23
Aviation	2474,79	2474,79	2133,99	2226,36	2369,69	2812,41	2637,23	2525,76	2442,94	2563,98	2879,30
Navigation	8105,72	8105,72	7435,45	8536,09	9962,71	10580,88	11367,17	10004,56	10032,81	11203,32	9949,93
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 emissions from biomass	2083,06	2083,06	2301,70	2581,37	2445,13	2279,59	2270,91	2328,69	2262,74	2204,50	2408,78
CO_2 captured	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO
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	83375,36	83375,36	83350,94	84915,80	84229,45	86391,99	86945,64	89098,55	93804,20	98624,77	97941,65
Total CO_2 equivalent emissions with land use, land-use change and forestry	81129,55	81129,55	80932,42	82402,70	81250,27	83670,13	83970,58	86709,18	91722,15	96608,74	95294,51
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 – 2009 (in kt)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)
1. Energy	94040,42	96392,71	96133,09	100038,52	100509,59	104309,84	103081,27	105297,67	102481,14	97677,64
A. Fuel combustion (sectoral approach)	94026,45	96382,88	96123,46	100031,49	100502,74	104304,25	103075,64	105293,09	102477,59	97673,20
1. Energy industries	54739,01	55254,97	54678,66	55921,54	57238,34	58058,17	55895,54	59371,47	58019,05	54480,47
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
3. Transport	18390,10	19251,76	19573,79	20651,49	21086,30	21375,01	22057,53	22686,15	21983,51	24831,54
4. Other sectors	11049,60	11904,42	12444,96	14355,70	13559,75	14214,11	14104,93	12729,20	12453,05	10674,72
5. Other	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	522,59	648,58	547,15	696,21	249,69
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
1. Solid fuels	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
C. CO_2 transport and storage	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Industrial processes	8903,19	8939,01	8841,78	9008,62	8983,06	9581,38	9351,32	9248,16	8599,07	6625,53
A. Mineral industry	7492,72	7549,59	7312,47	7348,96	7357,02	7926,76	7635,81	7471,57	6957,92	5321,32
B. Chemical industry	281,96	135,77	165,68	286,61	304,52	296,92	313,93	317,94	338,06	453,25
C. Metal industry	1000,97	1111,55	1239,96	1239,99	1182,25	1215,54	1233,61	1301,47	1167,74	732,64
D. Non-energy products from fuels and solvent use	33,61	47,17	32,18	37,97	41,86	47,37	72,20	60,48	41,15	27,70
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
H. Other	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
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
H. Urea application	38,47	37,04	36,05	35,19	36,33	31,91	29,92	33,62	28,64	24,93
I. Other carbon-containing fertilizers	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
J. Other										
4. Land use, land-use change and forestry (2)	-2339,38	-2630,66	-2903,34	-2632,47	-2609,09	-3388,93	-3463,86	-2086,45	-3310,91	-3377,93
A. Forest land	-1120,88	-1790,47	-1867,00	-1864,08	-1855,31	-2220,03	-2206,48	-1548,43	-2131,28	-2137,25
B. Cropland	-934,22	-707,58	-785,14	-448,94	-522,13	-659,14	-641,79	225,55	-697,47	-539,70
C. Grassland	-158,08	-158,09	-135,83	-157,66	-116,55	-350,45	-444,83	-454,41	-526,60	-545,90
D. Wetlands	2,51	0,74	2,37	1,37	26,30	3,10	4,23	3,58	2,82	2,82
E. Settlements	13,21	8,95	10,28	24,46	15,37	21,03	17,98	18,51	16,99	14,79
F. Other land	59,15	64,23	69,89	69,09	77,69	69,91	82,51	107,50	99,33	89,72
G. Harvested wood products	-201,08	-48,45	-197,90	-256,72	-234,47	-253,35	-275,48	-438,76	-74,69	-262,42
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Waste	0,22	0,22	0,48	0,85	1,05	1,93	2,41	3,13	3,68	12,46
A. Solid waste disposal	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	1,93	2,41	3,13	3,68	12,46
D. Waste water treatment and discharge										
E. Other	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
Memo items:										
International bunkers	14018,48	13513,65	12342,00	13304,19	13474,19	11815,09	12727,53	13103,79	12862,32	11147,83
Aviation	2525,76	2347,31	2347,39	3055,51	3140,94	2600,48	2779,42	2948,31	2930,90	2717,91
Navigation	11492,72	11166,34	9994,61	10248,68	10333,25	9214,61	9948,11	10155,48	9931,42	8429,92
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 emissions from biomass	2732,42	2626,81	2387,51	2145,10	2340,98	2332,95	2501,77	2639,25	2740,74	2741,47
CO_2 captured	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO
Long-term storage of C in waste disposal sites	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
Total CO_2 equivalent emissions without land use, land-use change and forestry	102982,30	105368,98	105011,40	109083,18	109530,03	113925,07	112464,91	114582,59	111112,52	104340,56
Total CO_2 equivalent emissions with land use, land-use change and forestry	100642,92	102738,31	102108,06	106450,71	106920,93	110536,14	109001,06	112496,14	107801,62	100962,62
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
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

Table A.II.1c *Evaluation of CO_2 emissions for the period 2010 – 2015 (in kt)*

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	2012	2013	2014	2015	Change from base to latest reported year
	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	%
1. Energy	90725,79	89559,15	85903,15	75823,30	72455,54	69220,34	-7,29
A. Fuel combustion (sectoral approach)	90719,82	89553,91	85898,19	75819,23	72451,79	69216,70	-7,24
1. Energy industries	52036,60	53838,38	54507,26	49205,02	45784,63	40776,46	-5,38
2. Manufacturing industries and construction	6813,24	4917,03	5457,78	5229,16	5397,33	5166,28	-44,68
3. Transport	22052,80	19779,97	16465,15	16246,67	16270,48	16804,69	18,98
4. Other sectors	9574,70	10802,99	9257,07	4903,11	4810,77	6262,95	-22,35
5. Other	242,49	215,53	210,93	235,28	188,58	206,32	100,00
B. Fugitive emissions from fuels	5,97	5,24	4,95	4,07	3,75	3,64	-91,48
1. Solid fuels	NO	NO	NO	NO	NO	NO	0,00
2. Oil and natural gas and other emissions from energy production	5,97	5,24	4,95	4,07	3,75	3,64	-91,48
C. CO_2 transport and storage	NO	NO	NO	NO	NO	NO	0,00
2. Industrial processes	6580,48	4941,10	5486,18	5869,44	6166,23	5707,24	-34,02
A. Mineral industry	4920,64	3108,57	3738,18	4170,20	4359,38	3956,73	-41,60
B. Chemical industry	632,88	584,38	502,02	516,91	569,38	495,05	-27,27
C. Metal industry	909,45	1137,50	1139,16	1072,63	1124,76	1143,43	12,98
D. Non-energy products from fuels and solvent use	24,15	22,51	21,56	23,54	29,37	30,70	-61,44
E. Electronic industry							
F. Product uses as ODS substitutes							
G. Other product manufacture and use	93,36	88,13	85,27	86,16	83,33	81,33	-20,63
H. Other	NA	NA	NA	NA	NA	NA	0,00
3. Agriculture	30,35	25,84	25,00	26,01	25,78	26,38	-56,34
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	0,00
H. Urea application	30,35	25,84	25,00	26,01	25,78	26,38	-56,34
I. Other carbon-containing fertilizers	NO	NO	NO	NO	NO	NO	0,00
J. Other							
4. Land use, land-use change and forestry (2)	-3351,26	-3440,73	-3431,62	-1890,55	-461,70	-3159,71	40,69
A. Forest land	-2227,92	-2240,05	-2186,51	-2267,52	-2280,31	-2248,31	97,33
B. Cropland	-331,59	-569,58	-582,52	958,62	2254,25	286,91	-135,53
C. Grassland	-558,89	-433,93	-874,06	-770,95	-622,81	-1382,40	-626949,84
D. Wetlands	2,61	2,59	2,85	2,52	0,09	0,07	100,00
E. Settlements	13,86	12,36	24,32	13,38	11,33	12,67	108,41
F. Other land	86,45	84,33	128,23	82,43	82,47	80,15	305,05
G. Harvested wood products	-335,77	-296,44	56,06	90,97	93,27	91,20	-128,07
H. Other	NO	NO	NO	NO	NO	NO	0,00
5. Waste	6,36	5,61	3,48	3,83	10,41	8,99	3985,89
A. Solid waste disposal	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	0,00
B. Biological treatment of solid waste							
C. Incineration and open burning of waste	6,36	5,61	3,48	3,83	10,41	8,99	3985,89
D. Waste water treatment and discharge							
E. Other	NO	NO	NO	NO	NO	NO	0,00
6. Other ***(as specified in summary 1.A)***	NO	NO	NO	NO	NO	NO	0,00
Memo items:							
International bunkers	11373,02	11652,07	9727,87	9382,76	8878,27	8657,31	-18,18
Aviation	2584,15	2696,04	2386,98	2466,45	2829,92	2869,09	15,93
Navigation	8788,87	8956,03	7340,89	6916,31	6048,35	5788,21	-28,59
Multilateral operations	NO	NO	NO	NO	NO	NO	0,00
CO_2 emissions from biomass	3240,68	3453,23	3424,52	2738,94	2682,47	3158,94	51,65
CO_2 captured	IE,NO	IE,NO	IE,NO	IE,NO	NO,IE	NO,IE	0,00
Long-term storage of C in waste disposal sites	NE	NE	NE	NE	NE	NE	0,00
Indirect N_2O							
Indirect CO_2 (3)	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO,NE	0,00
Total CO_2 equivalent emissions without land use, land-use change and forestry	97342,98	94531,70	91417,80	81722,58	78657,96	74962,94	-10,09
Total CO_2 equivalent emissions with land use, land-use change and forestry	93991,72	91090,98	87986,18	79832,04	78196,25	71803,23	-11,50
Total CO_2 equivalent emissions, including indirect CO2, without land use, land-use change and forestry	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	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)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)
1. Energy	56,26	56,26	57,63	60,25	59,43	60,52	61,32	63,41	62,65	64,95	66,44
A. Fuel combustion (sectoral approach)	9,60	9,60	10,33	11,02	10,66	10,26	10,23	10,35	10,29	10,26	10,78
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	0,48	0,48	0,47	0,47	0,45	0,44	0,46	0,50	0,50	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	4,14	4,14	4,83	5,56	5,16	4,77	4,66	4,74	4,56	4,36	4,76
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	159,37	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											
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	2,49	2,49	1,24	3,65	3,26	3,04	1,72	1,04	2,30	6,26	0,48
A. Forest land	1,86	1,86	0,70	2,04	2,13	1,86	1,22	0,51	1,49	4,67	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	183,37	183,37	182,24	186,02	188,05	193,92	194,12	198,04	196,33	203,51	201,19
A. Solid waste disposal	89,72	89,72	92,46	95,40	98,50	101,81	105,30	108,97	112,85	116,89	121,05
B. Biological treatment of solid waste	NO	NO	NO	NO	NO	NO	NO	NO	0,13	0,13	0,13
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	436,26	436,26	436,77	440,56	441,55	445,95	452,13	458,87	456,79	465,62	465,37
Total CH_4 emissions with CH_4 from LULUCF	438,75	438,75	438,00	444,21	444,80	448,99	453,85	459,91	459,08	471,88	465,85
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 – 2009 (in kt)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)
1. Energy	69,39	71,10	73,75	71,92	74,13	73,27	69,67	71,52	70,80	69,47
A. Fuel combustion (sectoral approach)	11,46	11,14	10,08	9,94	10,42	9,92	10,19	9,97	9,69	9,31
1. Energy industries	0,73	0,72	0,72	0,75	0,74	0,77	0,77	0,82	0,82	0,72
2. Manufacturing industries and construction	0,52	0,52	0,53	0,46	0,46	0,56	0,53	0,52	0,55	0,48
3. Transport	4,92	5,05	4,98	4,95	4,99	4,88	4,80	4,58	4,30	4,10
4. Other sectors	5,29	4,85	3,85	3,79	4,23	3,71	4,08	4,04	4,01	4,01
5. Other	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	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
1. Solid fuels	55,65	57,79	61,38	59,49	61,01	60,45	56,20	57,89	57,24	56,52
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
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
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
C. Metal industry	0,01	0,01	0,02	0,02	0,02	0,02	0,02	0,03	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
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
H. Other	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
A. Enteric fermentation	158,78	160,31	162,44	163,66	162,46	162,27	163,68	162,76	160,70	159,60
B. Manure management	30,43	29,95	30,11	30,05	30,04	30,19	29,53	29,38	28,93	28,53
C. Rice cultivation	3,98	4,22	4,48	4,52	4,55	4,62	4,46	5,00	5,00	5,60
D. Agricultural soils	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
E. Prescribed burning of savannas										
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
G. Liming										
H. Urea application										
I. Other carbon-containing fertilizers										
J. Other										
4. Land use, land-use change and forestry	8,26	1,11	0,15	0,21	0,54	0,42	0,83	12,77	1,73	1,83
A. Forest land	5,78	0,61	0,06	0,09	0,23	0,19	0,58	7,63	1,19	1,29
B. Cropland	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
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Other land	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
5. Waste	201,07	170,39	168,69	173,20	173,46	177,49	183,05	175,73	176,58	165,08
A. Solid waste disposal	125,99	109,22	114,13	122,30	124,45	132,63	137,09	134,76	138,96	128,86
B. Biological treatment of solid waste	0,13	NO	NO	NO	0,01	0,06	0,32	0,35	0,36	0,11
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
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
E. Other	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
Total CH_4 emissions without CH_4 from LULUCF	465,15	437,51	440,95	444,73	446,18	449,40	451,82	445,78	443,68	429,88
Total CH_4 emissions with CH_4 from LULUCF	473,42	438,62	441,10	444,94	446,72	449,82	452,65	458,55	445,41	431,71
Memo items:										
International bunkers	0,96	0,94	0,85	0,88	0,89	0,80	0,86	0,88	0,87	0,73
Aviation	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
Multilateral operations	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 20100 – 2015 (in kt)**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	2012	2013	2014	2015	Change from base to latest reported year
	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	%
1. Energy	63,59	65,99	69,26	59,89	55,98	52,91	-5,95
A. Fuel combustion (sectoral approach)	10,42	10,20	10,01	8,88	8,16	8,83	-8,08
1. Energy industries	0,66	0,67	0,67	0,63	0,59	0,55	-2,68
2. Manufacturing industries and construction	0,46	0,45	0,36	0,26	0,31	0,35	-26,14
3. Transport	4,33	3,77	2,87	3,21	3,15	3,23	-26,87
4. Other sectors	4,97	5,31	6,12	4,78	4,10	4,69	13,26
5. Other	0,00	0,00	0,00	0,00	0,00	0,00	100,00
B. Fugitive emissions from fuels	53,18	55,79	59,25	51,01	47,82	44,09	-5,51
1. Solid fuels	49,23	51,10	54,83	46,97	44,29	40,28	-10,89
2. Oil and natural gas and other emissions from energy production	3,95	4,70	4,41	4,04	3,53	3,81	161,43
C. CO_2 transport and storage							
2. Industrial processes	0,02	0,02	0,01	0,01	0,01	0,01	-83,57
A. Mineral industry							
B. Chemical industry	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	
C. Metal industry	0,02	0,02	0,01	0,01	0,01	0,01	-9,03
D. Non-energy products from fuels and solvent use	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	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	0,00
H. Other	NA	NA	NA	NA	NA	NA	0,00
3. Agriculture	198,83	197,98	195,45	192,18	190,39	190,18	-3,26
A. Enteric fermentation	162,93	162,30	160,34	158,31	157,06	156,76	-2,61
B. Manure management	28,47	28,06	27,53	26,85	26,58	26,45	-14,60
C. Rice cultivation	6,01	6,18	6,16	5,62	5,42	5,67	72,29
D. Agricultural soils	NE	NE	NE	NE	NE	NE	0,00
E. Prescribed burning of savannas							
F. Field burning of agricultural residues	1,41	1,44	1,41	1,41	1,33	1,31	-4,25
G. Liming							
H. Urea application							
I. Other carbon-containing fertilizers							
J. Other							
4. Land use, land-use change and forestry	0,65	0,71	1,74	0,64	0,38	0,43	-82,69
A. Forest land	0,55	0,23	0,87	0,07	0,04	0,17	-90,94
B. Cropland	NO	NO	NO	NO	NO	NO	0,00
C. Grassland	0,10	0,48	0,87	0,57	0,33	0,26	-58,26
D. Wetlands	NO	NO	NO	NO	NO	NO	0,00
E. Settlements	NO	NO	NO	NO	NO	NO	0,00
F. Other land	NO	NO	NO	NO	NO	NO	0,00
G. Harvested wood products							
H. Other	NO	NO	NO	NO	NO	NO	0,00
5. Waste	176,46	167,77	159,08	163,39	166,14	165,63	-9,67
A. Solid waste disposal	136,65	128,10	120,15	123,93	126,47	126,26	40,73
B. Biological treatment of solid waste	0,53	0,66	0,80	0,71	0,63	0,50	100,00
C. Incineration and open burning of waste	0,00	0,00	0,00	0,00	0,00	0,00	616,58
D. Waste water treatment and discharge	39,28	39,01	38,13	38,75	39,03	38,87	-58,50
E. Other	NO	NO	NO	NO	NO	NO	0,00
6. Other *(as specified in summary 1.A)*	NO	NO	NO	NO	NO	NO	0,00
Total CH_4 emissions without CH_4 from LULUCF	438,90	431,76	423,81	415,48	412,51	408,74	-6,31
Total CH_4 emissions with CH_4 from LULUCF	439,55	432,47	425,54	416,12	412,89	409,17	-6,74
Memo items:							
International bunkers	0,76	0,78	0,64	0,60	0,53	0,50	-26,71
Aviation	0,02	0,02	0,02	0,02	0,02	0,02	0,42
Navigation	0,74	0,76	0,62	0,59	0,51	0,48	-27,53
Multilateral operations	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)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)
1. Energy	2,68	2,68	2,78	2,80	2,87	2,97	2,94	2,97	3,11	3,38	3,40
A. Fuel combustion (sectoral approach)	2,68	2,68	2,78	2,80	2,87	2,97	2,94	2,97	3,11	3,38	3,40
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	0,19	0,19	0,18	0,19	0,21	0,24	0,25	0,24	0,22
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	1,10	1,10	1,16	1,09	1,07	1,06	0,99	1,01	1,01	1,01	1,02
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											
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	0,01	0,03	0,03	0,03	0,02	0,02	0,03	0,06	0,02
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	0,00	0,00	0,00	0,00	0,00	0,00
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	1,03	1,07
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	1,02	1,06
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	24,91	24,91	24,46	23,94	22,07	21,67	22,36	22,94	22,40	22,15	22,01
Total direct N_2O emissions with N_2O from LULUCF	24,93	24,93	24,47	23,97	22,09	21,70	22,38	22,95	22,43	22,21	22,03
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 – 2009 (in kt)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)
1. Energy	3,03	3,19	3,26	3,34	3,23	3,34	3,45	3,31	3,28	2,87
A. Fuel combustion (sectoral approach)	3,03	3,19	3,26	3,34	3,23	3,34	3,45	3,31	3,28	2,87
1. Energy industries	0,59	0,60	0,59	0,60	0,61	0,62	0,58	0,60	0,59	0,57
2. Manufacturing industries and construction	0,25	0,26	0,25	0,23	0,24	0,31	0,32	0,31	0,33	0,30
3. Transport	1,16	1,30	1,30	1,28	1,32	1,33	1,42	1,38	1,37	1,21
4. Other sectors	1,03	1,04	1,12	1,23	1,06	1,07	1,12	1,00	0,97	0,78
5. Other	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	0,01	0,02	0,02	0,02	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
1. Solid fuels	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
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
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
C. Metal industry	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
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
H. Other	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
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
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
E. Prescribed burning of savannas										
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
G. Liming										
H. Urea application										
I. Other carbon containing fertlizers										
J. Other										
4. Land use, land-use change and forestry	0,07	0,02	0,02	0,02	0,03	0,03	0,03	0,12	0,04	0,04
A. Forest land	0,04	0,00	0,00	0,00	0,00	0,00	0,00	0,05	0,01	0,01
B. Cropland	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
C. Grassland	0,02	0,01	0,00	0,00	0,00	0,00	0,00	0,04	0,01	0,01
D. Wetlands	0,00	0,00	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	0,00	0,00	0,00	0,00	0,00
F. Other land	0,01	0,01	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
5. Waste	1,08	1,06	1,05	1,08	1,07	1,08	1,11	1,13	1,09	1,09
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
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
D. Waste water treatment and discharge	1,07	1,06	1,05	1,08	1,07	1,07	1,09	1,10	1,07	1,08
E. Other	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
Total direct N_2O emissions without N_2O from LULUCF	21,24	20,82	20,68	20,42	20,43	19,88	19,34	19,68	18,90	17,67
Total direct N_2O emissions with N_2O from LULUCF	21,31	20,85	20,70	20,44	20,46	19,91	19,37	19,79	18,94	17,72
Memo items:										
International bunkers	1,23	1,06	0,96	0,92	0,90	0,75	0,79	0,76	0,73	0,66
Aviation	0,07	0,07	0,07	0,09	0,09	0,07	0,08	0,08	0,08	0,08
Navigation	1,16	0,99	0,89	0,83	0,81	0,68	0,71	0,68	0,64	0,58
Multilateral operations	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
Indirect CO_2 (3)										

Table A.II.3c Evaluation of N_2O emissions for the period 2010 – 2015 (in kt)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	2012	2013	2014	2015	Change from base to latest reported year
	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	%
1. Energy	2,57	2,32	1,63	1,50	1,57	1,61	-39,99
A. Fuel combustion (sectoral approach)	2,57	2,32	1,62	1,50	1,57	1,61	-39,98
1. Energy industries	0,53	0,54	0,55	0,49	0,46	0,41	-16,19
2. Manufacturing industries and construction	0,26	0,19	0,20	0,18	0,23	0,25	38,86
3. Transport	1,06	0,82	0,67	0,63	0,67	0,71	-21,94
4. Other sectors	0,71	0,77	0,20	0,20	0,21	0,23	-79,00
5. Other	0,01	0,01	0,01	0,01	0,01	0,01	100,00
B. Fugitive emissions from fuels	0,00	0,00	0,00	0,00	0,00	0,00	-91,70
1. Solid fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	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	-91,70
C. CO_2 transport and storage							
2. Industrial processes	1,87	2,02	1,48	0,55	0,57	0,54	-86,53
A. Mineral industry							
B. Chemical industry	1,38	1,53	0,99	0,07	0,09	0,07	-98,08
C. Metal industry	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	NA,NO	NO,NA	0,00
E. Electronic industry							
F. Product uses as ODS substitutes							
G. Other product manufacture and use	0,49	0,48	0,48	0,48	0,48	0,47	5,87
H. Other	NA	NA	NA	NA	NA	NA	0,00
3. Agriculture	12,80	12,08	11,86	11,91	11,78	11,84	-31,42
A. Enteric fermentation							
B. Manure management	1,06	1,04	1,05	1,04	1,04	1,04	-4,36
C. Rice cultivation							
D. Agricultural soils	11,70	11,00	10,78	10,83	10,70	10,77	-33,31
E. Prescribed burning of savannas							
F. Field burning of agricultural residues	0,04	0,04	0,04	0,04	0,03	0,03	-1,81
G. Liming							
H. Urea application							
I. Other carbon containing fertlizers							
J. Other							
4. Land use, land-use change and forestry	0,03	0,03	0,04	0,03	0,03	0,03	51,49
A. Forest land	0,00	0,00	0,01	0,00	0,00	0,00	-90,94
B. Cropland	0,00	0,00	0,00	0,00	0,00	0,00	4052,33
C. Grassland	0,00	0,00	0,01	0,00	0,00	0,00	-53,28
D. Wetlands	0,00	0,00	0,00	0,00	0,00	0,00	100,00
E. Settlements	0,00	0,00	0,00	0,00	0,00	0,00	794,89
F. Other land	0,02	0,02	0,02	0,02	0,02	0,02	1479,55
G. Harvested wood products							
H. Other	NO	NO	NO	NO	NO	NO	0,00
5. Waste	1,12	1,13	1,13	1,14	1,14	1,13	20,48
A. Solid waste disposal							
B. Biological treatment of solid waste	0,03	0,04	0,05	0,04	0,04	0,03	100,00
C. Incineration and open burning of waste	0,00	0,00	0,00	0,00	0,00	0,00	616,58
D. Waste water treatment and discharge	1,08	1,08	1,08	1,09	1,09	1,10	17,02
E. Other	NO	NO	NO	NO	NO	NO	0,00
6. Other *(as specified in summary 1.A)*	NO	NO	NO	NO	NO	NO	0,00
Total direct N_2O emissions without N_2O from LULUCF	18,35	17,55	16,10	15,10	15,05	15,12	-39,29
Total direct N_2O emissions with N_2O from LULUCF	18,39	17,58	16,14	15,13	15,08	15,15	-39,22
Memo items:							
International bunkers	0,69	0,66	0,56	0,58	0,54	0,58	-32,97
Aviation	0,07	0,08	0,07	0,07	0,08	0,08	14,76
Navigation	0,62	0,58	0,50	0,51	0,46	0,50	-37,17
Multilateral operations	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	NE,NO	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)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(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	6826,45
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	6721,15
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	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	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	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	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	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	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 – 2009

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)
Emissions of HFCs and PFCs - (kt CO_2 equivalent)	5384,09	4865,49	5178,35	4822,63	5015,77	5168,96	2809,66	3348,18	3829,30	4055,47
Emissions of HFCs - (kt CO_2 equivalent)	5261,83	4781,39	5090,07	4733,36	4927,91	5077,45	2722,45	3245,14	3710,35	3964,12
HFC-23	0,32	0,28	0,28	0,23	0,22	0,19	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
HFC-41	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
HFC-125	0,03	0,04	0,06	0,08	0,11	0,15	0,18	0,23	0,27	0,31
HFC-134	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
HFC-143	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
HFC-152	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
HFC-161	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	0,01
HFC-236cb	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
HFC-236fa	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
HFC-245fa	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
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
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
CF_4	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,00	0,01	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
C_3F_8	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
c-C_4F_8	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
C_6F_{14}	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
c-C_3F_6	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
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
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
SF_6	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
NF_3	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 2010 – 2015*

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	2012	2013	2014	2015	Change from base to latest reported year
	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	%
Emissions of HFCs and PFCs - (kt CO_2 equivalent)	4518,11	4772,18	5209,55	5822,78	5892,76	6022,21	338,59
Emissions of HFCs - (kt CO_2 equivalent)	4388,67	4661,66	5061,78	5650,22	5758,13	5902,68	399,04
HFC-23	0,01	0,01	0,01	0,02	0,01	0,01	-85,13
HFC-32	0,20	0,24	0,31	0,41	0,45	0,46	100,00
HFC-41	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	0,00
HFC-43-10mee	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	0,00
HFC-125	0,37	0,43	0,51	0,63	0,68	0,72	100,00
HFC-134	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	0,00
HFC-134a	1,30	1,32	1,29	1,37	1,31	1,33	100,00
HFC-143	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	0,00
HFC-143a	0,16	0,16	0,18	0,18	0,18	0,17	100,00
HFC-152	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	0,00
HFC-152a	1,29	1,31	1,35	1,28	1,28	1,29	100,00
HFC-161	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	0,00
HFC-227ea	0,01	0,01	0,01	0,01	0,01	0,01	100,00
HFC-236cb	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	0,00
HFC-236ea	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	0,00
HFC-236fa	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	0,00
HFC-245ca	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	0,00
HFC-245fa	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	0,00
HFC-365mfc	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	0,00
Unspecified mix of HFCs[4] - (kt CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	0,00
Emissions of PFCs - (kt CO_2 equivalent)	129,44	110,53	147,77	172,56	134,63	119,52	-37,18
CF_4	0,00	0,01	0,01	0,01	0,01	0,01	-65,38
C_2F_6	0,01	0,01	0,01	0,01	0,01	0,01	103,98
C_3F_8	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	0,00
C_4F_{10}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	0,00
$c\text{-}C_4F_8$	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	0,00
C_5F_{12}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	0,00
C_6F_{14}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	0,00
$C_{10}F_{18}$	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	0,00
$c\text{-}C_3F_6$	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	0,00
Unspecified mix of PFCs[4] - (kt CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	0,00
Unspecified mix of HFCs and PFCs - (kt CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	0,00
Emissions of SF_6 - (kt CO_2 equivalent)	5,86	5,13	5,05	5,15	4,92	5,06	72,78
SF_6	0,00	0,00	0,00	0,00	0,00	0,00	72,78
Emissions of NF_3 - (kt CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	0,00
NF_3	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	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 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)
CO_2 emissions without net CO_2 from LULUCF	83375,36	83375,36	83350,94	84915,80	84229,45	86391,99	86945,64	89098,55	93804,20	98624,77	97941,65
CO_2 emissions with net CO_2 from LULUCF	81129,55	81129,55	80932,42	82402,70	81250,27	83670,13	83970,58	86709,18	91722,15	96608,74	95294,51
CH_4 emissions without CH_4 from LULUCF	10906,61	10906,61	10919,21	11013,98	11038,71	11148,72	11303,20	11471,76	11419,64	11640,53	11634,36
CH_4 emissions with CH_4 from LULUCF	10968,79	10968,79	10950,11	11105,24	11120,09	11224,64	11346,25	11497,83	11477,04	11796,93	11646,29
N_2O emissions without N_2O from LULUCF	7423,22	7423,22	7289,30	7134,00	6575,73	6458,52	6662,98	6835,07	6675,00	6602,04	6560,21
N_2O emissions with N_2O from LULUCF	7428,84	7428,84	7292,60	7142,73	6584,24	6466,86	6668,92	6840,12	6683,18	6618,77	6565,54
HFCs	1182,82	1182,82	1400,08	1149,07	2032,44	2712,11	4157,38	4820,17	5166,49	5767,51	6721,15
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)	103081,19	103081,19	103153,73	104403,70	103992,47	106784,94	109135,47	112282,79	117194,53	122793,94	122966,37
Total (with LULUCF)	100903,18	100903,18	100769,43	101990,60	101103,17	104147,35	106209,40	109924,54	115178,06	120951,03	120336,49
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)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)
1. Energy	76869,62	76869,62	77006,70	79019,75	78659,44	80886,43	80949,77	83167,51	87703,96	92427,63	91883,56
2. Industrial processes and product use	11226,96	11226,96	11163,40	10577,36	11028,32	11636,59	13569,65	14338,11	14835,60	15552,78	16389,35
3. Agriculture	10120,79	10120,79	10144,10	9868,57	9314,84	9119,26	9465,84	9527,64	9443,03	9418,75	9346,04
4. Land use, land-use change and forestry[3]	-2178,02	-2178,02	-2384,30	-2413,10	-2889,29	-2637,59	-2926,07	-2358,25	-2016,48	-1842,91	-2629,89
5. Waste	4863,82	4863,82	4839,52	4938,02	4989,87	5142,66	5150,20	5249,53	5211,94	5394,79	5347,42
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total (including LULUCF)[5]	100903,18	100903,18	100769,43	101990,60	101103,17	104147,35	106209,40	109924,54	115178,06	120951,03	120336,49

Table A.II.5b Evaluation of GHG emissions / removals per gas and per sector for the period 2000 – 2009 (kt CO_2 eq)

GREENHOUSE GAS EMISSIONS	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)
CO_2 emissions without net CO_2 from LULUCF	102982,30	105368,98	105011,40	109083,18	109530,03	113925,07	112464,91	114582,59	111112,52	104340,56
CO_2 emissions with net CO_2 from LULUCF	100642,92	102738,31	102108,06	106450,71	106920,93	110536,14	109001,06	112496,14	107801,62	100962,62
CH_4 emissions without CH_4 from LULUCF	11628,86	10937,64	11023,64	11118,17	11154,41	11235,08	11295,52	11144,59	11092,07	10746,91
CH_4 emissions with CH_4 from LULUCF	11835,38	10965,42	11027,43	11123,49	11167,88	11245,57	11316,34	11463,87	11135,31	10792,73
N_2O emissions without N_2O from LULUCF	6328,64	6204,93	6161,18	6085,75	6088,43	5924,21	5763,70	5864,10	5632,82	5267,02
N_2O emissions with N_2O from LULUCF	6350,30	6212,34	6167,11	6092,29	6096,30	5932,09	5772,95	5898,59	5645,18	5279,77
HFCs	5261,83	4781,39	5090,07	4733,36	4927,91	5077,45	2722,45	3245,14	3710,35	3964,12
PFCs	122,26	84,10	88,29	89,28	87,86	91,51	87,21	103,04	118,95	91,35
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
SF_6	3,81	3,88	4,06	4,06	4,26	6,16	7,98	9,46	7,18	5,02
NF_3	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Total (without LULUCF)	126327,70	127380,92	127378,64	131113,78	131792,90	136259,48	132341,78	134948,92	131673,90	124414,97
Total (with LULUCF)	124216,49	124785,44	124485,01	128493,18	129205,14	132888,91	128907,99	133216,25	128418,60	121095,62
Total (without LULUCF, with indirect)	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

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)
1. Energy	96678,36	99120,02	98946,99	102830,84	103324,48	107136,64	105852,07	108071,31	105227,91	100268,60
2. Industrial processes and product use	15176,38	14575,50	14768,63	14532,25	14673,33	15425,62	12739,51	13173,76	12987,41	11185,12
3. Agriculture	9124,74	9109,03	9132,75	9099,06	9139,04	8936,41	8839,92	8971,78	8715,16	8497,16
4. Land use, land-use change and forestry(5)	-2111,21	-2595,48	-2893,62	-2620,60	-2587,75	-3370,57	-3433,79	-1732,67	-3255,30	-3319,36
5. Waste	5348,23	4576,37	4530,27	4651,63	4656,04	4760,81	4910,28	4732,08	4743,41	4464,09
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total (including LULUCF)(5)	124216,49	124785,44	124485,01	128493,18	129205,14	132888,91	128907,99	133216,25	128418,60	121095,62

Table A.II.5c **Evaluation of GHG emissions / removals per gas and per sector for the period 2010 – 2015 (kt CO_2 eq)**

GREENHOUSE GAS EMISSIONS	2010	2011	2012	2013	2014	2015	Change from base to latest reported year
	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	(%)
CO_2 emissions without net CO_2 from LULUCF	97342,98	94531,70	91417,80	81722,58	78657,96	74962,94	-10,09
CO_2 emissions with net CO_2 from LULUCF	93991,72	91090,98	87986,18	79832,04	78196,25	71803,23	-11,50
CH_4 emissions without CH_4 from LULUCF	10972,53	10793,89	10595,13	10387,06	10312,84	10218,43	-6,31
CH_4 emissions with CH_4 from LULUCF	10988,80	10811,64	10638,62	10403,05	10322,23	10229,20	-6,74
N_2O emissions without N_2O from LULUCF	5469,46	5228,73	4796,77	4499,27	4485,00	4506,46	-39,29
N_2O emissions with N_2O from LULUCF	5479,44	5238,67	4809,11	4508,83	4493,63	4514,97	-39,22
HFCs	4388,67	4661,66	5061,78	5650,22	5758,13	5902,68	399,04
PFCs	129,44	110,53	147,77	172,56	134,63	119,52	-37,18
Unspecified mix of HFCs and PFCs	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	0,00
SF_6	5,86	5,13	5,05	5,15	4,92	5,06	72,78
NF_3	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	0,00
Total (without LULUCF)	118308,93	115331,64	112024,30	102436,85	99353,49	95715,10	-7,15
Total (with LULUCF)	114983,93	111918,60	108648,50	100571,84	98909,79	92574,66	-8,25
Total (without LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	0,00
Total (with LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	0,00

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	2012	2013	2014	2015	Change from base to latest reported year
	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	CO_2 equivalent (kt)	(%)
1. Energy	93080,53	91901,25	88118,94	77766,86	74323,39	71022,38	-7,61
2. Industrial processes and product use	11662,02	10320,48	11140,73	11861,99	12232,95	11896,29	5,96
3. Agriculture	8815,94	8574,71	8446,56	8380,53	8294,91	8309,97	-17,89
4. Land use, land-use change and forestry(5)	-3325,00	-3413,04	-3375,80	-1865,00	-443,69	-3140,44	44,19
5. Waste	4750,44	4535,19	4318,07	4427,47	4502,23	4486,46	-7,76
6. Other	NO	NO	NO	NO	NO	NO	0,00
Total (including LULUCF)(5)	114983,93	111918,60	108648,50	100571,84	98909,79	92574,66	-8,25

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				

	CO2		CH4		N2O		F-gases	
	Method	Emission factor	Method	Emission factor	Method	Emission factor	Method	Emission factor
B. Manure management			T1,T2	CS,D	D	D		
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

Source categories	Gas	Criteria
Energy		
Energy industries – Liquid fuels	CO_2	Level, Trend
Energy industries– Solid fuels	CO_2	Level, Trend
Energy industries – Gaseous fuels	CO_2	Level, Trend
Manufacturing Industries & Construction – Solid fuels	CO_2	Trend
Manufacturing Industries & Construction – Liquid fuels	CO_2	Level, Trend
Manufacturing Industries & Construction – Gaseous fuels	CO_2	Level, Trend
Road Transportation	CO_2	Level, Trend
Domestic navigation	CO2	Level
Other Sectors - Liquid fuels	CO_2	Level, Trend
Other Sectors - Gaseous fuels	CO2	Level
Coal mining (surface)	CH4	Level
Industrial processes		
Cement production	CO_2	Level, Trend
Nitric acid production	N_2O	Trend
Ammonia production	CO_2	Trend
Other	CO_2	Trend
Other Process Uses of Carbonates	CO_2	Trend
Product Uses as Substitutes for ODS	F-gases	Level, Trend
Ferroalloys	CO2	Level
Agriculture		
Enteric fermentation – Non dairy cattle	CH_4	Level, Trend
Enteric fermentation - sheep	CH_4	Level
Enteric fermentation – dairy cattle	CH_4	Level
Enteric fermentation - other	CH_4	Level
Manure management	CH_4	Level
Direct N2O from agr. soils	N_2O	Level, Trend
Indirect N2O from nitrogen used in agr.	N_2O	Level, Trend
Waste		
Solid waste disposal	CH_4	Level, Trend
Wastewater Treatment and Discharge	CH_4	Level, Trend

Table A.III.4 Key categories for the Greek inventory system with LULUCF

Source categories	Gas	Criteria
Energy		
Energy industries – Liquid fuels	CO_2	Level, Trend
Energy industries– Solid fuels	CO_2	Level, Trend
Energy industries – Gaseous fuels	CO_2	Level, Trend
Manufacturing Industries & Construction – Solid fuels	CO_2	Trend
Manufacturing Industries & Construction – Liquid fuels	CO_2	Level, Trend
Manufacturing Industries & Construction – Gaseous fuels	CO_2	Level, Trend
Transport – Road transportation	CO_2	Level, Trend
Transport – Navigation	CO_2	Level, Trend
Transport – Domestic Aviation	CO_2	Level, Trend
Coal Mining (surface)	CH_4	Level
Other Sectors – Liquid fuels	CO_2	Level, Trend
Other Sectors – Gaseous fuels	CO_2	Level, Trend
Other (Not specified elsewhere) – Liquid fuels (1.A.5)	CO_2	Level
Industrial processes		
Cement production	CO_2	Level, Trend
Nitric acid production	N_2O	Trend
Ammonia production	CO_2	Trend
Other	CO_2	Trend
Other Process Uses of Carbonates	CO_2	Trend
Product Uses as Substitutes for ODS	F-gases	Level, Trend
Ferroalloys	CO2	Level
Agriculture		
Enteric fermentation – Non dairy cattle	CH_4	Level, Trend
Enteric fermentation - sheep	CH_4	Level
Enteric fermentation – dairy cattle	CH_4	Level
Enteric fermentation - other	CH_4	Level
Manure management	CH_4	Level
Direct N2O from agr. soils	N_2O	Level, Trend
Indirect N2O from nitrogen used in agr.	N_2O	Level, Trend
Waste		
Solid waste disposal	CH_4	Level, Trend
Wastewater Treatment and Discharge	CH_4	Level, Trend
LULUCF		
Forest land remaining forest land	CO_2	Level, Trend
Cropland remaining cropland	CO_2	Trend
Conversion to Grassland	CO_2	Level, Trend
Harvested Wood Products	CO_2	Trend

A.IV Summary of reporting of the Supplementary information under Article 7, paragraph 2, of the Kyoto Protocol in the NC7

Table A.IV.1 Summary of reporting of the Supplementary information under Article 7, paragraph 2, of the Kyoto Protocol in the NC7

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

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Data providers:

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- Ministry of Finance.
- Ministry of Economy, Competitiveness and Shipping.
- 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, Transport and Networks.
- Ministry of Education, Lifelong Learning 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 Culture and Tourism- Greek National Tourism Organisation.
- Hellenic Centre for Marine Research.
- National Committee for Combatting Desertification.
- Global Water Partnership.