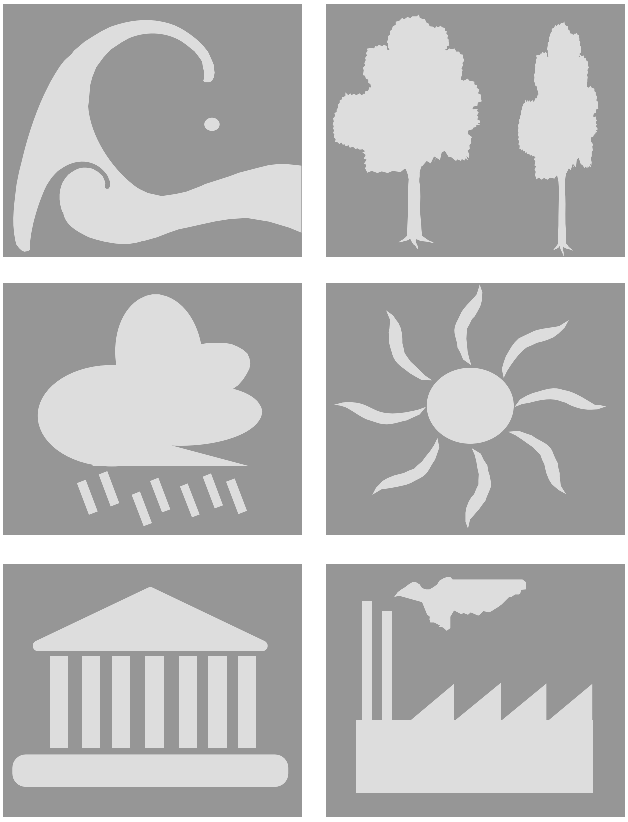
HELLENIC REPUBLIC

MINISTRY OF ENVIRONMENT, ENERGY AND CLIMATE CHANGE



6th NATIONAL COMMUNICATION AND 1st BIENNIAL REPORT UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

JANUARY 2014

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 Ministry for the Environment, Energy and Climate Change (MEECC) 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. MEECC 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. According to the population census results, the average household size is continuously decreasing. 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 25.7% of the total area of the country. Grassland, rangeland and pasture with vegetation that falls below the threshold of forest definition, covers 38.7% of the total area of the country. Agricultural land, including fallow land, account for 27.3% 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 – 2013, 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 five consecutive year recession while projections regarding the growth rates for 2013 envisage one more year of contraction (Ministry of Finance, National Reforms Programme 2013).

As a consequence, Greece has received financial and technical assistance from the other Eurozone countries and the IMF in the framework of the first Memorandum of Understanding (May, 2010) and the second one (January, 2012) in order to deal with its high deficit and Government debt, while through the PSI (Private Sector Involvement) agreement, private investors on Greek bonds were called to forgive the 53.5% of their principal and exchange their remaining holdings for new Greek government bonds and notes from the European Financial Stability Facility (EFSF).

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 second Memorandum of Understanding is expected to be completed by the end of 2014.

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. Moreover, the trend is expected to be affected by the high taxation imposed on vehicles with engines over 2000cm^3 (in 2011, 34% of passenger cars have an engine capacity greater than 1400cm^3).

1.1.6 Energy system

The total gross inland consumption in Greece increased continuously during the time period 1990 – 2011. In 2011, gross inland consumption reached a total of approximately 27.5 Mtoe, representing an increase of approximately 23% compared to 1990 levels. However, the average annual growth rate of increase during the period 1990 - 2011 (1.09%) is lower compared to the rate of increase recorded in the 1980s (3.3%).

The consumption of solid fuels and oil products accounts for 79.5% of total consumption, while the contribution of biomass and of the rest renewable energy sources (mostly hydropower, solar, wind energy and geothermal) are 2.6% and 3.4% respectively.

The share of natural gas in gross inland consumption is 13.5% while the rest 1 % of gross inland consumption is covered by electricity (net imports – exports). In 2011, gross inland consumption increased by approximately 28% compared to 1990, presenting a 1.2% average annual rate of increase. It should be mentioned that up to 1996 supply of natural gas was exclusively minor quantities from domestic primary production. In essence, the introduction of natural gas in the Greek energy system started in 1997 and since then its consumption has been continuously increasing. Furthermore, since 2007 to 2010 a decrease in gross inland consumptin is observed, presenting a about 5% average annual rate of decrease, while in 2011 a marginal increase compared to 2010 is observed.

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% and increases by 3.6% in 2011 compared to 2010. Gross electricity production in 2011 (59.4 TWh) was approximately 70% higher compared to 1990 levels.

Electricity generation from the use of fossil fuels is approximately 84% of electricity production in 2011. Specifically, 52% of electricity is produced by solid fuels (mainly lignite), while the share of liquid fuels (diesel, heavy fuel oil and refinery gas) and natural gas is 8.5% and 23.5% respectively. The rest of electricity production, i.e. around 16%, derives from renewable energy sources as hydropower, wind energy and biogas.

In 2011, final energy consumption in Greece totalled 18.6 Mtoe. Energy consumption in industry accounted for 17.8% of final energy consumption (including consumption of the energy sector). The share of transport in final energy consumption is estimated at 40.0% in 2011, while the share of residential and tertiary sector was 42.1%. The average annual rate of increase for the period 1990-2011 is estimated at 1.32%. The per capita final energy consumption has increased by 15% from 1990 to 2007 (1.4 and 1.6 toe/cap respectively).

Residential and tertiary sector and transportation increased their energy use from 1990 to 2011, 64% and 28% respectively, while industry sector decreased by 17%. This resulted in a total increase of 28% between 1990 and 2011.

1.1.7 Waste

Over the period 1990 – 2011, waste generation presented a continuous increase. Municipal solid waste generated quantities increased from 3.1 Mt in 1990 to 5.3 Mt in 2011, while the per capita solid waste generation increased from 0.82 kg/person/day in 1990 to 1.27 kg/person/day in 2011, 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.

The amount of recycled wastes present a remarkable increase during the last years from 8% in 2000 to 18% in 2011 due to the recycle projects that are promoted in Athens. During the previous decade no significant change has been observed ranging about 8-9%. Biogas recovery and flaring installations operate in 4 large SWDS in Greece (Athens, Thessalonika, Larissa, Patra), 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 the 2011 about 290 kt waste are disposed in managed and unmanaged SWDS consisted mainly of by wood and organic non-food materials.

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 2011, in compliance with the Directive 91/271/EEC concerning the collection, treatment and discharge of the urban wastewater.

1.2. Greenhouse gas inventory information

1.2.1 Emissions / Removals of GHG in Greece for the period 1990 – 2011

Emissions estimates were calculated according to the CORINAIR methodology, the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories and the IPCC Good Practice Guidance for Land Use, Land Use Change and Forestry. 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, HFCs / Perfluorocarbons, PFCs / Sulphur hexafluoride, SF_6).

An overview of GHG emissions for the time period 1990–2011 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***.

Base year GHG emissions for Greece (1990 for CO_2, CH_4, and N_2O - 1995 for F-gases) were estimated at 106.83 Mt CO_2 eq. Given that LULUCF was a net sink of GHG emissions in 1990 (as for the rest of the reporting period) the relevant emissions / removals are not considered in estimating base year emissions for Greece.

In 2011, GHG emissions (without *LULUCF*) amounted to 115.05 Mt CO_2 eq showing an increase of 7.69% compared to base year emissions and of 10% compared to 1990 levels. If emissions / removals from *LULUCF* were to be included then the increase would be 10.20 % (from 102.09 Mt CO_2 eq in 1990 to 112.50 Mt CO_2 eq in 2011).

Carbon dioxide emissions accounted for 82.41% of total GHG emissions in 2011 (without *LULUCF*) and increased by approximately 14.36% from 1990. Methane emissions accounted for 8.37% of total GHG emissions in 2011 and decreased by 6.83% from 1990, while nitrous oxide emissions accounted for 6.09% of the total GHG emissions in 2011 and decreased by 31.54% from 1990. Finally, f-gases emissions (from production and consumption) that accounted for 3.09% of total GHG emissions in 2011, and 39.93% of the IP sector, has an average increase of 34.47% from 1995 (base year for F-gases).

Table 1.1a Total GHG emissions in Greece (in Mt CO_2 eq) for the period 1990-2000

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
A. GHG emissions per gas (excluding LULUCF)											
CO_2	82,909.34	82,677.72	84,352.81	83,663.49	85,914.30	86,349.53	88,435.01	93,217.76	98,114.86	97,408.24	102,500.56
CH_4	10,336.24	10,290.78	10,401.93	10,384.35	10,568.30	10,594.76	10,824.32	10,733.05	10,966.78	10,881.82	10,833.97
N_2O	10,239.50	9,937.70	9,784.50	8,913.16	8,729.00	8,996.80	9,224.39	9,008.04	8,953.24	8,864.01	8,537.05
HFC	935.06	1,106.82	908.39	1,606.74	2,144.05	3,290.41	3,817.88	4,097.77	4,579.59	5,365.87	4,243.79
PFC	163.37	164.17	161.21	96.98	60.37	53.97	46.14	107.67	133.04	90.32	105.09
SF_6	3.07	3.16	3.26	3.35	3.45	3.59	3.68	3.73	3.78	3.87	3.99
Total	**104,586.58**	**104,180.35**	**105,612.11**	**104,668.07**	**107,419.48**	**109,289.05**	**112,351.42**	**117,168.02**	**122,751.30**	**122,614.13**	**126,224.44**
B. GHG emissions/removals from LULUCF											
CO_2	-2,526.52	-2,613.61	-2,914.11	-3,246.96	-2,885.90	-3,175.98	-2,794.41	-2,667.62	-2,977.03	-3,144.58	-2,821.21
CH_4	27.04	16.81	50.29	40.15	39.34	19.71	15.53	28.43	67.99	6.07	95.64
N_2O	2.74	1.71	5.10	4.07	3.99	2.00	1.58	2.89	6.90	0.62	9.71
Total	**-2,496.73**	**-2,595.09**	**-2,858.72**	**-3,202.73**	**-2,842.57**	**-3,154.27**	**-2,777.30**	**-2,636.31**	**-2,902.14**	**-3,137.89**	**-2,715.87**
C. GHG Emissions from International Transport											
CO_2	10,466.75	9,471.24	10,658.07	12,204.19	13,241.83	13,853.47	12,390.62	12,334.79	13,586.23	12,675.45	13,848.53
CH_4	14.38	13.09	14.89	17.45	18.40	19.50	17.36	17.44	19.64	17.47	20.30
N_2O	281.15	274.03	337.70	373.46	413.95	480.84	397.15	394.67	400.14	373.66	399.12
Total	**10,762.28**	**9,758.36**	**11,010.66**	**12,595.09**	**13,674.19**	**14,353.81**	**12,805.13**	**12,746.90**	**14,006.01**	**13,066.58**	**14,267.94**

Table 1.1b Total GHG emissions in Greece (in Mt CO2 eq) for the period 2001-2011

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
A. GHG emissions per gas (excluding LULUCF)											
CO_2	104,897.48	104,634.73	108,712.71	109,039.06	112,802.29	111,223.37	113,691.41	109,909.56	103,577.27	96,558.51	94,813.63
CH_4	10,041.74	10,060.22	10,086.62	10,126.53	10,163.13	10,209.92	10,052.82	10,008.74	9,739.24	9,784.13	9,630.76
N_2O	8,358.07	8,279.31	8,202.59	8,210.71	7,910.10	7,701.32	7,884.83	7,474.59	7,015.59	7,315.61	7,010.34
HFC	3,849.29	4,000.29	3,803.16	3,892.90	3,968.87	2,133.68	2,471.03	2,844.35	3,226.65	3,512.16	3,507.46
PFC	71.16	69.14	72.47	68.99	69.89	66.35	76.21	89.10	69.85	101.57	77.69
SF_6	4.06	4.25	4.25	4.47	6.45	8.37	9.92	7.53	5.26	6.14	5.15
Total	**127,221.80**	**127,047.95**	**130,881.80**	**131,342.67**	**134,920.73**	**131,343.00**	**134,186.20**	**130,333.87**	**123,633.85**	**117,278.12**	**115,045.02**
B. GHG emissions/removals from LULUCF											
CO_2	-2,680.59	-2,969.07	-2,643.28	-2,848.55	-2,777.29	-2,842.55	-1,940.26	-2,890.90	-2,636.74	-2,606.92	-2,553.09
CH_4	15.42	2.49	3.41	8.54	4.91	9.68	167.81	20.35	21.04	6.10	7.00
N_2O	1.56	0.25	0.35	0.87	0.50	0.98	17.03	2.07	2.14	0.62	0.64
Total	**-2,663.61**	**-2,966.32**	**-2,639.53**	**-2,839.14**	**-2,771.88**	**-2,831.89**	**-1,755.42**	**-2,868.48**	**-2,613.56**	**-2,600.19**	**-2,545.45**
C. GHG Emissions from International Transport											
CO_2	13,343.41	12,206.71	13,139.99	13,316.50	11,455.45	12,651.07	12,925.46	12,798.12	10,900.01	10,728.24	10,562.23
CH_4	20.00	17.97	18.56	18.82	16.80	18.17	18.69	18.27	15.48	16.08	15.44
N_2O	342.67	309.66	298.85	290.96	241.57	257.34	247.18	235.49	211.55	218.95	208.23
Total	**13,706.08**	**12,534.35**	**13,457.39**	**13,626.27**	**11,713.82**	**12,926.58**	**13,191.33**	**13,051.88**	**11,127.03**	**10,963.27**	**10,785.90**

Table 1.2a Total GHG emissions in Greece (in kt CO2 eq) for the period 1990-2000

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Energy	77,170.88	77,051.19	78,761.21	78,374.79	80,682.90	80,619.14	82,806.62	87,441.76	92,257.98	91,653.08	96,482.97
Industrial processes	10,072.94	9,974.64	9,850.59	10,130.49	10,615.36	12,263.12	12,909.68	13,306.33	13,892.01	14,583.38	13,712.49
Solvents	308.34	315.54	314.37	312.95	307.39	299.82	298.22	300.20	300.40	308.73	306.61
Agriculture	11,460.07	11,300.12	11,063.83	10,199.89	10,015.51	10,318.69	10,461.66	10,316.69	10,330.53	10,177.64	9,939.90
Waste	5,574.35	5,538.87	5,622.11	5,649.95	5,798.32	5,788.29	5,875.25	5,803.05	5,970.39	5,891.30	5,782.47
Total [1)]	**104,586.58**	**104,180.35**	**105,612.11**	**104,668.07**	**107,419.48**	**109,289.05**	**112,351.42**	**117,168.02**	**122,751.30**	**122,614.13**	**126,224.44**
LULUCF	**-2,496.73**	**-2,595.09**	**-2,858.72**	**-3,202.73**	**-2,842.57**	**-3,154.27**	**-2,777.30**	**-2,636.31**	**-2,902.14**	**-3,137.89**	**-2,715.87**
Index per sector											
Energy	100.00	99.84	102.06	101.56	104.55	104.47	107.30	113.31	119.55	118.77	125.03
Industrial processes	100.00	99.02	97.79	100.57	105.38	121.74	128.16	132.10	137.91	144.78	136.13
Solvents	100.00	102.33	101.95	101.49	99.69	97.24	96.72	97.36	97.42	100.13	99.44
Agriculture	100.00	98.60	96.54	89.00	87.39	90.04	91.29	90.02	90.14	88.81	86.74
Waste	100.00	99.36	100.86	101.36	104.02	103.84	105.40	104.10	107.10	105.69	103.73
Total [2)]	**100.00**	**99.61**	**100.98**	**100.08**	**102.71**	**104.50**	**107.42**	**112.03**	**117.37**	**117.24**	**120.69**

[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 CO2 eq) for the period 2001-2011

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Energy	98,955.51	98,863.99	102,762.35	103,078.73	106,230.56	104,879.59	107,436.55	104,109.16	99,587.47	92,293.12	92,165.18
Industrial processes	13,182.03	13,216.88	13,143.66	13,223.40	13,881.47	11,659.33	11,911.31	11,775.07	10,132.20	10,496.20	8,893.78
Solvents	304.28	305.13	305.93	306.75	309.29	311.92	313.41	314.13	315.60	316.17	316.41
Agriculture	9,843.48	9,813.84	9,750.33	9,833.78	9,541.44	9,374.78	9,590.02	9,211.13	8,927.68	9,270.66	8,965.84
Waste	4,936.49	4,848.11	4,919.53	4,900.02	4,957.98	5,117.38	4,934.91	4,924.37	4,670.90	4,901.96	4,703.81
Total [1)]	**127,221.80**	**127,047.95**	**130,881.80**	**131,342.67**	**134,920.73**	**131,343.00**	**134,186.20**	**130,333.87**	**123,633.85**	**117,278.12**	**115,045.02**
LULUCF	**-2,663.61**	**-2,966.32**	**-2,639.53**	**-2,839.14**	**-2,771.88**	**-2,831.89**	**-1,755.42**	**-2,868.48**	**-2,613.56**	**-2,600.19**	**-2,539.59**
Index per sector											
Energy	128.23	128.11	133.16	133.57	137.66	135.91	139.22	134.91	129.05	119.60	119.43
Industrial processes	130.87	131.21	130.48	131.28	137.81	115.75	118.25	116.90	100.59	104.20	88.29
Solvents	98.68	98.96	99.22	99.48	100.31	101.16	101.64	101.88	102.36	102.54	102.62
Agriculture	85.89	85.64	85.08	85.81	83.26	81.80	83.68	80.38	77.90	80.90	78.24
Waste	88.56	86.97	88.25	87.90	88.94	91.80	88.53	88.34	83.79	87.94	84.38
Total [2)]	**121.64**	**121.48**	**125.14**	**125.58**	**129.00**	**125.58**	**128.30**	**124.62**	**118.21**	**112.13**	**110.00**

[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 0.53%) is lower from both the annual growth rate of gross inland energy consumption (approximately 1.92% for the same period) and the GDP annual growth rate (approximately 4.20%). Moreover, the impact of population increase to GHG emissions was minor. The decreasing trend of emissions in all sectors of energy of the years 2008-2011 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.

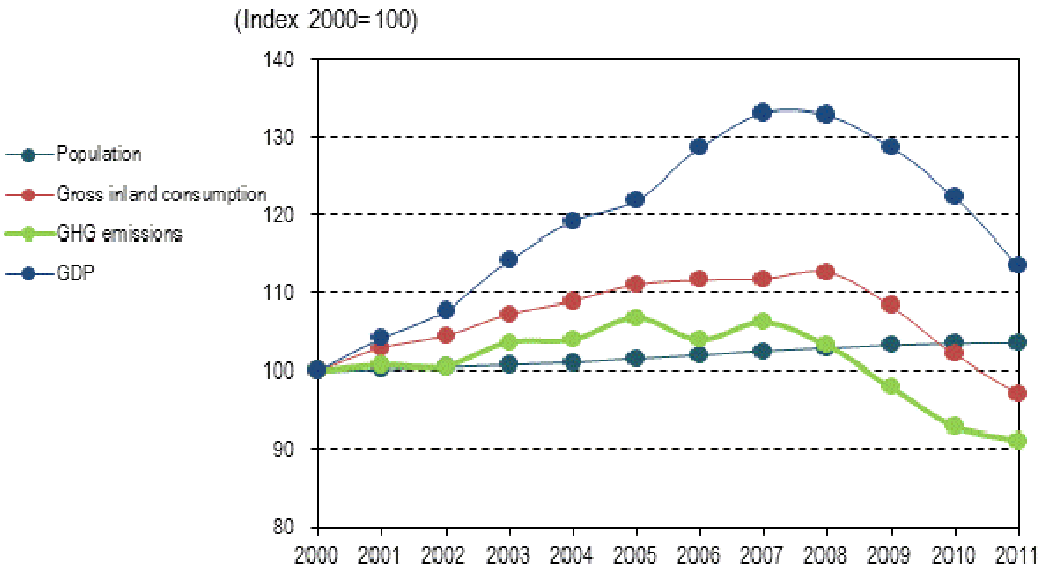


Figure 1.1 Factors underlying GHG emissions trends

1.2.2 National System for the GHG emissions/removals inventory

The Ministry of Environment, Energy and Climate Change, MEECC (former Ministry for the Environment, Physical Planning and Public Works) 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 MEECC 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 MEECC has the overall responsibility for the national GHG inventory, and the official consideration and approval of the inventory prior to its submission. (Contact person: Irini Nikolaou, Address: Villa Kazouli, Kifisias 241, Athens, Greece, e-mail: i.nikolaou@prv.ypeka.gr, tel.: +30210 8089275, fax: +30210 8089239).

The entities participating in it are:

- The **MEECC** 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 **National Technical University of Athens (NTUA) / School of Chemical Engineering**, which has the technical and scientific responsibility for the compilation of the annual inventory.
- **Governmental ministries and agencies** through their appointed focal persons, ensure the data provision.

Other competent Ministries / agencies through their appointed focal persons, ensure the data provision and contribute to methodological issues.

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

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 IPCC Guidelines, the IPCC Good Practice Guidance and the LULUCF Good Practice Guidance.

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 NTUA) check. The official approval procedure follows for one month period of interactions between the Inventory Team (NTUA) and the Climate Team (MEECC), starting on the 1st of February of the year of submission. During this period, the NTUA Inventory Team has to revise the report according to the observations and recommendations of the Climate Team. On the basis of this interaction process, the final version of the report is compiled. The General Director for the Environment of MEECC, who supervises the National System, approves the inventory and then the MEECC 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 MEECC Climate Team and the NTUA Inventory Team 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 MEECC web site (http://www.ypeka.gr/Default.aspx?tabid=470&language=el-GR).

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.

The National Centre for the Environment and Sustainable Development (N.C.E.S.D), operates the Greek Greenhouse Gas Registry under the Min. Dec. 54409/2332/2004.

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

Ms E.Chatziapostolou (e.hatziapostolou@prv.ypeka.gr)

Mr I.Haralampis (i.haralampis@prv.ypeka.gr)

Address: Timoleontos Vassou 11-13

11521 Athens

Greece

Tel: +302106469738

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.

1.3 Policies and Measures

1.3.1 Policy-making process

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

Climate change mitigation is one of the main targets identified in the Greek strategy for sustainable development launched by MEECC 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 MEECC 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 the Minister of Environment, Energy and Climate change, 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.

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 GHG emissions reduction potential from the implemented and adopted policies and measures was estimated to be 33.3 Mt CO2eq for 2015 and 41.0 Mt 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 (1st Commitment Period) and the 2020 targets pursuant to European Union obligations, exclusively with domestic measures and actions (see paragraph 5.1).

Respectively, **the total GHG emissions reduction potential for the planned policies and measures was estimated to be 0.8 Mt CO2eq for 2020, also with the interferences between them to be taken into account.** These policies include additional energy efficiency measures in the building and transport sector, which are planned to be implemented till 2030.

1.3.3 Minimization of adverse effects

The Kyoto Protocol aims at the implementation of effective policies and measures by Annex I Parties so as to prevent dangerous anthropogenic interference with the climate system, contributing thus in the minimisation of adverse effects of climate change on other Parties and especially developing countries. The Protocol 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 Projections

The projections of GHG emissions in the "with measures" scenario disaggregated by sector and by gas are presented in ***Tables 1.3*** and ***1.4.*** The projections of the "with additional measures" scenario, disaggregated by sector and by gas are presented in Tables ***Tables 1.5*** and ***1.6***. In ***Figure 1.2*** the evolution of GHG emissions and their projections till year 2030, along with the assigned amount of Greece for the first commitment period of Kyoto Protocol are presented.

Table 1.3 Projection of GHG emissions in the "with measures" scenario, disaggregated by sector (kt CO_2 eq)

Sources/Sinks	1990	1995	2000	2005	2010	2015	2020	2025	2030
Energy	77171	80619	96483	106231	92293	68110	77285	60785	66223
Industrial Processes	10073	12263	13712	13881	10496	11207	13081	14982	16805
Solvents	308	300	307	309	316	320	325	356	392
Agriculture	11460	10319	9940	9541	9271	8952	8758	9548	10416
Waste	5574	5788	5782	4958	4902	4993	5403	5847	6348
Total	**104587**	**109289**	**126224**	**134921**	**117278**	**93583**	**104852**	**91519**	**100184**
LULUCF	-2501	-3174	-2743	-2807	-2642	-2723	-2977	-2704	-2615

Table 1.4 Projections of GHG emissions (excluding LULUCF) in the "with measures" scenario, disaggregated by gas (kt CO_2 eq)

Gas	Base Year	1990	1995	2000	2005	2010	2015	2020	2025	2030
CO_2	82909	82909	86350	102501	112802	96559	72326	82103	67021	73141
CH_4	10336	10336	10595	10834	10163	9784	9483	9889	9987	10814
N_2O	10239	10239	8997	8537	7910	7316	7146	7206	7806	8490
HFCs	3290	935	3290	4244	3969	3512	4495	5495	6500	7500
PFCs	54	163	54	105	70	102	128	154	198	232
SF_6	4	3	4	4	6	6	6	6	7	8
Total	**106833**	**104587**	**109289**	**126224**	**134921**	**117278**	**93583**	**104852**	**91519**	**100184**
Change from base year	**100**	**-**	**102**	**118**	**126**	**110**	**88**	**98**	**86**	**94**

Table 1.5 Projection of GHG emissions in the "with additional measures" scenario, disaggregated by sector (kt CO_2 eq)

Sources/Sinks	1990	1995	2000	2005	2010	2015	2020	2025	2030
Energy	77171	80619	96483	106231	92293	68369	76309	57253	60938
Industrial Processes	10073	12263	13712	13881	10496	11207	13081	14982	16805
Solvents	308	300	307	309	316	320	325	356	392
Agriculture	11460	10319	9940	9541	9271	8952	8758	9548	10416
Waste	5574	5788	5782	4958	4902	4993	5403	5847	6348
Total	**104587**	**109289**	**126224**	**134921**	**117278**	**93842**	**103876**	**87987**	**94899**
LULUCF	-2501	-3174	-2743	-2807	-2642	-2723	-2977	-2704	-2615

Table 1.6 Projections of GHG emissions (excluding LULUCF) in the "with additional measures" scenario, disaggregated by gas (kt CO_2 eq)

Gas	Base Year	1990	1995	2000	2005	2010	2015	2020	2025	2030
CO_2	82909	82909	86350	102501	112802	96559	72505	81009	63461	67765
CH_4	10336	10336	10595	10834	10163	9784	9476	9867	9876	10707
N_2O	10239	10239	8997	8537	7910	7316	7233	7346	7944	8687
HFCs	3290	935	3290	4244	3969	3512	4495	5495	6500	7500
PFCs	54	163	54	105	70	102	128	154	198	232
SF_6	4	3	4	4	6	6	6	6	7	8
Total	**106833**	**104587**	**109289**	**126224**	**134921**	**117278**	**93842**	**103876**	**87987**	**94899**
Change from base year	**100**	**-**	**102**	**118**	**126**	**110**	**88**	**97**	**82**	**89**

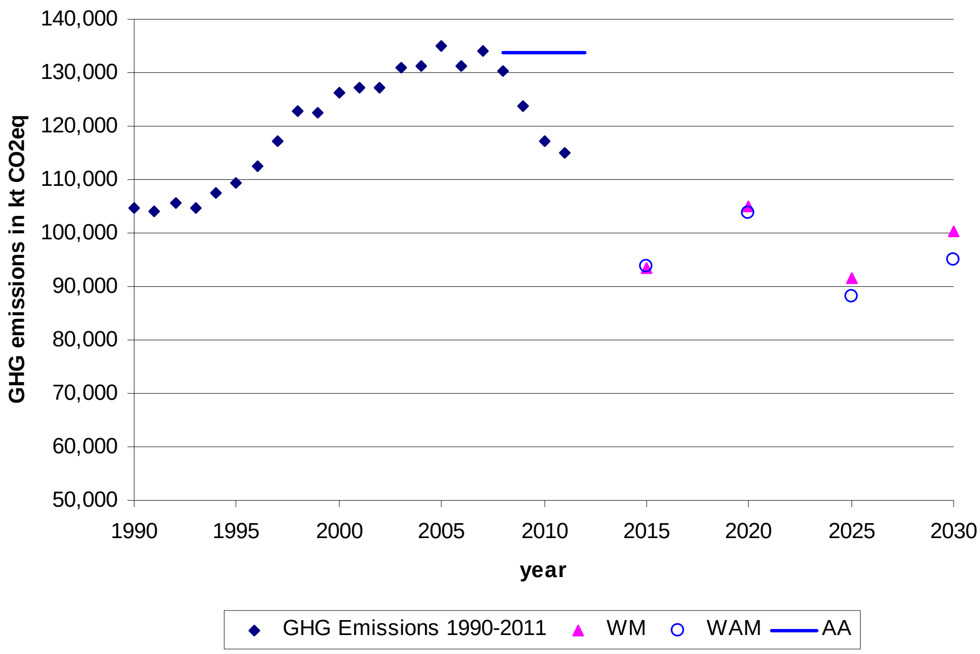


Figure 1.2 GHG emissions projection per scenario

As it is obvious from ***Table 1.7*** and ***Figure 1.2***, Greece achieves Kyoto Protocol target for the first commitment period, on the basis of the domestic policies and measures implemented. It should be mentioned that the figures of ***Table 1.7*** are provisional, since they will be finalised when the accounting of the 1st commitment period of the KP will be completed, i.e. after the UNFCCC review of the Greek GHG inventory in 2014.

Table 1.7 Evaluation of the progress in achievement of the KP 1st commitment period target.

Total GHG emissions (excluding LULUCF) for 2008-2011 (kt CO2eq)	**486,291**
Estimation of total GHG emissions (excluding LULUCF) for 2012 (kt CO2eq)	119,200
Estimation of total GHG emissions (excluding LULUCF) for 2008-2012 (kt CO2eq)	605,479
Assigned Amount of Greece (kt CO2eq)	**668,669.806**
Estmation of RMUs issuance (kt CO2eq)	3,000
Estimation of EU-ETS effect (kt CO2eq)	-28,000
Adjusted AA including EU-ETS effect and RMUs	**643,670**
Estimated surplus(+) / deficit (-) of AAUs for 1st KP period	**38,000**

1.4.2 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 1.8*** in terms of GHG emissions avoided on a CO2 equivalent basis, while the effect of planned policies and measures is illustrated in ***Table 1.9***. The difference between the "with measures" and "with additional measures" projections scenarios equals to the total effect of planned policies and measures. The effect of policies, or with other words GHG emissions avoided, correspond mainly to CO2 (more than 99%), with the exception of policies in 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.

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

According to the 2nd National Climate Change Programme adopted in 2002 and the latest projections presented in Chapter 5.1, Greece has the ability to reach its Kyoto Protocol target for the 1st and 2nd commitment period with the existing implemented and adopted policies and measures and the implementation of EU-ETS. For this reason, Greece has not as yet fully exploited the opportunities or allocated a specific budget for the use of the JI and CDM.

However, JI and CDM credits have been utilized by the installations subject to the EU-ETS. According to the National Allocation Plan 2008-2012, installations are allowed to use for compliance credits from these two mechanisms up to 9% of their allocated allowances. This figure was calculated according to the supplementarity principle of the Kyoto Protocol.

1.4.4 Methodology used for the presented GHG emission projections

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

- The combination of TIMES - MARKAL, WASP and COST models for the energy sector.
- 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 IPCC guidelines.

Table 1.8 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
Promotion of Natural Gas (CO_2 99,7%, CH_4 0,02%, N_2O 0,28%)	6510	11857	13940	12582
Promotion of Renewable Energy Sources (CO_2 99,7%, CH_4 0,02%, N_2O 0,28%)	1019	12613	16002	22496
Measures in Industry (CO_2 99,7%, CH_4 0,02%, N_2O 0,28%)	IE[1]	IE	200	300
Measures in Residential & Tertiary Sector (CO_2 99,7%, CH_4 0,02%, N_2O 0,28%)	IE[2]	IE	1,300	2200
Measures in Transport Sector (CO_2 98,9%, CH_4 0,3%, N_2O 0,8%)	IE[3]	IE	150	300
Measures in Waste Sector (only CH_4)		200	1000	1300
Measures in Agriculture Sector (CH_4 30%, N_2O 70%)		160	670	880
Total Effect	7529	24830	33262	40058

Table 1.9 Aggregate effect of planned policies and measures (kt CO2 eq)

Policies and Measures	Effect of planned policies and measures
	2020
Promotion of Natural Gas (CO_2 99,7%, CH_4 0,02%, N_2O 0,28%)	177
Promotion of Renewable Energy Sources (CO_2 99,7%, CH_4 0,02%, N_2O 0,28%)	248
Measures in Industry (CO_2 99,7%, CH_4 0,02%, N_2O 0,28%)	350
Measures in Residential & Tertiary Sector (CO_2 99,7%, CH_4 0,02%, N_2O 0,28%)	200
Total Effect	975

[1] The mitigation effect on GHG emissions from the substitution of diesel, HFO and solid fuels by natural gas in industry is included under the policy “promotion of natural gas”.
[2] The mitigation effect on GHG emissions from the substitution of diesel by natural gas in residential and tertiary sectors is included under the policy “promotion of natural gas”.
[3] The mitigation effect on GHG emissions from the use of biofuels in transportation is included under the policy “Promotion of Renewable Energy Sources”.

1.5 Vulnerability Assessment, Climate Change Impacts and Adaptation Measures

1.5.1 Climate Change Impact

1.5.1.1 Temperature changes in Greece

Current climate change has been estimated to account for a temperature increase of about 1ºC (ground surface temperature) in the last 500 years and of 0.76ºC in the last 100 years. 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. 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).

1.5.1.2 Extreme weather events and their regional impact in Greece

Among extreme events, maximum summer and minimum winter temperatures, warm days and warm nights, days with precipitation, frost days, energy demand for heating and cooling, forest fires and days with increased thermal discomfort were presented. By studying the variation in these climate indices between the reference period and each one of the two future periods, it was possible to determine climate change for each of Greece's 13 climate zones.

1.5.1.3 Changes in the intensity and distribution of landslides and floods in Greece

Concerning landslides and floods 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). 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.

1.5.1.4 Change in mean sea level and its impact on Greece's shorelines

Focusing 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 but 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). **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).

1.5.2 Vulnerability assessment

1.5.2.1 Natural ecosystems and biodiversity

Greece has one of the richest biodiversities in Europe and the Mediterranean on account of combined multiple factors. The ***plant and vertebrate species*** endemic to the Mediterranean region, certain ***mammals***, 35 ***inland water fish*** species, ***forest ecosystems*** (climate change attributed to the dieback of the Greek fir, the invasion of conifers into broadleaved forests, and the dieback of the Scots pine), many ephemeral ***wetlands*** and the Mediterranean ***marine ecosystem*** seem to be particularly vulnerable to climate change.

1.5.2.2 Agriculture and foods

Eastern Macedonia-Thrace and Western-Central Macedonia are the zones that will benefit the most depending on the crop/case. The most vulnerable arable crop was shown to be wheat, while cotton production is projected to decrease the most in Central Eastern 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. Furthermore, impacts on crop productivity will affect farmers' income and employment.

1.5.2.3 Forest ecosystems

Forest ecosystems occupy 65% of Greece's land surface (forests 25%, rangelands 40%). Forest ecosys-tems 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. Global warming is expected to affect both the number of summer wildfires and total burned area. Forests in southern continental Greece and Crete are expected to be most affected. Sea level rise (SLR) is predicted to accelerate relative to today, reaching 0.25 to 1 m by 2100. Finally, the main reasons for the desertification are soil erosion and salinization. The most significant impacts of droughts in the Nestos and the Mornos Basins refer to stream flow reduction and the reduction in agricultural production.

1.5.2.4 Fisheries and aquaculture

The rise in sea temperatures is likely to accelerate the growth rate of poikilothermal aquatic animals. 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%. These lower production levels may, apart from overfishing, also be attributable to changes in nutrient levels in the Greek seas. The temperature rise will also bring about changes in biodiversity, fishing ground characteristics and available stocks of commercial importance. 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.

1.5.2.5 Water resources

The impacts of climatic change on water systems can be summarised as follows:

1. An overall decrease in aquifer infiltration and recharge, as a result of decreased rainfall
2. Increased salinity of coastal and subsea aquifers
3. Higher pollutant load concentrations in coastal water bodies and the sea
4. Faster degradation of deltaic regions, in cases where degradation has already begun as a result of transversal dam construction upstream
5. Contamination or drainage of coastal wetlands
6. Amplification of the desertification phenomenon as a result of water deficits
7. Droughts determined by social factors such as population changes, population shifts, demographic characteristics, technology, government policies, environmental awareness, water use trends, social behaviour, level of water development and/or exploitation, and water availability

1.5.2.6 Coastal zones

With a total shoreline of roughly 16,300 km, Greece has the most extensive coastal zone of any country in Europe. 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. In addition, the role of tectonics is especially important in tectonically active zones, 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. the **'high risk'** coastal areas of Greece include the deltaic areas of many Greek rivers and gulfs. Apart from long-term SLR, other climate phenomena capable of causing coastal erosion are the anticipated increase in storminess and frequency of storm surges. The impacts of storm surges include: flooding of coastal areas; destruction of coastal infrastructure; coastal erosion; and intrusion of salt water in lagoons, river, etc.

1.5.2.7 Tourism

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. 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. Upper-rated hotels are also highly concentrated in a small number of regions. Another problem is high seasonality, which results in full capacity remaining idle for extensive periods each year (often for six months or more).

1.5.2.8 Human health care

Climate change affects the human organism both directly and indirectly. 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 to:

a) increased mortality due to the temperature rise

b) greater frequency of infectious disease epidemics due to extreme weather events

c) substantial impacts on human health due to the relocation of populations.

1.5.2.9 Energy

Climate change will affect both the energy input and the energy demand. In particular:

- Hydropower will be the renewable energy source mostly affected by climate change,
- The air temperature increase will reduce the efficiency of thermo-electrical units
- There will also be an increase of the loss on electricity distribution networks.

Warmer climate conditions will probably lead to decreased electricity demand in winter and increased electricity demand during summer, as a result of the increase of summer days.

1.5.2.10 Transport

The direct physical impacts of climate change on transport can be broken down into three main categories:

1. impacts on transport infrastructure and infrastructure maintenance; and
2. impacts due to alteration to the system's operation and reliability.

1.5.3 Adaptation measures

The Ministry of Environment, Energy and Climate Change (MEECC) is the competent authority for coordinating actions for climate change and 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. Although an over-arching adaptation strategy is not yet available, adaptation measures are currently under implementation as part of a broader network of measures that apply to the specific areas of identified vulnerabilities. The process of setting up a National Adaptation Strategy is ongoingand its development is included in the main priorities of the MEECC.

1.5.3.1 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. 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).

1.5.3.2 Agricultural production

The responsibility for agricultural issues in Greece falls under the Ministry of Rural Development and Food (MRDF). Aiming to the adaptation of the country concerning the agricultural sector Greece is participating in the Project **ADAGIO -** ADAptation of AGriculture in European RegIOns at Environmental Risk under Climate Change. In addition, the national agricultural policy is fully harmonized with European Common Agricultural Policy (CAP). The Rural Development Program's (RDP) actions 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. 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 main issues in relation to agriculture are **erosion of soils and drought problems**.

1.5.3.3 Forest ecosystems

The national strategy is implemented via the **Program of Rural Development** (RDP) 2007-2013 "Aleksandros Mpaltatzis", under which 69 projects have been implemented by the regional Forestry Services. Adaptation of forests to climate change is strengthened through the construction and improvement of the forest road network within managed forests, as well as preventing forest fires and natural disasters, reforestation and mountain anti flood for burned forest areas. In addition, a **Life+ project** "Adaptation of forest management to climate change in Greece (AdaptFor)" is in progress, implemented by the Goulandris Natural History Museum / Greek Biotope - Wetland Centre in cooperation with the MEECC. In addition, **Natura 2000** network has a key role in protecting and enhancing our natural capital. The **National Action Plan for Combating Desertification** that was approved in 2001 (Common Ministerial Decision 996005/31719) aims 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.

1.5.3.4 Fisheries and aquaculture

The Greek Operational Programme "**FISHERIES 2007-2013**" was approved by the European Commission and the overall strategy is summarized as "the viable and sustainable development of the Fisheries sector whilst reinforcing sector competitiveness and preserving social and economic cohesion". The strategic objectives include achieving a stable balance between fisheries resources and the respective fishing activities, thereby simultaneously ensuring the sector's financial sustainability. Concerning **aquacultures**, possible adaptation measures to climate change include institutional measures, policy measures and action planning which are summarized as follows: Insurance aquaculture, Technology transfer and research, Diversification of crop species, Adoption of selection systems for the installation and monitoring of aquacultures.

1.5.3.5 Water resources

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). In addition, the **River Basin Management Plans 2009-2015** was adopted by 8 out of the 14 Districts of Greece. 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. One of the most ambiguous projects aiming at the adaptation of water scarcity in the area of Thessaly is the **Acheloos water transfer project**. According to the **National Action Plan for Combating Desertification**, the suggested measures concern: Reduction of water loss through the improvement of irrigation efficiency, Reduction of water losses and demand in urban and industrial use and Increase of water supply through funding of programs for water recycling and reuse. The **MEDROPLAN Project**: "Mediterranean Drought Preparedness and Mitigation Planning" focuses on developing Guidelines for drought preparedness plans and to setting up a Network in Mediterranean countries. Regarding **Flood Risks,** Greece has transposed the EU Directive 2007/60/EC in 2010.

1.5.3.6 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. 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). According to Law 3983/2011 "**National Strategy for the protection and management of the marine environment** the Directive 2008/56 of the European Communities on the **Marine Strategy Directive** was incorporated into national legislation. The aim is to maintain and restore high environmental status of the marine environment by the year 2020.

1.5.3.7 Tourism

Strengthening the assessment of tourism investments, Empowering legislative tools, encouraging efficient energy use and Promoting dialogue are 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. 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.

1.5.3.8 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.

1.5.3.9 Energy

The program **Intelligent Energy Europe (IEE)** contributes 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.

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”: Promotion of alternative, and in particular renewable, energy sources; Protection and enhancement of natural processes; and Adaptation to new climate change conditions and mitigation of their consequences.

1.5.3.10 Transport

Concerning transport a set of proposed policies and specific policy measures are presented which, include: Cooperation between the competent authorities, Development of monitoring systems for crucial infrastructure , Recording of detailed data concerning the operation of the transport system, Policy measures aimed at reducing transport demand, etc.

1.6 Financial Resources and Transfer of Technology

While the international crisis was raging, Greece continued in 2012 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 2012 reached 327.41 MUSD, that is o.13% of GNI of which 33% was channelled bilaterally to developing countries, while 67% through International Organisations. Multilateral ODA reached 220.10 MUSD, while bilateral ODA amounted to 107.31 MUSD. In relation to 2011, total ODA fell, due to the difficult fiscal circumstances by 97.36 MUSD (approximately 23%), while ODA/GNI ratio dropped respectively from 0.15% in 2011 to 0.13% in 2012.

In the last five years (2008-2012) Greece continued to provide 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.

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) four Replenishments.. Contributions to United Nations Conventions and their Secretariats are channelled through other line Ministries, like MEECC. Over the period 2005-2011, MEECC has contributed annually an average amount of USD 91.488 to the UNFCCC Fund. MEECC's multilateral and multi-bilateral economic contributions to UN environmental related Organisations, Secretariats and Funds during the last five years are detailed in chapter 7.

Greece is engaged in a number of environmental cooperation and transfer of technology regional initiatives, the most important of which involves leadership of the Mediterranean Component of the EU's Initiative 'Water for Life' (MED EUWI), in the follow up of the World Summit for Sustainable Development (WSSD), and cooperation on environmental protection within the Black Sea Economic Cooperation (BSEC) Organisation.

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. 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). Funds that derive from the regular national budget, on an annual basis and at 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).

Programmes that are funded from Structural Funds are included in the European Commission's Support Frameworks and are managed by the Ministry of Economy.The main means of European Funds in the area of Research are the Framework Programmes. The 7th Framework Programme for Research and Technological Development (7th FP), has started in 2007 and will be completed in 2013. Until October of 2008 the Greek research organisations have obtained contributions of about 121MEuros, through the 7th FP. According to information from the European Commission (European Commission - European Research Area, 2009), up to now the 3.3% of signed grant agreements regard the sector of "Energy and Environment (including Climate Change).Regional development is substantial for the increase of the research potential in the EU. Greece is recieving this kind of support in the Research sector, in the context of the 'Convergence' objective, that is financed by the European Regional Development Fund.

International cooperation in the field of research is ensured by the implementation of projects. Greece in the past has participated in a number of bilateral and cross-border programmes. During the new programming period, the Community Initiative Programmes are replaced by the Programmes of Goal III "European Territorial Cooperation". The objective of “European Territorial Cooperation” is offering an important support to research and innovation. The total budget of Goal III programmes amounts to EUR 8.7 billion, of which EUR 210 million from the European Regional Development Fund (ERDF) have been earmarked for Greece. Thus, also including national resources, nearly EUR 300 million of Community and national resources will be allocated to European Territorial Cooperation Programmes.

Three programmes of the cross-border regions of Greece are aimed to research and are co - financed by Greece and the European Regional Development Fund: Adriatic Programme, Mediterranean Sea Basin**,** Black Sea. Greece participates in two transnational programmes: **MEDA Programme,** resulted from the merger of the INTERREG, ARCHIMED and MEDOCC Programmes, and **Southeast Europe Area,** resulted from the division of the CADSES programme into two different zones, north and south. Greece participates also in the INTERREG IV C interregional programme and in the INTERACT, ESPON and URBACT networks. The above mentioned programmes are including various projects that are directly or indirectly related to climate change observation, mitigation and adaptation actions.

The main institutes that perform research in the sector of climate change in Greece are: the Hellenic National Meteorological Service (HNMS), 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. 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.

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 Secretatariat 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 MEECC'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, ie 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 can not 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, Energy and Climate Change (MEECC) 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. MEECC 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.

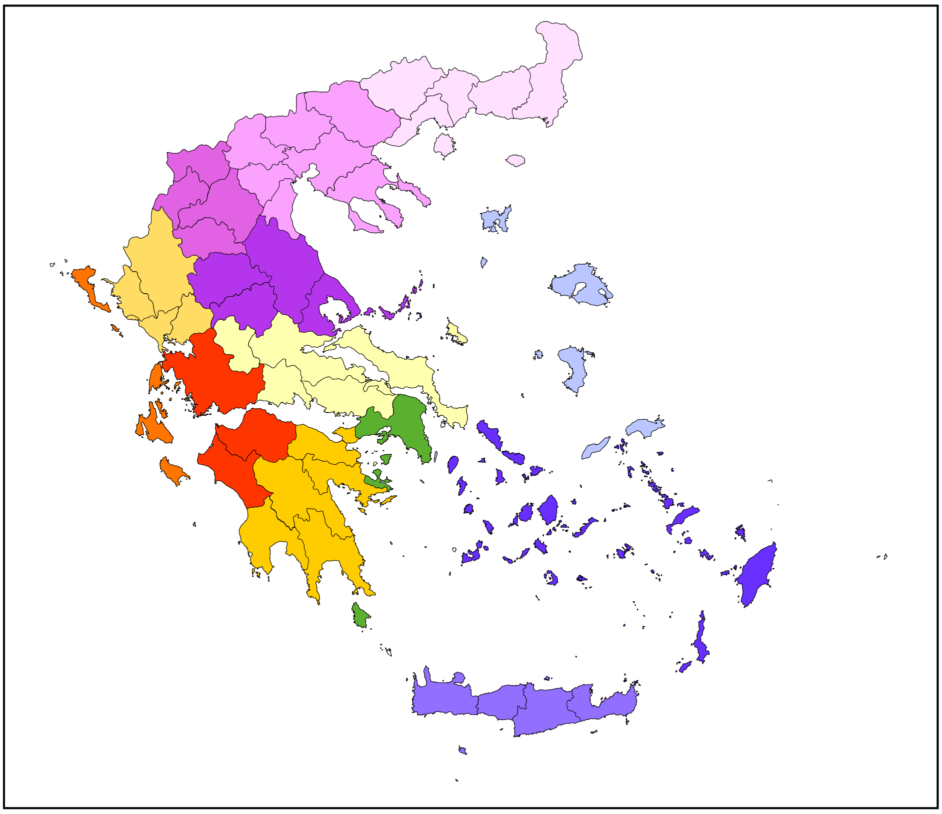


Figure 2.1 Major administrative regions of Greece

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 the following ministries:

- Ministry of Environment, Energy and Climate Change
- Ministry of Foreign Affairs
- Ministry of Interior
- Ministry of Administrative Reform and E-Governance
- Ministry of Finance
- Ministry of Development & Competitiveness
- Ministry of Infrastructure, Transport and Networks
- Ministry of Rural Development and Food

This committee is responsible for the initial formulation of policy, as well as for the monitoring, evaluation and modification/completion of the National Programme on Climate Change.

2.2 Preparation of national communications

As previously stated, the Ministry of Environment, Energy and Climate Change 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, MEECC is the governmental body with the overall responsibility for the preparation, approval and submission of national communications (Contact person: Irini Nikolaou, Address: Villa Kazouli, Kifisias 241, Athens, Greece, e-mail: i.nikolaou@prv.ypeka.gr, tel.: +30210 8089275, fax: +30210 8089239)

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

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

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***).

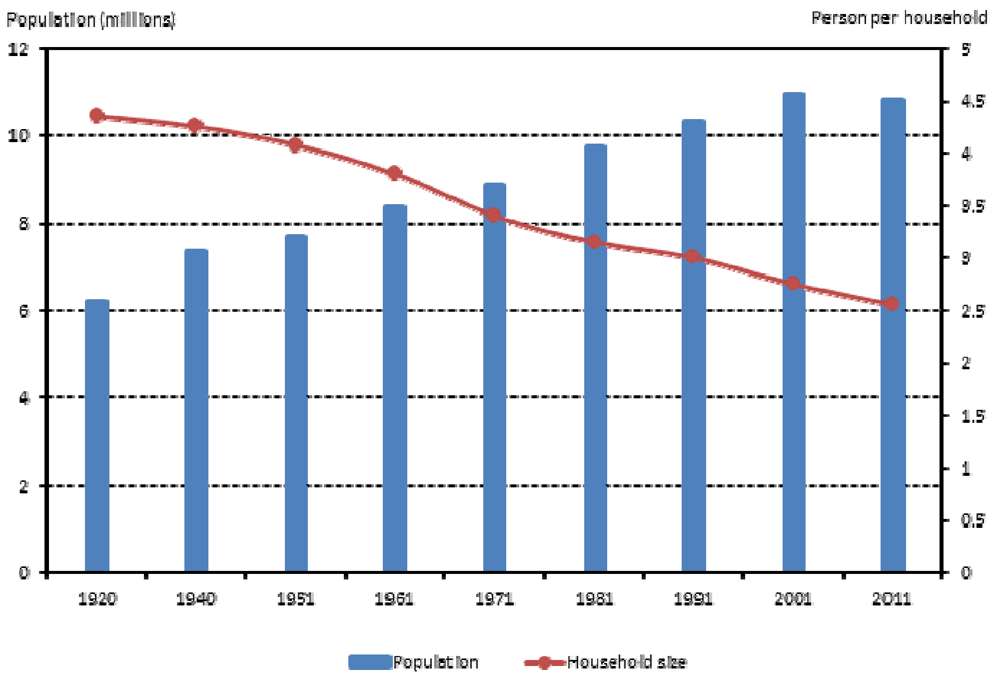


Figure 2.2 Population of Greece and average household size

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

The main floristic regions found in Greece are the Mediterranean, the European (Eurasian) and the Irano-Caspian. The Mediterranean flora is found in a zone of varying width along the coasts and on the islands of the Ionian and Aegean Seas. The width of this zone and the altitude to which it reaches decrease with increasing latitude. The Central European flora predominates on the mountains of Northern and Central Greece, gradually losing ground as we move south. Representatives of the Irano-Caspian flora, such as the oriental oak and others, are found in North-East Greece (Thrace) and on the islands of the North-East Aegean. In Crete representatives of the north-African flora are also found. Due to the geographical position and the coexistence of the above-mentioned flora regions, the flora of Greece is very rich, consisting of approximately 6,000 phanerogamous plants. Also, the country's mountainous nature and the many islands favour conditions of isolation and endemism. As a result, significant proportion of plant species and subspecies (13%) are endemic.

The large climatic variation in Greece is expressed by the variation of vegetation zones (types) of the natural vegetation, ranging from the thermomediterranean formations of the Oleo-Ceratonion sub-type, such as the most Xerothermophilous ecosystems of the natural palm forest in Crete island (Vai), to the most psychrobious (cold resistant) formations of Mid-European type of Pinus sylvestris and Picea excelsa as in the area of Drama (Elatia). The limits of the five vegetation zones are often overlapped and the illustration on the map is not well defined. These zones are:

- Coastal, hill and sub-mountain zone with Mediterranean vegetation (Quercetalia ilicis).
- Sub-7Mediterranean-Para-Mediterranean vegetation zone. Hill, sub-mountain, mountain
- (Quercetalia pubescentis).
- Zone of beech, beech-fir and mountain para-Mediterranean conifer forests (Fagetalia). Mountain-sub Alpine.
- Zone of boreal conifers (Vacinio-Picetalia) Mountain, sub-Alpine.
- Highland zone above the treeline, mountain Mediterranean, sub-Alpine and Alpine (Astragalo-Acantholimonetalia, Daphno-Festucetalia).

2.4.3 Land use

The various forms of land use in Greece in 2011 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, Energy and Climate Change,
- the “Agricultural Statistics of Greece” of the Hellenic Statistical Authority (ELSTAT, annual census),
- the “Distribution of the Country’s Area by Basic Categories of Land Use” of the Hellenic Statistical Authority (ELSTAT, decennial survey),
- the “Land Use Change Database” recently developed by the Ministry of Environment, Energy and Climate Change, which comprises acts of land use change since 1990,
- the “Forest Management Plans Database”, recently developed by the Ministry of Environment, Energy and Climate Change.

Forest land, divided into Forests (high and coppice forests) and Other Wooded Lands (branchy dwarf trees and scrubs), covers 25.7% of the total area of the country. Grassland, rangeland and pasture with vegetation that falls below the threshold of forest definition, covers 38.7% of the total area of the country. Agricultural land, including fallow land, account for 27.3% 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.

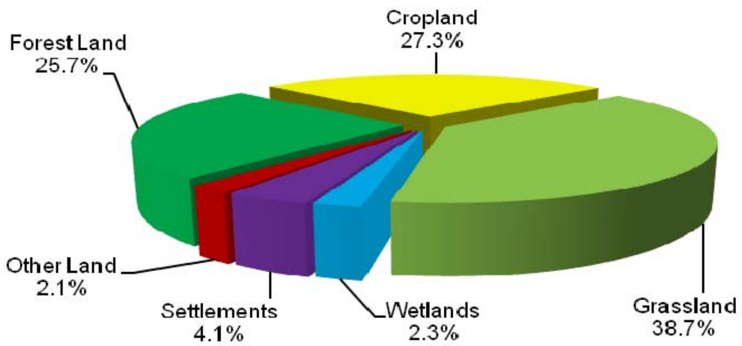


Figure 2.3 Distribution of the area of Greece in 2011 by land-use category

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 – 2013, 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.

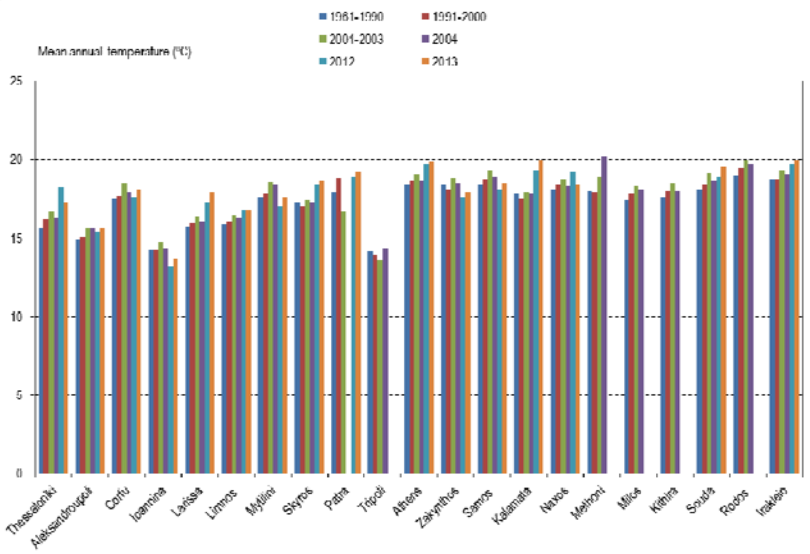


Figure 2.4 Mean annual temperature (in ˚C) at selected meteorological stations for the periods 1961 – 1990 and 1991 – 2000, 2001-2003 and for the years 2004, 2012 and 2013

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 and 2013, as measured at selected meteorological stations of Greece.

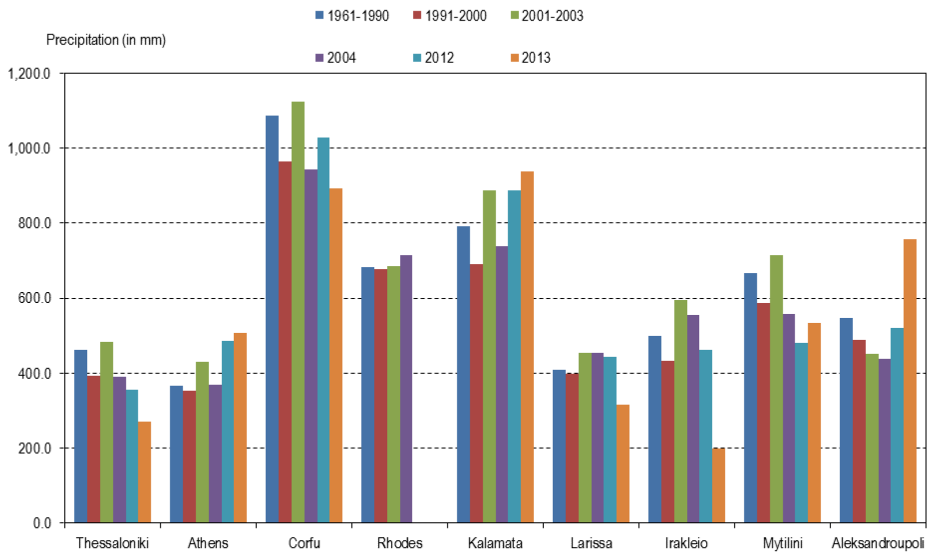


Figure 2.5 Precipitation height (in mm) at selected meteorological stations for the periods 1961 – 1990 and 1991 – 2000, 2001-2003 and for the years 2004, 2012 and 2013

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 five consecutive year recession while projections regarding the growth rates for 2013 envisage one more year of contraction (Ministry of Finance, National Reforms Programme 2013).

As a consequence, Greece has received financial and technical assistance from the other Eurozone countries and the IMF in the framework of the first Memorandum of Understanding (May, 2010) and the second one (January, 2012) in order to deal with its high deficit and Government debt, while through the PSI (Private Sector Involvement) agreement, private investors on Greek bonds were called to forgive the 53.5% of their principal and exchange their remaining holdings for new Greek government bonds and notes from the European Financial Stability Facility (EFSF).

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 second Memorandum of Understanding is expected to be completed by the end of 2014.

2.6.1 General

Over the last five years Greek economy faced its most-severe crisis since it experienced a significant recession having recorded a cumulative decline in real terms exceeding 20% (by the end of 2012 compared to GDP at the end of 2007). Growth for the 2013 is projected at -4.2%, with a mild recovery (0.6%) expected for 2014 followed by a gradual acceleration of growth. The repercussions from the international financial crisis are unavoidable felt also in Greece especially through the negative impact in the two significant exporting sectors (tourism and ship transportation) but at a large extent economic downturn relates also to the diminishing growth potential of the country since no significances changes have occurred in the domestic production model towards innovative or high value added activities.

Before this five 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 3.7% 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). 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.

0The number of unemployed in 2012 was at the range of to 1.2 million people on average, for ages above 15. The average unemployment rate (ages above 15) rose to 24.2% in 2012, from 17.7% in 2011 and 7.6% in 2008 – according to EL.STAT. data. According to the latest projections for the 2013, employment is expected to contract further (-3.5%), with the unemployment rate culminating to 25.8%.

Inflation followed a downward trend since 2010 from 4.7 in 2010 to 1.0 to 2012.

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 9.8% of GDP in 2008.

2009 was the year with highest budget deflect of Greece accounting to 15.7% of GDP and resulting in the developing of the first Memorandums of Understanding. After the austerity measures that adopted budget deflect was removed to 10.7% of GDP in 2010 and to 9.5% of GDP in 2011 while for 2012 the deflect was accounted at 9% of GDP.

Similarly it is the evolution of the general government debt as a per cent of GDP. Before crisis, it was measured at 107.4% of GDP in 2007 and 113.0% of GDP in 2008. In the first year of the economic crisis, 2009, Greek debt was accounted to 129.7% of GDP and in 2010 to 148.3% of GDP. Before the PSI implementation in 2011 Greek debt reached the 170.3% of GDP, while for 2011 it is estimated at the 156.9% 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 4.60% and for the period 2007-2011 at -3.75%, while the average annual increase of the private consumption is estimated at 4.70% for the 2007-2011 and at -3.9 for the same period.

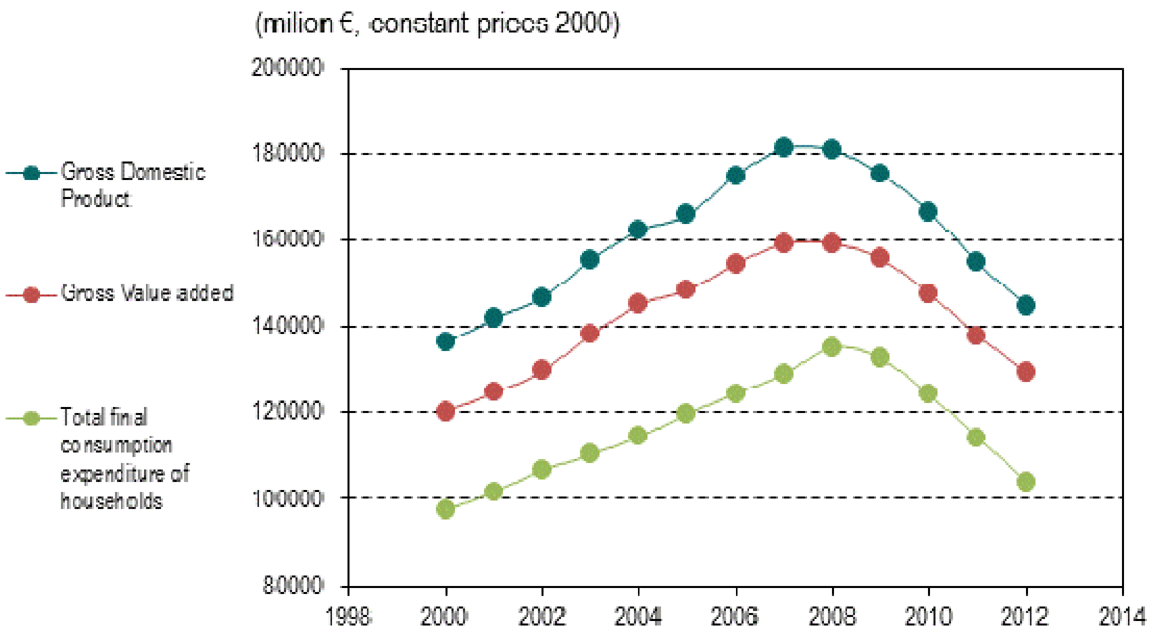


Figure 2.6 Basic macroeconomic indicators of the Greek economy for the period 2000 - 2012

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

In 2011, the tertiary sector accounted for 80% of the total gross value added (72% in 2000). The contribution of the primary sector decreased during the period 2000-2011 (5% in 2007 compared to 7% in 2000), while the contribution of industry (including energy industry) decreased from 14% in 2000 to 12% in 2011. On the contrary, the contribution of the construction sector decreased by approximately 4.2% from 2000 up to 2011.

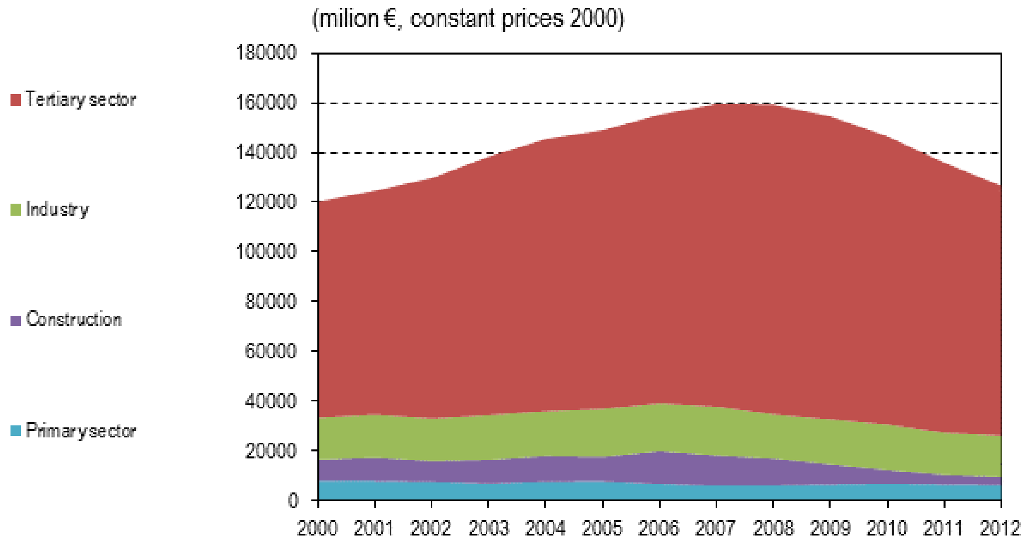


Figure 2.7 Gross value added (in constant prices 2000) per economic sector for the period 2000 – 2012

As it is concluded by the Figure 2.7, with the exception of the Primary sector, the rest sectors of economic activity presented negative growth rates as a result of the exonomic crisis for the period 2007-2011. The construction sector presented the highest average annual decrease rate (approximately 14%). The average annual rate of decrease of gross value added in tertiary and in the industry sector, during the period 2007-2011, was 3.5% and 3.1% respectively. The gross value added of the primary sector increased with a 0.8 % rate.

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 1.7% from 2000 to 2012. During the same period employment in the sector decreased by 31% and as a result employment in the primary sector accounts for 12% of total employment in 2012. The corresponding figure in 2000 was approximately 17%.

2.6.2.1 Agriculture

In 2009, 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 7.1% in 2007 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 remained constant since 2000 (38%), while total irrigated land in 2009 increased by 16% compared to 1990.
- 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.

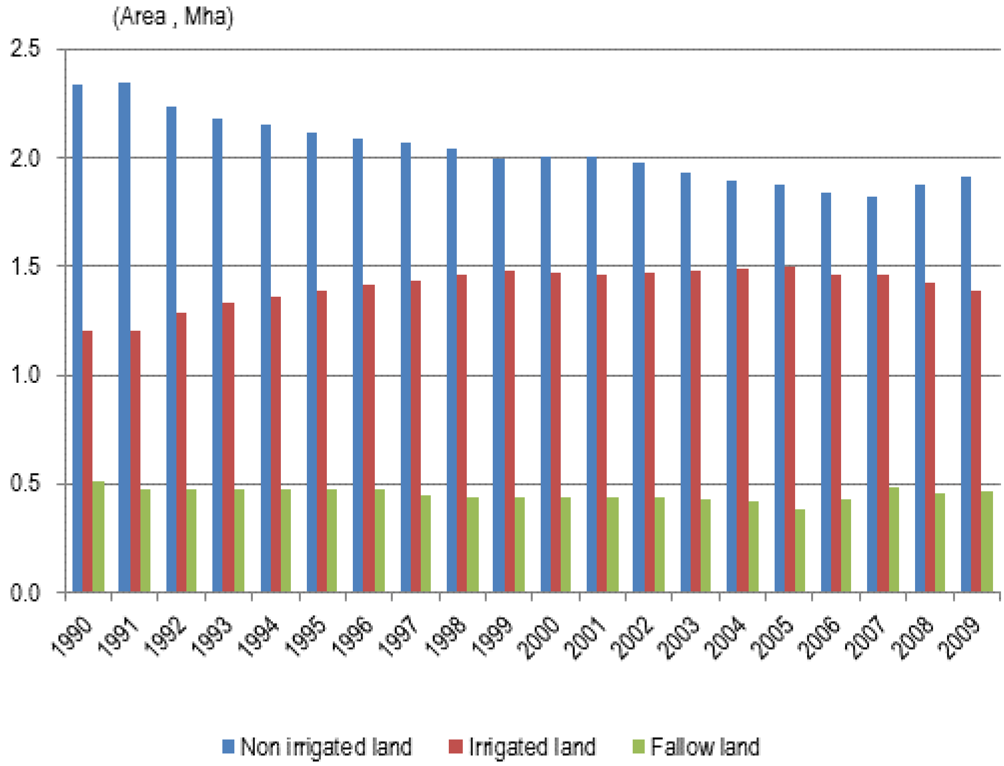


Figure 2.8 Distribution of agricultural land in irrigated and non-irrigated and fallow land (in Mha) for the period 1990 – 2009

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.

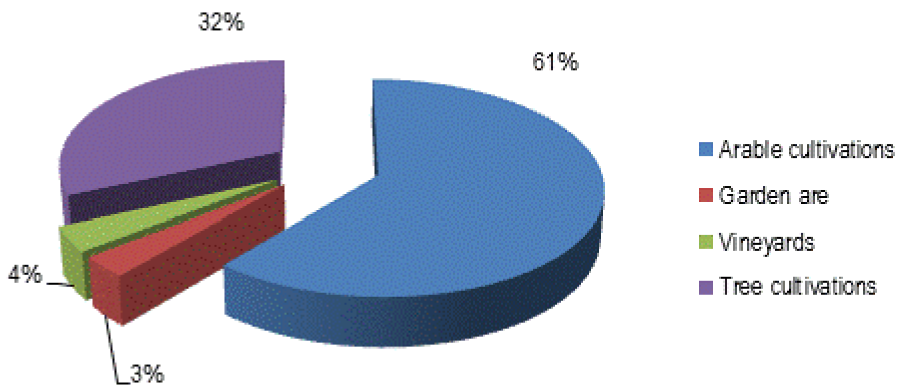


Figure 2.9 Agricultural land by cultivation type for the year 2009

The use of synthetic nitrogen fertilizers in 2009 decreased by approximately 58.7% 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 2009. 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 2011, livestock population amounted to approximately 44.6 million animals, of which: cattle 1.5%, sheep 19.8%, goats 11.5%, pigs 1.9% and poultry 65.2%. Livestock population decreased by approximately 0.26% compared to 1990 levels, while the larger decreases are observed in the number of Mules and asses, Horses and swine (77.4%, 40.0% and 12.6% respectively (see ***Table 2.1a*** and ***Table 2.1b***).

2.6.2.3 Forestry

According to the results of the First National Forest Inventory, the forests and other wooded land in Greece cover 6.5 Mha (49.7% of the area of Greece), of which 3.4 Mha are considered as productive forests. 40% 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 focussed 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 2.1a Number of animals (thousands) by species for the period 1990–2000

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Dairy cows	212	209	212	197	193	181	186	180	170	169	169
Other cattle	479	468	436	402	390	397	411	410	438	440	422
Buffalo	0.827	0.865	0.910	0.827	0.765	0.709	0.741	0.796	0.843	0.906	0.954
Sheep	8692	8673	8688	8725	8792	8856	8883	8904	8922	8958	9023
Swine	994	994	1000	1008	1005	997	993	995	990	979	957
Horses	46	42	40	38	36	35	33	32	31	30	29
Mules and Ashes	187	174	161	150	140	130	122	114	108	101	95
Goats	5339	5345	5360	5395	5449	5513	5565	5595	5610	5623	5640
Poultry	28747	28648	28972	29151	29231	29198	29266	29482	30005	30480	30150

Table 2.1b Number of animals (thousands) by species for the period 2001-2011

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Dairy cows	168	158	152	153	153	153	148	141	136	135	137
Other cattle	411	450	490	506	517	519	515	501	509	515	519
Buffalo	1.003	1.048	1.141	1.212	1.305	1.338	1.599	1.735	1.824	1.908	2.017
Sheep	9059	9062	8962	8874	8816	8818	8872	8875	8854	8832	8822
Swine	946	937	939	942	930	918	891	885	880	875	869
Horses	29	28	28	27	27	27	28	28	28	27	27
Mules and Ashes	90	84	79	74	69	66	60	55	51	46	42
Goats	5658	5652	5600	5517	5444	5409	5341	5279	5215	5155	5113
Poultry	29937	29312	29936	30429	31251	31592	30896	30067	29110	29079	29048

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 (74.1%) 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 accounts for 22% of the total timber production and is considerably lower than fuelwood. Sawlogs production is even smaller and accounts for 5% of the total yield.

Employment in the forestry sector refers to a total number of 4511 permanent staff in 2011. Employment in the forestry sector decreased by approximately 43% during the period 2000-2011. 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	259	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 21.2 in 1990 to 15.8 in 2011. 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 19.0%, of Energy industries 22.1% and of Manufacture about 57% in 2011.

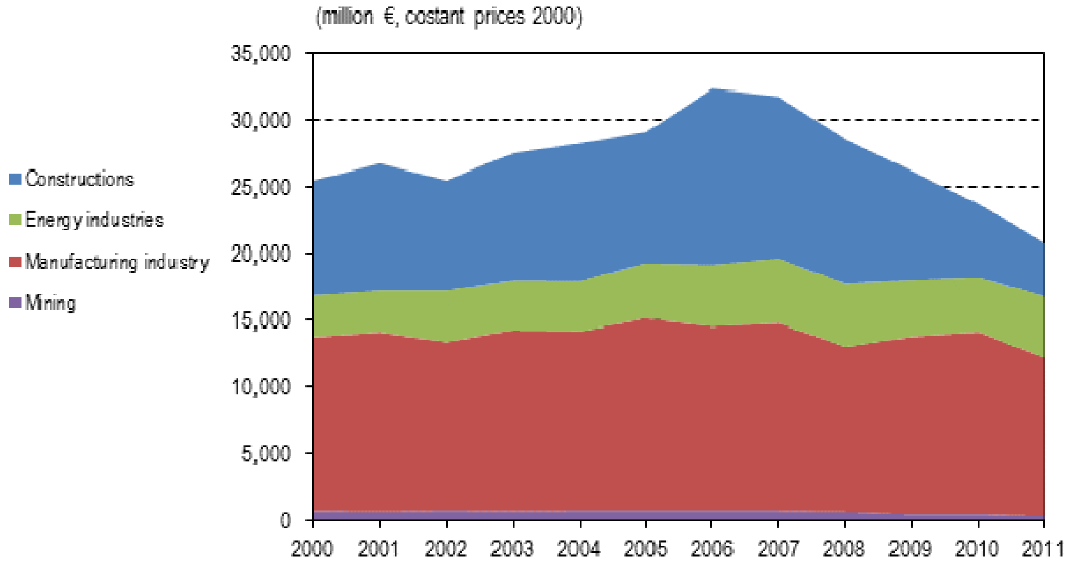


Figure 2.10 The structure of gross value added in the secondary sector for the period 2000 – 2011

Employment in the sector (***Table 2.3***) presents a similar to the gross value added trend. The total number of employees has increased by 8.5% during the period 1998 – 2007, while the share of the secondary sector in total employment is about 16% 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 2011, the gross value added of the mining sector (constant prices 2000 – see Figure 2.10) decreased by 52% compared to 2000 and 53% compared to 2007 due to economic recession.
- Employment in the mining sector decreased by 21% compared to 2000 and by 23% compared to 2007.

Table 2.3 Employment in the secondary sector for the period 1998 – 2011 (thousands employees)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Mines	21	20	14	15	13	14	14	13	13	14
Manufacture	583	575	528	546	548	532	532	540	542	544
Construction	296	285	300	307	319	346	350	365	365	389
Energy Industry	37	41	34	33	30	27	27	34	34	34

	2008	2009	2010	2011
Mines	12	12	11	11
Manufacture	573	548	523	479
Construction	386	369	322	250
Energy Industry	35	32	31	28

2.6.3.2 Manufacture

The contribution of Manufacture to the gross value added of the secondary sector increases from 51% in 2000 to 57% in 2011. The structure of gross value added of Manufacture is presented in ***Figure 2.11***.

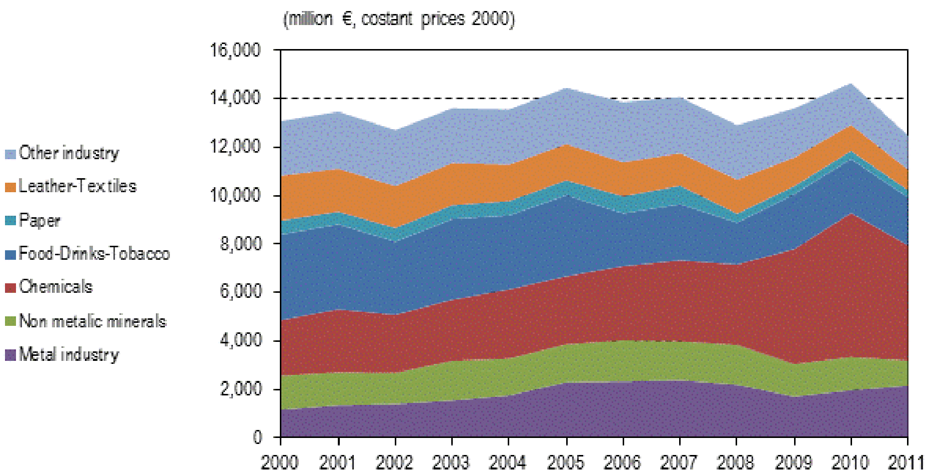


Figure 2.11 The structure of gross value added in Manufacture for the period 2000 – 2011

- In 2011, Chemicals (Mainly of Manufacture of coke and refined petroleum products) presented the highest contribution to the gross value added of Manufacture (38%), followed by the Metal industry (17%) and the Food, Beverages and Tobacco (16%).

- The industrial branches that presented a significant increase of their gross value added during the period 2000-2011, were those of Chemicals (increase by 107% from 2000 to 2011) and Metal industry (increase by 85% from 2000 to 2011).
- The total industrial production index (base year 2005) in 2007 showed an decrease of 21.1% compared to 2005 as a consequence of the economic recession (***Table 2.4***).

Table 2.4 Industrial production index for the period 2000-2011 (base year, 2005)

Branches	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Food & beverages	96.3	97.5	97.7	95.0	101.5	100.0	100.2	103.0	103.5	100.8	96.7	95.8
Tobacco	91.4	92.8	94.5	96.9	106.5	100.0	92.3	96.0	92.8	90.4	74.6	82.4
Textiles	161.2	149.2	144.4	136.6	122.0	100.0	91.6	93.5	73.2	52.8	41.9	32.7
Clothing	151.9	140.0	126.5	125.7	119.9	100.0	91.7	99.0	82.3	62.9	48.3	36.1
Leather & footwear	154.2	146.4	138.5	124.6	114.1	100.0	94.8	97.5	93.1	79.2	50.0	42.2
Wood & cork	126.0	112.9	111.4	105.2	106.1	100.0	94.8	83.9	75.9	55.2	60.4	75.5
Paper & paper products	108.7	97.6	93.6	92.2	94.5	100.0	102.7	105.2	100.4	97.4	94.1	85.7
Printing & publishing	99.6	76.2	74.7	77.4	74.1	100.0	108.3	104.5	99.4	88.1	75.7	57.2
Petroleum & coal products	98.8	97.5	99.6	99.9	97.5	100.0	106.6	109.7	105.0	104.8	110.8	94.7
Chemicals	114.1	90.9	90.1	91.6	96.8	100.0	98.5	102.6	97.7	83.5	84.7	81.0
Plastics & rubber	45.7	67.2	81.3	87.7	97.2	100.0	111.1	123.1	126.7	149.9	153.5	152.9
Non-metallic minerals	112.3	112.9	111.0	110.6	104.8	100.0	105.0	109.4	106.4	91.8	85.4	78.8
Basic metals	93.2	95.7	98.5	100.8	99.8	100.0	104.2	97.8	91.3	69.3	59.4	38.2
Final metallic products	84.3	86.9	92.6	91.9	97.7	100.0	105.5	107.7	100.8	82.7	92.6	98.5
Machinery	98.9	84.8	90.9	92.1	98.1	100.0	110.8	107.2	96.8	79.6	79.7	76.2
Office & computing equipment	84.4	75.3	79.4	83.5	82.1	100.0	113.5	113.0	112.5	82.1	64.9	59.7
Electrical machines	292.9	226.8	164.3	151.4	152.4	100.0	90.4	74.1	72.1	41.7	30.6	23.4
Transport equipment	103.6	96.8	84.1	93.2	97.5	100.0	103.6	104.8	103.2	82.4	79.1	70.4
Other transport equipment	328.8	237.2	159.9	203.0	192.7	100.0	83.8	99.2	83.9	72.8	71.6	49.8
Furniture & other industries	118.9	118.7	117.7	114.5	102.4	100.0	92.6	106.3	103.7	84.4	54.8	37.0
Total	103.4	100.2	100.5	101.0	101.7	100.0	100.9	103.2	99.0	89.7	84.4	77.9

2.6.3.3 Construction

The contribution of Construction to the gross value added of the secondary sector decreased from 33.8% in 2000 to 19.0% in 2011 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 4.9% for the period 2000 – 2011. As a result, employment decreased by approximately 31% during the period 2000-2011 and by 47 during the period 2007-2011.

2.6.3.4 Energy industries

The contribution of Energy industries to the Gross Value Added of the secondary sector increased from 13% in 2000 to 19% in 2011. The gross value added of the sector increased with an average annual rate of 4.3% for the period 2000 – 2011. 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 2011, and in 2007 the gross value added of the sector constitutes 79% 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 18, 20, 14, 23 and 27 % respectively.

Employment in the tertiary sector (***Table 2.5***) increased by 6% from 2000 until 2012. The share of the tertiary sector in the total employment increased from 63% of the economic active population in 2000 to 67% in 2011.

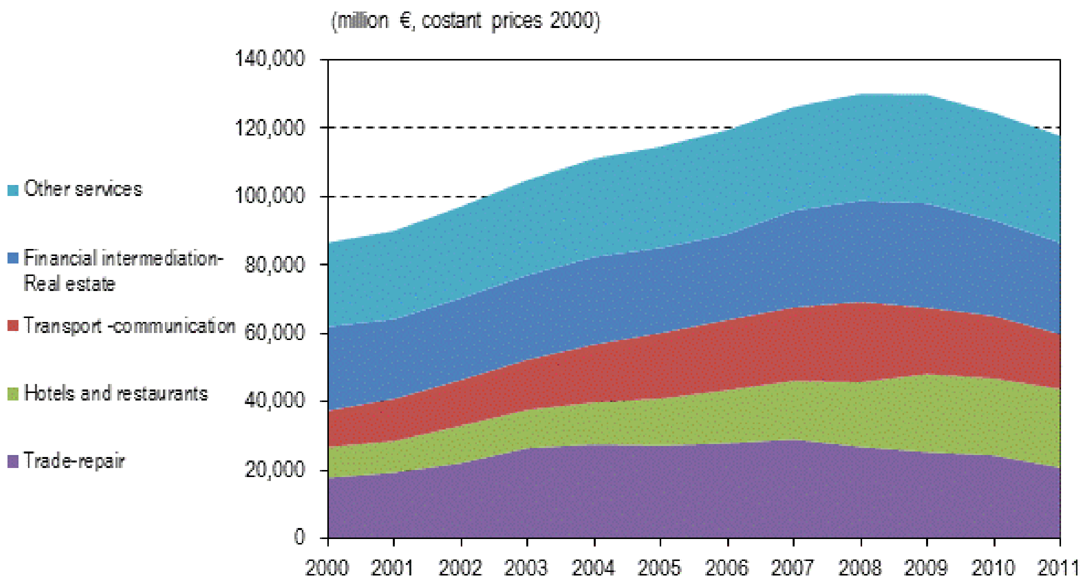


Figure 2.12 Structure of gross value added in the tertiary sector for the period 2000 – 2011

Table 2.5 Employment in the tertiary sector for the period 2000 – 2012 (thousands employees)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Manufacturing; electricity, gas, steam and air conditioning supply; water supply; sewerage, waste management and remediation activities	528	546	548	532	532	540	542	544	573	548	523	479	418
Wholesale and retail trade; repair of motor vehicles and motorcycles; transportation and storage; accommodation and food service activities	1291	1303	1323	1348	1381	1445	1492	1507	1534	1526	1490	1425	1284
Information and communication	82	87	99	97	100	86	89	89	88	89	87	79	77
Financial and insurance activities	108	104	99	106	109	110	112	111	114	112	111	110	109
Real estate activities	2	2	4	3	4	4	5	5	5	5	4	4	4
Professional, scientific and technical activities; administrative and support service activities	209	226	244	250	276	320	318	325	338	336	324	320	312
Public administration and defence; compulsory social security; education; human health and social work activities	798	803	830	841	931	926	966	990	974	978	976	946	894
Arts, entertainment and recreation, repair of household goods and other services	200	198	218	228	246	291	294	301	312	320	317	306	263

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% to the G.N.P., creates approximately 700,000 jobs and is a main tool of regional development. Tourist arrivals range around 17,000,000 and the nights spent in tourist accommodations rise to about 64,000,000 per year.

The tourist over-structure consists of 9,648 hotel units with circa 764,000 bed units, 23,735 rental accommodations (B.&B.), 81,549 places in 299 Campings. The special tourism infrastructure comprises 8 independent conference centers and convention facilities in 200 Hotels, 20 Spas and 6 Thalassotherapy centers, 20 Leisure ports (marinas) with 7,500 places and six (18- holes) Golf courses.

The greek tourism sector is closely connected to climate quality, as to the nature-based resources. The seaside and the nature-based tourism relies 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 2011, 34% of passenger cars have an engine capacity greater than 1400cm^3).

The annual mileage driven by all vehicles categories during the whole time period 1990 – 2011 is presented in the ***Figure 2.13***.

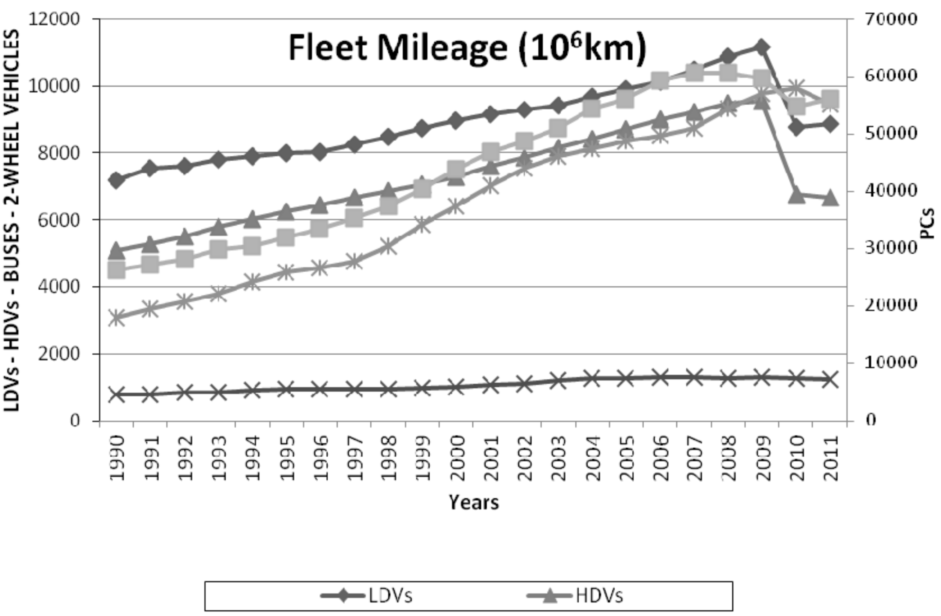


Figure 2.13 Annual mileage driven by all vehicles categories during the whole time period 1990 – 2011

Since 1995 the number of advanced technology catalytic passenger cars is constantly increasing (***Figure 2.14***), while the number of medium and large size passenger cars almost cars fleet has almost tripled compared to 1990 levels.

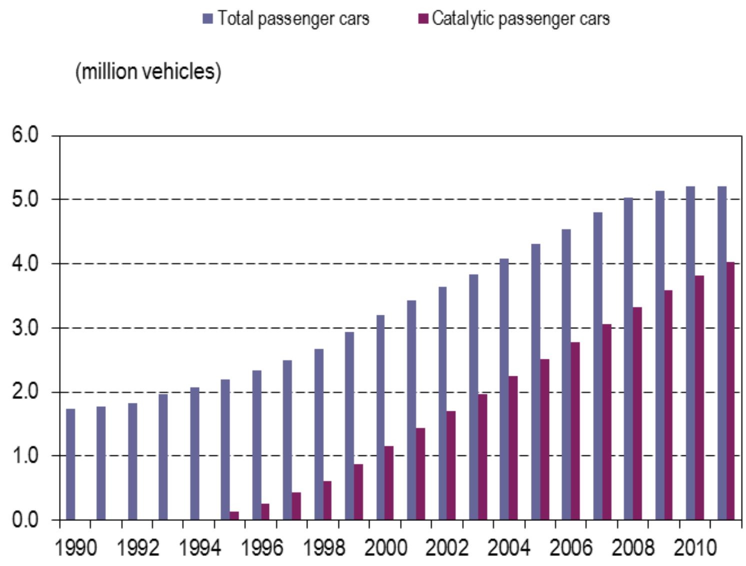


Figure 2.14 Number of catalytic and total passenger cars for the period 1990 - 2011

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 2011, it comprised of 2022 vessels (1436 fly the Greek flag) of a total dead-weight tonnage of approximately 98.2 GRT, that represent the 18% of world shipping capacity and the 50% of EU. Merchant (dry cargo) ships represent approximately 27% of this total, 27% are tankers, 46 % are passenger ships and other type of vessels. 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 2,554 km. Greece was the last European country to develop a railway system, which dates only from the 1880s. Over the last 20 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 (Parta - 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 Chalcida 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 2012, the Railways Organisation had approximately 2,600 employees, presenting a continuous decrease since 1989.

2.7.4 Air transport

According to the Civil Aviation Organisation data, aircraft traffic in 2011 (***Figure 2.15***) increased by 68% compared to 1990 data, reaching a number of Landing and Take-off (LTO) cycles of approximately 205000 (compared to 122000 in 1990). Passengers that embark and disembark in the airports of the country, mounted approximately at 38.8 millions in 2011. Since 2000 air traffic presents an average annual decrease by 4.0% and the number of passengers increased by approximately 7.0% annually. Air transport of goods in 2011 decreased by 35% compared to 2000 levels.

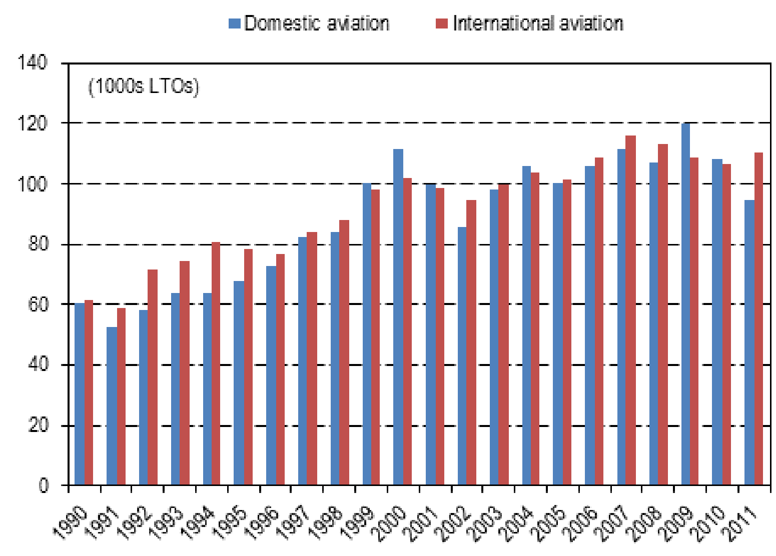


Figure 2.15 Domestic and international air traffic for the period 1990 – 2011

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 total gross inland consumption in Greece increased continuously during the time period 1990 – 2011. In 2011, gross inland consumption reached a total of approximately 27.5 Mtoe, representing an increase of approximately 23% compared to 1990 levels. However, the average annual growth rate of increase during the period 1990 - 2011 (1.09%) is lower compared to the rate of increase recorded in the 1980s (3.3%).

The energy sector relies on fossil fuel combustion for meeting the bulk of energy requirements in Greece. As shown in ***Figure 2.16***, gross inland consumption in 2011 amounted to approximately 1127 PJ. The consumption of solid fuels and oil products accounts for 79.5% of total consumption, while the contribution of biomass and of the rest renewable energy sources (mostly hydropower, solar, wind energy and geothermal) are 2.6% and 3.4% respectively. Finally, the share of natural gas in gross inland consumption is 13.5% while the rest 1 % of gross inland consumption is covered by electricity (net imports – exports). In 2011, gross inland consumption increased by approximately 28% compared to 1990, presenting a 1.2% average annual rate of increase. It should be mentioned that up to 1996 supply of natural gas was exclusively minor quantities from domestic primary production. In essence, the introduction of natural gas in the Greek energy system started in 1997 and since then its consumption has been continuously increasing. Furthermore, since 2007 to 2010 a decrease in gross inland consumptin is observed, presenting a about 5% average annual rate of decrease, while in 2011 a marginal increase compared to 2010 is observed.

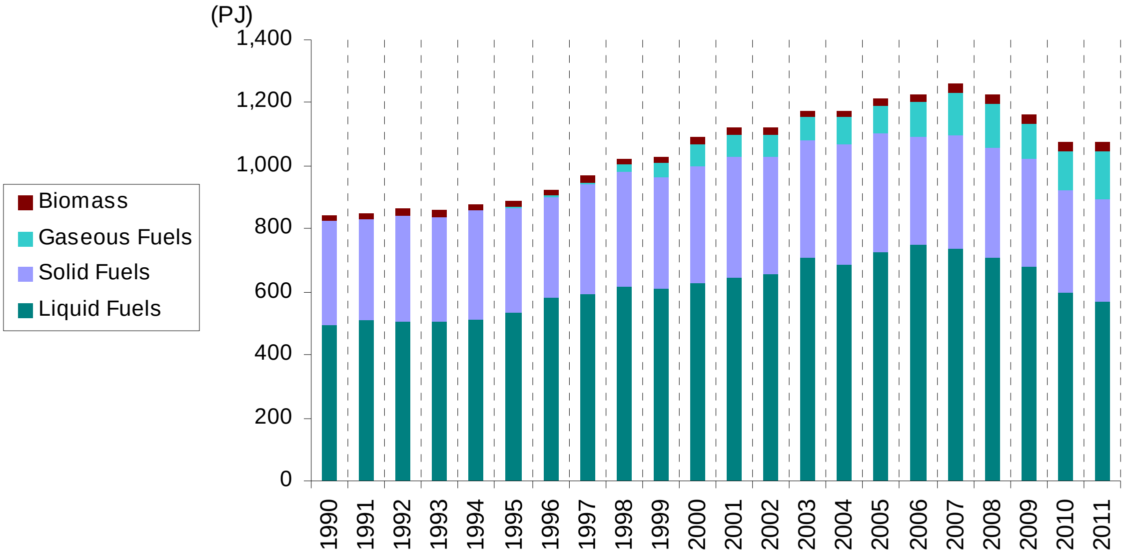


Figure 2.16 Gross inland consumption (in PJ) in Greece for the period 1990 - 2011

Import dependency (defined as the ratio of domestic energy supply to gross inland consumption) showed an upward trend during the period 1990 – 2011, increasing from 60% in 1990 to 65% in 2011, 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 55% of electricity production and 28 % of total Energy Supply. The lignite annual consumption is 62.8 million tonnes / year for 2011.

Production comes from opencast mines under operation:

- in Megalopolis (Peloponnese) with 2 power plants of 850 MW installed capacity and
- in Ptolemaes and Florina (Northern Greece) with 5 power plants of 4.439 MW installed capacity.

New lignite-fired power plants are under consideration substituting older one (Please refer to Chapter 5).

At the present rate of extraction, 65 million tonnes of lignite are produced annually, by moving a total of 320 Million m^3 of earth material. The confirmed lignite deposits amount to 4,3 billion tonnes, out of which 3.2 billion tonnes (~75%) are economically recoverable deposits. These reserves exhibit a remarkable geographical distribution throughout Greece. According to the extended drill holes exploration project, no significant rise of lignite reserves is expected in the future. Considering the current technical and economic situation, the lignite reserves suitable for electric power generation amount to 2,7 billion tonnes approximately. The Lower Calorific Value of lignite reserves ranges between 900 and 2,300 kcal/kg.

Lignite mining ensures security of energy supply, low and stable extraction cost, as well as availability of indigenous energy reserves with time horizon exceeding 40 years, under the current scheduled mine production in relation to power plants requirements.

Till now coal is used in Greece for cement production and non ferrous metal industry. Coal total imports were 380 thousands of metric tonnes for 2011.

(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.

The annual refining capacity of the four refineries amounts to 20.9 Mt of crude oil, while fluid catalytic cracking units operate in two of the refineries.

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. Greece is supplied with natural gas from Russia and Algeria (to a lesser extent in the case of the latter). The natural gas from Russia reaches

Greece through a pipeline system, while that from Algeria is transported by special tankers in liquefied form.

The construction of the required infrastructure (apart from the distribution networks) began in 1992 and is continuously improved. 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, 772 km in length, extend from the main pipeline, aiming at supplying the regions of Eastern Macedonia and Thrace, Thessaloniki, Platy, Trikala, Volos, Inofyta, Antikyra, Korinthos 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% and increases by 3.6% in 2011 compared to 2010 (***Figure 2.17***). Gross electricity production in 2011 (59.4 TWh) was approximately 70% higher compared to 1990 levels.

Electricity generation from the use of fossil fuels is approximately 84% of electricity production in 2011. Specifically, 52% of electricity is produced by solid fuels (mainly lignite), while the share of liquid fuels (diesel, heavy fuel oil and refinery gas) and natural gas is 8.5% and 23.5% respectively. The rest of electricity production, i.e. around 16%, derives from renewable energy sources as hydropower, wind energy and biogas.

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 34 major thermal and hydroelectric power plants and the 3 aeolic parks of the interconnected power grid of the mainland, as well as the 61 autonomous power plants located on Crete, Rhodes and other Greek islands (39thermal, 2 hydroelectric, 15 aeolic and 5 photovoltaic parks) form PPC's industrial colossus and constitute the energy basis of all financial activities of the country.

During the past few years the company, apart from the construction of new thermal (lignite, fuel oil and natural gas) and hydroelectric power plants, has also been investing on alternative energy resources (wind, sun and geothermal).

The total installed capacity of the 98 PPC power plants is currently 12,760 MW.

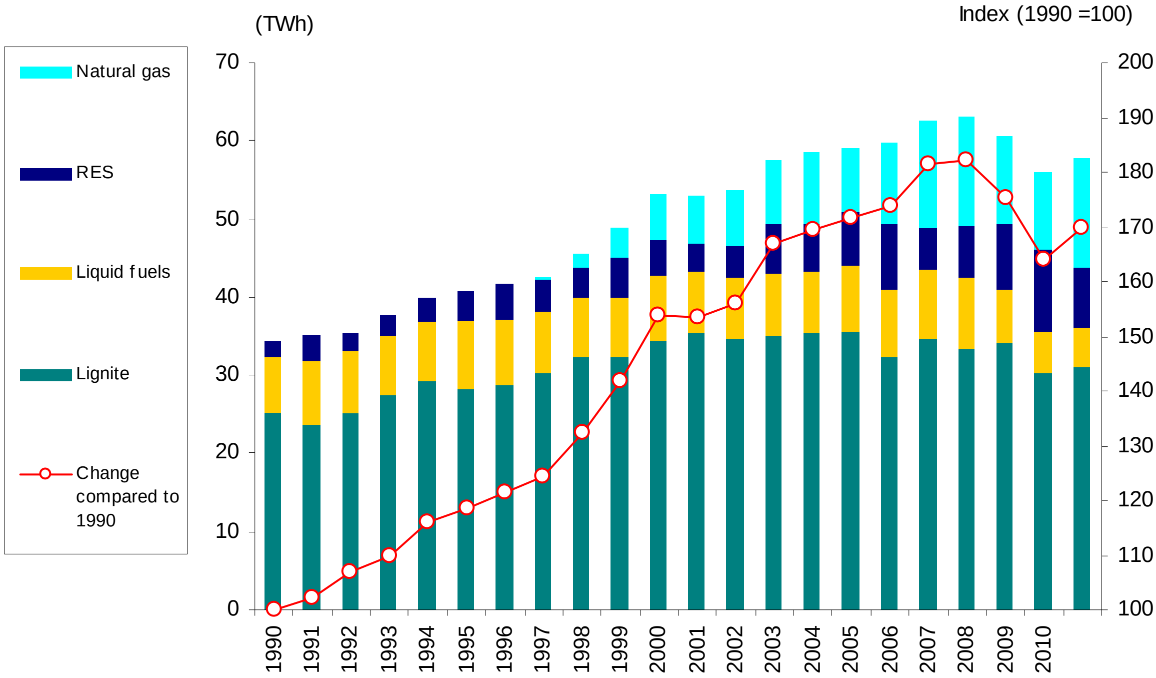


Figure 2.17 Gross electricity generation (in TWh) in Greece for the period 1990 – 2011

2.8.2 Final energy consumption

In 2011, final energy consumption in Greece totalled 18.6 Mtoe. Energy consumption in industry accounted for 17.8% of final energy consumption (including consumption of the energy sector). The share of transport in final energy consumption is estimated at 40.0% in 2011, while the share of residential and tertiary sector was 42.1%. The average annual rate of increase for the period 1990-2011 is estimated at 1.32%. The per capita final energy consumption has increased by 15% from 1990 to 2007 (1.4 and 1.6 toe/cap respectively).

Residential and tertiary sector and transportation increased their energy use from 1990 to 2011 (***Figure 2.18***), 64% and 28% respectively, while industry sector decreased by 17%. This resulted in a total increase of 28% between 1990 and 2011.

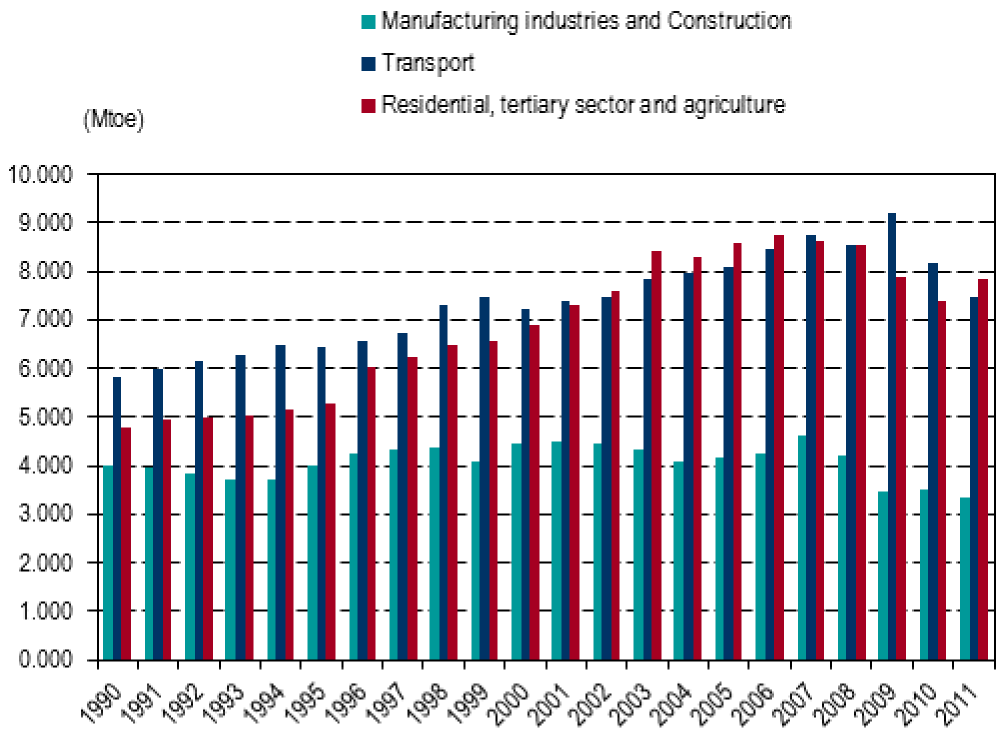


Figure 2.18 Final energy consumption (in Mtoe) by economic sector for the period 1990 – 2011

2.8.2.1 Industry

In 2011, the total energy consumption in industry (including energy industries and construction) totalled 5.5 Mtoe (***Figure 2.19***), accounted for 26.4% of the total energy demand in Greece. The consumption of the energy sector represents 17.8% of energy consumption in industry.

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 2011, oil products accounted for approximately 39% 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 2011 it reached a total of approximately 1.9 Mtoe or 35% of the total energy use of the sector. The use of RES, mainly in food and wood processing industries, represents approximately 3-5% of total energy consumption in industry for the period 1990 – 2011.

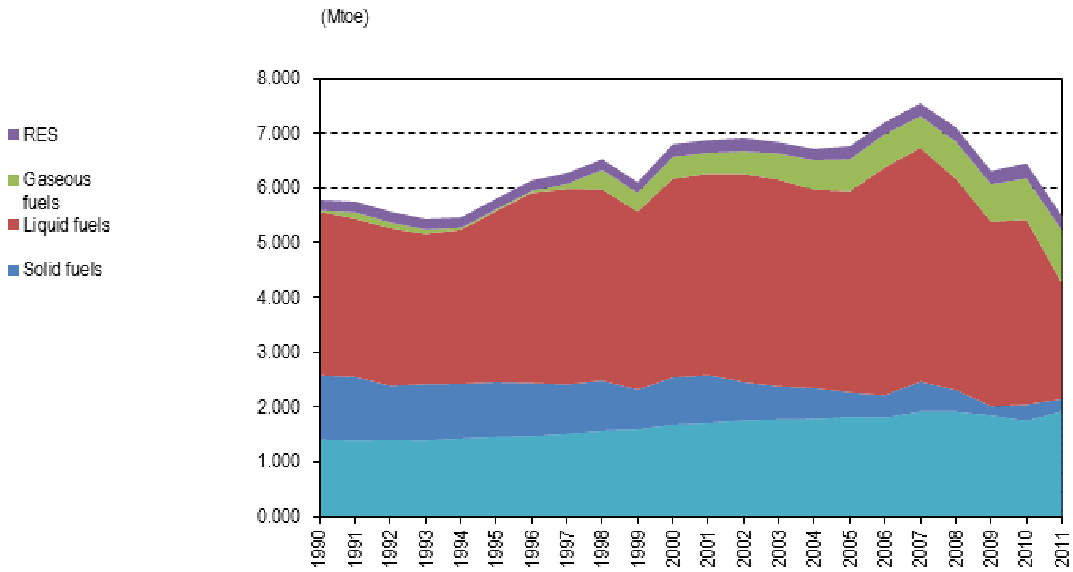


Figure 2.19 Energy consumption (in Mtoe) in industry for the period 1990 – 2011

2.8.2.2 Residential, tertiary sector and agriculture

In 2011, the energy use in the sector totalled 7.8 Mtoe or 40% of the total energy demand in Greece, compared to 4.97 Mtoe in 1990 (***Figure 2.20***). 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 2.20, is mostly the result of an increased demand for electricity and to a smaller extent for petroleum products. In 2011, consumption of oil products accounted for 39% (3.1 Mtoe)of energy consumption in the sector from 54% in 1990 (2.7 Mtoe), while the contribution of electricity to total energy consumption in the sector increased from 29% in 1990 (1.4 Mtoe) to 40% in 2011/ (3.2 Mtoe). The contribution of RES to total energy consumption in the sector decreased from 15% in 1990 (0.7 Mtoe) to 10% in 2011 (0.8 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.

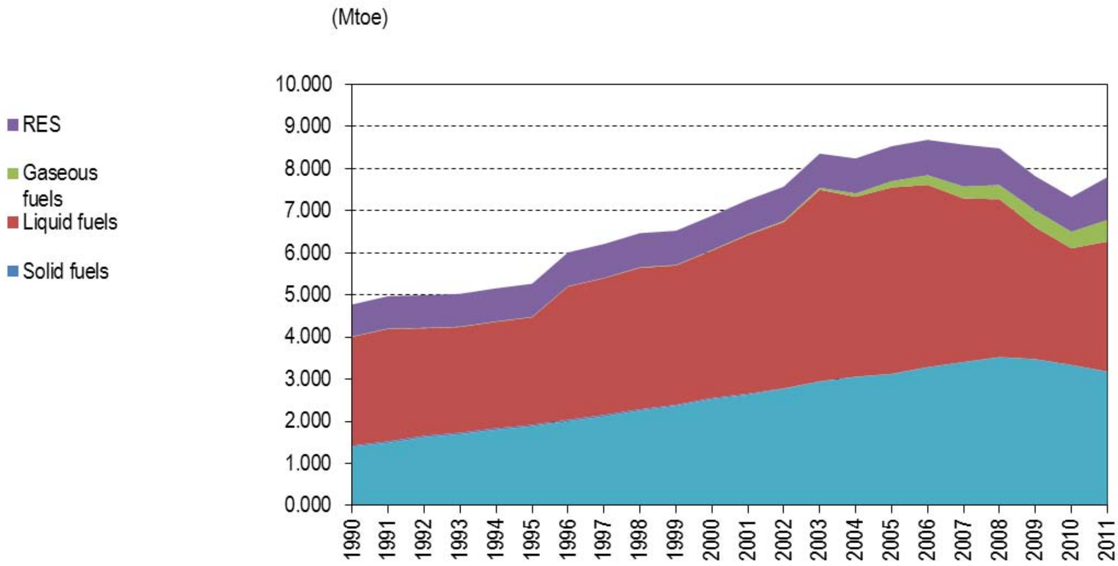


Figure 2.20 Final energy consumption (in Mtoe) in the residential, tertiary sector and in agriculture for the period 1990 - 2011

2.8.2.3 Transport

The energy use in transport has almost doubled during the 1980–1995 period. In 2011, energy consumption for transportation accounted for 7.5 Mtoe (6.0 Mtoe in 1990) or 35.9% of the total final energy demand in Greece. Oil products accounted for more than 99.5% 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 – 2011, waste generation presented a continuous increase. Municipal solid waste generated quantities increased from 3.1 Mt in 1990 to 5.3 Mt in 2011, while the per capita solid waste generation increased from 0.82 kg/person/day in 1990 to 1.27 kg/person/day in 2011, 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. The solid waste disposal / management practices applied in Greece are presented in ***Figure 2.21.***

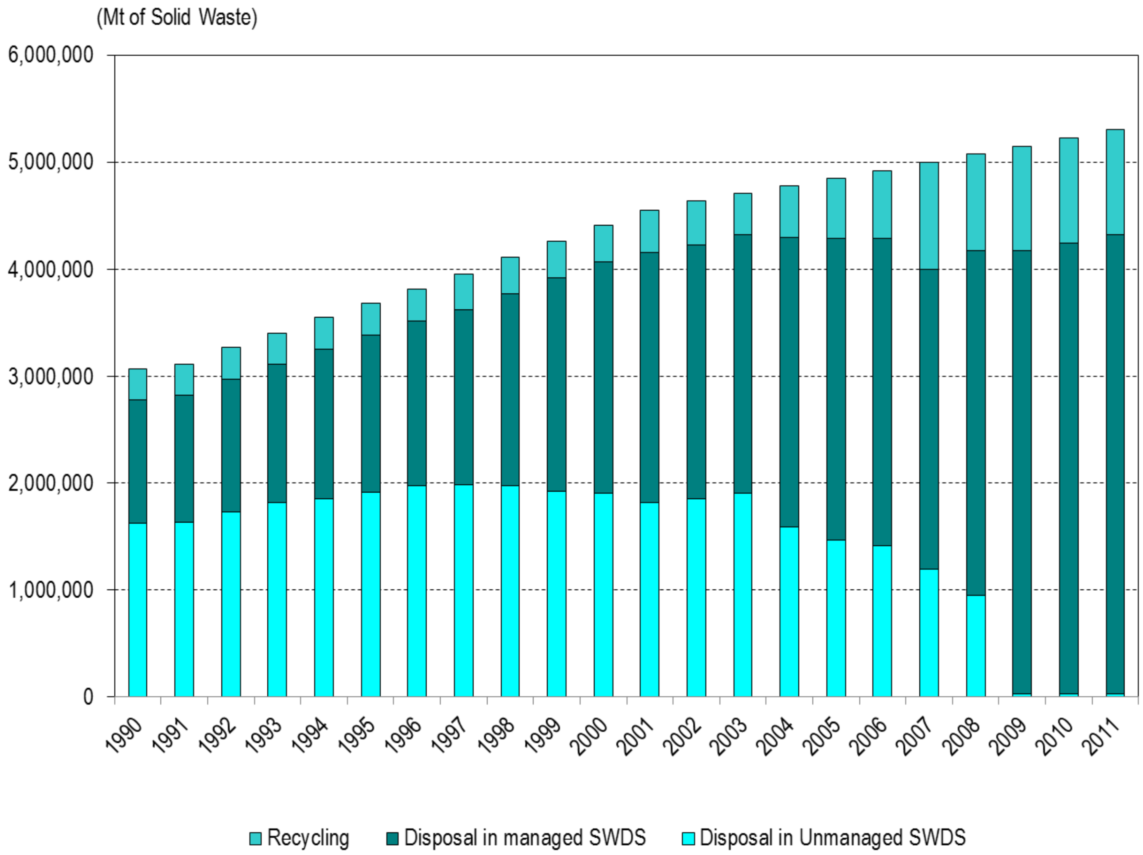


Figure 2.21 Solid waste disposal / management practices applied in Greece

Concerning the composition of waste in 2011, food waste make up the largest share with 51.9%, followed by plastic 13.9%, paper 7.7%, Textiles 4%, metal 3.8, glass 3.7%, garden (yard) waste 1.84%, Wood 1% and Rest waste (Soils 3.7% and Other Inorganic 8.62%).

The amount of recycled wastes present a remarkable increase during the last years from 8% in 2000 to 18% in 2011 due to the recycle projects that are promoted in Athens. During the previous decade no significant change has been observed ranging about 8-9%. Biogas recovery and flaring installations operate in 4 large SWDS in Greece (Athens, Thessalonika, Larissa, Patra), 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 the 2011 about 290 kt waste are 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 155 kt annually, until 2011. The construction of a sludge dehydration unit is planned to facilitate the on-site combustion of sludge.

The hospitals in the Attica region have the possibility to dispose clinical wastes in the central incineration unit in Ano Liosia, which can process a total of 30 tons of waste per day. In 2011 this unit accepted approximately 3.55 kt of clinical waste, i.e. it is still operating well below its nominal capacity due to high operational costs. Up to 2001 a small incinerator with a capacity of approximately 600 kg per day was in operation in Ano Liosia.

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 2011, 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 the 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 1990–2011 as reported in the National Inventory Report submitted to the UNFCCC in 2013 (MEECC, NTUA, 2013).

Emissions estimates were calculated according to the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (henceforth IPCC Guidelines), the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (henceforth IPCC Good Practice Guidance) and the IPCC Good Practice Guidance for Land Use, Land Use Change and Forestry (henceforth LULUCF Good Practice Guidance). 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).

An overview of GHG emissions for the time period 1990–2011 is presented in ***Table 3.1a*** and ***Table 3.1b***. The detailed CRF trend tables are presented in Annex I. Finally, emissions of the indirect greenhouse gases (NO_x, CO and NMVOC) along with SO_2 are presented in ***Table 3.2a*** and ***Table 3.2b***.

Total uncertainty for the 2011 emissions is estimated at 8.94% (including Land Use, Land Use Change and Forestry - LULUCF), while the uncertainty carried over into the GHG emissions trend is approximately 10.08% (MEECC, NTUA 2011). The uncertainty estimates for GHG emissions per gas (including LULUCF), in 2011, were estimated at:

- 2.7% for CO_2 emissions,
- 43.8% for CH_4 emissions,
- 89.9% for N_2O emissions
- 170.2% for F-gases

Base year GHG emissions for Greece (1990 for CO_2, CH_4, and N_2O - 1995 for F-gases) were estimated at 106.83 Mt CO_2 eq. Given that LULUCF was a net sink of GHG emissions in 1990 (as for the rest of the reporting period) the relevant emissions / removals are not considered in estimating base year emissions for Greece.

In 2011, GHG emissions (without *LULUCF*) amounted to 115.05 Mt CO_2 eq showing an increase of 7.69% compared to base year emissions and of 10% compared to 1990 levels. If emissions / removals from *LULUCF* were to be included then the increase would be 10.20 % (from 102.09 Mt CO_2 eq in 1990 to 112.50 Mt CO_2 eq in 2011).

Carbon dioxide emissions accounted for 82.41% of total GHG emissions in 2011 (without *LULUCF*) and increased by approximately 14.36% from 1990. Methane emissions accounted for 8.37% of total GHG emissions in 2011 and decreased by 6.83% from 1990, while nitrous oxide emissions accounted for 6.09% of the total GHG emissions in 2011 and decreased by 31.54% from 1990. Finally, f-gases emissions (from production and consumption) that accounted for 3.09% of total GHG emissions in 2011, and 39.93% of the IP sector, has an average increase of 34.47% from 1995 (base year for F-gases).

Table 3.1a Total GHG emissions in Greece (in kt CO_2 eq) for the period 1990-2000

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
A. GHG emissions per gas (excluding LULUCF)											
CO_2	82,909.34	82,677.72	84,352.81	83,663.49	85,914.30	86,349.53	88,435.01	93,217.76	98,114.86	97,408.24	102,500.56
CH_4	10,336.24	10,290.78	10,401.93	10,384.35	10,568.30	10,594.76	10,824.32	10,733.05	10,966.78	10,881.82	10,833.97
N_2O	10,239.50	9,937.70	9,784.50	8,913.16	8,729.00	8,996.80	9,224.39	9,008.04	8,953.24	8,864.01	8,537.05
HFC	935.06	1,106.82	908.39	1,606.74	2,144.05	3,290.41	3,817.88	4,097.77	4,579.59	5,365.87	4,243.79
PFC	163.37	164.17	161.21	96.98	60.37	53.97	46.14	107.67	133.04	90.32	105.09
SF_6	3.07	3.16	3.26	3.35	3.45	3.59	3.68	3.73	3.78	3.87	3.99
Total	**104,586.58**	**104,180.35**	**105,612.11**	**104,668.07**	**107,419.48**	**109,289.05**	**112,351.42**	**117,168.02**	**122,751.30**	**122,614.13**	**126,224.44**
B. GHG emissions/removals from LULUCF											
CO_2	-2,526.52	-2,613.61	-2,914.11	-3,246.96	-2,885.90	-3,175.98	-2,794.41	-2,667.62	-2,977.03	-3,144.58	-2,821.21
CH_4	27.04	16.81	50.29	40.15	39.34	19.71	15.53	28.43	67.99	6.07	95.64
N_2O	2.74	1.71	5.10	4.07	3.99	2.00	1.58	2.89	6.90	0.62	9.71
Total	**-2,496.73**	**-2,595.09**	**-2,858.72**	**-3,202.73**	**-2,842.57**	**-3,154.27**	**-2,777.30**	**-2,636.31**	**-2,902.14**	**-3,137.89**	**-2,715.87**
C. GHG Emissions from International Transport											
CO_2	10,466.75	9,471.24	10,658.07	12,204.19	13,241.83	13,853.47	12,390.62	12,334.79	13,586.23	12,675.45	13,848.53
CH_4	14.38	13.09	14.89	17.45	18.40	19.50	17.36	17.44	19.64	17.47	20.30
N_2O	281.15	274.03	337.70	373.46	413.95	480.84	397.15	394.67	400.14	373.66	399.12
Total	**10,762.28**	**9,758.36**	**11,010.66**	**12,595.09**	**13,674.19**	**14,353.81**	**12,805.13**	**12,746.90**	**14,006.01**	**13,066.58**	**14,267.94**

Table 3.1b Total GHG emissions in Greece (in kt CO2 eq) for the period 2001-2011

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
A. GHG emissions per gas (excluding LULUCF)											
CO_2	104,897.48	104,634.73	108,712.71	109,039.06	112,802.29	111,223.37	113,691.41	109,909.56	103,577.27	96,558.51	94,813.63
CH_4	10,041.74	10,060.22	10,086.62	10,126.53	10,163.13	10,209.92	10,052.82	10,008.74	9,739.24	9,784.13	9,630.76
N_2O	8,358.07	8,279.31	8,202.59	8,210.71	7,910.10	7,701.32	7,884.83	7,474.59	7,015.59	7,315.61	7,010.34
HFC	3,849.29	4,000.29	3,803.16	3,892.90	3,968.87	2,133.68	2,471.03	2,844.35	3,226.65	3,512.16	3,507.46
PFC	71.16	69.14	72.47	68.99	69.89	66.35	76.21	89.10	69.85	101.57	77.69
SF_6	4.06	4.25	4.25	4.47	6.45	8.37	9.92	7.53	5.26	6.14	5.15
Total	**127,221.80**	**127,047.95**	**130,881.80**	**131,342.67**	**134,920.73**	**131,343.00**	**134,186.20**	**130,333.87**	**123,633.85**	**117,278.12**	**115,045.02**
B. GHG emissions/removals from LULUCF											
CO_2	-2,680.59	-2,969.07	-2,643.28	-2,848.55	-2,777.29	-2,842.55	-1,940.26	-2,890.90	-2,636.74	-2,606.92	-2,553.09
CH_4	15.42	2.49	3.41	8.54	4.91	9.68	167.81	20.35	21.04	6.10	7.00
N_2O	1.56	0.25	0.35	0.87	0.50	0.98	17.03	2.07	2.14	0.62	0.64
Total	**-2,663.61**	**-2,966.32**	**-2,639.53**	**-2,839.14**	**-2,771.88**	**-2,831.89**	**-1,755.42**	**-2,868.48**	**-2,613.56**	**-2,600.19**	**-2,545.45**
C. GHG Emissions from International Transport											
CO_2	13,343.41	12,206.71	13,139.99	13,316.50	11,455.45	12,651.07	12,925.46	12,798.12	10,900.01	10,728.24	10,562.23
CH_4	20.00	17.97	18.56	18.82	16.80	18.17	18.69	18.27	15.48	16.08	15.44
N_2O	342.67	309.66	298.85	290.96	241.57	257.34	247.18	235.49	211.55	218.95	208.23
Total	**13,706.08**	**12,534.35**	**13,457.39**	**13,626.27**	**11,713.82**	**12,926.58**	**13,191.33**	**13,051.88**	**11,127.03**	**10,963.27**	**10,785.90**

Table 3.2a Indirect greenhouse gases and SO_2 emissions for the period 1990 – 2000 (kt)

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
NOx	326.33	335.99	342.82	340.35	348.93	329.21	333.15	346.81	369.97	367.79	360.57
CO	1,142.95	1,124.24	1,094.12	1,085.41	1,062.86	961.48	954.10	957.21	975.04	955.91	961.22
NMVOC	269.20	271.34	268.72	267.91	266.21	259.65	260.18	261.75	267.18	270.03	265.77
SO_2	476.07	517.02	533.97	530.68	521.93	539.97	530.08	528.90	536.43	555.17	495.96

Table 3.2b Indirect greenhouse gases and SO_2 emissions for the period 2001 – 2011 (kt)

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
NOx	**382.46**	**383.40**	**393.56**	**399.19**	**416.80**	**412.79**	**416.01**	**392.08**	**379.32**	**318.93**	**295.67**
CO	**918.13**	**856.40**	**811.99**	**810.77**	**721.71**	**740.04**	**750.54**	**629.27**	**598.17**	**527.28**	**496.60**
NMVOC	**262.96**	**258.12**	**245.68**	**245.94**	**221.35**	**231.13**	**220.06**	**228.07**	**212.36**	**184.68**	**158.53**
SO_2	**503.95**	**515.18**	**553.50**	**547.82**	**540.70**	**533.22**	**537.94**	**445.11**	**425.47**	**265.36**	**262.13**

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 0.53%) is lower from both the annual growth rate of gross inland energy consumption (approximately 1.92% for the same period) and the GDP annual growth rate (approximately 4.20%). Moreover, the impact of population increase to GHG emissions was minor. The decreasing trend of emissions in all sectors of energy of the years 2008-2011 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.

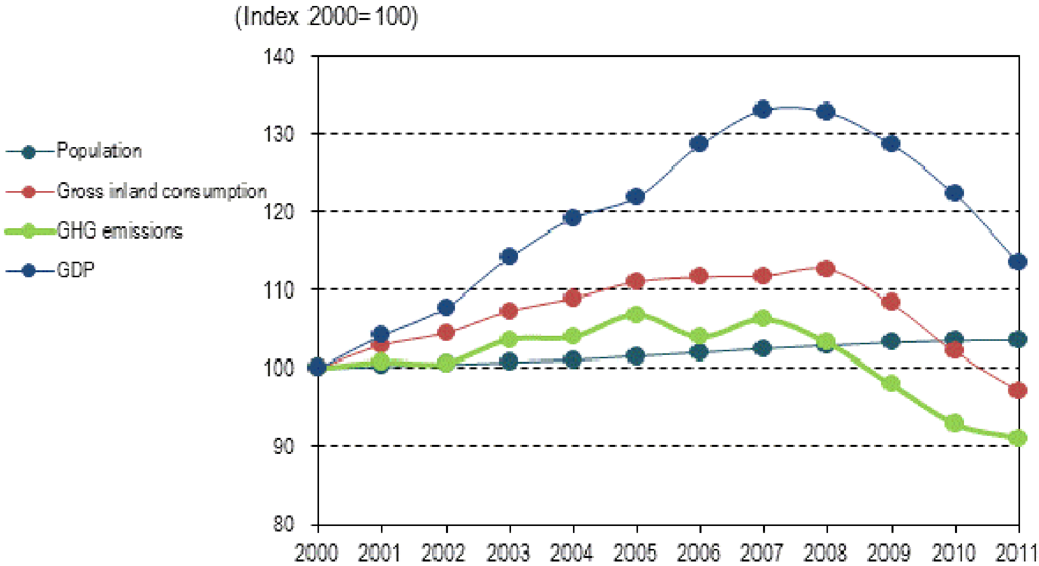


Figure 3.1 Factors underlying GHG emissions trends

3.2 GHG emissions trends

3.2.1 GHG emissions trends per sector

GHG emissions by sector for the period 1990 - 2011 are presented in ***Table 3.3a*** and ***Table 3.3b***, while the sectoral contribution to GHG emissions for 2011 (excluding LULUCF) is presented in ***Figure 3.2***.

Table 3.3a Total GHG emissions in Greece (in kt CO_2 eq) for the period 1990-2000

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Energy	77,170.88	77,051.19	78,761.21	78,374.79	80,682.90	80,619.14	82,806.62	87,441.76	92,257.98	91,653.08	96,482.97
Industrial processes	10,072.94	9,974.64	9,850.59	10,130.49	10,615.36	12,263.12	12,909.68	13,306.33	13,892.01	14,583.38	13,712.49
Solvents	308.34	315.54	314.37	312.95	307.39	299.82	298.22	300.20	300.40	308.73	306.61
Agriculture	11,460.07	11,300.12	11,063.83	10,199.89	10,015.51	10,318.69	10,461.66	10,316.69	10,330.53	10,177.64	9,939.90
Waste	5,574.35	5,538.87	5,622.11	5,649.95	5,798.32	5,788.29	5,875.25	5,803.05	5,970.39	5,891.30	5,782.47
Total [1)]	**104,586.58**	**104,180.35**	**105,612.11**	**104,668.07**	**107,419.48**	**109,289.05**	**112,351.42**	**117,168.02**	**122,751.30**	**122,614.13**	**126,224.44**
LULUCF	**-2,496.73**	**-2,595.09**	**-2,858.72**	**-3,202.73**	**-2,842.57**	**-3,154.27**	**-2,777.30**	**-2,636.31**	**-2,902.14**	**-3,137.89**	**-2,715.87**
Index per sector											
Energy	100.00	99.84	102.06	101.56	104.55	104.47	107.30	113.31	119.55	118.77	125.03
Industrial processes	100.00	99.02	97.79	100.57	105.38	121.74	128.16	132.10	137.91	144.78	136.13
Solvents	100.00	102.33	101.95	101.49	99.69	97.24	96.72	97.36	97.42	100.13	99.44
Agriculture	100.00	98.60	96.54	89.00	87.39	90.04	91.29	90.02	90.14	88.81	86.74
Waste	100.00	99.36	100.86	101.36	104.02	103.84	105.40	104.10	107.10	105.69	103.73
Total [2)]	**100.00**	**99.61**	**100.98**	**100.08**	**102.71**	**104.50**	**107.42**	**112.03**	**117.37**	**117.24**	**120.69**

[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 3.3b Total GHG emissions in Greece (in kt CO_2 eq) for the period 2001-2011

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Energy	98,955.51	98,863.99	102,762.35	103,078.73	106,230.56	104,879.59	107,436.55	104,109.16	99,587.47	92,293.12	92,165.18
Industrial processes	13,182.03	13,216.88	13,143.66	13,223.40	13,881.47	11,659.33	11,911.31	11,775.07	10,132.20	10,496.20	8,893.78
Solvents	304.28	305.13	305.93	306.75	309.29	311.92	313.41	314.13	315.60	316.17	316.41
Agriculture	9,843.48	9,813.84	9,750.33	9,833.78	9,541.44	9,374.78	9,590.02	9,211.13	8,927.68	9,270.66	8,965.84
Waste	4,936.49	4,848.11	4,919.53	4,900.02	4,957.98	5,117.38	4,934.91	4,924.37	4,670.90	4,901.96	4,703.81
Total [1)]	**127,221.80**	**127,047.95**	**130,881.80**	**131,342.67**	**134,920.73**	**131,343.00**	**134,186.20**	**130,333.87**	**123,633.85**	**117,278.12**	**115,045.02**
LULUCF	**-2,663.61**	**-2,966.32**	**-2,639.53**	**-2,839.14**	**-2,771.88**	**-2,831.89**	**-1,755.42**	**-2,868.48**	**-2,613.56**	**-2,600.19**	**-2,539.59**
Index per sector											
Energy	128.23	128.11	133.16	133.57	137.66	135.91	139.22	134.91	129.05	119.60	119.43
Industrial processes	130.87	131.21	130.48	131.28	137.81	115.75	118.25	116.90	100.59	104.20	88.29
Solvents	98.68	98.96	99.22	99.48	100.31	101.16	101.64	101.88	102.36	102.54	102.62
Agriculture	85.89	85.64	85.08	85.81	83.26	81.80	83.68	80.38	77.90	80.90	78.24
Waste	88.56	86.97	88.25	87.90	88.94	91.80	88.53	88.34	83.79	87.94	84.38
Total [2)]	**121.64**	**121.48**	**125.14**	**125.58**	**129.00**	**125.58**	**128.30**	**124.62**	**118.21**	**112.13**	**110.00**

[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

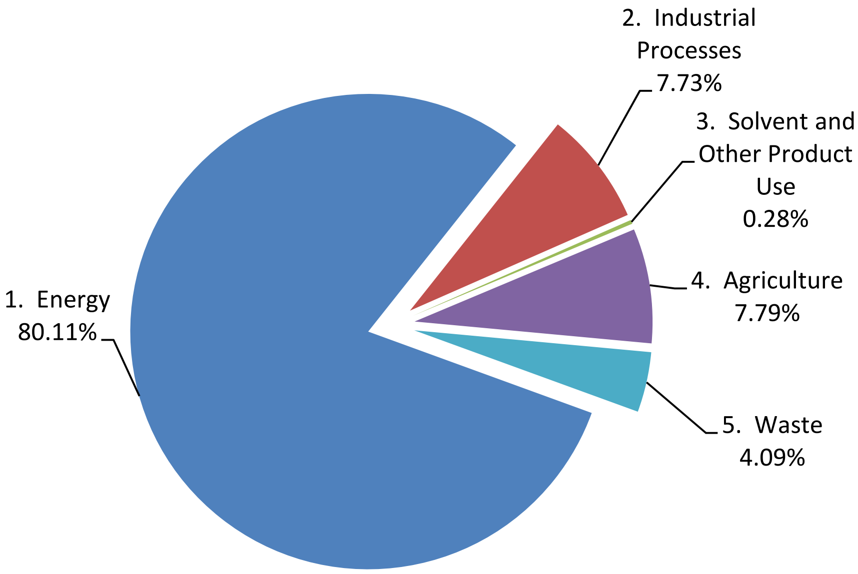


Figure 3.2 Contribution of activity sectors to total GHG emissions (without LULUCF) in 2011

- Emissions from *Energy* in 2011 ***(Figure 2.1)*** accounted for 80.11% of total GHG emissions (without LULUCF) and increased by approximately 19.43% 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 - 2011, 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 in all sectors of energy of the years 2008-2011 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.
- The majority of GHG emissions (59.94%) in 2011 derived from energy industries, while the contribution of transport, manufacturing industries and

construction and other sectors is estimated at 22.22%, 5.87% and 11.96%, respectively. The rest 0.01% 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 for the years 1990-2008 is transport, showing an average rate of increase of 2.44%. However, for years 2009-2011 a decrease was observed with an average rate of decrease equal to -1.99%. In addition, energy industries and other sectors (i.e. residential, tertiary and agriculture sectors) presented 1.16% and 1.69% average annual rate of increase, respectively. Finally, emissions from manufacturing industries and construction emissions had a mean annual rate of decrease of 2.36%.

- Emissions from *Industrial Processes* in 2011 accounted for 7.73% of the total emissions (excluding LULUCF) and decreased by 11.71 % compared to 1990 levels. In 2011 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. The decrease in emissions continues to be significant in the cement production category (key category), and is even greater than 2009-2010 (-8.14% between 2009-2010 versus -42.25% between 2010 and 2011). Emissions from chemical industry have slightly decreased (-3.01%). Emissions from metal production increased with regards to 2010 by 30.76%, due to the increased production of aluminium and nickel. As regards to f-gases emissions, they are at the same levels with 2011 (minor decrease of 0.98%). The general increasing trend during the last years of the time-series depicts the continuous substitution of CFCs in the context of the protocol of Montreal.
- The contribution of the *Solvents and other products use* sector to total GHG emissions is minor (0.28% of the total emissions) and has increased by 2.62% compared to 1990 level of emissions.
- Emissions from *Agriculture* that accounted for 7.79% of total emissions in 2011 (without *LULUCF*), decreased by approximately 21.76% 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 (4.09% of the total emissions, without *LULUCF*), decreased by approximately 11.56% 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 – 2011. During this period, the LULUCF sector offset on average 2.31% (1.31-3.06%) of the total national emissions (without LULUCF). The sink capacity of the LULUCF sector fluctuates between 1.76 Mt CO_2 eq. and 3.2 Mt CO_2 eq., showing a slightly decreasing 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 increased from 82.91 Mt in 1990 to 94.81 Mt in 2011 (without LULUCF). The increase of 14.36% from 1990 to 2011 is mainly attributed to the increased electricity production as well as to the increased energy consumption in the residential sector. The decrease in 2011 is mainly attributed to economic crisis. Other reasons are the increased share of natural gas in energy mix and RES technologies.

CO_2 emissions from *Energy* increased, from 74.88 Mt in 1990 to 89.82 Mt in 2011, presenting a total increase of 19.96% from 1990 to 2011. Carbon dioxide emissions from *Industrial processes* in 2011 decreased by 38.59% compared to 1990 levels and from *Solvents and other products use* decreased by 4.69% compared to 1990 levels. Finally, emissions from *Waste* in 2009 show a continuous increase from 1990. (***Figure 3.3***).

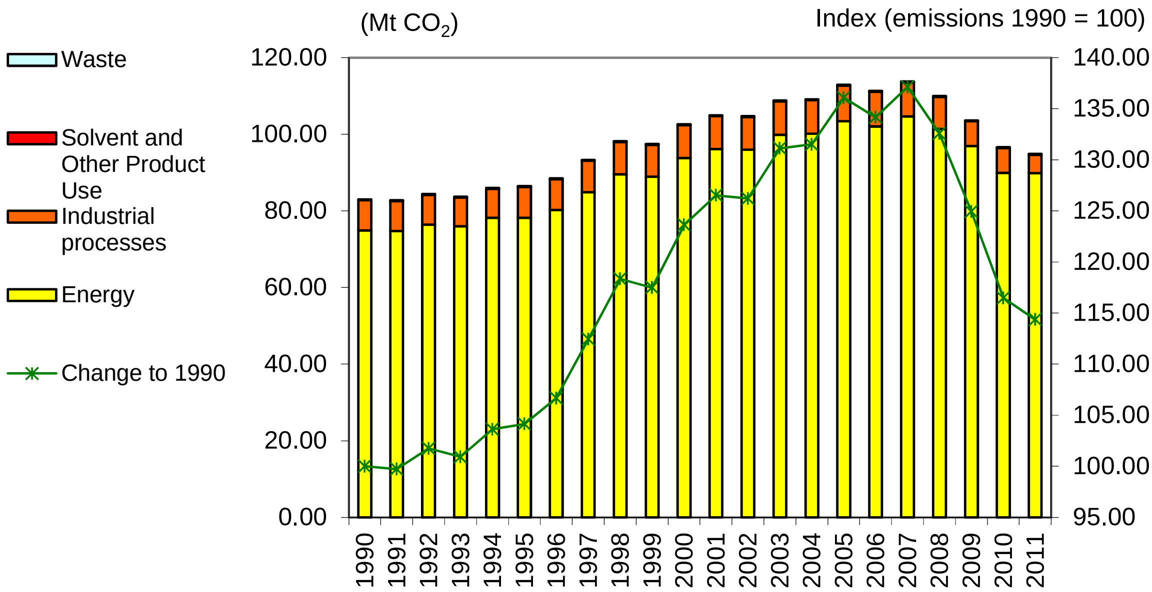


Figure 3.3 CO_2 emissions by sector (in Mt) for the years 1990 – 2011 (without LULUCF)

3.2.2.2 Methane

The trend of methane emissions from 1990 to 2007 by source category is presented in ***Figure 3.4***.

Emissions present an abrupt decrease in 2001 mainly due to Waste and LULUCF Sectors, while in 2011 emissions are slightly lower than 2010.

Waste represents the largest anthropogenic source of methane emissions in Greece accounting for 44.80% of total methane emissions in 2011 (without *LULUCF*). Methane emissions from Waste decreased by 17.70% since 1990 and are mainly attributed to Solid Waste Disposal on Land and Wastewater Handling.

Methane emissions from *Agriculture* in 2011 increased by 0.14% compared to 1990 levels. Methane emissions from *Agriculture*, with enteric fermentation being the main source category in the sector, in 2011 accounted for 38.41% 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 16.78% of the total methane emissions. Finally, the contribution of CH_4 emissions from *Iron and* Steel *Production* can be considered negligible (0.004%).

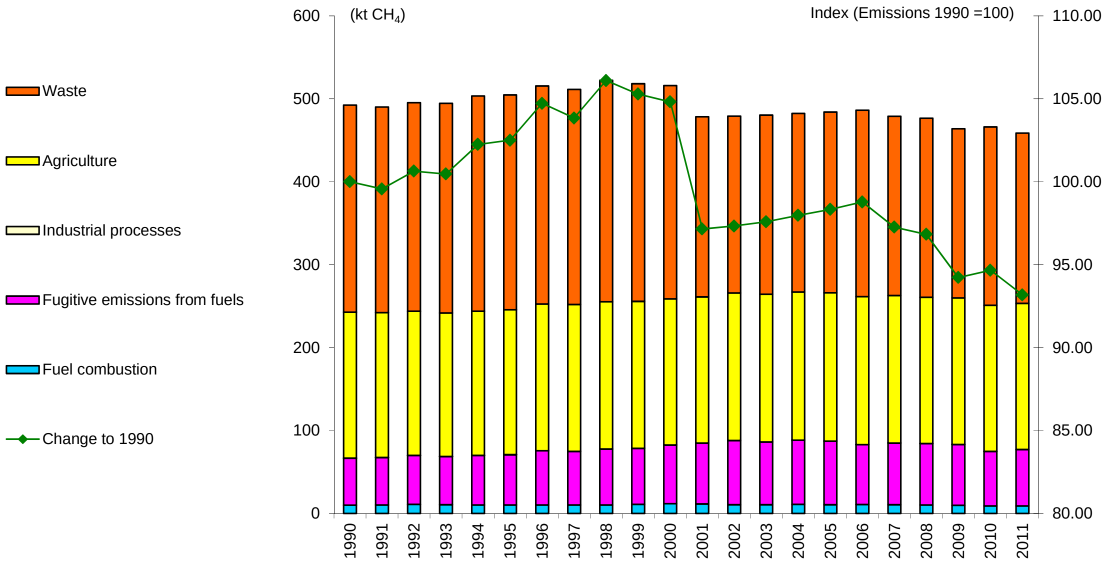


Figure 3.4 CH_4 emissions by sector (kt) for the years 1990 – 2011 (without LULUCF)

3.2.2.3 Nitrous oxide

The trend of nitrous oxide emissions from 1990 to 2007 by source category is presented in ***Figure 3.5***.

Agriculture represents the largest anthropogenic source of nitrous oxide emissions in Greece (75.13% approximately of the total nitrous oxide emissions in 2011, without *LULUCF*). Emissions from this sector decreased by 32.18% 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 10.38% of total nitrous oxide emissions in 2011) decreased by 18.63% from 1990. Emissions from the *Energy* sector tend to decrease mainly due to the penetration of natural gas in electricity production.

Production of nitric acid is the major source of N_2O emissions from *Industrial processes* and accounts for 6.78% of total N_2O emissions in 2011. Nitrous oxide emissions from this source decreased by 57.13% from 1990, due to the reduction of nitric acid production in Greece. However, it should be mentioned that the high decrease between 2008 and 2009, which was attributed to the economic recession, is counterbalanced by 12.59% increase of emissions between 2009-2011, compared to 2008.

N_2O emissions from *Waste* in 2011 (5.51% of total emissions without *LULUCF*) increased by 16.49% compared to 1990 levels.

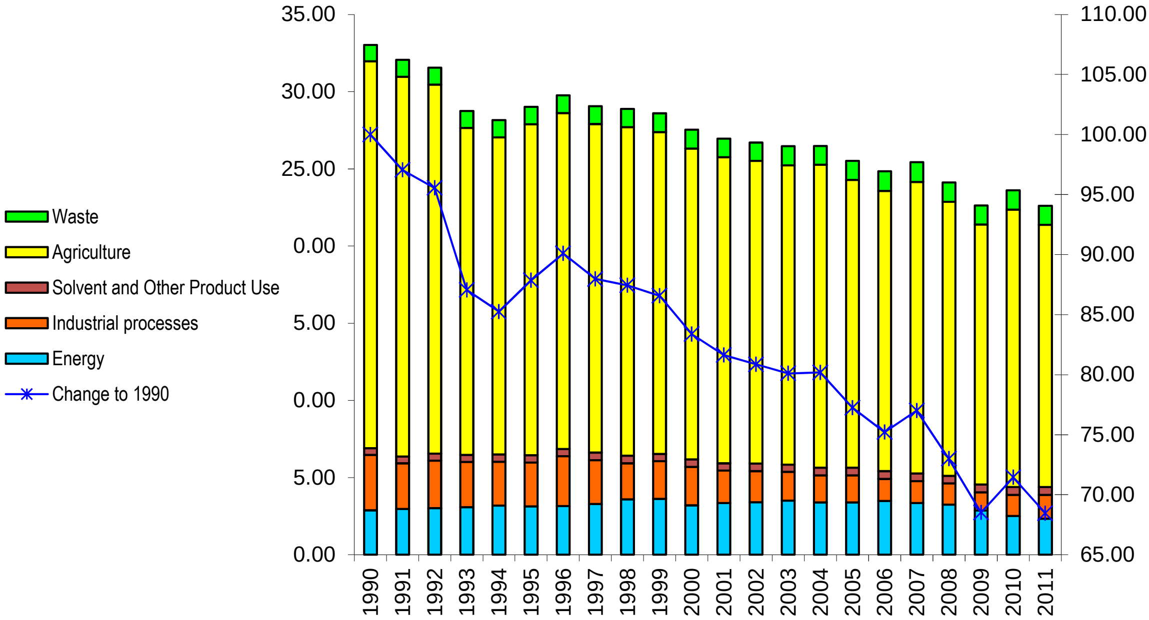


Figure 3.5 ***N_2O emissions by sector (kt) for the years 1990 – 2011 (without LULUCF)***

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 SF_6, 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 3.4a and Table 3.4b*** originate from:

- The production of HCFC-22 (emissions of HFC-23) and aluminium production (emissions of CF_4 and C_2F_6). 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 2008-2010 show flunctuations that are mainly attributed to the production levels. HFC-23 emissions are reported as not occurring since 2006, due to the closure of the plant producing HCFC-22.
- Manufacturing, operation and maintenance of refrigeration and air conditioning equipment. f-gases emissions increased significantly since 1995 (base year), mainly due to the increase of air conditioning equipment in the residential sector, the increasing trend of emissions from the commercial refrigeration and the introduction of new passenger cars with air-conditioning systems, but also due to substitution of CFCs, following the implementation of the Montreal Protocol, leading to an increase in the number of equipment operating with f-gases. The estimates in the current submission include the recovery of f-gases according to the

data providing by the Appliances Recycling SA., following the implementation of 2012 Inventory Improvement Plan.

- 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. The variation in the emission trend between 2005 and 2008 can be attributed to the flactuation in the production and export levels of 2005-2008 in aerosol product and consequently consumption also affected. In 2009 and 2010 emissions experience a strong decline which is attributed to the corresponding decrease of aerosols being sold.
- 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. Following the implementation of 2012 Inventory Improvement Plan, the inventory team has focused on gathering data concerning the imports of foam products containing f-gases (4.14.2)
- The use of SF_6 in the electricity transmission and distribution system of the Public Power Corporation of Greece. Emissions mainly derive from the use of SF_6 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 SF_6 leakages.
- Finally, the emissions from fire extinguishers, which follow a continous increasing trend in the inventory years.

Table 3.4a Actual F-gases emissions for the period 1990-2000 (in kt CO2 eq)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
HFC	**935.06**	**1,106.82**	**908.39**	**1,606.74**	**2,144.05**	**3,290.41**	**3,817.88**	**4,097.77**	**4,579.59**	**5,365.87**	**4,243.79**
HFC-23	935.06	1,106.82	908.39	1,606.64	2,143.91	3,253.07	3,746.34	3,965.47	4,371.38	5,043.57	3,768.07
HFC-32						0.03	0.21	0.70	1.29	2.21	4.61
HFC-125						4.88	9.69	19.28	31.09	48.40	78.46
HFC-134a				0.09	0.15	24.85	47.66	86.64	135.69	206.57	296.42
HFC-152a											
HFC-143a						7.58	13.98	25.68	40.14	61.03	90.47
HFC-227ea										4.09	5.75
PFC	**163.37**	**164.17**	**161.21**	**96.98**	**60.37**	**53.97**	**46.14**	**107.67**	**133.04**	**90.32**	**105.09**
SF_6	**3.07**	**3.16**	**3.26**	**3.35**	**3.45**	**3.59**	**3.68**	**3.73**	**3.78**	**3.87**	**3.99**
Total	**1,101.51**	**1,274.16**	**1,072.86**	**1,707.07**	**2,207.87**	**3,347.96**	**3,867.70**	**4,209.17**	**4,716.41**	**5,460.06**	**4,352.87**

Table 3.4b Actual F-gases emissions for the period 2001-2011 (in kt CO2 eq)

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
HFC	**3,849.29**	**4,000.29**	**3,803.16**	**3,892.90**	**3,968.87**	**2,133.68**	**2,471.03**	**2,844.35**	**3,226.65**	**3,512.16**	**3,507.46**
HFC-23	3,219.93	3,233.29	2,720.91	2,613.64	2,224.50	77.24	115.83	126.41	145.59	167.75	121.20
HFC-32	8.54	12.97	23.70	34.57	45.14	59.16	73.52	89.59	107.16	129.09	157.43
HFC-125	108.34	129.27	217.49	277.26	370.41	460.16	557.82	667.73	799.57	965.44	1,121.81
HFC-134a	394.07	472.32	613.43	725.76	1,010.56	1,170.81	1,316.26	1,503.83	1,652.72	1,650.69	1,517.11
HFC-152a	1.80	32.68	43.79	37.43	39.95	49.50	43.37	42.88	37.33	33.31	30.68
HFC-143a	108.81	109.66	170.77	186.46	255.94	290.37	332.31	378.73	445.74	524.90	517.09
HFC-227ea	7.79	10.11	13.08	17.78	22.36	26.44	31.90	35.17	38.56	40.98	42.14
PFC	**71.16**	**69.14**	**72.47**	**68.99**	**69.89**	**66.35**	**76.21**	**89.10**	**69.85**	**101.57**	**77.69**
SF_6	**4.06**	**4.25**	**4.25**	**4.47**	**6.45**	**8.37**	**9.92**	**7.53**	**5.26**	**6.14**	**5.15**
Total	**3,924.52**	**4,073.68**	**3,879.89**	**3,966.37**	**4,045.21**	**2,208.39**	**2,557.15**	**2,940.98**	**3,301.76**	**3,619.88**	**3,590.29**

3.2.3 Emissions trends for indirect greenhouse gases and SO_2

The role of carbon monoxide (CO), nitrogen oxides (NO_x) and non-methane organic volatile compounds (NMVOC) is important for climate change as these gases act as precursors of tropospheric ozone. In this way, they contribute to ozone formation and alter the atmospheric lifetimes of other greenhouse gases. For example, CO interacts with the hydroxyl radical (OH), the major atmospheric sink for methane, to form carbon dioxide. Therefore, increased atmospheric concentration of CO limits the number of OH compounds available to destroy methane, thus increasing the atmospheric lifetime of methane.

These gases are generated through a variety of anthropogenic activities, including fossil fuel combustion, solid waste incineration, oil and gas production and processing, industrial processes and solvent use and agricultural crop waste burning.

From the data of ***Table 3.2a*** and ***Table 3.2b*** which presents emissions from indirect greenhouse gases and SO_2 for the period 1990 – 2011, and of the ***Figure 3.6*** which shows the contribution of the several sectors in total emissions per gas for the same period, arise the following results:

- NO_x emissions decreased by 9.39% from 1990 to 2011. Energy sector accounts for the high majority of emissions (99.16%). The decrease in NO_x emissions from transport after 1998 is attributed to the substitution of old technology vehicles by new catalytic ones (NO_x emissions from this category account for the 43.71% of total NO_x emissions in 2011). Emissions from *Industrial processes* decreased by 36.27% from 1990 due to reductions in the production of nitric acid.

- The transport sector is the main source of CO emissions. Due to the substitution of old technology vehicles by new and more efficient ones, CO emissions from transport decreased by 66.56% from 1990 to 2011 and as a result total CO emissions in 2011 decreased by 56.55%. Emissions from industrial processes in 2011 increased by 16.62% compared to 1990 levels. The variation of CO emissions from *LULUCF* is related to the intensity and number of forest fires. In 2011 emissions from LULUCF accounted for 1.03% of total CO emissions (incl LULUCF), and are by 54.69% lower than emissions of 1990.

- NMVOC emissions decreased by 41.11% from 1990 to 2011. Emissions from transport (26.29% of total NMVOC emissions in 2011), decreased by 70.05% compared to 1990 levels, while emissions from *Energy* decreased by 51.99% from 1990 to 2011. The significant decrease of NMVOC emissions from *Industrial* *processes* (approximately 41.11% from 1990 to 2011) is attributed to the non-energy use of bitumen in the construction sector. Emissions from Solvents and other products use decreased by 4.04% compared to 1990 levels.

- SO_2 emissions decreased by 44.94% from 1990 to 2011. Emissions from energy, which is the main source of SO_2 emissions in Greece (98.38 % of total SO_2 emissions for 2011), decreased with a mean annual rate of decrease of 2.20% for the period 1990 – 2011. The operation of desulphurisation plants at large installations for electricity generation since 1998 resulted in the restriction of the increase of SO_2 emissions from electricity generation. Reductions with respect to the sulphur content of liquid fossil fuels and the introduction of natural gas in the Greek energy system resulted in a reduction of SO_2 emissions from manufacturing industry 88% for the period 1990 – 2011. Emissions from *Industrial processes* decreased by 50.44% from 1990 due to decrease of sulphuric acid industrial production.

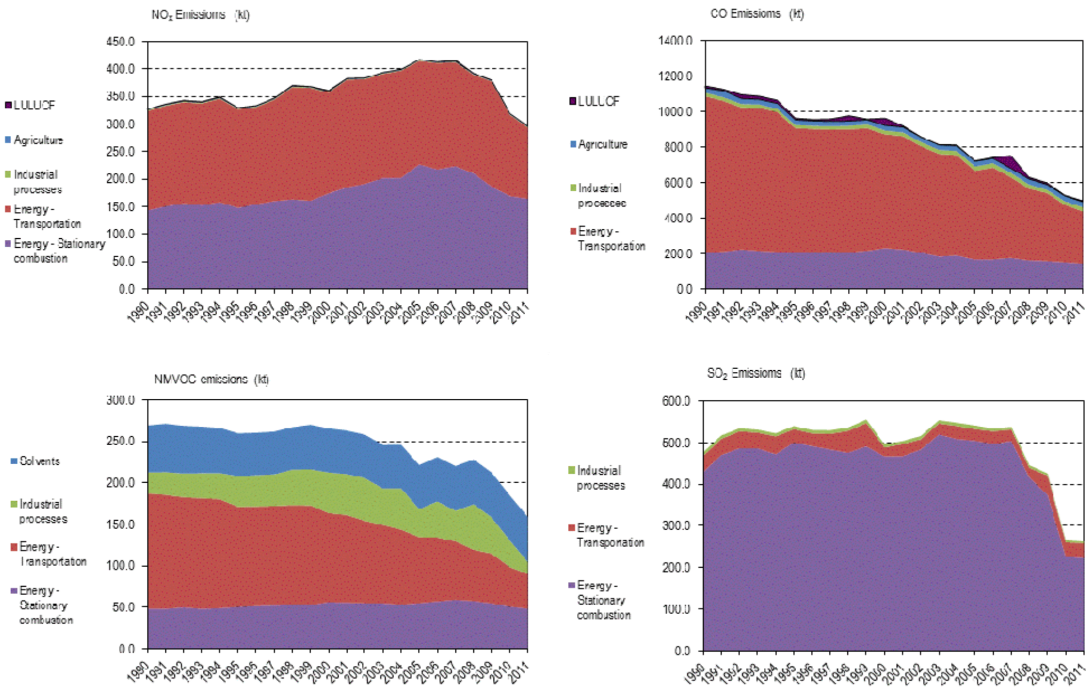


Figure 3.6 Emissions from indirect greenhouse gases and SO_2 per gas and sector for the period 1990 – 2011

3.3 National System for the GHG emissions/removals inventory

3.3.1 Overview

The Ministry of Environment, Energy and Climate Change, MEECC (former Ministry for the Environment, Physical Planning and Public Works) 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 MEECC 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 MEECC has the overall responsibility for the national GHG inventory, and the official consideration and approval of the inventory prior to its submission. (Contact person: Irini Nikolaou, Address: Villa Kazouli, Kifisias 241, Athens, Greece, e-mail: i.nikolaou@prv.ypeka.gr, tel.: +30210 8089275, fax: +30210 8089239).

Figure 3.7 provides an overview of the organizational structure of the National Inventory System. The entities participating in it are:

- The **MEECC** 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 **National Technical University of Athens (NTUA) / School of Chemical Engineering**, which has the technical and scientific responsibility for the compilation of the annual inventory.
- **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 cotribute to data providing and development of methodological issues as appropriate.

The legal framework defining the roles-responsibilities and the co-operation between the MEECC Climate team, the NTUA Inventory team and the designated contact points of the competent Ministries was formalized by circular 918/21-4-08 released by MEECC (former MINENV) entitled “Structure and operation of the National Greenhouse Gases Inventory System- Roles and Responsibilities”. The above-mentioned circular includes a description of each entity’s responsibilities, concerning the inventory preparation, data providing or other relative information. This formal framework has improved 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.

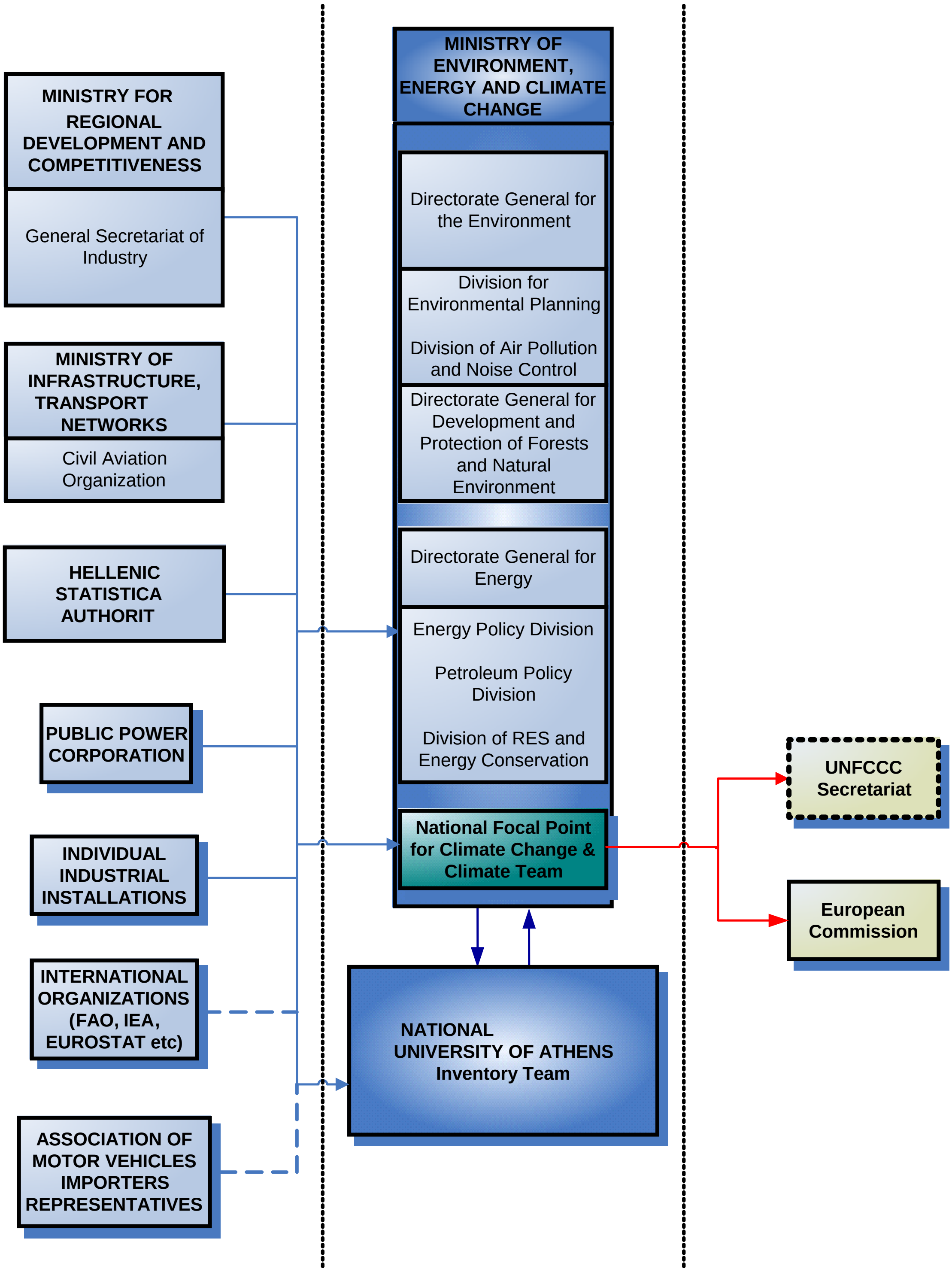


Figure 3.7 Organizational Structure of the National Inventory System

3.3.2 Roles and Responsibilities

3.3.2.1 Ministry of Environment, Energy and Climate Change

The Ministry of Environment, Energy and Climate Change, MEECC, 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 official consideration and approval of the inventory prior to its submission.
- The response to any issues raised by the inventory review process under Article 8 of the Kyoto Protocol, in co-operation with the technical consultant (NTUA Inventory Team), who has the technical and scientific responsibility for the inventory planning, preparation and management of all sectors, 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 institute which has the technical responsibility for the inventory planning, preparation and management (currently NTUA) at the beginning of each inventory cycle. The Centralised Inventory File is kept at the premises of the MEECC.
- 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 administration of the registry is assigned to the National Center for the Environment and Sustainable Development, which reports to the Ministry of Environment, Energy and Climate Change and operates under the authority of the latter.
- The supervision of Quality Assurance/Quality Control Plan (QA/QC)

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

For the fulfilment of the above-mentioned roles and responsibilities of the ministry, a Climate Team was established within the Ministry of Environment, Energy and Climate Change (MEECC Climate Team), comprising the following experts:

1. Irini Nikolaou
2. Katerina Pelekasi
3. George Zissis
4. Dimitris Niavis
5. Sotiria Baibou

For each inventory sector, specified in the circular, a member of the MEECC's Climate Team has been assigned as responsible for overseeing the NTUA's inventory work and for communication with other Ministries' / agencies' data providers.

3.3.2.2 National Technical University of Athens-School of Chemical Engineering

The Ministry of Environment, Energy and Climate Change 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. In this framework, NTUA (Inventory Team) has the following responsibilities / tasks to fulfil for the GHG inventory preparation:

1. Data collection (activity data and emission factors) for all source categories that are Energy, Industrial Processes, Solvents and Other Product Use, Agriculture, and Waste.
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 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 Article 3 of the Decision 280/2004/EC of the European Parliament and of the Council.
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 MEECC'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 inventory team at the beginning of the next inventory cycle.
13. Development of QA/QC procedures.
14. Implementing the QA/QC procedures under the supervision of MEECC.
15. Training the representatives of data providing agencies on inventory issues.

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

NTUA is also responsible in co-operation with MEECC's Climate Team to perform greenhouse gas balance projections in terms of sources and sinks, organized by gas and by sector, according to the national policies and measures adopted.

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

1. Prof. Ioannis Ziomas, Scientific responsible

Address: National Technical University of Athens, School of Chemical Engineering, Heroon Polytechniou 9, Zografos, 157 80 Athens, Greece.

E-mail: ziomas@chemeng.ntua.gr

Tel:+30 210 772 2358

FAX: +30 210 772 3155

2. Ioannis Sempos (Sebos)

Chemical Engineer, MBA, PhD

E-mail: isebos@mail.ntua.gr

Tel: +30 210 772 3240

FAX: +30 210 772 3155

3. Athina Progiou

Dr Mechanical Engineer

E-mail: athenaproyou@axonenviro.gr

Tel: +30 210 8223083

Fax: +30 210 8238604

4. Leonidas Kallinikos

Chemical Engineer, PhD

E-mail: leokalls@central.ntua.gr

Tel: +30 210 772 3146

FAX: +30 210 772 3155

5. Ioanna Katsavou

Chemical Engineer, PhD

E-mail: katsavou@central.ntua.gr

Tel: +30 210 772 3149

FAX: +30 210 772 3155

6. Panagiota-Maria Eleni

Chemical Engineer, PhD

E-mail: peleni@central.ntua.gr

Tel: +30 210 772 3149

FAX: +30 210 772 3155

7. Iordanis Tzamtzis

Forester, MSc

E-mail: itzamtzis@hotmail.com

Tel: +30 210 772 3146

FAX: +30 210 772 3155

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

3.3.2.3 Government Ministries/ Government agencies

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

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

Each of the following ministries/agencies, has appointed focal persons responsible for data provision, included in the above mentioned circular:

- The Ministry of Environment, Energy and Climate Change (Contact Persons: Chatzigianakis Konstantinos, Macheras Ioannis, Panagiotis Drougas) provides
  - ✓ annual data for energy consumption and production (more specifically: Energy policy division – Solid fuels and electricity; Petroleum policy division – Liquid and gaseous fuels; Division of RES and energy conservation – Renewable energy sources), data for NO_X and SO_2 emissions (Division of Air pollution and Noise control)
  - ✓ data for solid waste management (Department of Solid Waste Management) data for wastewater treatment (Cental Water Agency)
  - ✓ activity data and emissions for the installations included in the Emissions Trading system (Emissions Trading Office)
  - ✓ data for f-gases use (Division of Air pollution and Noise control)
  - ✓ data for emissions / removals from LULUCF activities (UNFCCC and KP scope) (General Directorate for the Development and Protection of Forests and Natural Environment).

- The Hellenic Statistical Authority (Contact persons: Ioanna Papanagnou and Konstantina Katartzi) represents the main source of information for the estimation of emissions / removals from most of the IPCC source / sink categories.

- The Ministry of Economy, Competitiveness and Shipping (Contact person: Xarikleia Piperopoulou, General Secretariat of Industry) 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, Transport and Networks (Contact person: Tselikas Panagiotis) provides information and data for the vehicle fleet and its technical characteristics. The Civil Aviation Organization (Contact person: Kokkinos Anastasios), supervised by the same Ministry provides information on Landing and Take-off cycles for both domestic and international aviation.

Data are also obtained from International Organizations as the United Nations Food and Agricultural Organization (FAO) from which data on the annual consumption of fertilizers are collected, 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 2005-2011 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 IPCC Guidelines, the IPCC Good Practice Guidance, the LULUCF Good Practice Guidance and the CORINAIR methodology[4]. 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 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 (NO_x, 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.

[4] Emissions estimates from road transport presented in this inventory derive from the implementation of the COPERT IV model (COmputer Program to calculate Emissions from Road Transport), developed for the Commission of the European Communities in the framework of the CORINAIR methodology.

3.3.3.4 GHG emissions inventory preparation process

The preparation of the Greek GHG emissions inventory is based on the application of the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, as elaborated by the IPCC good practice guidance.

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 IPCC Guidelines, the IPCC Good Practice Guidance and the LULUCF Good Practice Guidance.

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 NTUA) check. The official approval procedure follows for one month period of interactions between the Inventory Team (NTUA) and the Climate Team (MEECC), starting on the 1st of February of the year of submission. During this period, the NTUA Inventory Team has to revise the report according to the observations and recommendations of the Climate Team. On the basis of this interaction process, the final version of the report is compiled. The General Director for the Environment of MEECC, who supervises the National System, approves the inventory and then the MEECC 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 MEECC Climate Team and the NTUA Inventory Team 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 MEECC 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 Inventory Team to the person responsible for keeping the Centralised Inventory File (member of the Climate Team) in MEECC, who in turn provides the latest version of all relevant files (calculation files and NIR) to the Inventory Team 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 IPCC Good Practice Guidance defines procedures (in the form of decision trees) for the choice of estimation methods within the context of the IPCC Guidelines. Decision trees formalize the choice of the estimation method most suited to national circumstances considering at the same time the need for accuracy and the available resources (both financial and human). Generally, inventory uncertainty is lower when emissions are estimated using the most rigorous methods, but due to finite resources, this may not be feasible for every source category. Therefore it is good practice to identify those source categories (key source categories) that have the greatest contribution to overall inventory uncertainty in order to make the most efficient use of available resources.

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

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

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

The determination of the key categories for the Greek inventory system is based on the application of the Tier 1 methodology (see Annex I for an analytic presentation of calculations) described in the IPCC Good Practice Guidance, adopting the categorization of sources that is presented in table 7.1 of the IPCC Good Practice Guidance.

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***.

Seven key sources are found in the energy sector, being responsible for 80.8% of total GHG emissions in 2007 (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 are presented in ***Annex III, Table A.III.4***. The comparison of the results of the analysis with and without LULUCF reveals no differences in the source categories identified.

3.3.5 Improvement of GHG emissions / removals inventories

A number of recalculations have been performed in comparison with the previous inventory submissions in order to improve consistency with UNFCCC reporting guidelines and IPCC guidelines. The recalculations made are driven by the results of Greece's QA/QC system and the various review processes, while prioritisation is based on the key source analysis and the availability of resources

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 National Technical University of Athens is responsible in close co-operation with the Ministry of Environment, Energy and Climate Change. 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 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 within the NTUA), of the QA/QC procedures included in the plan for:

- data collection and processing,
- applying methods consistent with IPCC Good Practice Guidance and LULUCF Good Practice Guidance for calculating / recalculating emissions or removals,
- making quantitative estimates of inventory uncertainty,
- archiving information and record keeping and
- compiling national inventory reports.

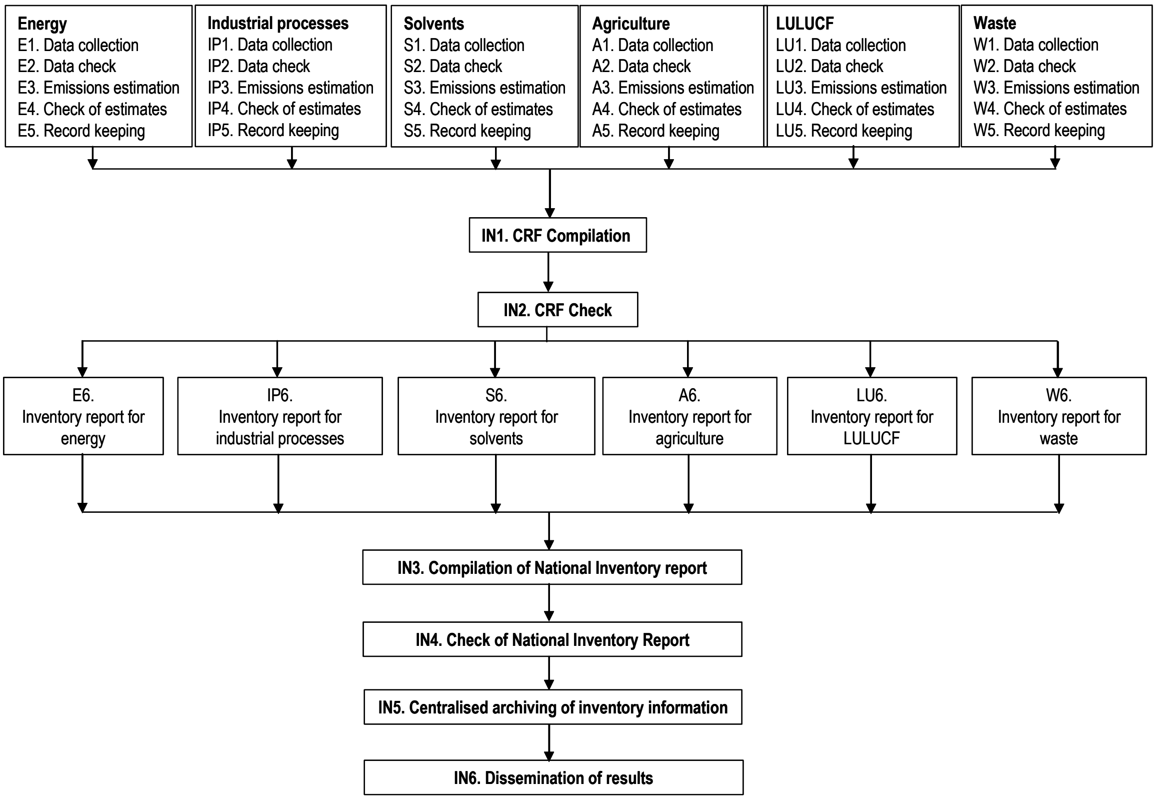


Figure 3.8 Flow chart activities concerning the GHG emissions inventory

The QA/QC system developed covers the following processes (see ***Table 3.5*** for the list of procedures within each process):

- **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 IPCC Good Practice Guidance, (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.

The implementation of the plan started in April 2004 and the first internal review was carried out in June 2004, following procedures and manuals (available only in Greek) developed by in house staff and outside consultants. The current in use version of the QA/QC manual was revised in May 2008. All the procedures described there, are followed by both the MEECC and the NTUA staff members.

Moreover, 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 MEECC/NTUA between September and November of each year and audits by independent local experts are planned and implemented.

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.

Table 3.5 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

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 Inventory Team (NTUA) and the Climate Team (MEECC), starting on the 1st of February of the year of submission. During this period, the NTUA Inventory Team has to revise the report according to the observations and recommendations of the Climate Team.

On the basis of this interaction process, the final version of the report is compiled. The General Director for the Environment of MEECC, who supervises the National System, approves the inventory and then the Ministry of Environment, Energy and Climate Change submits the NIR to the European Commission and to the UNFCCC Secretariat.

3.4 National registry

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

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

1. Each Party retains its organization designated as its registry administrator to maintain the national registry of that Party and remains responsible for all the obligations of Parties that are to be fulfilled through registries;
2. Each Kyoto unit issued by the Parties in such a consolidated system is issued by one of the constituent Parties and continues to carry the Party of origin identifier in its unique serial number;
3. Each Party retains its own set of national accounts as required by paragraph 21 of the Annex to Decision 15/CMP.1. Each account within a national registry keeps a unique account number comprising the identifier of the Party and a unique number within the Party where the account is maintained;
4. Kyoto transactions continue to be forwarded to and checked by the UNFCCC Independent Transaction Log (ITL), which remains responsible for verifying the accuracy and validity of those transactions;
5. The transaction log and registries continue to reconcile their data with each other in order to ensure data consistency and facilitate the automated checks of the ITL;
6. The requirements of paragraphs 44 to 48 of the Annex to Decision 13/CMP.1 concerning making non-confidential information accessible to the public would be fulfilled by each Party individually;
7. All registries reside on a consolidated IT platform sharing the same infrastructure technologies. The chosen architecture implements modalities to ensure that the consolidated national registries are uniquely identifiable, protected and distinguishable from each other, notably:
   - With regards to the data exchange, each national registry connects to the ITL directly and establishes a distinct and secure communication link through a consolidated communication channel (VPN tunnel);
   - The ITL remains responsible for authenticating the national registries and takes the full and final record of all transactions involving Kyoto units and

other administrative processes such that those actions cannot be disputed or repudiated;

- With regards to the data storage, the consolidated platform continues to guarantee that data is kept confidential and protected against unauthorized manipulation;
- The data storage architecture also ensures that the data pertaining to a national registry are distinguishable and uniquely identifiable from the data pertaining to other consolidated national registries;
- In addition, each consolidated national registry keeps a distinct user access entry point (URL) and a distinct set of authorisation and configuration rules.

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

(a) The National Centre for the Environment and Sustainable Development (N.C.E.S.D), operates the Greek Greenhouse Gas Registry under the Min. Dec. 54409/2332/2004.

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

Ms E.Chatziapostolou (e.hatziapostolou@prv.ypeka.gr)

Mr I.Haralampis (i.haralampis@prv.ypeka.gr)

Address: Timoleontos Vassou 11-13

11521 Athens

Greece

Tel: +302106469738

(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. This description includes:

- Readiness questionnaire
- Application logging
- Change management procedure
- Disaster recovery
- Manual Intervention
- Operational Plan
- Roles and responsibilities
- Security Plan
- Time Validation Plan
- Version change Management

The documents above were provided in the last inventory submission.

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, Energy and Climate Change: 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/euregistryGR/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, Energy and Climate Change (MEECC) is the main governmental body entrusted with the development and implementation of environmental policy in Greece. MEECC 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, MEECC 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, Energy and Climate Change	Energy policy, Climate change - Control of fuel quality - Management of water resources – Waste management - Industrial pollution — Severe Industrial accidents – Nature conservation - Forest protection and management
Ministry of Development, Competitiveness, Infrastructure, Transport and Networks	Economy, infrastructure and industrial development, 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 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, Religion Affairs, Culture and Sports, Ministry of Tourism	Conservation of historical and cultural monuments Touristic policy and environment
Ministry of Health	Management of environmental risk and hygiene
Ministry of Shipping and Aegean	Environmental management and sustainable development of the Aegean 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 Ministry. 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 MEECC 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 MEECC 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 the Minister of Environment, Energy and Climate change, 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, the Ministry of Environment, Energy and Climate Change is designated as the responsible authority for the implementation of the relative provisions. The co-ordination of all competent authorities is assigned to a seven-member inter-ministerial committee comprising members from the MEECC, the Ministry of Finance and the Ministry of Economy, Competitiveness and shipping). The competent authority for the monitoring of the implementation of the provisions of the Directive 2003/87/EC is assigned to the Emissions Trading Office, established in the framework of the above-mentioned Decision, and operating within the Directorate General for the Environment. Finally, with the same Decision the National Centre of Environment and Sustainable Development, an institute supervised by MEECC, is responsible for operating the National Registry. 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 for the period 2008-2012 is100 € 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 1500 to 3000 € 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.

The Joint Ministerial Decision 9267/468/207 designated the Emissions Trading Office as National Authority (DNA) for CDM and Focal Point (DFP) for approving projects pursuant to Article 6, paragraph 1(a).

As already mentioned, the Ministry of Environment, Energy and Climate Change (MEECC) 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 End-use Efficiency & Energy Services Directive (2006/32/EC), Greece has submitted two National Energy Efficiency Action Plan in 2007 and 2011.

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. A quarterly report is prepared and uploaded at the department webpage[5]. 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[6] 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, Energy and Climate Change, containing information about national GHG inventories, legislation, emission trading system, national allocation plans, etc, available in greek language).

[5] http://www.ypeka.gr/Default.aspx?tabid=701&language=el-GR

[6] SEC(2009) 92 Impact Assessment Guidelines: http://ec.europa.eu/governance/impact/docs/key_docs/iag_2009_en.pdf

2. http://www.ypeka.gr/Default.aspx?tabid=225&language=el-GR (official website of Ministry of Environment, Energy and Climate Change, 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, available in greek and english).

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 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.

With circular 958/1953 by the Ministry of Agriculture, sustainability in management practices extends to all functions and services derived from forests. This circular also introduces instructions on how to make a Management plan.

The 1975 Constitution of the 3rd Hellenic Republic (articles 24 and 117), Law Decree 86/1969, and Laws 998/1979 and 3208/2003 constitute the legal framework of the country for the protection and management of forest and other wooded land.

Law Decree 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 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 forest lands.

Forest 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).

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 Supporting Policies for the restriction of GHG emissions

In this chapter a short overview of the most important 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 2nd National Climate Change Program which aims in the restriction of emissions in the time horizon of 2010, 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.

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.

The 2nd National Program has been presented in detail in the 3rd and 4th National Communication on Climate Change. The main actions foreseen include:

- Further penetration of natural gas in all final demand energy sectors as well as in power generation, including co-generation.
- Promotion of renewable energy sources (RES) for electricity and heat production.
- Promotion of energy saving measures in industry and in the residential – tertiary sectors.
- Promotion of energy efficient appliances and energy equipment in the residential – tertiary sectors.
- Structural changes in agriculture and in chemical industry.
- Emission reduction actions in transport and waste management sectors.

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***. Additional to what presented in ***Table 4.2***, 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 ‘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.

Moreover, pursuant to the energy end-use efficiency and energy services directive 2006/32/EC, an Energy Efficiency National Action Plan (EEAP) is required. This plan constitutes a valuable supporting policy and tool for the restriction of GHG emissions, which illustrates the policies and measures that need to be implemented in order to fulfill the targets set by the directive, namely reduction of 9% of end-use energy consumption for the period 2008-2016 compared to the average of 2001-2005.

The first Greek action plan pursuant to 2006/32/EC was issued in December 2007, while the second one in September 2011. These plans describe and evaluate all the measures that have been, are being or are planned to be implemented to energy end-use sectors in Greece. Moreover, the 2nd EEAP includes an extensive description of the energy savings achieved through energy efficiency improvement measures by direct reference to the 1st EEAP. It also presents the progress in meeting the interim target for energy savings in 2010 based on data and estimates, and makes a forecast on energy savings for 2016. Finally, it describes the national strategies related to the forecasts and targets for primary energy savings.

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

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

CCPM
EU ETS directive 2003/87/EC as amended by Directive 2008/101/EC and Directive 2009/29/EC and implementing legislation, in particular 2010/2/EU, 2011/278/EU and 2011/638/EU
Effort Sharing Decision 406/2009/EC and RES directive 2009/28/EC
Regulation on CO2 from cars and vans (2009/443/EC and no. 510/2011)
Recast of the Energy Performance of Buildings Directive (Directive 2010/31/EU)
Eco-design framework directive 2005/32/EC and its implementing regulations, combined with Labelling Directive 2003/66/EC and 2010/30/EC • Stand-by Regulation 2008/1275/EC • Simple Set-to boxes regulation 2009/107/EC • Office/street lighting regulations 2009/245/EC, No 859/2009 and No 347/2010 • Household lighting regulation 2009/244/EC • External power supplies regulation 2009/278/EC • TVs (+labelling) Regulation No 642/2009, 1062/2010 • Electric motors Regulation No 640/2009 • Circulators Regulation No 641/2009 • Freezers/refrigerators (+labelling) Regulation No 643/2009, 1060/2010 • Household washing machines (+ labelling) Regulation No 1015/2010, 1061/2010 • Household dishwashers (+labelling) Regulation No 1016/2010, 1059/2010 • Industrial fans Regulation No 327/2011 • Air conditioning and comfort fans (Regulation No 206/2012, 392/2012) • Labelling for tyres Regulations No 1222/2009, 228/2011 and 1235/2011

Other measures

- F-gas Regulation 2006/842/EC
- Motor Vehicles Directive 2006/40/EC
- Directive on the geological storage of CO2 2009/31/EC
- Cogeneration Directive 2004/8/EC
- Directive 2006/32/EC on end-use energy efficiency and energy services
- Energy Star Program
- Completion of the internal energy market (including provisions of the 3rd package)
- Energy Taxation Directive 2003/96/EC
- Industrial emissions Directive 2010/75/EU (Recast of IPPC Directive 2008/1/EC and Large Combustion Plant Directive 2001/80/EC)
- Directive on national emissions' ceilings for certain pollutants 2001/81/EC
- Water Framework Directive 2000/60/EC
- Regulation EURO 5 and 6 2007/715/EC
- Regulation Euro VI for heavy duty vehicles 2009/595/EC
- Fuel Quality Directive 2009/30/EC
- Biofuels directive 2003/30/EC
- Landfill Directive 1999/31/EC
- Waste Directive 2006/12/EC
- Waste Management Framework Directive 2008/98/EC
- Nitrate Directive 1991/676/EEC
- Common Agricultural Policy (CAP) Reform 2006/144/EC
- CAP "Health Check" 2008 and the "Set aside" regulation 73/2009
- Eurovignette Directive on road infrastructure charging 2011/76/EU
- Directive on the Promotion of Clean and Energy Efficient Road Transport Vehicles 2009/33/EC

4.3.1.3 Emissions trading system – aviation – marine bunker fuels

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

Table 4.3 Energy Efficiency National Action Plan Measures

Horizontal Measures
H1. Information system for monitoring energy efficiency improvement and energy savings achievement
H2. Targeted education campaigns, provision of information and rewarding of "good practices"
H3. Programmes to provide financial support for investment in energy-saving technologies and research
H4. Tax exemptions of energy savings interventions
H5. Financing of Environmental Interventions-Establishment of Green Fund
Intersectoral Measures
I1. Energy performance of buildings
I2. Energy labelling of appliances and minimum energy efficiency requirements
I3. Implementation of an energy management system (EMS) in the tertiary and public sectors
I4. Energy upgrading of existing buildings through Energy Services Companies under Energy Performance Contracts (EPC)
I5. Installation of electronic and intelligent metering of electricity and natural gas consumers
I6. Promotion of cogeneration of high-efficiency heat and power (CHP) and district heating systems
I7. "Building the Future" Project
Residential Sector
R1. "Energy saving at home" programme – Energy upgrading of residential building envelopes - Financial aid for the upgrading of heating system boilers / burner units in existing buildings
R2. Compulsory installation of central solar thermal systems in new residential buildings and financial incentives for further penetration of small-scale solar thermal systems in residential buildings
R3. "Changing my old air-conditioner" action.
R4. Energy upgrading of social housing buildings-"Green Neighbourhood" programme.
Tertiary Private Sector
T1. Compulsory installation of central solar thermal systems in the buildings of the tertiary sector
Tertiary Public Sector
PS1. Compulsory installation of central solar thermal systems to meet domestic hot water requirements
PS2. Compulsory procurement procedures with respect to public buildings (green procurement – energy-efficient and RES technologies)
PS3. Integrated energy planning by municipalities – "ENERGY EFFICIENCY" (ΕΞΟΙΚΟΝΟΜΩ) Programme
PS4. Compulsory replacement of all light fittings with low energy efficiency in the public sector and the wider public sector
PS5. Implementation of Green Roofs to public buildings
PS6. Programme of Bioclimatic Urban Reformation
PS7. Installation of high-efficiency cogeneration of heat and power (CHP) systems with natural gas in hospitals
PS8. Interventions for improving energy efficiency in school buildings
PS9. Energy saving interventions in public buildings
Industry
I1. Creating "Green Business Parks" – Enhancing investment projects in Industrial and Business Areas & Innovation Zones
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 old vehicles
T6. 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)
T7. Eco-labelling – Energy label for cars
T8. Compulsory quotas of vehicles with greater energy efficiency in the fleets of the public services and of public bodies
T9. Linking of vehicle taxation to energy efficiency and CO2 emissions

In Greece, the trading system for the period 2008-2012 comprises 140 industrial installations (power plants, refineries, cement plants etc). An allowance reserve is also created which is intended to cover possible unknown new entrants in the period. According to the 2nd National Allocation Plan (NAP), the allowances of CO_2 emissions that are to be allocated to installations included in the EU-ETS (including the reserve) were fixed to **341.547.710 t CO_2**, which requires a considerable decrease of emissions by the enterprises that participate in the system. It is estimated that this decrease of emissions or, with other words, the effect of ETS supporting policy is a 16.7% reduction or 69.2 Mt of 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 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 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 glyoxlic 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 [7] and the other to verification and accreditation [8]. 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 imple-ment in national legislation since the provisions apply directly to operators or aircraft

[7] OJ L 181, 12.7.2012, p. 30
[8] OJ L 181, 12.7.2012, p. 1

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.

As concerns emissions from aviation, since the beginning of 2012, emissions from international aviation are included in the EU Emissions Trading System (EU ETS). Like industrial installations covered by the EU ETS, airlines receive tradeable allowances covering a certain level of CO2 emissions from their flights per year. The legislation, adopted in 2008, applies to EU and non-EU airlines alike. Emissions from flights to and from Iceland, Liechtenstein and Norway are also covered.

In April 2013 the EU decided to temporarily suspend enforcement of the EU ETS requirements for flights operated in 2010, 2011, and 2012 from or to non-European countries, while continuing to apply the legislation to flights within and between countries in Europe. The EU took this initiative to allow time for the International Civil Aviation Organization (ICAO) Assembly in autumn 2013 to reach a global agreement to tackle aviation emissions – something Europe has been seeking for more than 15 years.

In October 2013 the EU's hard work paid off when the ICAO Assembly agreed to develop by 2016 a global market-based mechanism (MBM) addressing international aviation emissions and apply it by 2020. Until then countries or groups of countries, such as the EU, can implement interim measures.

In response to the ICAO outcome and to give further momentum to the global discussions, the European Commission has proposed amending the EU ETS so that only the part of a flight that takes place in European regional airspace is covered by the EU ETS. The change would apply from the beginning of 2014 until the planned global MBM enters into force.

The key features of the revised system would be:

- Emissions from flights between airports in the European Economic Area (EEA, covering the 28 EU Member States plus Norway and Iceland) would continue to be covered.
- Emissions from flights to and from countries outside the EEA would be fully exempted for 2013.
- From 1 January 2014, flights to and from countries outside the EEA would benefit from a general exemption for the proportion of emissions that take place outside EEA airspace. Only the emissions from the proportion of a flight taking place within EEA airspace would be covered.
- To accommodate the special circumstances of developing countries, flights between the EEA and least developed countries, low-income countries and lower-middle income countries which benefit from the EU's Generalised System of Preferences and have a share of less than 1% of international aviation activity would be fully exempted from the EU ETS.

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, the Commission proposed a Regulation establishing an EU-wide MRV system for large ships. This system would cover all ships over 5,000 gross tons that use EU ports, irrespective of where the ships are registered.

According to the proposed Regulation, ship owners will have to monitor and report the verified amount of CO2 emitted by their ships on voyages to, from and between EU ports, Owners will also have to provide certain other information, such as data to determine the ships' energy efficiency.

It is proposed that the rules apply from 1 January 2018. They are designed to support a staged approach towards setting global energy efficiency standards for existing ships, as supported by several members of the International Maritime Organisation.

In an impact assessment accompanying the proposal, several policy options – from an MRV system to levies and to emission trading schemes – were assessed. Under the MRV option, CO2 emissions from the maritime transport sector are expected to be 2 % lower than the baseline in 2030. Various levy options are expected to result in in-sector emission reductions of up to 16 % by 2030, and a maritime emission trading scheme is expected to deliver an emission reduction of 16 to 21 % by 2030, compared to the baseline. These reductions are equivalent to an emission reduction by up to 10 % compared to 2005 levels.

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.

The Operational Programme for Energy (OPE), managed by the Ministry of Development, drew funds from the 2nd Community Support Framework which ended on December 31, 2002, to grant public aid to projects with a total budget of Euro 1.061 billion. The European Regional Development Fund provided 33.8 per cent of that amount and national resources 45.2 percent (including the PPC's funds) whereas private capital flows made up the remaining 21 percent. A part of the sub-programme 3 addressed the issue of RES promotion.

The Operational Programme Competitiveness (OPC) of the Ministry of Development, which comes under the 3rd Community Support Framework for the period 2000-2006, constitutes one of the major tools for the promotion of interventions that may lead to GHG emissions reduction. The total budget OPC amounts to €6.6 billion, of which the community contribution is 2.06 billion €, the Greek public spending €1.29 billion and the private funding €3.32 billion.

The OPC includes 9 priority sectors with 41 measures, which in turn comprise a total of 134 actions. These actions are designed to implement the corresponding policies in the Programme's areas of intervention. A central feature of the Operational Programme is to support entrepreneurship in such areas as new technologies, the liberalized energy markets, environment, tourism but also to fund actions for business modernization, especially addressed to small and medium-sized enterprises engaged in manufacturing-processing, tourism and the service sectors. Under the OPC, projects are promoted to upgrade industrial regions, the national quality assurance system, energy infrastructures and regional structures providing information, consultation, education and management support to businesses.

As reported analytically below, the OPC aims to finance or co-finance the further development of infrastructure for the penetration of natural gas (through interconnections with networks of natural gas of neighboring countries, further development of local networks, etc.) and RES into the electricity system (through the development of special energy infrastructures, interconnection of island grids, upgrading of electric transmission networks, etc.). It also finances specific investments for energy savings, installation of co-generation systems, installation of RES systems, etc. The total cost of measures in the OPC that aim at the further penetration of natural gas and RES as well as in the implementation of measures for energy saving amounts to €2.27 billion (34% of the total budget of the program), of which the public expenditure is €0.54 billion.

The Operational Programme Environment (OPE), which also comes under the 3rd Community Support Framework, promotes inter alia special actions for the reduction of atmospheric pollution, particularly for the regions of Athens and Thessalonica. It also finances or co-finances actions for the reinforcement of infrastructure for monitoring the quality of atmospheric environment and developing information management systems that support measures for the reduction of atmospheric pollution, as specified in relevant European Legislation. The fulfillment of climate change obligations constitutes a priority sector of OPE.

Specifically, it includes measures, actions and interventions aiming at:

- Fulfilling the country’s commitments that arise from the relative Directives of the EU and international conventions.
- Interventions in the sources of atmospheric pollution.
- Actions for the fulfilment of obligations which arise from international Treaties and Conventions concerning climate change issues and protection of the ozone layer.
- Traffic management in the big urban centres of the country.
- Reducing noise in urban and tourist developed regions.

The total budget for OPE is €21.47 million and the implementation of its actions is expected to contribute to the restriction of GHG emissions.

Furthermore, a considerable funding tool for RES and energy saving investments is the so called development law 3299/2004, as in force today, following its amendment by virtue of article 37 of law 3522/2006. Specifically, the Greek territory is divided into three (3) zones where the capital grants are as high as 20, 30 and 40 percent respectively of the eligible investment cost, the connection cost to the grid being also included in the case of large scale enterprises. The grant is increased up to 10 percent for medium-scale enterprises and up to 20 percent for the small ones. In particular, for investments in power generation using solar and wind energy, the grant intensity along with the above markup amounts to 40 percent.

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. Based on these decisions the program is progressing, according to the timetable, towards the implementation of medium-term program funding activities and projects of the Green Fund of EUR 400 million for the period 2011-2014.

The **Operational Programme "Environment and Sustainable Development 2007-2013"** is the Sectoral Program of the National Strategic Reference Framework 2007 - 2013 (NSRF) for Environment and Sustainable Development. The strategic objective of the program is the protection, enhancement and sustainable management of the environment. The program will contribute to economic growth through more efficient use of resources, such as reuse, recycling and recovery of waste. After the implementation of the Program, major environmental issues of the country will be effectively addressed, such as tackling climate change, with significant interventions for saving energy, use of renewable energy sources and promotion of clean urban public transport. The budget of the program amounts to 2,117.6 million €.

Specifically, the objectives of the program relating to the protection of the Atmospheric Environment & Urban Transport, Tackling Climate Change and Renewable Energy Sources are summarized as follows

- Energy savings in the public and broader public sector
- Encourage the use and dissemination of renewable energy standards through demonstration projects
- Promotion of sustainable regional development by using local energy resources
- Reduction of energy consumption in selected organizations, having a high energy cost function
- Support of autonomy and security of energy supply of Mount Athos with the use of RES
- Promoting sustainable solutions for urban transport in Thessaloniki
- Reduction of air pollution
- Reduction of greenhouse gases that cause climate change
- Monitoring the implementation and adaptations of Emissions Trading System to tackle climate change
- Mapping of noise based on the requirements of legislation
- Protecting public health by enhancing atmospheric environment
- Optimize energy performance of buildings

Life + 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. Therefore, Life + finances measures and projects with European added value for the Member States.

The Life + program consists of three modules:

1. Life + Nature and Biodiversity: in order to contribute to the implementation of Community policy and legislation on nature and biodiversity particularly in relation to Directive 79/409/EEC on the conservation of wild birds and Directive 92/43/EEC on the conservation flora and fauna and natural ecosystems and support further development and implementation of the Natura 2000 network, including coastal and marine species.

2. Life + Environment Policy and Governance: the implementation of the objectives of the 6th Environment Action Programme, including priority issues on climate change, the environment and health and quality of life, natural resources and waste and contribution to the development and demonstration of innovative policy approaches, technologies, methods and tools.

<u>3. Life + Information and Communication:</u> in order to disseminate information and raise awareness on environmental issues, including the prevention of forest fires.

The **National Strategic Plan for Rural Development** defines the priorities of Greece for the period 2007-2013, in accordance with Article 11 of Regulation (EC) 1698/2005 on the support of rural development by the European Agricultural Fund for Rural Development (EAFRD), which stipulates that the national rural development strategy will be implemented through the Rural Development Programme (RDP) 2007-2013. Rural Development policy 2007-2013 for Greece focuses on three main areas: A. Improving the competitiveness of agriculture and forestry, B. Improving the environment and countryside and C. Improving the quality of life in rural areas and diversification of rural economy.

For the period 2007 - 2013, the shaft on the actions related to climate change is Axis 2 ("Environmental protection and sustainable management of natural resources"). Axis Interventions aimed mainly at protecting soil and water resources, to mitigate the impacts of climate change, protection of biodiversity, protection and preservation of the rural landscape and improve the ecological stability of forests.

The **Operational Programme for Competitiveness and Entrepreneurship (OPCE II)** aims to improve the competitiveness and internationalization of business and manufacturing, with an emphasis on the aspect of innovativeness. A key component of the Plan is to protect the environment and sustainable development.

More specifically the project aims to ensure the energy supply of the country in pursuit of environmental goals, supporting energy market liberalization and integration of the country in major international transmission networks of electricity and natural gas.

Indicative Actions are:

- The penetration of natural gas in new areas.
- The expansion of the National Natural Gas Transmission System.
- The completion of the infrastructure required for Liquefied Natural Gas.
- Interconnection of islands with the National Electricity Transmission System.
- The construction of High Voltage Centers.
- To promote energy-saving actions in households and local authorities.
- Strengthening and expansion of the transmission system and electricity grid.
- Investment for the Production of Energy from Renewable Energy Sources (RES).
- The rational management of natural resources.

Moreover, the **Program for the Development of Interventions**, for the period 2010 to 2015, is a product of government's efforts to implement a sustainable response to the challenges the country is facing both in environmental, energy and spatial level and in terms of ensuring long-term economic growth and exit from the economic crisis, setting a solid foundation for future generations.

The Pillars of the Program for the Development of Interventions are:

<u>Addressing climate change by switching to a competitive, low-carbon economy</u>

This pillar incorporates a number of policies that focus on improving energy efficiency, increasing the country's energy potential of Renewable Energy Sources (RES) and natural gas, ensuring energy supply, providing reliable energy products and services to consumers and promote environmentally sound production and consumption patterns through the "Green Procurement". The total budget of investments included under this pillar is € 31.8 billion and it is expected to create over 169,000 jobs.

Sustainable management and protection 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 design for the prompt response to environmental risks and crises. Achieving these objectives is approached by undergoing development investment in technical projects and projects utilizing natural resources, as well as the restoration of natural landscapes. The total budget of the investments included under this pillar is the € 2.3 billion and it is expected to create over 11,000 jobs.

Quality of life enhancement, with respect to the environment

The actions of the third pillar aim to the improvement of the quality of life through the promotion of sustainable development, establishing the productive and social cohesion, while ensuring environmental protection. Under this Pillar important actions are included in order to improve the urban environment, such as reducing noise and pollution and the development of sustainable mobility. In addition, significant investments in recycling and waste management are promoted. The total budget of the investments included under this pillar is the € 9.5 billion and is expected to create about 30,000 jobs.

Strengthening of mechanisms and principles of environmental governance

The fourth pillar of the program aims to the strengthening of 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. The total budget of investments included under this pillar is € 846.7 million and is expected to create more than 2,400 jobs.

Finally, concerning 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 new Operational Programmes that will be prepared for that period.

4.3.1.5 Fiscal measures

4.3.1.5.1 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.

Major **reforms** were introduced in the energy taxation since 2010:

- Increases in the excise duties on oil products (Laws 3828/2010, 3833/2010 and 3845/2010; s. the table below). The excise duty rate on unleaded petrol was gradually increased from EUR 410/1000 lt on 1 January 2010 to EUR 670/1000 lt on 3 May 2010, which still applies.
- Law 3833/2010 introduced the excise duty on electricity starting from May 2010. Law 3899/2010, with effect from 17 December 2010 imposed a slightly higher rate for business use than for residential use:

  (i) Business Use
    - High Voltage: EUR 2.5/MWh
    - Medium - Low Voltage: EUR 5/MWh

  (ii) Non Business Use
    - Household Use: EUR 2.2/MWh
    - Other Use: EUR 5/MWh

  Electricity used in agriculture is exempt (Law 3899/2010). Law 3833/2010 specifies which renewable energy sources (wind, solar, tidal power etc.) are exempted from excise duties, when they are used for the generation of electricity for private purposes only. Fuels used for the purpose of electricity generation are also taxed, with the exception of coal and coke.
- In 2011 an excise duty was introduced in natural gas (Law 3986/2011), amounting to 1.50 Euro per gigajoule. Natural gas used as propellant is exempt.
- Starting from 15 October 2012 (Law 4092/2012) a uniform rate of 330 EUR/1000 lt applies for gas oil (diesel) for transport, heating and other use, as well as biodiesel and kerosene for transport, heating and other use. Since 15 October 2012 the reduced excise duty rate for heating gas oil and kerosene which applied during the winter season (from 15 October to 30 April of each year), was abolished[9].

The excise duty rate applicable to hard coal, lignite and coke is € 0.3/gigajoule. Reliefs are provided for the use of these products for mineralogical processing, exclusively for the generation of electric power, for chemical reduction, electrolytic and metallurgical processing.

The following table depicts the excise duty rates for specified products according to the National Customs Code.

[9] The uniform rate for heating and motor gas oil was introduced in 2008 (Law 3634/2008), however, at the same time an automatic refund was provided for users of heating gas oil during the heating season.

Table 4.4 Excise duty rates for specified products as on 1st July 2013

	Excise duties								
Energy products	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**Imposition Unit**
Kerosene propellant for transport	260	302	320	330	440	440	330	330	1000 lt
Leaded Petrol	360	384	409	421	681	681	681	681	1000 lt
Unleaded Petrol – LRP	342	347	352	359	670	670	670	670	1000 lt
Unleaded Petrol – up to 96.5 octanes	313	331	350	359	670	670	670	670	1000 lt
Unleaded petrol – more than 96.5 octanes	327	338	349	359	670	670	670	670	1000 lt
Gas oil (diesel) for transport	260	276	293	302	412	412	330	330	1000lt
Liquid petroleum gas (LPG) for propellant use	100	125	125	125	125	200	330	330	1000 kg
Coal & coke	0	0.3	0.3	0.3	0.3	0.3	0.3	0.3	gigajoule
Biodiesel	260	276	293	302	412	412	330	330	1000 lt
Electricity	0	0	0	0	2.2/ 2.5/ 5	2.2/ 2.5/ 5	2.2/ 2.5/ 5	2.2/ 2.5/ 5	MWh
Natural gas	0	0	0	0	0	1.5	1.5	1.5	gigajoule

Tax revenues from excise duties on energy products and electricity

Year	Total revenues (millions EUR)
2012	4,464.09
2011	4,651.18
2010	4,545.73
2009	3,258.06
2008	3,101.11

Source: Excise Duty Tables, Tax receipts – Energy products and Electricity, July 2013

4.3.1.5.2 Car registration tax

According to the National Customs Code (Law 2960/2001, Article 121), 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 cylinder capacity and the anti-pollutant technology of the vehicle. The passenger motor vehicles which are imported in the country and comply with the specifications of the recent Regulations 715/2007 and 692/2008 are subject to registration tax rates ranging from 5% to 50% (Euro 5), while those complying with the specifications of Directive 98/69/EC under phase B are subject to rates from 14% to 142% (Euro 4); finally, motor vehicles which comply with the specifications of Directive 98/69/EC under phase A and previous Directives (94/12/EC, 91/441/EEC, 89/458/EEC and 88/76/EEC) are subject to rates from 24% to 334%

(Euro 1, 2 and 3). Motor vehicles of conventional technology are subject to rates from 37% to 346% (s. table below).

Hybrid cars in compliance with the applicable provisions for anti-pollutant technology of Directive 94/12/EC, as well as electric cars are not subject to registration tax.

Table 4.5 Registration tax rates

Cylinder capacity	**EURO 5** Specifications of Regulations 715/2007 and 692/2008	**EURO 4** Specifications of Directive 98/69/EC phase B	**EURO 1, 2 & 3** Specifications of Directives 98/69/EC phase A, 94/12/EC, 91/441/EEC, 89/458/EEC & 88/76/EEC	**Conventional Technology**
Up to 900 cc	5%	14%	24%	37%
901-1400 cc	12%	27%	49%	66%
1401-1600 cc	20%	45%	95%	128%
1601-1800 cc	30%	56%	129%	148%
1801-2000 cc	40%	83%	216%	266%
2001 cc and above	50%	142%	334%	346%

In addition to registration tax, the customs authorities collect the luxury tax, introduced with Law 3833/2010 starting from 4 March 2010, for cars with a cylinder capacity higher than 2000 cc. However, a recent change with Law 4211/2013, provides that EU cars, registered in another EU Member State prior to the above date of entry into force of the luxury tax, shall not be subject to the luxury tax.

4.3.1.5.3 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.

Under the reform which applied only for the year 2010, the road tax was specified on the basis on the cylinder capacity (cc) of the car motor and the age of the car according to four categories, namely Euro V-IV, Euro III, Euro II and Euro I, as follows:

Table 4.6 Road tax in 2010

Engine size	786-1357	1358-1928	1929-2357	>2357
Euro V-IV (from 1/1/2005)	94	184	428	562
Euro III (from(1/1/2000)	137	252	521	680
Euro II (from 1/1/1996)	162	302	596	780
Euro I (from 31/12/1995)	187	352	671	880
Annual road tax 2009	112	202	446	580

For 2010, cars registered before 1 January 1996 (Euro I) and from 1 January 1996 to 1 January 1999 (Euro II), with engine size more than 2,500 cc, were subject to an additional tax ranging between EUR 250 and 650.

The current system, that was introduced with Law 3986/2011, distinguishes between cars that were registered before and after 31st October 2010.

All passenger cars which have been registered for the first time in Greece until 31 October 2010, as well as motorcycles, regardless of their registration date, shall be subject to the following road tax, based on their cylinder capacity:

Table 4.7 Road tax for passenger cars registered for the first time in Greece until 31 October 2010, and motorcycles, regardless of their registration date

Category	Cylinder capacity (in cc)	Annual road tax
A	Up to 300	€ 22
B	301-785	€ 55
C	786-1,071	€ 120
D	1,072-1,357	€ 135
E	1,358-1,548	€ 240
F	1,549-1,738	€ 265
G	1,739-1,928	€ 300
H	1,929-2,357	€ 660
I	2,358-3,000	€ 880
J	3,001-4,000	€ 1,100
K	4,001 and above	€ 1,320

Passenger cars that have been registered in Greece for the first time after 1 November 2010, are subject to road tax exclusively on the basis of their CO2 emissions as follows:

Table 4.8 Road tax for passenger cars registered for the first time in Greece after 1 November 2010

CO_2 emissions	Annual road tax per gr of CO_2 emissions
0-100	0
101-120	0.90
121-140	1.10
141-160	1.70
161-180	2.25
181-200	2.55
201-250	2.80
Above 251	3.40

Hybrid cars up to 1,929 cc and electric private vehicles, as well as private vehicles registered for the first time after 1 November 2010 with CO2 emissions below 100 gr/km are exempt from road tax. Hybrid cars with a cylinder capacity more than 1,929 cc, are subject to the 50% of the road tax corresponding to a car of conventional technology.

The annual road tax applicable to trucks and lorries for private use ranges from EUR 75 to EUR 1,490 and for buses for private use from EUR 210 to EUR 520, whereas the respective tax in the category for public use ranges for lorries from EUR 125 to EUR 1,460 and from EUR 210 to EUR 595 for public buses. Taxis registered until 31 October 2010 are subject to an annual road tax of EUR 290, whereas those registered after that date are taxed according to their CO2 emissions: (i) from 0-100 gr CO2 per km, no tax is due; (ii) from 101-150, the tax is EUR 2.25 per CO2 gr and (iii) above 151, EUR 2.80/gr CO2.

Table 4.9 Revenues from road tax during the period 1999-2012

Year	Revenues (in million EUR)
1999	396
2000	351
2001	764
2002	659
2003	596
2004	717
2005	765
2006	814
2007	865
2008	1,051
2009	1,244
2010	1,194
2011	1,115
2012	1,304

Source: Taxes in Europe Database

4.3.1.5.4 Corporate income taxation

Enterprises participating in a collective alternative system for the disposal of waste in accordance with the provisions of Law 2939/2001, may deduct from their gross income the fees paid for their participation, as provided in the Circular 1106/2008 of the Minister of Finance. The collective alternative disposal system is defined as the mandatory organization on a collective basis, under 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.). For the approval of such system the manager has to pay a fee to the National Organization of Alternative Disposal for Packaging, which is subsequently borne by the enterprises participating in such system.

Moreover, the Income Tax Code (Article 6 of Law 2238/1994, as amended by Article 36 of law 3775/2009) prescribes that revenues from the sale of electric energy produced by solar panels to the Public Power Company are exempt from taxation. This applies for solar systems up to 10 KW, with respect to households and small businesses.

4.3.1.5.5 VAT

The VAT rate applicable to motor vehicle fuels is 23% (standard rate), whereas the reduced rate of 13% applies to electricity, natural gas and district heating.

The VAT Code (Law 2859/2000) includes in Annex III and, thus, to the reduced VAT rate of 13%, the supply of services related to waste disposal and recycling as well as waste processing, unless they are rendered by government or public entities.

According to Article 39a of VAT Code, the delivery of recyclable waste is considered, under certain conditions, as an exemption from VAT, giving a right for deduction. By virtue of a provision in the same Article, in the event of transfer of CO_2 emission allowances to another person subject to VAT, the VAT shall be paid by the recipient, thus, the service provider is entitled to deduct the input VAT with respect to such transactions.

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 88 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, adopted and planned 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 2nd National Climate Change Program (2000-2010), 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 4.19*** and ***4.20*** present estimates of the expected effects of these policies and measures in the time horizon of the years 2015 and 2020. An ex-post estimation of the effect of policies for year 2005 and 2010 is also included.

The total realistic GHG emissions reduction potential from the implemented and adopted policies and measures was estimated to be 33.3 Mt CO2eq for 2015 and 41.0 Mt 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 (1st Commitment Period) and the 2020 targets pursuant to European Union obligations, exclusively with domestic measures and actions (see paragraph 5.1).

Respectively, **the total GHG emissions reduction potential for the planned policies and measures was estimated to be 0.8 Mt CO2eq for 2020, also with the interferences between them to be taken into account.** These policies include additional energy efficiency measures in the building and transport sector, which are planned to be implemented till 2030.

4.3.2.2 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 (e.g Aliveri, Megalopolis, etc).

In ***Table 4.10*** the achieved (2009, 2010 and 2011) and the anticipated (2015 and 2020) penetration of natural gas in the national energy system is presented. The 2009-2011 figures are obtained from the 2013 energy balance and the 2015 and 2020 are according to the "with measures" projections scenario. In January of 2011 the installed capacity for electricity production has overpass the target of 2nd National Climate Change Programme (installed capacity 4041.54 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. 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 4.10 Penetration of NG in the national energy system and projections according to WM scenario

Sector	2009	2010	2011	2015	2020
Power sector	76.1	86.3	108.4	108.8	105.1
Road transport	0.5	0.5	0.5	0.5	0.5
Industry	17.1	15.6	14.9	8.3	12.3
Commercial	6.1	5.8	6.9	4.2	4.9
Residential	10.7	10.7	14.6	12.0	12.7

Figures in PJ (NCV)

Important increase in the penetration of natural gas in the residential and the tertiary sector is observed for 2011 (21.5 PJ) compared to previous years.

Natural gas (0.5 PJ in 2011) is also consumed in the transport sector, where natural gas moving buses have already been placed in the public transportation system of Athens. The measure progresses satisfactory concerning the targets that had been placed within the 2nd National Climate Change Program.

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

- ✓ Fiscal measures
  - o Excise duty is 0
  - o Reduction of personal income taxation for converting the fuel installation from oil to natural gas, or installing a new natural gas fired one.
  - o Reduced VAT rate
- ✓ 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)

However, due to the economic recession and subsequent decrease of total energy consumption along with the increased share of RES, a decrease in use of NG (as every fuel) is expected in 2015 compared to 2011.

Based on the already implemented and adopted policies and measures for natural gas promotion, it is expected an increased penetration of natural gas in both the power generation sector, where in the framework of the liberalized market additional power units using natural gas as fuel will be installed in the upcoming years, and in the final demand sectors. The GHG reductions due to use of NG in the power sector are reported in the next section (section 4.3.2.3). The estimated reductions of GHG emissions due to implemented / adopted and planned policies in the final demand sectors are presented in ***Table 4.11***.

Table 4.11 Estimated GHG emissions reductions from NG use in final demand sectors

Sector	Policy status	2015	2020
Industry	Implemented / adopted	171	255
Residential	Implemented / adopted	255	271
Tertiary	Implemented / adopted	82	95
	Planned	-	20
Road	Implemented / adopted	9	10

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%).

4.3.2.3 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 Carbon Capture Ready 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.

Seven lignite-fired and five HFO-fired power units is expected to be decommissioned till 2020, while nine additional lignite-fired units till 2025. They will be substituted by NG-fired plants and RES.

The interconnection of islands to the mainland grid is being implemented according to the following phases:

- ✓ Interconnection of Cyclades islands (2016)
- ✓ Interconnection of Crete (2025)

The above-mentioned implemented / adopted measures are estimated to decrease GHG emissions by 13.4 Mt CO2eq in 2015 and 12.0 Mt CO2eq in 2020. The increased share of electricity from RES technologies will cause a reduced use of NG for electricity generation in 2020 compared to 2015.

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%).

4.3.2.4 Promotion of renewable energy sources

According to Greek National Action Plan for Renewable Energy Sources (time frame 2010-2020) the county's energy sector is planed to be reformed so that 20% of the primary energy use is coming from RES by 2020 (indicative penetration level: 40% electricity, 20% heat and 10% transport). In the electricity sector, the installation of almost 4.7 GW of wind energy plants is foreseen, together with 3.6 GW of PVs, 0.2 GW of bio-energy installations (biogas and solid biomass), 3.7 GW of hydro plants and pumped storage plants.

The implementation of Greek RES Roadmap is based on a sound legislative framework, the core of which is the law 3851/2010 (OG A/85/4th June 2010) on "Accelerating the development of Renewable Energy Sources to deal with climate change and other regulations in topics under the authority of the Ministry of Environment, Energy and Climate Change":

- ✓ The law aims to accelerate the permitting procedure of the larger projects as much as possible.
- ✓ Simplifies considerably the licensing of smaller projects.
- ✓ Offers new attractive feed-in-tariffs for all RES technologies (***Table 4.12***).
- ✓ Introduces new clauses for offshore wind.
- ✓ Deals with the NIMBY (Not In My Back Yard) phenomenon at several levels.
- ✓ Establishes an Autonomous RES Office to act as a One-Stop-Shop for RES-Electricity.

Table 4.12a Current renewable energy feed-in tariffs

Type of RES plants	Price of energy (€/MWh)	
	Interconnected System	Non-intercon-nected islands
On shore wind farms > 50 kW	87.85	99.45
Wind farms <= 50 kW	250	
Offshore wind farms	108.30	
Small Hyro plants < 15 MWe	87.85	
CSP	264.85	
CSP with storage system (at least 2h at nominal load)	284.85	
Geothermal energy of low temperature	150	
Geothermal energy of high temperature	99.45	
Biomass plants ≤1MW (excluding biodegradable sewages)	200	
Biomass plants >1 and ≤5MW (excluding biodegradable sewages)	175	
Biomass plants >5MW (excluding biodegradable sewages)	150	
Landfill gases sewage treatment plants and biogases (including biodegradable sewages) ≤2 MW	120	
Landfill gases sewage treatment plants and biogases (including biodegradable sewages) >2 MW	99.45	
Gas from biomass ≤3MW	220	
Gas from biomass >3MW	200	
Other	87.85	99.45

Source: http://www.lagie.gr (accessed on 24.01.2013)

Table 4.12b Current renewable energy feed-in tariffs for PV

Year / Month	Price of energy (€/MWh)		
	Interconnected System		Non-intercon-nected islands
	A	B	C
	>100 kW	<=100 kW	Regardless of kW
2012 August	180.00	225.00	225.00
2013 February	171.90	214.88	214.88
2013 August	164.16	205.21	205.21
2014 February	156.78	195.97	195.97
2014 August	149.72	187.15	187.15
For each year n from 2015 onwards	1.3 x $aSMP_{n-1}$	1.4 x $aSMP_{n-1}$	1.4 x $aSMP_{n-1}$

where aSMP is the Average System Marginal Price of the electrical system
Source: http://www.lagie.gr (accessed on 24.01.2013)

Table 4.12c Current renewable energy feed-in tariffs for small PV (<10kWpeak) in buildings of residential sector and small enterprises

Year / Month	Price of energy (€/MWh)
2012 August	250.00
2013 February	238.75
2013 August	228.01
2014 February	217.75
2014 August	207.95
2015 February	198.59
2015 August	189.65
2016 February	181.12
2016 August	172.97
2017 February	165.18
2017 August	157.75
2018 February	150.65
2018 August	143.87

Source: http://www.lagie.gr (accessed on 24.01.2013)

In NC5/Table 4.10, the installed capacity of RES systems as it was in December 2007 – January 2008 was presented. Since then, the evolution of Net Maximum Electricity Capacity from RES is presented in the ***Table 4.13***.

Table 4.13 Evolution of Net Maximum Electricity Capacity from RES

RES type	Reported in NC5 (Dec 2007 – Jan 2008)	2009	2010	2011	2012	March 2013
Large Scale Hydros	3017.8	3017.8	3017.8	3017.8	3017.8	3017.8
Small Scale Hydros	147.07	182.61	197.13	205.63	213.23	217.98
Wind	853.19	950	1294.15	1640.46	1742.84	1782.04
PV	1.3	46.037	186.82	521.85	1212.06	2350.93
Biogas / Biomass	38.72	40.8	41.05	44.53	44.75	45.31
Total	4058.08	4237,247	4736.95	5430.27	6230.68	7225.35

Figures in MW

Compared to what reported in NC5, 3356 additional MW have been installed. The status of ongoing RES projects that are within the licensing process are presented in the ***Table 4.14*** (March 2013). The projects with "installation authorization" have completed the licensing process and can start construction works.

Table 4.14 Status of RES projects in Greece (March 2013)

	Small Hydros	Wind	PV	Biogas / Biomass	Hybrids	CSP	Geothermal	Total
Production authorisation application	152.50	35525.5	100.00	173.10	506	424.25	20.00	24901.35
Production authorisation	968.30	23325.0	4453.64	446.70	294.65	417.80	8.00	29914.09
Connection offer obtained from HTSO*	92.44	4200.77	2359.55	149.48	4.15	50.38	-	6856.77
Purchase agreement with the HTSO*	50.30	1623.40	633.60	25.00	0.08	38.00	-	2370.38
Installation authorisation	21.28	787.16	1131.91	12.76	_	-	-	1953.11

Figures in MW

* Hellenic Transmission System Operator (HTSO)

Concerning the promotion of RES-heat-cooling technologies and in order to fully implement the National Renewable Energy Action Plan and to meet the "20- 20-20" targets new financial incentives for the support of the heat production from biomass and geothermal energy have been put in place or are planned. Also, the implementation of all the technical measures that are described in the Energy Performance of Buildings Regulation (KENAK), aiming to achieve significant energy savings has started since 2010. Although solar thermal applications already have a significant penetration in the Greek building sector, the legislative framework passed in 2010 along with the technical requirements that are set by KENAK on minimum required contribution of solar thermal systems for all new buildings, is expected to contribute further. The new building regulation will act as the main legislative tool for the promotion of RES systems for heating and cooling at the tertiary and residential sector but also in industry and the agricultural sector.

Furthermore, the successful implementation of end-use energy saving measures, along with the development of new market mechanisms (e.g. Energy Service Companies-ESCOs) for both the public and private sector as called for in Directive 2006/32/EC, which was transposed into Greek law in 2010, are considered essential in order to achieve the projected RES share in heating and cooling.

Concerning biofuels, 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. Recently, by decision 460/2009 (O.G. B’ 67/28.01.2010) of the State Chemical Council (SCC) the EN 590:2009 standard was adopted formally and the maximum biodiesel percentage was increased to 7%.

According to the directive 2003/30/EC, 5.75% of the total quantity of diesel and gasoline consumed in road transportation in Greece up to 2010, based on the energy content, has to be biofuel. The target for 2020 is 10% as in the rest European countries according to the directive 2009/28/EC. Greece has approved the target with the law L3851/2010.

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 14.9 Mt CO2eq in 2015 and 20.3 Mt CO2eq in 2020. Concerning biofuels in transport sector, the estimated reduction of GHG emissions according to implemented / adopted policies is expected to be 1147 ktCO2eq in 2015 and 2173 ktCO2eq in 2020.

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

4.3.2.5 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.

Concerning planned interventions, apart from the further promotion of natural gas and RES (biomass, solar energy) in industry, further implementation of energy conservation programs in various industrial units is pursued due to public financial support schemes (as the Development Assistance Act) and also the operation of the EU-ETS. Incentives for the creation of “Green Business Parks" and enhancing investment projects in industrial and business areas & innovation zones with energy efficient and low carbon facilities are planned.

It is estimated that the emissions reductions which can be achieved from the implementation of adopted measures in industry (CHP and PaMs included in national Energy Efficiency Action Plan) can reach 200 kt CO_2 eq in 2015 and 300 kt CO_2 eq in 2020. The effect of planned policies in GHG emissions reduction is expected to be 350 kt CO_2eq in 2020. The affected GHG from this policy is mainly CO_2 (more than 99%).

4.3.2.6 Measures in transport sector

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.

(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 was completed, while the connections with Livadia and Chalcida are 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 approximately 600 buses approximately 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.

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) is 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). Incentives for the replacement of passenger cars and promotion of energy efficient vehicles (natural gas, biofuels, hybrid cars) are under implementation or under planning phase.

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 is expected to contribute to GHG emissions reduction.

(D) New planned 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, Energy and Climate Change) 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 will be applicable until the end of 2013. Finally, the green ring was adopted in 2012 concerning traffic restriction measures for the older technology cars in the centre of Athens.

As GHG emissions have already decrease 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 150 kt CO2eq in 2015 and 300 kt CO2eq in 2020.

4.3.2.7 Measures in residential and tertiary sector

Several actions are included in the 2nd National Climate Change Program and 1st and 2nd 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.

An example of the financial incentives and subsidies for the replacement of low energy class household devices is the programme “Replace air-conditioning appliance, co-funded by the 4th Community Support Framework 2007-2013, which lasted from June 2009 to August 2009. It aimed to replace air-conditioning appliances of low energy performance with high energy performance (inverter technology) appliances of energy class A or B, within the cooling range of 9000 Btu/h to 24000 Btu/h. The scheme provided a 35% subsidized price, (up to 500 Euro per appliance) for new appliances replacing old ones. A total number of 140672 air-conditioning appliances were replaced resulting in 53.01 GWh energy savings annually and a correspondingly reduction of 46.65 kt of CO2 emissions.

In ***Tables 4.15 and 4.16***, the energy efficiency measures related to residential and tertiary sector are presented. It is estimated that the total decrease of 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 1.3 and 2.2 Mt CO2eq for 2015 and 2020, respectively. The effect of planned policies in GHG emissions reduction is expected to be 300 kt CO2eq in 2020. The affected GHG from the measures described in this section is mainly CO2 (more than 99%).

Table 4.15 Energy efficiency measures in the residential sector (source: 2nd National Energy Efficiency Action Plan)

Title of measure	End-use targeted	Duration	Brief description
Targeted education campaigns, provision of information and rewarding of "good practices"	Use of energy efficient appliances and rational use of energy use by all citizens and in all end-use sectors	Start: 2008	Targeted education campaigns, provision of information and rewarding of "good practices" in order to spread the message to the general public about the benefits and the prospects for the entire development effort of Greece, the reduction of air pollution and the long-term conservation and rehabilitation of the environment that can flow from the adoption of energy-saving measures. Making people aware of the direct financial benefit to be gained by the application of simple energy-saving measures, thus encouraging them to adopt those measures.
Tax exemptions of energy savings interventions	Energy efficient technologies / interventions in all end-use areas	Start: 2000	Law 3522/2006 "Changes in income tax, simplifications to the Code of Books and Records and other provisions" Article 2(2), providing for a 20% deduction from revenue of expenditure up to amount of 700 euros for the implementation of energy efficiency improvement interventions. Law 3842/2010 "Restoring tax fairness, tackling tax evasion and other provisions" Article 1(4)(i) provides for a 10% tax deduction of expenditure for building upgrade interventions following energy inspection, pursuant to the provisions of Law 3661/2008 and its delegated acts. The amount of expenditure, based on which the deduction is determined, may not exceed 6,000 euros.
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

Title of measure	End-use targeted	Duration	Brief description
			and environmental costs incurred by consumers.
"Energy saving at home" programme – Energy upgrading of residential building envelopes - Financial aid for the upgrading of heating system boilers / burner units in existing buildings	Energy consumption for domestic hot water, heating-cooling	Start: 1/2/2011	The "Energy saving 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 programme covers old, authorised buildings, which were not built under the Thermal Insulation Regulation (Presidential Decree dated 1.5/4.7.1979, Government Gazette, Issue IV, No 362), are located in areas with a zone price less than or equal to 2,100 euros/m2, are used as primary or secondary residence and whose owners meet certain income criteria.
Compulsory installation of central solar thermal systems in new residential buildings and financial incentives for further penetration of small-scale solar thermal systems in residential buildings	Energy consumption for domestic hot water, heating-cooling	Start: 2012	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.
"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.
Energy upgrading of social housing buildings- "Green Neighbourhood" programme	Total energy consumption of the target group	Start: 2011 End: 2012	The objective of the programme is to upgrade four industrial buildings to nearly zero energy buildings and optimise the local microclimate.

Table 4.16 Energy efficiency measures in the tertiary sector (source: 2nd National Energy Efficiency Action Plan)

Title of measure	End-use targeted	Duration	Brief description
Compulsory installation of central solar thermal systems in the buildings of the tertiary sector	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 installation of central solar thermal systems to meet domestic hot water requirements	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.
Compulsory procurement procedures with respect to public buildings (green procurement – energy-efficient and RES technologies)	Total energy consumption of the target group	Start: 2008	Public expenditure on goods, services and works, at pan-European level, account for about 17% of the European GDP every year. They involve, among others, the procurement of electronic and electrical equipment, devices, computer hardware, construction, textile, food, energy, paper, furniture, transport and cleaning. All these goods, services and works have significant environmental impacts during their entire life cycle, from production, use up to their withdrawal. They are responsible for greenhouse gas emissions, pollution, reduced biodiversity and depletion of natural resources. Green Public Procurement (GPP) is a tool that provides the necessary incentives to significantly reduce these negative impacts.
Integrated energy planning by municipalities – "ENERGY EFFICIENCY" (ΕΞΟΙΚΟΝΟΜΩ) Programme	Total energy consumption of the target group	Start: 2009	The purpose of the "ENERGY EFFICIENCY" (ΕΞΟΙΚΟΝΟΜΩ) Programme is the implementation of actions and proven best practices for reducing energy consumption in the urban environment, with emphasis on the building sector (municipal buildings) and the upgrade of public spaces, on one hand, and in the area of

Title of measure	End-use targeted	Duration	Brief description
			municipal and private transport and energy intensive municipal facilities, on the other, through the implementation of technical interventions and actions to raise awareness and mobilise citizens, the local government, businesses and bodies. Furthermore, the participation of Greek municipalities in the European initiative "Covenant of Mayors" which aims at integrated energy planning at the local level and achieving specific environmental objectives is supported and promoted both at central and at regional level.
Compulsory replacement of all light fittings with low energy efficiency 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 lighting units with low energy efficiency by units with high efficiency (lamps, ballasts, reflectors, etc.). • annual recording / reporting of energy interventions and redetermination of the target for further improvement.
Implementation of Green Roofs to public buildings	Energy consumption for cooling-heating	Start: 2011	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 reversing climate change. It aims at: • improving thermal, optical and environmental conditions of the users of public buildings • informing more people of the techniques, advantages

Title of measure	End-use targeted	Duration	Brief description
			and features of Green Roofs • reducing energy consumption, limiting the emission of greenhouse gases and therefore contributing to climate change reversal
Programme of Bioclimatic Urban Reformation	Energy consumption for cooling-heating	Start: 2011	The program involves bioclimatic interventions in areas where significant climate problems are observed and its main objective is to improve the quality of life, to slow down and ultimately to reverse the urban climate change and to improve the economic and social parameters associated with it. Projects meeting specific climate targets and for which fully mature studies have been prepared are eligible.
Installation of high-efficiency cogeneration of heat and power (CHP) systems with natural gas in hospitals	Energy consumption for heating, domestic hot water, electricity production	Start: 2011	Installation high-efficiency cogeneration of heat and power units with natural gas to hospitals, with a view to improve energy efficiency
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 onstruction school buildings to improve energy efficiency
Energy saving interventions in public buildings	Final energy consumption of the buildings in the target group	Start: 2011	

4.3.2.8 Measures in agricultural sector

The legislative framework concerning the rules for agriculture production in Greece is fully harmonized with the European Common Agricultural Policy (CAP) and it incorporates actions contributing to the decrease of greenhouse gas emissions from agricultural activities. The legislative framework is based mainly in the Council regulations (EC) no 1782/2003 and 73/2009 and in the Council regulation (EC) no 1698/2005 for Rural Development concerning the period 2007-2013. The main regulations and directives included in the European Common Agricultural Policy are presented in ***Table 4.17***.

Table 4.17 Regulations and directives included in legislative framework for agriculture production in Greece

Regulation / directives	Description
Council regulations (EC) no 1782/2003 and 73/2009	Common rules for direct support schemes for farmers under the common agricultural policy
Council regulation (EC) no 1698/2005	Support for rural development by the European Agricultural Fund for Rural Development (EAFRD)
Council regulation (EC) no 1290/2005	Financing of the common agricultural policy
Council regulation (EC) no 74/2009	Amending Regulation (EC) No 1698/2005 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD)
Council regulation (EC) no 834/2007	Organic production and labeling of organic products
Council directive 91/271/EC of 21 may 1991	Urban waste water treatment
Directive 2000/60/ec of the european parliament and of the council	Establishing a framework for Community action in the field of water policy

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

- ✓ Organic production.
- ✓ Decrease of the use of synthetic nitrogen fertilizers by 30% beyond the limit defined in cross compliance system.
- ✓ Decrease in agricultural production for the reduction of the rate of intensity of agricultural land use on the framework of Environmental Protection and Sustainable Management of natural resources. Decrease of grazing density through the decrease of livestock population and adoption rules for management of farm waste.
- ✓ Disengagement of subsidies from the agricultural production.
- ✓ Improving management of animal waste
- ✓ Improvement of energy efficiency, renewable energy generation and use, including biomass

Organic production and decrease of the use of synthetic nitrogen fertilizers result in a substantial decrease of N_2O emissions. According to the Ministry of Rural Development and Food records, the total land with organic farming in Greece concerns about 300,000 ha while the total land concerning the decrease of the use of synthetic nitrogen fertilizers by 30% beyond the limit defined in cross compliance system concerns about 110,000 ha. The total area covering the actions of Rural Development Program in Greece is expected to extend to 720.000 hectares by the end of 2013.

Decrease in agricultural production for 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 contribute to the reduction of GHGs.

Additional, 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.

As far as the legal framework for the EU Rural Development for 2014-2020 is concerned it has been reviewed as part of the political agreement for the CAP reform (June 2013); the development of the new programmes will be based on the revised legal provisions. The priorities set for the policy framework reflect the increased importance of sustainable development of agricultural activities and rural areas, with a focus on climate change mitigation and adaptation objectives.

In total, the measures in the agricultural sector are expected to reduce GHG emissions as presented in ***Table 4.18***.

Table 4.18 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	100	100	100
Organic farming (N_2O)	300	350	400	450
Reduction of Animal Population	270	430	550	650
Total	**670**	**880**	**1050**	**1200**

4.3.2.9 Measures in the industrial processes sector

Concerning fluorinated gases, Greece has the commitment to implement Directive 2002/96/EC and its modification 2003/108/EC for the recovery of f-gases from air conditioning and refrigeration equipment. The directives have been incorporated in the national legislation with the P.D. 117/2004 and P.D.15/2006, while the enhancement for electric and electronic equipment recycling actions is promoted by the OPC (Action 2.9.4).

Furthermore, the Regulation (EC) 1005/2009 of the European Parliament and of the Council, which was introduced in 1/1/2010 and replaced the earlier Regulation (EC) 2037/2000, concerning the ozone depleting substances, is the main tool for the implementation of the Montreal Protocol in the EU. The regulation adopts a time schedule for the reduction of hydrochlorofluorocarbons, such as HCFC-22 (HCFC-22 is the source of HFC-23 emissions), with specific quantitative targets for several periods (2010–2013, 2014 – 2016 and 2017 – 2019) compared to 1997 production. Production of hydrochlorofluorocarbons is not allowed after 31 December 2019. The only plant producing HCFC-22 in Greece has ceased operation since 2006. The designation of the competent authorities, measures and procedures for the implementation of Regulation (EC) 2037/2000 on substances that deplete the ozone layer, is based on the JMD 37411/1829/E103 (O.G.G B 1827/11 September 2007).

Finally, the Regulation 842/2006 of the European Parliament and of the Council of 17 May 2006 on certain fluorinated greenhouse gases and its implementing acts (supplementary regulations: 1516/2008, 1497/2008, 1494/2008, 1493/2008, 303/2008, 304/2008, 305/2008, 306/2008, 307/2008 and 308/2008), is anticipated to reduce emissions of certain fluorinated gases (HFCs, PFCs and sulphur hexafluorides), to improve containment and monitoring of these gases and restrict their marketing and use. The regulations, although not needed, have been incorporated in the national legislation with the JMD 18694/658/E103 (O.G.G. 1232/B/11-4-2012) in order to improve the national legislation for the environment with necessary measures for the proper management and reduction of fluorinated greenhouse gases emissions.

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. emissions from plants producing cement, lime, ceramics, glass, iron and steel, ferroalloys, alluminium (PFCs), nitric acid (N2O)). The cap and trade principle of EU ETS is described in section 4.3.1.3.

4.3.2.10 Measures in the waste sector

National policies and measures for the waste sector are related to the operation of managed solid waste disposal sites. With Decision 50910/2727 (December 2003), the measures, the terms and the processes for the rational management of waste in national and regional level have been specified. Fundamental objectives are the elimination of unmanaged solid waste disposal sites, the coverage of all urban and rural areas of the country with modern installations for final disposal and the promotion of measures for the prevention and reduction of produced waste, as well as the exploitation of materials with maximization of recycling and recovery of products and energy.

The necessity to reduce the quantities of biodegradable wastes landfill through the installation of treatment facilities, Joint Ministerial Decision 29407/3508 in agreement with Directive 1999/31/EC, is acknowledged. Based on this Directive, it is estimated that the biodegradable wastes landfill will be 2.7 Mt, 2.7 Mt, 2.9 Mt and 3.0 for the years 2015, 2020, 2025 and 2030, respectively. The implementation of the Directive is expected to contribute in the reduction of GHG emissions (CH4) at approximately 0.5 Mt CO2eq, 0.8 Mt CO2eq, 1.1 Mt CO2eq and 1.4 Mt CO2eq in 2015, 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 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 CO2 eq, 500 kt CO2 eq, 500 kt CO2 eq and 500 kt CO2 eq for the years 2015, 2020, 2025 and 2030, respectively.

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 2011, 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 up to now 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.

4.3.2.11 Measures in 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 directive 958/1953.

The measures for the LULUCF sector are arisen from rural development actions and other financial mechanisms. In the overall Greek fiscal deficiency the policies already implemented and measures taken, and those that are expected to be adopted according to the Rural Development Program “Alexandros Mpaltatzis” (concerning the forth programming period 2007-2013) aim for the above mentioned targets achievement, contribute to the mitigation of the climate change, and could be divided into the following broad categories:

1. Forest protection
   - ✓ A large number of activities take place every year in the context of the forest fires prevention policy. The fuel management and the vegetation treatment at the most vulnerable forest areas, the conservation of the existing mountainous road network and the development of new roads where necessary, the regular patrolling during the fire season, and the public awareness campaigns are the main preventative measures against forest fires.
   - ✓ Furthermore, the Greek Ministry of Environment, Energy and Climate Change (MEEC) elaborates policy measures in the context of the acceleration and simplification 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. With the completion of the current Forest Map project the 62.5% of the total estimated forest area is expected to be recorded, while the procurement for the rest area is due in 2013.
2. Forest management
   - ✓ One of the main responsibilities of the Greek Forest Services is the forest management through the development and implementation of the Forest Management Plans. For that purposes, financial and human resources are allocated in order either to update the Forest Management Plans that have been expired or to develop new ones. The public forest wood production (timber, industrial and fuelwood) in 2010 was approximately 738,806.00 m3, while the wood production from private forests (approximately 36% of the total forest land) was approximately 309,156.00 m3.
   - ✓ Additionally, in some regions the treatment of the forests for resin production purposes is being implemented with a significant economic, social and ecological (preventative) value.
3. Restoration – increase of forest lands
   - ✓ The rehabilitation of burnt and degraded (flood and erosion protection) forest lands has always been a main part in the Forest Service’s agenda. During 2010 the public nurseries in operation numbered 33 in which 4,928,686.00 of plants of different forest species (evergreen, deciduous) were produced. The area reforested in 2008, 2009, and 2010, as well as the amount of money spent on those projects were 1,118.00 ha, 1,124.00 ha, 0.531 ha, and 2,195,000.00€, 1,879,200.00€, and 808,500.00€, respectively.
4. Adaptation of forest management to climate change
   - ✓ In January 2010, the Life+ project entitled AdaptFor “Adaptation of Forest Management to climate change in Greece” was launched, which is implemented by

the Goulandris Natural History Museum / Greek Biotope - Wetland Centre in cooperation with the General Directorate for the Development and Protection of Forests and Natural Environment (MEEC), and is expected to be completed in June 2013. The project's objectives are: the demonstration of the approach of adapting forest management to climate change, the enhancement of the capacity of forest services to adapt forest management to climate change, and the dissemination of the need for adaptation of forest management to climate change to other stakeholders and to the general public.

5. Other projects

- ✓ A couple more projects that have already been launched under the Rural Development Program "Alexandros Mpaltatzis" (2007-2013) are "The improvement of the employment in the framework of forest fire prevention and the restoration of forest areas affected by forest fires", and "The opening and conservation of the road network into the forests under forest management".

Table 4.19 Effects of implemented / adopted policies and measures (included in the "with measures" scenario)

P&M No	Policies and Measures	Activity Affected	GHG affected	Type of instrument	Status	Implementing entity/ entities	Effects of Policies and Measures (kt CO2 eq) 2005	2010	2015	2020
PROMOTION OF NATURAL GAS										
1	Gradual decommissioning of old inefficient thermal power units and commissioning of new ones – increase of NG share in electricity production	Elec. generation	CO_2	Economic	I	PPC / Private / MEECC	6017	11171	13423	11951
2	Natural gas in residential sector	Thermal uses	CO_2	Economic	I	MEECC	53	187	255	271
3	Natural gas in tertiary sector	Thermal uses	CO_2	Economic	I	MEECC	54	102	82	95
4	Natural gas in industry	Thermal uses	CO_2	Economic	I	MEECC	378	388	171	255
5	Use of natural gas in transportation	Road transport	CO_2	Economic	I	MTT / MEECC	8	9	9	10
PROMOTION OF RENEWABLE ENERGY SOURCES										
6	Promotion of RES for electricity generation	Elec. generation	CO_2	Economic / Fiscal / Regulatory	I	RAE / MEECC / Private	1019	12221	14855	20323
7	Biofuel use in transportation	Road transport	CO_2	Economic / Fiscal / Regulatory	I	MTT / MEECC	-	392	1147	2173
8	**Interconnection of islands to mainland's electrical grid**	Elec. generation	CO_2	Economic	I	MEECC / LAGIE	-	-	IE	IE
INDUSTRY										
9	Partial implementation National Energy Efficiency Action Plan	Energy conservation	CO_2	Economic / Fiscal / Regulatory / Information	I	MEECC	-	NE	200	300
RESIDENTIAL & TERTIARY SECTOR										
10	Partial implementation National Energy Efficiency Action Plan	Energy conservation	CO_2	Economic / Fiscal / Regulatory /	I	MEECC	-	NE	1300	2200

P&M No	Policies and Measures	Activity Affected	GHG affected	Type of instrument	Status	Implementing entity/ entities	Effects of Policies and Measures (kt CO2 eq) 2005	2010	2015	2020
				Information						
TRANSPORT SECTOR										
11	Interventions in vehicles	Road transport	CO_2 / CH_4 / N_2O	Fiscal / Regulatory / Economic	I	MTT / MEECC	-	-	150	300
WASTE SECTOR										
12	Recovery of organic waste	Waste management	CH_4	Planning	I	MEECC	-	-	500	800
13	Recovery of biogas	Waste management	CH_4	Planning	I	MEECC	-	-	500	500
AGRICULTURE SECTOR										
14	Establishing common rules for direct support schemes under the common agricultural policy: Reduce of the rate of intensity of agricultural land use. Reduction of agricultural production. Adoption rules for management of farm waste.	Agric. Production	CH_4 / N_2O	Planning	I	MRDF	-	-	270	430
15	Establishing common rules for direct support schemes under the common agricultural policy: Increase of organic farming.	Agric. Production	N_2O	Planning	I	MRDF	-	-	300	350
16	Establishing common rules for direct support schemes under the common agricultural policy: Decrease of the use of synthetic nitrogen fertilizers by 30% beyond the limit defined in cross compliance system.	Agric. Production	N_2O	Planning	I	MRDF	-	-	100	100

I : Implemented A : Adopted NE.: not estimated

Table 4.20 Effects of planned policies and measures

P&M No	Policies and Measures	Activity Affected	GHG affected	Type of instrument	Implementing entity/ entities	Effects of Policies and Measures (kt CO2 eq) 2020
PROMOTION OF NATURAL GAS						
17	Gradual decommissioning of old inefficient thermal power units and commissioning of new ones – increase of NG share in electricity production (additional effect according to WAM scenario).	Elec. generation	CO_2	Economic	PPC / Private / MEECC	150
18	Wider use of natural gas in residential sector	Thermal uses	CO_2	Economic	MEECC	-
19	Wider use of natural gas in tertiary sector	Thermal uses	CO_2	Economic	MEECC	20
20	Wider use of natural gas in industry	Thermal uses	CO_2	Economic	MEECC	7
21	Wider use of natural gas in transportation	Road transport	CO_2	Economic	MTT / MEECC	-
PROMOTION OF RENEWABLE ENERGY SOURCES						
22	Wider use of RES for electricity generation	Elec. generation	CO_2	Economic / Fiscal / Regulatory	RAE / MEECC / Private	233
23	Wider use of biofuel in transportation	Road transport	CO_2	Economic / Fiscal / Regulatory	MTT / MEECC	15
INDUSTRY						
24	Wider use of CHP	Power / heat gener.	CO_2	Economic	MEECC / private	350
25	Full implementation National Energy Efficiency Action Plan	Energy conservation	CO_2	Economic / Fiscal / Regulatory / Information	MEECC	-
RESIDENTIAL & TERTIARY SECTOR						
26	Full implementation National Energy	Energy	CO_2	Economic /	MEECC	200

P&M No	Policies and Measures	Activity Affected	GHG affected	Type of instrument	Implementing entity/ entities	Effects of Policies and Measures (kt CO2 eq) 2020
	Efficiency Action Plan	conservation		Fiscal / Regulatory / Information		

I : Implemented A : Adopted NE.: not estimated
MEECC: Ministry of Environment, Energy and Climate Change
MECS : Ministry of Economy, Competitiveness and Shipping
MITN : Ministry of Infrastructure, Transport and Networks
MRDF : Ministry for Rural development and Food
RAE : Regulative Authority for Energy
PPC : Public Power Corporation
LAGIE: National Operator of Electricity Market

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 en-ergy (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 Comission 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 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 com-modity prices are expected for third countries.

Commission regulation implementing Directive 2009/125/EC with regard to ecodesign 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 abso-lute costs related to product re-design and re-assessment.

With regard to impacts on trade, the process for establishing ecodesign 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' [10] b) the 'Roadmap to a Single European Transport Area - Towards a Competitive and Resource Efficient Transport System'[11] and c) the 'Energy Roadmap 2050.' [12] 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 Energ 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

[10] COM (2011) 112 final
[11] COM (2011) 144 final
[12] 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.

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” scenario and a “with additional measures” (WAM) scenario concerning the national projections of greenhouse gas emissions by sources and their removal by sinks for the years 2015, 2020, 2025 and 2030. The “with measures” scenario assumes that no additional emission reduction policies and measures are adopted than the existing ones (implemented and adopted). The “with additional measures” scenario assumes the implementation of additional policies (planned) that are described below, while their GHG reduction effect will be mainly materialised after 2020. 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, Energy and Climate Change.

The projections of GHG emissions in the “with measures” scenario disaggregated by sector and by gas are presented in ***Tables 5.1*** and ***5.2.*** The projections of the “with additional measures” scenario, disaggregated by sector and by gas are presented in Tables ***Tables 5.3*** and ***5.4***. In ***Figure 5.1*** the evolution of GHG emissions and their projections till year 2030, along with the assigned amount of Greece for the first commitment period of Kyoto Protocol are presented. In ***Tables 5.5*** and ***5.6***, a split of the projections for years 2015 and 2020 of the GHG emissions is presented between the sectors covered and not covered by the EU ETS.

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

Sources/Sinks	1990	1995	2000	2005	2010	2015	2020	2025	2030
Energy	77171	80619	96483	106231	92293	68110	77285	60785	66223
Industrial Processes	10073	12263	13712	13881	10496	11207	13081	14982	16805
Solvents	308	300	307	309	316	320	325	356	392
Agriculture	11460	10319	9940	9541	9271	8952	8758	9548	10416
Waste	5574	5788	5782	4958	4902	4993	5403	5847	6348
Total	**104587**	**109289**	**126224**	**134921**	**117278**	**93583**	**104852**	**91519**	**100184**
LULUCF	-2501	-3174	-2743	-2807	-2642	-2723	-2977	-2704	-2615

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

Gas	Base Year	1990	1995	2000	2005	2010	2015	2020	2025	2030
CO_2	82909	82909	86350	102501	112802	96559	72326	82103	67021	73141
CH_4	10336	10336	10595	10834	10163	9784	9483	9889	9987	10814
N_2O	10239	10239	8997	8537	7910	7316	7146	7206	7806	8490
HFCs	3290	935	3290	4244	3969	3512	4495	5495	6500	7500
PFCs	54	163	54	105	70	102	128	154	198	232
SF_6	4	3	4	4	6	6	6	6	7	8
Total	**106833**	**104587**	**109289**	**126224**	**134921**	**117278**	**93583**	**104852**	**91519**	**100184**
Change from base year	**100**	**-**	**102**	**118**	**126**	**110**	**88**	**98**	**86**	**94**

Table 5.3 Projection of GHG emissions in the "with additional measures" scenario, disaggregated by sector (kt CO_2 eq)

Sources/Sinks	1990	1995	2000	2005	2010	2015	2020	2025	2030
Energy	77171	80619	96483	106231	92293	68369	76309	57253	60938
Industrial Processes	10073	12263	13712	13881	10496	11207	13081	14982	16805
Solvents	308	300	307	309	316	320	325	356	392
Agriculture	11460	10319	9940	9541	9271	8952	8758	9548	10416
Waste	5574	5788	5782	4958	4902	4993	5403	5847	6348
Total	**104587**	**109289**	**126224**	**134921**	**117278**	**93842**	**103876**	**87987**	**94899**
LULUCF	-2501	-3174	-2743	-2807	-2642	-2723	-2977	-2704	-2615

Table 5.4 Projections of GHG emissions (excluding LULUCF) in the "with additional measures" scenario, disaggregated by gas (kt CO_2 eq)

Gas	Base Year	1990	1995	2000	2005	2010	2015	2020	2025	2030
CO_2	82909	82909	86350	102501	112802	96559	72505	81009	63461	67765
CH_4	10336	10336	10595	10834	10163	9784	9476	9867	9876	10707
N_2O	10239	10239	8997	8537	7910	7316	7233	7346	7944	8687
HFCs	3290	935	3290	4244	3969	3512	4495	5495	6500	7500
PFCs	54	163	54	105	70	102	128	154	198	232
SF_6	4	3	4	4	6	6	6	6	7	8
Total	**106833**	**104587**	**109289**	**126224**	**134921**	**117278**	**93842**	**103876**	**87987**	**94899**
Change from base year	**100**	**-**	**102**	**118**	**126**	**110**	**88**	**97**	**82**	**89**

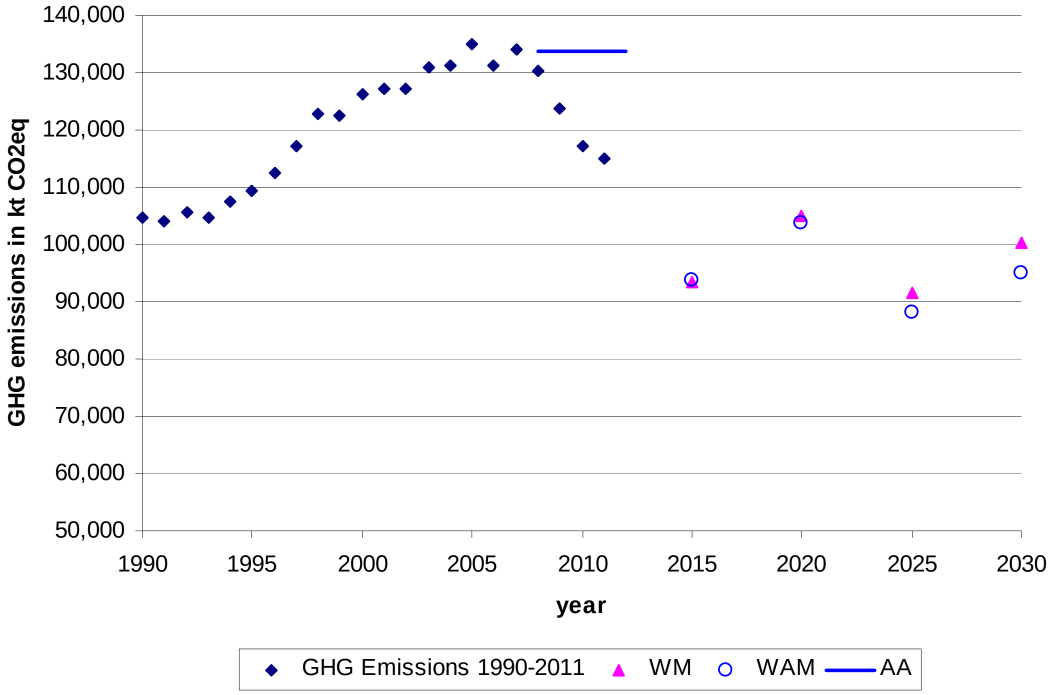


Figure 5.1 GHG emissions projection per scenario

Table 5.5 GHG emissions (in kt CO2eq) of the sectors not covered by the EU ETS according to WM scenario

Non-ETS emissions	2015	2020
Total (excluding LULUCF and all aviation emissions)	**49786**	**58228**
Energy - Energy Industries (1A1)	1081	1119
Manufacturing Industries and Construction (1A2)	3275	4107
Transport (1A3) - **excluding domestic aviation**	16700	22544
Other combustion sectors (1A4 + 1 A5)	8559	8951
Energy - Fugitive emissions form fuels (1B)	1003	1065
Industrial Processes (2)	4903	5957
Solvents and other product use (3 + 7)	320	325
Agriculture (4)	8952	8758
Waste (6)	4993	5403

Table 5.6 GHG emissions (in kt CO2eq) of the sectors covered by the EU ETS according to WM scenario

ETS emissions	2015	2020
Total excluding LULUCF and including international bunkers	**54269**	**61200**
Energy - Energy Industries (1A1)	34542	35744
Manufacturing Industries and Construction (1A2)	2272	2586
Other combustion sectors (1A4 + 1 A5)		
Energy - Fugitive emissions form fuels (1B)		
Industrial Processes (2)	6304	7124
Aviation (all in- and outgoing flights, i.e. domestic and international)	11152	15745
Domestic aviation (1A3a)	680	1170
International Bunkers	10472	14576

The fulfilment of the Kyoto Protocol target (1st commitment period) is evaluated through a comparison between:

1. the total GHG emissions of the years 2008-2012, and
2. the Assigned Amount of Greece for the same period (668,669,806 t CO2 eq)[13].

The total GHG emissions of Greece for the 1st comittemnt period are estimated by summing the reported GHG emissions for the years 2008-2011 (2013 GHG submission to UNFCCC) and a proxy GHG inventory prepared for the year 2012 GHG[14].

The available AAUs at the end of the 1st KP are estimated from the initial Assigned Amount by taking into account the ETS-effect and the removals from forestry activities under Article 3.3 and 3.4 (forest management):

- ✓ The estimated RMUs from these activities are about 3 Mt CO2 eq for the period 2008-2012. It should be mentioned that Greece has selected a commitment period accounting for 3.3 and 3.4 activities.

- ✓ The anticipated ETS-effect, i.e. the algebraic sum of CO2 emitted from installations covered by the ETS (2008-2012) minus the CO2 allowances (EUAs) allocated to these installations is estimated to have a small effect to the assigned amount, which is estimated to reduce the available AAUs by about 4%.

As it is obvious from ***Table 5.7*** and ***Figure 5.1***, Greece achieves Kyoto Protocol target for the first commitment period, on the basis of the domestic policies and measures implemented. It should be mentioned that the figures of ***Table 5.7*** are provisional, since they will be finalised when the accounting of the 1st commitment period of the KP will be completed, i.e. after the UNFCCC review of the Greek GHG inventory in 2014.

[13] FCCC/IRR/2007/GRC http://unfccc.int/national_reports/initial_reports_under_the_kyoto_protocol/items/3765.php

[14] It is an early approximate estimation of the GHG emissions prepared in year X (July) for year X-1, prepared by the Greek inventory team. It is being communicated to DG CLIMA / EC pursuant to MMR.

Table 5.7 Evaluation of the progress in achievement of the KP 1st commitment period target.

Total GHG emissions (excluding LULUCF) for 2008-2011 (kt CO2eq)	**486,291**
Estimation of total GHG emissions (excluding LULUCF) for 2012 (kt CO2eq)	119,200
Estimation of total GHG emissions (excluding LULUCF) for 2008-2012 (kt CO2eq)	605,479
Assigned Amount of Greece (kt CO2eq)	**668,669.806**
Estmation of RMUs issuance (kt CO2eq)	3,000
Estimation of EU-ETS effect (kt CO2eq)	-28,000
Adjusted AA including EU-ETS effect and RMUs	**643,670**
Estimated surplus(+) / deficit (-) of AAUs for 1st KP period	**38,000**

Concerning the 2020 non-ETS target of Greece pursuant to European legislation (2013/162/EU and its amendment 2013/634/EU), by comparing the annual emissions allocation for the years 2013-2020 (Annex 1 of 2013/634/EU) with the projected emissions from non-ETS sectors (***Table 5.5***), 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 second IPCC assessment report. However, the same conclusion would result if global warming potential values from the fourth IPCC assessment report were considered.

5.2 Assessment of aggregate effects of policies and measures

In this chapter the estimated and expected total effect of implemented, adopted and planned policies and measures is presented. The effects of individual policies and measures are reported in the policies and measures section (chapter 4).

The aggregate effect of currently implemented and adopted policies and measures (that is incorporated in the "with measures" projections scenario) is presented in ***Tables 5.8*** in terms of GHG emissions avoided on a CO2 equivalent basis, while the effect of planned policies and measures is illustrated in ***Table 5.9***. The difference between the "with measures" and "with additional measures" projections scenarios equals to the total effect of planned policies and measures. The effect of policies, or with other words GHG emissions avoided, correspond mainly to CO2 (more than 99%), with the exception of policies in 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.

Table 5.8 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
Promotion of Natural Gas (CO2 99,7%, CH4 0,02%, N2O 0,28%)	6510	11857	13940	12582
Promotion of Renewable Energy Sources (CO2 99,7%, CH4 0,02%, N2O 0,28%)	1019	12613	16002	22496
Measures in Industry (CO2 99,7%, CH4 0,02%, N2O 0,28%)	IE[15]	IE	200	300
Measures in Residential & Tertiary Sector (CO2 99,7%, CH4 0,02%, N2O 0,28%)	IE[16]	IE	1,300	2200
Measures in Transport Sector (CO2 98,9%, CH4 0,3%, N2O 0,8%)	IE[17]	IE	150	300
Measures in Waste Sector (only CH4)		200	1000	1300
Measures in Agriculture Sector (CH4 30%, N2O 70%)		160	670	880
Total Effect	7529	24830	33262	40058

Table 5.9 Aggregate effect of planned policies and measures (kt CO2 eq)

Policies and Measures	Effect of planned policies and measures
	2020
Promotion of Natural Gas (CO2 99,7%, CH4 0,02%, N2O 0,28%)	177
Promotion of Renewable Energy Sources (CO2 99,7%, CH4 0,02%, N2O 0,28%)	248
Measures in Industry (CO2 99,7%, CH4 0,02%, N2O 0,28%)	350
Measures in Residential & Tertiary Sector (CO2 99,7%, CH4 0,02%, N2O 0,28%)	200
Total Effect	975

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

According to the 2nd National Climate Change Programme adopted in 2002 and the latest projections presented in Chapter 5.1, Greece has the ability to reach its Kyoto Protocol target for the 1st and 2nd commitment period with the existing implemented and adopted policies and measures and the implementation of EU-ETS. For this reason, Greece has not as yet fully exploited the opportunities or allocated a specific budget for the use of the JI and CDM.

However, JI and CDM credits have been utilized by the installations subject to the EU-ETS. According to the National Allocation Plan 2008-2012, installations are allowed to use for compliance credits from these two mechanisms up to 9% of their allocated allowances. This figure was calculated according to the supplementarity principle of the Kyoto Protocol.

[15] The mitigation effect on GHG emissions from the substitution of diesel, HFO and solid fuels by natural gas in industry is included under the policy “promotion of natural gas”.

[16] The mitigation effect on GHG emissions from the substitution of diesel by natural gas in residential and tertiary sectors is included under the policy “promotion of natural gas”.

[17] The mitigation effect on GHG emissions from the use of biofuels in transportation is included under the policy “Promotion of Renewable Energy Sources”.

5.4 Methodology used for the presented GHG emission projections

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

- The combination of TIMES - MARKAL, WASP and COST models for the energy sector.
- 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 IPCC guidelines.

5.4.1 Energy Sector

5.4.1.1 Methodology

In order to simulate the Greek energy system and to project its future structure and the implied greenhouse gases emissions, the TIMES / MARKAL model was used along with WASP IV model (for optimum electricity generation planning) and COST model (for the stochastic simulation of Electricity Generation System). The execution of the above mentioned models was performed by the personnel of the **Center for Renewable Energy Sources / Energy Systems Analysis Lab**. 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. In ***Figure 5.2*** an illustrative graphical presentation of the use of the three models is presented.

The evaluation of policies has been performed using the TIMES - MARKAL energy model. TIMES - MARKAL 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 - MARKAL 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 - MARKAL 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 - MARKAL 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 WASP IV model of the International Association for Energy Economics (IAEE) has been used. Using WASP enables the identification of the best possible electricity generation system that satisfies the given energy demand.

Finally, the COST model has been used in order to simulate the operation of the energy generation system. This model identifies the analytical charging of the electricity generation units and the cooperation between the wind farms and the thermal stations.

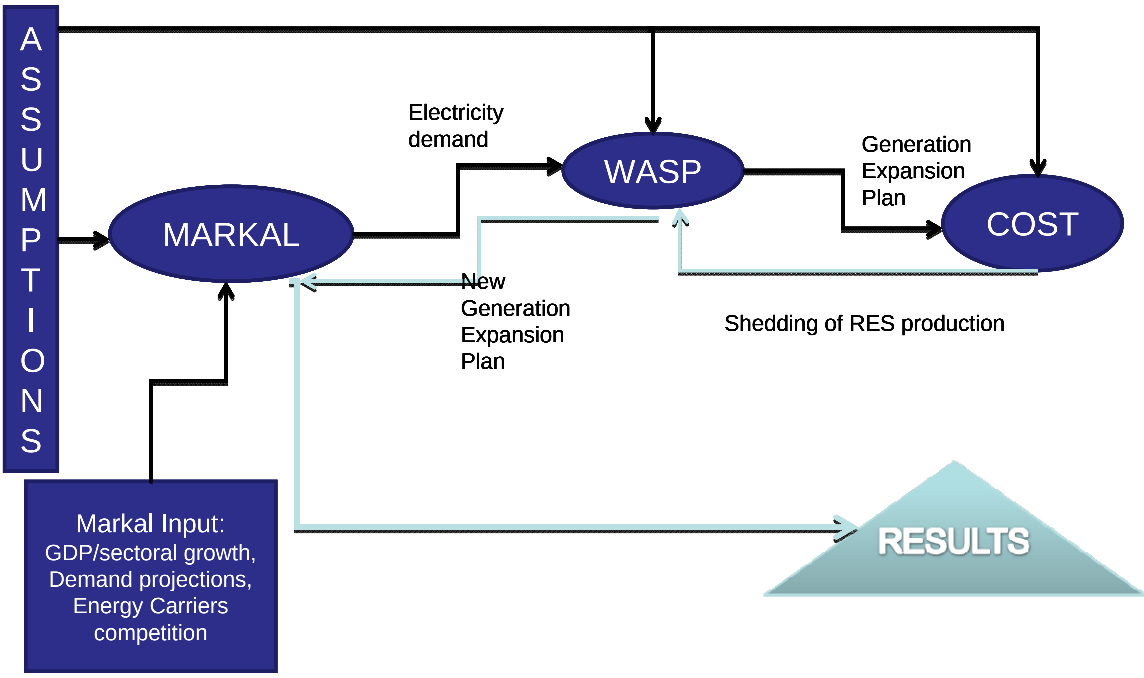


Figure 5.2 Models used for the energy sector

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. The use of food-based biofuels to meet the 10% renewable energy target of the Renewable Energy Directive will be limited to 5%.
- 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[18] (AEAs) in tonnes for each year from 2013 to 2020 are to be calculated. The national target for emissions not included in the ETS (non-ETS) is a 4% reduction of emissions by 2020 compared to 2005. According to European Commission Decision 2013/162/EU and its amendment 2013/634/EU, the AEAs for Greece for the years 2013-2020 are presented in ***Table 5.10***.

Table 5.10 AEAs for Greece pursuant to European Commission Decision 2013/162/EU and its amendment 2013/634/EU(figures in tons of CO2eq)

Year	GWP from 2nd IPCC AR	GWP from 4th IPCC AR
2013	2 057 904	2 048 785
2014	2 020 124	2 011 173
2015	1 982 344	1 973 560
2016	1 944 565	1 935 948
2017	1 906 785	1 898 336
2018	1 869 006	1 860 724
2019	1 831 226	1 823 111
2020	1 793 446	1 785 499

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

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

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[19].

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. Impemented and adopted policies and measures, which were presented in chapter 4, are incorporated in the "with measures" scenario, while planned policies are incorporated in the "with additional measures" scenario. The main assumptions made for the projection of GHG emissions in both scenarios are analysed as follows:

International fuel prices: They are presented in ***Table 5.11*** below.

Table 5.11 International fuel prices according to IEA

Fuel	Unit cost	2010	2015	2020	2025	2030
Coal	$/ton	83.1	85.2	87.9	88.7	89.5
Crude oil	$/bbl	72.2	91.1	93.8	95.7	97.0
Natural gas	$/MBTU	8.2	8.6	9.0	9.3	9.6

Demographic characteristics: the population during the period 2010-2030 is presented in ***Table 5.12***. The number of households is given in ***Table 5.13***.

Table 5.12 Population evolution 2010-2030

Year	2010	2015	2020	2025	2030
Population (in thousands)	11308	11373	11439	11505	11571

Table 5.13 Number of households

Year	2010	2015	2020	2025	2030
Households (in thousands)	3836	3857	3878	3899	3920

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

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

and the way that they are diffused in the population and the impacts in its living standards. In ***Table 5.14*** the projected macroeconomic data till 2030 are presented.CO2 emission allowances prices considered were also added in this table. The projection of main macroeconomic indexes were provided by the Ministry of Finance.

Table 5.14 Macroeconomic data in million euros (constant prices 2010)

Information/Period	2010	2015	2020	2025	2030
GDP (billion euros)	222.152	180.561	209.290	231.073	248.931
Annual rate of increase of GDP	-	0.1%	3.5%	2.0%	1.5%
Value added (billion euros)	195.223	158.914	184.199	203.370	219.088
CO2 emission allowances €/tCO2	-	6.67	10.0	20.0	30.0

Energy demand: The total energy deliveries and the final energy consumption according to both the “with measures” and “with additional measures” scenarios are presented in ***Tables 5.15 – 5.18***.

Table 5.15 Total inland energy deliveries according to “with measures scenario”

Total inland energy deliveries in ktoe	2015	2020	2025	2030
Solid fuels	4687	4961	3524	3506
Liquid fuels	11601	14348	15333	17363
Natural Gas	3594	3601	4011	4229
Electricity	39	1	1	1
RES	3316	4691	7325	9075
Total	23236	27601	30194	34174

Table 5.16 Total inland energy deliveries according to “with additional measures scenario”

Total inland energy deliveries in ktoe	2015	2020	2025	2030
Solid fuels	4715	5200	3238	3223
Liquid fuels	11598	13975	13978	15444
Natural Gas	3594	3200	4011	4229
Electricity	39	1	1	1
RES	3312	4993	6971	8788
Total	23257	27368	28199	31685

Table 5.17 Final energy consumption according to "with measures scenario"

Final energy consumption in ktoe	2015	2020	2025	2030
Solid fuels	305	305	341	362
Liquid fuels	9231	11971	13403	15435
Natural gas	597	729	667	705
Electricity	4308	4842	5312	5778
Heat	164	278	416	504
RES	1766	2403	3252	3866
Total	16370	20528	23393	26649

Table 5.18 Final energy consumption according to "with additional measures scenario"

Final energy consumption in ktoe	2015	2020	2025	2030
Solid fuels	305	305	341	362
Liquid fuels	9229	11620	12066	13546
Natural gas	615	763	678	840
Electricity	4316	4961	5453	5948
Heat	129	181	248	302
RES	1771	2686	3071	3626
Total	16364	20516	21859	24624

Policies and measures: The "with measures" scenario defines the future development of the system under current policies and consumers' behaviour, as well as under the emerging future trends. Specifically, both scenarios (WM and WAM) include the impacts from the following policies / interventions:

- The deregulation of local electricity market.
- The commissioning and decommissioning of power plants in the interconnected system as presented in the PaMs chapter.
- The interconnection of the Cyclades islands and Crete to the interconnected system.
- The continuation of infrastructure projects for the further penetration of natural gas in the residential/tertiary and industrial sectors as well as the enhancement of the security of gas supply through the interconnection of the Greek gas network with the networks of neighbouring countries and the extension / reinforcement of the liquefied gas station.
- The completion of a series of infrastructures that are implemented or planned in the transport sector and include new motorways, upgrades in public transportation, modernization of railway network, etc.
- The continuation of present policies (Law 2244/1995, Development Law, etc.) for the promotion of RES, CHP, natural gas and energy conservation.
- The Council Directive 2001/80/EC of 23 October 2001on the limitation of emissions of certain pollutants into the air from large combustion plants.

- The Council Directive 2002/91/EC of 16 December 2002 on the energy performance of buildings.
- The Council Directive 2003/30/EC for the promotion of the use of biofuels or other renewable fuels for transport.
- The Council Directive 2003/17/EC relating to the quality of petrol and diesel fuels. As a result of the implementation of this Directive, in the "with measures" scenario GHG emissions have been increased due to the operation of new units or the increased operation of existing units in the Greek refineries, in order to produce the mandated low sulphur fuels.
- The Council Directive 2006/32/EC on energy end-use efficiency and energy services.

5.4.1.4 Projections

In the current paragraph the structure and results of two alternative scenarios will be presented, the "with measures" and "with additional measures" scenarios.

The "**with measures**" scenario (WM) encompasses currently implemented and adopted policies and measures and includes evolution in the energy sector, not taking into account the planned new measures - policies. It assumes an emissions allowance cost and the international fuel prices of previous tables, while RES penetration and measures for energy efficiency according to the current rate. Electricity demand is estimated to be 61.9 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 4.8GW in year 2010 to 3.7GW in year 2020. In 2020, it is anticipated that natural gas plants will be about 4.7GW and RES are being exploited as follows: 4.7 GW of wind farms, 3.7GW of hydros, 0.2 GW of biogas/biomass and 3.6 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 ***Table 5.14***.
- 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 27.1 Mtoe).

Concerning energy efficiency, the WM scenario contains the mitigation effect of the following energy saving measures from 1st and 2nd National Energy Efficiency Action Plans :

- Promotion of energy efficient appliances and application of minimum energy performance requirements.
- Promotion of CHP and district heating.

- Mandatory replacement of all lighting fixtures of low energy efficiency in the public and broader public sector with energy efficient lighting by 2020.
- Incentives for the replacement of old medium and heavy duty vehicles with new energy efficient.
- 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) which will lead to increase the share of energy efficient vehicles in total passenger kilometers by 2020.
- Energy upgrade of buildings in the residential and tertiary sector.
- Upgrading of heating system boilers / burner units in existing (penetration of natural gas in the residential sector, doubling of the contribution of heat pumps by 2020 compared with 2011 in the tertiary sector).
- Installation of central solar thermal systems.
- Application of the regulation on the energy performance of buildings that will result in lower heating and cooling needs in new buildings in relation to the existing ones.

The "**with additional measures**" (WAM) scenario contains the following additional measures that they will mainly materialize reduction of GHGs after 2020:

- Installation of insulation in buildings built before 1980 that will result in 50% reduction of the demand for heating in existing buildings by 2030.
- Penetration of electric vehicles with a share of at least 5% in total passenger for short-distance journeys by 2030
- 20% share of the fixed rail transport in total passenger for short-distance journeys by 2030.
- 30% share of the fixed rail transport in total freight transport by 2030.
- 10% share of the fixed rail transport in total passenger-km by 2030.

Concerning the international fuel prices, the decommissioning of old public electricity plants and commissioning of new ones and the operation of interconnections, the same assumptions as in with measures scenario were applied. Electricity demand is estimated to be 63.4 TWh in 2020. The installed power of lignite plants will be decreased from 4.8GW in year 2010 to 3.7GW in year 2020. Natural gas plants will be about 4.5GW and cogeneration plants about 1.6GW in year 2020. RES are being exploited as follows: 5.3 GW of wind farms, 5.1 GW of photovoltaic systems, 3.7GW of hydros, 0.2 GW of biogas/bimomass.

The estimation of the GHG emissions is based on the formation of analytical energy balances for the years 2015, 2020, 2025 and 2030 and the computation of emissions per fuel and technology in every sector. ***Tables 5.19 - 5.22*** include the projections of emissions from the energy sector for the 'with measures' scenario, while ***Tables 5.23 – 5.26*** for the "with additional measures" scenario.

Table 5.19 CO_2 emissions from the energy sector (in MT) for 'with measures' scenario of projections

Sector / Year	2015	2020	2025	2030
Energy Industries	35502	36738	17915	18357
Fugitives emissions	10	11	3	3
Man Industry and Construction	5500	6637	7677	8778
Transport	17168	23439	26513	30696
Tertiary	713	766	748	748
Residential	5447	5384	4003	3452
Agriculture	1790	2131	2362	2563
TOTAL	**66131**	**75107**	**59220**	**64597**

Table 5.20 CH4 emissions from the energy sector (in kt) for 'with measures' scenario of projections

Sector / Year	2015	2020	2025	2030
Energy Industries	0.5	0.5	0.3	0.3
Fugitives emissions	46.9	49.8	15.4	15.2
Man Industry and Construction	0.5	0.6	0.6	0.7
Transport	3.2	3.7	3.7	4.1
Tertiary	0.0	0.0	0.0	0.0
Residential	12.4	13.0	16.8	16.2
Agriculture	0.4	0.5	0.7	0.9
TOTAL	**63.9**	**68.1**	**37.6**	**37.4**

Table 5.21 N2O emissions from the energy sector (in kt) for 'with measures' scenario of projections

Sector / Year	2015	2020	2025	2030
Energy Industries	0.4	0.4	0.2	0.2
Fugitives emissions	0.0	0.0	0.0	0.0
Man Industry and Construction	0.1	0.1	0.2	0.2
Transport	0.5	0.6	0.7	0.8
Tertiary	0.0	0.0	0.0	0.0
Residential	0.4	0.4	0.5	0.5
Agriculture	0.7	0.8	0.9	1.0
TOTAL	**2.1**	**2.4**	**2.5**	**2.7**

Table 5.22 Total emissions from the energy sector (in Mt CO2 eq) for 'with measures' scenario of projections

Sector / Year	2015	2020	2025	2030
Energy Industries	35622	36863	17975	18419
Fugitives emissions	1003	1065	330	326
Man Industry and Construction	5547	6693	7741	8851
Transport	17380	23714	26814	31042
Tertiary	715	768	749	749
Residential	5827	5781	4509	3939
Agriculture	2017	2402	2666	2897
TOTAL	**68110**	**77285**	**60785**	**66223**

Table 5.23 CO_2 emissions from the energy sector (in Mt) for the "with additional measures" scenario of projections

Sector / Year	2015	2020	2025	2030
Energy Industries	35641	37010	18480	18466
Fugitives emissions	10	11	3	3
Man Industry and Construction	5500	6631	7676	8624
Transport	17168	23394	22685	25509
Tertiary	761	836	771	636
Residential	5440	4000	3684	3419
Agriculture	1790	2131	2362	2563
TOTAL	**66310**	**74013**	**55661**	**59221**

Table 5.24 CH_4 emissions from the energy sector (in kt) for the "with additional measures" scenario of projections

Sector / Year	2015	2020	2025	2030
Energy Industries	0.5	0.6	0.3	0.3
Fugitives emissions	46.9	49.8	15.4	15.2
Man Industry and Construction	0.5	0.6	0.6	0.7
Transport	3.2	3.6	3.2	3.4
Tertiary	0.0	0.0	0.0	0.0
Residential	12.1	12.0	12.0	11.8
Agriculture	0.4	0.5	0.7	0.9
TOTAL	**63.6**	**67.0**	**32.3**	**32.3**

Table 5.25 N_2O emissions from the energy sector (in kt) for the "with additional measures" scenario of projections

Sector / Year	2015	2020	2025	2030
Energy Industries	0.4	0.4	0.2	0.2
Fugitives emissions	0.0	0.0	0.0	0.0
Man Industry and Construction	0.1	0.1	0.2	0.2
Transport	0.7	1.1	1.3	1.6
Tertiary	0.0	0.0	0.0	0.0
Residential	0.4	0.4	0.4	0.3
Agriculture	0.7	0.8	0.9	1.0
TOTAL	**2.3**	**2.9**	**2.9**	**3.3**

Table 5.26 Total emissions from the energy sector (in Mt CO_2 eq) for the "with additional measures" scenario of projections

Sector / Year	2015	2020	2025	2030
Energy Industries	35766	37140	18546	18532
Fugitives emissions	1003	1065	330	326
Man Industry and Construction	5544	6684	7737	8693
Transport	17467	23816	23155	26080
Tertiary	763	838	772	637
Residential	5810	4364	4047	3774
Agriculture	2017	2402	2666	2897
TOTAL	**68369**	**76309**	**57253**	**60938**

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:

$$E_{g,t} = \sum_{j=1}^{J} A_{0,j} \cdot \left(1 + r(x_i)\right)^t \cdot C_{g,j}$$

where,

j : An activity, which constitutes a source of GHG emissions (source)

$E_{g,t}$: Projection of emissions of g-greenhouse gas in year-t

$A_{0,j}$: Activity data of the j-source of emissions in base year

$r(x_i)$: Growth rate of activity data for j-source based on the changes of the determinant parameter x

$C_{g,j}$: Emission factor of the g-greenhouse gas for the j-source.

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

Projected emissions from industrial processes 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.

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 5.27***. The economic recession of our times is taken into consideration.

Table 5.27 Main assumptions for the "with measures" and "with additional measures" scenarios in Industrial processes sector.

Process	Projections
Mineral products (Mt)	The energy projected to be consumed in cement plants by Times-Markal 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-Markal 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.
Production of F-gases	HCFC-22 production has been stopped since 2006.
Consumption of F-gases	All new and replaced refrigeration and air-conditioning equipment will use HFCs as the refrigerant agent. Linear projection of the emissions was performed.

The projections of GHG from industrial processes show a decrease compared with 1990 levels (***Table 5.28***). Key highlights include:

- CO2 emissions are expected to be increased from 2015 due to recovery of the economy. The CO2 emissions in 2020 are expected to be increased by around 6% compared to 2010.
- PFCs emissions from aluminium production have a decreasing trend till 2010 as the production of aluminium is expected to be decreased due to the economic recession, while 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 increase with a rate of about 5-10% per annum for the period 2009 – 2020. This increase is attributed both to the high rates of air-conditioning penetration and to the final disposal of these equipments.

Table 5.28 Projections of GHG emissions from the industrial processes sector (in kt CO_2eq)

Year	1990	1995	2000	2005	2009	2010	2015	2020	2025	2030
A. Greenhouse gas emissions per source category										
Mineral products	6,681	7,073	7,366	7,790	5,325	4,925	4,638	5,219	5,892	6,511
Chemical industry	1,350	879	1,047	843	821	1,091	863	947	1,000	1,068
Metal production	1,104	1,017	1,040	1,249	708	894	1,116	1,305	1,433	1,538
Production of F-gases	935	3,253	3,735	2,157	0	0	0	0	0	0
Consumption of F-gases and SF6	3	41	524	1,842	3,279	3,586	4,591	5,611	6,657	7,688
Total	10,073	12,263	13,712	13,881	10,132	10,496	11,207	13,081	14,982	16,805
B. Greenhouse gas emissions per gas										
Mineral Products										
Carbon dioxide	6,681	7,073	7,366	7,790	5,325	4,925	4,638	5,219	5,892	6,511
Chemical Industry										
Nitrous oxide	1,109	878	771	546	367	428	550	600	650	700
Metal Industry										
Carbon dioxide	940	963	946	1203	685	860	1079	1261	1385	1486
PFCs	163	54	94	45	23	34	38	44	48	52
Consumption of F-gases										
HFCs+PFCs	-	37	509	1,811	3,227	3,580	4,585	5,605	6,650	7,680
SF6	3	4	4	6	5	6	6	6	7	8

5.4.2.3 Solvents and other products use

Population is considered as the determinant parameter (in accordance to the methodology used for emissions calculation in the National Inventory) of the emissions from solvents and other products use. It is estimated that emissions (***Table 5.29***) will show a total increase (compared to 2000 levels) by 5.9% in 2020 (325 kt CO2eq).

Table 5.29 GHG emissions from solvents and other products use (in kt CO_2)

Year	CO_2 emissions
2000	307
2005	309
2010	316
2015	320
2020	325
2025	356
2030	392

5.4.2.4 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 to show an increase of 35 % for the period 2000 - 2020 according to the suggestion of Ministry for Environment (Report for the national strategy on the biodegradable waste management, MINENV 2002). The quantities of the solid waste generated were not estimated based on the per capita production generation rate assumptions, because this would result in stabilization of them. For the period 2020-2030 , the generation rate of quantities of solid waste is estimated based on the analysis of the trends observed in the previous decade.

In order to estimate the composition of MSW generated on an annual basis, the assumptions presented in the last National Inventory Report (2013) were used for the whole period from 1990 to 2030. 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 adopted policies and measures taking into consideration the deflection from the targets due to economic recession. The composition of the solid waste landfill 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 landfill for the period 1990 – 2030 are presented in ***Table 5.30***.

Table 5.30 Main assumptions of projections scenarios for solid waste disposal on land

	Historical data					Projection			
	1990	1995	2000	2005	2010	2015	2020	2025	2030
Generation rate (kg / cap / day)	0.821	0.940	1.094	1.186	1.253	1.344	1.439	1.538	1.638
Biodegradable landfill in managed sites (kt)	837	1,063	1,545	2,023	2,803	2,727	2,711	2,868	3,025
Biodegradable landfill in unmanaged sites (kt)	1,172	1,375	1,365	1,054	18	0	0	0	0
Fraction of biodegrable landfill (%)	89	91	91	88	75	68	63	63	63

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 IPCC methodology was followed for the other source categories (domestic wastewater handling, human sewage and industrial wastewater handling). The key results (***Table 5.31***) are summarized below:

- Methane emissions from solid waste disposal on land show an increase of 12.6% in 2020 (3.9 Mt CO2eq) compared to 2010 levels (3.4 Mt CO2eq) and an increase of 15.4 % in 2030 (4.5 Mt CO2eq) compared to 2020 levels. The trend of declining increase of emissions expected after 2010, significant lower than the increase of expected waste generation for these years, is mainly due to the implementation of EU Directive 99/31 regarding the recovery of organic waste. The Directive has been incorporated in 2002 in the Greek Law (Joint Ministerial Decision 29407/3508).

- Methane emissions from domestic wastewater handling decrease by 90 % in 2020 (0.22 Mt CO2eq) compared to 1990 levels (2.16 Mt CO2eq). The reduction of emissions from domestic wastewater handling is mainly due to the increased number of wastewater handling facilities under aerobic conditions. According to estimates provided by the Ministry for Environment the penetration of such facilities show an increase of 32% in 1999 and is expected to show an increase of 95% in 2020 compared to 1990 levels.

- Methane emissions from industrial wastewater handling and sludge of industrial wastewater decrease by 1.7 % in 2020 (0.84 Mt CO2eq) compared to 1990 levels (0.86 Mt CO2eq). For the projection of the emissions from this sector, the industrial production for approximately 25 industrial sectors / sub-sectors was estimated for the period 2010-2030 using the trend observed in the last decade.

Table 5.31 GHG emissions from the waste sector (kt CO_2eq)

Year	1990	1995	2000	2005	2010	2015	2020	2025	2030
A. Greenhouse gas emissions per source category									
Solid waste disposal on land	2226	2607	3122	3337	3447	3668	3959	4244	4560
Domestic wastewater	2488	2282	1643	688	593	594	597	597	592
Industrial wastewater	860	900	1018	930	858	728	844	1002	1190
Waste incineration	0.35	0.35	0.35	2.13	3.83	3.18	3.68	4.37	5.19
B. Greenhouse gas emissions per gas									
Carbon dioxide	0.220	0.220	0.220	1.935	3.143	2.586	2.998	3.561	4.229
Methane	5243	5436	5401	4575	4513	4547	4933	5373	5874
Nitrous oxide	331	352	381	381	386	444	467	470	469
Total	**5574**	**5788**	**5782**	**4958**	**4902**	**4993**	**5403**	**5847**	**6348**

5.4.2.5 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 trends observed in the last decade, taking into consideration the economic recession of the current decade and the anticipated economic recovery for the next decade. As a result it was assumed that the number of swine, horses, sheep, poultry, non-dairy cattle and buffalo increases annual with a rate of 0.08%, 0.26%, 0.48%, 0.81%, 1.24% and 6.6%, respectively, for the period 2000 - 2030. The number of goats, dairy cows and mules and asses decreases with a mean annual rate of 0.12% and 0.27% and 2.51%, and respectively for the period 2000-2030. In ***Table 5.32*** the evolution of animal population is presented, for the period 1990 – 2030.

The use of synthetic nitrogen fertilizers (***Table 5.33***) decreases continuously with a mean annual rate of 1. 3% for the period 2000 – 2020, while in the period 2020-2030 increases with a mean annual rate of 2.1. 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 2020-2030 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 1990-2011 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 1990-2011.

Table 5.32 Animal population (thousands) per species (3-year average)

Animal population (thousands)	Historical data					Projection			
	1990	1995	2000	2005	2010	2015	2020	2025	2030
Dairy cattle	212	181	169	153	135	130	128	141	155
Non dairy cattle	479	397	422	517	515	506	502	538	579
Buffalos	0.8	0.7	1.0	1.3	1.9	2.0	2.1	2.3	2.5
Sheep	8692	8856	9023	8816	8832	8642	8526	9379	10316
Goats	5339	5513	5640	5444	5155	4820	4498	4947	5441
Horses	46	35	29	27	27	26	26	28.6	31.5
Asses & mules	187	130	95	69	46	36	26	25	24
Swine	994	997	957	930	875	830	810	891	980
Poultry	28747	29198	30150	31251	29079	29849	30938	34032	37435

Table 5.33 Projection of nitrogen inputs in soils (in kt) from synthetic fertilizers

	Historical data					Projection			
	1990	1995	2000	2005	2010	2015	2020	2025	2030
Synthetic fertilizers (kt N)	424	316	270	224	213	205	200	220	242

Finally for the projection of agricultural crops production, similarly with the animal population, an analysis based on the trends observed in the last decade, was performed. In ***Table 5.34***, 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 IPCC Guidelines for Eastern Europe are used. The CH4 emissions manure management are estimated based on emissions factors suggested by IPCC 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 IPCC Good Practice Guidance 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 5.34 Projection of agricultural crops production

Production (ktn)	Historical data						Projection		
	1990	1995	2000	2005	2010	2015	2020	2025	2030
Wheat	1938	2315	2183	2044	1912	1775	1639	1557	1479
Barley	312	412	303	234	325	193	175	193	212
Oats	61	84	86	84	89	85	87	91	90
Rye	36	39	32	33	40	33	31	33	34
Maize	2013	1839	2038	2534	2685	2290	2385	2504	2629
Rice	99	212	147	167	207	158	158	166	174
Beans	28	28	28	23	21	21	21	2	2
Peas	2	3	2	3	1	2	2	4	4
Lentils	1	1	1	2	4	4	4	5	5
Other	1	1	1	0	5	5	5	913	913
Potatoes	955	1052	883	819	905	825	830	1365	1365
Sugarbeet	2780	2544	3033	2573	1026	1128	1241	1557	1479

Total GHG emissions from agriculture decrease by 12% in 2020 (8.8 Mt CO2 eq) compared to 2000 levels (9.9 Mt CO2eq) and increase by 18.9% in 2030 (10.4 Mt CO2eq) compared to 2020 levels (***Table 5.35***). The contribution of agricultural soils to the total emissions of the sector is 58%, when at the same time the contribution of enteric fermentation is around 35%.

Table 5.35 GHG emissions from agriculture in the "with measures" scenario (kt CO_2eq)

Year	1990	1995	2000	2005	2010	2015	2020	2025	2030
A. Greenhouse gas emissions per source category									
Enteric fermentation	3246	3183	3241	3286	3224	3131	3066	3336	3633
Manure management	656	612	610	627	599	583	578	627	681
Rice cultivation	69	110	84	97	118	118	118	118	118
Agricultural soils	7452	6373	5965	5490	5288	5085	4960	5431	5948
Field burning of agricultural residues	37	41	40	41	42	37	36	36	37
B. Greenhouse gas emissions per gas									
Methane	3694	3672	3699	3758	3699	3594	3526	3825	4154
Nitrous oxide	7766	6647	6241	5783	5572	5359	5232	5724	6263
Total	**11460**	**10319**	**9940**	**9541**	**9271**	**8952**	**8758**	**9548**	**10416**

In general, a declining trend in emissions from the agriculture sector is expected for the period 2013-2020. 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 period 2020-2030, 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 an slight increase of GHGs emissions compared to what would be in their absents.

5.4.2.6 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 – 2011. Emission factors used are the ones used in the preparation of the last 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 2011 levels.
- The annual biomass uptake in these lands, as well as, the annual losses as a result of the fellings will remain constant, equal to that estimated for the period 1990 – 2011.
- Area under deforestation activities will remain constant and equal to the average area deforested during the period 1990 – 2011.
- Areas affected by wildfires each year will be equal to the average area burnt in the period 1990 – 2011 (this assumption results in reduced interannual variation in net emissions/ removals of GHG from this sector in relation to the variation observed during 1990 – 2011).

Table 5.36 presents emissions (with positive sign) and removals (with negative sign) of the three GHG from this sector, as estimated for the years 1990, 1995, 2000, 2005, 2010 and their projected evolution until 2030.

Table 5.36 Net emissions / removals of GHG from Land Use, Land Use Changes and Forestry per gas (kt CO2 eq)

	1990	1995	2000	2005	2010	2015	2020	2025	2030
Carbon dioxide	-2531	-3195	-2848	-2812	-2649	-2757	-3011	-2738	-2649
Methane	27	20	96	5	6	31	31	31	31
Nitrous oxide	3	2	10	0	1	3	3	3	3
Total	-2501	-3174	-2743	-2807	-2642	-2723	-2977	-2704	-2615

According to qualitative projections concerning the activities of Article 3.3 of KP (Afforestation, Reforestation and Deforestation), the net removal potential of Greece is expected to be around 1.5 Mt CO2 during the years 2008-2012. Greece has elected forest management under Article 3, para 4 of the Kyoto Protocol to account for in the first commitment period, too. It is estimated that under the current forest management practices in Greece about 1.5 - 2 Mt CO2 per year are removed. Thus, the country-specific maximum for forest management activities agreed in the Marrakech (330 kt CO2 / year) is fully utilized.

5.5 Evaluation of GHG emissions scenarios

Table 5.37 presents the evolution of specific sectoral indicators, which evaluate the effectiveness of the implemented and adopted policies and measures aiming at reducing GHG emissions in Greece. These indicators were estimated on the basis of the background information and the results obtained by the "with measures" scenario. The main findings of this analysis are summarized below:

- ***CO2 emissions intensity per GDP*** unit is projected to show a significant decrease during the period 2000-2020 as a result of the implemented and adopted policies and measures, and particularly because of the penetration of natural gas and various renewable energy sources into the energy system.
- In the ***transport sector*** emissions per passenger-kilometre covered are expected to remain more or less stable as a result of the government measures favouring the use of low consumption vehicles and the corresponding decrease of kilometres driven. As for emissions from freight transport, a decreasing trend is expected. This is attributed to the penetration of biofuels and the improvement of road transportation infrastructure as well as the modernization of the fleet and the increased use of vehicles with lower specific consumption.
- In the ***industrial sector***, the intensity of CO2 emissions decreases during the entire period examined as a result of the implementation of energy conservation policies in the sector, the penetration of natural gas, but also the reduction in production due to economic recession.
- In the ***residential sector***, CO2 emissions per household were increased substantially during the last decade as a result of the improved standards of living. However, a decreasing trend is projected during the rest of the period (2010-2020) because of the penetration of natural gas into the sector and the promotion of policies that aim at the improvement of energy efficiency of buildings as well as the stabilization of the population live in the country and the economic recession.
- In the ***tertiary sector***, a decrease of CO2 emissions intensity is projected. The initial increasing trend of years before 2006 was primarily attributed to the improved working conditions and the high growth rates of the sector. The decreasing trend of the last years is attributed to the natural gas penetration, which substitute diesel and electricity in some energy uses (e.g. heating, air-conditioning, etc.), the promotion of policies that aim at the improvement of energy efficiency of buildings, and economic recession.
- In the ***power generation sector***, CO2 emissions per unit of energy produced from conventional fossil-fuelled power plans (both public and auto-producer units) shows a remarkable decrease during the period 2000-2020, primarily as a result of natural gas penetration into the electric system and the decommissioning schedule of old lignite-fired power units.
- In the ***agricultural sector***, although N2O emissions per nitrogen unit from the use of fertilizers and animal manure, and specific CH4 emissions of cattle production (kg CH4 / head) remain constant for 2010 to 2020, the total N2O and CH4 emissions is expected to decrease due to reduction of fertilizer use and the decrease of livestock population.
- Finally in the ***waste sector***, CH4 emissions per kt of landfill waste to managed disposal sites increases slightly for the period 2010-2020, due to the fact that high amounts of solid have already been landfilled during the decade 2000-2010, and they will continue generating emissions, although the amounts of waste to be landfilled in 2010 -2020 will remain almost constant.

Table 5.37 Projection of basic indices for the evaluation of policies and measures implementation to reduce GHG emissions

Sector	Index	2000	2005	2010	2015	2020
Total*	MACRO: Emissions intensity ($t\ CO_2$ / M€)	926	812	703	404	397
Transport	TRANSPORT C0: Specific CO_2 emissions of passenger cars ($kt\ CO_2$/Mp-km)	0.19	0.19	0.20	0.19	0.19
Transport	TRANSPORT D0: Specific CO_2 emissions of road freight transport ($kt\ CO_2$/Mt-km)	0.53	0.57	0.55	0.44	0.41
Industry*	INDUSTRY A1: Emissions intensity ($t\ CO_2$ / M€)	435	400	337	290	302
Residential	HOUSEHOLDS A1: Specific CO_2 emissions of households ($t\ CO_2$ / household)	2.06	2.64	1.75	1,41	1,39
Tertiary*	SERVICES A0: CO_2 emissions intensity of the services sector ($t\ CO_2$ / M€)	9.62	15.30	10.67	5.43	5.03
Energy	TRANSFORMATION B0: Specific CO_2 emissions of conventional power plants ($t\ CO_2$ / TJ)	269	253	242	189	185
Agriculture	Specific N_20 emissions of fertiliser and manure use ($kt\ N_2O$ / kt N)	0.07	0.08	0.08	0.08	0.08
Agriculture	Specific CH_4 emissions of cattle production **($t\ CH_4$ / head)**	0.069	0.069	0.069	0.069	0.069
Waste	Specific CH_4 emissions from landfills ($kt\ CH_4$/kt waste)	0.05	0.05	0.06	0.06	0.07

* GDP and GVA used in constant 2000 prices.

5.6 Sensitivity analyis

During the preparation of projections, many alternative scenarios based on sensitivity analysis of their input variables and underlying assumptions were examined. Among them the most representative for WM and WAM scenarios were selected and reported.

In this chapter five additional scenarios of GHG emissions projections are presented for sensitivity analysis purposes. In ***Table 5.38*** the main assumptions and the deviation of key input variables comparing to the examined “with measures” (WM or WEM) and “with additional measures” (WAM) scenarios 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 5.38 Main assumptions of Sensitivity Analysis Scenarios

Scenario No	Main assumptions
SensSc1	Achieving in 2020 the following targets: - 20% of the primary energy use is coming from RES and - 40% share of RES in power production. A new lignite-fired plant of 600MW capacity will start operation in 2019.
SensSc2	Same as SensSc1 without the commissioning of the lignite-fired plant in 2019.
SensSc3	Achieving in 2020 the following targets: - 20% of the primary energy use is coming from RES and - 34% share of RES in power production. A new lignite-fired plant of 600MW capacity will start operation in 2019.
SensSc4	No binding targets concerning RES and CO2 emissions (i.e. the model is run without the constraint of 20% RES in 2020 and -4% of non-ETS sector GHG emissions). CO2 price (EUAs) as in *Table 5.14*. A new lignite-fired plant of 600MW capacity will start operation in 2019.
SensSc5	Same as SensSc4 without the commissioning of the lignite-fired plant in 2019.

In ***Figure 5.3*** the evolution of GHG emission projections of the scenarios of ***Table 5.38*** is illustrated. As it can be concluded from the 5 sensitivity scenarios examined, the deviation of key input variables from the WM and WAM scenarios is projected to have a small effect on total GHG emissions in 2015 (decrease of about 1-2%). However, the total emissions for year 2020 are estimated to increase for about 3-7%. The highest increase is estimated by scenarios 3, 4 and 5.

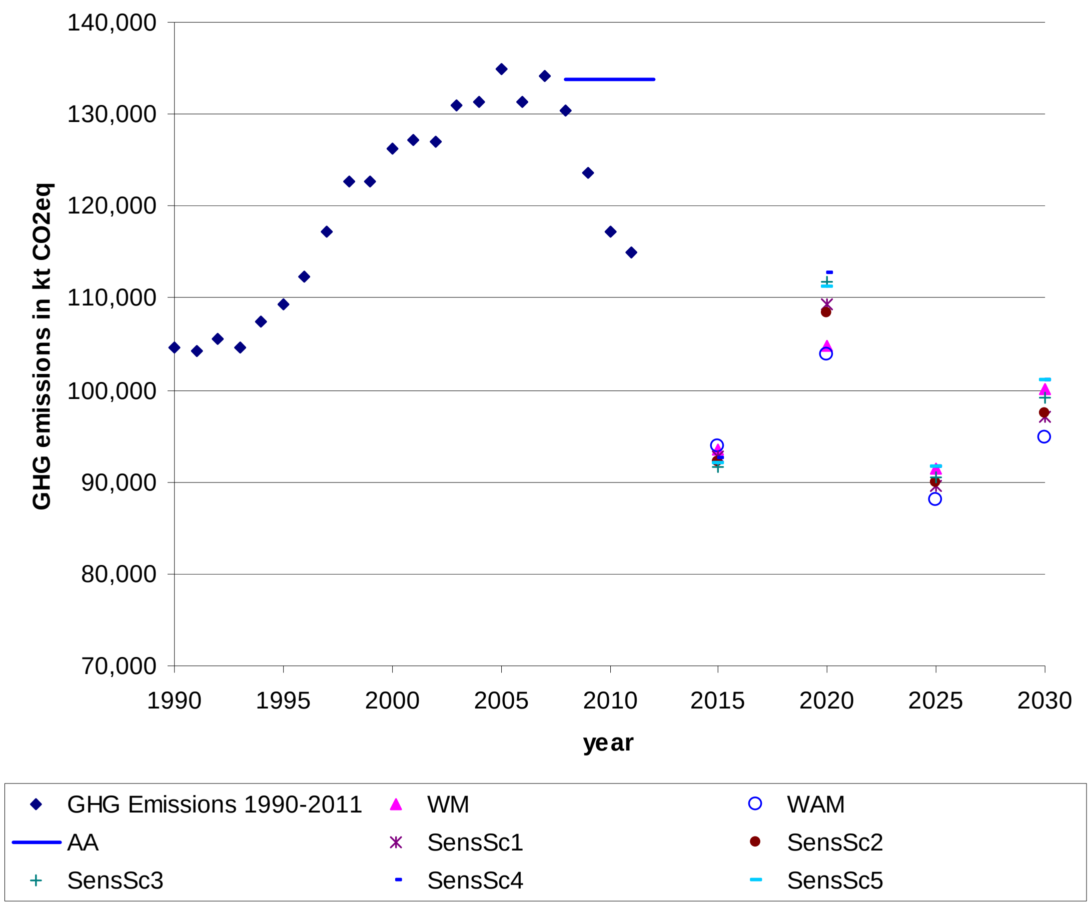


Figure 5.3 Evolution of GHG emission projections corresponding to the sensitivity analysis scenarios examined

CHAPTER 6. VULNERABILITY ASSESSMENT, CLIMATE CHANGE IMPACTS AND ADAPTATION MEASURES

6.1 Expected impacts of climate change

6.1.1 Temperature changes

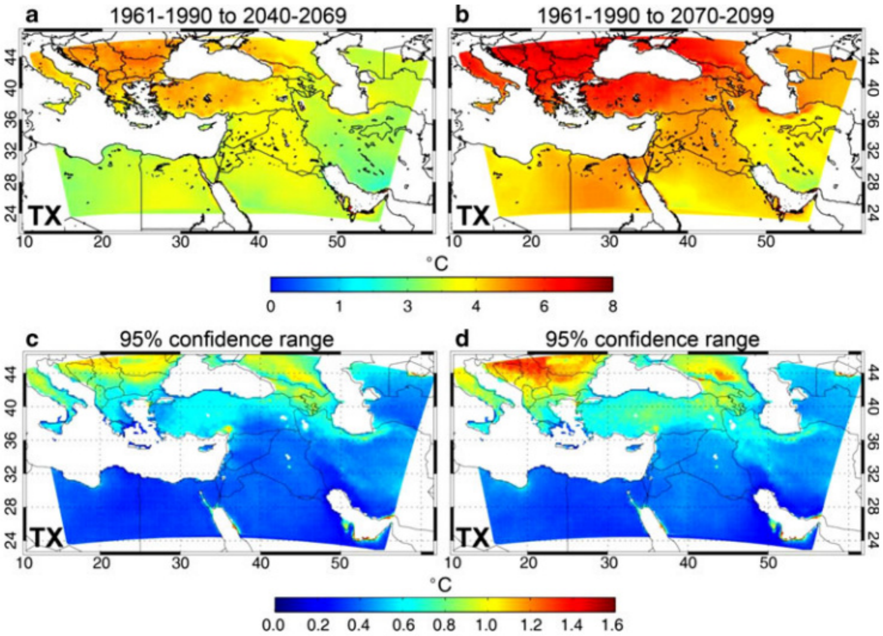
The climate in Greece is typical of the Mediterranean climate: mild and rainy winters, relatively warm and dry summers with, generally, long sunshine duration almost all the year. A great variety of climate subtypes, always in the Mediterranean climate frame, are encountered in several regions, due to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

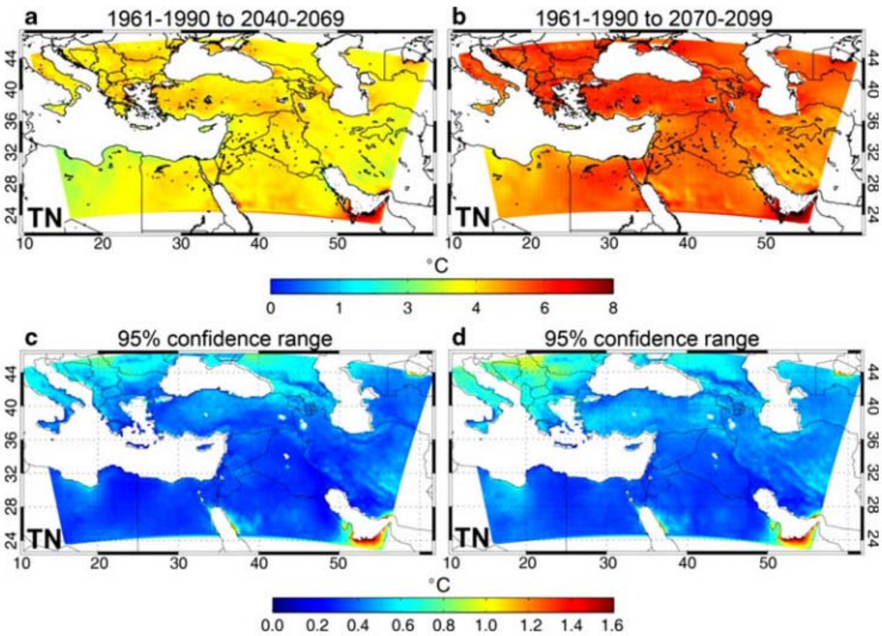
In ***Figure 6.1*** and ***Figure 6.2*** model projections of daytime maximum (TX) and nighttime maximum (TN) temperature during summer by the middle and the end of the twenty-first century are presented, concerning the Eastern Mediterranean and Middle East region (EMME). They also show the 95-percentile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



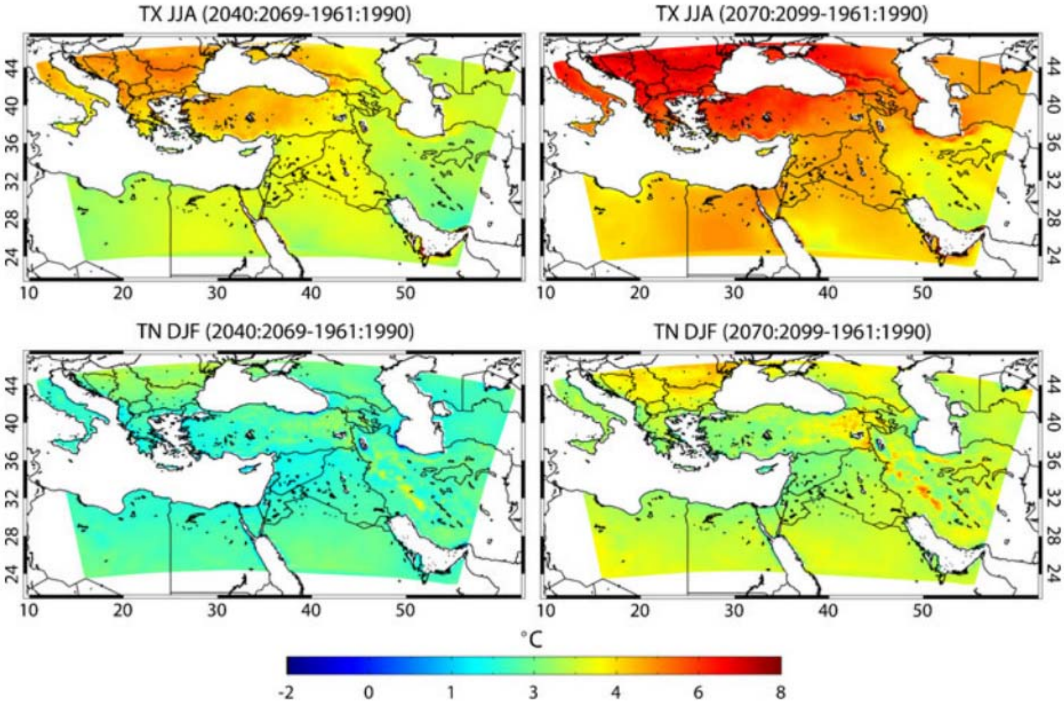
Source: (Lelieveld, Hadjinicolaou et al. 2013). Model projected heat extremes and air pollution in the eastern Mediterranean and Middle East in the twenty-first century, 2013.

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 nighttime 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

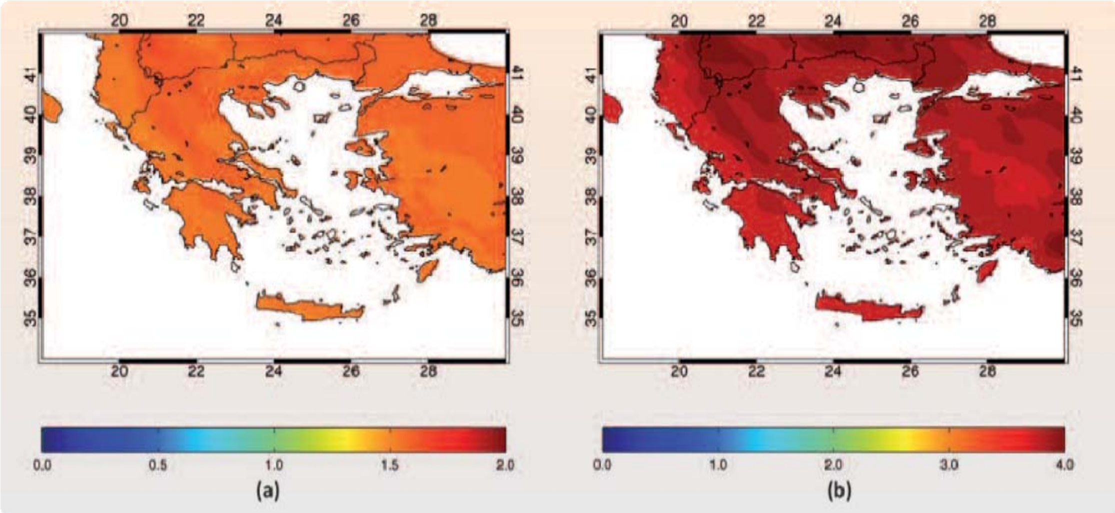
Source: Hellenic National Meteorological Service, 2012.

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 Ioniaon 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 occured, 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).

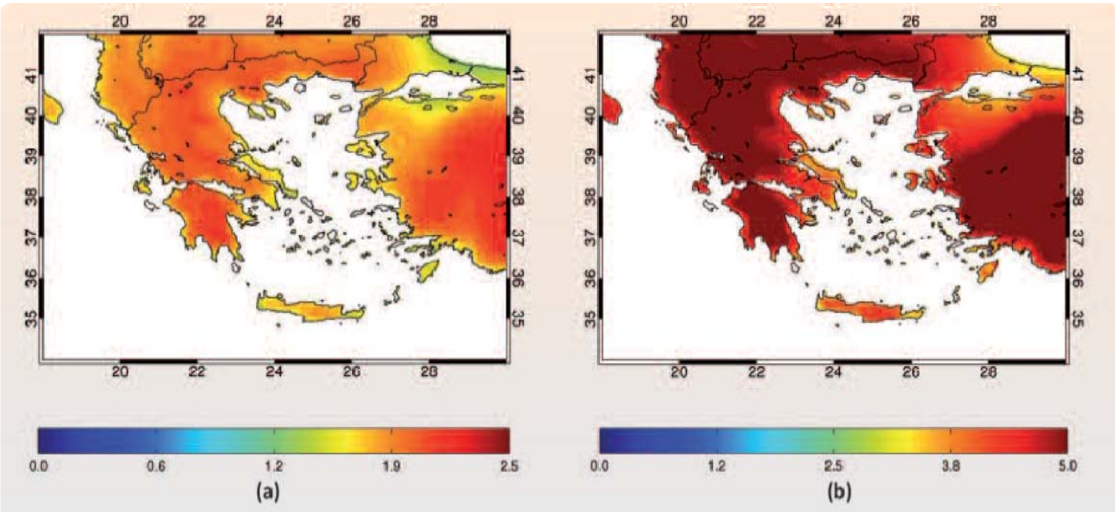
The increase in this parameter is likely to have an impact on forests, presently adapted to colder weather conditions. If the conditions become prohibitive, certain categories of forests (e.g. fir) would have to shift to higher altitudes.



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.

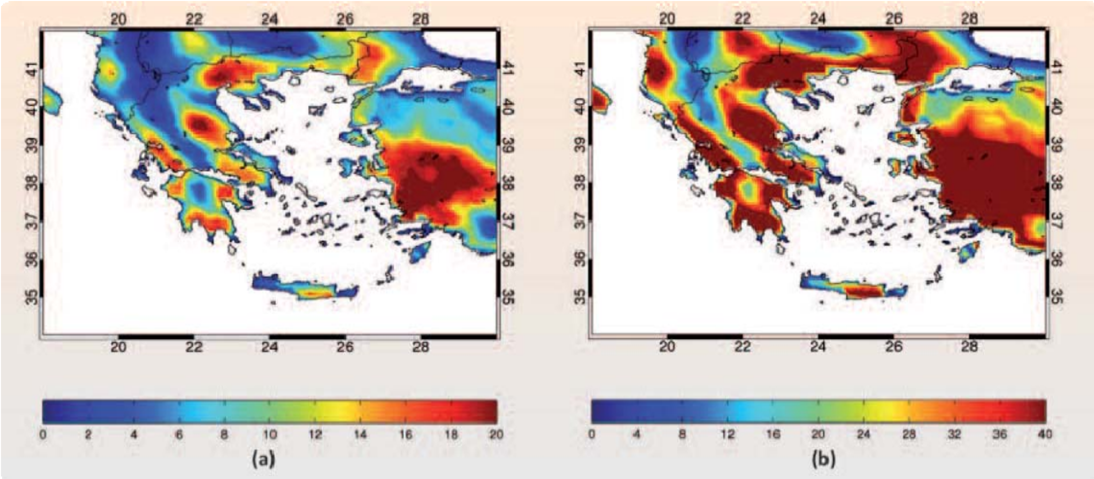


Source: (Bank.of.Greece 2011) "The environmental, economic and social impacts of climate change in Greece"

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.



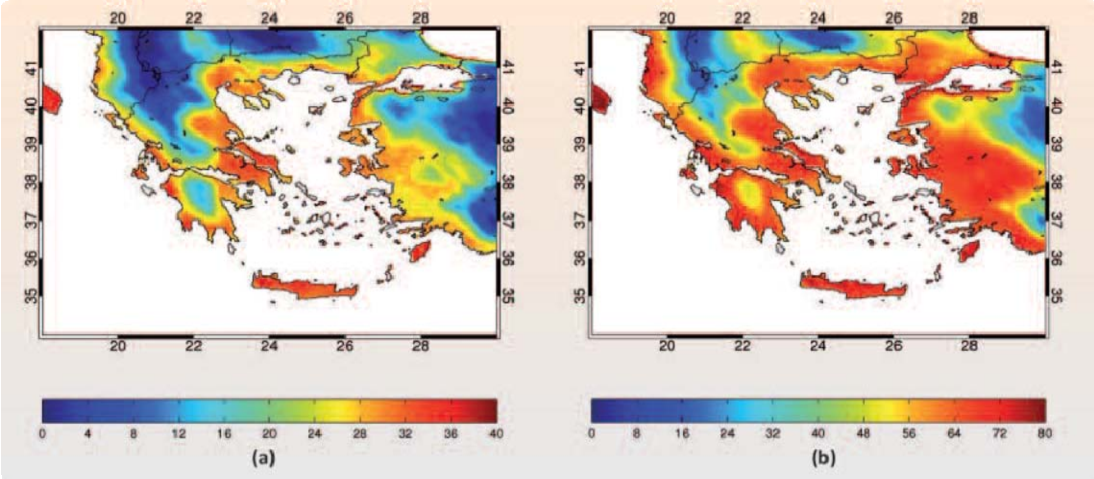
Source: (Bank.of.Greece 2011) "The environmental, economic and social impacts of climate change in Greece"

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 ***Table 6. 2***.

On 5 of February 2012 at the area of Ilia (west Peloponesse-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.

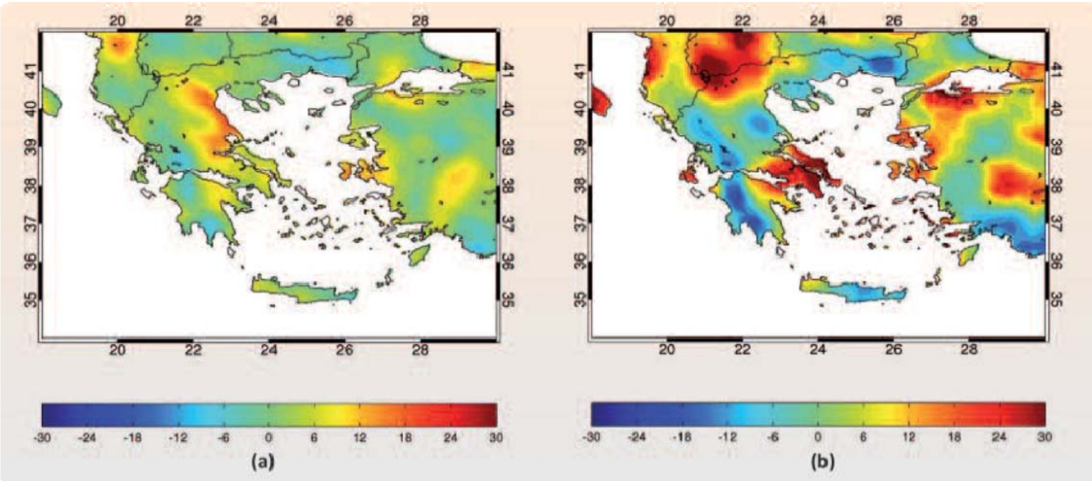
Region	Days	Place	High °C	Millimetres
Aegean Islands	8	Mytilini	25.5	648
Crete	92	Heraklion	19.0	483
Peloponnese	77	Kalamata	30.7	780
Western Greece	112	Agrinio	36.7	931
	86	Patras	26.1	663
Central Greece	98	Athens	14.4	365
	110	Lamia	22.6	574
	117	Larissa	16.7	423
Northern Greece	114	Thessaloniki	17.7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

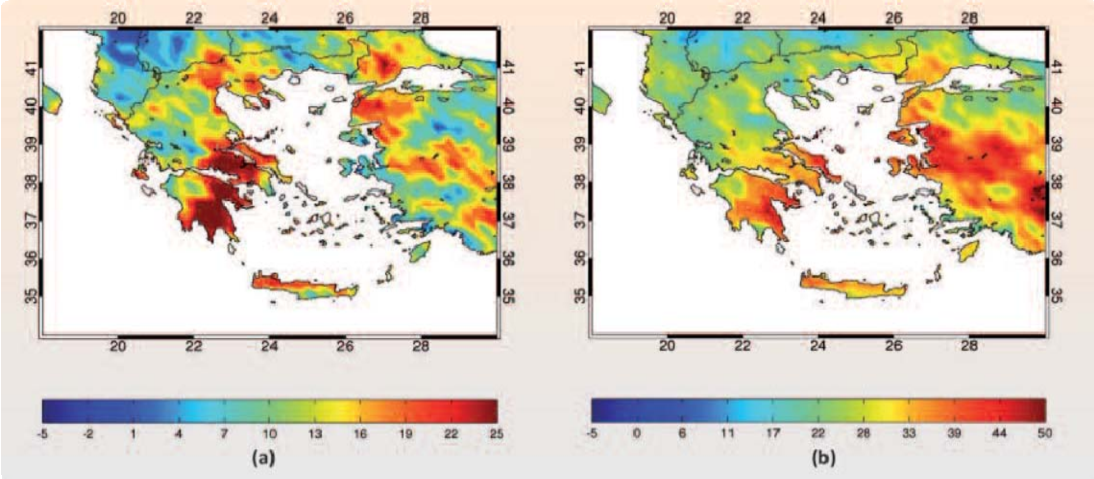
In the eastern continental regions, in particular, maximum consecutive 3-day precipitation is projected to increase by 20%. These contrasts become even more pronounced toward the end of the 21st century, with the amount of extreme rainfall projected to decrease by 10-20% in regions of Western Greece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



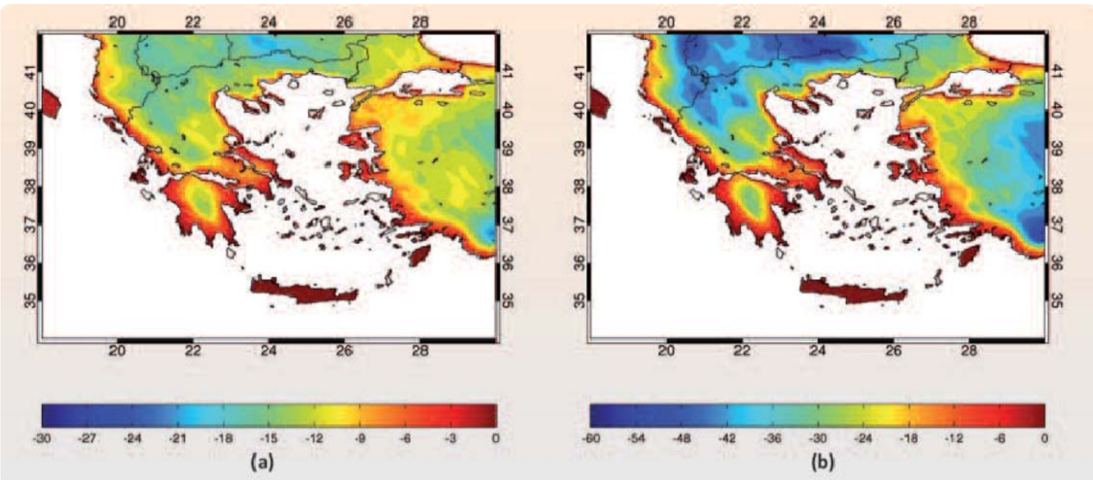
Source: (Bank.of.Greece 2011) “The environmental, economic and social impacts of climate change in Greece”

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

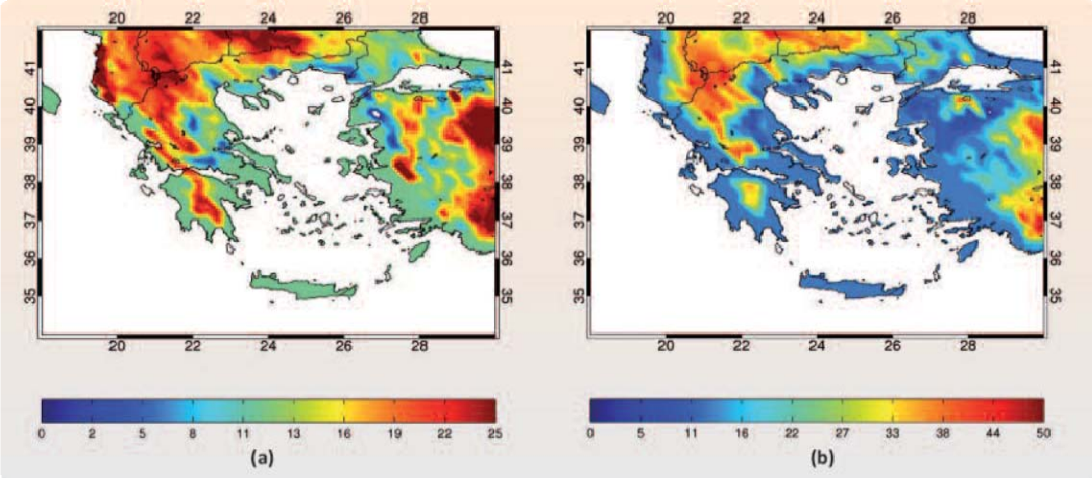
The projected changes in the number of frost days per year are represented in ***Figure 6.10***.

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).

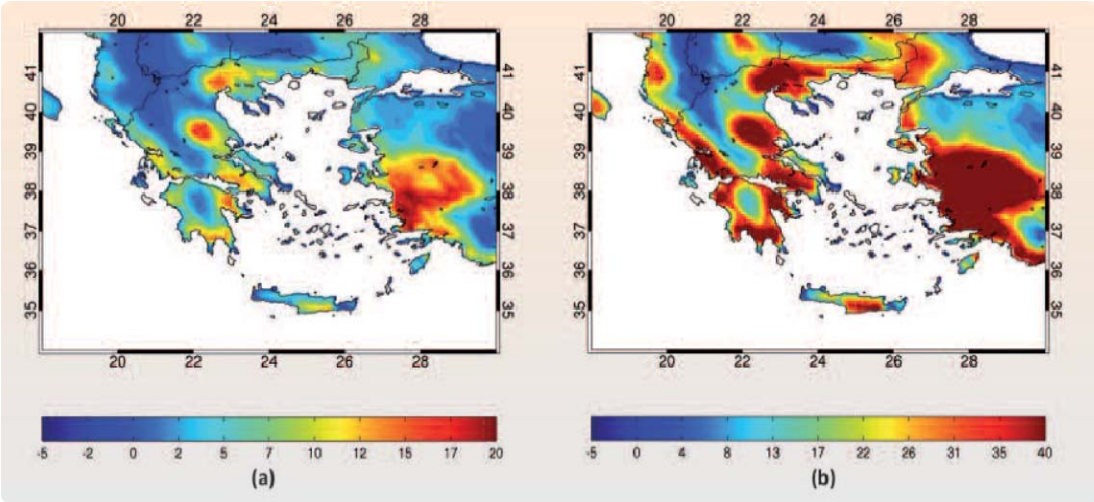
Energy demand for heating and cooling

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.***

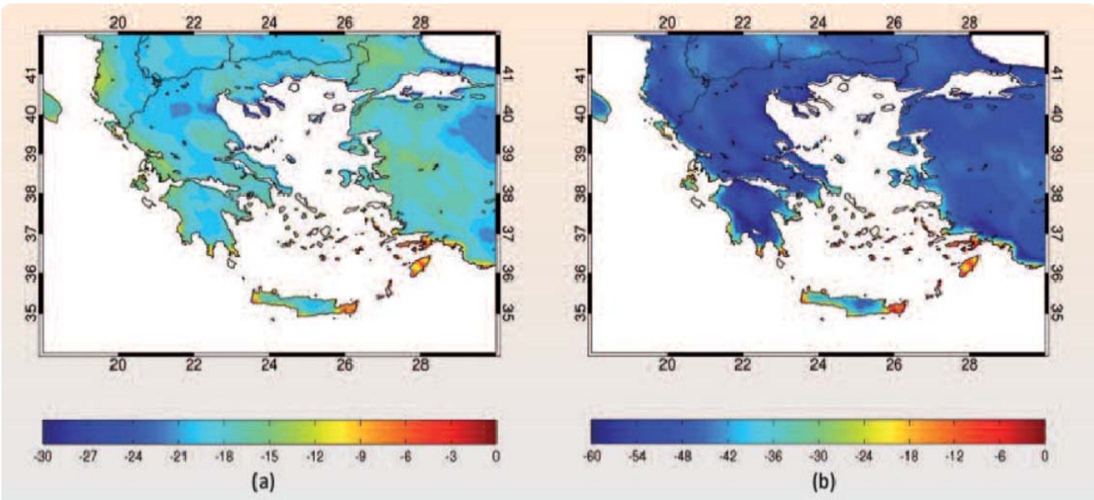


Source: (Bank.of.Greece 2011) “The environmental, economic and social impacts of climate change in Greece”

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”

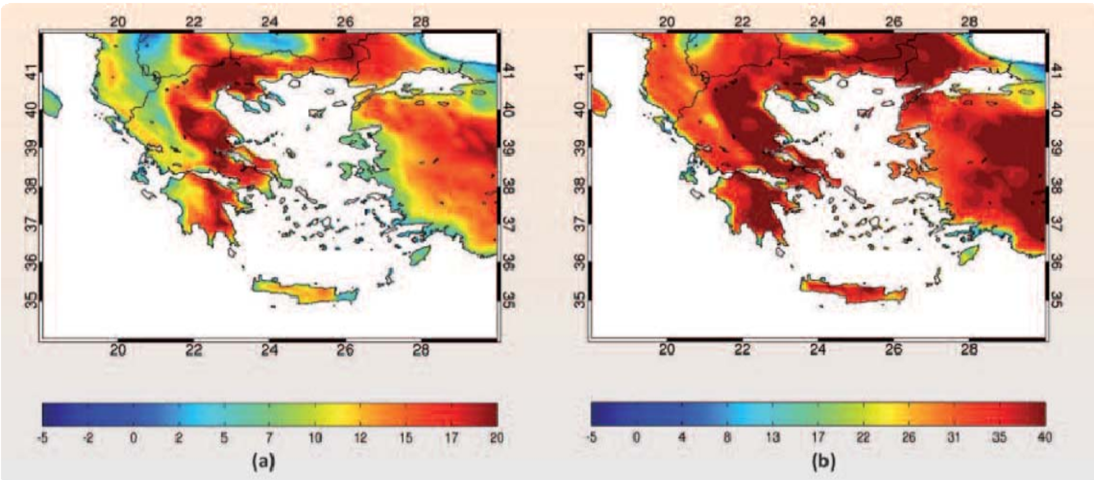
Figure 6.13 Variation in number of days with strong heating needs in (a) 2021-2050 and (b) 2071-2100, relative to 1961-1990

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 fire vulnerability of forests.

In Greece, during 7-12 August 2012 a 6 day fire-episode occurred at the Aghion Oros, an area protected by Natura 2000, which is also a world heritage of UNESCO with old byzantine monasteries. The fire burnt 40 km^2 of land. In addition, during 18-21 August 2012, a 4 day fire-episode occurred at the island of Chios (the only place in the world that the famous mastic can be cultivated) and the 145 km^2 of forest and farmland were burnt.

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).



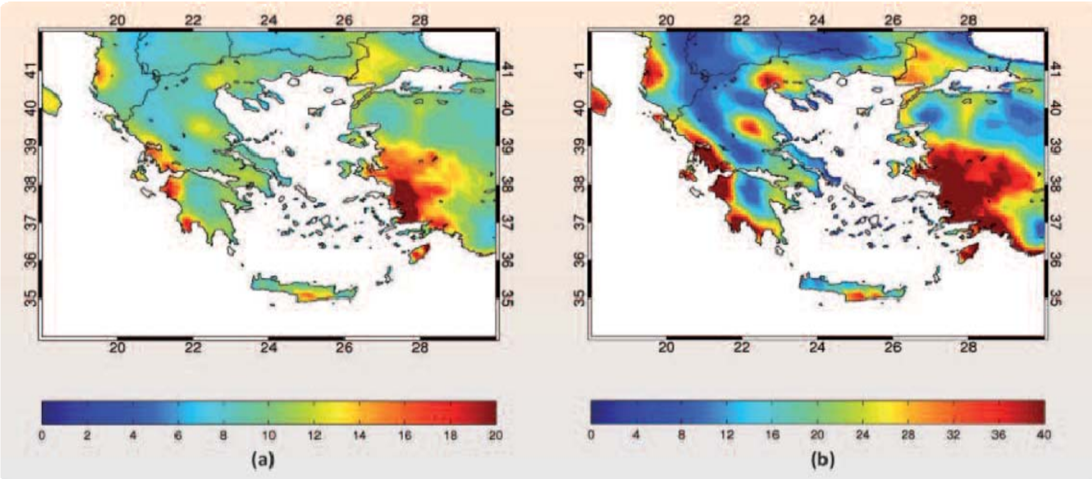
Source: (Bank.of.Greece 2011) "The environmental, economic and social impacts of climate change in Greece"

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.

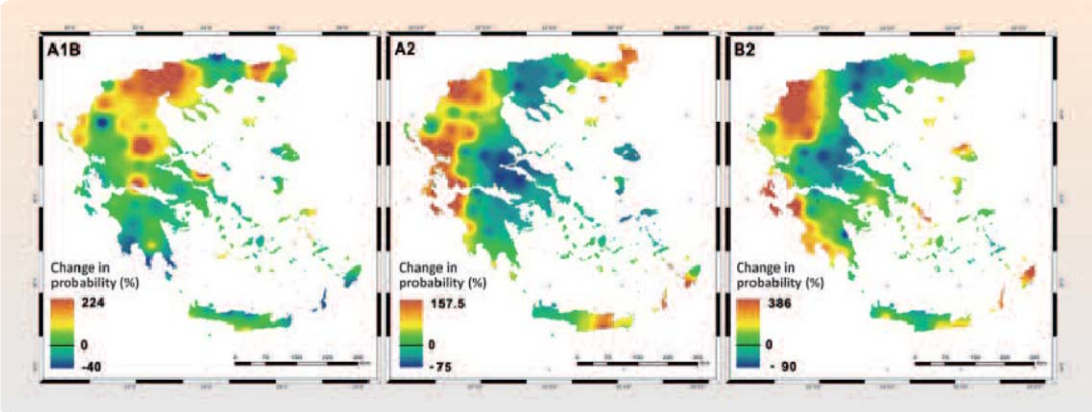
The temporal distribution of flood events in Greece between 1880 and 2010 presents a significant increase during the last decades. This is not a trend in natural processes (i.e. climate change) but is due to:

- 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.

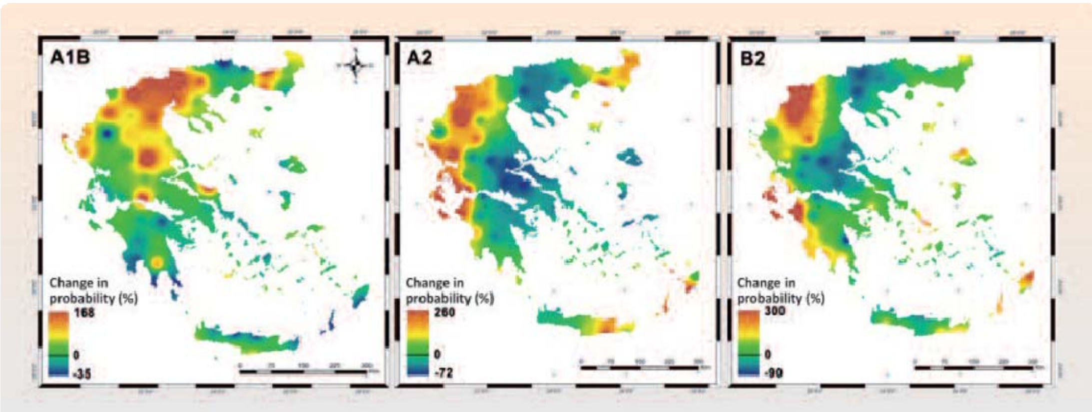
The final results were obtained by calculating the percentage change in probability of rainfall exceeding the thresholds between the reference period (1960-1990) and the periods 2071-2100 (for Scenarios A2 and B2) and 2090-2099 (for Scenario A1B). The results present similar spatial distributions with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



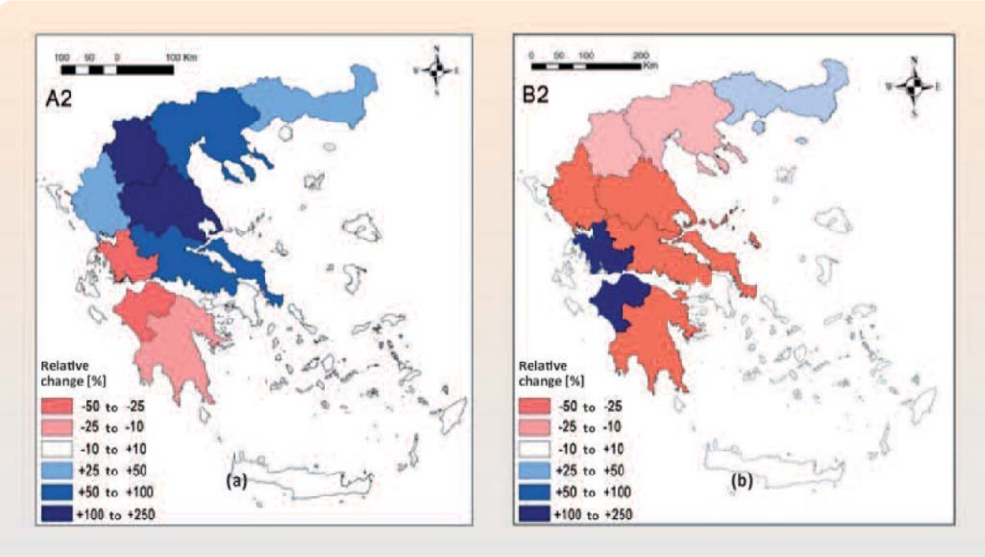
Source: (Bank.of.Greece 2011) “The environmental, economic and social impacts of climate change in Greece”

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 Euboia, 12.3 mm/year in SW Akarnania (Vött 2007) and 6 mm/year in the Peloponnese (Lambeck and Purcell 2005). During the last 5,000- 6,000 years, the sea level continued to rise at a rate of

<1 mm/year, without ever exceeding the current levels and without excluding small variations in the rate of increase (Lambeck and Purcell 2005; Vött 2007; Poulos, Ghionis et al. 2009a).

Current and future mean sea levels

As shown by instrumental measurements (tide gauges, satellite altimetry), mean sea level has been rising at a rate of 1.8 mm/year since the late-19th century, while based on satellite measurements for the last 15 years, this rate has accelerated to 3 mm/year. As reported in IPCC (2007), by 2100 the air temperature is projected to rise by 1.1-2.9ºC under the most conservative scenario (B1) and by as much as 2.4-6.4ºC under the worst-case scenario (A1FI). Meanwhile, sea level rise for the period 2090-2099, relative to the period 1980-1999, is projected to range between 0.18 m and 0.38 m under Scenario B1, and between 0.26-0.59 m under Scenario A1FI. However, subsequent studies anticipate an even greater sea level rise by 2100. According to the semi-empirical model advanced by Rahmstorf (2007) relating the rates of change in global surface temperature to sea level, a rise in temperature of 1ºC corresponds to a sea level rise of 10-30 cm. Applying this ratio to the rise in temperature of 1.4-5.8ºC projected by the SRES scenarios (IPCC 2007), sea level rise figures of 0.5-1.4 m were obtained. The most adverse projections are reported in Pfeffer et al. (2008), with sea level rise likely to reach 0.8 m to 2 m. According to this study, the IPCC (2007) has not successfully modeled the dynamic development (decline) of the Greenland and Antarctic glaciers (Bank.of.Greece 2011).

Coastline classification into geomorphologic-geodynamic categories and map representation

Given that the sea level rise by 2100 is, depending on the scenario, projected to be between 0.2 m and 2 m, the parts of Greece's coastline that would find themselves 'endangered' if the sea level were to rise by 1 m are examined. However, the vulnerability of a coastal region cannot be safely estimated on the basis of the rate and scale of sea level rise alone. Other local factors, such as tectonics, sediment transport (from inland) and coastal geomorphology/lithology, also need to be taken into account (Bank.of.Greece 2011).

Tectonics obviously play a highly important role in tectonically active areas, as a rise in sea level can be offset (amplified) by tectonic uplift (subsidence). Typical examples in Greece are the coastal zone of the Northern Peloponnese, with an uplift rate of 0.3 to 1.5 mm/year, Crete with 0.7 to 4 mm/year and Rhodes with 1.2 to 1.9 mm/year. Thus, a supposed average value of sea level rise of 4.3 mm/year would be reduced to 3.5 mm/year due to the counteraction of a mean tectonic uplift of 0.8 mm/year.

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

Lastly, another important determinant of coastal vulnerability to sea level rise is the coast's **morphology** and, specifically, the slope and lithological composition, factors directly associated with erosion rates. An erosion rate can range from very high (several meters per year) in the case of coastlines with a low-lying geomorphology and an 'erodible' lithology, to low (mms per year) in the case of hard coastal limestone formations (e.g. cliffs).

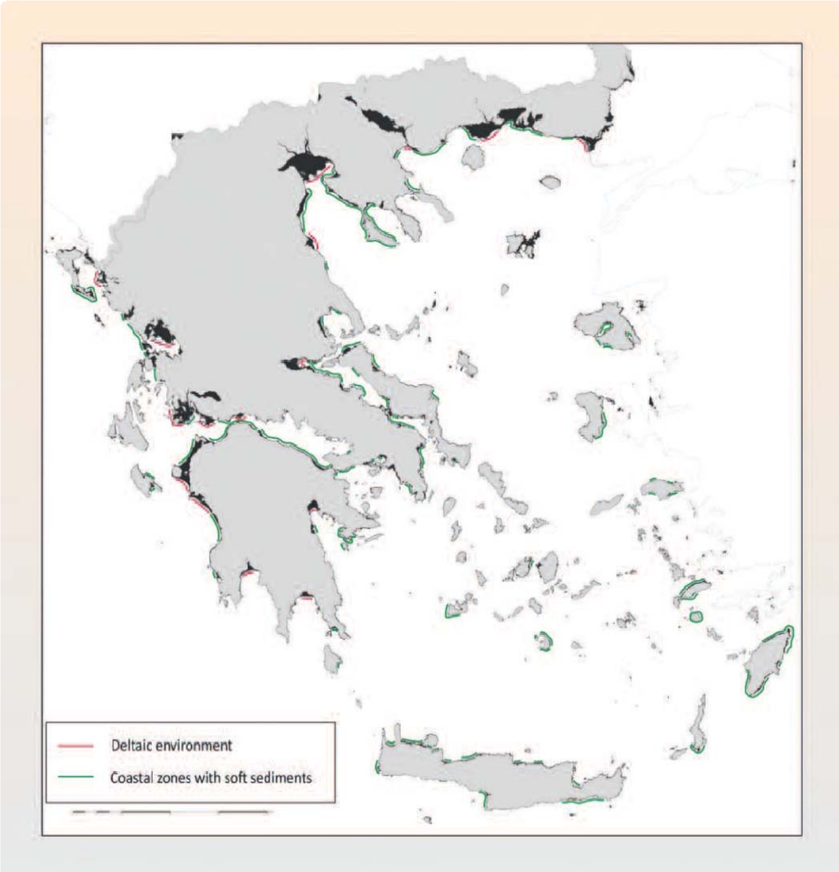
Taking all of the above factors into consideration and using a map scale of 1:50,000, Greece's coastal areas can be subdivided into the following three main zones (***Figure 6.19***) (Bank.of.Greece 2011):

1) Deltaic coastal areas. Represented in red in ***Figure 6.19***, these low-lying coastal areas are formed of loose, unconsolidated sediment deposits and are highly vulnerable to sea level rise.

2) Coastal areas consisting of non-consolidated sediments of Neogene and Quaternary age. Represented in green, these coastal areas, usually of low altitude, are prone to recessional erosion and present a medium vulnerability to sea level rise.

3) Rocky coastal areas. These coastal areas (without any specific coloring/marking in ***Figure 6.19***) consist mostly of hard rock of low vulnerability to erosion and sea level rise, form the bulk of Greece's coastline.

The estimation of the length of these three types of coastal areas, as illustrated in ***Figure 6.19***, shows that out of the total ~16,300 km of coastline, 960 km (6%) correspond to deltaic areas of high vulnerability (red colour); 2,400 km (15%) correspond to non-consolidated sediments of medium vulnerability (green colour), and the remaining 12,810 km (79%) correspond to rocky coastal regions of low vulnerability. Thus, the total coastline length presenting medium to high vulnerability to sea level rise amounts to 3,360 km or 21% of Greece's total shoreline.



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

Figure 6.19 Classification map of Greece's coastal zones

Estimates of shoreline retreat due to the rise in mean sea level

Table 6. 3 presents indicative approximate values of flooded coastal areas and shoreline retreat (without any correction for tectonic and geodynamic effects) in response to possible sea level rises, respectively, of 0.5 m and 1 m in high-risk deltaic areas, such as the Axios river delta, the Aliakmon river delta and the Alfeios river delta (Bank.of.Greece 2011). The shoreline retreat was estimated to range between 30 m and 2,750 m in response to a possible sea level rise of 0.5 m, and between 400 and 6,500 m in response to a rise of 1 m.

Assessing the severity of a possible sea level rise impact on coastal regions involves a degree of uncertainty, concerning:

a) The intensity of the sea level rise, with projections ranging between 0.2 m and 2 m. The sea level rise will be determined by the interaction between several factors, both natural (e.g. astronomical forcing) and anthropogenic (e.g. greenhouse gases). The severity of each factor will determine the overall evolution of the current climate cycle, which should soon be crossing the finish line of the current ‘warm’ interglacial period.

b) The relationship between tectonic uplift and the eustatic sea level rise. In several areas of Greece, the high tectonic uplift may locally offset and sometimes even exceed the eustatic sea level rise.

c) The sedimentation of clastic materials in coastal areas, which is determined by geological and climatic conditions, as well as by anthropogenic intervention (e.g. dams, river sand mining). In the case of river delta areas for instance, these factors could alter their vulnerability to sea level rise.

Table 6. 3 Estimated coastline retreat (in m) and coastal inundation from a potential sea-level rise of 0.5 m and 1 m, for various deltaic areas of Thermaikos Gulf and Kyparissiakos Gulf (Poulos, Ghionis et al. 2009b; Bank.of.Greece 2011)

Coastal area	Sea-level rise (m)	Coastline retreat, Bruun’s model (m)	Coastline retreat due to:		Total coastline retreat (m)	Inundated area (km^2)
			sea-level rise (m)	coast erosion (m)		
Alfeios Delta (northern part)	0.5	51.1	175	15	190	224
	1.0	102.2	810	-110	700	683
Alfeios Delta (southern part)	0.5	54.5	15-30	0-15	30	35
	1.0	109.0	10-100	400	400-450	344
Axios Delta	0.5	52.7	250-2,000	0	250-2,000	10,825
	1.0	213.6	2.000-2,500	0	2,000-2,500	28,482
Aliakmon Delta	0.5	63.6	50-1,750	0	50-1,750	4,875
	1.0	195.4	250-2,500	0	250-2,500	8,950
Deltaic plain of Loudias-Aliakmonas	0.5		500-2,750	0	500-2,750	8,900
	1.0		5,000-6,500	0	5,000-6,500	25,575

6.2 Vulnerability assessment

6.2.1 Natural ecosystems and biodiversity

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 ***plant and vertebrate species*** endemic to 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 exposures are likely to be invaded first by thermophilous species, while northern exposures 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 (Thessaly) 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. 4 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. 4 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).

6.2.2 Agriculture and food security

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 6.5***, 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 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).

6.2.3 Forest ecosystems

Forest ecosystems occupy 65% of Greece's land surface (forests 25%, rangelands 40%). 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).

Assuming that today's forest management strategy remains unchanged and that no mitigation 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 deforestation/pastoralisation 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.

Table 6. 5a Assessment of possible impacts of climate change in different climate zones in Greece

Climate zones	Scenarios / Periods	A1B 2041-2050	A1B 2091-2100	A2 2041-2050	A2 2091-2100	B2 2041-2050	B2 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. 5b Assessment of possible impacts of climate change in different climate zones in Greece (continued)

Climate zones	Scenarios / Periods	A1B 2041-2050	A1B 2091-2100	A2 2041-2050	A2 2091-2100	B2 2041-2050	B2 2091-2100
Eastern Peloponnese	Cotton						
	Wheat						
	Maize						
	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"

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 forestrial 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 planes (*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 constitute 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.

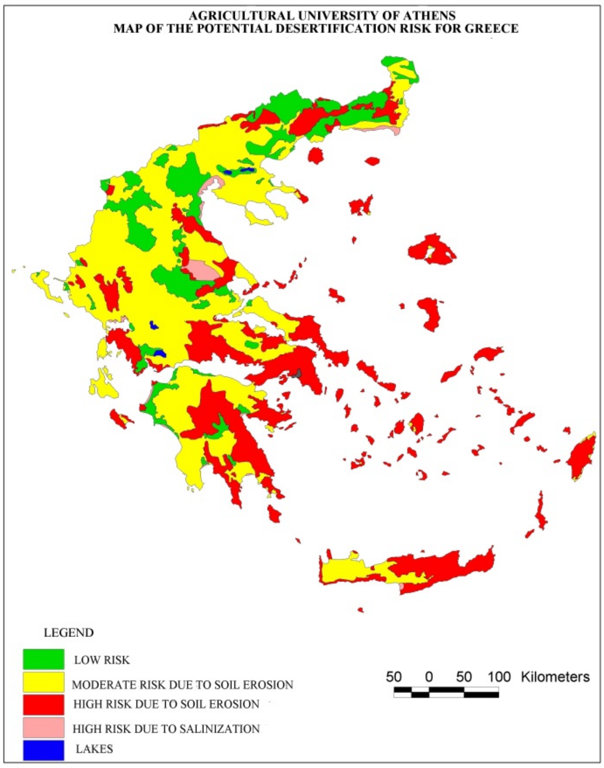
Sea level rise (SLR) is predicted to accelerate relative to today, reaching 0.25 to 1 m by 2100, thereby bringing about changes in the spatial distribution of present coastal area land uses (Nicholls 2004; Rahmstorf 2007). According to the report concerning "The environmental, economic and social impacts 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.

Desertification

The potential desertification risk in Greece is estimated primarily by the National Committee for Combating Desertification. The Committee has published various national reports regarding the implementation of the United Nations Convention to Combat Desertification. According to the latest available information, the map of potential desertification risk can be found in ***Figure 6.20.***

As it can be seen in the map, the main reasons for the desertification are soil erosion and salinization. According to Yassoglou (Yassoglou 2000) the pressures that are associated to climate change and lead to soil desertification are drought, over-exploitation of land (including over-grazing) and water resources, irrational irrigational schemes, forest fires and land abandonment. On the other hand, salinization is also associated(though not uniquely) with climate change. In particular, some of the effects of climate change include soil salinization and also secondary salinization through irrigation and sea water level rises. In combination with the higher evapotranspiration rates, the lack of sufficient water resources and the increased irrigation that is generally experienced in the recent years, as it has been already mentioned, may force farmers to apply new irrigation schemes that will lead to secondary salinization of valuable lands. According to Yassoglou, this will have tremendous negative socioeconomic effects.



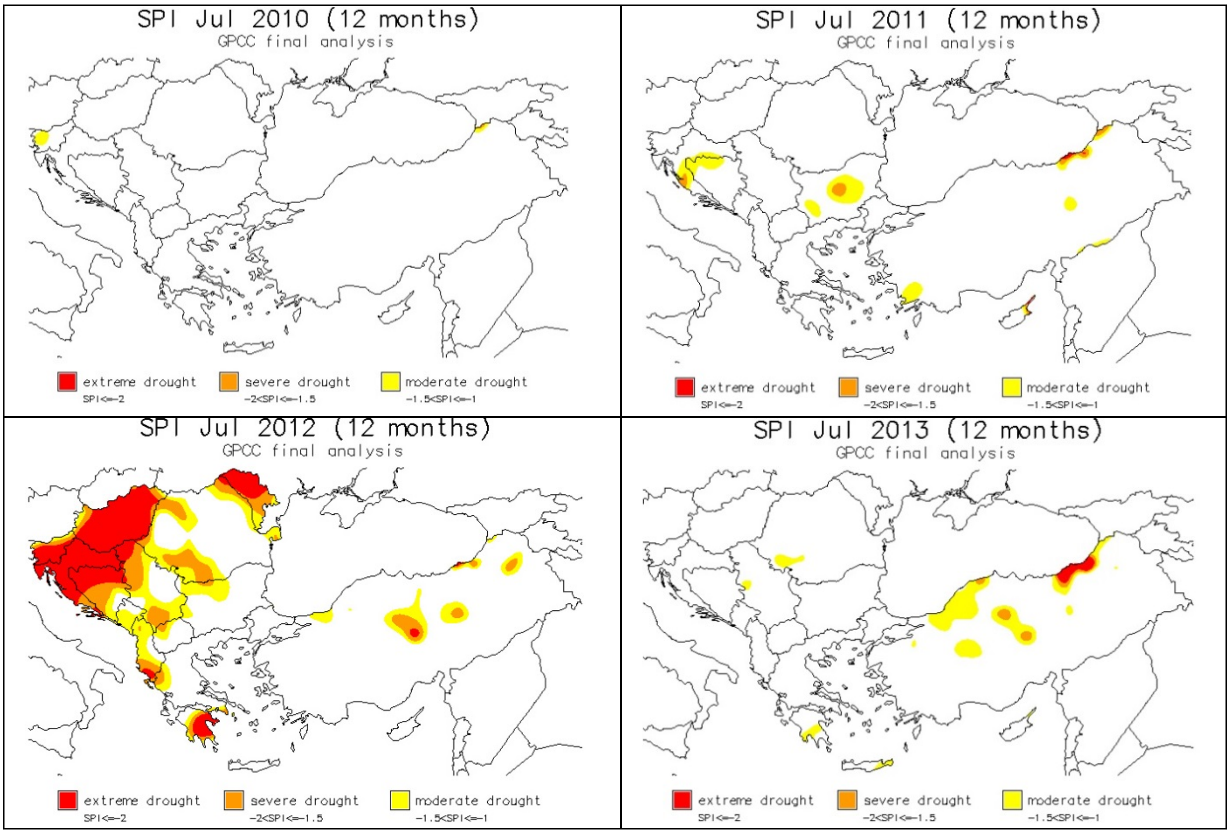
Source: National Committee for Combating Desertification, 2009 (Available on the website http://www.gnccd.com)

Figure 6.20 Map of the potential desertification risk for Greece.

In the Standardized Precipitation Index (SPI)[20] is presented for Greece and for the years 2005-2008, according to data collected from the Drought Management Centre of Southeastern Europe (http://www.dmcsee.org). As it can be seen from the charts, the higher drought was experienced in

[20] The SPI can be calculated at various time scales which reflect the impact of the drought on the availability of water resources. The SPI calculation is based on the distribution of precipitation over long time periods (30 years (1961-1990) was used). The long term precipitation record is fit to a probability distribution, which is then normalized so that the mean (average) SPI for any place and time period is zero (DMCSEE, Drought Management Centre for Southeastern Europe, 2007).

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.

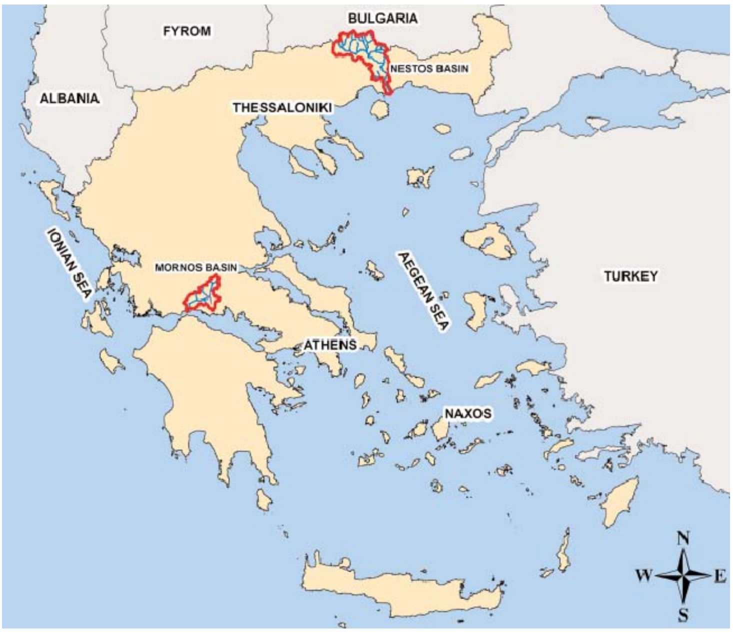


Figure 6.22 Nestos and Mornos Basins in Greece

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 industrial round wood. According to the NSSG (2007), domestic wood production covered only one-third of the national demand for industrial roundwood, but the entire demand for fuelwood.

Table 6. 6 Average annual timber production, 1988-2008

Type of timber	1000 m^3	% of the total
Industrial 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 industrial roundwood (which includes sawn wood, carpentry and joinery wood, windows, doors and their frames, parquet panels, etc.) has decreased, while the production of engineered wood (particle boards, pre-laminated boards, MDF, wooden crates, etc.) has increased. Both categories (industrial roundwood and engineered woods) 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 industrial 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 industrial 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. 7***, 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 event, due to the score 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. 7 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**

6.2.4 Fisheries and aquaculture

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 CO_2 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).

6.2.5 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 completetion of the works regarding the diversion of the Aheloos River towards the region of Thessaly (8). In that way, the water region 4 will export 13% of its potential towards the regions 6 and 8 and the region of Thessaly, which is currently unbalanced, will receive about 16% of its water potential. It is important to note that in order to avoid water stress in some areas of the country the percentage of internal water transport is projected to be doubled.

International water sources are flown into the country from regions 10, 11 and 12 (northern Greece). It is therefore very important to stress out that the impact of climate change on the rivers of neighbour countries will also affect the Greek balance.

Conflict and mismatch between water requirements and water resources

The spatial examination of water sufficiency on a regional or national scale is where the concept of available water reserves comes into play. These reserves represent resources minus water abstraction on a local scale, and resources minus consumption on a national (or drainage basin) scale. One fundamental reason for this distinction is that water abstracted (for instance, at a local scale) may re-enter the system, thus becoming available for re-use, meaning that the available water resources need to be ‘recalculated’ to take any water re-entrances into account. In any event, management programs need to distinguish between “water transfer” (from one basin or sub-basin to another, which alters the regional distribution of natural and exploitable natural resources) and “water addition” (transfer of water from a site of withdrawal to another area for use).

When examining water as a natural resource in adequacy terms, a clear distinction needs to be made between two very different concepts, sometimes confused even by specialists and policy makers. The first concept, drought or aridity, refers to a deficiency in the water supply to the environment – either direct (rainfall) or indirect (surface and underground), relative to the measurements of past time series. The second concept, water scarcity, refers to a decrease in available water potential, in comparison with present or anticipated use. Water scarcity can be a result of a drought (in which case the two concepts may quantitatively coincide), but can also occur at a time of normal or above-average water supply, as a result either of water mismanagement or of incorrect water use planning.

When discussing water availability issues, another major consideration is the breakdown of consumption by sector. At the global level, agriculture is the prime consumer of water: water consumption driven by agricultural needs has not only risen exponentially, it is projected to exceed 3,000 million m^3 by 2025 (Bank.of.Greece 2011), i.e. six times the consumption of the early 20th century. The industrial sector, second in terms of quantities consumed, also accounts for a steady rise in water consumption. By 2025, the water consumed by the global industrial sector is projected to be in the order of 1,000 million m^3. Water consumption by households, i.e. the sector that has always had the smallest consumption, is also projected to increase significantly.

Typical cases of water scarcity are presented by the Greek islands, especially the smaller ones, but also by the Attica region. Several islands (for instance the Cyclades) used to have sufficient water resources, despite low precipitation levels, small total surface area (hence limited potential for water accumulation) and high temperature and sunshine levels (thus high evaporation). However, the shift in land use away from traditional agriculture, stockbreeding, etc. to tourism activities, the sharp influx of tourists during the summer, improved living standards (more frequent showering and laundering, etc.) and changes in lifestyle (swimming pools, car washing, gardening, etc.) generate a higher demand for water, which the existing water potential cannot meet. The problem is further exacerbated by the uneven distribution of rainfall, both temporal and spatial. Similar in nature is the problem faced by the Attica region, which includes the wider urban area of Athens and Piraeus and the surrounding municipalities. As a result of intense rural migration and residential, economic and administrative centralization, the Attica basin at the end of the 1990s accounted for over 40% of the total national population and close to 70% of total national economic activity (Bank.of.Greece 2011).

Droughts

Like other natural hazards, drought has both a natural and social component. The risk associated with drought for any region is a product of both the region's exposure to the event and the vulnerability of society to the event. Vulnerability, on the other hand, is determined by social factors such as population changes, population shifts (regional and rural to urban), demographic characteristics, technology, government policies, environmental awareness, water use trends, social behaviour, level of water development and/or exploitation, and water availability in general. These factors change over time and thus vulnerability is likely to increase or decrease in response to these changes. Subsequent droughts in the same region will have different effects, even if they are identical in intensity, duration, and spatial characteristics, because societal characteristics evolve through time.

Drought is a natural hazard that differs from other hazards in that it has a slow onset, evolves over months or even years, affects a large spatial region, and causes little structural damage. Its onset and end, and the severity of drought are often difficult to determine. Like other hazards, the impacts of drought span economic, environmental, and social sectors and can be reduced through mitigation and preparedness. Because droughts are a normal part of climate variability for virtually all regions, it is important to develop plans to deal with these extended periods of water shortage in a timely, systematic manner as they evolve. To be effective, these plans must evaluate both a region's exposure and vulnerability to the hazard and incorporate these elements into a drought preparedness plan that is dynamic, evolving with societal changes.

Droughts differ from one another in three essential characteristics: intensity, duration, and spatial coverage. Intensity refers to the degree of the precipitation shortfall and/or the severity of impacts associated with the shortfall. It is generally measured by the departure of some climatic index from normal and is closely linked to duration in the determination of impact. Another distinguishing feature of drought is its duration. Droughts also differ in terms of their spatial characteristics. Drought impacts are closely related not only to the magnitude of the event, but also the timing of the onset, duration, and spatial extent. The spatial and temporal characteristics of drought affect the planning and responses.

Physical impacts of climate change on Greece’s water sector

The hydrological cycle begins with evaporation and atmospheric precipitation (rainfall, snowfall, hail, etc.). Upon reaching the earth’s surface, precipitation waters are separated at a primary stage into evaporation/transpiration (through vegetation), drainage (through the hydro-graphic networks), and infiltration. At a secondary stage, the picture becomes more complex, as drained water may, further down the line, either evaporate or partly infiltrate and, conversely, infiltrated water may flow out to the surface through spring discharges, only to undergo surface drainage and partial evaporation. These processes can occur several times. Moreover, before recharging the underground aquifer, infiltration water first satisfies the water needs of the ground and underground zones and of the root system (detained, adsorbed, capillary water), where plant and animal organisms grow. Therefore, any change in the atmospheric precipitation regime inevitably entails significant changes in the entire hydrological cycle, as well as in hydrological (surface) and hydrogeological (underground) water balances.

The primary factor that determines the distribution of total annual precipitation in Greece, which averages 800 mm, is the presence of the Pindos mountain range, to the West of which precipitation levels are considerably more important than in Eastern Greece. The water deficit is normal, with the distribution of surface drainage broadly matching rainfall distribution. For instance concerning the Thessaly water district: the increase in rainfall from 130 mm in 1989-1990 to 170 mm in 1990-1991 (increase of about 30%) resulted in an increase in drainage from 26 mm to 50 mm (increase of about 90%). The decrease in rainfall from 170 mm to 140 mm (decrease of about 17%) brought about a decrease in drainage, from 50 mm to 33 mm (decrease of about 70%). This seems to indicate that an increase in rainfall is associated with a three-fold increase in drainage, whereas a decrease in rainfall is associated with a roughly similar decrease in drainage.

Three factors —geographical location (winward/leeward), morphology and geology— determine water accumulation, both in surface water bodies (lakes) and underground (extensive karstic fields). The vulnerability of karstic formations to pollution means, however, that there can be degradation in water system quality. Climate change is expected to result in increased evaporation and transpiration, increased needs for irrigation and, perhaps, tourism, and increased pollution concentrations, due to decreased dilution (increased load in smaller water volumes) (Stournaras 2007; Bank.of.Greece 2011).

Evapotranspiration represents an important hydrological loss, occurring both on the surface and in upper soil layers. Evapotranspiration rates in Greece are high, particularly in the drier eastern regions.

The impacts of climatic change on water systems (mainly underground water systems) can be summarised as follows:

1. An overall decrease in aquifer infiltration and recharge, as a result of decreased rainfall and higher evapotranspiration.
2. Increased salinity of coastal and subsea aquifers, particularly karstic ones, as a result of the advance of the sea-water intrusion farther inland due to the decline of groundwater levels caused by lower inflow and overpumping.
3. Higher pollutant load concentrations in coastal water bodies and the sea, due to decreased dilution.
4. Faster degradation of deltaic regions, in cases where degradation has already begun as a result of transversal dam construction upstream (reduced drainage and sediment discharge) and parallel levee construction in the flat zone of the deltas (debris channeled to a single outlet).
5. Contamination or drainage of coastal wetlands.
6. Amplification of the desertification phenomenon as a result of water deficits and soil changes (compaction, sealing, etc.).

Fresh water salinization

Freshwater inland resources can be contaminated due to the intrusion of saline water, both underground and on surface, increasing drought problems (e.g. experienced in 2003 in the southern region of the Venice lagoon), both for human use and agriculture production. Problems of saline intrusion would be further exacerbated by reductions in runoff and by increased withdrawals in response to higher demand. Excessive demand already contributes to saline intrusion problems in many coastal areas of Italy, Spain, Greece and North Africa.

Large areas of the Mediterranean coastline have already been affected by saline intrusion driven by abstraction of water for agriculture and public water supply, with demand for the latter being markedly increased by tourism. Across Greece, for example, it is estimated that the total surface area of aquifers impacted by seawater intrusion is about 1,500 km^2 (Daskalaki P. and Voudouris 2007). The Argolid Plain in eastern Peloponnesus in Greece has undergone a rapid expansion of irrigated agriculture since the 1950s. Groundwater abstraction to support the irrigation of oranges, horticultural crops and olives has been excessive and led to the intrusion of sea water into aquifers. This phenomenon was first recorded in the early 1960s, when groundwater, pumped from certain wells, showed an increase in the concentration of chloride. On the Argolid Plain boreholes have had to be abandoned due to excessive levels of salinity found in the groundwater as a result of such salt water intrusion.

A typology of the economic impacts of water use

Water resources provide goods and services, the management of which has an economic and a socio-political dimension, and concerns several sectors of the economy. The possible economic impacts of climate change on freshwater availability are, thus, likely to affect a wide range of activities highly important to society, with additional repercussions further down the line. The major economic impacts expected include:

1. Lower productivity on account of the shortage (and, as a result, the poorer quality) of water resources in sectors where water is a major input in the production process (agriculture, hydroelectric power plants, industry, forestry, aquaculture, etc.).
2. Increased cost of pollution and wastewater treatment.
3. Increased risks (flooding, fires, etc.).
4. Decrease in benefits from recreation activities.
5. Loss of benefits due to damage to water ecosystems.
6. Higher cost of extracting underground waters.
7. Increased risk of further seawater intrusion into underground aquifers.
8. Impacts on human health.
9. Negative impact on welfare, as a result of possible restrictions on water use.

The intensity of these economic impacts is, of course, expected to vary in function of the severity of the respective climate changes.

Water reserves, climate change and the economic cost of non-action in Greece

Published research on the economic assessment of water resources in Greece covers a wide range of goods and services. Unfortunately, the heterogeneity of the units used to measure the impacts makes the use of the relevant results for ‘benefit transfer’ problematic. Furthermore, the monetary valuations available from Greek studies do not seem to serve even ‘conservative’ estimates.

In Greece, the needs of the Attica and greater Thessaloniki areas are met, respectively, by the Athens Water Supply and Sewerage Company (EYDAP) and the Thessaloniki Water Supply and Sewerage Company (EYATH). In all other regions, the domestic water supply is managed either by a Municipal Water Supply and Sewerage Company (DEYA) or, otherwise, by a similar municipal service. These companies are usually able to recover their operating and administrative costs, plus part of the capital costs of the water supply and sewerage networks and of municipal well drillings, if needed. In brief, from the perspective of the Greek consumer, there is a wide disparity in what water bills actually cover and which body they are payable to, while from the perspective of the water companies only part of their total costs are recovered. In order to estimate the impacts at a Water District level, reference values were used corresponding to the average prices charged by the DEYAs for 1 m3 of water (Hellenic Union of Municipal Enterprises for Water Supply and Sewerage, 2007). Meanwhile, in order to estimate the costs from climate change the following research assumptions were adopted: a) to estimate future demand, average expected water consumption was set at 200 liters daily per person for permanent residents and at 300 liters per person and overnight stay for tourists; b) the number of overnight stays in future was considered to remain stable, i.e. the same as today’s; c) the price of water was also considered to remain stable. The cost estimates are given both undiscounted and discounted using discount rates of 1% and 3%.

During the decade 2041-2050, the impact of climate change on the water supply sector alone would cost from 0.89% to 1.32% of GDP. During the decade 2091-2100, the decline in GDP would start at 0.51% in the best case and climb as high as 1.84% of GDP (Bank.of.Greece 2011).

The final stage of the economic valuation process consisted in estimating the cost of the climate change impact in Net Present Value (NPV) terms. The NPVs were estimated both undiscounted and discounted (using discount rates of 1% and 3%). When discounting was used, the total cost for the Greek economy was found to be greatest at 1.69% of GDP, and lowest at 0.34% of GDP. The climatic zones most vulnerable from an economic point of view were shown to be Central Macedonia and Central, Eastern and Western Greece.

6.2.6 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.

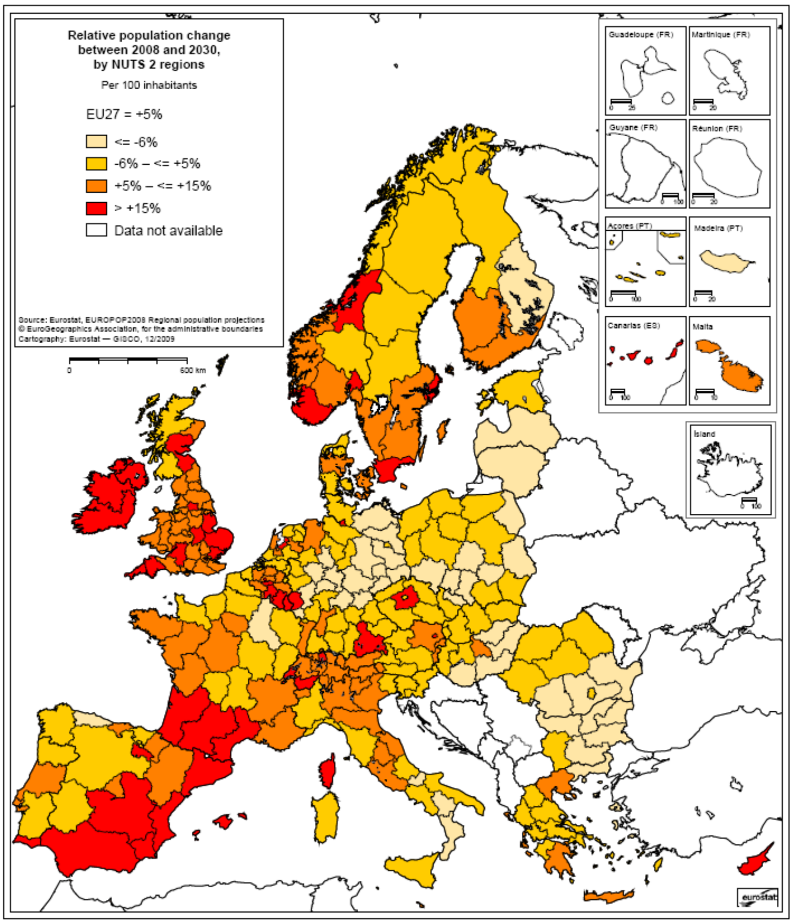
Coastal areas help generate and preserve microclimates. The presence of coastal forests and wetlands ensures the minimization of floods, erosion and other natural disasters, and offers valuable regulating and supporting ecosystem services. The last 20 years have seen a boom in the construction of summer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

6.2.7 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	11,319,20	11,319,200	16,037,592	65,420,236	11,319,200	11,319,200
2011-2020	188,143,297	767,470,509	132,789,98	121,412,900	185,058,981	754,889,025	130,613,100	119,422,525
2021-2030	215,685,205	879,818,929	152,228,83	137,264,579	212,149,382	865,395,668	149,733,282	135,014,340
2031-2040	247,258,916	1,008,613,80	174,513,30	155,185,855	247,258,916	1,008,613,802	174,513,301	155,185,855
2041-2050	277,013,603	1,129,988,54	195,513,91	171,460,195	299,719,636	1,222,610,560	211,539,644	185,514,310
2051-2060	310,348,915	1,265,969,31	219,041,70	189,441,225	335,787,351	1,369,737,286	236,995,939	204,969,195
2061-2070	339,823,403	1,386,201,07	239,844,55	204,568,892	395,532,158	1,613,447,151	279,163,331	238,104,776
2071-2080	372,097,146	1,517,851,50	262,623,09	220,904,565	433,096,678	1,766,679,615	305,676,059	257,118,428
2081-2090	398,245,218	1,624,514,21	281,078,18	233,163,716	496,174,370	2,023,984,923	350,195,773	290,499,056
2091-2100	416,652,612	1,699,601,29	294,069,97	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,	783,304,306		123,917,788	-3,084,316	-12,581,484	-2,176,885	-1,990,375
2021-2030	219,245,	894,340,269		139,530,120	-3,535,823	-14,423,261	-2,495,555	-2,250,239
2031-2040	257,461,	1,050,231,522		161,589,180	0	0	0	0
2041-2050	293,260,	1,196,263,518		181,516,509	22,706,033	92,622,012	16,025,731	14,054,114
2051-2060	328,551,	1,340,219,688		200,552,145	25,438,436	103,767,976	17,954,238	15,527,969
2061-2070	366,765,	1,496,102,085		220,787,555	55,708,755	227,246,078	39,318,779	33,535,884
2071-2080	398,702,	1,626,377,767		236,699,225	60,999,532	248,828,115	43,052,966	36,213,863
2081-2090	430,006,	1,754,073,094		251,759,078	97,929,152	399,470,708	69,117,587	57,335,340
2091-2100	438,395,	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.

6.2.8 Human health care

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. 14***. 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. 14 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	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).

6.2.9 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 economical activities will remain steady for all working days, so that the everyday peak load is mainly depending on the climatic variations. In that way, in every working day of the month the peak load is estimated as the sum of a basic load, independent of the temperature, and of a load that depends on it. The impact of the weather on the latter is estimated using appropriate functions (load-temperature modelling). The modelling is being implemented by the combination of the energy demand with the relevant climatic information. Firstly, each parameter is separated and estimated according to the historical data, and then it is projected in the future.

It is common sense that warmer climate conditions will probably lead to decreased demand in winter and increased demand during summer, as a result of the increase of summer days. Moreover, the effect of higher temperatures in summer is likely to be considerably larger on peak energy demand than on net demand, suggesting that there will be a need to install additional generating capacity over and above that needed to cater for underlying economic growth (Giannakopoulos, Le Sager et al. 2009a).

The Hellenic Transmission System Operator is the association having the responsibility of the covering the functioning, exploitation, maintenance and development of the Greek electricity system. The association has performed three projection scenarios of the peak load that follow the methodology that has been described above, and are characterised as:

- *Reference scenario:* the maximum expected peak load is based on the assumption of normally high temperature during the summer months, with a possibility of being up to that value of 97.7%.

- *Extreme scenario:* the maximum expected peak load is based on the assumption of abnormally extended heat wave days during July, with a possibility of being up to that value of 99.86%.

- *Mild scenario:* the maximum expected peak load is based on the assumption of mild summer days during July, with a possibility of being up to that value of 90%.

On a more long-term period of time, the changes in the number of days with large cooling and heating demand are shown in ***Figure 6.24***. As it can be seen from the chart on the left, the increase of the cold degree days will be quite important in northern part of Greece, leading to the corresponding increase in the electricity demand. As regards to the heating needs, the Southeast Mediterranean seems to experience a smaller decrease of the heating degree days than the rest of the Europe, possibly because it is already a warmer region (chart on the right of the same Figure).

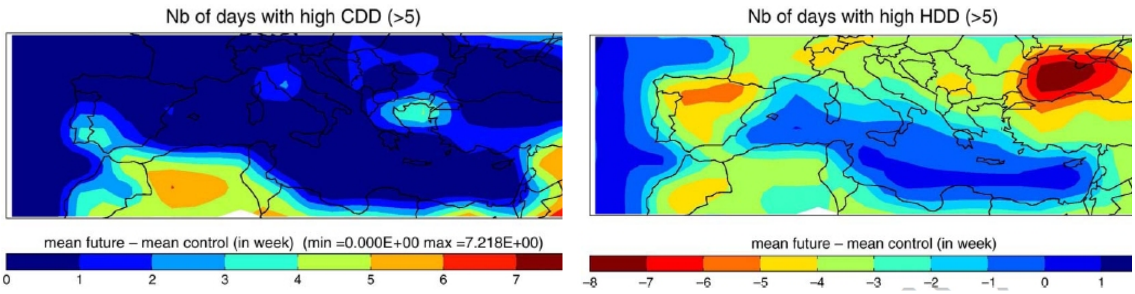


Figure 6.24 Change in the number of days with (a) large cooling demand and (b) large heating demand between the future and the control period (1961-1990)

A change of energy sources is also expected to occur in the country: a low water supply reduces energy production from hydroelectric plants, as well as from conventional power plants, which require water for cooling and for driving the turbines. Additional capacity may need to be installed unless adaptation or mitigation strategies are to put into place. On the other hand, conditions for renewable energy production, such as solar power, may improve under climate change.

Finally, projected monthly difference between the historical data of 1961-1990 and the projections of the PRECIS regional climatic model under the A2 and B2 scenarios, as they have been performed by the National Observatory of Athens (National Communication 5) are being presented in ***Figure 6.25***.

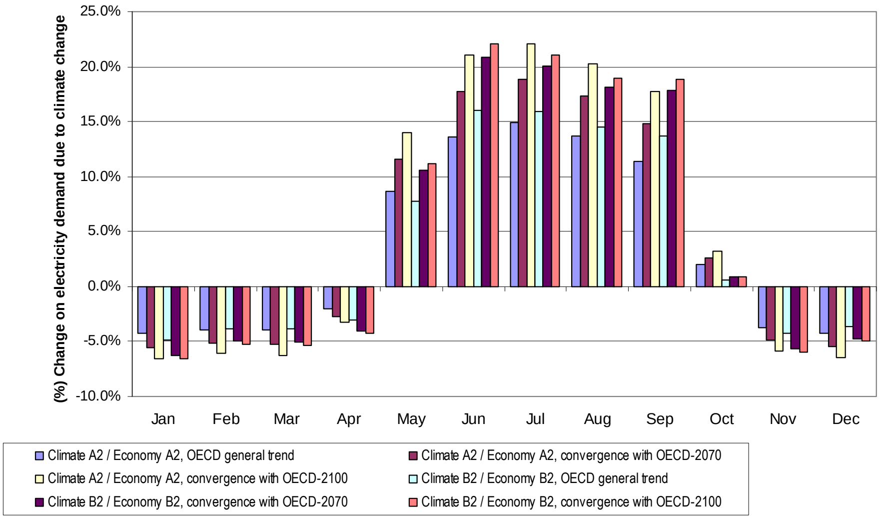


Figure 6.25 Change of the monthly electricity demand in Greece during the period 2071-2100 exclusively as a result of climate change under the A2 and B2 IPCC scenarios.

6.2.10 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 6.15***. 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 6.16 and ***6.17*** 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. 15 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 (Thessalonki 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. 16 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. 17 Estimated demand for freight transport

	Road transport (billion tkm/year)	Railway transport (billion tkm/year)	Air transport (thousand tonnes/year)	Sea transport (million tonnes/year)
Reference year	25.6	0.7	130	151
2015	29.5	0.8	151.3	189
2030	37.0	1.0	190.0	240
2050	46.5	1.4	239.5	302
2100	67.5	2.0	335.0	350

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

Main results of Phase 3: Valuating the cost of climate change impacts on Greece's transport sector

Based on the data calculated in the previous phases (regarding transport network components, estimated network vulnerability, and existing and estimated transport demand) and on the detailed methodologies for estimating the specific aspects of climate change impacts likely to be felt in Greece (i.e. mean temperature rise, increased heat wave frequency, SLR anticipated for the wider Mediterranean basin, higher frequency and intensity of flooding incidents, and reduced snowfall), the third phase of the methodology consisted in calculating the additional costs likely to be incurred as a result of repair of infrastructure damage/deterioration, prevention, increased maintenance, and finally, the estimated delays to be expected from the average annual temperature rise under the three scenarios considered.

From the estimated economic impacts the highest costs are expected to come from delays/cancellations (i.e. the cost of passenger value of time – VOT) in all types of transport as a result of the different aspects of climate change, without overlooking the costs associated with the redevelopment and redesign of transport infrastructure and increased maintenance needs.

6.3 Adaptation measures

The Ministry of Environment, Energy and Climate Change (MEECC) is the competent authority for coordinating actions for climate change and works towards both mitigation and adjustment to the implications of climate change as well as the enhancement of mechanisms and institutions for environmental governance. In this capacity MEECC 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. For this reason, MEECC cooperates with other competent ministries as well as with regional, prefectural and local authorities. Other ministries are also responsible for integrating environmental policy targets within their respective fields. Although an over-arching adaptation strategy is not yet available, adaptation measures are currently under implementation as part of a broader network of measures that apply to the specific areas of identified vulnerabilities.

Similarly to other European countries, Greece's attention and policy efforts have been mainly concentrated on mitigation action, and as a result policy response to adaptation has been weak. Several advances, however, have taken place in recent years towards this direction. For example, the implementation of adaptation measures as part of a broader network of measures that address the vulnerabilities of specific areas, the improvements of risk assessments and the integrated evaluations of climate change impacts (e.g. Bank of Greece, 2011).

The National Action Plan regarding Climate Change is focused on mitigation measures aimed at compliance with the Kyoto Protocol, (National Gazette, 58/A/5.3.03). The process of setting up a National Adaptation Strategy is ongoing and its development is included in the main priorities of the MEECC. Individual measures and ad-hoc political initiatives have been under implementation to facilitate the recovery of socio-ecological systems from past extreme weather events, and to improve Greece's resilience and response to any future ones.

The 'Adaptation to Climate Change in the Mediterranean Area' workshop, in June 2011, was followed by the publication of a report entitled "Environmental, Economic and Social Impacts of Climate Change in Greece" (Bank of Greece, 2011). This report presented for the first time socio-economic evaluations of adaptation measures, providing a more complete framework on adaptation to climate change in Greece. This framework could serve as the basis for the preparation work required for the development of the Greek NAS. Furthermore, the European Centre for Environmental Research and Training of the Panteio University in collaboration with the GSEE, TEE and WWF Hellas produced the "Roadmap for the Adaptation of Greece to Climate Change" (available in Greek).

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, aims 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 are:

- 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.

Moreover in the Operational Programme '**Environment and Sustainable Development**' (2007-2013) the following priority axis that are related to adaptation to climate change are included:

1. Protection of the Atmospheric Environment & Response to climate change – Renewable Energy Sources
2. Water resources management and protection
3. Prevention and response to environmental danger
4. Protection of the natural environment and of Biodiversity

Under the **Seventh Framework Programs** (FP7) of the European Commission the following projects concerning adaptation, mitigation and policies are being implemented (see also para. 8.1.2): ClimateCost, MEECE — Marine Ecosystem Evolution in a Changing Environment, ADAGIO, SERPEC-CC.

According to the "**Green Paper**" a 2030 framework for climate and energy policies is described, integrating different policy objectives, such as reducing greenhouse gas (GHG), emissions, securing energy supply and supporting growth, competitiveness and jobs through a high technology, cost effective and resource efficient approach. The Green Paper was adopted by the European Commission at the end of March 2013 which launched a public consultation process on the topics that should be included.

The Green Paper raises a number of questions, such as, inter alia, the following:

• What will be the type, nature and level of climate and energy targets that should be set for 2030?

• How to achieve coherence between different policy instruments?

• How can the energy system better contribute to the competitiveness of the EU?

• How to take into account the different capacities of Member States? etc.

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.

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 participate 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.).

In addition to the above mentioned, one could refer to the following adaptation actions related to particular areas and sectors.

6.3.1 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. 18***.

Table 6. 18 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) focusing in 13 targets:

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

Action Axis:

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

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, Foresty and Fisheries. Especially in the Fisheries areas many of the affected from climate change species, like *Posidonia oceanica*[21] and *Mediterranean monk seal*[22] are being protected.

Finally, **CITES** (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) is an international agreement between governments (179 parties), among which is Greece. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival. Because the trade in wild animals and plants crosses borders

[21] The Regulation 1967/2006 of the European Union introduces the prohibition of fishery with trawls etc. over sea beds with sea vegetation, especially Posidonia Oceanica.

[22] The Hellenic Society for the Study and Protection of the Monk Seal promoted a 2005-09 project (co-funded under the EU LIFE-Nature programme) to draft and implement an action plan to mitigate the seal-fisheries conflict, with the active participation of fishermen. The project also aims at evaluating and revising the National Conservation Strategy for the Mediterranean Monk Seal.

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.

6.3.2 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, Energy and Climate Change (MEECC) 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).

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, N. L. Bindoff et al. 2009)).

Aiming to the adaptation of the country concerning the agricultural sector Greece is participating in the Project **ADAGIO -** ADAptation of AGriculture in European RegIOns at Environmental Risk under Climate Change. The project is focusing 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 and 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 6.3.3 and 6.3.5).

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.

6.3.3 Adaptation policies concerning forest ecosystems

The National Strategic Plan of Rural Development 2007-2013 identifies the Greek priorities. The national strategy is implemented via the Program of Rural Development (RDP) 2007-2013 "Aleksandros Mpaltatzis" (MRDF) (climate-adapt.eea.europa.eu). Under the "**Aleksandros Mpaltatzis**" program 69 projects have been implemented by the Forestry Services of the regions of Attica, Macedonia and Thrace, Epirus and Western Macedonia, Peloponnese, Western Greece and the Ionian, Thessaly and Central Greece, Crete and the Aegean with a total budget amounting to 57.038.531,30 €.

Adaptation of forests to climate change is strengthened through the **Program of Rural Development**, as described below:

Under Measure 125: "Infrastructure related to the development and adaptation of agriculture and forestry", the local Forest Services deal with the "Construction and improvement of the forest road network within managed forests" (Action 125B).

Under Measure 226: "Restoring forestry potential and introducing prevention actions", special funding has been allocated to operations preventive forest fires and natural disasters, reforestation and mountain anti flood for burned forest areas.

All the selected actions of Action 1 (“Improvement of the prevention conditions for the fire protection of forests and of forest yields”), Measure 226 of the Program of Rural Development are related to the prevention of forest fires and of natural disasters and that are related to climate change. Some selected actions include the following:

- Studies regarding fire protection for prevention of forest fires
- Construction fire preventing forest roads in forests where the approach of fire extinguishing means is not possible due to lack of road system. Also, opening of dirt roads and pathways in order to improve the forestry road network of forest fire extinction.
- Small technical works for the improvement and the repairing of accessibility of fire preventive roads, so that the fire extinguishing means can easily access the fire.
- Construction of water supply centres (water tanks etc) and the indispensable works to improve the network of water provision for the refill of fire extinguishing means.
- Cleaning of the flora that is close to the ground along forest roads and other regions of high risk.

- Preventive forestry works, like forestry actions of moderation of the combustible material and diversification of its structure, rarefaction of bushy plantation and of small and old degraded tufts, aiming at the reduction of consequences in case of fire. Trimming and removal of a part of the flammable plantation are also included as measures that will prevent a fire to be transmitted by the tree summits and will reduce the rapidness of the fire transmission tree by tree.
- Cultivating interventions in conifer forests in order to remove the flammable biomass.
- Construction and improvement of the permanent forest fire surveillance systems (observatories, innovative systems of fire tracing and timely notification, supply of technical equipment).
- Supply of instruments of communication.

In addition to these measures, actions have been undertaken to increase forest area, mainly by restoration of the fire hit areas. All these actions are part of the Action 3 ("Reforestation works – Mountainous flood preventing and corrosion preventive systems for restoration of burnt regions"), Measure 226 of the Program of Rural Development. Selectable actions include the following:

- Reforestation studies for the restoration of burnt areas.
- Restoration works (reforestations) of forestry potential that has experienced destruction during the fires.
- Woodcutting, carriage and removal of burnt trees.
- Horticultural works (reforestation, manufacture of soil gradient, etc) and planting along gradients mostly with hydrophile species (planes, poplars, alders, osiers)
- Corrosion preventive works in small erosion gullies using wood, stone, cement dust, wire etc.
- Works in watersheds, for the limitation of soil degradation and the restraint of water, construction of dikes for the confinement of rain waters etc.
- Drainage works for the soil sliding
- Works aiming at the prevention of decay and precipitation of soil and at the restraint of produced materials in the appropriate positions of the watershed.

A wide variety of technical works, like water damns, works for the watercourse formulation etc., are also implemented in order to mitigate the damage caused by the forest fires. The total area of the restoration works and the works aiming at the prevention from floods and from soil degradation in forests amounts to 180,000 hectares. According to **Rural Development Regulation** (2007-2013) restoring forestry and introducing prevention actions started in 2011. Enhancement of forest fires prevention and restoring of forest burnt area (45 M Euros), along with anti-erosion, anti-flood works for prevention of flooding in the lowlands. (25 M Euros) and anti-erosion, anti-flood works for restoration of forest burnt areas (100 M Euros) are included in the RDR actions.

In addition, a **Life+ project** "Adaptation of forest management to climate change in Greece (AdaptFor)" is in progress, implemented by the Goulandris Natural History Museum / Greek Biotope - Wetland Centre in cooperation with the MEECC. The project aimed:

a) To demonstrate the approach of adapting forest management to climate change.

b) To enhance the capacity of forest services to adapt forest management to climate change and to disseminate 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 is 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.

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. Natura 2000 Network concerning Greece funds the conservation of mature forest trees in coppice oak forests and the maintenance of stands in buffer zones from the streams etc. in an EU ecological network of protected areas called Natura 2000 (10 M Euros).

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, Raptis et al. 2013).

In addition, measures to counter after-fire impacts and avoid soil erosion have been adopted which include prohibition of grazing in burned lands and soil support to allow for natural regeneration by not clearing burned trees and bushes or by planting appropriate trees, bushes and plants where rapid natural coverage of the ground is not ensured.

Since 2003, a wide array of desertification-specific projects have been carried out to better assess the extent and impacts of desertification within the country, estimate the effectiveness of policies and measures already undertaken, and propose new remedial and preventative steps. In addition, substantial levels of funding are being allocated to other projects that contribute to the anti-desertification fight, but which are not designated as desertification-related activities in the budgets of the implementing ministries and institutes. For example: EUR 650 million have been allocated by the Greek government for re-establishment of lands impacted by forest fires over the 2007-10 period; in 2006, expenditure to support early retirement of aged farmers and afforestation of agricultural land amounted to EUR 236 million and EUR 19 million, respectively (including contribution from the EU); over the period 2000-06, EUR 122 million were spent to support organic farming. Also, in the recent years, the Committee for Combating Desertification has oriented its actions to broadening the public awareness on the problem. To this end the Committee has created a website that contains all available information over the desertification issue in Greece (http://www.gnccd.com) and has organized a meeting on the 16th of June 2007 (World Day to Combat Desertification and Drought), from which very useful conclusions have been drawn. Greece has also been one of the founding members of the Drought Management Centre for South Eastern Europe (2007) while it has founded a focal point to ensure the implementation of the National Plan. Various projects have also been undertaken by Greek Universities and Institutes, such as the Xerochore project[23], undertaken by the Environmental & Energy Management Research Unit of the National Technical University of Athens and the update of desertification maps that is being performed by the Agricultural University of Athens.

6.3.4 Adaptation policies concerning fisheries and aquaculture

The impacts of rising temperatures on marine ecosystem structures and fish populations have already been felt with the 'El Niño' phenomenon. 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 is 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 are reflected in and are 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 is to achieve a stable balance between fisheries resources and the respective fishing activities,

[23] XEROCHORE is a Support Action aimed at assisting in the development of a European Drought Policy in accordance with the EU-Water Framework Directive (EU-WFD). The Support Action is financed by the 7th Framework Programme (Grant Agreement Number: 211837) and spans a duration of 18 months (May 2008 - November 2009).

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 are 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** are defined:

- 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 dependant 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.

6.3.5 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.

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 Mediterrenean 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" focuses 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 provide 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 will be 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 are:

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, miti-gation 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 groundwaters (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.

6.3.6 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).

6.3.7 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).

6.3.8 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.

6.3.9 Adaptation policies concerning energy

The program **Intelligent Energy Europe (IEE)** contributes 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 is 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 (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.

6.3.10 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. 19 Summary of information on vulnerability and adaptation to climate change

Vulnerable Area	Vulnerability / Adaptation
Agriculture and food security	Vulnerability: Shorter growing season; higher risk of heat stress during flowering period; extreme events during developing period; higher risk of raining days during sowing days; higher rainfall intensity; longer dry spells. Adaptation: Program of Rural Development 2007-2013
Biodiversity and natural ecosystems	Vulnerability: Mainly decrease of species population and variety, invasion of alien species Adaptation: National Biodiversity Strategy (evaluation under the new governmental authorities); specific measures for touristic destinations
Coastal zones	Vulnerability: Flooding and erosion; freshwater shortage; coastal ecosystems Adaptation: Specific Framework for Spatial Planning Plans for the Tourism sector and for Coastal Areas; National Strategy for the Management of Water Resources; Societies for the protection of Species / National marine parks; specific measures for touristic destinations
Drought	Vulnerability: Soil degradation, salinization Adaptation: National Action Plan for Combating Desertification
Fisheries	Vulnerability: Fluctuation of marine species population Adaptation: Binding fishing code
Forests	Vulnerability: Forest fires, floods, losing of forest biodiversity Adaptation: Program of Rural Development 2007-2013
Human health	Vulnerability: Up to the moment mainly danger because of forest fires and floods, as well as air pollution aggravated in cases of extreme heat waves Adaptation: Circular of the General Secretariat of Civil protection regarding floods and air pollution, public awareness, National Action Plan for the 'Response of Environmental Hazards Threatening Health'
Infrastructure and economy	Vulnerability: effect on tourism, loss of properties in cases of erosion, forest fires and floods Adaptation: Rural Development Regulation (2007-2013), National, National Action Plan for Combating Desertification, Greek National Tourism Organization
Water resources	Vulnerability: Water quantity and quality Adaptation: National Strategy for the Management of Water Resources (regional objectives to be finalized by the end of 2009), National Biodiversity Strategy (under public consultation)

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”) coordinates programming, allocation and monitoring of development cooperation multilateral and bilateral funding.

Development cooperation funds are also channeled through other public bodies: the Ministry of Economy is responsible for Greece’s contributions to multilateral institutions, such as the Global Environmental Facility (GEF), the World Bank, the European Bank for Reconstruction and Development (EBRD), UNDP etc, while line Ministries are responsible for sectoral/thematic contributions to related United Nations Conventions and their Secretariats, i.e. the Hellenic Ministry of Environment, Energy and Climate Change (MEECC) is responsible for the allocation of annual official multilateral and multi-bilateral contributions to International Organizations, UN Convention Secretariats, Trust Funds and Agencies related to environmental issues.

7.2 ODA general trends

While the international crisis was raging, Greece continued in 2012 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 2008-2012

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**

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

Total (bilateral and multilateral) ODA granted by Greece in 2012 reached 327.41 MUSD, that is o.13% of GNI of which 33% was channelled bilaterally to developing countries, while 67% through International Organisations. Multilateral ODA reached 220.10 MUSD, while bilateral ODA amounted to 107.31 MUSD. In relation to 2011, total ODA fell, due to the difficult fiscal circumstances by 97.36 MUSD (approximately 23%), while ODA/GNI ratio dropped respectively from 0.15% in 2011 to 0.13% in 2012.

7.3 Bilateral cooperation

In the last five years (2008-2012) Greece continued to provide 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***).

Total bilateral ODA granted in 2012 reached 107.31 MUSD, that is 0,04% of GNI, a fall by 46.59 MUSD in relation to the previous year 2011 (153.90 MUSD or 0.05% of GNI). 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.

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

7.4 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 2012 amounted to 220.10 MUSD (0.09% of GNI), a fall by 50.77 MUSD in relation to the previous year 2011 (270.87 MUSD). Greece's overall ODA-eligible financial contributions towards Multilateral Organizations and programmes over recent years 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***. Contributions to United Nations Conventions and their Secretariats are channelled through other line Ministries, like MEECC. Over the period 2005-2011, MEECC has contributed annually an average amount of USD 91.488 to the UNFCCC Fund. MEECC's multilateral and multi-bilateral economic contributions to UN environmental related Organisations, Secretariats and Funds during the last five 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 (of total pledged EURO 5,73 million)

Source: Hellenic Ministry of Economy and Finance

Table 7.4(a) ODA eligible financial contributions to multilateral institutions and programmes (2008-2012)

Multilateral institutions and programmes					(in MUSD)
	2008	2009	2010	2011	2012
United Nations	14.19	13.75	12.85	12.15	10.15
European Union	238.87	286.06	277.60	256.36	204.05
World Bank Group	79.51	0.00	0.00	0.00	0.00
Regional Banks	44.27	0.72	1.01	0.00	0.69
Other Agencies	14.15	9.80	4.44	2.36	5.22
TOTAL	**390.99**	**310.33**	**295.90**	**270.87**	**220.11**

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

Table 7.4(b) Contributions to UN Environmental related Organizations, Secretariats and Funds (Source: MEECC, September 2013)

Type	Receiving Organization / Foundation / Entity	2005	2006	2007	2008	2009	2010	2011*
Multilateral	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
	UNECE/EMEP	26.890 USD	29.151 USD	27.400 USD	4.510 USD	31.910 USD	31.910 USD	36.530 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
	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
	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
	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
	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
	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
	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
	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
	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
	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
	UNESCO	29.347 EUR	30.000 EUR	30.000 EUR	30.000 EUR	30.000 EUR	30.000 EUR	1.000 EUR
	UNFCCC-Kyoto Protocol	35.596 USD	65.631 USD	69.582 USD	70.698 USD	68.952 USD	65.172 EUR	64.385 EUR

Type	Receiving Organization / Foundation / Entity	2005	2006	2007	2008	2009	2010	2011*
Multi-Bilateral and Bilateral-	UNFCC-Kyoto Protocol (ITL)			23.461 USD	47.205 USD	96.276 USD	30.544 EUR	55.849,76 EUR[24]
	Stockholm Convention on Persistent Organic Pollutants			0 USD	58.481 USD	34.215 USD	34.048 USD	34.346 USD
	Aarhus Convention			10.000 USD	10.000 USD	10.000 USD	10.000 USD	1.000 USD
	Espoo Conventon on Environmental Impact Assessment In A Transboundary Context					5.000 USD	5.000 USD	1.000 USD
	MED-WET (Mediterranean Wetlands)	160.000 EUR	170.000 EUR	170.000 EUR	170.000 EUR	170.000 EUR	170.000 EUR	--
	Bureau Europeen De 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
	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
	Ramsar Bureau/IUCN	15.738 CHF	20.218 CHF	24.109 CHF	25.048 CHF	24.941 CHF	31.529 CHF	32.318 CHF
	Ramsar Convention / MedWet Coordination Unit	--	4.685 CHF	5.252 CHF	5.222 CHF	5.222 CHF	5.222 CHF	5.222 CHF
	IMPEL	--	--	--	--	--	3.000 EUR	1.000 EUR
	OECD	--	--	--	--	--	3.079 EUR	--
	SUM **(indicative approximations due to currency differences)**	**1.866.422 €**	**2.385.000 €**	**2.618.634 €**	**3.020.000 €**	**2.840.000 €**	**2.545.000 €**	**2.285.000 €**
	SUBSUM (Multi)	1.491.404 €	2.000.000 €	2.218.634 €	2.600.000 €	2.400.000 €		1.913.000 €
	SUBSUM (Multi-Bi and Bi)	375.018 €	385.000 €	400.000 €	420.000 €	440.000 €		372.000 €

* Some amounts for 2011 have been transmitted/deposited in late 2012-early 2013 due to budgetary constrains

[24] This amount corresponds to the Greek contribution of two years, namely 2011 and 2012.

7.5 Environmental cooperation and transfer of technology

7.5.1 Multilateral/Regional cooperation

7.5.1.1 Mediterranean Component of the EU's Initiative 'Water for Life' (MED EUWI)

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.

7.5.1.2 Regional cooperation on environmental protection within the Black Sea Economic Cooperation (BSEC) Organisation

On the regional level, Greece, as a member of the Black Sea Economic Cooperation Organization (BSEC), is actively engaged in efforts made by BSEC member states in order to promote cooperation and exchange of best practices for the protection of the Black Sea marine and coastal environment. To this end, BSEC Member States have elaborated a general cooperation framework, *the BSEC Action Plan for Cooperation in the Field of Environmental Protection*, the main directions of which include:

- ✓ Harmonizing environmental legislation among the BSEC Member States, based on best practices and transfer of technology and taking into account the EU relevant legislative framework;
- ✓ Strengthening cooperation in the Black Sea basin in the fields of pollution prevention and biodiversity conservation, with particular attention to the areas not covered by the Bucharest Convention;
- ✓ Promoting the use of economic incentives and tools in the field of environmental protection, in order to leverage funding for projects of mutual interest;
- ✓ Promoting the development of innovative, environmentally friendly and resource saving technologies;

Environmental Cooperation between BSEC member states is promoted through high level meetings but also through the nomination of national focal points with the participation of experts on environmental protection, as well as investment programmes directed at the preservation of the region's environment and the development of green technologies. Cooperation also aims at intensifying control of the transboundary spreading of dangerous substances in the environment of the Black Sea region and at providing state-of-the-art mechanisms for integrated management of river ecosystems in the BSEC region. In this respect, joint scientific-technical research programmes and projects, exchange of officials, experts, researchers and members of the civil society, as well as training programmes, meetings, conferences and symposia are regularly organised.

On the international level, the BSEC Working Group on Environmental Protection cooperates with international organisations such as UNEP, UNDP and the International Maritime Organization (IMO), as well as with the European Commission's General Directorate Environment (i.e., in relation to the EU Water Initiative). The BSEC Working Group on Environment also closely follows regional environmental initiatives, supporting the activities of the International Commission for the Protection of the Danube River (ICPDR) and of the Commission on the Protection of the Black Sea against Pollution (the Black Sea Commission-BSC), in implementing the Bucharest Convention (1992) requirements on the protection of the Black Sea environment.

The Secretary General of the BSEC Permanent Secretariat attended and delivered a statement at the 1st International Conference on Climate Policy, Sustainable Development and Green Finance held in Moscow on 20-21 May 2013.

The Joint Declaration on Combating Climate Change in the wider Black Sea area adopted by the Council of Ministers of Foreign Affairs of BSEC (*Thessaloniki Declaration, November 2010*), the Joint Declaration adopted by the Ministers in charge of Environmental Protection of the BSEC Member States (*Bucharest Declaration, May 2011*) and the Joint Declaration on Climate Change and Green Economy adopted by the Ministers in Charge of Environmental Protection and Heads of Delegations of the BSEC Member States (*Belgrade Declaration, April 2012*) all focused on different aspects of climate change policy and highlighted the BSEC area's States intention to address climate change and its impacts in the region. A *Climate Change Adaptation Strategy* is currently being drafted.

Programmes and projects currently implemented in the field of environmental protection within the BSEC include issues related to climate change. In addition, Greece has been financing RES and EE projects and projects in the field of environmental protection through the BSEC Hellenic Development Fund (BSEC-HDF) - a special fund, established in April 2008, as a voluntary contribution from the Hellenic Republic. The Fund's aims included supporting BSEC efforts to strengthen regional cooperation among its member states and enhance its project-oriented approach, targeting the following specific key areas: transport, renewable energy sources (RES), environmental protection, business cooperation and trade facilitation, tourism and culture.

7.5.2 Bilateral cooperation

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 on-going 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

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

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 Observating System (EuroGOOS) and has participated in several operational oceanography R&D projects.

The research areas in the National Technical University of Athens (NTUA) are closely connected to the impacts of climate change in significant sectors, such as water scarcity, desertification and extreme weather events (mainly floods). The 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 (ie. 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 8.1***.

Table 8.1 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)	3. National and Kapodistrian University of Athens (NKUA) 4. National Observatory of Athens (NOA) 5. 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 Enginnering, 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.

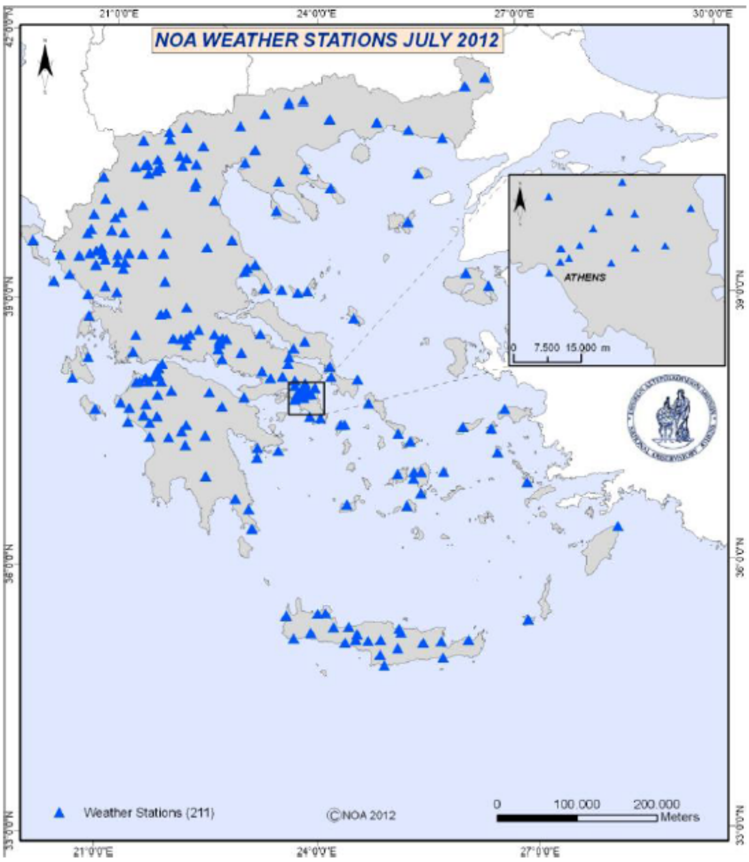


Figure 8.1 NOA Meteorological stations network.

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 Klimatology** 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 dans 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.
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 8.2a 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 Observing 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 8.2b 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 8.2c 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/) and the Hellenic Navy Hydrographic Service (HNHS, http://www.hnhs.gr/portal/page/portal/HNHS).

8.3.2.2 Hellenic Centre for Marine Research (HCMR)

The Hellenic Centre for Marine Research (HCMR) was set up as a single institution in order to integrate government-funded marine science research in Greece. The institutes of National Centre for Marine Research (NCMR) with the Institute of Marine Biology of Crete (IMBC), were merged together with their respective field stations and become the Hellenic Centre for Marine Research (Law: (2919/25.6.2001)).

Its present structure consists of five institutes, which carry out research into specific thematic areas.

- Institute of Oceanography
- Institute of Aquaculture
- Institute of Marine Biological Resources
- Institute of Inland Waters
- Institute of Marine Biology and Genetics

It enjoys top-level scientific support from its two research vessels, the RV AEGAEO and RV PHILIA, its state-of-the-art 2-man submersible THETIS as well as three deepwater ROVs, named the MAX ROVER, SUPER ACHILLES and SEABOTIX.

The global scientific community can also access the Mediterranean Marine Science Journal, (http://www.medit-mar-sc.net/index.php/marine), 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 selfevolving, 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

Detailed information concerning all the programs that HCMR participated is available (pdfs in Greek Language): http://www.hcmr.gr/gr/listview2_el.php?id=844

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 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 a 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 co-ordinator 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 Hellenic Navy Hydrographic Service maintains a quite dense network of permanent tide gauge stations equipped with instruments for Sea - level Monitoring (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 tranmission of data.
- From those nine (9) stations, four (4) transmitt data in real time mode, using GPRS.
- Nine (9) stations also have a temperature sensor.

One (1) station has a CGPS systerm.

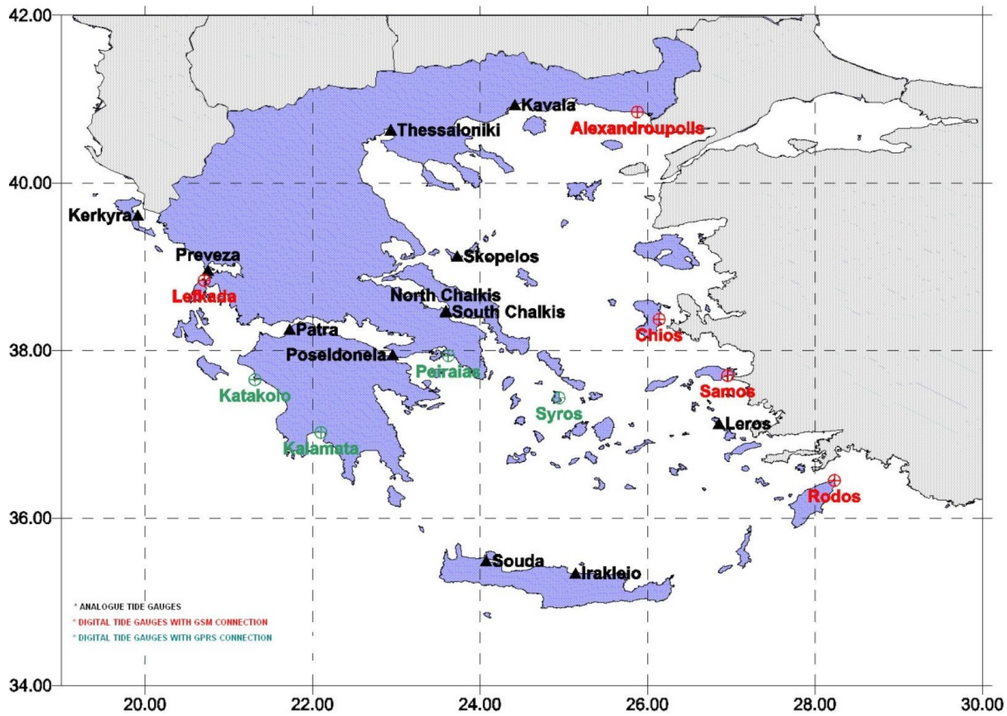


Figure 8.2 Map of Permanent Network of Sea - level and Temperature Monitoring

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).

8.3.2.4 National Contribution

In ***Tables 8.3a*** and ***8.3b*** the total national contribution to oceanic essential climate variables are reported. The climate of Greece does not justify the participation in some networks (ie global tropical moored buoy network). In this case the relevant cells are shaded grey.

Table 8.3a 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 8.3b 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 8.4***. The launching of a satellite in 2010 has improved the data collection and creates a new climatological database.

Table 8.4 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)

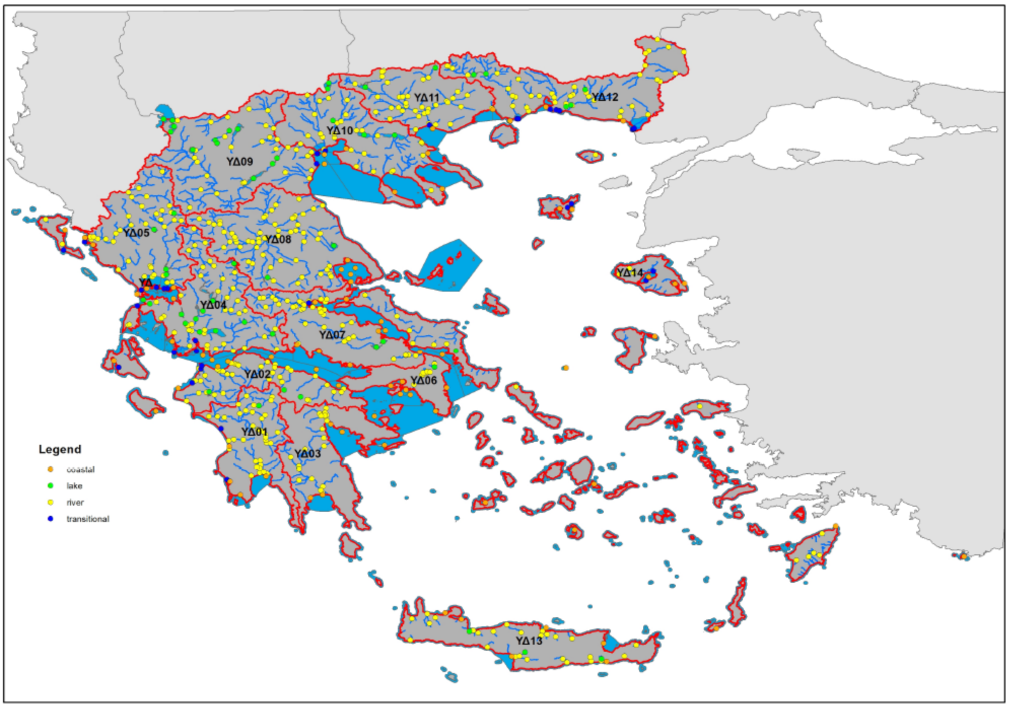


Figure 8.3 Network of surface waters

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

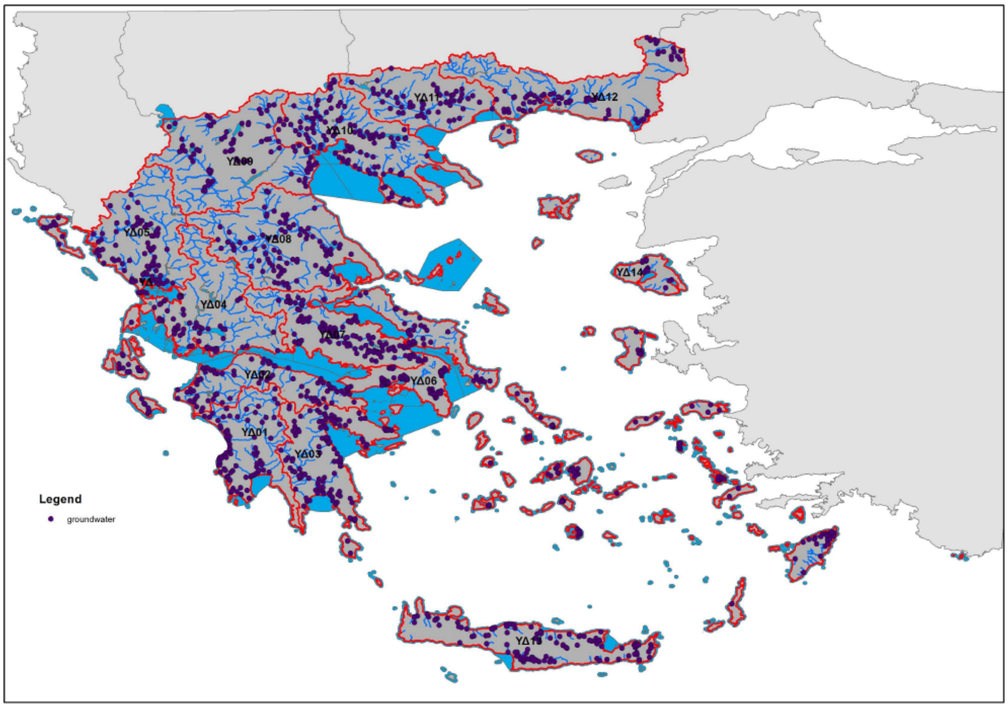


Figure 8.4 Network of ground waters

(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 8.5*** 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 8.5 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, Energy and Climate Change reminds to the Ministry's services the obligation to conform with 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

The environmental education has been considered a priority in the Greek educational system as early as the beginning of 1980's. 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.

9.2.2.1 Ministry of Education and Religious Affairs (M.E.)

The Ministry of Education and Religious Affairs (M.E.) published in October 2007 and in October 2009 two circulars regarding the Planning and Implementation of School Activities Programmes including, among others, the environmental education for the school years 2007-2008 and 2009-2010, respectively.

The first circular was mostly focused on forests, that has been considered as a crucial issue 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
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 (ie. 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.

According to UNESCO, the years 2005-2014 have been designated as the "Decade of Education for Sustainable Development (ESD)". Consistent with 106553/G7/13-10-2006 "The framework of reference for Sustainability Education and school activities", the **year 2013** is dedicated to the human environment and sustainable management. In this context, according to the relevant circular published by the Ministry of Education and Religious Affairs (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 conserning environmental education are:

- Troubis G., Troubis A. Flogaiti E., *Discover and Understand the Forest*, Greek company for environmental awareness & education, 1988

  This book includes ideas and suggestions for educational activities for teachers, forest group leaders and parents. It consists of 3 Parts of which Part A: Includes theoretical Information, Part B: Educational Activities and Part C : General Information

- 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 . This is one of the first materials released in Greece and materially affect the course of Environmental Education in our country. Twelve years after the material was updated and this version includes most modern environmental information. The issues addressed are: Soil, Water, Sea, Forest, agroecosystems, Air, and Biodiversity. The material includes informative texts for teachers and 150 educational activities. The forest is a unique ecosystem due to the high value of biodiversity and particular conditions forming in the region where it is located. 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. Furthermore, we examine the role of forests in society and the economy , the importance of ecosystem management and the dangers threatening it. Particular reference is made to Greek forests.

- George Voutsinos, Konstantinos Kosmas, George Kalkanis, Konstantinos Soutsas, *Natural Resource Management,* Ministry of Education and Religious Affairs

  This book is addressed to students of the 5th year of study in the Unified Upper Secondary Schools and was formerly being distributed and lately is available online (http://ebooks.edu.gr/modules/ebook/show.php/DSGL-B115/90/712,2690/).

A. Programmes of Environmental Education

During the school year 2011-2012 only in Athens more that 250 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 100 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

	School year 2008-2009 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	Grava's meteorological station: climate changes and micro-climate in the Municipality of Galatsi							X						
5	The bigger world experiment: prediction of climate of the 21st century								X					
6	Effect of forests on climate factors								X	X				
7	National network of environmental education: Climate change & natural disasters												X	X
8	National network of environmental education: Geo-environmental – geo-mythical trajectories: Geo-mythology and Climate change								X					
9	Environmental impacts on Thriassion after the implementation of new investments in the area's industries						X	X						
10	Energy saving at home, at school, in the city				X									
11	Environment and quality of life at Vilia								X					
12	Becoming and energetic citizen, taking care of the environment								X					
13	Electricity saving				X									
14	The green choice of auto mobility – hybrid cars					X								
15	Parnitha's national park: before and after fire, protection and conservation													X

The Environmental Education Centres (EEC) are also involved in the implementation of educational programmes and activities. Currently 47 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
- develop activities in the local communities.

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 during 2012-2013, 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 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

It should be noted that especially for the current school year (2013-2014), the Ministry has already suggested the thematic axis of educational activities. In particular the main axes are four, including the "Environmental Education" axis.

2. Exploitation and development of administrative educational structures

i. Development of the national network of Environmental Education Centres

ii. Support of coordinators per administrative structure at a national level: teachers/ responsible persons for the Environmental Education per prefecture and educational level.

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 2013-2014” 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 of teachers on issues of education and sustainable development. In the context of the Operational Programme “Education and Initial Professional Training” the NTUA has trained 12,000 educators in the period 2007-2008.

ii. Development of e-learning programmes

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 2013-2014. Every national network consists of 120 schools, while Regional School Networks are operating for the coordination of more than 300 schools on particular issues. 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.

  Founders and coordinating bodies of thematic networks may be the EECs and the Directorates of Primary and Secondary Education, through the Environmental Education Coordinators. The developed actions that are related to climate change are presented in ***Table 9.2***.

Table 9.2 Coordinated and developed actions in the National Thematic Networks

Subject	Programme title	Coordinator
Urban environment	Sustainable City: The City as a training ground for sustainability	EEC of Eleftherio –Kordelio - Vertisko
Industry	Industrial heritage	EEC of Naoussa
Biodiversity	The Seed, a source of life	EEC of Lavrion
Biodiversity	The workshop of life	EEC of Kastoria
Agriculture	Agriculture and Environment	EEC of Naoussa
Forest	Learing about Forests	Hellenic Society for the Protection of Nature (HSPN)
	Forest fires	EEC of Argiroupoli
Waste Management	Nature without garbage	HSPN
	Waste: The useful… useless	EEC of Edessa
Sea	The sea	EEC of Argiroupoli
Thermalism	Thermalism - Ecology - Culture	EEC of Eleftherio - Kordelio
Olive	Olive National Thematic Network	EEC of Kalamata
Weather - Climate	Climate change - extreme weather phenomena	EEC of Stylida
Castle	Castle : The place defines and builds the man	EEC of Molaoi
Ports	The ports of Greece	EEC of Drapetsona
Lakes - Salinas	Sali(e)cology	EEC of Messologi
	Lakes: Sources of inspiration	EEC of Kastoria
Honey - Bee	Bee works, people's goods	EEC of Arnaia
Silk	Silk	EEC of Soufli
Water	Water Power	EEC of Filliata
	Water and Sustainable Development	EEC of Edessa
	Water resources	EEC of Soufli
	Sustainable water management	EEC of Eleftherio –Kordelio - Vertisko
Fauna	Wildlife at risk	EEC of Stylida
Suburban green	The green corners of my neighborhood	HSPN
Environmental awareness - Game	Learning about the environment while playing	EEC of Philippon
Rivers - Bridges	Stonebridges in Greece	EEC of Makrinitsas
	The Greek rivers in nature, tradition and culture	EEC of Thermos
Earthquakes	The earthquake Arc …unites us	EEC of Lithakia
Caves	The caves of Greece in the light	EEC of Vamos
School Environment	Eco-Schools	HSPN
Information and communications technology	Sustainable Technology	EEC of Corfu
The environment in space and time	Geoenvironmental geomythologikal paths	EEC of Stylida
Local products	The local products in a sustainable society	EEC of Krestenon
Local natural and human environment	European Mountain Trails	EEC of Maroneia
Tourism	Tourism and Environment	EEC of Archanon
Outdoor Living	Outdoor Life and Environmental Education	EEC of Paranestio
Natural environment and archaeological landscape	Environmental routes the traces of the past , seeking a sustainable future	EEC of Lavrio

- Pilot programme regarding recycling operating under REWARDING RECYCLE organization. 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

  The program organized the events named "Great Recycling Feasts for Students" which have taken place in 19 municipalities across the country and 2,224 schools have already participated (http://marathonrecycling.blogspot.gr/2011/12/blog-post_20.html).

  Up to date, 4,109,238 packages have already been recycled. In particular:
  * 2,674,108 plastic packaging or 133,705.42 kg of plastic
  * 917,314 aluminum packaging or 13,759.71 kg of aluminum
  * 149,385 tinplate packaging or 8,216.18 kg of cans
  * 368 431 glass containers or 105,002.76 kg of glass
  Through these actions, the following environmental benefits were achieved:
  * More than 97,870 kg of gases that contribute to global warming will not be released
  * Almost 62,900 kg of bauxite will not be mined
  * Save more than 10,890 kg of oil

- Finally the MECC, in cooperation with the Centre of Educational Research, is updating and creating a new software of environmental education, based on the material that has been elaborated in the context of the Operational Programme "Education and Initial Professional Training" (http://www.epeaek.gr/epeaek/el/home.jsp).

D. Cooperation at a national and international level

Greece has participated in various meetings that promoted the close cooperation between the Ministries of Education and Environment, in the context of the United Nations Economic Commission for Europe (UNECE). Since the joint high-level meeting of Ministers of Education and Environment in Vilnius (Lithuania, 2005), Greece has adopted the Strategy for the Education for Sustainable Development. In the same time Greece has chaired the Steering Committee for ESD and the Bureau of the Steering Committee until the Belgrade Conference in 2007. In the Belgrade Conference "Environment for Europe" in 2007, Greece has also chaired the joint session that regarded Education for Sustainable Development. In 2012, during the Seventh (7th) meeting of the UNECE Steering Committee on ESD the representative of Greece updated the Committee about the activities of Mediterranean Education Initiative for Environment and Sustainability (MEdIES), an initiative on ESD launched in Johannesburg during the World Summit on Sustainable Development (See also para. 9.2.2.5).

At a national level, actions of the Hellenic National UNESCO Committee include the following:

(a) UNESCO's Associated Schools Project Network (ASPnet): Under the ASPnet the Greek National Commission for UNESCO has developed a network that currently comprises of a total of 148 educational units of various grades throuout the Greek territory.

(b) South Eastern Mediterranean Environment Project (SEMEP): it is consisted by a network of 13 schools. It has started as an Environmental Education Programme but in the meantime it has been considered compatible with the directives of the UN Decade of Education for Sustainable Development, and continued as such.

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. Today eTwinning is perhaps the largest network of teachers in the history of education.

9.2.2.2 Ministry of Environment, Energy and climate Change

The Ministry of Environment, and especially the Department of International Relations and EU Affairs, is cooperating closely with the Ministry of Education in the context of the education for sustainable development.

In addition to that, the Ministry has published the following printed material that are available to all Greek schools:

- *"50 Simple Things Kids can do to save the Earth"*, Ministry of Environment, Energy and Climate Change, ISBN: 960840294-8.
- *"Kids, let's talk about the Environment"*, Ministry of Environment, Energy and Climate Change & National Centre for the Environment and Sustainable Development, September 2009.

9.2.2.3 Hellenic Association of Teachers for Environmental Education

The Hellenic Association of Teachers for Environmental Education (HATEE) (http://www.peekpe.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 specific, in November 2007 the 3rd Hellenic Seminar on Environmental Education has been held by the HATEE regarding the "Education for the Sustainability and Environmental Education: Society – Economy – Environment – Civilization" (http://www.peekpe.gr/Syn3.htm), followed by the 4th Hellenic Seminar on Environmental Education in December 2008 (http://www.peekpe.gr/Syn4.htm). The 5th Hellenic Seminar on Environmental Education was held in November 2010 focusing on "The crossroads of Education for Sustainable Development"

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.

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.

One of the most active NGOs in Greece is the **Hellenic Society for the Protection of Nature** (**HSPN**), with more than 50 years of action, which focuses a large part of its activity on environmental education, developing and supporting networks of schools and student groups. The HSPN has been active in international and national networks of environmental education, in which almost a million of students and tens of thousands educators are participating. Environmental education is being implemented via integrated Programmes (www.eepf.gr/):

- "LIFE Program Nestos". This three-year LIFE-Nature program aims to the protection of raptors in Nestos area and reforesting areas of the river delta, the construction of bird nesting areas in the lagoons and generally ecotourism development. Financial support: European Commission
- "Lagoon Constantius, in Ambrakikos". Ecotourism development in the lagoon, in collaboration with the Holy Prophet Elias Monastery in Preveza. Financial support: Ministry of Environment .
- "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.
- "Green key" program. Providing eco-labels for tourism
- "Trail map Vidra"
- "The Foloi oak forest"
- "New journalists for the environment"
- "Ecological schools"
- "Nature without rubbish"

Some of the above programmes are internationally coordinated by the Foundation for Environmental Education (FEE).

In particular the "ecological schools" programme is related to energy, water and waste issues and includes the connection between the environmental education and the analytical official school schedule. Up to February 2009 (1-2-2009) 417 Greek schools have participated in the programme. Also, in the context of the "New journalists for the environment" programme, secondary education students are asked to participate in a simulated news agency that deals with environmental issues, such as waste, water, energy, coasts, cities and agriculture.

WWF has also worked extensively on environmental education, with actions that are specifically referring to climate change. In the webpage of the institution material can be found on the basis of the school education level (primary, secondary etc). In addition to the above, more than 100 integrated programmes are offered to schools, 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).

Arcturos protects the Brown Bear, Wolves, Greek shepherd dogs, Chamois, European otters, Red deers, Red deer, Lynx, Golden jackal and flora. Arctoros' 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 Vernos 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 (i.e. “Action for Climate”, “Watersave”, “Protection of marine and coastal ecosystems-Save the Med” and “Water Reuse”, which were approved for 1013-2014).

9.2.2.5 The MEdIES programme

Since the WSSD in 2002, Greece has been very active on promoting Education for Sustainable Development (ESD), also encompassing climate change issues, on the regional and international levels. Greece launched in the WSSD and is leading the implementation of the *Mediterranean Educational Initiative for Environment & Sustainability - MEdIES*. MEdIES is a Type II Initiative on ESD, supported financially by the Hellenic Ministry of Environment and officially approved by the Hellenic Ministry of Education. 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 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.

The core of this initiative is an e-network of Educators who implement the common integrated educational programmes, in countries around the Mediterranean basin, on cross-cutting themes that are used as a vehicle to approach sustainable development. The Scope of MEdIES is pursued through concrete activities such as: Publications & educational material, Training seminars, and the use and promotion of Information & Communication Technologies (ICTs) though its interactive webpage (www.medies.net).

Examples of concrete activities, in the field, implemented in the context of MEdIES since 2002, 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. 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.

   b. Rainwater Harvesting in the Greek Islands 2009 -2013. 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 (kindergarden) as well as older students (16yrs), with very satisfactory results. So far 451 students and 105 teachers from the dodecanese have participated in the 2013 activities.

c. 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).

d. 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.

e. MARLISCO: MARine Litter in Europe Seas: Social AwarenesS and CO-Responsibility. A major objective of this project is to understand and subsequently facilitate societal engagement in order to inspire changes in attitudes and behaviour. This project aimes to provide a series of mechanisms to engage key stakeholders with an interest in, or responsibility for, some aspect of reducing the quantity of litter entering the ocean.

(b) **Experiential Workshops and Conferences** for educators on the theme of climate change:

a. “Recent developments & perspectives for Education for Sustainable Development”, Athens, 3 December 2012. Main objective of the meeting was to inform the educational community (formal and non formal, at all levels of primary, secondary and tertiary education) about the recent international developments related to ESD, focusing on the Rio+20 UNCSD and the International Confernece on EE for Sustainlable Development "Tbilisi+35".

b. “4th Meeting of the Network of Mediterranean Universities for SD focusing on ESD” held in Athens on 3-4 December 2012.

c. “7th Scientific Meeting of Students for the Environment & Sustainable Development”, 29-30 November 2012. This year’s Meeting targeted on Water and to all its dimensions: environmental, socio-economic, cultural, etc. Approximately 200 secondary school students participated in the two-day meetings that included presentations from guest speakers, presentations from the students’ own projects on water topics as well as four workshops.

d. “Non Conventional Water Resources Management (NCWRM) in Malta” under “Alter Aqua Programme”, with sixty one (61) teachers attending the training on 9-11 July 2012 and twenty one (21) teachers on 8-10 July 2013. The training served as an initial in depth capacity building for primary, mainly, teachers of Gozo (Malta) on how to use the newly produced educational material. It offered to participants clarifications on the methods applied, and pedagogical tips on activities, “correct answers” to worksheets, pedagogic bibliography, etc.

e. “2nd Regional Workshop of RUCAS TEMPUS project on ESD” (7-9 Jan 2012), During the workshop two areas were revisited, namely:

(1) the Course Syllabus: CHEMISTRY and MANGEMENT of AQUATIC ECOSYSTEMS and

(2) the Course Syllabus of the inter-university post Graduate Pogramme CHEMICAL EDUCATION and NEW EDUCATIONAL TECHNOLOGIES.

f. "EuroMAB 2013" (Oct 15-19) in Canada, organised by the Canadian Biospheres Reserves Association, the Canadian Commission for UNESCO and UNESCO. Apart from many national, transboundary and regional management and operational issues for further organization and promotion of BRs as actual Sustainable Development Laboratories, the ESD issue in them was examined

g. "World Social Sciences Forum" in Montreal, Quebec (13-15 October 2013). It brought together a few hundred of participants from all over the world and the Key theme was "Social Transformation" and the Digital Age. The key message is the ned for urgent cooperation of social sciences with others in understanding the rapidly changing global realities and in addressing current global challenges: social, cultural, economic, political and environmental.

(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.

Additionally, Greece played a key role in the elaboration and adoption of the UNECE Strategy on Education on Sustainable Development (ESD) that was adopted at Ministerial level in Vilnius, March 2005. Greece also participated in the Expert Group on Indicators for the implementation of the Strategy.

9.2.2.6 MEDROPLAN: Mediterranean Drought Preparedness and Mitigation Planning

Under the MEDROPLAN project the development of participative and educational activities are organized with the goal of integrating (http://www.iamz.ciheam.org/medroplan/training.htm):

- Stakeholders' groups for understanding the potential uses and limitations of the Guidelines for Drought Preparedness Plans in their planning and decision-making activities.
- Regional policymakers and resource management planners for assisting the scientists to consider variables and time-windows that are actually useful, and to define ways for presenting research results that can be effectively assimilated in the stakeholders' activities.
- Regional scientists for testing and extending the work agenda and methods of analysis.

Among the expected project training achievements are:

- Mediterranean wide training workshops on drought risk management
- Advanced training courses for institutional resource managers focused on urban and irrigation water management
- Demand driven local training
- Publication of the Drought Management Guidelines in 6 languages
- Web-based information exchange

Some of the training workshops and conferences held are summarized bellow:

- Workshop on: "Drought Guidelines for Mediterranean Countries: A methodology to develop risk management and a proactive approach in drought preparedness", Applicability in Algeria, Morocco, and Tunisia, Tunis (Tunisia), 7-8 October 2008.

- First International Conference: “Drought management: scientific and technological innovations”, Zaragoza (Spain), 12-14 June 2008.
- Meeting: “Applicability and application of the MEDROPLAN Guidelines in the Mediterranean countries”, Mediterranean Agronomic Institute of Zaragoza, 11 June 2008.
- “Medroplan Workshop Marrakech”, Marrakech (Morocco), 15-16 May 2007.
- “Testing and Revising the Drought Guidelines, Naxos (Greece), 15-16 September 2006.

9.2.2.7 General Secreteriat for Youth – “Ecological and Environmental Awareness Program for the promotion and protection of Biodiversity”

The General Secretariat for Youth, for the first time in 30 years of operation initiates its own program development concerning ecological and environmental awareness among young people entitled “Ecological and Environmental Awareness Program for the promotion and protection of Biodiversity”. The main axis of this program is the importance of conservation and protection of Greek (and not only) biodiversity. The program started in 2012 aiming to the promotion of the economic value of biodiversity conservation and the perspectives that can be created for the local community, such as job retention or creation, the environmentally friendly tourism development, etc. The conservation of flora and fauna species is a requirement and a right for generations to come.

The program is divided into four interrelated parts:

A) Awareness through broadcasting messages that focus on the concept of biodiversity and the emergence of species of Greek flora and fauna which are threatened or endangered and need protection. Messages will be delivered via television and the internet.

B) Awareness concerning biodiversity, the importance of the conservation of species, environmental and economic value and ways of protecting , through a special website that will be linked to the website of the General Secretariat for Youth.

C) Awareness by involving young people in collaboration with environmental organizations and / or other agencies to protect the environment, such as contests and online events.

D) Production of educational material (manual) to biodiversity, particularly comprehensible for students.

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,
- 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.

According to the database created in the context of the ESTIA Programme (Centres of Environmental Information) by the Ministry of Environment, the Greek universities, polytechnic schools and technical education centres, that are related to environmental issues, amount to 36. The list of institutes can be found in the webpage: http://www.ekke.gr/estia/eng_pages/eng_index.htm , while by clicking on each institution's name, further information can be accessed over the departments, courses and postgraduate programmes that are related to the issue.

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 of Lifelong Learning

The public institution that plans and executes the actions in lifelong education in Greece is the General Secretatariat of Lifelong Learning (http://www.gsae.edu.gr/, available in greek only), that is functioning under the Ministry of Education.

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)

During 2007-2008, 77 adults have graduated successfully, while in 2008-2009 this number amounted to 51. Finally in 2011-2012 the Vocational Training of Agioi Anargyroi was funded with €33,000 and 71 students graduated successfully.

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 nation 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 teachers 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.

Training Programme of Voluntary Action for the Management of Hazards and Crisis and the Confrontation of Emergencies

The Programme is operating with the participation and cooperation of various institutions (General Secretariat of Civil Protection, Fire Service, Ministry of Defense etc). The main thematic areas include, among others, emergencies that could be caused by climate change extreme events (forest fires, extreme weather events and floods). Since the first operation of the programme in 2001, about 10,000 voluntaries have been trained in various aspects of civil protection (strategies of decision making and problem resolving, information management, participation in teams, psycho-social support of affected/hurt people, panic management etc.), while the programme has run in 220 Municipalities of Greece.

In cooperation with the National Center for Public Administration 20 workshops ahave been implemented for the training of 2,500 people on risk management issues. The program has received public recognition in the former EU Commissioner Environment, Margot Wallrstrom and has represented Greece at the 10th International Conference on Volunteerism held in Geneva in 2001 and in the 10th European Civil Protection Conference held in Brussels in 2002.

Second Chance Schools

The General Secretariat of Lifelong Learning, through the Institute of Continuous Training of Adults, has the responsibility for the operation of 58 Second Chance Schools (SCS), since 2001, 8 of which are located in penitentiaries.

The SCS are addressed to adults that have graduated from Primary School but have not completed the compulsory education. In the SCS, after a two-year attendance, the graduates receive a title that is equivalent to the Lower Secondary Education Certificate. The education methods in the SCS follows the principles of the adult education (participation of students, cooperation in teams, case studies, cross-thematic action planning, educational visits etc.).

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.

During the academic year 2012, 4,187 adults have attended the Second Chance Schools in 281 classes.

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. The Sivitanideios Public School of Trades and Vocations has organized the Summer Schools of Youth Entrepreneurship for the students of Technical Vocational Educational Schools (http://www.therina.gr/default_uk.htm). The financed summer schools that have been held in Athens included, among others, the following:

- “Green house”: Bioclimatic and environmentally sound approach for the study and planning of houses and installations with the use of software.
- “Green roof services”
- “Presentation of an original technological study of bioclimatic and ecologically sound applications in habitations of Athens and presentation in small scale model”.

The summer schools were held between the 6th July and 2nd of August 2008 in three 14-day periods.

Also, based on the need of pure climatological knowledge (real sense of climate), the Department of Meteorology-Climatology of the Aristotle University of Thessaloniki (AUTH) in collaboration with the Institute of Environmental Research and Sustainable Development of the National Observatory of Athens (NOA), organized a Summer School founded by John S. Latsis Public Benefit Foundation. The first summer schools was held in Athens in 2008 and since then every year up to 2011 (4 – 15 July) In 2011 the summerchool was entitled “Mediterranean Agroforestry and its role in the Present Environmental Challenges” and its main objective was to advance the scientific knowledge in a group of young people, with a forestry/agriculture academic background, who would also like to eventually work in the field of Mediterranean agroforestry systems (http://summerschool.karp.teilam.gr/).

Specifically, the aims of the summer school are to present to the students:

- The major types of agroforestry systems with special emphasis on those practiced in the Mediterranean countries.
- The factors that affected and are still affecting the evolution and function of Mediterranean agroforestry systems.
- The methods and techniques that are at the forefront of scientific knowledge for the management of these systems.
- The major role that these systems play and will play even more in the future in confronting the major environmental problems, namely carbon sequestration, animal and plant biodiversity, forest fires and water quality.
- The economic perspective governing the management of these systems.
- The benefits of the agroforestry systems will be compared to the “conventional” agricultural systems.

In addition, the John S. Latsis Public Benefit Foundation signed an agreement with the Trento University, Department of Economics, to finance a series of Summer Schools for the period 2009-2018 concerning the Adaptive Economic Dynamics. The program had been in the past financial support of the Latsis Group as a project with high scientific prestige and excellent structure and organization (http://www-ceel.economia.unitn.it/summer_school/index.html).

Furthermore, the Agean University (https://summerschools.pns.aegean.gr/) has organized successfully during summer 2012 and 2013 several summer schools and has already announced the forthcoming summer schools for 2014. Some of the topics of the summer schools are provided below:

- Transitions in Landscape and Land Use
- Analysis of Ecological Data
- Interaction between shipping and marine environment
- Modelling and Analysis of Environmental Data using ICT

The Technologiac Institute of Ionian Islands with the co-financing of the European Social Fund and the Ministry of Education and Religious Affairs, Culture and Sports has implemented (1-15 September 2013) at the Prefecture of Cephalonia and under the Act “Promotion of the TEI of Ionian Islands as an International Pole of Education and Innovation” the Summer School on “Dynamics & Management of the Mediterranean Marine Environment” (http://www.teiion.gr/index.php/en/anaouncements/727--31052013.html).

The Summer School's **main purpose** is to introduce participants to the subjects of dynamic processes in the marine (oceanographic) and atmospheric environment of the Mediterranean basin and their biological effects by emphasizing the dynamic effects of the last 4 decades and to the marine environment management of the Mediterranean (especially of the coastal areas) based on the protection of biodiversity and sustainable development. For this reason, the Summer School offers the following two main specializations:

- Dynamics of the Mediterranean area (of oceanographic and atmospheric perspective) and its effects on biodiversity and the quality of the marine environment.
- Management Method of anthropogenic impacts on the marine environment (with emphasis on coastal areas).

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).

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.

In 2009, the Summer Ecological University was specialized on the "Economy of Water: history, natural ecosystems and management" and was held in Hydra from 6 to 24 of July. The 12th Summer Ecological University was held in Samothrace on 5-22 June 2011 and was entitled "Agriculture on the verge".

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.

The environmental educational activities of the association include the running of 6 school programmes, the organization of Panhellenic Symposiums (the 4th one was held in January 2010 and is entitled "Sustainable schools of the present and the future") and the production of school activities material (publication of the book "Realization, Awareness, Action for Sustainability", 2008, ISBN: 978-960-88435-5-4).

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.

During 2008 the Committee has had various meetings with representatives from NGOs (WWF, Greenpeace, etc.). The issue of climate change and energy has been considered as a key one and 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 (2007).

The Hellenic Parliament has also been informed over the WWF study: “Solutions for climate change: Sustainability vision for Greece of 2050” and participated in the “Hour of Earth” event, that aimed at the energy saving and decrease of air emissions. Also, the Parliament has adopted environmental measures and actions, such as the reuse of used material, the installation of a photovoltaic system, the use of hybrid and antipollution technology cars.

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 allover 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.

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, Energy and Climate Change

The Ministry of Environment, Energy and Climate Change, MoEECC, (former Ministry for the Environment, Physical Planning and Public Works) 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.

The Ministry of Environment, Energy and Climate Change in order to achieve its Mission, has developed a strategic plan based on 4 pillars amplified into strategic objectives :

PILLAR 1

Combating Climate Change by moving towards a competitive economy of low carbon consumption. The Strategic Objectives are:

- Improve energy efficiency
- Increase the share of our country’s energy use from renewable sources and natural gas, whilst ensuring the reliability of energy supplies.
- Secure consumers the provision of reliable energy products and services
- Promote green products, sustainable production and consumption patterns

PILLAR 2

Natural resource protection and environmental enhancement

- Protect and promote Biodiversity and the natural landscape
- Ensure the effective management and protection of water resources
- Effective management and protection of our forests
- Environmental Crises prevention and effective risk management

PILLAR 3

Improve quality of life with respect to the environment

- Urban Regeneration

- Improve air quality and soundscape
- Enhance accessibility and sustainable mobility for all
- Efficient waste management and promotion of recycling

PILLAR 4

Enhancement of environmental governance mechanisms and processes

- Strengthen the planning system in order to ensure policy cohesion
- Simplify and code environmental legislation whilst strengthening its enforcement mechanisms
- Promote environmental research, innovative technologies and accessibility to environmental information
- Enable environmental accountability and volunteerism

On regional level, MoEECC's main objective is the achievement of effective cooperation with neighbouring countries based on shared goals and the promotion of Greece's role as a catalyst for peace, prosperity and sustainable livelihoods in the areas of the Mediterranean, Southeast Europe and Black Sea, that correspond to the neighborhood of the enlarged EU. In particular, MoEECC 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, MoEECC participates actively in the activities of the Organisation of Black Sea Economic Cooperation (BSEC), of the UNEP/MAP that is being hosted in Athens, Greece since 1981, of the Adriatic-Ioanian Initiative and of the "Mediterranean Component of the EU Water Initiative (MED EUWI)" which is being led by Greece since its launching in 2003. In the context of these organisations and initiatives, Greece/MoEECC aims to promote strong transboundary links and cooperation for sustainable development. Furthermore, MoEECC 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 is 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.

The Ministry of Environment, Energy and Climate Change has participated in various actions to help the access of the public to environmental information. Some of these actions are included in the following:

<u>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)</u>

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 body is designed to promote green sustainable development, combining wider environmental strategy with applied research in areas critical for policymakers in order to protect and exploit natural resources.

The National Centre for Viable and Sustainable Development (NCVSD) through the provision of permanent, reliable and objective information, technical knowledge and proposals, supports training and implementation of effective policies in the above mentioned issues. It contributes, as a knowhow mechanism, in the integration of the environmental dimension in sectoral development policies and, through this, to a horizontal coordination of public policies which have a direct or indirect influence in spatial and environmental management.

3. Special Service of Environmental Inspectors – SSEI

The Special Service of Environmental Inspectors (SSEI) was established in 2003 and since then Greece has a control mechanism for the enforcement of environmental legislation and the protection of environment. This need had been foreseen many years ago by the Environmental Law 1650/86. Its main responsibility is to carry out audit and determine whether the projects and activities of public, semi-public and private sector across the country are in compliance with the environmental legislation. The mission of SSEI is centralized in the provision of effective and integrated environmental protection that aims, among others, to the achievement of sustainable development of the country's regions. The means used to achieve this mission include:

- Provision of suitable guidelines and directives for the best behaviour of operators and other citizens
- Proper operation, that is based on transparency, justice and decent administration.

4. Funding Programs concerning Environmental Awareness

Under the supervision of the Ministry of Environment, Energy and Climate Change 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. The total budget of investments included under this pillar is € 846.7 million and is expected to create more than 2,400 jobs.

9.3.1.3 Ministry of Foreign Affairs

On May 18th 2007, Greece undertook the rotating annual Chairmanship of the Human Security Network (HSN). The HSN is an informal international forum in co-operation with international organizations, civil society and the academia, aiming at raising awareness at the international level regarding new forms of threats that endanger peoples' security. Member states of the HSN include: Austria, Slovenia, Chile, Greece, Ireland, Jordan, Canada, Costa Rica, Mali, Norway, Switzerland, Thailand, and South Africa as an observer.

The Hellenic Chairmanship-in-office 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 (caused by the climatic change) 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.

Seeking to actively contribute to the international dialogue for adequate policy planning so as to confront climate change implications on human security, the Hellenic Chairmanship proceeded, in co-operation with competent International Organizations, to the elaboration of a number of relevant policy texts. To this end, the Hellenic Chairmanship of the HSN, in co-operation with the Hellenic Foundation for European and Foreign Policy (ELIAMEP), collected and then presented an overview of existing studies on the impact of climate change on human security of vulnerable groups in the developing world. Based on the former, and in collaboration with prominent Greek and International Research Centres, the Hellenic Chairmanship began preparing in 2008, policy papers on the impact of climate change on the three aforementioned vulnerable groups: a policy paper on the impact of climate change on children, drafted in collaboration with UNICEF, a policy paper on Climate change and Women, drafted in collaboration with the Women's Environment and Development Organization (WEDO) and a policy paper on persons fleeing their homes as a result of climate change, in collaboration with the United Nations University. Finally, a comprehensive policy paper was elaborated in co-operation with the International Institute for Environment and Development and under the supervision of leading climate change expert, Dr. Saleemul Huq, on Development Co-operation and the Impact of Climate Change on Human Security. The main findings and policy proposals of these papers were presented at a High-Level International Conference (Athens, May 2008) concluding the works of the Hellenic HSN Chairmanship. Finally, the Greek MFA sponsored the translation, publication and presentation to the Greek public (November 2008) of the Stern report: "The economics of Climate Change" (extended synopsis), a report which has played a considerable role on international public awareness regarding the impact of climate change on all sectors of the economy.

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, Energy and Climate Change, 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

- "**Climate Change, Environmental Degradation and Migration: Addressing Vulnerabilities and Harnessing Opportunities**", (Geneva, February 19th 2008) in cooperation with the International Organisation for Migration (IOM).
- **Climate Change and Human Security: Women, a most vulnerable group**, (Vienna, March 13th 2008), in co-operation with the Austrian Ministry of Foreign Affairs.
- **International Conference on Climate Change – Annual Ministerial Meeting of the Human Security Network** (Athens, May 29th – 30th 2008).
- **Climate Change and Human Security** (Athens, November 27th 2007), in co-operation with UNEP/MAP: Launching event, first presentation of UNDP's "Human Development Report 2007/2008 Fighting climate change: Human solidarity in a divided world". The event also hosted a poster exhibition and a children paintings' exhibition, in co-operation with UNEP/MAP.
- **Climate Change Human Security Implications on Children** (Bali, December 10th 2007/New York, December 12th 2007), in cooperation with UNICEF: side events of the International Conference on Climate Change in Bali and the UN General Assembly's Special Session on Children, in New York.

9.3.1.4 Other public sector bodies

Other ministries have also undertaken initiatives in order to promote public awareness on the issue of climate change:

<u>Ministry of Infrastructure, Transport and Networks</u>

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 Climate Change (MECC) with the collaboration of the Ministry of Infrastructure, Transport and Networks 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.

This decision of the MECC encourages the spirit of respect and trust in a responsible citizenship, which calls to implement the "Green Ring". The MECC is working closely with the Ministry of Infrastructure, Transport and Networks in order to provide to the vehicles the “green sign” electronically.

- *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.

<u>Ministry of Rural Development and Food</u>

The General Secretariat of Development and Protection of Forests and of Natural Environment has planned the publication of printed material regarding the role of the forests on climate change, as a mitigation of impacts mechanism, but also for the adaptation to it. In the information material, the importance of the sustainable management and biodiversity protection of the forests will also be highlighted.

Also, the Secretariat is planning to participate in the organization of training seminars addressing to forest employees, who will, in turn, educate and inform schools and other kind of teams on the role of the forest in climate change and other issues.

<u>Municipalities</u>

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:

- The environmental awareness park "Anthonis 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 neighboring municipalities (Athens, Ag.Anargiron, Ilion, Peristeri, New Philadelphia, New Chalcedon, Axarnes, Petroupoli, Agaleo).At the same time environmental education programs for schools also take place in the Park undewr 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 a educational software entitled "e-Energy School" that can be used by all levels of interested citizens (students, professionals, institutional bodies).
- Organization of a conference entitled "Energy and local government" by the Municipality of Nigrita. Also, organization of a festival that included various activities for the raising of public awareness on energy savings and RES and foundation of Environmental Education Centres.
- Support and implementation of solar and wind energy systems, especially in the islands (i.e. Syros, Santorini etc.)
- Energy autonomous village of Anavra in Magnisia. The village consists of 700 inhabitants, all farmers, with zero unemployment, with an average age of 40 years old and the population has doubled in the last 15 years. Some of the infrastructures of the village include a wind farm, which gives income of 100,000 euro per year in the community, three modern livestock farms that house in the winter 25,000 animals, the standard slaughterhouse,a folklore museum and of course the environmental - cultural park, with an area of 240 acres.

9.3.2 Non-governmental Organisations Initiatives

9.3.2.1 Greenpeace

The action on climate change constitutes one of the basic thematic campaigns of the Greek office of Greenpeace. Within this framework, Greenpeace has undertaken a number of initiatives which address two main directions:

1. Highlighting policies and behaviours which generated and intensify the climate change problem, e.g. dependence from fossil fuels, non-rational energy use, degradation of forests, disproportionate facilitation of the use of private cars, etc. and
2. Presenting alternative solutions aiming at eliminating the above mentioned factors and at following a totally different approach with respect to relevant development processes.

The website of the organisation (http://www.greenpeace.org/greece/campaigns/climate-change) offers plenty of information on climate change issues and suggests ways of reducing the atomic energy consumption (e.g. “10+1 ways of saving the climate” – test in electronic format, “Greenfreeze guidance”- guidance on the refrigerators that use R600a), while it also provides data on the campaigns performed by the organisation (support of the operation of two wind parks in Eyboia and Crete, lower taxation on the purchase and installation of Renewable Energy Solutions (RES) systems etc). Also, the website provides continuous information on the progress of major international UNFCCC and EU agreements.

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.

The main actions (projects & campaigns) regarding the climate change issue in the recent years are:

a) 2007-Present: Implementation of Public awareness raising campaign “Climate action!” Environmental education program in schools in 8 of the largest cities n Greece (attended more than 22.000 pupils) and public events, focusing on awareness raising of citizens and pupils. Educational-informational package for teachers and special magazine edition developed under the campaign. The campaign firstly was funded by: European Regional Development Fund – Operational Programm “Environment”, Measure 5.2, “Environmental Awareness” and was implemented as part of “Sustainable Energy Europe”. After 2009 the environmental program is funded by private donations.

b) 2009-2011: Project Partner in empower program: eParticipation Trial Project co-funded by the European Commission under the EU eParticipation Preparatory Action. The program is implemented in Greece, Italy and Portugal, and aiming to motivate and strengthen the involvement of NGOs and citizens in the decision-making process on environmental issues : climate change, biodiversity, mercury, waste management, water resources management, GMOs, at a National and European level by providing method and tools for supporting citizens’ participation and collection of signatures to promote relevant public initiatives and demands of civil society (http://www.ep-empower.eu/epetitions/en/Home.aspx)

c) 2008-2009: Project Partner in Lifelong Learning Programme “LAUTC-Learning About Us Through Culture”(Lead partner NGO CESIE, Italy, www.lautc.eu)

d) 2007: Intercultural Youth Exchange Programme “Environment and Human Interactions: Practices from the past... Solutions for the future!”,with the partivipation of 32 young people from six partner organizations from EuroMed Region, 26 July-6 August, at Sifnos island,Greece-Financed by the European Commision programme YOUTH IN

ACTION, Action 3.1, through the Greek General Secretariat for Youth,Supported by the Municipality of Sifnos.

e) 2005-2008 : Project Partner in INTERREG IIB MEDOCC project “Med Eco-Quartiers” (Lead partner Municipality of Pezenas, France, www.med-ecoquartiers.org)

f) Ongoing information and awareness-raising on energy and climate change issues and relevant local, national and international policies

g) 2004-2007: Partner in LIFE-Environment project 'Sun and Wind' (beneficiary: Commune di Palermo, Italia) on applications of traditional Mediterranean bioclimatic practices in contemporary architecture.

h) 2005-2006: Project Partner in GRUNDTVIG II Programme “Learning Europe towards a learning democracy”. Developing new methods for the integration of minority groups and migrants in society" (Lead partner Institut fur Migrations- und Aussiedlerfragen Heimvolkshochschule St. Hedwigs-Haus e.v, http://www.st-hedwigshaus.de/grundtvig.html)

i) 2006: Implementation of youth meeting in Lesvos in August 2006 under EU’s YOUTH Program titled “Re-turn to Renewable Energy” with the participation of 42 young people from 8 Mediterranean countries.

j) 2006: Conference “Climate Change and Policy for energy efficiency and renewable energy: the role of local authorities and social partners”, together with the Central Union of Greek Municipalities.

k) Lobbying governments and international organizations through the participation in international networks of NGOs active in climate issues (INFORSE - International Network for Sustainable Energy and CAN - Climate Action Network)

l) Partner in E.C. Youth project: “It's time to be a critical consumer!” with young NGO members from Greece, Italia, Belgium, Portugal, Turkey, Lebanon, Jordan, Tunisia

m) Cooperation with municipalities and local authorities for the promotion of energy efficiency and climate protection policies and measures.

9.3.2.3 WWF Hellas

The WWF Hellas organisation is part of the global WWF Network. The organisation is aiming at the conservation of the Greek biodiversity as part of the Mediterranean and at the constrain - and 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

The website of the organization offers information on what citizens and companies can do to contribute to the mitigation of climate change. At the same time WWF Hellas is cooperating with other research centres, such as the National Observatory of Athens, to the elaboration of important scientific reports (*"Tommorow of Greece: Climate change impacts in Greece in the short term future"* (Athens 2009), *"Solutions for climate change: A sustainability vision for Greece in 2050"* (Athens, 2008), etc.).

Also, in 2012 the organization has created 3 new programs in collaboration with two companies and one bank. More specific Frigoglass, Unilever and HSBC in collaboration with WWF Greece offer Environmental Education workshops ("Journey to Future City", "use responsible", "Living") in which 9,200 students, 1000 educators and 178 schools was participated.

9.3.2.4 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 it 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. Education: As part of its activities, the IENE organizes meetings, lectures, seminars, workshops and task forces and promotes exchanges and general educational activities and programmes which have the objective of promoting knowledge and experience on energy and environmental and development matters. The establishment of scholarship programmes for post-graduate studies in the fields of energy, and environment, in Greece and abroad, constitutes one of the basic goals of the IENE. The educational goals of the Institute include the promulgation of methods, tools and practices for the protection of the environment, the utilisation and promotion of renewable sources of energy, new forms of energy and new technologies (e.g. Hydrogen and Fuel Cells), as well as the use of clean and effective technologies based on traditional fuels.

3. Research and Technological Development

4. Documentation

5. 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 submitt 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.

6. 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.

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).

9.3.2.5 Law+Nature

The civil non-profit society Nomos+Physis (Law+Nature) (http://www.nomosphysis.org.gr/index_en.php) specializes in the fields of law, institutions and policy for environmental protection and sustainable development. Its mission is to contribute to the development of environmental law (in Greece, as well as in its neighbouring countries) and to raise public awareness regarding the legal and institutional aspects of environmental protection and sustainable development.

9.3.2.6 Kallisto

"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

The staff members of CALLISTO include experts with long experience and specialisation in the field of nature conservation and practical knowledge on monitoring large carnivore populations (brown bear, wolf) using radio-telemetry and non invasive molecular biology methods. Members of the society include also experts on other relevant fields: animation of volunteers, regional development, journalism, communication, vocational training.

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 International cooperation

Apart from the cooperating actions that have been already mentioned above (Steering Committee of the Ministry of Education, the MEdIES programme and activities of the IENE) that are mainly referring to the European, and principally Mediterranean level, the following actions should be additionally mentioned:

9.3.4.1 Governmental initiatives: Countries of the Africa Region

Greece's long-standing cooperation with countries of the African region is channelled 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.

(a) Political relations:

Greece holds good political relations with countries in the African region and especially with countries in North Africa, due to their proximity and the increased collaboration, commercial relations and cultural links. Good political relations between Greece and countries in the region are expressed both through bilateral cooperation as well as through cooperation in international fora, especially the United Nations as well as the Euro-Mediterranean Partnership, Francophonie etc. Furthermore, in many cases there is mutual support between Greece and African countries for candidacies in various international organisations.

(b) Institutional framework:

Regarding the Institutional framework and bilateral Treaties, Greece has established inter-governmental Agreements with a number of African countries on several sectors, such as:

- economic/scientific/technical cooperation (e.g. Ethiopia, D.R. Kongo, Kenya, Nigeria, Mautiritius, Burundi, Nigeria, S. Africa, Uganda, Tunisia, Morocco, Algeria, Libya, Egypt);
- cooperation on tourism (e.g. Ethiopia, Kenya, Mautiritius, S. Africa, Uganda, Tunisia, Morocco, Egypt),
- cooperation on health issues (e.g Ethiopia, S. Africa, Seychelles);
- commercial / trade cooperation (e.g. D.R. Kongo, Nigeria, Rwanda, Ethiopia, Madagascar, Burundi, Tunisia, Morocco);
- education / cultural cooperation (e.g. Ethiopia, Burundi, Nigeria, S. Africa, Seychelles, Tunisia, Morocco, Algeria, Egypt);
- air transport cooperation (e.g. Ethiopia, D.R. Kongo, S. Africa, Uganda, Tanzania, Morocco, Libya, Egypt);
- agricultural cooperation (e.g. Mautiritius);

- maritime cooperation (e.g. Nigeria, Madagascar, S. Africa, Tunisia, Morocco, Egypt);
- cooperation on legal issues (e.g. Kenya, S. Africa);
- cooperation on promotion / mutual protection of investments (e.g. S. Africa, Tunisia, Morocco, Algeria, Egypt);
- cooperation on taxation issues (e.g. S. Africa, Morocco, Egypt);
- sports cooperation (e.g. Tunisia) etc.

(c) Economic / commercial relations and Official Development Assistance (ODA):

Greece has developed bilateral economic and commercial relations with a number of African countries. Greek exports to African and Middle East countries for 2007 (latest data available) were of the order of EURO 1,112 million. Furthermore Greece has provided development assistance to many countries in the region. The total Greek ODA granted to African countries for 2007 was EURO 22.84 million. The main sectors at which development assistance aimed, include environment and climate change, education and training, health, culture, water, employment and food/humanitarian aid. Further information on the financial funding can be found in Chapter 7.

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.

Mediterranean Sea: Linking Greece with North Africa

Greece is linked to the North African region through the Mediterranean sea. Due to this link, a long-standing collaboration exists between Greece and the North African countries on environmental and sustainable development issues, both bilaterally and through multilateral processes, such as the Barcelona Convention and the Mediterranean Action Plan of the United Nations Environment Programme (UNEP/MAP), the Mediterranean Commission for Sustainable Development (MCSD) and the “Barcelona Process: Union for the Mediterranean”.

Specific sectors of cooperation

International level

i. UN System

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).

ii. Human Security Network

Greece, as the chairmanship-in-office of the Human Security Network during the period 2007-2008, has chosen to focus its activities on the human security implications of climate change with emphasis on its impact on the vulnerable population groups of children, women and persons fleeing their homes due to climate change as well as to the adaptation opportunities. A main consideration of the Hellenic Chairmanship of the Human Security Network was that adaptation programs to climate change in developing countries will greatly contribute to limiting the threats against human security, while increasing the chances for achieving the MDGs. Emphasis in European development assistance should therefore be given to addressing climate change impacts on vulnerable regions. In this respect, Greece has already started setting, in cooperation with international and regional organisations, special trust funds for adaptation programs to climate change in Africa and Small Island States.

iii. EU-Africa cooperation

Greece, as a Member State of the EU actively participates in the EU-Africa cooperation. In the framework of implementing the Cairo Declaration as a follow-up of the 2000 EU-Africa Conference, Greece (through the Hellenic Ministry of Environment, Energy and Climate Change - http://www.ypeka.gr/) and Finland (through the Ministry of Environment) undertook the role of "Chef de file" for the subject "Environmental protection, including drought and desertification". In this framework, the Ministry developed four documents that were used as a basis for the bilateral discussions between EU and Africa on this issue.

iv. 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.

v. EU - Africa Infrastructure Trust Fund

Greece participates as a Donor country in the EU–Africa Infrastructure Trust Fund with the amount of EURO 1 million. The purpose of the Fund is to co-finance infrastructural projects in the sector of transportation, energy, water and information technology. Criteria for assessing the environmental impact of the eligible projects are not only included in the selection criteria, but are also integrated into the main feasibility studies. Financing mainly aims to secure the viability of the projects from the environmental aspect. For example, in the energy sector this principle is translated into financing hydropower factories that are expensive (vis-à-vis coal factories) but environmentally cleaner.

Cooperation at a regional level

i. Barcelona Convention and UNEP/MAP

Greece has assigned especially high priority to the 1976 Barcelona Convention concerning the Protection of the Mediterranean Sea against Pollution and its implementing programme. The Mediterranean Action Plan of UNEP, the first-ever plan adopted as a Regional Seas Programme under UNEP's umbrella, involves 21 countries bordering the Mediterranean Sea (as well as the EU), including the five North African Mediterranean Countries. Seven Protocols addressing specific aspects of Mediterranean environmental conservation complete the legal framework of the Barcelona Convention. Through MAP, the Contracting Parties to the Barcelona Convention and its Protocols are joining efforts to meet the challenges of protecting the marine and coastal environment while boosting regional and national plans to achieve sustainable development. Greece is very active within the UNEP/MAP - Barcelona Convention system, especially as UNEP/MAP Coordination Unit is based in Athens since 1981.

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. More specifically:

Egypt: Activities of the running Phase I (until April 2009) support the preparation of the new 30-year Egyptian National Master Plan for Water and Wastewater and the Rural Sanitation Strategy (that is under development), within the Integrated Water Resource Management (IWRM) framework of the Egyptian National Water Resources Plan 2017. Activities include (i) an affordability assessment component, that develops financing scenarios that are socially and politically acceptable and (ii) a financing strategy component that offers different financing scenarios for discussion among stakeholders. Activities in Egypt are led by the Egyptian Holding Company for Water and Wastewater, following an agreement between the Ministers of Housing and of Water Resources and Irrigation. The Dialogue's activities are implemented in close cooperation and under the technical coordination of OECD with the MED EUWI Secretariat. Related assessments and scenarios have been elaborated in 2008 and a set of public, multilateral and bilateral consultation events and meetings with the participation of authorities, stakeholders and donors were organized. A foreseen Phase II of the Dialogue (2009-2010/11) would be based on the results of Phase I. Overall, Phase II will aim to assist with: (i) building consensus in further identifying financially realistic water supply and sanitation and IWRM targets and the policies that will support their achievement, (ii) strengthening the co-ordination of activities taken by different parties involved in the water sector in Egypt, and (iii) further identifying governance and capacity development needs. For Phase II, core resources for dialogue activities have been secured through the Hellenic Ministry of Foreign Affairs and the GEF Strategic Partnership for the Mediterranean. Resources for consultants' work are under negotiation with donors at the country level. The EUWI Thematic Budget may also contribute to activities, if so decided.

Libya: Targeted consultation activities on water governance in Libya were launched in 2007. Activities undertaken facilitated the establishment of an IWRM process in the country, through a structured approach with the collaboration of key national and regional institutions. An agreement with the Libyan General Water Authority and the African Water Facility on the implementation of elements of the Libyan Water Strategy is under discussion while additional technical activities are explored within the MED EUWI framework after request of the General Water Authority. Actions also contribute to the linked Rabat Declaration on IWRM Planning in North Africa (a sub-regional process launched in 2006 together with the UNEP Collaborating Centre on Water and Environment and the African Development Bank). Envisaged follow-up activities would aim to assist key stakeholders in Libya to develop a common understanding on critical IWRM planning issues with an emphasis on institutional settings. Financial support is discussed with the African Water Facility. The EUWI Thematic Budget (in case Libya is eligible and if so decided) and donors may contribute to activities.

Morocco: Morocco has also requested the organisation of a country dialogue. More Country Dialogues are currently implemented in the Middle East, i.e. with Lebanon, Palestine and Syria.

iv. “Barcelona Process: Union for the Mediterranean”

Within the framework of the Euro-Mediterranean Partnership (“Barcelona Process”), launched in 1995, Greece has been active and remains engaged in cooperation with Mediterranean partners on several environmental issues including on marine pollution control for the Mediterranean Sea. In 2005, “Horizon 2020” was launched, with Greece and the other partners agreeing to co-operate to de-pollute the Mediterranean by 2020, drawing on core EU funding to support the venture. The “Union for the Mediterranean” launched in July 2008, builds on the “Barcelona Process”, extends co-operation between the EU countries and Mediterranean countries and includes the de-pollution of the Mediterranean as one of its 6 priority action projects. In this context, Greece has submitted a project proposal officially incorporated in the context of the “Barcelona Process: Union for the Mediterranean”, aiming to support a “Multistakeholder Cooperation for the promotion of Sustainable Development in the Mediterranean with emphasis on water” with the intention to effectively support the elaboration of a new “Mediterranean Strategy on Water”.

Cooperation at a bilateral level

In 1999, the Ministry of Environment began a Bilateral Development Assistance Programme within the framework of the overall national programme. It was built on priorities and obligations associated with OECD DAC, UN institutions, the Rio Conventions of Biodiversity, Climate Change and Desertification, and Greece's bilateral environmental Memoranda of Understanding with neighbouring countries. 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.

The targets set at the WSSD, as described in the Johannesburg Plan of Implementation (JPoI), together with the MDGs, set an integrated and detailed framework for the promotion of important issues related to the environment and sustainable development regarding the bilateral cooperation of Greece with Mediterranean countries of North Africa as well as with other African countries. Greece, through the Ministry of Environment, financed the initial phase of four Type II Initiative Partnerships, which were launched during WSSD and involved NGOs and other stakeholders as implementation actors. These four Type II Initiative Partnerships are:

i. 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.

ii.“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 and Religious Affairs, Sport and Culture (http://www.minedu.gov.gr/), as it has already been mentioned in the previous sections.

iii.“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.

iv.“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 1st BIENNIAL REPORT

A.I.1 Introduction

This Annex I to the Greek 6th National Communication (NC) under the UNFCCC is the 1st 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.

As concerns the changes of the national arrangemnts of Greece since the 5th National Communication, the following changes were performed:

1. The UNFCCC Focal point of Greece was changed from Ms Elpida Politi, since Ms Politi has retired. Currently, the UNFCCC Focal point of Greece is Ms Irini Nikolaou (Address: Villa Kazouli, Kifisias 241, Athens, Greece, e-mail: i.nikolaou@prv.ypeka.gr, tel.: +30210 8089275, fax: +30210 8089239).
2. Till the 2012 GHG inventory submission, the compilation of the LULUCF inventory (UNFCCC and KP LULUCF) was a responsibility of the General Directorate for the Development and Protection of Forests and Natural Environment (GDDPFNE) of MEECC and was conducted by external consultant. From this submission and the subsequent, the responsibility for the compilation of the LULUCF inventory (UNFCCC and KP LULUCF) is assighed to the National Technical University of Athens (NTUA).

A.I.3 Quantified economy-wide emission reduction target

Greece, as a Member State of EU, is under the joint quantified economy-wide emission reduction target of EU and its Member States.

The EU and its member States (including Greece) communicated an independent quantified economy-wide emission reduction target of a 20 per cent emission reduction by 2020 compared with 1990 levels. This is documented in the UNFCCC document FCCC/SB/2011/INF.1/Rev.1

of 7 June 2011. In the EU submission to the UNFCCC from 20 March 2012 (FCCC/AWGLCA/2012/MISC.1) the EU target is further explained.

The use of carbon credits from international market-based mechanisms by Greece is explained in the EU submission from 2012. With regard to the role of LULUCF, the EU pledge does not include emissions/removals from Land Use, Land-Use Change and Forestry.

More detailed information on the EU and its Member States target is given in CTF Table 2.

Legally binding target trajectories for the period 2013-2020 are enshrined in both the EU-ETS Directive (Directive 2003/87/EC and respective amendments) and the Effort Sharing Decision (Decision No 406/2009/EC). These legally binding trajectories not only result in a 20% GHG reduction in 2020 compared to 1990 but also define the EU's annual target pathway to reduce EU GHG emissions from 2013 to 2020. The Effort Sharing Decision sets annual national emission targets for all Member States for the period 2013-2020 for those sectors not covered by the EU emissions trading system (ETS), expressed as percentage changes from 2005 levels. In March 2013, the Commission formally adopted the national annual limits throughout the period for each Member State. By 2020, the national targets will collectively deliver a reduction of around 10% in total EU emissions from the sectors covered compared with 2005 levels. The emission reduction to be achieved from the sectors covered by the EU ETS will be 21% below 2005 emission levels. The 2020 targets that have assigned to Greece pursuant to European legislation (e.g. EU-ETS Directive, Effort Sharing Decision, etc) are described in Chapter 5.4.1.2 of the 6th NC.

A.I.4 Progress in achivement 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. The progress in achievement of the Greek target for the 1st KP comitment period is evaluated in ***Table 5.7***.

The major changes in the Greek domestic institutional arrangements are the following:

- ✓ The reform to the EU Emission Trading Scheme 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. More information is provided in Chapter 4.3.1.3.
- ✓ 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) was adopted in May 2013, re-pealing Decision No 280/2004/EC (Monitoring Mechanism Decision). More information is provided in Chapter 4.2.

<u>Assessment of the economic and social consequences of response measures</u>

The formulation of climate policy in Greece follows EU policy. In the EU a wide-ranging impact assessment system accompanying all new policy initiatives has been established[25]. It is

[25] SeeS http://ec.europa.eu/governance/impact/index_en.htm

based on an integrated approach which analyses both benefits and costs, and addresses all significant economic, social and environmental impacts of possible new initiatives. The impact assessment is thus a key element in the development of the European Commission's legislative proposals. The Commission is required to take the impact assessment reports into account when taking decisions, while the impact assessments are also presented and discussed during the scrutiny of legislative proposals from the Council and the Parliament. This approach ensures that potential economic, social and environmental consequences for various stakeholders (within, but also outside of, the European Union) are identified and assessed 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. They are prepared for i) legislative proposals which have significant economic, social and environmental impacts, ii) non-legislative initiatives (white papers, action plans, expenditure programmes, negotiating guidelines for international agreements) which define future policies and iii) certain implementing measures (so-called 'comitology' items) and delegated acts which are likely to have significant impacts. Each year, the Secretariat General, involving the Impact Assessment Board and the Commission departments, screen all forthcoming initiatives and decides for which an impact assessment is needed.

Impact assessments follow a set of key steps:

1. Planning of impact assessment (IA): Roadmap, integration in the Commission's strategic planning and programming (SPP) cycle and timetable.
2. Work closely with your IA support unit throughout all steps of the IA process.
3. Set up an impact assessment steering group and involve it in all IA work phases.
4. Consult interested parties, collect expertise and analyse the results.
5. Carry out the IA analysis.
6. Present the findings in the IA report.
7. Present the draft IA report together with the executive summary to the Impact Assessment Board (IAB) and take into account the possible time needed to resubmit a revised version.
8. Finalise the IA report in the light of the IAB's recommendations.
9. IA report and IAB opinion(s) go into inter-service consultation alongside the proposal.
10. Submission of IA report, executive summary, IAB opinion(s) and proposal to the College of Commissioners.
11. Transmission of the IA report and the executive summary with the proposal to the other EU institutions.
12. Final IA report and IAB opinion(s) published on dedicated Europa website.
13. In the light of new information or on request from the EP or the Council, the Commission may decide to update the IA report

The impact assessment approach ensures that all relevant expertise within the Commission is used, together with inputs from stakeholders. This also enhances the coherence of initiatives across policy areas and makes the impact assessment system accountable and transparent. All impact assessments and all opinions of the Impact Assessment Board on their quality are published online once the Commission has adopted the relevant proposal.

Specific guidelines for the impact assessment have been adopted (European Commission 2009[26]). The guidelines provide in-depth information on when and how to prepare an Impact Assessment, who to involve and how to proceed. The key analytical steps in an Impact Assessment are: i) identifying the problem, ii) defining objectives, iii) developing main policy options, iv) analysing the impacts of the options, v) comparing the options, and vi) outlining policy monitoring and evaluation. As to the assessment of economic, social and environmental consequences, the following key points are to be addressed (see guidelines):

- ✓ identify direct and indirect environmental, economic and social impacts and how they occur;
- ✓ identify who is affected by these impacts (including those outside the EU) and in what way;
- ✓ identify whether there are specific impacts that should be examined (fundamental rights, small and medium-sized enterprises, consumers, competition, international, national, regional);
- ✓ assess the impacts in qualitative, quantitative and monetary terms or explain in the IA why quantification is not possible or proportionate;
- ✓ consider the risks and uncertainties in the policy choices, including expected compliance patterns.

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. Appropriate consultation tools can be consultative committees, expert groups, open hearings, ad hoc meetings, consultation via the internet, questionnaires, focus groups or seminars/workshops. 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.

All key strategies and climate policies have been subject to impact assessments as described above. All impact assessments and all opinions of the Impact Assessment Board are published online[27].

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

A.I.4.2.1 Estimates of emission reductions and removals from LULUCF

In this section, estimates for emission reductions and removals in the land use, land use change and forestry (LULUCF) sector are given according to accounting rules under the UNFCCC and under the Kyoto Protocol respectively.

A.I.4.2.1.1 LULUCF under the UNFCCC

The CTF Table 1 for show emissions/removals of Greece from LULUCF.

The LULUCF sector of Greece offsets about 2.21 % of the total emissions ("without LULUCF") in 2011. The most important LULUCF category, Forest Land, in 2011 was a net sink, offsetting 1.85 % of total emissions ("without LULUCF").

[26] SEC(2009) 92. Impact Assessment Guidelines.
[27] For 2013 and other years, see http://ec.europa.eu/governance/impact/ia_carried_out/cia_2013_en.htm

CTF Table 4(a)i was completed for year 2011. The 2012 data will be available through the 2014 submission to UNFCCC (information will be available at the latest by 15 March 2014 in line with the requirements of the MMR).

A.I.4.2.1.2 LULUCF under the Kyoto Protocol

As concerns KP-LULUCF, apart from the activities afforestation, reforestation and deforestation, which are mandatory according to Article 3.3, Greece has elected forest management under Article 3, para 4 of the Kyoto Protocol to account for in the first commitment period. Greece has also chosen commitment period accounting for the Article 3.3 and 3.4 activities. CTF Table 4(a)ii shows the net emissions/removals from activities under 3.3 and 3.4 of the Kyoto Protocol and the related accounting quantities for the years 2008-2011. It contains the same as the data reported in the accounting table that is part of the CRF tables for KP LULUCF activities (2013 submission to the UNFCCC). The resulting RMUs to be issued that are reported in this table are related to compliance with the first commitment period under the Kyoto Protocol. The information reported in this table is not yet relevant for compliance with the 2020 target.

Concerning the activities of Article 3.3 of KP (afforestation, reforestation and deforestation), the net removal potential of Greece is expected to be around 1.5 Mt CO2 during the years 2008-2012. As concerns Article 3.4, it is estimated that under the current forest management practices in Greece about 1.5 - 2 Mt CO2 per year are removed. Thus, the country-specific maximum for forest management activities agreed in the Marrakech (330 kt CO2 / year) is fully utilized. Therefore, the estimated RMUs from these activities are about 3 Mt CO2 eq for the period 2008-2012.

A.I.4.2.2 Use of units from the market-based mechanisms and land use, land-use change and forestry activities

The use of units from market-based mechanisms and land use, land-use change and forest activities (LULUCF) from 2008 to 2012 count towards achievement of the Kyoto Protocol targets for the first commitment period (CP1).

Final data on surrendered units is available only for the EU ETS for these years. Final CP1 compliance actions for sectors which are not covered by the EU ETS will take place when reviewed inventory data will be available for the complete period, in the “true-up” period in 2015.

Table A.I.1 shows the annual quantities of units which have been included in the retirement account in the respective years. They are equal to the amount of units surrendered by the EU ETS operators. To cover the emissions of the non-ETS sectors, the respective units will be retired by the end of the “true-up” period. Therefore, the amount of units already retired is not an indicator for fulfilment of the target of the first commitment period. CTF Table 4(b) shows the annual quantities of units which have been included in the retirement account in the respective years for Greece, too.

Table A.I.1 Summary information on retirement

	Retirement					
	Unit type					
Year	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Year 1 (2008)	NO	NO	NO	NO	NO	NO
Year 2 (2009)	69660497	NO	NO	193945	NO	NO
Year 3 (2010)	63506167	21114	NO	133742	NO	NO
Year 4 (2011)	56267156	8251	NO	3650453	NO	NO
Year 5 (2012)	44278562	2710390	NO	7472013	NO	NO
Total	233712382	2739755	NO	11450153	NO	NO

As described in Chapter 5.1 and Table 5.7 of the 6th NC, Greece is expected to achieve Kyoto Protocol target for the first commitment period, on the basis of the domestic policies and measures implemented. However, it should be mentioned that the figures of Table 5.7 are provisional, since they will be finalised when the accounting of the 1st commitment period of the KP will be completed, i.e. after the UNFCCC review of the Greek GHG inventory in 2014. Therefore, no governmental use of flexible mechanisms is intended by Greece. However, as reported in Chapter 5.3 of the 6th NC, installations under EU-ETS scheme are allowed to use for compliance credits from JI and CDM up to 9% of their allocated allowances. During the CP1 of the KP 28,002,589 credits from CDM and JI (i.e. CERs and ERUs) have been used by the EU ETS operators for compliance purposes (surrendered to the Greek regisrty). This is the total use of flexible mechanisms during the CP1 for Greece.

Concerning the use of sinks for the 1st comitment period of the KP, the estimated RMUs from forestry activities under Article 3.3 and 3.4 (forest management) are expected to be around 3 Mt CO2 eq for the period 2008-2012.

A.I.5 Projections

The projections for years 2015, 2020, 2025 and 2030 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 5th national communication in the model or methodologies used for the preparation of projections has 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 6th National Communication. Together, they present a comprehensive description of the Greece's climate support.

This chapter covers the quantitative information for 2011 and 2012, using the required table formats.

The CTF tables with detailed data on the support provided in 2011 and 2012 are included in the CTF tables[28].

[28] These tables will be submitted to the UNFCCC using the official upload software.

A.I.6.1 Finance

The provision of financial support by Greece to non-Annex I Parties is presented in chapter 7 of the 6th 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 6th 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 6th NC and CTF Table 9.

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 (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	**74,877.74**	**74,716.39**	**76,358.94**	**75,978.53**	**78,226.97**	**78,158.80**	**80,244.67**	**84,849.24**	**89,512.53**	**88,878.24**
A. Fuel Combustion (Sectoral Approach)	74,807.51	74,645.49	76,300.73	75,931.20	78,181.75	78,120.08	80,201.07	84,810.09	89,485.35	88,876.79
1. Energy Industries	42,992.74	41,850.29	44,131.81	44,030.08	46,006.63	44,769.81	43,948.69	47,385.19	49,904.80	50,199.06
2. Manufacturing Industries and Construction	9,566.03	9,467.36	8,828.86	8,527.17	8,452.07	9,215.80	9,769.38	9,974.00	10,030.91	8,979.19
3. Transport	14,122.84	14,906.69	15,280.56	15,455.24	15,744.89	16,082.99	16,530.01	17,232.94	18,984.42	19,307.26
4. Other Sectors	8,125.91	8,421.16	8,059.51	7,918.71	7,978.16	8,051.48	9,952.98	10,217.96	10,565.23	10,391.28
5. Other	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO
B. Fugitive Emissions from Fuels	70.23	70.90	58.20	47.33	45.22	38.73	43.60	39.15	27.18	1.44
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	70.23	70.90	58.20	47.33	45.22	38.73	43.60	39.15	27.18	1.44
2. Industrial Processes	**7,861.66**	**7,785.33**	**7,820.82**	**7,514.62**	**7,523.89**	**8,035.86**	**8,037.96**	**8,215.23**	**8,449.72**	**8,369.82**
A. Mineral Products	6,681.06	6,602.10	6,675.93	6,628.06	6,597.08	7,072.89	7,061.42	7,141.36	7,182.28	7,162.18
B. Chemical Industry	240.28	229.59	218.32	140.72	NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	83.17	350.99	344.81
C. Metal Production	940.32	953.64	926.57	745.84	926.82	962.97	976.54	990.70	916.44	862.83
D. Other Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	169.71	175.78	172.84	170.12	163.22	154.65	152.16	153.07	152.39	159.96
4. Agriculture										
A. Enteric Fermentation										
B. Manure Management										
C. Rice Cultivation										
D. Agricultural Soils										
E. Prescribed Burning of Savannas										
F. Field Burning of Agricultural Residues										
G. Other										
5. Land Use, Land-Use Change and Forestry(2)	**-2,526.52**	**-2,613.61**	**-2,914.11**	**-3,246.96**	**-2,885.90**	**-3,175.98**	**-2,794.41**	**-2,667.62**	**-2,977.03**	**-3,144.58**
A. Forest Land	-1,344.13	-1,377.26	-1,794.67	-1,976.56	-1,679.83	-1,890.49	-1,904.46	-1,677.79	-1,907.05	-1,884.90
B. Cropland	-1,205.35	-1,251.05	-1,145.88	-1,310.60	-1,229.83	-1,315.31	-936.24	-1,025.02	-1,103.72	-1,296.42
C. Grassland	0.23	0.21	0.30	21.74	4.49	12.35	8.60	5.66	5.71	6.04
D. Wetlands	NE,NO	NE,NO	0.04	0.67	0.20	0.01	0.14	0.48	1.96	0.02
E. Settlements	5.19	6.52	3.14	3.47	4.06	1.90	12.70	3.45	2.99	5.99
F. Other Land	17.54	7.96	22.95	14.32	15.01	15.56	24.85	25.60	23.07	24.71
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Waste	**0.22**	**0.22**	**0.22**	**0.22**	**0.22**	**0.22**	**0.22**	**0.22**	**0.22**	**0.22**
A. Solid Waste Disposal on Land	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
B. Waste-water Handling										
C. Waste Incineration	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
D. Other	NO	NO	NO	NO	NO	NO	NO	NA,NO	NA,NO	NA,NO
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total CO_2 emissions including net CO_2 from LULUCF	**80,382.82**	**80,064.11**	**81,438.70**	**80,416.53**	**83,028.40**	**83,173.55**	**85,640.60**	**90,550.14**	**95,137.83**	**94,263.66**
Total CO_2 emissions excluding net CO_2 from LULUCF	**82,909.34**	**82,677.72**	**84,352.81**	**83,663.49**	**85,914.30**	**86,349.53**	**88,435.01**	**93,217.76**	**98,114.86**	**97,408.24**
Memo Items:										
International Bunkers	**10,466.75**	**9,471.24**	**10,658.07**	**12,204.19**	**13,241.83**	**13,853.47**	**12,390.62**	**12,334.79**	**13,586.23**	**12,675.45**
Aviation	2,439.00	2,103.14	2,194.20	2,335.46	2,771.76	2,599.12	2,489.26	2,407.68	2,526.96	2,837.73
Marine	8,027.75	7,368.10	8,463.86	9,868.73	10,470.07	11,254.35	9,901.36	9,927.11	11,059.27	9,837.72
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass	2,083.06	2,102.29	2,381.96	2,245.72	2,080.18	2,071.50	2,129.28	2,063.33	2,005.09	2,209.40

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
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	**93,754.92**	**96,133.41**	**95,960.24**	**99,868.85**	**100,173.05**	**103,352.69**	**102,053.58**	**104,613.84**	**101,333.93**	**96,949.70**
A. Fuel Combustion (Sectoral Approach)	93,730.77	96,116.36	95,942.39	99,857.23	100,161.59	103,343.23	102,044.47	104,606.88	101,328.60	96,942.18
1. Energy Industries	54,629.23	55,149.40	54,572.12	55,809.09	57,129.73	57,939.93	55,765.64	59,232.38	58,019.05	54,480.47
2. Manufacturing Industries and Construction	9,721.62	9,894.81	9,444.31	9,133.51	8,491.51	10,170.76	10,383.78	10,102.46	9,346.07	7,411.93
3. Transport	18,383.06	19,228.03	19,539.81	20,629.98	21,052.79	21,102.65	21,868.95	22,614.30	21,579.96	24,436.61
4. Other Sectors	10,996.86	11,844.13	12,386.16	14,284.64	13,487.56	14,129.89	14,026.09	12,657.74	12,383.52	10,613.15
5. Other	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO
B. Fugitive Emissions from Fuels	24.15	17.04	17.85	11.62	11.47	9.46	9.11	6.96	5.33	7.52
1. Solid Fuels	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO
2. Oil and Natural Gas	24.15	17.04	17.85	11.62	11.47	9.46	9.11	6.96	5.33	7.52
2. Industrial Processes	**8,588.09**	**8,609.17**	**8,518.89**	**8,687.52**	**8,709.08**	**9,289.97**	**9,007.74**	**8,914.09**	**8,411.27**	**6,462.60**
A. Mineral Products	7,365.84	7,422.54	7,191.10	7,227.87	7,236.01	7,789.96	7,502.29	7,341.67	6,962.97	5,324.52
B. Chemical Industry	275.90	135.77	165.68	286.61	304.52	296.92	313.93	317.94	338.06	453.25
C. Metal Production	946.34	1,050.87	1,162.10	1,173.04	1,168.56	1,203.09	1,191.52	1,254.48	1,110.24	684.83
D. Other Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	157.33	154.67	155.12	155.50	155.87	157.70	159.64	160.34	160.68	161.38
4. Agriculture										
A. Enteric Fermentation										
B. Manure Management										
C. Rice Cultivation										
D. Agricultural Soils										
E. Prescribed Burning of Savannas										
F. Field Burning of Agricultural Residues										
G. Other										
5. Land Use, Land-Use Change and Forestry(2)	**-2,821.21**	**-2,680.59**	**-2,969.07**	**-2,643.28**	**-2,848.55**	**-2,777.29**	**-2,842.55**	**-1,940.26**	**-2,890.90**	**-2,636.74**
A. Forest Land	-1,907.46	-2,026.49	-2,051.41	-2,074.82	-2,092.69	-2,111.78	-2,129.30	-2,129.30	-2,129.30	-2,129.30
B. Cropland	-963.00	-699.42	-968.28	-630.38	-836.68	-716.55	-770.88	109.08	-825.94	-561.01
C. Grassland	5.59	5.58	5.78	7.98	6.26	5.68	6.07	6.05	5.87	9.11
D. Wetlands	2.11	0.21	1.94	0.93	24.92	0.21	1.41	0.75	0.15	0.15
E. Settlements	10.44	5.71	6.71	20.89	10.91	15.86	11.86	11.92	9.94	7.35
F. Other Land	31.10	33.82	36.19	32.11	38.73	29.28	38.28	61.24	48.37	36.96
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Waste	**0.22**	**0.22**	**0.48**	**0.85**	**1.05**	**1.93**	**2.41**	**3.13**	**3.68**	**3.60**
A. Solid Waste Disposal on Land	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
B. Waste-water Handling										
C. Waste Incineration	0.22	0.22	0.48	0.85	1.05	1.93	2.41	3.13	3.68	3.60
D. Other	NA,NO	NO	NO	NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total CO_2 emissions including net CO_2 from LULUCF	**99,679.35**	**102,216.89**	**101,665.66**	**106,069.43**	**106,190.51**	**110,025.00**	**108,380.82**	**111,751.14**	**107,018.66**	**100,940.53**
Total CO_2 emissions excluding net CO_2 from LULUCF	**102,500.56**	**104,897.48**	**104,634.73**	**108,712.71**	**109,039.06**	**112,802.29**	**111,223.37**	**113,691.41**	**109,909.56**	**103,577.27**
Memo Items:										
International Bunkers	**13,848.53**	**13,343.41**	**12,206.71**	**13,139.99**	**13,316.50**	**11,455.45**	**12,651.07**	**12,925.46**	**12,798.12**	**10,900.01**
Aviation	2,489.34	2,313.49	2,313.55	3,011.38	3,095.58	2,376.88	2,850.96	2,913.77	3,029.92	2,606.08
Marine	11,359.18	11,029.93	9,893.16	10,128.61	10,220.92	9,078.57	9,800.12	10,011.69	9,768.20	8,293.93
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass	2,533.01	2,428.98	2,190.48	1,947.09	2,143.19	2,134.95	2,303.74	2,441.63	2,530.59	2,532.39

Table A.II.1c ***Evaluation of CO_2 emissions for the period 2010 – 2011 (in kt)***

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	Change from base to latest reported year
	(Gg)	(Gg)	%
1. Energy	**89,946.18**	**89,821.28**	**19.96**
A. Fuel Combustion (Sectoral Approach)	89,935.58	89,812.11	20.06
1. Energy Industries	52,036.60	53,838.38	25.23
2. Manufacturing Industries and Construction	6,717.41	5,271.14	-44.90
3. Transport	21,662.47	19,960.70	41.34
4. Other Sectors	9,519.10	10,741.89	32.19
5. Other	IE,NO	IE,NO	0.00
B. Fugitive Emissions from Fuels	10.60	9.17	-86.94
1. Solid Fuels	IE,NO	IE,NO	0.00
2. Oil and Natural Gas	10.60	9.17	-86.94
2. Industrial Processes	**6,447.55**	**4,827.60**	**-38.59**
A. Mineral Products	4,925.08	3,115.64	-53.37
B. Chemical Industry	662.97	583.10	142.67
C. Metal Production	859.50	1,128.86	20.05
D. Other Production	NA	NA	0.00
E. Production of Halocarbons and SF_6			
F. Consumption of Halocarbons and SF_6			
G. Other	NO	NO	0.00
3. Solvent and Other Product Use	161.64	161.75	-4.69
4. Agriculture			
A. Enteric Fermentation			
B. Manure Management			
C. Rice Cultivation			
D. Agricultural Soils			
E. Prescribed Burning of Savannas			
F. Field Burning of Agricultural Residues			
G. Other			
5. Land Use, Land-Use Change and Forestry[(2)]	**-2,606.92**	**-2,553.09**	**1.05**
A. Forest Land	-2,129.30	-2,129.30	58.41
B. Cropland	-526.74	-470.92	-60.93
C. Grassland	6.32	5.96	2,513.86
D. Wetlands	0.15	0.15	100.00
E. Settlements	6.92	5.57	7.23
F. Other Land	35.73	35.45	102.08
G. Other	NO	NO	0.00
6. Waste	**3.14**	**2.99**	**1,256.82**
A. Solid Waste Disposal on Land	NA,NO	NA,NO	0.00
B. Waste-water Handling			
C. Waste Incineration	3.14	2.99	1,256.82
D. Other	NA,NO	NA,NO	0.00
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**0.00**
Total CO_2 emissions including net CO_2 from LULUCF	**93,951.59**	**92,260.54**	**14.78**
Total CO_2 emissions excluding net CO_2 from LULUCF	**96,558.51**	**94,813.63**	**14.36**
Memo Items:			
International Bunkers	**10,728.24**	**10,562.23**	**0.91**
Aviation	2,084.93	2,268.30	-7.00
Marine	8,643.31	8,293.93	3.32
Multilateral Operations	NO	NO	0.00
CO_2 Emissions from Biomass	2,656.04	2,861.61	37.38

Table A.II.2a Evaluation of CH_4 emissions for the period 1990 – 1999 (in kt)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	66.60	67.33	69.99	68.66	69.95	70.77	75.57	74.82	77.68	78.54
A. Fuel Combustion (Sectoral Approach)	10.09	10.15	10.93	10.57	10.18	10.18	10.34	10.24	10.35	11.06
1. Energy Industries	0.60	0.61	0.62	0.63	0.64	0.65	0.65	0.67	0.70	0.71
2. Manufacturing Industries and Construction	0.43	0.43	0.43	0.42	0.40	0.42	0.44	0.45	0.44	0.42
3. Transport	5.06	5.10	5.06	5.13	5.16	5.21	5.24	5.33	5.53	5.70
4. Other Sectors	4.00	4.01	4.81	4.39	3.98	3.90	4.01	3.78	3.68	4.23
5. Other	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO
B. Fugitive Emissions from Fuels	56.52	57.18	59.07	58.10	59.77	60.59	65.23	64.58	67.33	67.48
1. Solid Fuels	52.16	52.96	55.33	55.09	56.96	57.95	60.08	59.14	61.19	62.36
2. Oil and Natural Gas	4.36	4.23	3.74	3.01	2.82	2.64	5.15	5.44	6.14	5.12
2. Industrial Processes	**0.03**	**0.04**	**0.03**	**0.04**	**0.04**	**0.04**	**0.04**	**0.04**	**0.04**	**0.03**
A. Mineral Products	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
B. Chemical Industry	0.02	0.03	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.02
C. Metal Production	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use										
4. Agriculture	**175.91**	**174.92**	**173.81**	**173.05**	**173.79**	**174.86**	**176.92**	**177.06**	**177.55**	**177.04**
A. Enteric Fermentation	154.58	153.49	152.63	150.85	150.81	151.58	153.12	153.16	154.29	154.42
B. Manure Management	16.74	16.67	16.77	16.75	16.71	16.61	16.67	16.66	16.67	16.63
C. Rice Cultivation	3.29	2.95	2.94	4.05	4.74	5.22	5.72	5.82	5.25	4.67
D. Agricultural Soils	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	1.29	1.81	1.47	1.41	1.53	1.44	1.41	1.43	1.34	1.32
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Land Use, Land-Use Change and Forestry	**1.29**	**0.80**	**2.39**	**1.91**	**1.87**	**0.94**	**0.74**	**1.35**	**3.24**	**0.29**
A. Forest Land	0.62	0.23	0.68	0.71	0.62	0.41	0.17	0.49	1.55	0.10
B. Cropland	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C. Grassland	0.67	0.57	1.71	1.20	1.25	0.53	0.57	0.86	1.69	0.19
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,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. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Waste	**249.66**	**247.75**	**251.49**	**252.74**	**259.48**	**258.84**	**262.92**	**259.18**	**266.96**	**262.59**
A. Solid Waste Disposal on Land	105.99	109.28	112.52	116.13	119.98	124.13	128.45	133.05	137.80	142.68
B. Waste-water Handling	143.67	138.47	138.97	136.61	139.50	134.72	134.46	126.01	129.04	119.78
C. Waste Incineration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	0.13	0.13	0.13
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total CH_4 emissions including CH_4 from LULUCF	**493.49**	**490.84**	**497.72**	**496.40**	**505.13**	**505.45**	**516.18**	**512.45**	**525.47**	**518.47**
Total CH_4 emissions excluding CH_4 from LULUCF	**492.20**	**490.04**	**495.33**	**494.49**	**503.25**	**504.51**	**515.44**	**511.10**	**522.23**	**518.18**
Memo Items:										
International Bunkers	0.68	0.62	0.71	0.83	0.88	0.93	0.83	0.83	0.94	0.83
Aviation	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Marine	0.68	0.62	0.70	0.82	0.87	0.92	0.82	0.82	0.92	0.82
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass										

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
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	82.56	84.80	87.95	86.09	88.46	87.14	83.04	84.93	84.10	83.28
A. Fuel Combustion (Sectoral Approach)	11.81	11.53	10.56	10.58	11.07	10.49	10.79	10.52	10.12	9.71
1. Energy Industries	0.79	0.78	0.78	0.80	0.80	0.83	0.84	0.90	0.89	0.79
2. Manufacturing Industries and Construction	0.48	0.47	0.48	0.41	0.42	0.49	0.46	0.45	0.49	0.42
3. Transport	5.76	5.91	5.86	5.84	5.89	5.71	5.61	5.37	5.07	4.85
4. Other Sectors	4.79	4.37	3.45	3.52	3.97	3.46	3.87	3.79	3.66	3.65
5. Other	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO
B. Fugitive Emissions from Fuels	70.75	73.27	77.39	75.51	77.38	76.64	72.26	74.42	73.98	73.57
1. Solid Fuels	64.21	66.68	70.82	68.64	70.39	69.74	64.84	66.80	66.05	65.22
2. Oil and Natural Gas	6.54	6.60	6.57	6.87	6.99	6.90	7.42	7.62	7.93	8.35
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 Products	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
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 Production	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use										
4. Agriculture	**176.13**	**176.17**	**177.91**	**178.10**	**178.45**	**178.96**	**178.30**	**177.89**	**176.56**	**176.54**
A. Enteric Fermentation	154.31	154.18	155.83	156.06	156.12	156.48	156.17	155.58	154.20	153.84
B. Manure Management	16.45	16.34	16.22	16.25	16.36	16.43	16.36	16.03	15.81	15.62
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,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	1.39	1.42	1.38	1.27	1.42	1.43	1.32	1.28	1.54	1.48
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Land Use, Land-Use Change and Forestry	**4.55**	**0.73**	**0.12**	**0.16**	**0.41**	**0.23**	**0.46**	**7.99**	**0.97**	**1.00**
A. Forest Land	1.91	0.20	0.02	0.03	0.08	0.06	0.19	2.53	0.39	0.43
B. Cropland	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C. Grassland	2.64	0.53	0.10	0.13	0.33	0.17	0.27	5.47	0.58	0.57
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,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. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Waste	**257.19**	**217.20**	**213.18**	**216.11**	**215.29**	**217.84**	**224.82**	**215.86**	**215.93**	**203.93**
A. Solid Waste Disposal on Land	148.39	132.35	138.02	146.95	149.79	158.79	165.07	162.75	167.07	156.88
B. Waste-water Handling	108.68	84.85	75.16	69.15	65.49	58.99	59.43	52.75	48.50	46.94
C. Waste Incineration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Other	0.13	NO	NO	NO	0.01	0.06	0.32	0.35	0.36	0.11
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total CH_4 emissions including CH_4 from LULUCF	**520.46**	**478.91**	**479.18**	**480.48**	**482.62**	**484.19**	**486.65**	**486.70**	**477.58**	**464.78**
Total CH_4 emissions excluding CH_4 from LULUCF	**515.90**	**478.18**	**479.06**	**480.32**	**482.22**	**483.96**	**486.19**	**478.71**	**476.61**	**463.77**
Memo Items:										
International Bunkers	0.97	0.95	0.86	0.88	0.90	0.80	0.87	0.89	0.87	0.74
Aviation	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01
Marine	0.95	0.94	0.84	0.87	0.88	0.79	0.85	0.87	0.86	0.72
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass										

Table A.II.2c Evaluation of CH_4 emissions for the period 20100 – 2011 (in kt)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	Change from base to latest reported year
	(Gg)	(Gg)	%
1. Energy	74.85	76.96	15.55
A. Fuel Combustion (Sectoral Approach)	9.09	8.99	-10.89
1. Energy Industries	0.73	0.74	22.81
2. Manufacturing Industries and Construction	0.42	0.42	-2.28
3. Transport	4.38	3.85	-23.91
4. Other Sectors	3.56	3.98	-0.44
5. Other	IE,NO	IE,NO	0.00
B. Fugitive Emissions from Fuels	65.76	67.97	20.27
1. Solid Fuels	56.80	58.96	13.05
2. Oil and Natural Gas	8.96	9.02	106.72
2. Industrial Processes	**0.02**	**0.02**	**-42.33**
A. Mineral Products	NA,NO	NA,NO	0.00
B. Chemical Industry	NA,NO	NA,NO	-100.00
C. Metal Production	0.02	0.02	99.48
D. Other Production			
E. Production of Halocarbons and SF_6			
F. Consumption of Halocarbons and SF_6			
G. Other	NO	NO	0.00
3. Solvent and Other Product Use			
4. Agriculture	**176.13**	**176.16**	**0.14**
A. Enteric Fermentation	153.52	153.53	-0.68
B. Manure Management	15.56	15.53	-7.27
C. Rice Cultivation	5.60	5.60	70.20
D. Agricultural Soils	NE,NO	NE,NO	0.00
E. Prescribed Burning of Savannas	NO	NO	0.00
F. Field Burning of Agricultural Residues	1.45	1.50	16.70
G. Other	NO	NO	0.00
5. Land Use, Land-Use Change and Forestry	**0.29**	**0.58**	**-54.69**
A. Forest Land	0.18	0.08	-87.41
B. Cropland	NA,NO	NA,NO	0.00
C. Grassland	0.11	0.51	-24.36
D. Wetlands	NE,NO	NE,NO	0.00
E. Settlements	NO	NO	0.00
F. Other Land	NO	NO	0.00
G. Other	NO	NO	0.00
6. Waste	**214.91**	**205.47**	**-17.70**
A. Solid Waste Disposal on Land	163.93	155.47	46.69
B. Waste-water Handling	50.87	49.88	-65.28
C. Waste Incineration	0.00	0.00	409.25
D. Other	0.11	0.11	100.00
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**0.00**
Total CH_4 emissions including CH_4 from LULUCF	**466.20**	**459.19**	**-6.95**
Total CH_4 emissions excluding CH_4 from LULUCF	**465.91**	**458.61**	**-6.83**
Memo Items:			
International Bunkers	0.77	0.74	7.34
Aviation	0.01	0.01	53.21
Marine	0.75	0.72	6.79
Multilateral Operations	NO	NO	0.00
CO_2 Emissions from Biomass			

Table A.II.3a Evaluation of N_2O emissions for the period 1990 – 1999 (in kt)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	**2.89**	**2.97**	**3.01**	**3.08**	**3.18**	**3.14**	**3.15**	**3.29**	**3.59**	**3.63**
A. Fuel Combustion (Sectoral Approach)	2.88	2.97	3.01	3.08	3.18	3.14	3.14	3.29	3.59	3.63
1. Energy Industries	0.50	0.48	0.51	0.51	0.53	0.51	0.50	0.54	0.57	0.56
2. Manufacturing Industries and Construction	0.14	0.15	0.15	0.15	0.15	0.16	0.16	0.17	0.18	0.16
3. Transport	1.02	1.07	1.14	1.25	1.33	1.37	1.35	1.46	1.73	1.77
4. Other Sectors	1.23	1.27	1.21	1.17	1.17	1.10	1.13	1.12	1.12	1.13
5. Other	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO
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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2. Industrial Processes	**3.58**	**2.95**	**3.08**	**2.93**	**2.85**	**2.83**	**3.24**	**2.84**	**2.34**	**2.43**
A. Mineral Products	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
B. Chemical Industry	3.58	2.95	3.08	2.93	2.85	2.83	3.24	2.84	2.34	2.43
C. Metal Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	0.45	0.45	0.46	0.46	0.47	0.47	0.47	0.47	0.48	0.48
4. Agriculture	**25.05**	**24.60**	**23.92**	**21.18**	**20.54**	**21.44**	**21.76**	**21.29**	**21.30**	**20.84**
A. Enteric Fermentation										
B. Manure Management	0.98	0.97	0.95	0.88	0.86	0.85	0.87	0.87	0.87	0.87
C. Rice Cultivation										
D. Agricultural Soils	24.04	23.59	22.93	20.26	19.63	20.56	20.85	20.38	20.39	19.94
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Land Use, Land-Use Change and Forestry	**0.01**	**0.01**	**0.02**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.02**	**0.00**
A. Forest Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
B. Cropland	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C. Grassland	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.00
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,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. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Waste	**1.07**	**1.08**	**1.10**	**1.10**	**1.13**	**1.14**	**1.14**	**1.16**	**1.17**	**1.22**
A. Solid Waste Disposal on Land										
B. Waste-water Handling	1.07	1.08	1.10	1.10	1.13	1.14	1.14	1.15	1.16	1.21
C. Waste Incineration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	0.01	0.01	0.01
7. Other ***(as specified in Summary 1.A)***	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total N_2O emissions including N_2O from LULUCF	**33.04**	**32.06**	**31.58**	**28.77**	**28.17**	**29.03**	**29.76**	**29.07**	**28.90**	**28.60**
Total N_2O emissions excluding N_2O from LULUCF	**33.03**	**32.06**	**31.56**	**28.75**	**28.16**	**29.02**	**29.76**	**29.06**	**28.88**	**28.59**
Memo Items:										
International Bunkers	**0.91**	**0.88**	**1.09**	**1.20**	**1.34**	**1.55**	**1.28**	**1.27**	**1.29**	**1.21**
Aviation	0.08	0.07	0.07	0.07	0.09	0.08	0.08	0.08	0.08	0.09
Marine	0.83	0.82	1.02	1.13	1.25	1.47	1.20	1.20	1.21	1.12
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass										

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
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	**3.21**	**3.36**	**3.41**	**3.50**	**3.38**	**3.38**	**3.49**	**3.35**	**3.26**	**2.87**
A. Fuel Combustion (Sectoral Approach)	3.21	3.36	3.41	3.50	3.38	3.38	3.49	3.35	3.26	2.87
1. Energy Industries	0.60	0.61	0.60	0.61	0.63	0.63	0.59	0.62	0.61	0.59
2. Manufacturing Industries and Construction	0.17	0.17	0.16	0.15	0.14	0.15	0.15	0.15	0.15	0.13
3. Transport	1.28	1.42	1.41	1.39	1.43	1.41	1.50	1.46	1.41	1.27
4. Other Sectors	1.15	1.16	1.24	1.35	1.18	1.19	1.24	1.12	1.08	0.88
5. Other	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO
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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2. Industrial Processes	**2.49**	**2.09**	**2.01**	**1.86**	**1.77**	**1.76**	**1.43**	**1.42**	**1.36**	**1.19**
A. Mineral Products	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
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 Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	0.48	0.48	0.48	0.49	0.49	0.49	0.49	0.49	0.49	0.50
4. Agriculture	**20.13**	**19.82**	**19.61**	**19.39**	**19.63**	**18.66**	**18.16**	**18.88**	**17.75**	**16.84**
A. Enteric Fermentation										
B. Manure Management	0.86	0.85	0.86	0.88	0.90	0.91	0.91	0.90	0.87	0.88
C. Rice Cultivation										
D. Agricultural Soils	19.24	18.94	18.71	18.47	18.70	17.71	17.22	17.95	16.84	15.93
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	0.03	0.04	0.03	0.03	0.04	0.04	0.03	0.03	0.04	0.04
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Land Use, Land-Use Change and Forestry	**0.03**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.05**	**0.01**	**0.01**
A. Forest Land	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00
B. Cropland	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C. Grassland	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,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. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Waste	**1.23**	**1.21**	**1.20**	**1.23**	**1.22**	**1.23**	**1.27**	**1.29**	**1.25**	**1.24**
A. Solid Waste Disposal on Land										
B. Waste-water Handling	1.22	1.21	1.20	1.23	1.22	1.23	1.25	1.26	1.22	1.23
C. Waste Incineration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Other	0.01	NO	NO	NO	0.00	0.00	0.02	0.03	0.03	0.01
7. Other ***(as specified in Summary 1.A)***	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total N_2O emissions including N_2O from LULUCF	**27.57**	**26.97**	**26.71**	**26.46**	**26.49**	**25.52**	**24.85**	**25.49**	**24.12**	**22.64**
Total N_2O emissions excluding N_2O from LULUCF	**27.54**	**26.96**	**26.71**	**26.46**	**26.49**	**25.52**	**24.84**	**25.43**	**24.11**	**22.63**
Memo Items:										
International Bunkers	**1.29**	**1.11**	**1.00**	**0.96**	**0.94**	**0.78**	**0.83**	**0.80**	**0.76**	**0.68**
Aviation	0.08	0.07	0.07	0.10	0.10	0.08	0.09	0.09	0.10	0.08
Marine	1.21	1.03	0.93	0.87	0.84	0.70	0.74	0.71	0.66	0.60
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass										

Table A.II.3c **Evaluation of N_2O emissions for the period 2010 – 2011 (in kt)**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	Change from base to latest reported year
	(Gg)	(Gg)	%
1. Energy	**2.50**	**2.35**	**-18.65**
A. Fuel Combustion (Sectoral Approach)	2.50	2.35	-18.63
1. Energy Industries	0.55	0.56	12.23
2. Manufacturing Industries and Construction	0.12	0.11	-25.01
3. Transport	1.04	0.83	-17.87
4. Other Sectors	0.79	0.85	-30.93
5. Other	IE,NO	IE,NO	0.00
B. Fugitive Emissions from Fuels	0.00	0.00	-87.03
1. Solid Fuels	NA,NO	NA,NO	0.00
2. Oil and Natural Gas	0.00	0.00	-87.03
2. Industrial Processes	**1.38**	**1.53**	**-57.13**
A. Mineral Products	NA,NO	NA,NO	0.00
B. Chemical Industry	1.38	1.53	-57.13
C. Metal Production	NA	NA	0.00
D. Other Production			
E. Production of Halocarbons and SF_6			
F. Consumption of Halocarbons and SF_6			
G. Other	NO	NO	0.00
3. Solvent and Other Product Use	0.50	0.50	11.56
4. Agriculture	**17.97**	**16.99**	**-32.18**
A. Enteric Fermentation			
B. Manure Management	0.88	0.88	-9.91
C. Rice Cultivation			
D. Agricultural Soils	17.06	16.07	-33.16
E. Prescribed Burning of Savannas	NO	NO	0.00
F. Field Burning of Agricultural Residues	0.04	0.04	19.76
G. Other	NO	NO	0.00
5. Land Use, Land-Use Change and Forestry	**0.00**	**0.00**	**-54.69**
A. Forest Land	0.00	0.00	-87.41
B. Cropland	NA,NO	NA,NO	0.00
C. Grassland	0.00	0.00	-24.36
D. Wetlands	NE,NO	NE,NO	0.00
E. Settlements	NO	NO	0.00
F. Other Land	NO	NO	0.00
G. Other	NO	NO	0.00
6. Waste	**1.24**	**1.25**	**16.49**
A. Solid Waste Disposal on Land			
B. Waste-water Handling	1.23	1.24	15.58
C. Waste Incineration	0.00	0.00	409.25
D. Other	0.01	0.01	100.00
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**0.00**
Total N_2O emissions including N_2O from LULUCF	**23.60**	**22.62**	**-31.54**
Total N_2O emissions excluding N_2O from LULUCF	**23.60**	**22.61**	**-31.54**
Memo Items:			
International Bunkers	**0.71**	**0.67**	**-25.94**
Aviation	0.07	0.07	-7.08
Marine	0.64	0.60	-27.69
Multilateral Operations	NO	NO	0.00
CO_2 Emissions from Biomass			

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 (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Emissions of HFCs[3] - (Gg CO_2 equivalent)	**935.06**	**1,106.82**	**908.39**	**1,606.74**	**2,144.05**	**3,290.41**	**3,817.88**	**4,097.77**	**4,579.59**	**5,365.87**
HFC-23	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	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
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	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
HFC-134a	NA,NO	NA,NO	NA,NO	0.00	0.00	0.02	0.04	0.07	0.10	0.16
HFC-152a	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-143	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	0.00	0.00	0.01	0.01	0.02
HFC-227ea	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
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
Unspecified mix of listed HFCs[4] - (Gg 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[3] - (Gg CO_2 equivalent)	**163.37**	**164.17**	**161.21**	**96.98**	**60.37**	**53.97**	**46.14**	**107.67**	**133.04**	**90.32**
CF_4	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
C_3F_8	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
C_4F_{10}	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
$c\text{-}C_4F_8$	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
C_5F_{12}	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
C_6F_{14}	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
Unspecified mix of listed PFCs[4] - (Gg 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 SF6[3] - (Gg CO_2 equivalent)	**3.07**	**3.16**	**3.26**	**3.35**	**3.45**	**3.59**	**3.68**	**3.73**	**3.78**	**3.87**
SF_6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Emissions of HFCs(3) - (Gg CO_2 equivalent)	**4,243.79**	**3,849.29**	**4,000.29**	**3,803.16**	**3,892.90**	**3,968.87**	**2,133.68**	**2,471.03**	**2,844.35**	**3,226.65**
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	0.11	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	0.05	0.08	0.10	0.13	0.16	0.20	0.24	0.29
HFC-134	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-134a	0.23	0.30	0.36	0.47	0.56	0.78	0.90	1.01	1.16	1.27
HFC-152a	NA,NO	0.01	0.23	0.31	0.27	0.29	0.35	0.31	0.31	0.27
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	0.03	0.04	0.05	0.07	0.08	0.09	0.10	0.12
HFC-227ea	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
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
Unspecified mix of listed HFCs(4) - (Gg 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(3) - (Gg CO_2 equivalent)	**105.09**	**71.16**	**69.14**	**72.47**	**68.99**	**69.89**	**66.35**	**76.21**	**89.10**	**69.85**
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	0.00	0.01	0.01
C_3F_8	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_4F_{10}	NE,NO	NE,NO	NE,NO	NE,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
$c\text{-}C_4F_8$	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_5F_{12}	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_6F_{14}	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Unspecified mix of listed PFCs(4) - (Gg 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 SF6(3) - (Gg CO_2 equivalent)	**3.99**	**4.06**	**4.25**	**4.25**	**4.47**	**6.45**	**8.37**	**9.92**	**7.53**	**5.26**
SF_6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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 – 2011*

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	Change from base to latest reported year
	(Gg)	(Gg)	%
Emissions of HFCs(3) - (Gg CO_2 equivalent)	**3,512.16**	**3,507.46**	**275.10**
HFC-23	0.01	0.01	-87.04
HFC-32	0.20	0.24	100.00
HFC-41	NA,NO	NA,NO	0.00
HFC-43-10mee	NA,NO	NA,NO	0.00
HFC-125	0.34	0.40	100.00
HFC-134	NA,NO	NA,NO	0.00
HFC-134a	1.27	1.17	100.00
HFC-152a	0.24	0.22	100.00
HFC-143	NA,NO	NA,NO	0.00
HFC-143a	0.14	0.14	100.00
HFC-227ea	0.01	0.01	100.00
HFC-236fa	NA,NO	NA,NO	0.00
HFC-245ca	NA,NO	NA,NO	0.00
Unspecified mix of listed HFCs(4) - (Gg CO_2 equivalent)	NA,NO	NA,NO	0.00
Emissions of PFCs(3) - (Gg CO_2 equivalent)	**101.57**	**77.69**	**-52.45**
CF_4	0.00	0.01	-75.94
C_2F_6	0.01	0.00	84.74
C_3F_8	NA,NO	NA,NO	0.00
C_4F_{10}	NA,NO	NA,NO	0.00
$c\text{-}C_4F_8$	NA,NO	NA,NO	0.00
C_5F_{12}	NA,NO	NA,NO	0.00
C_6F_{14}	NA,NO	NA,NO	0.00
Unspecified mix of listed PFCs(4) - (Gg CO_2 equivalent)	NA,NO	NA,NO	0.00
Emissions of SF6(3) - (Gg CO_2 equivalent)	**6.14**	**5.15**	**67.76**
SF_6	0.00	0.00	67.76

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 (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)
CO_2 emissions including net CO_2 from LULUCF	80,382.82	80,064.11	81,438.70	80,416.53	83,028.40	83,173.55	85,640.60	90,550.14	95,137.83	94,263.66
CO_2 emissions excluding net CO_2 from LULUCF	82,909.34	82,677.72	84,352.81	83,663.49	85,914.30	86,349.53	88,435.01	93,217.76	98,114.86	97,408.24
CH_4 emissions including CH_4 from LULUCF	10,363.28	10,307.60	10,452.22	10,424.50	10,607.64	10,614.47	10,839.86	10,761.48	11,034.78	10,887.90
CH_4 emissions excluding CH_4 from LULUCF	10,336.24	10,290.78	10,401.93	10,384.35	10,568.30	10,594.76	10,824.32	10,733.05	10,966.78	10,881.82
N_2O emissions including N_2O from LULUCF	10,242.24	9,939.40	9,789.61	8,917.23	8,732.99	8,998.80	9,225.97	9,010.92	8,960.14	8,864.62
N_2O emissions excluding N_2O from LULUCF	10,239.50	9,937.70	9,784.50	8,913.16	8,729.00	8,996.80	9,224.39	9,008.04	8,953.24	8,864.01
HFCs	935.06	1,106.82	908.39	1,606.74	2,144.05	3,290.41	3,817.88	4,097.77	4,579.59	5,365.87
PFCs	163.37	164.17	161.21	96.98	60.37	53.97	46.14	107.67	133.04	90.32
SF_6	3.07	3.16	3.26	3.35	3.45	3.59	3.68	3.73	3.78	3.87
Total (including LULUCF)	**102,089.85**	**101,585.26**	**102,753.38**	**101,465.33**	**104,576.91**	**106,134.78**	**109,574.12**	**114,531.72**	**119,849.16**	**119,476.24**
Total (excluding LULUCF)	**104,586.58**	**104,180.35**	**105,612.11**	**104,668.07**	**107,419.48**	**109,289.05**	**112,351.42**	**117,168.02**	**122,751.30**	**122,614.13**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)
1. Energy	77,170.88	77,051.19	78,761.21	78,374.79	80,682.90	80,619.14	82,806.62	87,441.76	92,257.98	91,653.08
2. Industrial Processes	10,072.94	9,974.64	9,850.59	10,130.49	10,615.36	12,263.12	12,909.68	13,306.33	13,892.01	14,583.38
3. Solvent and Other Product Use	308.34	315.54	314.37	312.95	307.39	299.82	298.22	300.20	300.40	308.73
4. Agriculture	11,460.07	11,300.12	11,063.83	10,199.89	10,015.51	10,318.69	10,461.66	10,316.69	10,330.53	10,177.64
5. Land Use, Land-Use Change and Forestry(5)	-2,496.73	-2,595.09	-2,858.72	-3,202.73	-2,842.57	-3,154.27	-2,777.30	-2,636.31	-2,902.14	-3,137.89
6. Waste	5,574.35	5,538.87	5,622.11	5,649.95	5,798.32	5,788.29	5,875.25	5,803.05	5,970.39	5,891.30
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)(5)	**102,089.85**	**101,585.26**	**102,753.38**	**101,465.33**	**104,576.91**	**106,134.78**	**109,574.12**	**114,531.72**	**119,849.16**	**119,476.24**

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 (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)
CO_2 emissions including net CO_2 from LULUCF	99,679.35	102,216.89	101,665.66	106,069.43	106,190.51	110,025.00	108,380.82	111,751.14	107,018.66	100,940.53
CO_2 emissions excluding net CO_2 from LULUCF	102,500.56	104,897.48	104,634.73	108,712.71	109,039.06	112,802.29	111,223.37	113,691.41	109,909.56	103,577.27
CH_4 emissions including CH_4 from LULUCF	10,929.60	10,057.16	10,062.72	10,090.03	10,135.07	10,168.05	10,219.61	10,220.63	10,029.09	9,760.28
CH_4 emissions excluding CH_4 from LULUCF	10,833.97	10,041.74	10,060.22	10,086.62	10,126.53	10,163.13	10,209.92	10,052.82	10,008.74	9,739.24
N_2O emissions including N_2O from LULUCF	8,546.75	8,359.64	8,279.57	8,202.93	8,211.58	7,910.60	7,702.30	7,901.86	7,476.65	7,017.72
N_2O emissions excluding N_2O from LULUCF	8,537.05	8,358.07	8,279.31	8,202.59	8,210.71	7,910.10	7,701.32	7,884.83	7,474.59	7,015.59
HFCs	4,243.79	3,849.29	4,000.29	3,803.16	3,892.90	3,968.87	2,133.68	2,471.03	2,844.35	3,226.65
PFCs	105.09	71.16	69.14	72.47	68.99	69.89	66.35	76.21	89.10	69.85
SF_6	3.99	4.06	4.25	4.25	4.47	6.45	8.37	9.92	7.53	5.26
Total (including LULUCF)	**123,508.57**	**124,558.20**	**124,081.63**	**128,242.27**	**128,503.53**	**132,148.86**	**128,511.11**	**132,430.78**	**127,465.38**	**121,020.29**
Total (excluding LULUCF)	**126,224.44**	**127,221.80**	**127,047.95**	**130,881.80**	**131,342.67**	**134,920.73**	**131,343.00**	**134,186.20**	**130,333.87**	**123,633.85**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)
1. Energy	96,482.97	98,955.51	98,863.99	102,762.35	103,078.73	106,230.56	104,879.59	107,436.55	104,109.16	99,587.47
2. Industrial Processes	13,712.49	13,182.03	13,216.88	13,143.66	13,223.40	13,881.47	11,659.33	11,911.31	11,775.07	10,132.20
3. Solvent and Other Product Use	306.61	304.28	305.13	305.93	306.75	309.29	311.92	313.41	314.13	315.60
4. Agriculture	9,939.90	9,843.48	9,813.84	9,750.33	9,833.78	9,541.44	9,374.78	9,590.02	9,211.13	8,927.68
5. Land Use, Land-Use Change and Forestry(5)	-2,715.87	-2,663.61	-2,966.32	-2,639.53	-2,839.14	-2,771.88	-2,831.89	-1,755.42	-2,868.48	-2,613.56
6. Waste	5,782.47	4,936.49	4,848.11	4,919.53	4,900.02	4,957.98	5,117.38	4,934.91	4,924.37	4,670.90
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)(5)	**123,508.57**	**124,558.20**	**124,081.63**	**128,242.27**	**128,503.53**	**132,148.86**	**128,511.11**	**132,430.78**	**127,465.38**	**121,020.29**

Table A.II.5c *Evaluation of GHG emissions / removals per gas and per sector for the period 2010 – 2011 (kt CO_2 eq)*

GREENHOUSE GAS EMISSIONS	2010	2011	Change from base to latest reported year
	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	(%)
CO_2 emissions including net CO_2 from LULUCF	93,951.59	92,260.54	14.78
CO_2 emissions excluding net CO_2 from LULUCF	96,558.51	94,813.63	14.36
CH_4 emissions including CH_4 from LULUCF	9,790.23	9,643.01	-6.95
CH_4 emissions excluding CH_4 from LULUCF	9,784.13	9,630.76	-6.83
N_2O emissions including N_2O from LULUCF	7,316.22	7,011.59	-31.54
N_2O emissions excluding N_2O from LULUCF	7,315.61	7,010.34	-31.54
HFCs	3,512.16	3,507.46	275.10
PFCs	101.57	77.69	-52.45
SF_6	6.14	5.15	67.76
Total (including LULUCF)	**114,677.93**	**112,505.42**	**10.20**
Total (excluding LULUCF)	**117,278.12**	**115,045.02**	**10.00**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	Change from base to latest reported year
	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	(%)
1. Energy	92,293.12	92,165.18	19.43
2. Industrial Processes	10,496.20	8,893.78	-11.71
3. Solvent and Other Product Use	316.17	316.41	2.62
4. Agriculture	9,270.66	8,965.84	-21.76
5. Land Use, Land-Use Change and Forestry(5)	-2,600.19	-2,539.59	1.72
6. Waste	4,901.96	4,703.81	-15.62
7. Other	NA	NA	0.00
Total (including LULUCF)(5)	**114,677.93**	**112,505.42**	**10.20**

A.III Inventory preparation details

Table A.III.1 Overview of methods applied for the calculation of GHG emissions / removals

	CO_2		CH_4		N_2O		F-gases	
	Method	Emission factor	Method	Emission factor	Method	Emission factor	Method	Emission factor
1. Energy								
A. Fuel combustion								
1. Energy industries	T2	CS, PS	T2	D	T2	D		
2. Manufacturing industries and Construction	T2	CS, PS	T2	D	T2	D		
3. Transport	T1,T2	D, CS	CR,M,T1,T2	CR,D,M	CR,M,T1,T2	CR,D,M		
4. Other sectors	T2	CS,D	T2	D	T2	D		
B. Fugitive emissions from fuels								
1. Solid fuels	NA	NA	T1	D	NA	NA		
2. Oil and Natural gas	T1	D	T1	D	T1	D		
2. Industrial processes								
A. Mineral products	CS,T1	CS, D, OTH, PS	NA	NA	NA	NA		
B. Chemical industry	NA, T1, T1a	NA,CS	T1, NA	D, NA	D	D		
C. Metal production	CS, T1	CS, PS	CR	CR	NA	NA	T3	PS
E. Production of halocarbons and SF_6							T1, NA	D, NA
F. Consumption of halocarbons and SF_6							NA, T2 , CS	NA, D, CS
3. Solvents and other products use	CR	CR			OTH	OTH		
4. Agriculture								
A. Enteric fermentation			T1,T2	CS,D				
B. Manure management			T1,T2	CS,D	D	D		
C. Rice cultivation			D	D				
D. Agricultural soils			NA	NA	D,T1,T1a,T1b	CS,D		

	CO2		CH4		N2O		F-gases	
	Method	Emission factor	Method	Emission factor	Method	Emission factor	Method	Emission factor
F. Field burning of agricultural residues			D	D	D	D		
5. Land Use, Land Use Change and Forestry								
A. Forest land	T1,T2	CS,D	T1	D	T1	D		
B. Cropland	T1,T2	CS,D	NA	NA	NA	NA		
C. Grassland	T1,T2	CS,D	T1	D	T1	D		
D. Wetlands	T1, T2	CS, D	NA	NA	NA	NA		
E. Settlements	T1,T2	CS, D	NA	NA	NA	NA		
F. Other Land	T1,T2	CS, D	NA	NA	NA	NA		
6. Waste								
A. Solid waste disposal on land	NA	NA	T2	D, CS				
B. Wastewater handling			CS,D	D, CS	D, CR	D, CS		
C. Waste incineration	D	D, CS	D	CS	D	CS		
KP-LULUCF								
KP.A.1. Afforestation - Reforestation	T1	D	NA	NA	NA	NA		
KP.A.2. Deforestation	T2	CS	NA	NA	NA	NA		
KP.B.1. Forest Management	T2	CS	T1	CS, D	T1	CS, 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)	21
Nitrous oxide (N_2O)	310
Hydrofluorocarbons (HFC)	
HFC-23	11700
HFC-32	650
HFC-125	2800
HFC-134a	1300
HFC-143a	3800
HFC-152a	140
HFC-227ea	2900
HFC-236fa	6300
HFC-4310mee	1300
Perfluorocarbons (PFC)	
CF_4	6500
C_2F_6	9200
C_4F_{10}	7000
C_6F_{14}	7400
Sulphur hexafluoride (SF_6)	23900

Table A.III.3 Key categories for the Greek inventory system without LULUCF

Source categories	Gas	Criteria
Energy		
Energy industries – Solid fuels	CO_2	Level, Trend
Energy industries– Liquid 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 transport	CO_2	Level, Trend
Transport – Navigation	CO_2	Level, Trend
Coal mining and handling	CH_4	Level
Other Sectors - Liquid fuels	CO_2	Level, Trend
Other Sectors – Gaseous fuels	CO_2	Level, Trend
Industrial processes		
Cement production	CO_2	Level, Trend
Ferroalloys	CO_2	Level
Nitric acid production	N_2O	Level, Trend
Other chemicals	CO_2	Trend
Ozone depleting substances substitutes	F-gases	Level, Trend
Agriculture		
Enteric fermentation – Non dairy cattle	CH_4	Level
Enteric fermentation – Sheep	CH_4	Level
Enteric fermentation – Other	CH_4	Level
Agricultural soils – Direct emissions	N_2O	Level, Trend
Agricultural soils – Animal production	N_2O	Level, Trend
Agricultural soils – Indirect emissions	N_2O	Level, Trend
Waste		
Solid waste disposal on land	CH_4	Level, Trend
Wastewater handling	CH_4	Level, Trend

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

Source categories	Gas	Criteria
Energy		
Energy industries – Solid fuels	CO_2	Level, Trend
Energy industries– Liquid 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 transport	CO_2	Level, Trend
Transport – Navigation	CO_2	Level, Trend
Coal mining and handling	CH_4	Level
Other Sectors - Liquid fuels	CO_2	Level, Trend
Other Sectors – Gaseous fuels	CO_2	Level, Trend
Industrial processes		
Cement production	CO_2	Level, Trend
Ferroalloys	CO_2	Level
Nitric acid production	N_2O	Level, Trend
Other chemicals	CO_2	Trend
Ozone depleting substances substitutes	F-gases	Level, Trend
Agriculture		
Enteric fermentation – Non dairy cattle	CH_4	Level
Enteric fermentation – Sheep	CH_4	Level
Enteric fermentation – Other	CH_4	Level
Agricultural soils – Direct emissions	N_2O	Level, Trend
Agricultural soils – Animal production	N_2O	Level, Trend
Agricultural soils – Indirect emissions	N_2O	Level, Trend
Waste		
Solid waste disposal on land	CH_4	Level, Trend
Wastewater handling	CH_4	Level, Trend
LULUCF		
Forest land remaining forest land	CO_2	Level, Trend
Cropland remaining cropland	CO_2	Level, Trend
Conversion to forestland	CO_2	Trend

A.IV Summary of reporting of the Supplementary information under Article 7, paragraph 2, of the Kyoto Protocol in the NC6

Table A.IV.1 Summary of reporting of the Supplementary information under Article 7, paragraph 2, of the Kyoto Protocol in the NC6

Information reported under Article 7, paragraph 2 NC5 section		NC5 section
National systems in accordance with Article 5, paragraph 1		3.3
National registries		3.4
Supplementarity relating to the mechanisms pursuant to Articles 6, 12 and 17		5.3
Policies and measures in accordance with Article 2		4.3
Domestic and regional programmes and/or legislative arrangements and enforcement and administrative procedures		4.1 & 4.2
Information under Article 10		
	Art 10a	3.3
	Art 10b	4.1 & 4.2
	Art 10c	7.5
	Art 10d	8
	Art 10e	9
Financial resources (Annex II only)		7.2, 7.3 & 7.4

A.V National Communication Preparation Process

Overall responsibility: Ministry of Environment, Energy and Climate Change
Official consideration and approval : Irini Nikolaou
Technical and scientific responsibility: NTUA (Ioannis Ziomas (head), Ioannis Sempos, Athina Progiou, Leonidas Kallinikos, Ioanna Katsavou, Panagiota Maria Eleni, Iordanis Tzamtzis)

Data providers:

- Ministry of Environment, Energy and Climate Change.
- 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.
- Region of Thessaly.
- 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.