

# Cyprus

Sixth National Communication  
accompanied by the  
Biennial Report under the UNFCCC

**Department of Environment**  
Ministry of Agriculture,  
Natural Resources and Environment

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## TABLE OF CONTENTS

Preface .....	1	5.5. sensitivity analysis .....	60
Executive summary .....	2	6. Vulnerability assessment, climate change impacts and adaptation measures .....	62
National circumstances .....	2	6.1. Introduction .....	62
Inventory .....	3	6.2. Observed patterns of climate change across and projections for the future .....	62
Policies and measures .....	7	6.3. Expected impacts and vulnerabilities of climate change in Cyprus .....	71
Projections .....	7	6.4. Actions for adaptation to climate change .....	125
Impacts, Vulnerability and Adaptation .....	10	7. Financial resources and transfer of technology .....	131
Financial Resources and Transfer of Technology .....	10	7.1. Introduction .....	131
Research and Systematic Observation .....	11	7.2. Provision of new and additional resources .....	131
Education, training and public awareness .....	12	7.3. Assistance to developing country Parties that are particularly vulnerable to climate change .....	131
1. Introduction .....	13	7.4. Activities related to transfer of technology .....	132
2. National circumstances .....	14	8. Research and systemic observation .....	133
2.1. Introduction .....	14	8.1. Introduction .....	133
2.2. Geographic profile .....	14	8.2. General policy on and funding of research and systematic observation .....	133
2.3. Government Structure .....	14	8.3. Summary information on GCOS activities .....	137
2.4. Population .....	16	8.4. Research .....	143
2.5. Climate .....	17	9. Education, training and public awareness .....	164
2.6. Economy .....	19	9.1. Introduction .....	164
2.7. Energy .....	21	9.2. General policy toward education, training and public awareness .....	164
2.8. Transport .....	24	9.3. Primary, secondary and higher education .....	164
2.9. Industry .....	25	9.4. Public information campaigns .....	166
2.10. Waste .....	26	9.5. Training programmes .....	166
2.11. Building stock and urban structure .....	26	9.6. Resource or information centres .....	167
2.12. Agriculture .....	27	9.7. Involvement of the public and non-governmental organisations .....	167
2.13. Forest .....	27	9.8. International Cooperation on Education, Training and Public Awareness .....	171
3. Greenhouse gas inventory information .....	28	LIST OF REFERENCES .....	172
3.1. Introduction .....	28	ANNEX - CYPRUS' 1 <sup>ST</sup> BIENNIAL REPORT .....	178
3.2. Descriptive Summary of GHG Emissions Trends .....	28	A1. Introduction .....	179
3.3. National system .....	31	A2. Information on GHG emissions and trends, GHG inventory including information on national inventory system .....	179
3.4. National registry .....	36	A2.1. Introduction and summary information from the national GHG inventory .....	179
4. Policies and measures .....	38	A2.2. National inventory arrangements .....	181
4.1. National policies .....	38	A3. Quantified economy-wide emission reduction target .....	182
4.2. Sectoral policies and measures: Energy .....	38	A4. Progress in achievement of the quantified economy-wide emission reduction targets .....	182
4.3. Sectoral policies and measures: Transport .....	46	A5. Projections .....	183
4.4. Sectoral policies and measures: Industry .....	47	A5.1. Introduction .....	183
4.5. Sectoral policies and measures: Agriculture .....	47	A5.2. Projections .....	183
4.6. Sectoral policies and measures: Forestry .....	47		
4.7. Sectoral policies and measures: Waste .....	47		
4.8. Other measures .....	50		
4.9. Policies and measures no longer in place .....	50		
4.10. EU policies .....	51		
5. Projections and the total effects of policies and measures .....	54		
5.1. Introduction .....	54		
5.2. Projections .....	54		
5.3. Assessment of aggregate effect of policies and measures .....	56		
5.4. Methodology used for the presented GHG emission projections .....	57		

A5.3. Changes in projection methodologies .....	185	A6.2. General information .....	185
A6. Provision of financial, technological and capacity building support to developing countries.....	185	A6.3. Financial Resources .....	185
A6.1. Introduction .....	185	A6.4. Common reporting format tables.....	186

## PREFACE

This Communication has been prepared, written and compiled by Ms Nicoletta Kythreotou of the Department of the Environment of the Ministry of Agriculture, Natural Resources and Environment. Contributions by other authors are acknowledged accordingly in the text.

Cyprus became an Annex I Party on 1/1/2013. Consequently, this National Communication is the first submitted by Cyprus as Annex I Party, and it will be prepared for the first time using Reporting Guidelines for Annex I Parties. Following CP and CMP decisions the rest of Annex I Parties would submit their 6th National Communication.

Following however, the need to maintain consistency of references to the numbering of NCs, we chose to entitle this report as "6th National Communication" to provide consistency of titles among Annex I Parties.

The present National Communication acts as a consolidated National Communication covering the first, second, third, fourth, fifth and sixth National Communications of Cyprus. The report contains several historical developments that the reader can easily connect to the appropriate NC.

This sixth National Communication is accompanied by the 1<sup>st</sup> Biennial Report that has to be submitted on the 1st January 2013, according to decision 2/CP.17.

## EXECUTIVE SUMMARY

### NATIONAL CIRCUMSTANCES

#### Population

The population of Cyprus is estimated at 952.1 thousand at the end of 2011 compared with 929.5 thousand the previous year, showing an increase of 2.4%. After the Turkish invasion of July-August 1974 the total population experienced negative growth up to mid-1977, through war losses, emigration and fertility decline. In the following years, demographic developments favoured population growth. However, the overall growth conceals pronounced differences between the population in the Government controlled area and the Turkish Cypriot community in the areas of the Republic of Cyprus in which the Government of the Republic of Cyprus does not exercise effective control. While the population in the Government controlled area increased gradually since 1977 at a rate which ranged between 0.7% and 2.7%, in the areas of the Republic of Cyprus in which the Government of the Republic of Cyprus does not exercise effective control, on the contrary, the Turkish Cypriot community has been decreasing since 1986. This difference in the population growth is exclusively due to migration movements, since both the fertility and mortality of Turkish Cypriots are similar to those of the rest of the Cyprus population.

Total population figures do not include illegal settlers from Turkey, the number of which most probably is in the range of 160-170 thousands, estimated on information of significant arrivals of Turks in the occupied area.

The population in the government controlled area of Cyprus was estimated at 862 thousand at the end of 2011, compared to 587.1 thousand in 1990, recording an increase of 46.8%. The share of urban population was 67.4% in 2011 as compared to 67.5% in the previous year. The number of households in 2011 was 309.3 thousand, recording an increase of 3.1% compared to 2010, whilst the average household size showed a gradual decrease during the years, reaching 2.77 at the end of 2011.

The population density at the end of 2011 for the government controlled area of Cyprus was 103 inhabitants/ km<sup>2</sup>. Cyprus has a relatively high population

density when compared to other Parties to the UN Convention.

#### Climate

Cyprus has an intense Mediterranean climate with the typical seasonal rhythm strongly marked in respect of temperature, rainfall and weather generally. Hot and dry summers from mid-May to mid-October and mild, rainy, rather changeable, winters from November to mid-March are separated by short autumn and spring seasons of rapid change in weather conditions.

Annual precipitation in Cyprus has on average decreased by about 100mm in the last 80 years. The average annual temperature in Cyprus, both in urban and in rural areas, presents an increasing trend. The greater increase in temperature in the towns is due to the urbanization effect, however, the fact that an increase is also observed in rural areas, it is indicative of the general increase in temperature in our area as well as globally. In Nicosia the average annual temperature increased from 18.9°C in the first 30-year period of the century to 20°C in the last 30-year period, an increase of 1.1°C.

#### Economy

The economy of Cyprus can generally be characterised as small, open and dynamic, with services constituting its engine power. Since the accession of the country to the European Union on 1 May 2004, its economy has undergone significant economic and structural reforms that have transformed the economic landscape. Interest rates have been liberalised, while other wide-ranging structural reforms have been promoted, covering the areas of competition, the financial sector and the business sector.

The tertiary sector (services) is the biggest contributor to GDP, accounting for about for about 82.6% in 2012. This development reflects the gradual restructuring of the Cypriot economy from an exporter of minerals and agricultural products in the period 1961-73 and an exporter of manufactured goods in the latter part of the 1970s and the early part of the 80s, to an international tourist, business and services centre during the 1980s, 1990s and the 2000s. The secondary sector (manufacturing) accounted for around 14.7% of GDP in 2012. The primary sector (agriculture and fishing) is continuously shrinking and only reached 2.7% of GDP in 2012.

The private sector, which is dominated by small and medium-sized enterprises, has a leading role in the production process. On the other hand, the government's role is mainly to support the private sector and regulate the markets in order to maintain conditions of macroeconomic stability and a favourable business climate, via the creation of the necessary legal and institutional framework and secure conditions of fair competition.

Before the emergence of the global economic crisis, Cyprus had enjoyed a track record of satisfactory economic growth, low unemployment and relatively stable macroeconomic conditions. However, the international economic crisis has had a major impact on the economy, as reflected in the main economic indicators. The exposure of the Cypriot biggest banks to the Greek market and the holding of significant amount of Greek Government Bonds played a major role for the steep increase of borrowing costs from international markets and the resulting request for assistance from Troika.

More importantly, the decision by the Eurogroup to impose a haircut on uninsured deposits in the two biggest Cypriot banks, have had significant negative consequences on one of the main drivers of the Cyprus economy that is the banking sector. The abrupt and sudden shrinking of the banking sector and the loss of wealth by depositors unavoidably is affecting the real economy.

The agreement with Troika for a macroeconomic adjustment Programme (Memorandum of Understanding), is envisaged to bring back economic stability. The Programme is an ambitious one, aiming at achieving 4% of GDP primary balance by 2018.

### **Energy**

Total primary energy consumption in Cyprus rose over the period from 1990 despite continued efforts to improve energy efficiency. Trends in the consumption of different energy types within the total have changed significantly since 1990. Since 1990 there has been a decrease of nearly 38% in the consumption of carbon intensive coal used in cement industry. The consumption of oil increased by 59% between 1990 and 2011. Renewables have the most marked increase with consumption increasing by 187% from 1990 levels.

Fossil fuels continue to dominate total energy consumption and the share of renewable energy sources remains small despite the increase in use. The overall increase in total primary energy consumption has also acted to counteract some of the environmental benefits from fuel switching.

The final energy needs of the economy of Cyprus represent 69% of the country's primary energy consumption. There are very significant energy losses linked to the transformation and distribution of useful energy (e.g. as electricity) to the end users. Energy losses broadly depend on the average efficiency of conventional thermal power stations and CHP plants and the penetration of non-thermal renewables.

### **Transport**

Both freight and passenger transport, have continued to grow strongly since 1990 with continued growth in GHG emissions. According to the available information, there is no clear relation between freight or passenger transport with GDP. The transport sector is now the largest consumer of energy in Cyprus after electricity production and the issue of growing greenhouse gas emissions from this sector needs to be addressed.

### **Forest**

Wild vegetation in Cyprus is classified in two major categories: a) forest and b) Other Wooded Land (OWL, which includes maquis and garique), which are either of state or private ownership. These two categories account for 41.7 % (386,167 hectares) of the total land area. The change of forest cover is almost invariable the last 15 years.

## **INVENTORY**

The latest national greenhouse gas emissions inventory was prepared in early 2013 and was submitted to the UNFCCC secretariat in April 2013. Emissions estimates were calculated according to the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (henceforth IPCC Guidelines) and the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (henceforth IPCC Good Practice Guidance). It is noted that base year emissions are calculated using 1990 as the base year for carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O), and 1994 for fluorinated gases (F-gases):

Hydrofluorocarbons, HFC / Perfluorocarbons, PFC / Sulphur hexafluoride, SF6).

**Table E1. Emission for greenhouse gases (in Gg) for the period 1990-2011**

Sector	1990	2000	2010	2011
Energy	4214	6361	7441	7137
Industry	728	831	642	697
Solvents	NE	NE	NE	NE
Agriculture	679	744	722	730
Waste	470	639	639	590
<b>TOTAL excl. LULUCF</b>	<b>6091</b>	<b>8574</b>	<b>9444</b>	<b>9154</b>
LULUCF	-139	-150	-166	-76
<b>TOTAL incl. LULUCF</b>	<b>5952</b>	<b>8424</b>	<b>9278</b>	<b>9078</b>

Base year GHG emissions for Cyprus (1990) were estimated at 6091 Gg CO<sub>2</sub> eq. LULUCF emissions are not considered in estimating base year emissions for Cyprus. In 2011, GHG emissions (without LULUCF) amounted to 9154 Gg CO<sub>2</sub> eq. showing an increase of 50% compared to base year emissions. If emissions /removals from LULUCF were to be included then the increase would be 53%.

### Energy

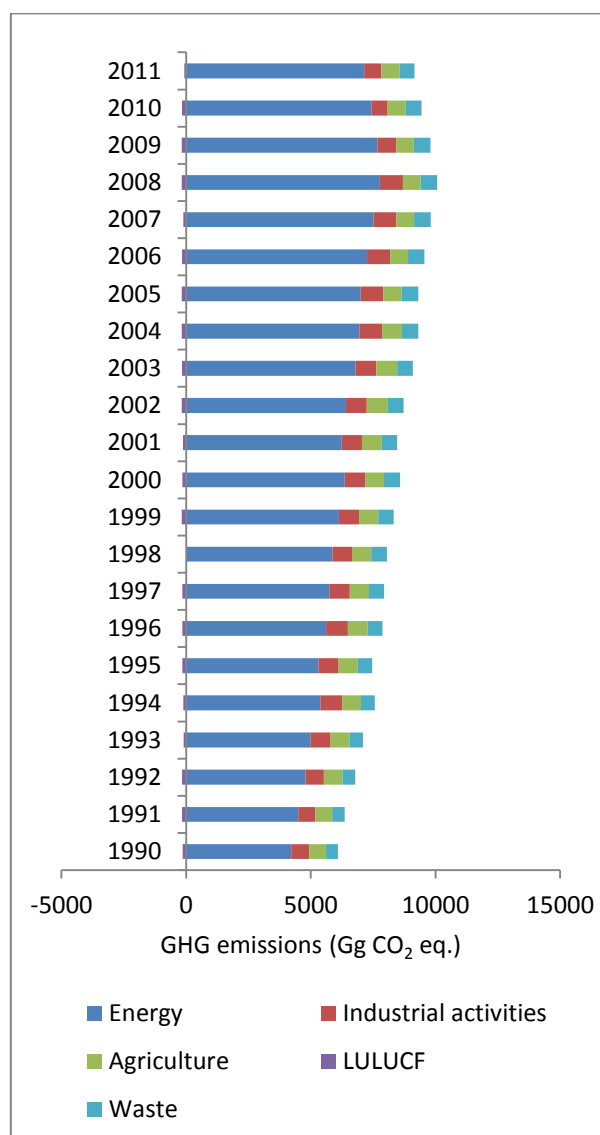
Emissions from Energy in 2011 accounted for 78% of total GHG emissions (without LULUCF) and increased by 69% compared to 1990 levels. After robust growth rates in the 1980s (average annual growth was 6.1%), economic performance in the 1990s was mixed: real GDP growth was 9.7% in 1992, 1.7% in 1993, 6.0% in 1994, 6.0% in 1995, 1.9% in 1996 and 2.3% in 1997. This pattern underlined the economy's vulnerability to swings in tourist arrivals (i.e., to economic and political conditions in Cyprus, Western Europe, and the Middle East) and the need to diversify the economy. This behaviour of economic growth was also reflected in the emission trends.

The majority of energy related GHG emissions (52.2%) in 2011 was derived from energy industries, while the contribution of transport, manufacturing industries and construction and other sectors is estimated at 32%, 7.2% and 8.9% respectively. The substantial increase of GHG emissions from road transport is directly linked to the increase of vehicles fleet but also to the increase of transportation activity. The renewal of the passenger car

fleet and the implied improvement of energy efficiency, limit the increase of GHG emissions. The implemented, adopted and planned measures for the improvement of public transport are expected to moderate the high use of passenger cars.

### Agriculture

Emissions from Agriculture accounted for 8% of total emissions in 2011 (without LULUCF), and increased by approximately 7% compared to 1990 levels. The peak of Agriculture emissions was in 2002 when an increase of 26% compared to 1990 was observed. Since 2002 a reduction in emissions was observed, due to the reduction of N<sub>2</sub>O emissions from agricultural soils, because of the reduction in the use of synthetic nitrogen



**Figure E1. Contribution of activity sectors to total GHG emissions during the period 1990-2011 (including LULUCF)**



fertilizers. The reduction of the use of fertilisers was caused by the drought that was taking place during the same period that had an extreme in 2008. Further reduction was caused by the recent changes in manure management and the reduction in the animal population.

### Waste

Emissions from the Waste Sector in 2011 contributed 6% of the total emissions (without LULUCF). Even though waste management of both liquid and solid wastes improved significantly since 1990, due to the increase in population and solid waste production per capita due to the changes in social conditions, the emissions of the sector increased by 26% between 1990 and 2011.

### Land Use, Land Use Change and Forestry

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 about 1% of the total national emissions (without LULUCF). The magnitude of this sink decreased from approximately 139 Gg CO<sub>2</sub> eq. in 1990, to 76 Gg CO<sub>2</sub> eq. in 2011, i.e. a decrease of 45%. Even though during 2011 there was an increase of the area covered with forests by 211 ha, the CO<sub>2</sub> balance is reduced due to a large wildfire (1974 ha burnt).

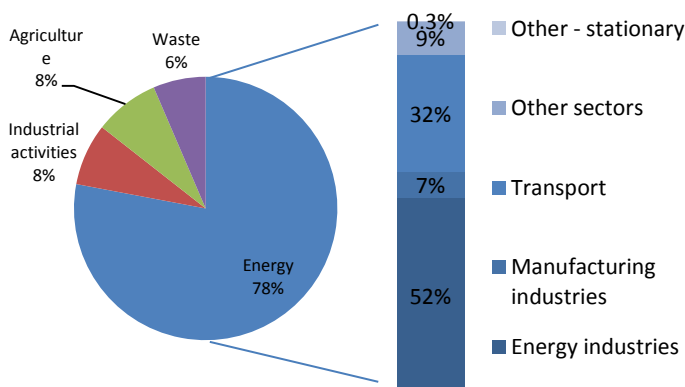


Figure E2. Relative contribution of activity sectors to total GHG emissions in 2011 excluding LULUCF

### Institutional arrangements

The Ministry of Agriculture, Natural Resources and Environment (MANRE) is the governmental body responsible for the development and implementation of the majority of the environmental policy in Cyprus. The MANRE is responsible for the co-ordination of all involved ministries, as well as any relevant public or

private organisation, in relation to the implementation of the provisions of the European legislation associated with climate change.

In this context, the MANRE has the overall responsibility for the national GHG inventory, and the official preparation and approval of the inventory prior to its submission<sup>1</sup>. The Figure below provides an overview of the organisational structure of the National Inventory System. The entities participating are:

- The MANRE, designated as the national entity responsible for the national inventory, which keeps the overall responsibility, plays an active role in the inventory planning, preparation and management, and also compiles the annual inventory.
- Governmental ministries and agencies, and non-governmental organisations through their appointed focal persons, ensure the data provision.

No legal framework is available defining the roles-responsibilities and the co-operation between the MANRE and contact points of the involved ministries and agencies.

### Quality assurance/quality control (QA/QC) procedures

A QA/QC system is being implemented since the May 2007. The MANRE is responsible for the implementation of the QA/QC system. The system has the following objectives:

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

### Methodology and data

The preparation of the Cypriot 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

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compilation of the inventory is completed in three main stages.

**Stage 1:** The first stage consists of data collection and checks for all source / sink categories. The main data sources used are the National Statistical Service, the national energy balance, the government ministries / agencies involved, 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. National Statistical Service, ETS reports and energy balance) 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 entering the data in the CRF Reporter.

**Stage 3:** The last stage involves the compilation of the NIR and its internal check. During this period, the

Inventory Team has to revise the report according to the observations and recommendations of the supervisor of the team. On the basis of this interaction process, the final version of the report is compiled. The Director of the Department of Environment approves the inventory and then the MANRE submits the NIR.

Data from all the involved parties come in MS Excel spread-sheets. The main database maintained by the inventory compiler is also in the form of MS Excel spread-sheets. The collected data is transferred to the main database of the inventory compiler. No special software is used or applied for processing or storage of the data used in the inventory. The inventory compiler has one MS Excel spread-sheet containing all the data collected and one MS Excel spread-sheet containing the calculations performed for the estimation of the GHGs emissions.

### National registry

The national registry of Cyprus is limited to the EU-ETS. For this, Cyprus cooperates with the member states of the European Union and the registry of the European Community (CITL).

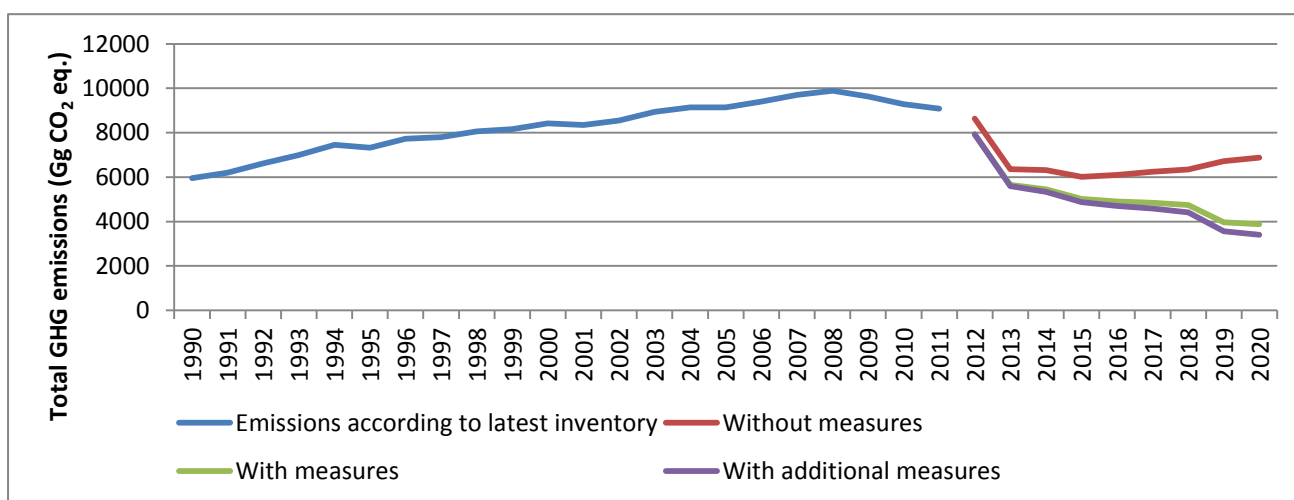


Figure E3. GHG emissions projections

## POLICIES AND MEASURES

The national policies are prepared, updated, monitored and updated by the Ministry of Agriculture, Natural Resources and Environment, in collaboration with the responsible ministry for each measure or policy. Currently, the main focus of the policy related to reduction of greenhouse gas emissions is energy. Energy in 2011 accounted for 78% of total GHG emissions (without LULUCF) and increased by 69% compared to 1990 levels. The sector of energy for which most measures are implemented is energy production.

### Policy making process

The Ministry of Agriculture, Natural Resources and Environment is the main governmental body entrusted with the development and implementation of environmental policy in Cyprus. MANRE 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, MANRE 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 Cypriot strategy for sustainable development launched by MANRE in 2007. 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 with other involved ministries.

### Policies & measures: existing situation

Policies and measures currently in implementation are presented in the Table below. The contribution of each measure is estimated for the total of the GHG emissions of the relevant sector. The impact to each GHG is according to the contribution of the GHG to the total sectoral emissions in the latest inventory (NIR2013).

## PROJECTIONS

Three scenarios are available for the projection of GHG emissions: “without measures” or “business as usual” (BaU), “with measures” or “with existing measures” (WEM) and a “with additional measures” (WAM). Projections are prepared for 2015 and 2020. The “without measures” scenario assumes that no emission reduction policies are implemented. 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” scenarios assume the implementation of additional policies (planned).

The effect of currently implemented and adopted policies and measures (that is incorporated in the “with measures” projections scenario) is presented in Table E4 in terms of GHG emissions avoided on a CO<sub>2</sub> equivalent basis, while the effect of planned policies and measures is illustrated in Table E5. 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 GHG emissions avoided, correspond mainly to CO<sub>2</sub> (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 CH<sub>4</sub>, while in the agriculture sector about 70% to N<sub>2</sub>O and 30% to CH<sub>4</sub>.

**Table E2. Policies and measures included in the “With Measures” scenario**

	2015	2020
<b>A. Energy*</b>		
1. Natural Gas		16TJ for electricity
2.1. RES-Electricity	5.5% of electricity	12.4% of electricity
2.2. RES-Heating/ cooling	0.76% of electricity 13% of thermal & cooling	0.82% of electricity 15% of thermal & cooling
2.3. RES-Transport	2.6% of transport	4.0% of transport
3.1. Savings from energy efficiency in residential buildings	12% of electricity 0.6% of thermal & cooling	24% of electricity 1.2% of thermal & cooling
3.2. Savings from energy efficiency in tertiary buildings	1.7% of electricity 0.08% of thermal & cooling	3.4% of electricity 0.18% of thermal & cooling
3.3. Savings from efficient bulbs	3.2% of electricity	2% of electricity
3.4. Savings from housing insulation	1.7% of electricity 0.08% of thermal & cooling	1.5% of electricity 0.08% of thermal & cooling
3.5. Savings in existing companies	2.1% of electricity 0.1% of thermal & cooling	1.3% of electricity 0.07% of thermal & cooling
4. Improvement of production and distribution systems	0.14% of electricity	0.12% of electricity
5. Promotion of waste to energy in industry	3.6%	3.8%
<b>B. Transport*</b>		
1. Promotion of public transport	1.9% of transport	4.4% of transport
2. Promotion of low CO <sub>2</sub> vehicles	2% of transport	5% of transport
<b>C. Waste</b>		
1. Methane recovery from managed waste disposal sites	10% of biogas collected	70% of biogas collected
2. Management of unmanaged waste disposal sites	20% of biogas collected	60% of biogas collected
3. Promotion of anaerobic digestion - sewage sludge	0.03 Gg CO <sub>2</sub> eq. reductions	0.05 Gg CO <sub>2</sub> eq. reductions
<b>D. Agriculture</b>		
1. Promotion of anaerobic digestion – animal waste	0.06 Gg CO <sub>2</sub> eq. reductions	0.085 Gg CO <sub>2</sub> eq. reductions

**Table E3. Policies and measures included in the “With Additional Measures” scenario**

	2015	2020
<b>A. Energy*</b>		
1. Natural Gas		16TJ for electricity
2.1. RES-Electricity	8.4% of electricity	16% of electricity
2.2. RES-Heating/ cooling	0.8% of electricity 14% of thermal & cooling	0.9% of electricity 16% of thermal & cooling
2.3. RES-Transport	2.96% of transport	4.76% of transport
3.1. Savings from energy efficiency in residential buildings	20% of electricity 0.9% of thermal & cooling	33% of electricity 1.7% of thermal & cooling
3.2. Savings from energy efficiency in tertiary buildings	8% of electricity 0.4% of thermal & cooling	15% of electricity 0.8% of thermal & cooling
3.3. Savings from efficient bulbs	3.7% of electricity	1.8% of electricity
3.4. Savings from housing insulation	3.0% of electricity 0.14% of thermal & cooling	3.6% of electricity 0.18% of thermal & cooling
3.5. Savings in existing companies	3.5% of electricity 0.2% of thermal & cooling	3.2% of electricity 0.2% of thermal & cooling
4. Improvement of production and distribution systems	0.1% of electricity	0.1% of electricity
5. Promotion of waste to energy in industry	4.1%	4.3%
<b>B. Transport*</b>		
1. Promotion of public transport	6% of transport	11% of transport
2. Promotion of low CO <sub>2</sub> vehicles	2% of transport	7% of transport
<b>C. Waste</b>		
1. Methane recovery from managed waste disposal sites	10% of biogas collected	80% of biogas collected
2. Management of unmanaged waste disposal sites	30% of biogas collected	70% of biogas collected
3. Promotion of anaerobic digestion - sewage sludge	0.06 Gg CO <sub>2</sub> eq. reductions	0.11 Gg CO <sub>2</sub> eq. reductions
<b>D. Agriculture</b>		
1. Promotion of anaerobic digestion – animal waste	0.12 Gg CO <sub>2</sub> eq. reductions	0.17 Gg CO <sub>2</sub> eq. reductions

\* all reductions are in fuel consumption

Table E4. Effect of currently implemented and adopted policies and measures (Gg CO<sub>2</sub> eq.)

Policies and Measures	2015	2020
<b>A. Energy</b>	<b>877</b>	<b>2543</b>
1. Natural Gas	0	887
2.1. RES-Electricity	144	373
2.2. RES-Heating/ cooling	77	99
2.3. RES-Transport	40	69
3.1. Savings from energy efficiency in residential buildings	365	841
3.2. Savings from energy efficiency in tertiary buildings	45	104
3.3. Savings from efficient bulbs	85	60
3.4. Savings from housing insulation	46	45
3.5. Savings in existing companies	58	45
4. Improvement of production and distribution systems	4	4
5. Promotion of waste to energy in industry	14	16
<b>B. Transport</b>	<b>60</b>	<b>162</b>
1. Promotion of public transport	30	77
2. Promotion of low CO <sub>2</sub> vehicles	30	85
<b>C. Waste</b>	<b>42</b>	<b>281</b>
1. Methane recovery from managed waste disposal sites	30	241
2. Management of unmanaged waste disposal sites	12	40
3. Promotion of anaerobic digestion - sewage sludge	0.01	0.03
<b>D. Agriculture</b>	<b>0.03</b>	<b>0.06</b>
1. Promotion of anaerobic digestion – animal waste	0.03	0.06
<b>TOTAL</b>	<b>979</b>	<b>2986</b>

Table E5. Effect of planned policies and measures (Gg CO<sub>2</sub> eq.)

Policies and Measures	2015	2020
<b>A. Energy</b>	<b>986</b>	<b>2870</b>
1. Natural Gas	0	887
2.1. RES-Electricity	144	373
2.2. RES-Heating/ cooling	77	99
2.3. RES-Transport	40	69
3.1. Savings from energy efficiency in residential buildings	347	808
3.2. Savings from energy efficiency in tertiary buildings	131	361
3.3. Savings from efficient bulbs	85	60
3.4. Savings from housing insulation	66	96
3.5. Savings in existing companies	80	97
4. Improvement of production and distribution systems	2	3
5. Promotion of waste to energy in industry	14	16
<b>B. Transport</b>	<b>89</b>	<b>273</b>
1. Promotion of public transport	60	153
2. Promotion of low CO <sub>2</sub> vehicles	30	119
<b>C. Waste</b>	<b>0.24</b>	<b>0.84</b>
1. Methane recovery	0.07	0.38
2. Management of uncontrolled disposal sites	0.14	0.39
3. Promotion of anaerobic digestion - sewage sludge	0.03	0.07
<b>D. Agriculture</b>	<b>0.06</b>	<b>0.12</b>
1. Promotion of anaerobic digestion – animal waste	0.06	0.12
<b>TOTAL</b>	<b>1076</b>	<b>3144</b>

## IMPACTS, VULNERABILITY AND ADAPTATION

Cyprus as an arid and semi-arid island of the Mediterranean region is already affected by climate changes and their adverse impacts in several sectors of its economy. During the last century it has been observed that the climate of the island changed with precipitation reducing at a rate of 1mm per year, where the mean temperature increased by 0.5°C. The reduction in precipitation and the increase of the temperature had an adverse impact on the availability of the natural water resources, which were reduced by 40% from the estimates made in 1970. Extreme climatic phenomena are more frequent than before, with droughts causing water shortage and scarcity, and adverse effects on the economy, the social life and the environment. The unsustainable depletion of groundwater caused by uncontrolled water pumping in many areas has led to sea intrusion into groundwater aquifers and to the deterioration of water quality that is pumped.

Climate change is expected to lead to further reduction of precipitation and temperature increase in the coming years which will result in higher evaporation and drier conditions. The unsustainable depletion of groundwater will likely be worsened by reduced surface water infiltration in the Mediterranean region. In addition, the increase in the intrusion of salt water to coastal aquifers from sea level rise will further reduce the availability of usable ground water. Agriculture and food security are expected to be threatened. Furthermore, the demand for water will increase with the increase in temperature and particularly crop water demand. With growing dependence on air conditioning, frequent heat waves during summer could result in increased demand for energy production and even cause loss of life if power supplies fail. Rural-to-urban migration is likely to increase under climate change conditions, as many rural livelihoods become less viable. Disease patterns are likely to change, making control more difficult. Climate change is expected to affect human health through increase in heat stroke mortality, tropical vector-borne diseases such as malaria, and urban air pollution.

In the coming years, Cyprus is not expected to become very vulnerable to sea flooding. Nevertheless the coastal zone of Cyprus is considered to be a valuable and vulnerable area. This zone, in which most urban development and economic activity takes place, covers

23% of the total country's area, 50% of total population as three out of four of Cyprus main cities and 90% of the tourism industry are located by the coastline. Moreover, a great percentage of the island's 'natural beauties' is also located near coastal areas. The most vulnerable part in this regard is the low-lying region of Larnaca located at the south coast of the island. Erosion constitutes a greater threat than flooding especially for the sandy and gravel beaches of the island. At the moment, 38% of the coastline is already subject to erosion, mostly the result of human activities such as beach mining, dam and illegal breakwater construction and urbanisation. With a sea level rise, the problem of erosion could be exacerbated in these areas, inducing safety threats for infrastructures such as Larnaca airport, desalination stations, and power plants, increasing dangers arising from potential storm surges, and increasing the economic demand for coastal defences. Low-lying areas will be significantly prone to sea level rise impacts and will be threatened with inundation risk and greater exposure to storms

Taking into consideration the current and expected adverse impacts of climate change in Cyprus, it is essential that, in addition to emission reduction (mitigation) measures, adaptation measures must be identified and applied in order for natural as well as human systems to develop adequate adaptive responses to avoid the risks posed by climate change. Moreover, adaptation will contribute towards the enhancement of social and economic activities viability, the reduction of their vulnerability and the elimination, at the degree possible, of extreme climatic phenomena. Therefore, it is important to plan for adaptive strategies at national level and work towards strengthening national capacities in order for Cyprus to be able and prepared to respond to the adverse impacts of climate change.

The preparation of the adaptation strategy of the country has started, through a 50% EU funded project "CYPADAPT". It is anticipated that the strategy will be complete in early 2014.

## FINANCIAL RESOURCES AND TRANSFER OF TECHNOLOGY

Cyprus was a non-Annex I party to the UNFCCC until 1/1/2013 and a non-Annex B party to the Kyoto Protocol. Consequently, Cyprus had no obligations to allocate financial resources for assistance to developing country parties that are particularly vulnerable to climate change.

Nevertheless, in 2009, along with the rest of the member states of the EU, Cyprus committed to provide finance for climate change to developing countries.

### **Provision of new and additional resources**

CyprusAid is the Development Cooperation Service of the Republic of Cyprus, established in its current form by the Council of Ministers in 2005. CyprusAid functions within the framework of a policy making mechanism that has been put in place in order to steer Cyprus' Official Development Assistance. This policy mechanism is one that retains a high degree of centralisation in the decision making process, while at the same time allows for a more decentralized approach in the aid delivery arrangements. The mechanism comprises of a Coordination Body (CB) headed by the Minister of Foreign Affairs and having the Minister of Finance and the Permanent Secretary of the Planning Bureau as members. The CB is responsible for the setting of targets (quantitative, territorial and sectoral) on the basis of international obligations, EU policy recommendations and national priorities. The Planning Bureau is responsible for the preparation of policy preparation, as well as the management and implementation of the decisions of the CB while the MFA is responsible for representing the Republic abroad and also for publicizing the Republic of Cyprus ODA activities. A second body, headed by the Permanent Secretary of the Ministry of Foreign Affairs (MFA) and comprised of representatives of the Ministries of Finance, Commerce, Industry and Tourism, Agriculture, Natural Resources and Environment, Labour and Social Insurance, Education and Culture and the Planning Bureau, as well as representatives of civil society, acts in a consultative capacity to the Coordination Body.

According to the relevant EU ministerial decision and the necessary decision from the national council of ministers, Cyprus was going to provide €1.8 million as fast start finance. The amount was new and additional. The €1.8 million were going to be given in three years 2010-2011-2012, €0.6 million annually. Funding was provided for the years 2010 and 2012.

### **Assistance to developing country Parties that are particularly vulnerable to climate change**

CyprusAid after studying options funds and organizations implementing projects on climate change, and with the consent of the Ministry of Finance promoted cooperation with the "Global Climate Change Alliance-GCCA", a

funding mechanism coordinated by the European Commission. This mechanism acts as an intermediary / coordinator for contributions and projects to tackle climate change. The choice of "GCCA" as a means of disposing of contribution of Cyprus based on that provides recognition to donors. Furthermore, the "GCCA" is an initiative of the European Commission and the substantial and political support of Member States in this, strengthens and makes this mechanism valuable in the international arena on climate change. Moreover, GCCA focuses climate support on LDCs and SIDS.

## **RESEARCH AND SYSTEMATIC OBSERVATION**

Until the early nineties, research activities in Cyprus were quite limited, not only by international standards, but also in relation to the comparatively high level of development of the Cyprus economy. Despite the high educational level of the population, the absence of a local University impeded the development of research. In addition, the small size of enterprises also acted as a serious constraint to the development of research activity in Cyprus.

Apart from the establishment of the University of Cyprus in 1992, several steps have been taken towards the upgrading of research activities. The most significant ones are:

- the establishment of the Research Promotion Foundation in 1996. RPF is a non-profit organisation established by the Government with the mission to develop, implement and manage all national research programmes.
- the expansion of research activities of internationally recognised research organisations of Cyprus, namely, the Institute of Neurology and Genetics, the Agricultural Research Institute and the State General Laboratory.
- the establishment of Cyprus University of Technology in September 2007, and of the Cyprus Institute in September 2007
- the establishment of the new research institutions, the 3 biggest private colleges of Cyprus upgraded into Universities in 2007.

Almost all higher academic institutions in Cyprus have research in all fields of climate change, including climate modelling and forecast, adaptation and impacts and

particularly mitigation. Research is funded by national and EU financial resources.

Systematic observation takes place through the measurements of meteorological parameters, ground level pollutants, observation System on quantity/quality of surface water and several research programmes related to marine monitoring parameters. Moreover, Cyprus participates to the EU satellite programmes GMES and Copernicus, and the European Space Agency, through which several parameters related to climate change are monitored.

## EDUCATION, TRAINING AND PUBLIC AWARENESS

Climate change in the context of formal and non - formal education is an issue of interdisciplinary investigation and interconnected with all the issues of environment and sustainable development as a matter of national, regional and international interest. The consideration of climate change in this context relies on the fact that climate change is not a mono-dimensional problem, cut off from the rest of the issues, but could be the apparent cause and consequence of a chain of direct and indirect human effects on all environmental issues. Within this context

the issue of climate change is examined and treated in the following ways in the Cypriot educational system.

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, Cyprus has posed legal obligations for the access of information regarding the state of the Environment. In addition, law no. 119(I)/2004 by which Cyprus 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 law, “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 Cypriot 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.



## 1. INTRODUCTION

This document represents the sixth National Communication (NC) of Cyprus, required under the United Nations Framework Convention on Climate Change (UNFCCC), as reaffirmed by UNFCCC decision 9/CP.16 and UNFCCC decision 2/CP.17. It provides a comprehensive overview of climate change related activity at national level.

As defined in the UNFCCC reporting guidelines for National Communications, the information is structured into:

- National circumstances relevant to greenhouse gas emissions and removals (section 2),
- Greenhouse gas inventory information (section 3),
- Policies and measures (section 4),
- Projections and the total effects of policies and measures (section 5),
- Vulnerability assessment, climate change impacts and adaptation measures (section 6),
- Financial resources and transfer of technology (section 7),
- Research and systemic observation (section 8) and
- Education, training and public awareness (section 9)

Supplementary information required under Article 7, paragraph 2, of the Kyoto Protocol and additional information related to assigned amount units are not submitted because Cyprus was not an Annex B party during the first commitment period of the Kyoto Protocol.

Following provisions of decision 2/CP.17 developed country Parties are requested to submit their first biennial report (BR1) to the secretariat by 1 January 2014. They have two options to report information in the BR1: Parties could present the BR1 as an annex to the NC or as a separate report. The BR1 of Cyprus is presented as an annex to the NC.

As part of the preparation of these reports a consultation was held during December 2013. This invited feedback from involved national organisation with a relationship to the climate change issues, to help enhance the quality of the NC.

This communication focuses to the years for which data is available; i.e. until 2011.

## 2. NATIONAL CIRCUMSTANCES

### 2.1. INTRODUCTION

This chapter reports the national circumstances of the Republic of Cyprus. It illustrates a number of key characteristics that relate directly or indirectly to the greenhouse gas emissions and include energy, transport, land use, climatic conditions and trade patterns. The chapter analyses how these various factors have influenced greenhouse gas emissions to-date and how the historic trends observed might influence emissions going forward.

This communication focuses to the years until 2011.

The Ministry of Agriculture, Natural Resources and Environment is the governmental body with the overall responsibility for the preparation, approval and submission of national communications (Contact persons: Dr Theodoulos Mesimeris and Ms Nicoletta Kythreotou, National UNFCCC focal points). Experts from governmental and non-governmental institutions participated in the preparation of the present national communication as information providers.

### 2.2. GEOGRAPHIC PROFILE

Cyprus is an island country, located in the eastern end of the Mediterranean Sea, and the third largest island in the Mediterranean Sea, after the Italian islands of Sicily and Sardinia (both in terms of area and population). The total area of the island is 9,251 km<sup>2</sup>. It measures 240 km long and 100 km wide at its widest point. It lies between latitudes 34° and 36° N, and longitudes 32° and 35° E.

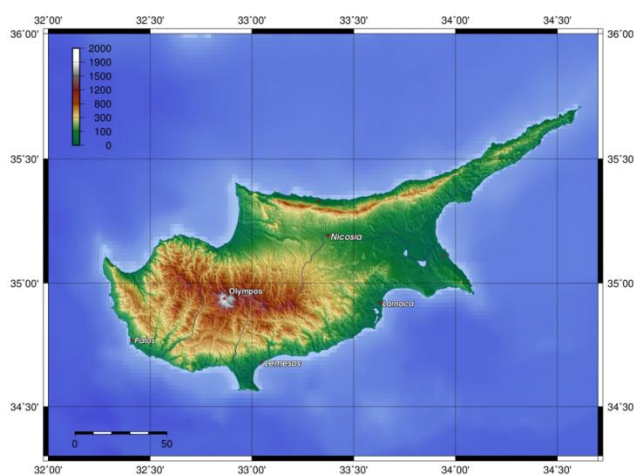


Figure 2.1. Topographic map of Cyprus

The physical relief of the island is dominated by two mountain ranges, the Troodos Mountains and the smaller Kyrenia Range, and the central plain they encompass, the Mesaoria. The Mesaoria plain is drained by the Pedieos River, the longest on the island. The Troodos Mountains cover most of the southern and western portions of the island and account for roughly half its area. The highest point on Cyprus is Mount Olympus at 1,952 m, located in the centre of the Troodos range. The narrow Kyrenia Range, extending along the northern coastline, occupies substantially less area, and elevations are lower, reaching a maximum of 1,024 m.

### 2.3. GOVERNMENT STRUCTURE

Cyprus is an independent sovereign Republic with a presidential system of government. The constitution provides for separate executive, legislative and judicial branches of government with independent powers. The President is both Head of State and Government.

#### Presidency

According to the 1960 Constitution, the President is to be Greek Cypriot elected directly by the Greek Cypriot community and the Vice-President is to be Turkish Cypriot elected directly by the Turkish Cypriot community, for a five-year term of office. The Constitution provides that executive power is exercised jointly by the President and the Vice-President, through a Council of Ministers appointed by them (seven and three ministers respectively).

Both the President and the Vice-President have the right of final veto on decisions of the Council of Ministers and laws or decisions of the House of Representatives concerning foreign affairs, defence and security. In 1964, however, the Turkish Cypriot Vice-President and the three Turkish Cypriot ministers withdrew from the government and since then the government has been functioning by necessity only with Greek Cypriots in all ministries, which have been subsequently increased to eleven. The post of Vice-President remains vacant.

The ministries are the following: Ministry of Defence, Ministry of Agriculture, Natural Resources and Environment, Ministry of Justice and Public Order, Ministry of Energy, Commerce, Industry and Tourism, Ministry of Foreign Affairs, Ministry of Labour and Social Insurance, Ministry of Interior, Ministry of Finance,

Ministry of Education and Culture, Ministry of Communications and Works, Ministry of Health.

### Council of Ministers

The Council of Ministers exercises executive power in all matters. Each Minister is the head of his or her Ministry and exercises executive power on all matters within that Ministry's domain. The Government Spokesman and the Deputy Minister to the President are also present at the meetings of the Council of Ministers. The Ministers are appointed by the President. The ministries mainly prepare and implement national laws.

### Local Authorities

Cyprus is separated into 6 districts: Nicosia (Lefkosa), Limassol (Lemesos), Pafos, Larnaca, Ammochostos and Keryneia (Figure 2.2). Each district has a District Officer, who reports to the Minister for the Interior. Keryneia are not under the effective control of the Republic of Cyprus, whereas Ammochostos is partially under the effective control of the Republic of Cyprus.

There are two types of local authorities: Municipalities and Communities, which are governed by separate laws. In principle, Municipalities constitute the form of local government in urban and tourist centres, while Communities constitute the local structure in rural areas. Mayors and Community Presidents are elected directly by the residents for a five-year term.

Any Community may become a Municipality by local referendum subject to the approval of the Council of Ministers, provided it has either a population of more than 5,000, or has the economic resources to function as a Municipality. The main responsibilities of Municipalities are the construction, maintenance and lighting of streets, the collection, disposal and treatment of waste and environmental protection and improvement. The functions of Communities are generally similar to those of Municipalities, although structurally different. The government provides to most Communities essential administrative and technical assistance through its District Offices.

Currently, there are 39 municipalities and 485 communities, of which 9 and 132 respectively are not under the effective control of the Republic of Cyprus.

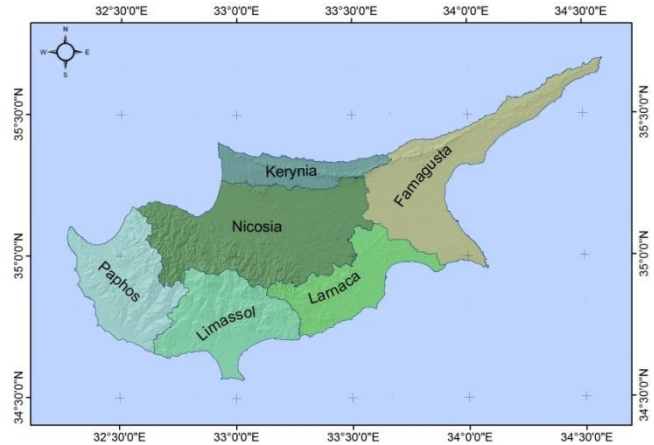


Figure 2.2. The six administrative districts of Cyprus

### Legislature

#### House of Representatives

Legislative authority is exercised by a unicameral House of Representatives. Its members are elected for a five-year term. At the time of its establishment the House consisted of 50 members, 35 of whom were to be Greek Cypriots and 15 Turkish Cypriots. In 1985 the number of seats was increased to 80, 56 allocated to Greek Cypriot members and 24 reserved for Turkish Cypriot deputies. Following the withdrawal of the Turkish Cypriot members in 1964, the House has been functioning only with the Greek Cypriot members.

The Maronite, Armenian and Latin religious groups, which vote as part of the Greek Cypriot community, elect one additional representative each from their ranks. These non-voting representatives attend meetings, but do not participate in the House deliberations. They are consulted on issues of particular interest to their respective group.

Given the vacancy in the Vice- President's office, the House President serves as Acting President of the Republic in the case of temporary absence or temporary incapacity of the President of the Republic.

### Judiciary

The administration of justice is exercised by the Republic's separate and independent judiciary. Under the 1960 Constitution and other legislation in force, the following judicial institutions have been established: The Supreme Court, The Assize Courts and District Courts.

### Independent Officers and Bodies

There are also independent officers and bodies which do not come under any ministry, including the: Attorney-General and Auditor-General who head the Law Office and Audit Office respectively; Governor of the Central Bank; Ombudsman (Commissioner for Administration); Public Service Commission; Education Service Commission; Planning Bureau; Treasury; Commission for the Protection of Competition; Commissioner of Electronic Communications and Postal Regulation; Commissioner for Personal Data Protection; Commissioner for the Protection of Children's Rights; Law Commissioner; Commissioner for the Environment; Commissioner for the Reform of the Civil Service; Commissioner for Humanitarian Affairs; Commissioner for Volunteering and Nongovernmental Organisations; Tenders Review Authority; Internal Audit Service; Cyprus Radio Television Authority; Cyprus Securities and Exchange Commission.

### **Member of the European Union**

On 1 May 2004 the Republic of Cyprus became a full member of the EU. Accession to the EU was a natural choice for Cyprus, dictated by its culture, civilisation, history, its European outlook and adherence to the ideals of democracy, freedom and justice.

The application of the EU laws and regulations (the *acquis communautaire*) is suspended in the area under military occupation by Turkey, pending a solution to the occupation and forcible division of the country. Meanwhile, the government, in cooperation with the EU Commission, has been promoting arrangements to facilitate increased economic transactions between the two communities and improve the standard of living of Turkish Cypriots, who are also victims of Turkey's military aggression against Cyprus.

While Cyprus has a lot to benefit from EU membership, it also has a lot to offer as a member state. Strategically situated at the crossroads of Europe, the Middle East, North Africa and Asia, Cyprus is becoming an even more important regional business centre, as well as an international communications and transport hub. It is also a prospective energy (natural gas) provider for Europe.

Given its modern infrastructure, sound legal system, tax incentives, low crime rate and well educated labour force, Cyprus is a favourite regional operations platform for European and other international companies.

Since its accession to the EU, Cyprus has undergone significant structural reforms that have transformed its economic landscape. Trade and interest rates have been liberalised, while price controls and investment restrictions have been lifted. Private financing has been introduced for the construction and operation of major infrastructure projects and monopolies have been abolished.

The new political context created by the accession to the EU is also expected to impact positively on the efforts to reach a comprehensive settlement to the division of Cyprus that will reunite its people and reintegrate its economy.

Cyprus held the Presidency of the Council of the European Union for the first time from July – December 2012. During this period an agreement on the Unitary Patent Package and on the Single Supervisory Mechanism (SSM) was reached, negotiations for a Free Trade Agreement with Japan were launched, while the same negotiations with Singapore were completed. Significant progress was also achieved on the Multiannual Financial Framework and the Common European Asylum System.

## **2.4. POPULATION<sup>2</sup>**

In general, aggregate increases in population are drivers for increasing consumption, energy use and greenhouse gas emissions.

The population of Cyprus is estimated at 952.1 thousand at the end of 2011 compared with 929.5 thousand the previous year, showing an increase of 2.4%. After the Turkish invasion of July-August 1974 the total population experienced negative growth up to mid-1977, through war losses, emigration and fertility decline. In the following years, demographic developments favoured population growth. However, the overall growth conceals pronounced differences between the population in the Government controlled area and the Turkish Cypriot community in the areas of the Republic of Cyprus in which the Government of the Republic of Cyprus does not exercise effective control. While the population in the Government controlled area increased gradually since 1977 at a rate which ranged between 0.7% and

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<sup>2</sup> Information on population was obtained from the publication: Demographic Report 2010 & 2011 (Statistical Service, 2012)

2.7%, in the areas of the Republic of Cyprus in which the Government of the Republic of Cyprus does not exercise effective control, on the contrary, the Turkish Cypriot community has been decreasing since 1986. This difference in the population growth is exclusively due to migration movements, since both the fertility and mortality of Turkish Cypriots are similar to those of the rest of the Cyprus population.

Total population figures do not include illegal settlers from Turkey, the number of which most probably is in the range of 160-170 thousands, estimated on information of significant arrivals of Turks in the occupied area.

The population in the government controlled area of Cyprus was estimated at 862 thousand at the end of 2011, compared to 587.1 thousand in 1990, recording an increase of 46.8%. The share of urban population was 67.4% in 2011 as compared to 67.5% in the previous year. The number of households in 2011 was 309.3 thousand, recording an increase of 3.1% compared to 2010, whilst the average household size showed a gradual decrease during the years, reaching 2.77 at the end of 2011.

The population density at the end of 2011 for the government controlled area of Cyprus was 103 inhabitants/km<sup>2</sup>. Cyprus has a relatively high population density when compared to other Parties to the UN Convention. As higher population densities have implications for settlement and building patterns, this leads to differences in energy consumption and a tendency for shorter transport distances. However, shorter transport distances in turn facilitate economic integration among communities and regions, resulting in a tendency for higher transport intensity. So in this respect population density can have both a positive and negative impact on greenhouse gas emissions.

## 2.5. CLIMATE<sup>3</sup>

Cyprus has an intense Mediterranean climate with the typical seasonal rhythm strongly marked in respect of temperature, rainfall and weather generally. Hot and dry summers from mid-May to mid-October and mild, rainy,

rather changeable, winters from November to mid-March are separated by short autumn and spring seasons of rapid change in weather conditions.

The central Troodos massif, rising to 1951 metres and, to a less extent, the long narrow Kyrenia mountain range, with peaks of about 1,000 metres, play an important part in the climate of Cyprus. The predominantly clear skies and high sunshine amounts give large seasonal and daily differences between temperatures of the sea and the interior of the island which also cause considerable local effects especially near the coasts.

During the summer, the island is mainly under the influence of a trough of low pressure extending from the great continental thermal low centred over southwest Asia. It is a season of high temperatures with almost cloudless skies. Rainfall is almost negligible, but isolated thunderstorms sometimes occur which give rainfall amounting to less than 5% of the total in the average year.

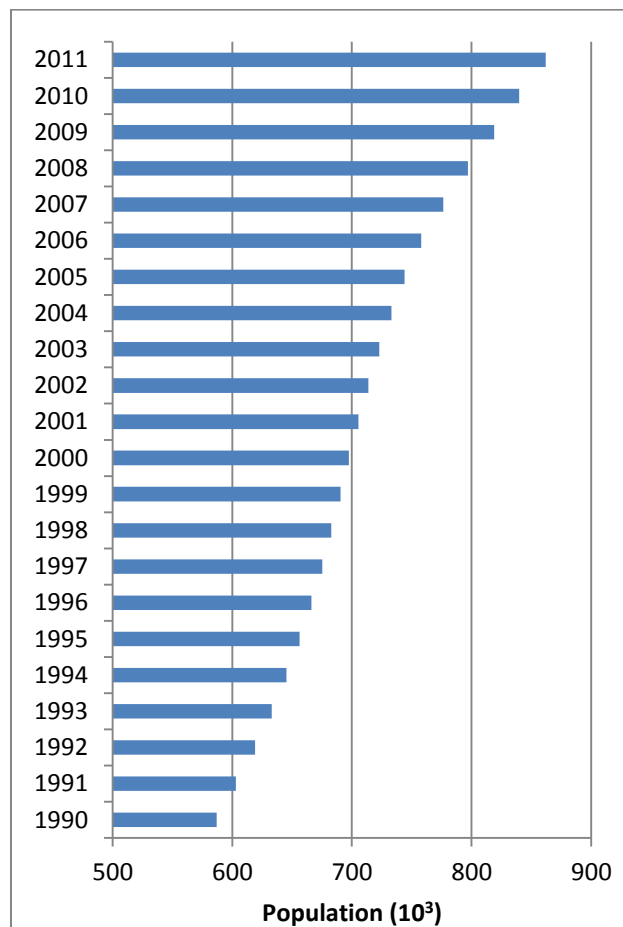


Figure 2.3. Population in the areas under the effective control of the Republic of Cyprus on 31<sup>st</sup> December of each year, 1990-2011<sup>1</sup>

<sup>3</sup> Mr. Panayiotis Michael, Met officer, Department of Meteorology, Nikis 28, 1086 Nicosia; Tel.: +35722802915; e-mail: mpanayiotis@ms.moa.gov.cy

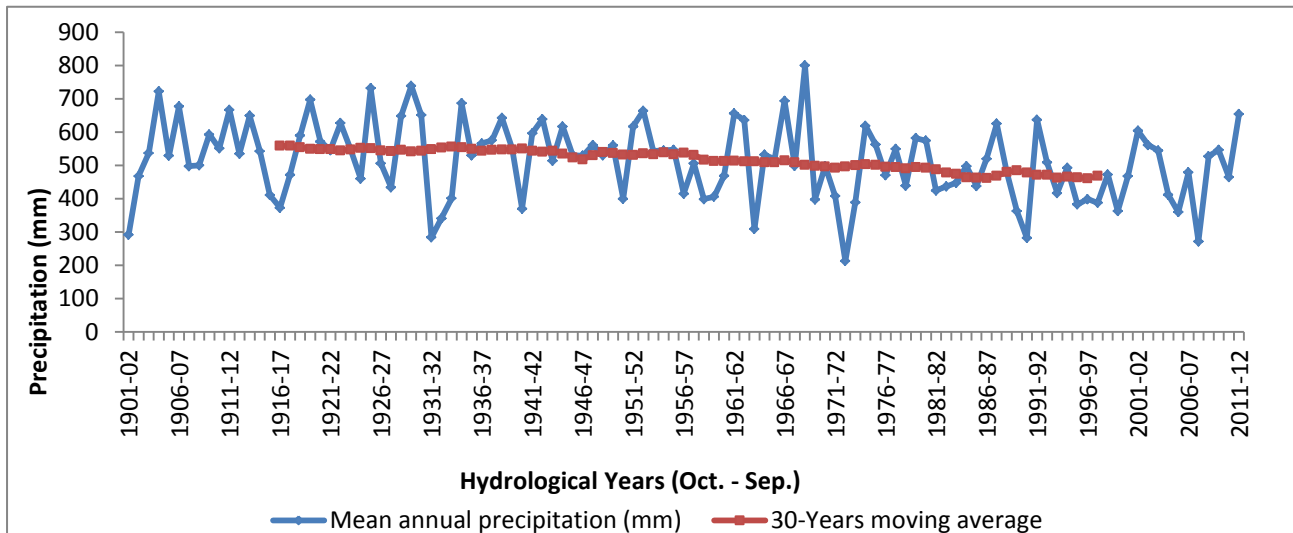


Figure 2.4. Mean annual precipitation in Cyprus 1901-02 – 2011-12 (normal 1961-90: 503 mm)

In winter Cyprus is near the track of fairly frequent depressions which mainly cross the Mediterranean Sea from west to east. These depressions give periods of unsaddle weather conditions usually lasting from two to five days and produce most of the annual precipitation. Snow occurs rarely in the lowlands and on the Kyrenia range, but falls frequently every winter on ground above 1,000 metres usually occurring by the first week in December and ending by the middle of April.

### Precipitation

The mean annual precipitation varies from year to year and from place to place. The lowest mean annual precipitation for Cyprus was 213mm in 1972-73 and the highest was 800mm in 1968-69. The mean annual precipitation for the period 1961-90 is 503mm. The wettest months are normally December, January and February and the driest are July, August and September.

Statistical analysis of rainfall in Cyprus reveals a decreasing trend of rainfall amounts in the last 110 years. Annual precipitation in Cyprus has on average decreased by about 100mm in the last 80 years (see Figure 2.4).

During the recent years, it has been observed that even though the total annual amount of rainfall does not change significantly, the annual distribution of rainfall has changed considerably, showing extreme rainfall years large amounts of rain alternating with periods of drought (Michaelides et al. 2009).

### Temperature

Cyprus has a hot summer and mild winter, but this generalization must be modified by consideration of altitude, which lowers temperatures by about 5°C per 1,000 metres and of marine influences which give cooler summers and warmer winters near most of the coastline and especially on the west coast.

The annual mean temperature for Cyprus varies from year to year, from 16.1°C to 19.7°C, with an average of 17.5°C. The year 2010 was the warmest ever recorded in Cyprus. The years 1961, 1965 and 1967 were the coldest in the last 62 years.

The seasonal difference between mid-summer and mid-winter temperatures is quite large at 18°C inland and about 14°C on the coasts. Differences between day maximum and night minimum temperatures are also quite large especially inland in summer. These differences are in winter 8 to 10°C on the lowlands and 5 to 6°C on the mountains increasing in summer to 16°C on the central plain and 9 to 12°C elsewhere.

The average annual temperature in Cyprus, both in urban and in rural areas, presents an increasing trend. The greater increase in temperature in the towns is due to the urbanization effect, however, the fact that an increase is also observed in rural areas, it is indicative of the general increase in temperature in our area as well as globally. In Nicosia the average annual temperature increased from 18.9°C in the first 30-year period of the century to 20°C in the last 30-year period, an increase of 1.1°C (see figure below).

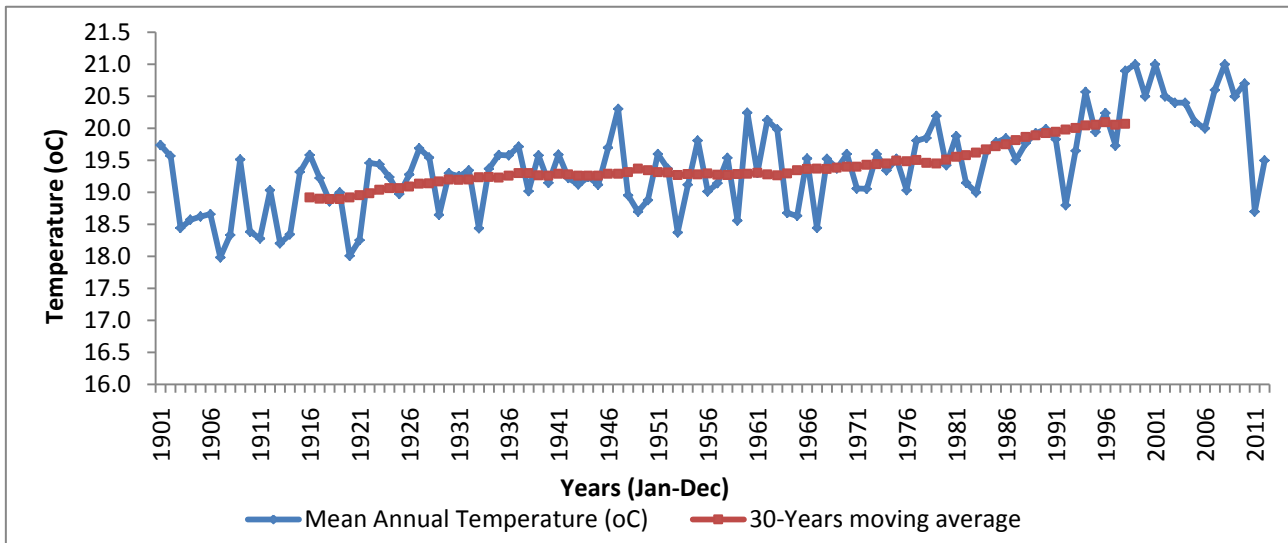


Figure 2.5. Mean annual temperature for Nicosia 1901-2012 (normal 1961-90: 19.5 °C)

## Wind

Over the eastern Mediterranean generally surface winds are mostly westerly or south-westerly in winter and north-westerly or northerly in summer. Usually of light or moderate strength, they rarely reach gale force.

Over the island of Cyprus however winds are quite variable in direction with orography and local heating effects playing a large part in determination of local wind direction and strength. Temperature differences between sea and land which are built up daily in predominant periods of clear skies (mainly in summer), cause considerable sea and land breezes. Whilst these are most marked near the coasts they regularly penetrate far inland.

Gales are infrequent over Cyprus but may occur especially on exposed coasts with winter depressions. Small whirlwinds are common in summer appearing mostly near midday as "dust devils" on the hot dry central plain. Very rarely vortices, approaching a diameter of 100 metres or so and with the characteristics of water spouts at sea and of small tornadoes on land occur in a thundery type of weather. Localized damage caused by these has been reported on a few occasions but in general Cyprus suffers relatively little wind damage.

## Sunshine

All parts of Cyprus enjoy a very sunny climate compared with most European countries. In the central plain and eastern lowlands the average number of hours of bright

sunshine for the whole year is 75% of the time that the sun is above the horizon. Over the whole summer six months there is an average of 11.5 hours of bright sunshine per day whilst in winter this is reduced only to 5.5 hours in the cloudiest months, December and January.

Even on the high mountains the cloudiest winter months have an average of nearly 4 hours bright sunshine per day which goes up to 11 hours during June and July.

## 2.6. ECONOMY<sup>4</sup>

The economic profile of a country has a strong link to greenhouse gas emissions, with the overall level and types of economic activity, strongly correlated to energy use. However, this is also dependent on factors such as energy efficiency and the structure of the economy.

The economy of Cyprus can generally be characterised as small, open and dynamic, with services constituting its engine power. Since the accession of the country to the European Union on 1 May 2004, its economy has undergone significant economic and structural reforms that have transformed the economic landscape. Interest rates have been liberalised, while other wide-ranging structural reforms have been promoted, covering the

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areas of competition, the financial sector and the business sector.

The tertiary sector (services) is the biggest contributor to GDP, accounting for about 82.6% in 2012. This development reflects the gradual restructuring of the Cypriot economy from an exporter of minerals and agricultural products in the period 1961-73 and an exporter of manufactured goods in the latter part of the 1970s and the early part of the 80s, to an international tourist, business and services centre during the 1980s, 1990s and the 2000s. The secondary sector (manufacturing) accounted for around 14.7% of GDP in 2012. The primary sector (agriculture and fishing) is continuously shrinking and only reached 2.7% of GDP in 2012.

**Table 2.1. Main economic indicators**

	2009	2010	2011	2012
GDP (in € mln)	16,853	17,406	17,878	17,720
Real GDP growth rate	-1,9%	1,3%	0.4%	-2,4%
Per capita GDP in PPS, (EU-28 = 100)	100	97	95	91
Rate of Inflation HICP	0.2	2.6	3.5	3.1
Unemployment Rate	5.4%	6.3%	7.9%	11.8%
Employment Growth	-0.6%	0.2%	0.5%	-3.3%

The private sector, which is dominated by small and medium-sized enterprises, has a leading role in the production process. On the other hand, the government's role is mainly to support the private sector and regulate the markets in order to maintain conditions of macroeconomic stability and a favourable business climate, via the creation of the necessary legal and institutional framework and secure conditions of fair competition.

Before the emergence of the global economic crisis, Cyprus had enjoyed a track record of satisfactory economic growth, low unemployment and relatively stable macroeconomic conditions. However, the international economic crisis has had a major impact on the economy, as reflected in the main economic indicators. A worsening external environment and tightening financial and fiscal conditions reinforced the adverse effect on economic activity. More stringent bank lending conditions, declining foreign demand for housing, worsening labour market conditions and weakening confidence affected private consumption negatively. The exposure of the Cypriot biggest banks to the Greek

market and the holding of significant amount of Greek Government Bonds played a major role for the steep increase of borrowing costs from international markets and the resulting request for assistance from Troika (European Commission, European Central Bank and International Monetary Fund).

More importantly, the decision by the Eurogroup to impose a haircut on uninsured deposits in the two biggest Cypriot banks, have had significant negative consequences on one of the main drivers of the Cyprus economy that is the banking sector. The abrupt and sudden shrinking of the banking sector and the loss of wealth by depositors unavoidably is affecting the real economy.

The agreement with Troika for a macroeconomic adjustment Programme (Memorandum of Understanding-MoU) is envisaged to bring back economic stability. The Programme is an ambitious one, aiming at achieving 4% of GDP primary balance by 2018. The adjustment programme assumes a strong contraction of the national economy in years 2013-2014 – mainly due to significant decreases in private and public consumption as well as fixed investment – and a slow rebound of economic growth from 2015 onwards.

### 2.6.1. TRADE PATTERNS<sup>5</sup>

Due to the island's small domestic market and the open nature of its economy, trade and access to international markets is of utmost importance for Cyprus' well-being. The country's trade balance is traditionally in deficit because the island has to import extensively in order to satisfy domestic demand, while the island also depends on imports for its energy supplies. Nevertheless, in the period January to November 2011, Cyprus' trade deficit shrank to 4.45 billion euro, compared to 4.93 billion euro in the corresponding period in 2010.

Traditionally, more than half of Cyprus' trade in goods is with the European Union, and the island's main export partners are Greece, the United Kingdom, Germany and Lebanon. During the first eleven months of 2011, exports accounted for 1.27 billion euro, half of which consisted of

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shipments to other EU member states. Exports to Near East and Middle Eastern Countries occupied the second place in importance with 0.15 billion euro. The main domestic export commodities are pharmaceutical products, photo-sensitive devices, and raw and manufactured food products.

Total imports in the same period amounted to 5.72 billion euro, of which 3.9 billion euro were arrivals from other EU member states, 0.18 billion euro from other European countries and 1.64 billion euro imports from third countries. The leading import partners are Greece, Israel, the United Kingdom, Germany, Italy and France, while the chief imports are fuels and lubricants, machinery, chemicals, vehicles, iron and steel.

## 2.7. ENERGY<sup>6</sup>

Energy use is the largest source of GHG emissions. The following sections provide a high-level overview of the most relevant factors. Climate policy drivers have had some impact on changes in the national energy system to-date (for-example leading to improvements in energy efficiency or increases in the share of renewables), although to a large extent these have been driven by other factors. Historic trends in GHG emissions from energy-related activities are shown in later sections. However, the impacts of future climate policy in the energy sector are likely to be far more significant, particularly as a result of the new EU Climate and Energy package. These will lead to more sizeable shifts in energy use towards renewables as well as an overall impact on primary and final energy consumption due to improvements in energy efficiency; these effects should become more noticeable within these indicators in coming years.

Total primary energy consumption in Cyprus rose over the period from 1990 despite continued efforts to improve energy efficiency. Trends in the consumption of different energy types within the total have changed significantly since 1990. Since 1990 there has been a decrease of nearly 38% in the consumption of carbon intensive coal used in cement industry. The consumption of oil increased by 59% between 1990 and 2011.

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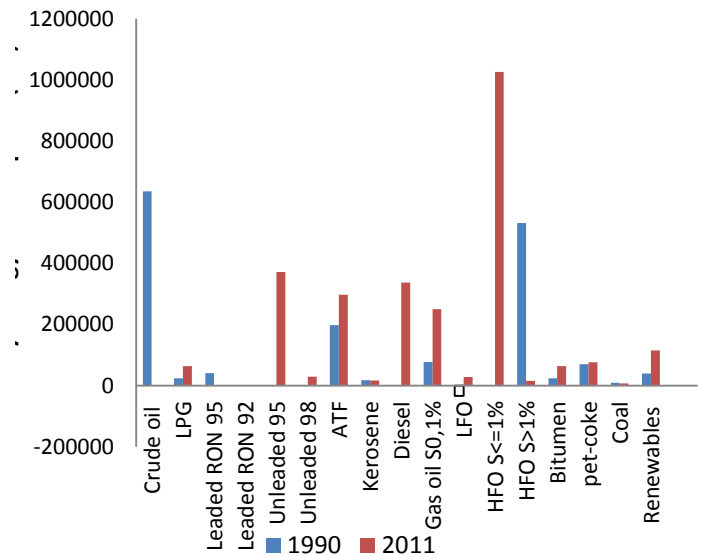


Figure 2.6. Primary energy consumption by fuel for Cyprus, 1990 and 2011

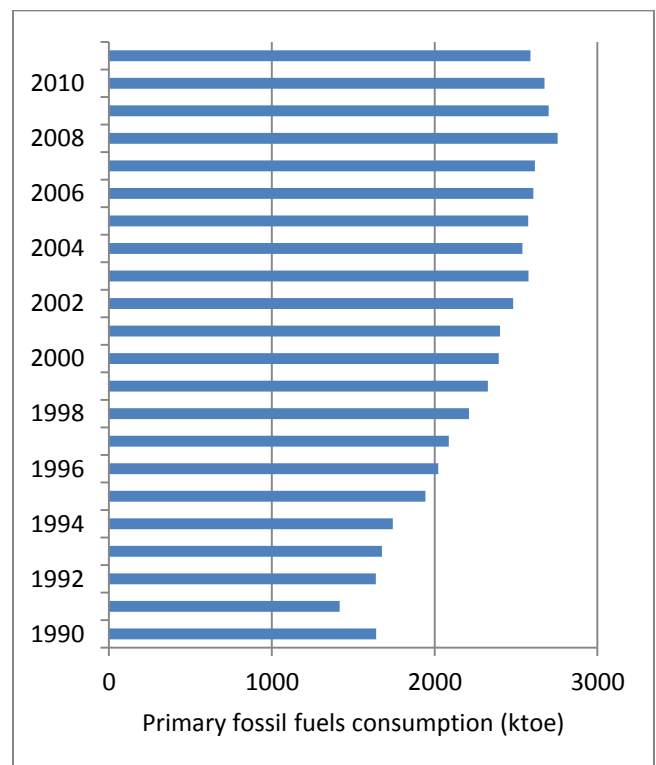


Figure 2.7. Primary consumption of fossil fuels in ktOE, 1990-2011

Renewables have the most marked increase with consumption increasing by 187% from 1990 levels.

Fossil fuels continue to dominate total energy consumption and the share of renewable energy sources remains small despite the increase in use. The overall increase in total primary energy consumption has also acted to counteract some of the environmental benefits from fuel switching.

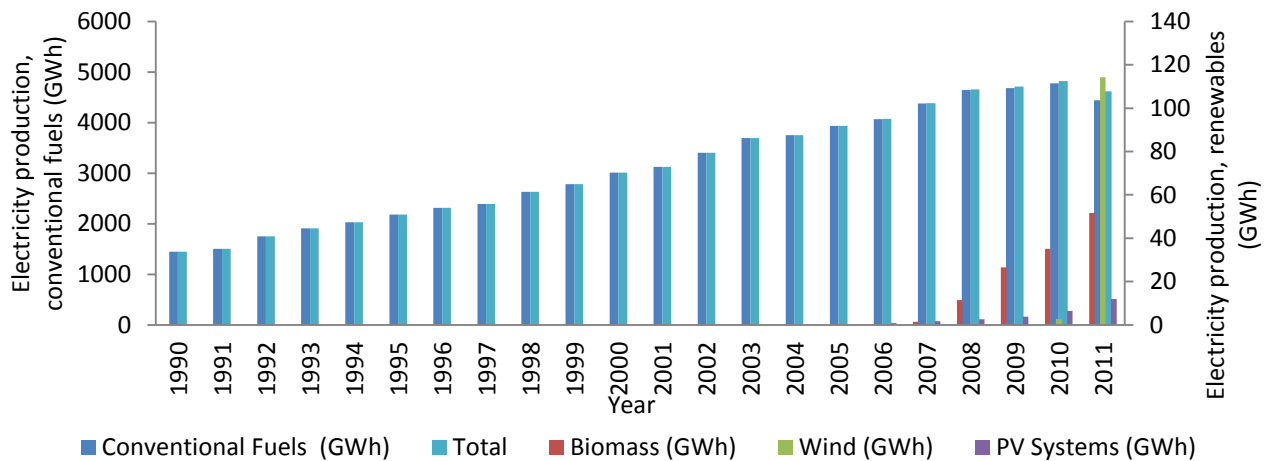


Figure 2.8. Gross electricity production by source in GWh, 1990-2011

The final energy needs of the economy of Cyprus represent 69% of the country's primary energy consumption. There are very significant energy losses linked to the transformation and distribution of useful energy (e.g. as electricity) to the end users. Energy losses broadly depend on the average efficiency of conventional thermal power stations and CHP plants and the penetration of non-thermal renewables.

Although the absolute amount of electricity production from renewables has increased by more than 170 times since 2006, renewable electricity still makes only a 3.8% contribution to total generation. Overall, the generation mix of electricity in Cyprus has become less carbon intensive since 2008, when the first combined cycle unit for the production of electricity entered in operation and the contribution of renewable sources started to be significant. The increase in total electricity production was 219.7% from 1990 to 2011.

### 2.7.1. ENERGY SUPPLY

All the oil consumed is from imports and the trend, although cyclical since 1990, has been upwards of 59.2 % since 1990. In the case of solid fuels, overall consumption has increased by 85% between 1990 and 2004, due to the thrive of the constructing industry. From 2004 until 2008 the consumption of solid fuel was stable, while after 2008, it decreases substantially to reach 1990s levels.

The share of primary energy met by renewables has increased steadily over time to around 4.2% of total primary energy consumption in 2011. The bulk of renewable energy consumed, over 85.8 %, comes from solar thermal and biomass. Wind is the next biggest contributor, providing 8.6% of total renewable energy). Biofuels has seen the biggest increase - from zero 0 in 1990 to contributing around 13.9% of total renewable energy in 2011.

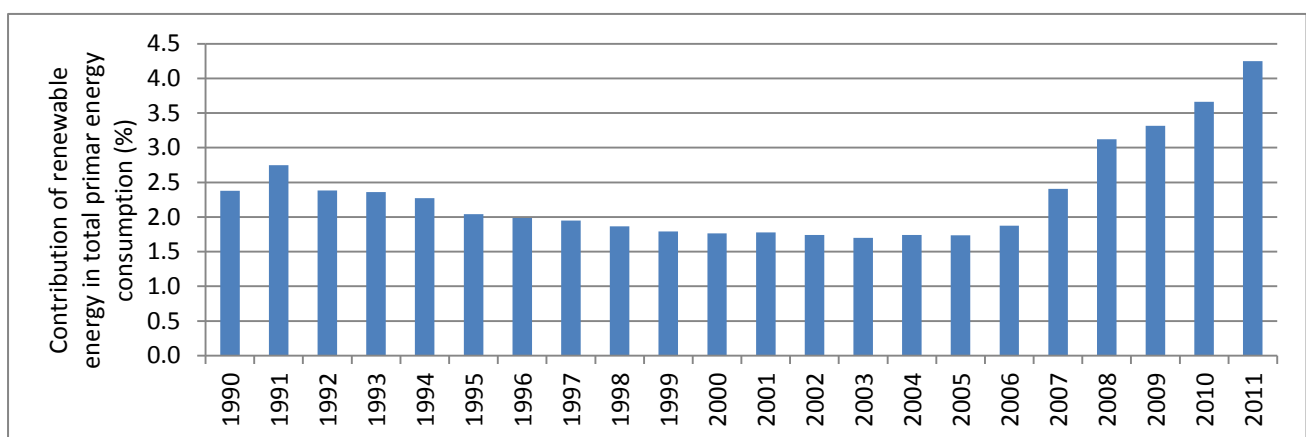


Figure 2.9. Share of renewable energy in total primary energy consumption in per cent, 1990-2011

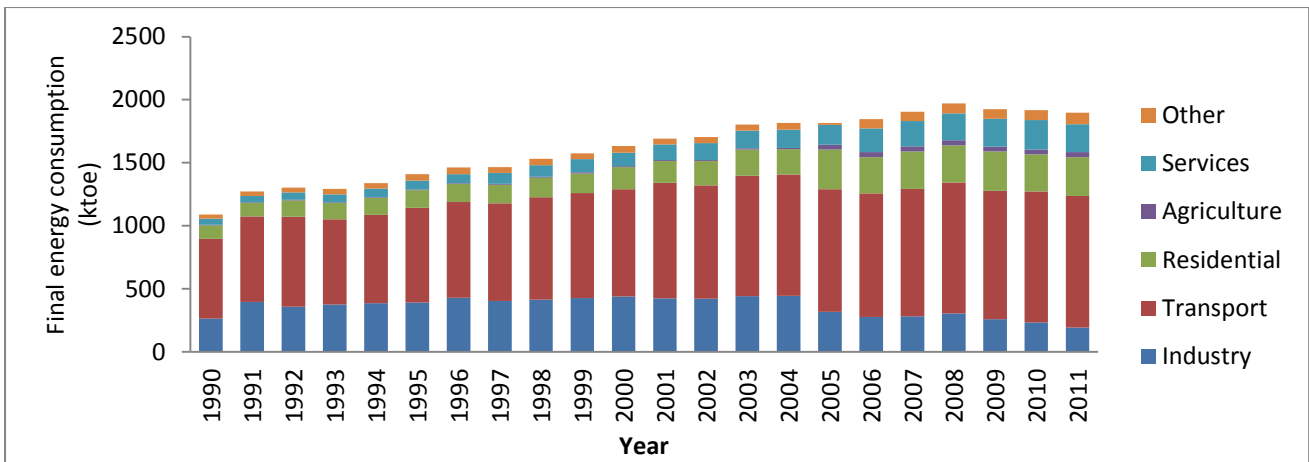


Figure 2.10. Final energy consumption by sector in ktoe, 1990-2011

Based on 2011 figures Cyprus, as all EU countries, has a significant challenge ahead to reach the new Renewable Energy Sources (RES) targets for 2020. The RES targets include all sources of electricity, heat and transport fuel. Cyprus' target is 13% of the final energy consumption to be from renewable sources by 2020.

### 2.7.2. ENERGY CONSUMPTION IN DIFFERENT SECTORS

Final energy consumption in Cyprus increased by about 74% between 1990 and 2011. The transport sector has seen the biggest increase in overall energy consumption, increasing its consumption by over 65% since 1990. This is having a significant impact on GHG emissions. The Services sector has also increased its energy consumption markedly, by 358% since 1990, which correlates with an increasing share of GVA coming from this sector. Households are also one of the largest consumers of final energy in the EU. Space heating and cooling are the most significant components of household energy demand, and can vary substantially from year to year depending on climatic conditions. In very recent years, household energy consumption has declined partly as a result of higher fuel prices. Final energy consumption in industry has fallen since 1990, largely as a result of a shift towards less energy-intensive manufacturing industries, as well as the continuing transition to a more service oriented economy.

### 2.7.3. LIBERALISATION OF ENERGY MARKETS

As far as the electricity domestic market is concerned the new regulatory regime has been established since 2004 by liberalising 35% of the market. The proportion of the liberalised market increased from 35% to 65% from 1/1/2009, so eligible customers (those who can choose their supplier) are all non-domestic customers. From 1/1/2014, the electricity market in Cyprus will be fully liberalized and eligible customers will be all the customers. The main objective of the liberalization process is to provide competitive prices and improved services to all electricity customers. With respect to the further structuring of energy markets, one major change is the EU's Third Energy Package. Cyprus has achieved compliance on transposition of the 3rd Energy Package

### 2.7.4. ENERGY PRICES

The graph below shows how the average end-user prices of electricity have varied since 1990 for industry, households and agriculture in Cyprus. In addition, it illustrates how disposable income has varied over this period, as this provides a very broad indication of how expenditure on energy varies as a share of income.

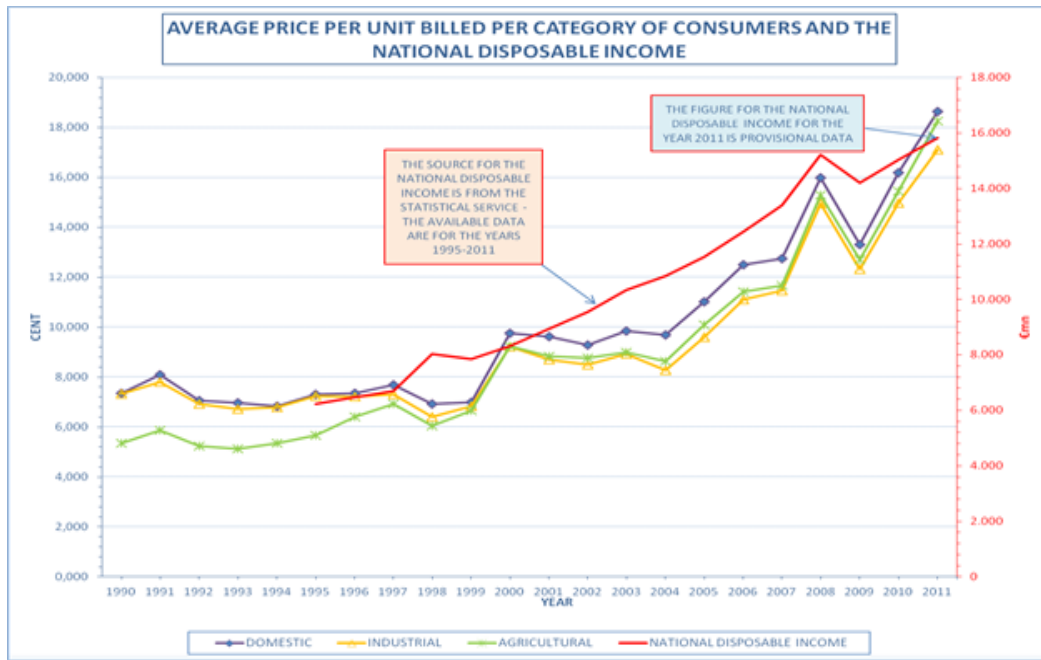


Figure 2.11. Change in average end-user energy prices in Cyprus compared to the gross disposable income for households, industry and agriculture, 1990-2011

## 2.8. TRANSPORT

Both freight and passenger transport, have continued to grow strongly since 1990 with continued growth in GHG emissions. According to the available information, there is no clear relation between freight or passenger transport with GDP. The transport sector is now the largest consumer of energy in Cyprus after electricity production and the issue of growing greenhouse gas emissions from this sector needs to be addressed.

### 2.8.1. FREIGHT TRANSPORT

Since 2002 (the year for which the first data is available) the demand for freight transport in Cyprus has decreased. All the freight transport in Cyprus takes place via road.

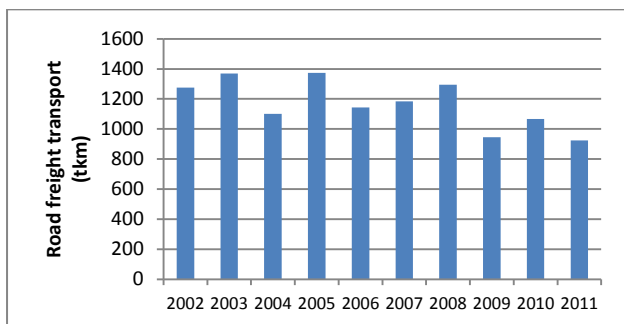


Figure 2.12. Growth in road freight transport 1990-2011 (tkm)

### 2.8.2. PASSENGER TRANSPORT

Since 1990 the demand for passenger transport in Cyprus has been increasing. It appears that the desired outcome, of a gradual decoupling in passenger transport from GDP, has not yet been observed. Given the continuing upward trend in demand, a reduction in absolute carbon emissions in this sector will need to come primarily via improved vehicle efficiency, modal shift to less energy intensive transport modes, and the shift to less carbon intensive transport fuels (e.g. sustainably produced biofuels or low carbon electricity).

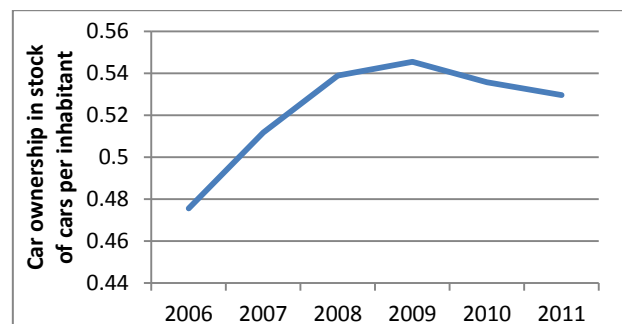


Figure 2.13. Level of car ownership in stock of cars per inhabitant, 2006 – 2011

### 2.8.3. PRICES OF TRANSPORT FUELS<sup>7</sup>

Overall, the prices for both road transport fuels approximately doubled between 1990 and 2011 due to substantial increases in oil prices (when adjusting for inflation, real prices increased by around a third over the same period). The tax on petrol increased by 180% (in 1990 €128/1000 litres and 2011 €359/1000 litres) and the tax on diesel increased from zero to €330/1000 litres over the same period. Furthermore, the VAT tax was zero in 1990 and in 2011 was 15%. Rising prices will also help stimulate demand for more efficient vehicles. Road fuels have declined sharply from their peak in 2008 as the price of oil has declined, with (nominal) prices again similar to those in the early 2000s.

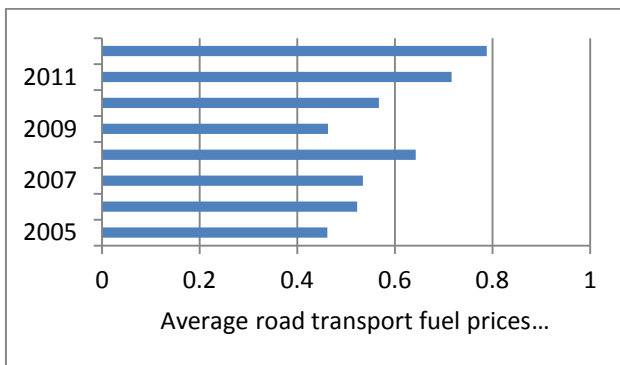


Figure 2.14. Average road transport fuel prices including taxes in €/litre, 2005-2011

### 2.9. INDUSTRY

The energy and emissions intensity of different branches of manufacturing can change significantly. GVA in manufacturing in Cyprus increased by 34% from 1995 to 2011. GVA in mining changed by around 132% over the same period. The structure of industry has also changed from 1995 to 2011, showing a decrease in the share of GVA in total GVA (excluding construction) from 11,5% to 6,1%.

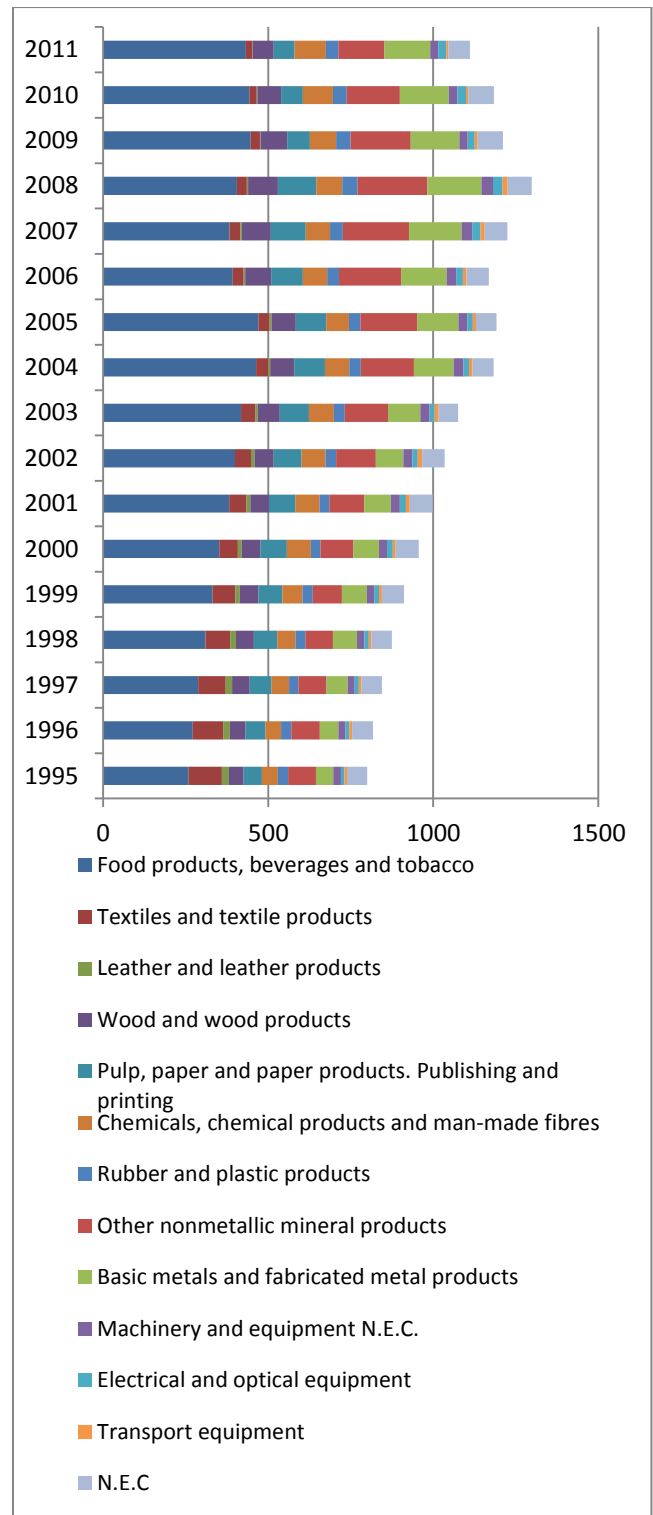


Figure 2.15. Composition of industry based on gross value added (at basic prices) of main economic sectors in million €, 1995-2011

<sup>7</sup> Mr. Savvas Ioannou, Industrial Applications' Officer, Energy Service, Ministry of Energy, Commerce, Industry and Tourism; 1421 Nicosia; Tel.+357 22 409445; email: sid.cie@cytanet.com.cy

## 2.10. WASTE

Greenhouse gas emissions from waste depend on the quantity of waste and how it is disposed of (including recycling and landfill). All routes have an impact on emissions through the consumption of energy in the collection, treatment and production of waste. Waste to landfill produces large methane emissions if not managed correctly (e.g. via methane recovery and diversion of biodegradable municipal waste from landfill). Recycling of waste with energy recovery generally result in lower greenhouse gas emissions than disposing of the waste to landfill, and these routes are increasingly used, in part as a result of policy drivers.

The chart below shows the amount of municipal waste generated per capita broken down by different treatment route. In 2011 97% of waste was sent to landfill compared to 80% in 1990. No municipal waste is incinerated in Cyprus.

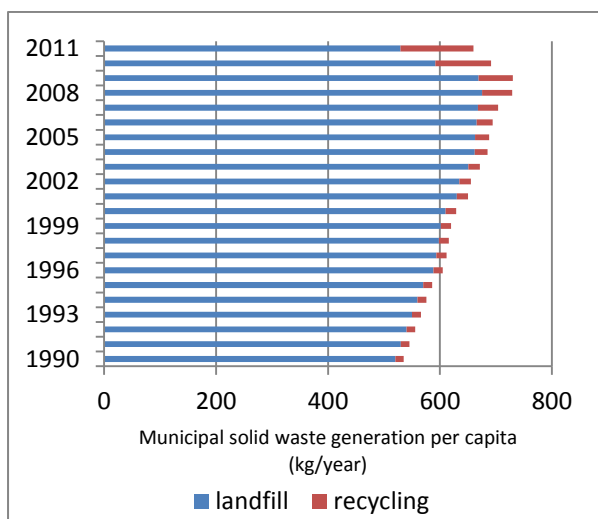


Figure 2.16. Generation and treatment of municipal waste per capita in kg/ capita, 1990-2011

## 2.11. BUILDING STOCK AND URBAN STRUCTURE

Energy consumption for space heating or cooling within buildings forms a significant component of the country's energy consumption. The level of energy consumption within buildings is primarily affected by: the thermal properties of the building (in terms of insulation, building type – e.g. flat/house); the efficiency of the heating or cooling system; and the stock/efficiency of the appliances used. In general, newer dwellings are likely to be more energy efficient than older buildings.

The building sector has one of the highest potentials for improved energy efficiency and measures to reduce the space heating/cooling demand in buildings represent a significant part of this potential. Many of these measures (such as improved insulation) are highly cost-effective, but a number of other barriers to their implementation exist. These are being addressed by a number of the policies related to end-use energy efficiency.

### 2.11.1. BUILDING PERMISSIONS

The construction industry is demonstrating negative growth rates in recent years due to the country's economic downturn. This is evident from the number of building permissions issued during the period 2011-2013.

According to the Cyprus Statistical Service, during the period January-December 2011, 7,506 building permissions were issued, 14.5% less than the previous year (2010). During January-December 2012, 7,172 building permissions were issued, a 4.4 % reduction from the corresponding period of the previous year (2011).

Looking at the latest data concerning the period January-July 2013, 3,220 building permissions were issued, representing a significant decrease of 24.8% over the corresponding period of the previous year, where the number of building permissions issued was 4,284. Regarding the 3,220 building permissions issued, 2,234 (69.38%) concerned residential buildings, 514 (15.97%) non-residential buildings, 176 (5.46%) Civil Engineering projects, 266 (8.26%) concerned the division of plots and 30 building permissions (0.93%) were issued for road construction projects.

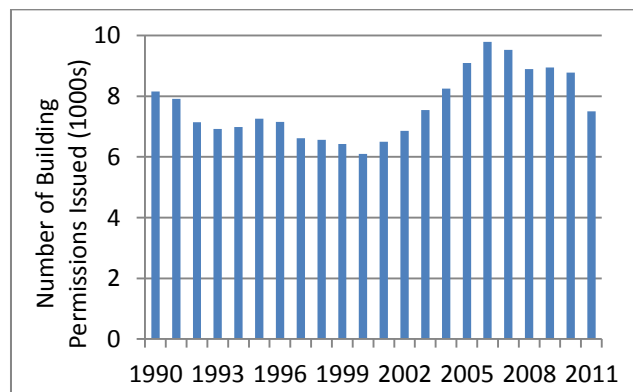


Figure 2.17. Building permissions issues, 1990-2011<sup>8</sup>

<sup>8</sup> Construction and Housing Statistics 2013, Cyprus Statistical Service

### 2.11.2. DWELLING STOCK

According to the Cyprus Statistical Service<sup>7</sup>, the dwelling stock at the end of 2011 increased by 3.2% and reached 421,449 units as against 408,259 in 2010. Of these dwellings, 62.5% were in the urban areas. The occupied living quarters in 2011 numbered 344,010 units.

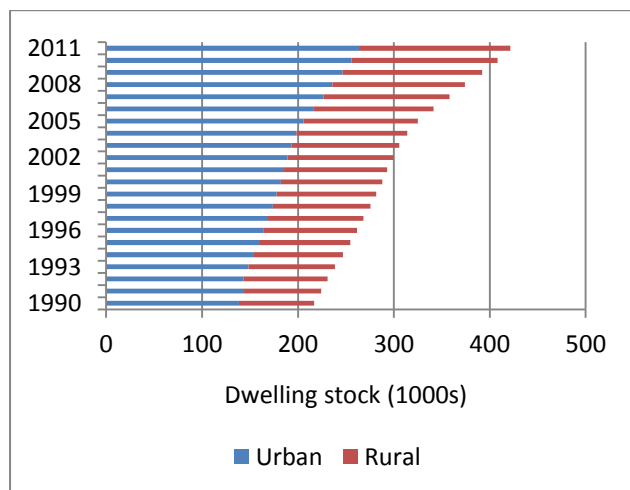


Figure 2.18. Total dwelling stock, 1990-2011<sup>7</sup>

### 2.12. AGRICULTURE

Agriculture is a significant source of GHG emissions, for example, due to N<sub>2</sub>O associated with fertilizer use and CH<sub>4</sub> from livestock (as well as energy consumption in the sector itself). The overall decrease in agricultural activity will have a generally positive effect on total greenhouse gas emissions. The consumption of nitrogenous fertilizer has decreased by 59% since 1990, which will lead to an overall positive impact on total greenhouse gas emissions. In addition, animal population reduced by 7% between the same period.

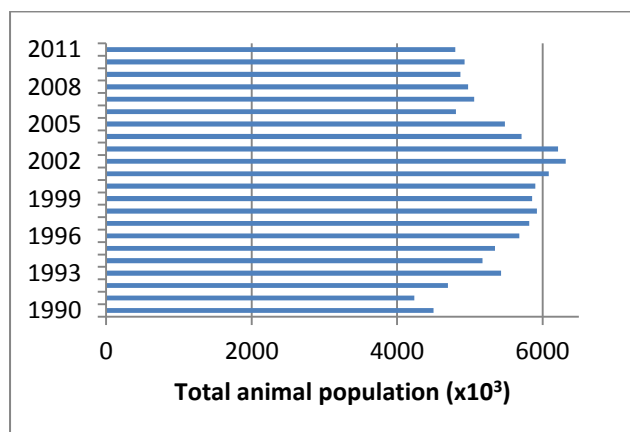


Figure 2.19. Total animal populations (cattle, pigs and poultry), 1990-2011

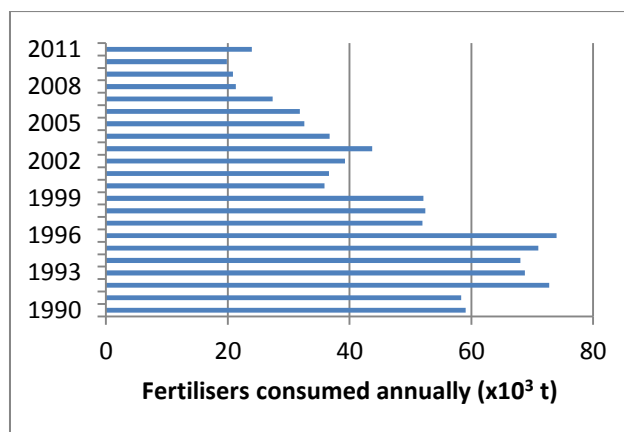


Figure 2.20. Fertilisers consumed annually, 1990-2011

### 2.13. FOREST<sup>9</sup>

Wild vegetation in Cyprus is classified in two major categories: a) forest and b) Other Wooded Land (OWL, which includes maquis and garique), which are either of state or private ownership. These two categories account for 41.7% (386,167 hectares) of the total land area. The change of forest cover is almost invariable the last 15 years. Analytical data are shown on Table 2.2.

Table 2.2. Wild vegetation in Cyprus

Category of Vegetation	Forests	Other Wooded Land (OWL)	Total
<b>1999</b>			
Area (ha)	171,610	213,860	<b>385,470</b>
%	18.5	23.1	<b>41.7</b>
<b>2005</b>			
Area (ha)	172,851	213,865	<b>386,716</b>
%	18.7	23.1	<b>41.8</b>
<b>2010</b>			
Area (ha)	172,841	213,285	<b>386,126</b>
%	18.7	23.1	<b>41.7</b>
<b>2012</b>			
Area (ha)	172,778	213,389	<b>386,167</b>
%	18.7	23.1	<b>41.7</b>

<sup>9</sup> Dr. Andreas K. Christou; Senior Forest Conservator; Head of Research, Publicity & Silviculture Sector; Department of Forests, 1414, Nicosia, Cyprus; Tel.: 22819490, Fax.: 22303935; Email: achristou@fd.moa.gov.cy

### 3. GREENHOUSE GAS INVENTORY INFORMATION

#### 3.1. INTRODUCTION

The latest national greenhouse gas emissions inventory was prepared in early 2013 and was submitted to the UNFCCC secretariat in April 2013<sup>10</sup>. The following sections present the most important findings presented in the report.

Emissions estimates were calculated according to the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (henceforth IPCC Guidelines) and the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (henceforth IPCC Good Practice Guidance). It is noted that base year emissions are calculated using 1990 as the base year for carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O), and 1994 for fluorinated gases (F-gases: Hydrofluorocarbons, HFC / Perfluorocarbons, PFC / Sulphur hexafluoride, SF<sub>6</sub>).

#### 3.2. DESCRIPTIVE SUMMARY OF GHG EMISSIONS TRENDS

##### 3.2.1. OVERALL GREENHOUSE GAS EMISSIONS TRENDS

Base year GHG emissions for Cyprus (1990) were estimated at 6091 Gg CO<sub>2</sub> eq. LULUCF emissions are not considered in estimating base year emissions for Cyprus. In 2011, GHG emissions (without LULUCF) amounted to 9154 Gg CO<sub>2</sub> eq. showing an increase of 50% compared to base year emissions. If emissions /removals from LULUCF were to be included then the increase would be 53%.

<sup>10</sup> Department of Environment, 2013. Cyprus National Greenhouse Gas Inventory Report 1990 – 2011. Ministry of Agriculture, Natural Resources and Environment (available from [https://unfccc.int/national\\_reports/annex\\_i\\_ghg\\_inventories/national\\_inventories\\_submissions/items/7383.php](https://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/7383.php))

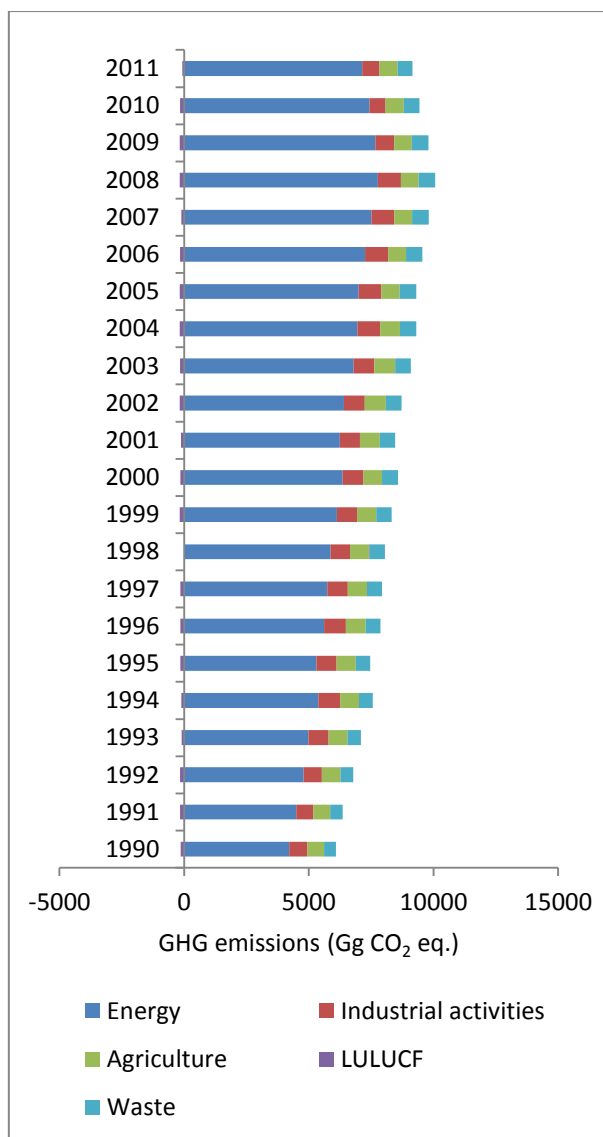


Figure 3.1. Contribution of activity sectors to total GHG emissions during the period 1990-2011 (including LULUCF)

##### Energy

Emissions from Energy in 2011 accounted for 78% of total GHG emissions (without LULUCF) and increased by 69% compared to 1990 levels. After robust growth rates in the 1980s (average annual growth was 6.1%), economic performance in the 1990s was mixed: real GDP growth was 9.7% in 1992, 1.7% in 1993, 6.0% in 1994, 6.0% in 1995, 1.9% in 1996 and 2.3% in 1997. This pattern underlined the economy's vulnerability to swings in tourist arrivals (i.e., to economic and political conditions in Cyprus, Western Europe, and the Middle East) and the need to diversify the economy. This behaviour of economic growth was also reflected in the emission trends.



The majority of energy related GHG emissions (52.2%) in 2011 was derived from energy industries, while the contribution of transport, manufacturing industries and construction and other sectors is estimated at 32%, 7.2% and 8.9% respectively. The substantial increase of GHG emissions from road transport is directly linked to the increase of vehicles fleet but also to the increase of transportation activity. The renewal of the passenger car fleet and the implied improvement of energy efficiency, limit the increase of GHG emissions. The implemented, adopted and planned measures for the improvement of public transport are expected to moderate the high use of passenger cars.

### Industrial Processes

Emissions from Industrial processes in 2011 accounted for 8% of the total emissions (without LULUCF) and decreased by 4% compared to 1990 levels. Between 1990 and 2008 the emissions of the sector were increasing (mainly depicted in the CO<sub>2</sub> emissions) and are mainly attributed to the growth of the constructions sector. However, during 2008-2010, the constructions sector experienced the same impact as all economic activities and the emissions of the sector in 2010 decreased by 24% compared to 2008. An additional cause of the increase between 1990 and 2008 is that emissions from consumption of f-gases, was mainly available for years after 2005. Total emissions of the sector in 2011 are higher than emissions of 2010 by 9% due to a better estimation of the emissions from consumption of f-gases

### Solvents and other products use

Emissions from Solvents and other products use have not been estimated due to lack of IPCC methodology.

### Agriculture

Emissions from Agriculture accounted for 8% of total emissions in 2011 (without LULUCF), and increased by approximately 7% compared to 1990 levels. The peak of Agriculture emissions was in 2002 when an increase of 26% compared to 1990 was observed. Since 2002 a reduction in emissions was observed, due to the reduction of N<sub>2</sub>O emissions from agricultural soils, because of the reduction in the use of synthetic nitrogen fertilizers. The reduction of the use of fertilisers was caused by the drought that was taking place during the same period that had an extreme in 2008. Further

reduction was caused by the recent changes in manure management and the reduction in the animal population.

### Waste

Emissions from the Waste Sector in 2011 contributed 6% of the total emissions (without LULUCF). Even though waste management of both liquid and solid wastes improved significantly since 1990, due to the increase in population and solid waste production per capita due to the changes in social conditions, the emissions of the sector increased by 26% between 1990 and 2011.

### Land Use, Land Use Change and Forestry

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 about 1% of the total national emissions (without LULUCF). The magnitude of this sink decreased from approximately 139 Gg CO<sub>2</sub> eq. in 1990, to 76 Gg CO<sub>2</sub> eq. in 2011, i.e. a decrease of 45%. Even though during 2011 there was an increase of the area covered with forests by 211 ha, the CO<sub>2</sub> balance is reduced due to a large wildfire (1974 ha burnt).

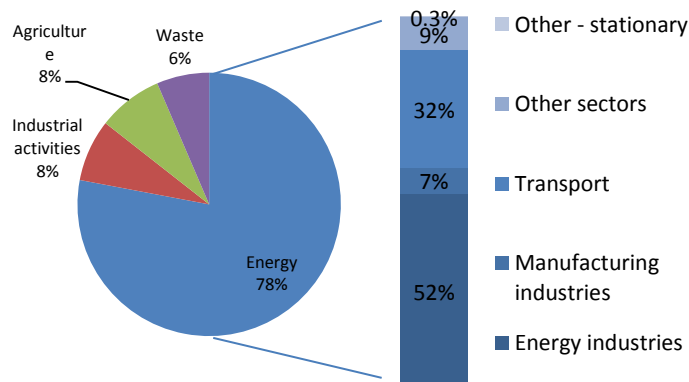


Figure 3.2. Relative contribution of activity sectors to total GHG emissions in 2011 excluding LULUCF

### 3.2.2. EMISSION TRENDS BY GAS

The GHG emissions (CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, HFCs) for the period 1990 - 2011 are presented in Figure 2.1 (in Gg CO<sub>2</sub> eq). Carbon dioxide emissions accounted for 84% of total GHG emissions in 2011 (without LULUCF) and increased by 56% from 1990. Methane emissions accounted for 10% of total GHG emissions in 2011 (without LULUCF) and increased by 25% from 1990, while nitrous oxide

emissions accounted for 2% of the total GHG emissions in 2011 (without LULUCF) and increased by 2% from 1990. Finally, F-gases and SF6 emissions accounted for 1% of total GHG emissions in 2011.

**Table 3.1. Emission for greenhouse gases (in Gg) for the period 1990-2011**

Sector	1990	2000	2010	2011
Energy	4214	6361	7441	7137
Industry	728	831	642	697
Solvents	NE	NE	NE	NE
Agriculture	679	744	722	730
Waste	470	639	639	590
<b>TOTAL excl. LULUCF</b>	6091	8574	9444	9154
LULUCF	-139	-150	-166	-76
<b>TOTAL incl. LULUCF</b>	5952	8424	9278	9078

### 3.2.3. INFORMATION ON INDIRECT GREENHOUSE GAS EMISSIONS

The role of carbon monoxide (CO), nitrogen oxides (NO<sub>x</sub>) 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. Emissions trends for indirect greenhouse gases and SO<sub>2</sub> are presented in Table 3.2.

### 3.2.4. ACCURACY/UNCERTAINTY OF THE DATA

For the estimation of uncertainties per gas, a combination of the information provided by the IPCC and critical evaluation of information from indigenous sources was applied. The uncertainty analysis was carried out without the LULUCF sector. The combined uncertainty for GHG emissions for 2011 was estimated at 8.3% (compared to 11.17% in 1990), while the trend uncertainty for the same year was 8.92% (compared to

3.41% in 1990). The uncertainty by gas was 0.11% for CO<sub>2</sub> emissions, 0.08% for CH<sub>4</sub> emissions, 0.41% for N<sub>2</sub>O emissions and 0.08% for the F-gases emissions.

**Table 3.2. Emissions trends for indirect greenhouse gases and SO<sub>2</sub> (in Gg) for the period 1990-2011**

	1990	2000	2011
<b>Energy</b>			
NO <sub>x</sub>	15.23	20.07	20.38
CO	50.67	33.13	IE,NA,NE,NO
NMVOC	11.56	8.54	3.75
SO <sub>2</sub>	29.08	45.25	20.87
<b>Industrial processes</b>			
NO <sub>x</sub>	NA,NE,NO	NA,NE,NO	NA,NO
CO	0.00	0.00	NA,NE,NO
NMVOC	0.05	0.07	0.22
SO <sub>2</sub>	NA,NE,NO	NA,NE,NO	0.02
<b>Solvent and other product use</b>			
NO <sub>x</sub>	NA	NA	NA
CO	NA	NA	NA
NMVOC	2.65	2.54	2.73
SO <sub>2</sub>	NA	NA	NA
<b>Agriculture</b>			
NO <sub>x</sub>	0.98	0.19	0.06
CO	8.78	2.08	0.53
NMVOC	2.02	2.50	2.47
SO <sub>2</sub>	NA	NA	NA
<b>Waste</b>			
NO <sub>x</sub>	0.0006	0.0007	NA,NO
CO	0.0012	0.0014	NA,NO
NMVOC	0.03	0.05	0.04
SO <sub>2</sub>	0.0006	0.0007	NA,NO

### 3.2.5. GENERAL ASSESSMENT OF THE COMPLETENESS

In the present inventory report, estimates of GHG emissions in Cyprus for the years 1990-2011 are presented. Emissions estimates included in the CRF tables submitted and discussed in the present report, cover the areas of the Republic of Cyprus under the effective control of the Government of the Republic of Cyprus. All major sources are reported including emissions estimates for indirect greenhouse gases and SO<sub>2</sub>. The deficiencies of the 2013 submission are the following:

- Civil aviation emissions (1AA3a): no data available on consumption of fuel for inland aviation.
- Navigation (1AA3d): no data available on consumption of fuel for domestic navigation.
- Fugitive emissions from transport of oil (1B2a3): lack of IPCC methodology.

- Fugitive emissions from distribution of products (1B2a5): lack of IPCC methodology.
- Fugitive emissions from venting of oil (1B2C1.1): lack of IPCC methodology.
- CO<sub>2</sub> emissions from asphalt roofing (2A5): lack of IPCC methodology.
- CO<sub>2</sub> emissions from asphalt roofing-road paving (2A6): lack of IPCC methodology.
- CH<sub>4</sub> and N<sub>2</sub>O from ceramics production (2A7.2): lack of IPCC methodology.
- Emissions from metal production (2C): no activity data available.
- Emissions from food and drink industries (2D2): no activity data available.
- Consumption of halocarbons and SF<sub>6</sub> (2F) and Consumption of halocarbons and SF<sub>6</sub> potential emissions (2FP): lack of activity data to complete the time series.
- Emissions from solvent and other product use (3): lack of IPCC method.
- Emissions from LULUCF (5): no activity data available other than forest land remaining forest land (5A1), wildfires (5(V)) and harvested wood products (5G).
- N<sub>2</sub>O emissions from industrial wastewater handling: lack of IPCC methodology.

In this context, the MANRE has the overall responsibility for the national GHG inventory, and the official preparation and approval of the inventory prior to its submission<sup>11</sup>. The Figure below provides an overview of the organisational structure of the National Inventory System. The entities participating are:

- The MANRE, designated as the national entity responsible for the national inventory, which keeps the overall responsibility, plays an active role in the inventory planning, preparation and management, and also compiles the annual inventory.
- Governmental ministries and agencies, and non-governmental organisations through their appointed focal persons, ensure the data provision.

No legal framework is available defining the roles-responsibilities and the co-operation between the MANRE and contact points of the involved ministries and agencies.

### 3.2.6. CHANGES SINCE THE PREVIOUS NATIONAL COMMUNICATION

This is the first national communication submitted by Cyprus.

## 3.3. NATIONAL SYSTEM

### 3.3.1. INSTITUTIONAL ARRANGEMENTS

The Ministry of Agriculture, Natural Resources and Environment (MANRE) is the governmental body responsible for the development and implementation of the majority of the environmental policy in Cyprus. The MANRE is responsible for the co-ordination of all involved ministries, as well as any relevant public or private organisation, in relation to the implementation of the provisions of the European legislation associated with climate change.

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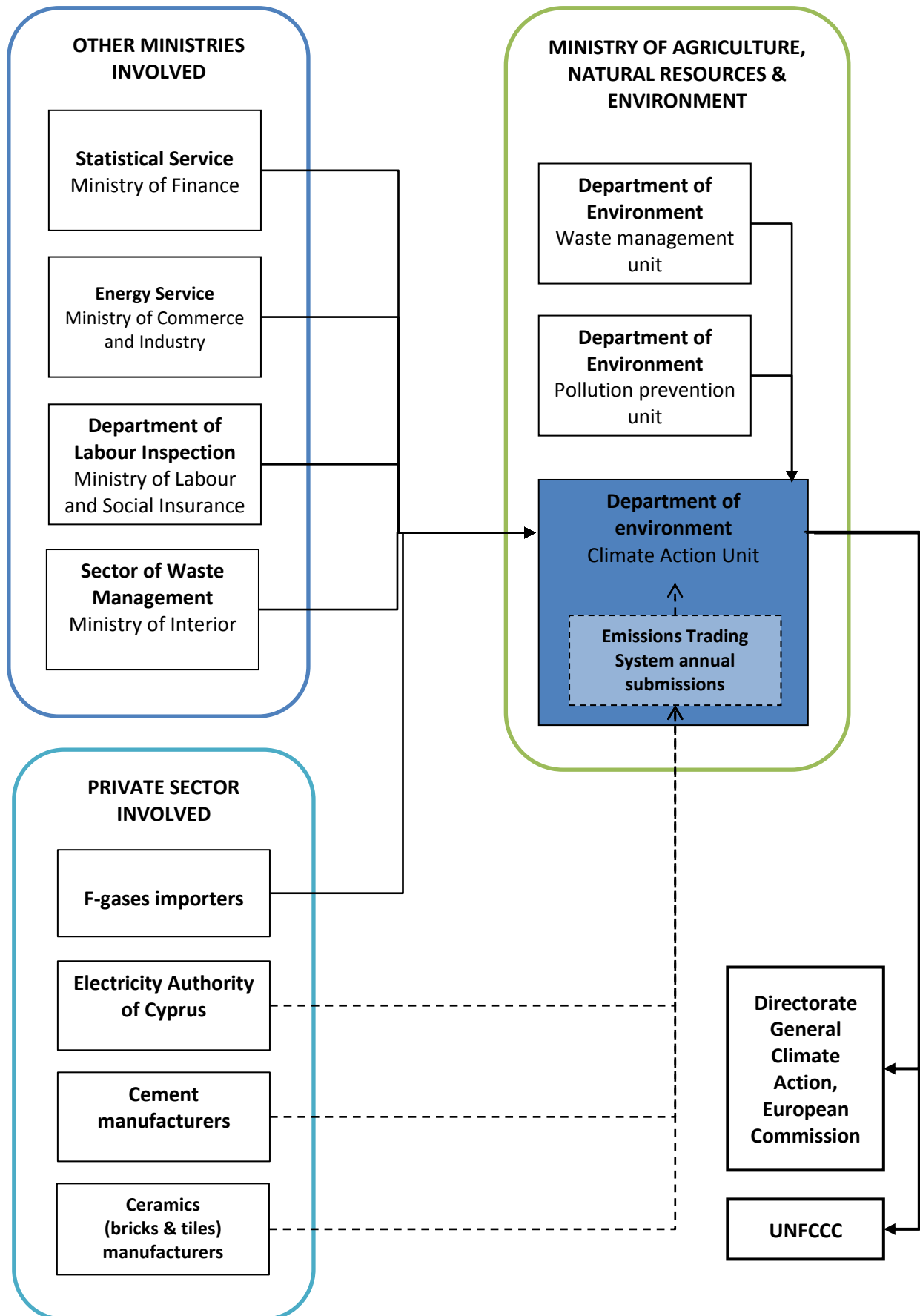


Figure 3.3. Organisational Structure of the National Inventory System

### 3.3.2. QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) PROCEDURES

A QA/QC system is being implemented since the May 2007. The MANRE is responsible for the implementation of the QA/QC system. The system has the following objectives:

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, of the QA/QC procedures included in the plan for the following:

- 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.
- Compiling national inventory reports.

The QA/QC system developed covers the following processes:

- **QA/QC system management:** comprises of all activities that are necessary for the management and control of the inventory agency in order to ensure the accomplishment of the abovementioned quality objectives.
- **Quality control:** 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:** comprises of activities related to central archiving of inventory

information and the compilation of the national inventory report.

- **Quality assurance:** comprises of 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:** defines procedures for estimating and documenting uncertainty estimates per source / sink category and for the whole inventory.
- **Inventory improvement:** related to the preparation and the justification of any recalculations made.

The implementation of the plan started in May 2007 and the first internal review was carried out in October 2011. The outcome of the review is the current version of the QA/QC. No activities have yet taken place for the procedure no. QM 03 concerning training.

### 3.3.3. THE INVENTORY METHODOLOGY AND DATA

The preparation of the Cypriot 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 checks for all source / sink categories. The main data sources used are the National Statistical Service, the national energy balance, the government ministries / agencies involved, 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. National Statistical Service, ETS reports and energy balance) 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 entering the data in the CRF Reporter.

**Stage 3:** The last stage involves the compilation of the NIR and its internal check. During this period, the Inventory Team has to revise the report according to the observations and recommendations of the supervisor of the team. On the basis of this interaction process, the final version of the report is compiled. The Director of the

Department of Environment approves the inventory and then the MANRE submits the NIR.

Data from all the involved parties come in MS Excel spread-sheets. The main database maintained by the inventory compiler is also in the form of MS Excel spread-sheets. The collected data is transferred to the main database of the inventory compiler. No special software is used or applied for processing or storage of the data used in the inventory. The inventory compiler has one MS Excel spread-sheet containing all the data collected and one MS Excel spread-sheet containing the calculations performed for the estimation of the GHGs emissions.

**Table 3.3. Quality assurance / quality control procedures for the Cypriot GHG emissions inventory**

Process	Procedure code	Procedure
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

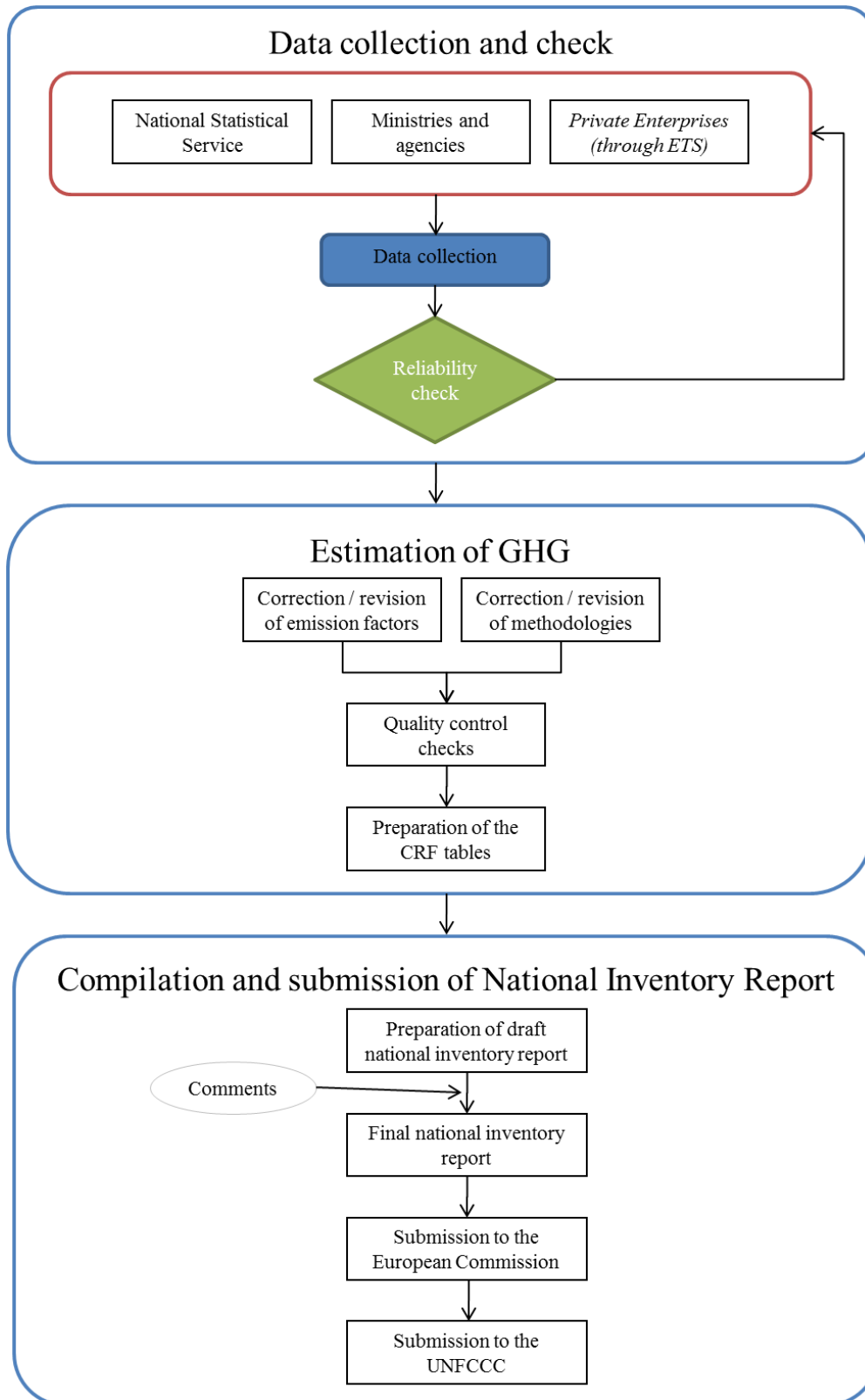


Figure 3.4. GHG emissions inventory preparation process in Cyprus

The estimation of GHG emissions / removals per source / sink category is based on the methods described in the IPCC Guidelines and the IPCC Good Practice Guidance. 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.

The key categories analysis 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) need also 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 are depended on the availability of the data needed for the correct application of the selected methodology.
- Availability of resources needs also to be considered as searching for and the collection of the necessary data to apply a detailed methodology for a source category should not affect the completeness and the on-time preparation of an inventory submission.

## GLOBAL WARMING POTENTIAL

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 common greenhouse gases are given in Table 3.4. Corresponding values of GWP for other gases (NO<sub>x</sub>, 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.

Table 3.5. Key categories for the Cypriot inventory system without LULUCF for 2011

Table 3.4. Global Warming Potential (in t of CO<sub>2</sub> eq) for the 100-year horizon

Gas	GWP
Carbon dioxide (CO <sub>2</sub> )	1
Methane (CH <sub>4</sub> )	21
Nitrous Oxide (N <sub>2</sub> O)	310
Hydrofluorocarbons (HFC)	
HFC-32	650
HFC-125	2800
HFC-134a	1300
HFC-143a	3800
Sulphur hexafluoride (SF <sub>6</sub> )	23900

## KEY CATEGORIES ASSESSMENT

The determination of the key categories for the Cypriot inventory system is based on the application of the Tier 1 methodology (see Annex I for an 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 and base year estimates were calculated considering 1990 as base year. The summary of the key categories assessment for the Cypriot inventory system (without LULUCF) for the year 2011 are presented in Table 3.5.

## 3.4. NATIONAL REGISTRY

The national registry of Cyprus is limited to the EU-ETS. For this, Cyprus cooperates with the member states of the European Union and the registry of the European Community (CITL).



<b>IPCC Source category</b>	<b>GHG</b>	<b>Level assessment</b>	<b>Trend assessment</b>
1AA1A. Public electricity and heat production	CO <sub>2</sub>	✓	✓
1AA2F1. Other	CO <sub>2</sub>	✓	✓
1AA2F2. Non-metallic minerals	CO <sub>2</sub>	✓	✓
1AA3B. Road transport	CO <sub>2</sub>	✓	✓
1AA4A. Commercial/ Institutional	CO <sub>2</sub>		✓
1AA4B. Residential	CO <sub>2</sub>	✓	✓
1AA4C. Agriculture/ Forestry/ Fisheries	CO <sub>2</sub>		✓
2A1. Cement Production	CO <sub>2</sub>	✓	✓
2F. Consumption of halocarbons and SF <sub>6</sub>	HFC&SF <sub>6</sub>	✓	✓
4A. Enteric Fermentation	CH <sub>4</sub>	✓	
4B. Manure Management	N <sub>2</sub> O	✓	
4D1. Direct Soil Emissions	N <sub>2</sub> O	✓	✓
4D3. Indirect emissions	N <sub>2</sub> O		✓
6A. Solid waste disposal on land	CH <sub>4</sub>	✓	✓

## 4. POLICIES AND MEASURES

### 4.1. NATIONAL POLICIES

#### 4.1.1. INTRODUCTION

The national policies are prepared, updated, monitored and updated by the Ministry of Agriculture, Natural Resources and Environment, in collaboration with the responsible ministry for each measure or policy. Currently, the main focus of the policy related to reduction of greenhouse gas emissions is energy. Energy in 2011 accounted for 78% of total GHG emissions (without LULUCF) and increased by 69% compared to 1990 levels. The sector of energy for which most measures are implemented is energy production.

#### Policy making process

The Ministry of Agriculture, Natural Resources and Environment is the main governmental body entrusted with the development and implementation of environmental policy in Cyprus. MANRE 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, MANRE 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 Cypriot strategy for sustainable development launched by MANRE in 2007. 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 with other involved ministries.

#### 4.1.2. MONITORING & EVALUATION

The Ministry of Agriculture, Natural Resources and Environment is responsible for the monitoring of the implementation of policies and measures for achieving of the national targets with respect to GHG emissions. A reporting template provided by EU (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 Article 3(2) of the Monitoring Mechanism Decision (EU Commission Decision 280/2004/EC) and elaborated in Articles 8, 9 and 10 of the Implementing Provisions (EU Commission Decision 2005/166/EC) and UNFCCC reporting guidelines for national communications (FCCC/CP/1999/7).

### 4.2. SECTORAL POLICIES AND MEASURES: ENERGY

The emissions of the energy sector except transport increased from 3,038 Gg CO<sub>2</sub> eq. in 1990 to 4,887 Gg CO<sub>2</sub> eq. in 2011, corresponding to 61% increase. In 2011, emissions decreased by 5% compared to 2010. Energy is the sector which has to contribute the most in the reduction of greenhouse gases of Cyprus. The import of natural gas, and its initial use for electricity production, is expected to contribute considerable reductions of emissions in 2020.

Cyprus is the southernmost region of the European Union at the crossroads of three continents, with a dominant position in the Mediterranean and South East. In general Cyprus presents the common energy problems of most islands:

- (a) Isolated energy system.
- (b) High rates of economic and social development involving high rates of growth in energy demand.
- (c) High cost of energy supply.
- (d) High dependence on petroleum products - small supply security.
- (e) Seasonal variations in energy demand.
- (f) Maximum operation of the system of production and distribution of electricity in peak load demand.

(g) Strict limitations of protection and promotion of the island environment that act as a disincentive to develop initiatives in energy investments.

The competent authority in relation to energy policies is the Energy Service of the Ministry of Energy, Commerce, Industry and Tourism.

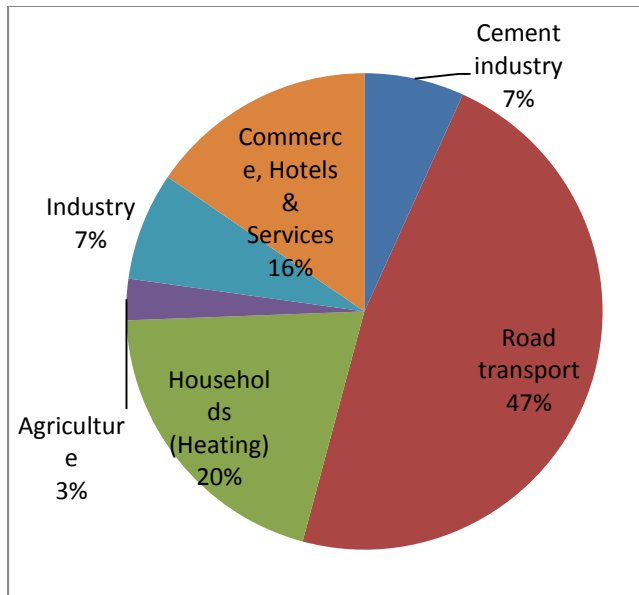


Figure 4.1. Main energy consumers in 2011

## A1. NATURAL GAS

The Government of Cyprus, recognizing the positive contribution that the introduction and use of natural gas will have on the economy and the environment of Cyprus, has decided to introduce natural gas to Cyprus, primarily for use in electricity generation. It is however expected that after its arrival, natural gas will be first supplied for electricity production, while in the future natural gas will also be used in other sectors of the economy (commercial, industrial, residential).

According to the up-to-date available information, natural gas is expected in Cyprus by 2018 – 2019, while there are efforts from the Government to import natural gas as an interim solution earlier. Consequently, the Electricity Authority of Cyprus (single conventional fuel electricity producer) has included natural gas in its new development strategy. By importing natural gas, apart from the reduction of emissions from the actual use of the natural gas, this action will also contribute positively to emission reductions through the increased efficiency of the newer technologies used.

### Competent authority

Energy Service, Ministry of Energy, Commerce, Industry and Tourism

### Other involved authorities

- Cyprus Energy Regulatory Authority
- Public Natural Gas Company (DEFA)
- Electricity Authority of Cyprus
- Department of Environment

### Type

Political, legislative

### National legislation

- K.Δ.Π. 115/2006
- N. 183(I)/2004 as amended
- Relevant European legislation Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC

### Measures towards attainment

- Import and use of natural gas for electricity production
- Installation of combined cycle electricity production units using natural gas as fuel
- Decommissioning or conversion of existing electricity production units

### Comments

According to the delays noticed for the procedures and political decisions necessary for the import of natural gas, 2018 has been considered by the EAC as a more realistic date by which commercial supply of natural gas to Cyprus will commence. Therefore, 2018 has been used as the year of import of natural gas for the “With Existing Measures” and the “With Additional Measures” scenario. Natural gas is not included in the “Without measures” scenario.

## A2. RENEWABLE ENERGY SOURCES

The share of renewable energy sources in the primary energy consumption, based on the energy balance of Cyprus, has increased from 1.7% in 2007 to 4.2% in 2011 (Energy Service, 2013). Table 4.2 shows the distribution of the renewable energy sources according to the type of renewable technology and consumer.

Renewable energy sources and energy efficiency is promoted to the public by provisions of financial support schemes. The first support scheme was created in 1999 and the latest version, is for the period 2009 to 2013, and

was published in August 2010. The scheme has been well accepted by the public from the start of its implementation and the number of applications submitted annual to the competent authority for subsidies is increasing considerable year by year. The scheme is separated into three categories:

- (a) promotion of electricity production from large commercial wind farms, solar thermal and photovoltaic systems, the utilization of biomass
- (b) promotion of Energy Conservation and the Renewable Energy Sources for Individuals and Organizations that not exercise economic activity
- (c) promotion of Energy Conservation and the Renewable Energy Sources for Individuals and legal entities that exercise economic activity

According to Scheme (a), there are different buying price for the kWh produced which is further differentiated according to the type of technology implemented. The support scheme has been approved by the DG Competition (C(2009)5398).

The largest projects for which subsidy has been approved so far, are seven commercial scale wind farms with total installed capacity of 165 MWp (Cyprus Institute of Energy). The largest of the wind farms is already in operation since August 2010 (installed capacity 82MW). 1.74 MWp of large photovoltaic plants has also been accepted for subsidy appraisal and further approval

during 2009 and 2.26 MWp in 2010 (total of 32 projects) (Cyprus Institute of Energy, 2010b). All the projects are expected to be operational within 2012. It should be noted that the total installed capacity of the current electricity producing installations is approximately 1,000 MWp.

According to Directive 2009/28/EC, the share of renewable energy in gross final energy consumption in the European Union for 2020 should at least reach 20%. The specific binding target for Cyprus is 13%. Also, the share of energy from renewable sources in all forms of transport (vehicles, trains, metro) in 2020 should represent at least 10% of the final consumption of energy in transport. Each Member State is obliged to submit to the Commission the National Action Plan for Renewable Energy, which includes, inter-alia, the target path for achieving the targets for the share of RES in electricity, heating and cooling, and transport. The estimated target trajectory of energy from renewable sources for the years 2010, 2015 and 2020 for Cyprus to reach the goal of 13% and the intermediate targets to reach the 10% renewables in transport by 2020 are presented in Table 4.3.

Details on how Cyprus will achieve the targets are available in the National Renewable Energy Action Plans that has been prepared according to Article 4 of the renewable energy Directive (2009/28/EC) and submitted in July 2010.

**Table 4.2. Renewable energy sources in the energy balance of Cyprus in toe, 2011 (Energy Service, 2013)**

	Biofuels	Solar Thermal	Geothermal	Biomass	Electricity - Biomass	Electricity - Wind	Electricity - PV Systems	TOTAL
Cement industry				6953				6953
Road transport	16012							16012
Households (Heating)		53542	1045	5493			101	60181
Agriculture				4277	1023			5300
Industry				210				210
Commerce, Hotels & Services		9449		2615		5	46	12115
<b>TOTAL</b>	<b>16012</b>	<b>62991</b>	<b>1045</b>	<b>19548</b>	<b>1023</b>	<b>5</b>	<b>147</b>	<b>100771</b>
Electricity to Grid					3415	9826	880	14121

**Table 4.3. Summary of the targets trajectory for Renewable energy sources in Cyprus (according to the National Renewable Energy Action Plan)**

	2010	2015	2020
<b>Renewable energy sources to reach 13% in 2020 in the gross final energy consumption</b>			
Heating and cooling	16.2%	20%	23.5%
Electricity production	4.3%	8.4%	16%
Transport	2.2%	3.1%	4.9%
Total share of RES	6.5%	9.0%	13%
<b>Renewable energy sources in transport to reach 10% in 2020</b>			
Transport	2.2%	3.3%	10%

## A2.1. RENEWABLE ENERGY SOURCES IN ELECTRICITY PRODUCTION

Electricity production contributed 52% to the emissions of the energy sector in 2011, which corresponds to 41% to the total emissions of the country (excluding LULUCF) (Department of Environment, 2013). This corresponds to 3,722 Gg CO<sub>2</sub> eq., whereas the total emissions of the country without LULUCF were 9,154 Gg CO<sub>2</sub> eq. All units producing electricity in Cyprus for public use running on conventional fuels are operated by the Electricity Authority of Cyprus. The main fuel is HFO and some contribution of gas oil. Electricity production is regulated by the Emissions Trading System.

### Competent authority

Energy Service, Ministry of Energy, Commerce, Industry and Tourism

### Other involved authorities

- Cyprus Energy Regulatory Authority
- Transmission System Operator
- Ministry of Finance
- Department of Town Planning and Housing, Ministry of Interior
- Department of Environment, Ministry of Agriculture, Natural Resources and Environment

### Type

Legislative, voluntary

### National legislation

- Law No. 112(I)/2013 on the promotion and encouragement of the use of renewable energy sources which has repealed the old one (N.33(I)/2013)
- Law 110(I)/2011 establishing a European emissions trading system and other relevant issues

### Relevant EU legislation

- Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity from renewable energy sources in the internal electricity market (Directive 2001/77/EC is repealed by Directive 2009/28/EC from 1 January 2012. Moreover, from 1 April 2010, Article 2, paragraph 2 of Article 3 and Articles 4 to 8 will be deleted)
- Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC

- Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community

### Target

RES share in electricity production

- 2010: 4.3%
- 2015: 8.4%
- 2020: 16%

### Measures towards attainment

- RES support schemes
- Informational campaigns
- Implementation of relevant legislation

### Cost so far

€21,714,979

## A2.2. RENEWABLE ENERGY SOURCES FOR HEATING AND COOLING

Heating and cooling for industrial, housing and tertiary sectors, contributed 9% to the emissions of the energy sector in 2011, and 6.9% to the total emissions of the country (excluding LULUCF) (Department of Environment, 2013). The RES technologies promoted through the scheme are solar thermal, biomass and geothermal.

### Competent authority

Energy Service, Ministry of Energy, Commerce, Industry and Tourism

### Other involved authorities

- Department of Town Planning and Housing, Ministry of Interior
- Department of Environment, Ministry of Agriculture, Natural Resources and Environment
- Department of Labour Inspection, Ministry of Labour and Social Insurance

### Type

Legislative, voluntary

### National legislation

- Law No. 112(I)/2013 on the promotion and encouragement of the use of renewable energy sources, which has repealed the old one (N.33(I)/2013)
- Law No. 142(I)/2006 regulating energy efficiency in buildings
- Law No. 30(I)/2009 amending Law No. 142(I)/2006 regulating energy efficiency in buildings

- Law No. 56(I)/2003 on Integrated Pollution Prevention Control (with amending laws no. 15(I)/2006, 12(I)/2008)

#### Relevant EU legislation

- Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity from renewable energy sources in the internal electricity market (Directive 2001/77/EC is repealed by Directive 2009/28/EC from 1 January 2012. Moreover, from 1 April 2010, Article 2, paragraph 2 of Article 3 and Articles 4 to 8 will be deleted)
- Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC
- Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community
- Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control and related amendments

#### Target<sup>12</sup>

RES share in energy consumption for heating and cooling

- 2010: 16.2%
- 2015: 20%
- 2020: 23.5%

#### Measures towards attainment

- RES support schemes
- Informational campaigns
- Implementation of relevant legislation

#### Cost so far

€24,627,614

#### Comments

- Directive 2009/29/EC and its predecessor, 2003/87/EC indirectly promote the production of energy conservation through the use of alternative technologies using RES
- EU on waste and IPPC are indirectly promoting anaerobic digestion to livestock breeding units.

### A2.3. RENEWABLE ENERGY SOURCES IN TRANSPORT

According to the Directive 2009/28/EC on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC and the action plan submitted by Cyprus for the achievement of the target set, RES in transport should be 2.2% in 2010, 3.1% in 2015 and 4.9% in 2020. Moreover, in order to reach the 10% target by 2020, the aim is to have 2.2% RES in 2010 and 3.3% in 2015.

#### Competent authority

Energy Service, Ministry of Energy, Commerce, Industry and Tourism

#### Other involved authorities

- Department of Customs
- Department of Environment, Ministry of Agriculture, Natural Resources and Environment

#### Type

Legislative, voluntary

#### National legislation

- Law No. 112(I)/2013 on the promotion and encouragement of the use of renewable energy sources, which has repealed the old one (N.33(I)/2013)
- Law No.148 (I)/2003 on the petroleum products and fuels specification
- Decrees 63/2008 and 16/2009 on the content of biofuels in transport conventional fuels

#### Relevant EU legislation

- Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity from renewable energy sources in the internal electricity market (Directive 2001/77/EC is repealed by Directive 2009/28/EC from 1 January 2012. Moreover, from 1 April 2010, Article 2, paragraph 2 of Article 3 and Articles 4 to 8 will be deleted)
- Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC
- Directive 2009/30/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending

<sup>12</sup> % includes the target from measure A5, i.e. use of waste as fuel for cement industry; does not include the use of waste as fuel for cement industry.

Council Directive 1999/32/EC as regards the specification of fuel used by inland waterway vessels and repealing Directive 93/12/EEC

- Decision 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020

#### Target

RES share in transport

- 2010: 2.2%
- 2015: 3.3%
- 2020: 10%

#### Measures towards attainment

- Implementation of grant scheme for installations producing biofuels
- Implementation of relevant legislation

#### Cost so far

€2,611,923

### A3. ENERGY EFFICIENCY AND SAVINGS

According to the Directives 2002/91/EC and 2010/31/EC, the member states have submitted to the European commission their action plan to achieve the target for energy savings in buildings. Measure A3, presents the targets set by Cyprus through the action plan submitted in 2011. These shall be revised during 2014 for the new national submission. Tables in the pages that follow describe the measures included in the energy efficiency and savings measure.

#### A3.1. SAVINGS FROM ENERGY EFFICIENCY IN RESIDENTIAL BUILDINGS

##### Competent authority

Energy Service, Ministry of Energy, Commerce, Industry and Tourism

##### Other involved authorities

- Ministry of Interior
- Municipalities
- Department of Environment

##### Type

Legislative, compulsory

##### National legislation

Law No. 142(I)/2006 regulating energy efficiency of buildings and amending Law No. 30(I)/2009

##### Relevant EU legislation

Decision 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020

##### Target<sup>13</sup>

Energy savings

- 2015: 12% electricity, 0.6% heating & cooling
- 2020: 24% electricity, 1.2% heating & cooling

##### Measures towards attainment

- Implementation of national action plan on energy efficiency
- Implementation of national legislation

##### Comments

- Decision 406/2009/EC is also requiring the sector of buildings to reduce its emissions.

#### A3.1. SAVINGS FROM ENERGY EFFICIENCY IN TERTIARY BUILDINGS

##### Competent authority

Energy Service, Ministry of Energy, Commerce, Industry and Tourism

##### Other involved authorities

- Ministry of Interior
- Municipalities
- Department of Environment

##### Type

Legislative, compulsory

##### National legislation

Law No. 142(I)/2006 regulating energy efficiency of buildings and amending Law No. 30(I)/2009

##### Relevant EU legislation

Decision 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020

##### Target<sup>13</sup>

- Energy savings
  - 2015: 1.7% electricity, 0.1% heating & cooling
  - 2020: 3.5% electricity, 0.2% heating & cooling

<sup>13</sup> % includes the target from measure A5, i.e. use of waste as fuel for cement industry; does not include the use of waste as fuel for cement industry.

#### Measures towards attainment

- Implementation of national action plan on energy efficiency
- Implementation of national legislation

#### Comments

- Decision 406/2009/EC is also requiring the sector of buildings to reduce its emissions.

### A3.3. SAVINGS FROM EFFICIENT BULBS

#### Competent authority

Energy Service, Ministry of Energy, Commerce, Industry and Tourism

#### Other involved authorities

Department of Environment

#### Type

Legislative, compulsory

#### National legislation

Law No. 31/2009 on energy end-use efficiency and energy services

#### Relevant EU legislation

- Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC
- Decision 406/209/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020

#### Target

Energy savings

- 2015: 3.2% electricity
- 2020: 2% electricity

#### Measures towards attainment

- Information campaign and promotion of energy efficient lamps

#### Cost so far

€2,710,840

### A3.4. SAVINGS FROM INSULATION IN RESIDENTIAL SECTOR

#### Competent authority

Energy Service, Ministry of Energy, Commerce, Industry and Tourism

#### Other involved authorities

Department of Environment

#### Type

Legislative, compulsory

#### National legislation

Law No. 31/2009 on energy end-use efficiency and energy services

#### Relevant EU legislation

- Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC.
- Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings
- Decision 406/209/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020

#### Target

Energy savings

- 2015: 1.7% electricity, 0.1% heating & cooling
- 2020: 1.5% electricity, 0.1% heating & cooling

#### Measures towards attainment

Grant scheme for energy conservation

#### Cost so far

€33,512,981

### A3.5. SAVINGS IN EXISTING COMPANIES

#### Competent authority

Energy Service, Ministry of Energy, Commerce, Industry and Tourism

#### Other involved authorities

Department of Environment

#### Type

Legislative, compulsory

#### National legislation

Law No. 31/2009 on energy end-use efficiency and energy services

#### Relevant EU legislation

- Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC.



- Decision 406/209/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020

Target

Energy savings

- 2015: 2.1% electricity, 0.1% heating & cooling
- 2020: 1.3% electricity, 0.07% heating & cooling

Measures towards attainment

Grant scheme for energy conservation

Cost so far

€6,129,138

Planned Cost

~€1,000,000 annually

#### A4. IMPROVEMENT OF ELECTRICITY DISTRIBUTION SYSTEM

The electricity Distribution System is under the management of the Distribution System Operator of Cyprus. No specific target is available for the reduction of losses; the target was set as annual reduction of emissions from losses by 0.1% (reduction from electricity emissions). Competent authority is the National Transition System Operator of Cyprus, whereas other involved authorities are the Electricity Authority of Cyprus and the Department of Environment.

Some of the actions taken in order to improve the electricity distribution system include the following:

- In order to maintain voltage levels within permissible limits, the Electricity Authority of Cyprus installed 4 x 16MVAR (64 MVAR) inductor VAR Compensators at medium voltage (distribution system);
- Actions are underway in order to receive TA for increasing RES electricity generation;
- Better grid and load management via smart meters/grids; the Electricity Authority of Cyprus is currently deploying a pilot system which will indicate best technical solutions as well as the costs and benefits of a potential full roll-out

#### A5. PROMOTION OF BIOMASS AND ALTERNATIVE FUELS IN INDUSTRY

There are two cement plants in operation in Cyprus which have merged into one company in 2009. Both cement plants stopped their operation since the late 2011, that a new cement plant started its operation. One of the advantages of the new installation, in addition to the higher efficiency in production, is that it can use larger amounts of biomass and alternative fuels for the production of thermal energy.

Competent authority

Energy Service, Ministry of Energy, Commerce, Industry and Tourism

Other involved authorities

Department of Environment

Type

Voluntary

National legislation

Law No. 33(I)/2003 on the promotion and encouragement of the use of renewable energy sources and Energy Conservation

Relevant European legislation

- Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity from renewable energy sources in the internal electricity market (Directive 2001/77/EC is repealed by Directive 2009/28/EC from 1 January 2012. Moreover, from 1 April 2010, Article 2, paragraph 2 of Article 3 and Articles 4 to 8 will be deleted)
- Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC
- Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community

Target

Energy production from waste

- 2015: 3.6% of energy
- 2020: 3.8% of energy

### 4.3. SECTORAL POLICIES AND MEASURES: TRANSPORT

In 2011, road transport emissions contributed 24.5% of the total national emissions excluding LULUCF (Department of Environment, 2013). The emissions of road transport increased by 91% compared to 1990. According to information from the International Road Federation, Cyprus has the highest car ownership rate in the world with 742 cars per 1,000 people (International Road Federation, 2009). Other means of transport are very low compared to other countries: 3% public transport and bicycle less than 2% (Ministry of Communications and Public Works, 2010).

In addition to the importance for emissions, transport has been an issue of particularly great interest to the society of Cyprus, due to the very large growth of the number of privately owned cars and the associated problems in traffic that are experienced, especially in the capital, Nicosia. Even though many studies have been completed since the 1990s on how to deal with traffic in the urban areas of Cyprus and especially Nicosia, only recently (end of 2009) action has been taken and measures are implemented.

The following two measures are currently under study. However, the preparation of the measures is not mature enough to estimate the reduction in GHG emissions or cost.

- a. Deployment of electric vehicle infrastructure: The Department of Electrical and Mechanical Services is preparing a regulatory framework in order to promote the electric vehicle and also facilitate the deployment of the electric vehicle infrastructure. The regulatory framework will consist of direct financial incentives (through structural funds proposals) for the installation of charging stations, tax incentives and also public procurements for the deployment of infrastructure. Furthermore, it will consist of policy measures with non-financial incentives such as preferential access to parking areas, roadside parking, building and parking permits etc.
- b. Permission of Liquid Petroleum Gas to be used as Transport Fuel: In 2014 is expected through legislation the permission of the usage of liquid petroleum gas (LPG) as a transport fuel. Depending on the usage of

the LPG on private vehicles is expected to have an impact on the greenhouse gases emissions.

#### B1. PROMOTION OF PUBLIC TRANSPORT

According to the plans of the Ministry of Communications and Public Works, the target is to increase the contribution of public transport from 2% in 2009 to 10% by 2015 (Department of Environment, 2010). Towards this end, at the end of 2009 the legal framework concerning public transport was revised, which has allowed the development of the new urban, suburban and intercity bus routes and schedules.

##### Competent authority

Ministry of Communications and Public Works

##### Other involved authorities

Department of Environment

##### Type

Policy

##### National legislation

- Law No. 101(I)/2009 on the access to the profession of road transport (amending)
- Law No. 96(I)/2009 on the regulation of road transport (amending)

##### Relevant EU legislation

- Decision 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020

##### Target

- Reduction in fuel consumption for transport
- 2015: 1.9%
  - 2020: 4.4%

##### Measures towards attainment

- Development and implementation of mobility master plans and land use transportation studies for the four large urban areas in the areas under the effective control of the Republic of Cyprus
- Development of infrastructure for public transport (bus lanes, bus priority lanes, new bus stops, new bus stations)
- Development and implementation of "park-and-ride" systems
- Study for the development of a tram system

### Comments

- Approximately 50% of the non-ETS emissions of Cyprus are from transport, therefore considerable effort is needed by the sector to reduce the overall non-ETS emissions

## B2. PROMOTION OF LOW CO<sub>2</sub> VEHICLES

The Motor Vehicle and Road Traffic Law of 2013 has brought changes to the registration and licence of a motor vehicle. The new road tax charge for vehicles registered from 1/1/2014 will depend on their CO<sub>2</sub> emissions. Vehicles registered by 31/12/2013 do not have to pay road tax based on their CO<sub>2</sub> emissions, but their owners will be charged an additional fee depending on engine size.

Electric cars and vehicles with CO<sub>2</sub> emissions of less than or equal to 120g/km (combined cycle) are exempted from the additional registration fee.

The registration fee for vehicles with CO<sub>2</sub> emissions over 120g/km and up to 150g/km will be €25 per gram over 120g. A €750 fee will be charged for vehicles emitting between 150g/km and 180g/km and a €2,250 fee for emissions above that, plus €400 for every gram over 180.

The new road tax will be charged as follows: vehicles emitting 120g/km, €0.5 per gram, 120g/km – 150g/km, €3, 150g/km – 180g/km, €3, and over 180g/km, €8.

For already registered vehicles (cars and motorcycles), the law provides for a special fee – above and beyond the current road tax – of €10 for low emissions, €20 for vehicles with engine displacements up to 2050 cc, and €30 for vehicles with engine displacements higher than 2050 cc.

### Competent authority

Ministry of Communications and Public Works

### Type

Legislative, voluntary

### National legislation

Motor Vehicle and Road Traffic Law of 2013 (no. 100(I)/2013)

### Target

Reduction in CO<sub>2</sub> emissions from road transport

- 2015: 2%
- 2020: 5%

### Comments

Approximately 50% of the non-ETS emissions of Cyprus are from transport; therefore considerable effort is needed by the sector to reduce the overall non-ETS emissions

## 4.4. SECTORAL POLICIES AND MEASURES: INDUSTRY

No policies and measures for industrial activities are in place or planned.

## 4.5. SECTORAL POLICIES AND MEASURES: AGRICULTURE

## D1. PROMOTION OF ANAEROBIC DIGESTION - LIVESTOCK BREEDING WASTE TREATMENT

Even though anaerobic digestion is not clearly stated in the European or national legislation, the technology is preferred by large livestock breeding plants to comply with the terms stated on the wastewater and air disposal permits. The technology is strongly promoted by the Department of Environment, especially for the large installations that fall under the IPPC directive. Relevant national legislation that encourages the promotion of anaerobic digestion is (a) the Control of Water Pollution (Waste Water Disposal) Regulations 2003, K.Δ.Π. 772/2003; (b) the Control of Water Pollution (Sensitive Areas for urban waste water discharges) K.Δ.Π. 111/2004. It is a voluntary measure which is expected to increase by 1% annually, starting from additional 1% in 2012, until 2015; after 2015, the increase in the reduction will reduce to 0.5% annually.

## 4.6. SECTORAL POLICIES AND MEASURES: FORESTRY

No policies and measures for forestry are in place or planned.

## 4.7. SECTORAL POLICIES AND MEASURES: WASTE

With the Landfill Directive being the main guiding force, in combination to the improvement of the infrastructure of the country, Cyprus has been developing during the recent years the revised strategy for solid waste

management. The management of the municipal solid waste is under the competence of the Ministry of Interior.

## C1. METHANE RECOVERY FROM EXISTING AND NEW WASTE MANAGEMENT SITES

All the solid waste management sites in Cyprus are currently under replacement or improvement. Currently in Cyprus, there are:

- (a) Two landfills are in operation (Pafos landfill and Koshi landfill for Larnaca and Ammochostos districts)
- (b) Two landfills are in the design phase (Nicosia and Limassol landfills) and are expected to be in operation by 2014.

Biogas collection systems have been included in the design of all landfills.

### Competent authority

Ministry of Interior

### Other involved authorities

Department of Environment

### Type

Legal

### National legislation

- Law No. 215(I)/2002 on solid and hazardous waste and amendments No. 162(I)/2005, 17(I)/2006, 63(I)/2009
- Decree No. K.Δ.Π. 160/2003 and K.Δ.Π. 161/2003 on application for waste management permit
- Regulations No. K.Δ.Π. 562/2003 on landfills
- Law No. 85(I)/2005 on council of disposal or recovery sites of household sites
- Decree No. K.Δ.Π. 282/2007 establishing criteria and procedures for the acceptance of waste at landfills

### Relevant EU legislation

- Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste
- Directive 2006/12/EC of the European Parliament and of the Council of 5 April 2006 on waste
- Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives
- Council Directive 75/442/EEC of 15 July 1975 on waste
- Council Decision 2003/33/EC establishing criteria and procedures for the acceptance of waste at landfills

pursuant to article 16 of and Annex II to Directive 1999/31/EC

- Commission Decision 2000/532/EC of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste

### Target

Biogas collection

- 2010: 10%
- 2015: 10%
- 2020: 70%

### Measures towards attainment

In Cyprus S.M.W are collected under the responsibility of the Local Authorities (either with their own services or by contracts with private companies) and dispose them in four official disposal landfills. Two of the disposal landfills, the residual landfill of Larnaca-Ammochostos and the landfill of Paphos, meet the requirements of the European Union framework Council Directive on the landfill of waste 99/31/EC. The other two landfills of the Districts of Nicosia (Kotsiatis) and Lemesos (Bati) operate with controlled disposal but, they do not meet the requirements of the Directive.

The Larnaca-Ammochostos residual landfill is part of the Integrated Waste Management Plant (I.W.M.P) in which mechanical sorting of mixed S.M.W for recyclable materials take place and also the organic fragment (Biological Treatment) is processed for the production of compost. The designed maximum capacity of the Plant is 160,000 tn/y S.M.W (Output products: 17% recovery of recyclables, 17% RDF, 35% Compost, 1% water losses/flight materials, 30% Residuals) and the construction cost was €46 million plus V.A.T which was co-financed by the Cohesion Fund and National Fund from the Programming Period 2004-2006.

The design stage of the two (2) districts (Nicosia and Limassol) has been completed and it is expected the approval of the tender documents related to construction of the two (2) projects.

### Cost so far

€820,000

### Planned Cost

€140,000,000

### Comments

It is anticipated the construction of the two (2) projects (Nicosia and Limassol) to commence the second half of the 2014.

## C2. MANAGEMENT OF UNCONTROLLED DISPOSAL SITES

In addition to methane collection, the new waste management sites will allow the discontinuation of operation of the uncontrolled disposal sites that are currently operating.

### Competent authority

Ministry of Interior

### Other involved authorities

Department of Environment

### Type

Policy

### National legislation

- Law No. 215(I)/2002 on solid and hazardous waste and amendments No. 162(I)/2005, 17(I)/2006, 63(I)/2009
- Decree No. Κ.Δ.Π. 160/2003 and Κ.Δ.Π. 161/2003 on application for waste management permit
- Regulations No. Κ.Δ.Π. 562/2003 on landfills
- Law No. 85(I)/2005 on council of disposal or recovery sites of household sites
- Decree No. Κ.Δ.Π. 282/2007 establishing criteria and procedures for the acceptance of waste at landfills

### Relevant EU legislation

- Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste
- Directive 2006/12/EC of the European Parliament and of the Council of 5 April 2006 on waste
- Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives
- Council Directive 75/442/EEC of 15 July 1975 on waste
- Council Decision 2003/33/EC establishing criteria and procedures for the acceptance of waste at landfills pursuant to article 16 of and Annex II to Directive 1999/31/EC
- Commission Decision 2000/532/EC of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste

### Target

Biogas collection

- 2010: 5%
- 2015: 20%
- 2020: 60%

### Measures towards attainment

Before the operation of the residual landfill of Larnaca-Ammochostos (01/04/2010) and the landfill of Paphos (01/06/2005), the disposal of Solid Municipal Waste (S.M.W) was uncontrolled, especially in rural areas. During the implementation of the Strategic Plan for the Uncontrolled Waste Disposal Landfills in Cyprus (U.W.D.L), a study was completed which identified and recorded 117 U.W.D.L, throughout Cyprus, and ranked them according to their potential risk to the environment. The study was co-funded by the European Union within the framework of the Pre-accession Regulation 2003. There were operated 37 U.W.D.L in Paphos, 13 in Larnaca, 3 in Ammochostos, 44 in Lemesos and 20 in Nicosia. The operation of all U.W.D.L were gradually terminated, except of 1 in Nicosia (Kotsiatis) and 1 in Lemesos (Bati), which are used for the disposal of the S.M.W from the two districts. Rehabilitation and reintegration in the natural environment of the U.W.D.L have been done through four different construction contracts for each district. The contract for Paphos was signed in June 2013 and restoration works have been already began. Tenders were submitted and technical proposals were evaluated for Larnaca-Ammochostos districts. It is expected the final decision from Tenders Review Authority due to three (3) hierarchical recourses.

### Cost so far

€2,000,000

### Planned Cost

€36,000,000

### Comments

It is anticipated to begin the design stage of the rehabilitation of U.W.D.L for the other two districts (Nicosia and Limassol) next year (2014) and the construction of these projects 2016.

## C3. PROMOTION OF ANAEROBIC DIGESTION - SEWAGE SLUDGE

Even though anaerobic digestion is not clearly stated in the European or national legislation, the technology is preferred by the wastewater treatment plants to comply

with the terms stated on the wastewater and air disposal permits. The technology is strongly promoted by the Department of Environment, especially for the large installations that fall under the IPPC directive. Relevant national legislation that encourages the promotion of anaerobic digestion is (a) the Control of Water Pollution (Waste Water Disposal) Regulations 2003, Κ.Δ.Π. 772/2003; (b) the Control of Water Pollution (Sensitive Areas for urban waste water discharges) Κ.Δ.Π. 111/2004. It is a voluntary measure which is expected to increase by 0.5% annual, starting from 0.5% in 2012.

## 4.8. OTHER MEASURES

### 4.8.1. EMISSIONS TRADING SYSTEM

The European Union Emissions Trading System (EU ETS) covers 13 installations in Cyprus, responsible for around 58% of the Cyprus' emissions (Energy Service, 2013). The EU ETS covers electricity generation (three installations) and the main energy-intensive industries of the country, cement production (two installations) and ceramics production (eight installations). Phase II of the system started on 1 January 2008 and will run until 31 December 2012.

### 4.8.2. LOCAL AUTHORITIES INITIATIVES

In 2008 a new NGO was established in Cyprus, the "Cyprus Energy Agency", funded by the European Commission (75%) and the Union of Cyprus Communities (25%). The purpose of the "Cyprus Energy Agency" is to promote renewable energy sources and innovative technologies, energy efficiency and viable transport. The establishment of the particular NGO has created a new dynamic in the initiatives of local authorities. With the coordination of the organisation, Cypriot communities participate in programs for the reduction of emissions.

Particular attention at the moment is paid to the energy efficiency in municipalities and communities. Already, eleven municipalities and three communities have developed their own Energy Action Plans for the period 2010 to 2020. The measures included are implemented locally and are additional to the measures promoted and implemented by the competent authorities at national level.

The programs in which the municipalities and communities participate are the Covenant of Mayors and the European Islands Network on Energy and Environment (ISLE-PACT). The total reduction in CO<sub>2</sub> emissions has been estimated at 124 Gg CO<sub>2</sub> by 2020.

### ***These measures have been taken into consideration in the "With Additional Measures" scenario.***

Further measures have also been designed at local level, with the initiative on municipalities and communities. An example is the municipality of Aglantzia that has designed the following measures and is in the stage of implementation:

- (a) Established an Inter-municipal Bicycle Company for bicycle hiring in central Nicosia - in collaboration with other municipalities of central Nicosia
- (b) "Car-pooling" service: service providing transport of people from other cities to Nicosia – in collaboration with the University of Cyprus
- (c) Improvement of pedestrian routes in the municipality (approximately 5000 metres)
- (d) Improvement of cycling routes in the municipality (approximately 2500 metres)
- (e) Improvement and expansion of green areas in the municipality

## 4.9. POLICIES AND MEASURES NO LONGER IN PLACE

Two measures that have been repealed during 2013:

- (a) The promotion of alternative technologies in road transport. The promotion of hybrid and electric vehicles was part of the energy efficiency scheme of the Ministry of Energy, Commerce, Industry and Tourism. This Scheme included subsidies, tax reductions and reduced circulation fees, for the following categories and subcategories of road transport: Purchase of a new Hybrid Vehicle, Purchase of a new Fuel Flexible Vehicle - FFV/Dual Propulsion Vehicle, Purchase of a new Electric Vehicle and Purchase of a new low carbon emission vehicle.
- (b) Since 2008, withdrawal of old vehicle schemes by the Ministry of Communications and Public Works were implemented. Until 2011 24,752 vehicles have been withdrawal from the start of the scheme. One of the

conditions that had to be met during the latest scheme (end of 2010) was that the owner of the vehicle withdrawn had to buy a new vehicle with CO<sub>2</sub> emissions lower or equal to 165 g/km. It was a voluntary measure.

#### 4.10. EU POLICIES

##### Europe 2020<sup>14</sup>

Europe 2020 is the growth strategy for the European Union for this decade and builds upon the lessons learnt from the Lisbon Strategy and also draws on the benefits that have arisen from the coordinated response to the financial crisis in the European Recovery Plan. The main objective of Europe 2020 is to deliver ‘smart, sustainable, inclusive growth’ as a result of greater coordination of both national and European policies. The three priorities of the Europe 2020 strategy are outlined in a 2010 communication entitled ‘Europe 2020: A strategy for smart, sustainable, inclusive growth’ and include:

- Smart growth: developing an economy based on knowledge and innovation;
- Sustainable growth: promoting a more resource-efficient, greener and more competitive economy;
- Inclusive growth: fostering a high employment economy delivering social and territorial cohesion.

Seven flagship initiatives have been presented to address these priorities. In relation to sustainable growth, these include the “Re-source Efficient Europe Flagship” which was launched in 2011. The flagship initiative provides a long-term framework for actions in many policy areas, supporting policy agendas for climate change, energy, transport, industry, raw materials, agriculture, fisheries, biodiversity and regional development.

In contrast to the Lisbon Strategy, there is more of an emphasis on sustainability in the Europe 2020 Strategy and therefore attaining the EU’s 20/20/20 climate and energy targets is one of the five headline targets. The national targets for Cyprus that are included in the Europe 2020 strategy that are relevant to climate change are the following:

- To reduce the emissions from fuel combustion, fugitive emissions from fuels, industrial processes, solvent and other product use, agriculture and waste to 95% of 2005 by 2020.
- Achieve an increase of 14.3% (463 ktoe) in energy savings in the projected primary energy consumption of the year 2020.
- To increase the contribution of renewable energy sources in 2020, to 13% of the gross final energy consumption and 10% RES in the final consumption of energy in transport.

##### European climate change program

The European Climate Change Programme (ECCP) was established in June 2000 to provide a cohesive framework to identify and develop the necessary elements of an EU strategy to implement the Kyoto Protocol. In autumn 2005, the ECCP II was launched as a continued programme for policy preparation and development. This second phase investigated new policy areas such as adaptation, aviation and carbon capture and storage, as well as reviewing and further implementing policies and measures that were the focus of ECCP I. Further information was included in the EU’s 4th National Communication.

##### Energy & Climate package

In December 2008, the European Parliament and the European Council agreed on the EU Climate and Energy package, which for the first time provided an integrated and ambitious package of policies and measures to tackle climate change. The Climate and Energy package was formally adopted in 2009. It includes the 20-20-20 targets, which set the following key objectives:

- To reduce greenhouse gas emissions by at least 20 % compared to 1990 by 2020, with a firm commitment to increase this target to 30 % in the event of a satisfactory international agreement being reached;
- To achieve 20 % of energy from renewable sources by 2020 (as a share of total EU gross final energy consumption), supplemented by a target to achieve a minimum of 10 % renewable in all forms of transport; and
- A commitment to save 20 % of total primary energy consumption by 2020 compared to a Business as Usual baseline.

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In order to deliver these key objectives the Climate and Energy package comprises four pieces of complementary legislation:

- A Directive revising the EU Emissions Trading System (EU ETS), which covers some 40% of EU greenhouse gas emissions;
- An "effort-sharing" Decision setting binding national targets for emissions from sectors not covered by the EU ETS;
- A Directive setting binding national targets for increasing the share of renewable energy sources in the energy mix;
- A Directive creating a legal framework for the safe and environmentally sound use of carbon capture and storage technologies.

The package is complemented by two further legislative acts that were agreed at the same time: A regulation requiring a reduction in CO<sub>2</sub> emissions from new cars (CO<sub>2</sub> regulation) and a revision of the Fuel Quality Directive. Energy efficiency is not directly covered by the Climate and Energy package; however the Energy Efficiency Directive was adopted in 2012 to help achieve the energy efficiency target.

The 20-20-20 targets have recently been adopted as one of the headline targets of the Europe 2020 strategy and progress towards achieving the three key objectives of the Climate and Energy package includes:

- GHG emissions for the EU27 in 2011 have reduced by 17% compared to 1990 levels.
- The share of renewables in the final energy consumption of the EU27 was 13 % in 2011 – compared to 8.5 % in 2005.
- Primary energy consumption peaked in 2006 (approximately 1706 Mtoe) and is decreasing since 2007 to reach 1583 Mtoe in 2011.

The national targets for Cyprus that are included in the Climate and Energy package are the following:

- Reduce the emissions from Fuel combustion, Fugitive emissions from fuels, Industrial processes, Solvent and other product use, Agriculture and Waste to 95% of 2005 by 2020.
- New targets are also allocated to the installations included in the EU-ETS. On average, the goal is to reduce the EU wide emissions from installations

included in the EU-ETS by 21% by 2020 compared to 2005.

- Increase of the contribution of Renewable Energy Sources (RES) to 13% of the total energy consumption by the year 2020.

The share of energy from renewable sources in all forms of transport in 2020 is at least 10 % of the final consumption of energy in transport

### **The Energy 2020 strategy**

The achievement of Europe's ambitious goals will require substantial change in Europe's energy system, with public authorities, energy regulators, infrastructure operators, the energy industry and citizens all actively involved, and tough choices to be made. The European Commission therefore published a Second Strategic Energy Review on 13<sup>th</sup> November 2008 as a further step towards achieving the core energy objectives of sustainability, competitiveness and security of supply. For further details on the strategy refer to the 6th National Communication of the EU.

The regulation identifies a set of priority infrastructure that needs to be constructed in order to facilitate a functioning internal market that can integrate a large scale production of renewables and guarantee security of supply. Further actions to support the building of a truly pan-European integrated energy market include the timely and accurate implementation of the internal market legislation, streamlining permit procedures and market rules for infrastructure developments and to provide the right financing framework.

In order to extend Europe's leadership in energy technology and innovation the Energy 2020 Strategy calls for the implementation of the Strategic Energy Technology (SET) plan, which establishes an energy technology policy for Europe – accelerating the development and deployment of cost-effective low carbon technologies. The importance of funding for 'frontier research' and strengthening external links is also emphasised within the Energy 2020 Strategy.

### **Roadmaps 2050**

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' b) the 'Roadmap to a Single European



Transport Area - Towards a Competitive and Resource Efficient Transport System' and c) the 'Energy Roadmap 2050.' 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. For further details on the roadmaps refer to the 6th National Communication of the EU.

### **2030 Framework for Climate and Energy policies**

On the 27th of March 2013 the European Commission adopted a Green Paper entitled 'A 2030 Framework for climate and energy policies'. The key objectives of the 2030 framework will include the reduction of greenhouse gas emissions, securing energy supply and supporting economic growth. For further details on the roadmaps refer to the 6th National Communication of the EU.

### **7th Environmental Action Programme**

Since the 1970s, Environment Action Programmes (EAPs) have provided been the foundation in the development of EU environmental policy. In July 2012, the 6th EAP expired and the process to agree upon a successor programme was a priority for the EU. A political agreement on a new General Union Environment Action Programme to 2020 (entitled 'Living well, within the limits of our planet') was found between the European Commission, the European Parliament and the Council in June 2013. The 7th EAP - proposed by the European Commission in 2012 - provides an overarching framework for environmental policy (without set specific objectives for climate policy as this now is a separate policy area) for the next decade, identifying nine priority objectives for the EU and its Member States. For further details on the roadmaps refer to the 6th National Communication of the EU.

## 5. PROJECTIONS AND THE TOTAL EFFECTS OF POLICIES AND MEASURES

### 5.1. INTRODUCTION

This Chapter describes a “without measures” or “business as usual” (BaU) scenario, a “with measures” or “with existing measures” (WEM) scenario and a “with additional measures” (WAM) scenario concerning the national projections of greenhouse gas emissions by sources and their removals by sinks for the years 2010, 2015 and 2020. The “without measures” scenario assumes that no emission reduction policies are implemented. 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” scenarios assume the implementation of additional policies (planned). The three scenarios are presented in the following section.

### 5.2. PROJECTIONS

The projections of GHG emissions in the “without measures” scenario disaggregated by sector and by gas are presented in Tables 5.1 and 5.2. The “with measures” scenario, disaggregated by sector and by gas is presented in Tables 5.3 and 5.4. The “with additional measures” scenario disaggregated by sector and by gas is presented in Tables 5.5 and 5.6. In Figure 5.1 the evolution of GHG emission projections is also illustrated.

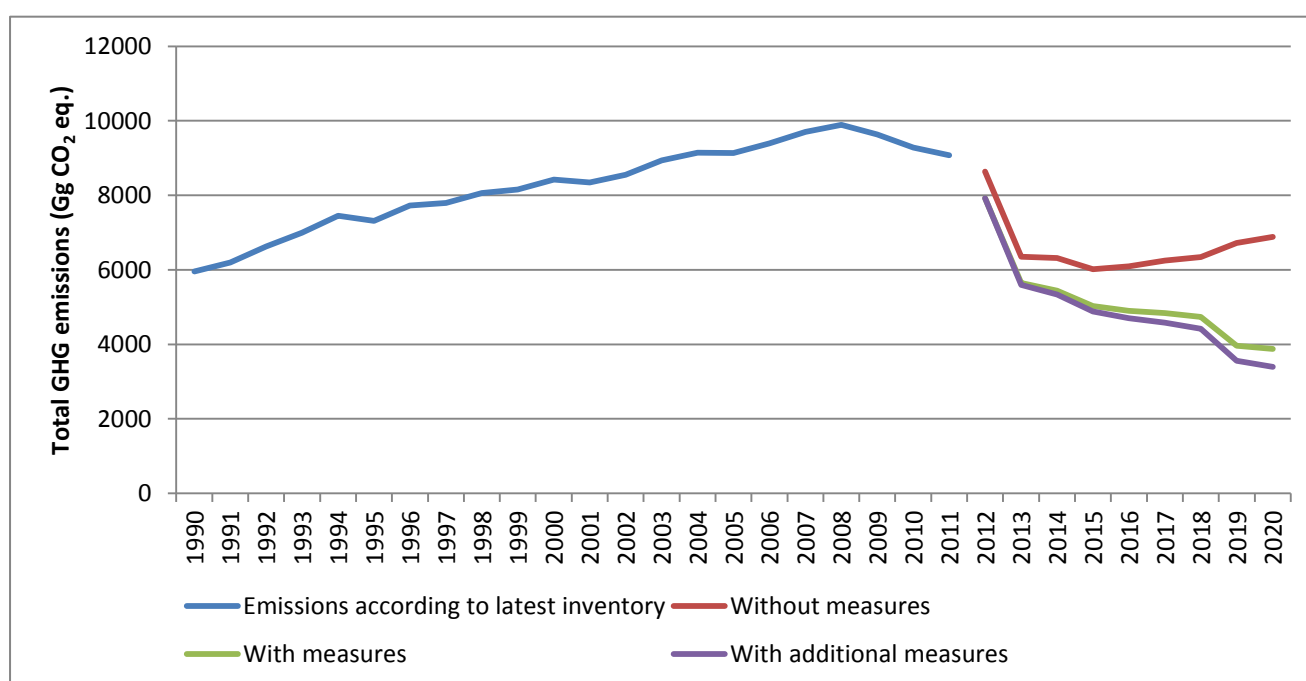


Figure 5.1. GHG emissions projections

Table 5.1. Projection of GHG emissions according to the “without measures” scenario, disaggregated by sector (Gg CO<sub>2</sub> eq.)

	Energy	Industrial activities	Agriculture	Waste	Total excl. LULUCF	LULUCF	Total incl. LULUCF
<b>1990</b>	4214	728	679	470	6091	-139	5952
<b>1995</b>	5308	805	779	574	7466	-149	7317
<b>2000</b>	6361	831	744	639	8575	-150	8424
<b>2005</b>	6995	915	738	663	9311	-174	9137
<b>2010</b>	7441	642	722	639	9444	-166	9278
<b>2015</b>	4731	462	484	391	6068	-51	6017
<b>2020</b>	5410	528	553	448	6939	-58	6881

Table 5.2. Projections of GHG emissions (excluding LULUCF) according to the "without measures" scenario, disaggregated by gas (Gg CO<sub>2</sub> eq.)

	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	Total excl. LULUCF
1990	4922	719	450	0	6091
1995	6088	868	510	0	7465
2000	7144	927	484	19	8574
2005	7857	960	472	22	9311
2010	7992	945	450	56	9444
2015	4741	555	283	78	5657
2020	5422	634	324	89	6470

Table 5.3. Projection of GHG emissions according to the "with measures" scenario, disaggregated by sector (Gg CO<sub>2</sub> eq.)

	Energy	Industrial activities	Agriculture	Waste	Total excl. LULUCF	LULUCF	Total incl. LULUCF
1990	4214	728	679	470	6091	-139	5952
1995	5308	805	779	574	7466	-149	7317
2000	6361	831	744	639	8575	-150	8424
2005	6995	915	738	663	9311	-174	9137
2010	7441	642	722	639	9444	-166	9278
2015	3779	462	484	350	5075	-51	5024
2020	2689	528	553	167	3937	-58	3879

Table 5.4. Projections of GHG emissions (excluding LULUCF) according to the "with measures" scenario, disaggregated by gas (Gg CO<sub>2</sub> eq.)

	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	Total excl. LULUCF
1990	4922	719	450	0	6091
1995	6088	868	510	0	7465
2000	7144	927	484	19	8574
2005	7857	960	472	22	9311
2010	7992	945	450	56	9444
2015	4138	551	301	84	5075
2020	3105	395	340	96	3937

Table 5.5. Projection of GHG emissions according to the "with additional measures" scenario, disaggregated by sector (Gg CO<sub>2</sub> eq.)

	Energy	Industrial activities	Agriculture	Waste	Total excl. LULUCF	LULUCF	Total incl. LULUCF
1990	4214	728	679	470	6091	-139	5952
1995	5308	805	779	574	7466	-149	7317
2000	6361	831	744	639	8575	-150	8424
2005	6995	915	738	663	9311	-174	9137
2010	7441	642	722	639	9444	-166	9278
2015	3641	462	484	344	4931	-51	4880
2020	2251	528	553	125	3458	-58	3400

Table 5.6. Projections of GHG emissions (excluding LULUCF) according to the "with additional measures" scenario, disaggregated by gas (Gg CO<sub>2</sub> eq.)

	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	Total excl. LULUCF
1990	4922	719	450	0	6091
1995	6088	868	510	0	7465
2000	7144	927	484	19	8574
2005	7857	960	472	22	9311
2010	7992	945	450	56	9444
2015	4000	546	301	84	4978
2020	2669	354	339	96	3779

### 5.3. ASSESSMENT OF AGREEGATE EFFECT OF POLICIES AND MEASURES

The effect of currently implemented and adopted policies and measures (that is incorporated in the “with measures” projections scenario) is presented in Table 5.7 in terms of GHG emissions avoided on a CO<sub>2</sub> equivalent basis, while the effect of planned policies and measures is also illustrated in Table 5.7. 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 GHG emissions avoided, correspond mainly to CO<sub>2</sub> (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 CH<sub>4</sub>, while in the agriculture sector about 70% to N<sub>2</sub>O and 30% to CH<sub>4</sub>.

**Table 5.7. Effect of currently implemented and adopted policies and measures (Gg CO<sub>2</sub> eq.)**

Policies and Measures	Implemented and adopted		Planned	
	2015	2020	2015	2020
<b>A. Energy</b>	<b>877</b>	<b>2543</b>	<b>986</b>	<b>2870</b>
1. Natural Gas	0	887	0	887
2.1. RES-Electricity	144	373	144	373
2.2. RES-Heating/ cooling	77	99	77	99
2.3. RES-Transport	40	69	40	69
3.1. Savings from energy efficiency in residential buildings	365	841	347	808
3.2. Savings from energy efficiency in tertiary buildings	45	104	131	361
3.3. Savings from efficient bulbs	85	60	85	60
3.4. Savings from housing insulation	46	45	66	96
3.5. Savings in existing companies	58	45	80	97
4. Improvement of production and distribution systems	4	4	2	3
5. Promotion of waste to energy in industry	14	16	14	16
<b>B. Transport</b>	<b>60</b>	<b>162</b>	<b>89</b>	<b>273</b>
1. Promotion of public transport	30	77	60	153
2. Promotion of low CO <sub>2</sub> vehicles	30	85	30	119
<b>C. Waste</b>	<b>42</b>	<b>281</b>	<b>48</b>	<b>322</b>
1. Methane recovery from managed waste disposal sites	30	241	30	275
2. Management of unmanaged waste disposal sites	12	40	17	47
3. Promotion of anaerobic digestion - sewage sludge	0.01	0.03	0.03	0.07
<b>D. Agriculture</b>	<b>0.03</b>	<b>0.06</b>	<b>0.06</b>	<b>0.12</b>
1. Promotion of anaerobic digestion – animal waste	0.03	0.06	0.06	0.12
<b>TOTAL</b>	<b>979</b>	<b>2986</b>	<b>1123</b>	<b>3465</b>

## 5.4. METHODOLOGY USED FOR THE PRESENTED GHG EMISSION PROJECTIONS

### 5.4.1. WITHOUT MEASURES

Three different projections for gross electricity production were examined for choosing the “Without measures” projections (Figure 5.2):

- The Electricity Authority of Cyprus projection sent on 30/05/2013 to the compilers of this report, based on “Official projection of total production of electrical energy (GWh) and power (MW) for the period 2013 – 2022”, prepared by the Cyprus Transmission System Operator as published on 5/4/2013.
- The minimum projection of the Cyprus Transmission System Operator published on 15/3/2013.
- The PRIMES projections, version 7/1/13.

Given the recent financial situation in Cyprus, the projections of the EAC were considered the most appropriate to use. Therefore, the “Without measures” projections (Figure 5.3) are based on:

- Gross electricity production and respective CO<sub>2</sub> emissions prepared by the Electricity Authority of Cyprus and sent on 30/05/2013, based on “Official projection of total production of electrical energy

(GWh) and power (MW) for the period 2013 – 2022”, prepared by the Cyprus Transmission System Operator as published on 5/4/2013.

- The contribution of the other sectors of emissions and gases to the total national inventory report of 2013.

The parameters used and steps implemented for the estimation of the total greenhouse gases emissions of the country for 2012 to 2020 were as follows:

- For the emissions from electricity production, the projections of the Electricity Authority of Cyprus (EAC) for CO<sub>2</sub> emissions were used. The EAC has included natural gas in its planning for 2019 and 2020 and this is reflected in the projections of emissions. Due to the delays of the import of natural gas, the import of natural gas was not used in the “Without measures” scenario. Thus the emissions for 2019 and 2020 have been replaced with our estimations. The total electricity demand provided by the EAC with the average emission factor for 2014-2018 (0.74 t CO<sub>2</sub>/MWh) from the information provided by the EAC and estimated the CO<sub>2</sub> without the import of natural gas.
- The emissions from the other sectors and CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O emissions were estimated using the contribution of each sector and gas to the total in the National Inventory of 2013 (Department of Environment, 2013).

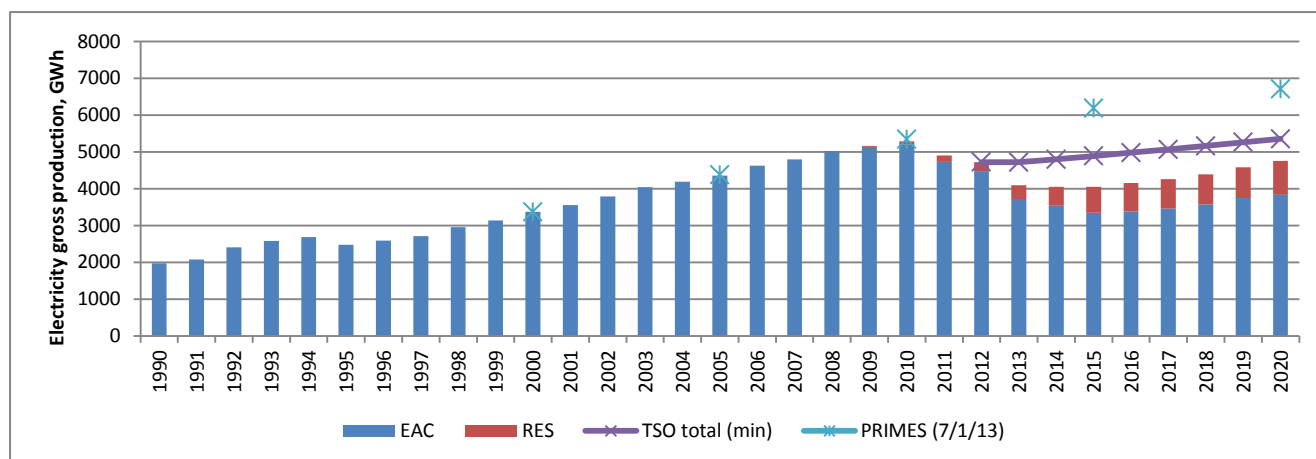


Figure 5.2. Three projections for gross electricity production examined for the “Without measures” scenario

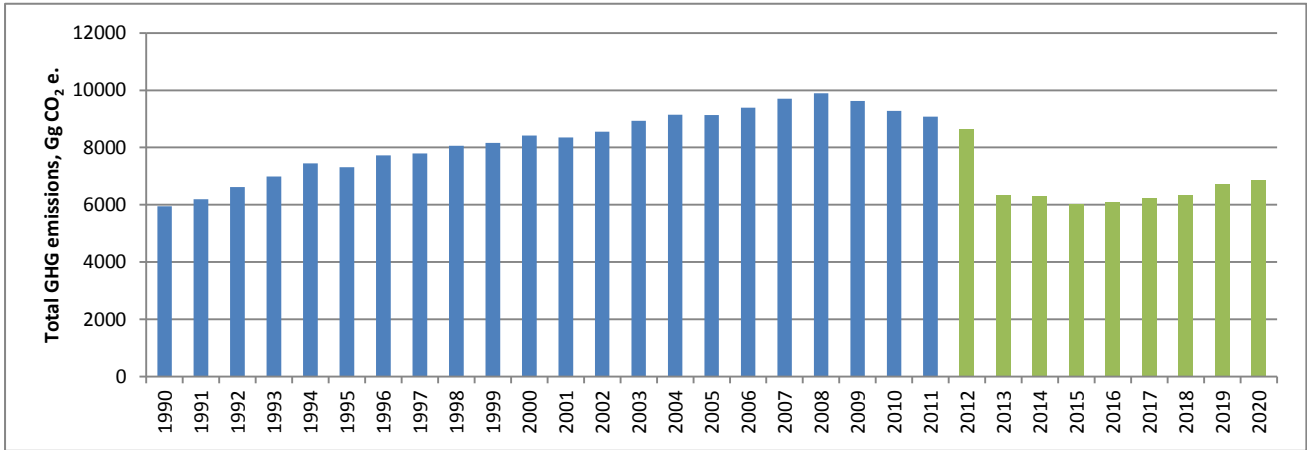


Figure 5.3. Projections for the “Without measures” scenario

#### 5.4.2. WITH MEASURES

The “*With Measures*” scenario includes implementation of policies and measures as shown in Table 5.8. The contribution of each measure is estimated for the total of the GHG emissions of the relevant sector. The impact to each GHG is according to the contribution of the GHG to the total sectoral emissions in the latest inventory (NIR2013).

#### 5.4.3. WITH ADDITIONAL MEASURES

The “*With Additional Measures*” scenario includes implementation of policies and measures as shown in Table 5.9. The contribution of each measure is estimated for the total of the GHG emissions of the relevant sector. The impact to each GHG is according to the contribution of the GHG to the total sectoral emissions in the latest inventory (NIR2013).

**Table 5.8. Policies and measures included in the “With Measures” scenario**

	2015	2020
<b>A. Energy*</b>		
1. Natural Gas		16TJ for electricity
2.1. RES-Electricity	5.5% of electricity	12.4% of electricity
2.2. RES-Heating/ cooling	0.76% of electricity 13% of thermal & cooling	0.82% of electricity 15% of thermal & cooling
2.3. RES-Transport	2.6% of transport	4.0% of transport
3.1. Savings from energy efficiency in residential buildings	12% of electricity 0.6% of thermal & cooling	24% of electricity 1.2% of thermal & cooling
3.2. Savings from energy efficiency in tertiary buildings	1.7% of electricity 0.08% of thermal & cooling	3.4% of electricity 0.18% of thermal & cooling
3.3. Savings from efficient bulbs	3.2% of electricity	2% of electricity
3.4. Savings from housing insulation	1.7% of electricity 0.08% of thermal & cooling	1.5% of electricity 0.08% of thermal & cooling
3.5. Savings in existing companies	2.1% of electricity 0.1% of thermal & cooling	1.3% of electricity 0.07% of thermal & cooling
4. Improvement of production and distribution systems	0.14% of electricity	0.12% of electricity
5. Promotion of waste to energy in industry	3.6%	3.8%
<b>B. Transport*</b>		
1. Promotion of public transport	1.9% of transport	4.4% of transport
2. Promotion of low CO <sub>2</sub> vehicles	2% of transport	5% of transport
<b>C. Waste</b>		
1. Methane recovery from managed waste disposal sites	10% of biogas collected	70% of biogas collected
2. Management of unmanaged waste disposal sites	20% of biogas collected	60% of biogas collected
3. Promotion of anaerobic digestion - sewage sludge	0.03 Gg CO <sub>2</sub> eq. reductions	0.05 Gg CO <sub>2</sub> eq. reductions
<b>D. Agriculture</b>		
1. Promotion of anaerobic digestion – animal waste	0.06 Gg CO <sub>2</sub> eq. reductions	0.085 Gg CO <sub>2</sub> eq. reductions

\* all reductions are in fuel consumption

**Table 5.9. Policies and measures included in the “With Additional Measures” scenario**

	2015	2020
<b>A. Energy*</b>		
1. Natural Gas		16TJ for electricity
2.1. RES-Electricity	8.4% of electricity	16% of electricity
2.2. RES-Heating/ cooling	0.8% of electricity 14% of thermal & cooling	0.9% of electricity 16% of thermal & cooling
2.3. RES-Transport	2.96% of transport	4.76% of transport
3.1. Savings from energy efficiency in residential buildings	20% of electricity 0.9% of thermal & cooling	33% of electricity 1.7% of thermal & cooling
3.2. Savings from energy efficiency in tertiary buildings	8% of electricity 0.4% of thermal & cooling	15% of electricity 0.8% of thermal & cooling
3.3. Savings from efficient bulbs	3.7% of electricity	1.8% of electricity
3.4. Savings from housing insulation	3.0% of electricity 0.14% of thermal & cooling	3.6% of electricity 0.18% of thermal & cooling
3.5. Savings in existing companies	3.5% of electricity 0.2% of thermal & cooling	3.2% of electricity 0.2% of thermal & cooling
4. Improvement of production and distribution systems	0.1% of electricity	0.1% of electricity
5. Promotion of waste to energy in industry	4.1%	4.3%
<b>B. Transport*</b>		
1. Promotion of public transport	6% of transport	11% of transport
2. Promotion of low CO <sub>2</sub> vehicles	2% of transport	7% of transport
<b>C. Waste</b>		
1. Methane recovery from managed waste disposal sites	10% of biogas collected	80% of biogas collected
2. Management of unmanaged waste disposal sites	30% of biogas collected	70% of biogas collected
3. Promotion of anaerobic digestion - sewage sludge	0.06 Gg CO <sub>2</sub> eq. reductions	0.11 Gg CO <sub>2</sub> eq. reductions
<b>D. Agriculture</b>		
1. Promotion of anaerobic digestion – animal waste	0.12 Gg CO <sub>2</sub> eq. reductions	0.17 Gg CO <sub>2</sub> eq. reductions

\* all reductions are in fuel consumption

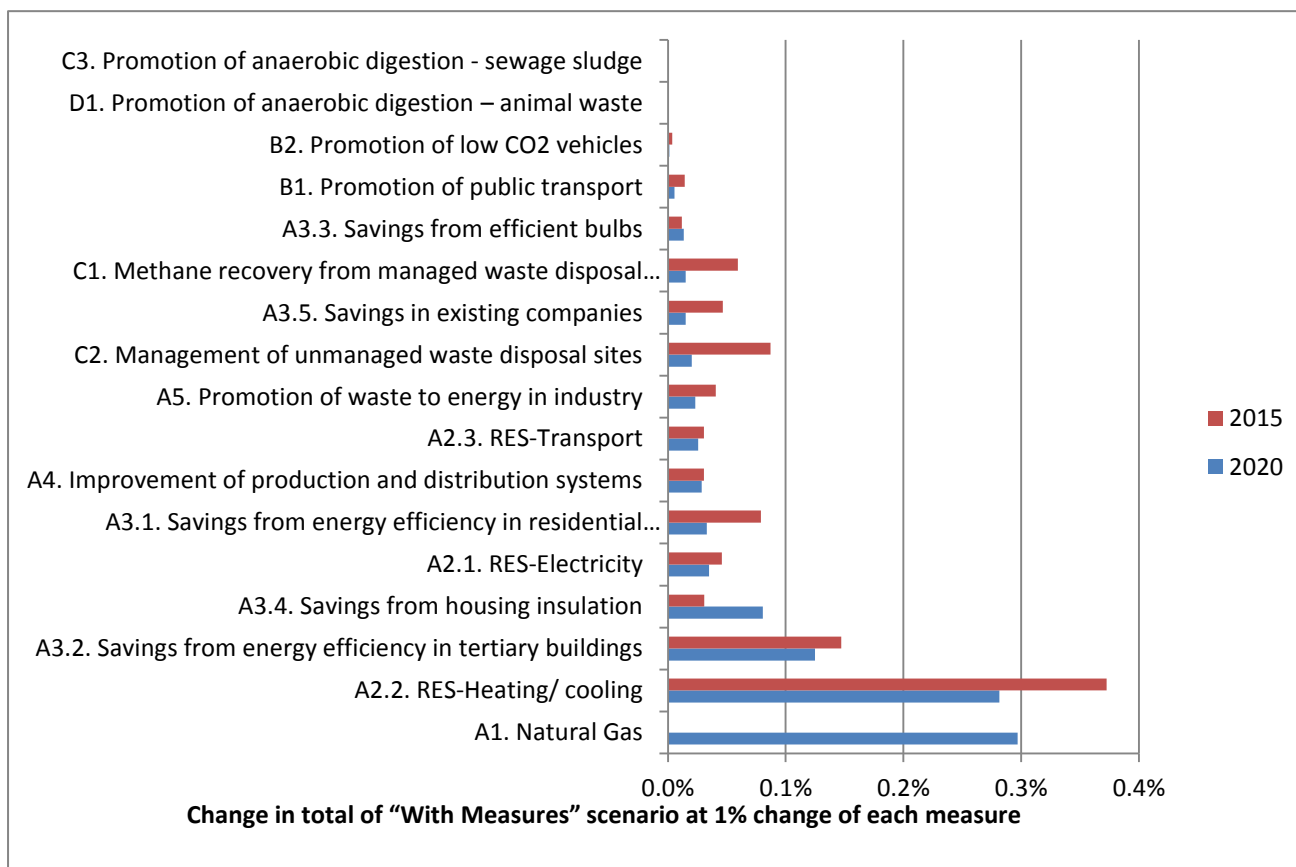
## 5.5. SENSITIVITY ANALYSIS

Sensitivity analysis was carried out using the change in the total of each scenario at 1% change of each measure.

The results of the calculations for the “With measures” scenario are presented in Table 5.10 and Figure 5.4. The results of the calculations for the “With additional measures” scenario are presented in Table 5.11 and Figure 5.5.

**Table 5.10. Change in total of “With Measures” scenario at 1% change of each measure**

	2015	2020
A1. Natural Gas	0.00%	0.33%
A2.1. RES-Electricity	0.15%	0.14%
A2.2. RES-Heating/ cooling	0.08%	0.04%
A2.3. RES-Transport	0.04%	0.03%
A3.1. Savings from energy efficiency in residential buildings	0.39%	0.31%
A3.2. Savings from energy efficiency in tertiary buildings	0.05%	0.04%
A3.3. Savings from efficient bulbs	0.09%	0.02%
A3.4. Savings from housing insulation	0.05%	0.02%
A3.5. Savings in existing companies	0.06%	0.02%
A4. Improvement of production and distribution systems	0.00%	0.00%
A5. Promotion of waste to energy in industry	0.01%	0.01%
B1. Promotion of public transport	0.03%	0.03%
B2. Promotion of low CO <sub>2</sub> vehicles	0.03%	0.03%
C1. Methane recovery from managed waste disposal sites	0.03%	0.08%
C2. Management of unmanaged waste disposal sites	0.01%	0.01%
C3. Promotion of anaerobic digestion - sewage sludge	0.00%	0.00%
D1. Promotion of anaerobic digestion – animal waste	0.00%	0.00%

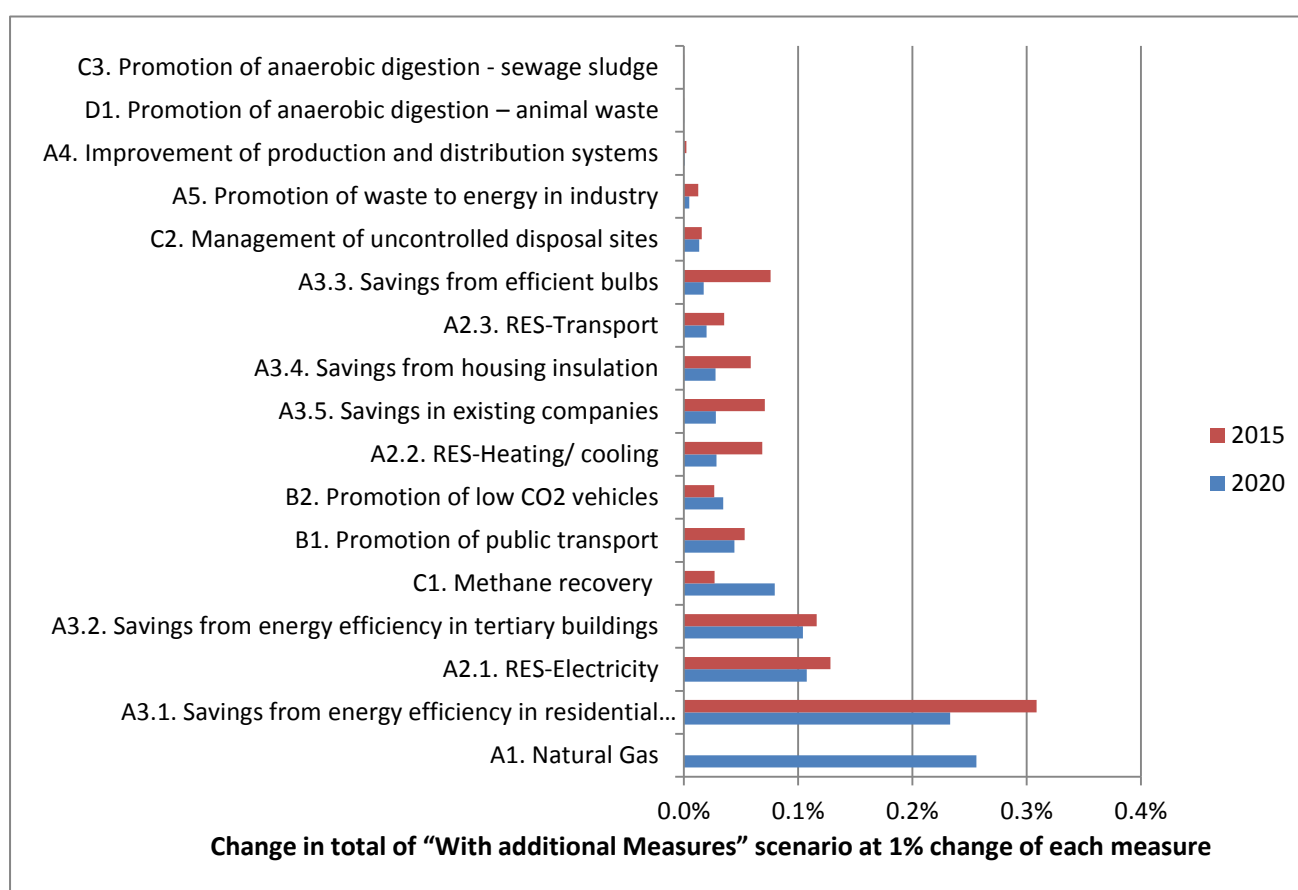


**Figure 5.4. Change in total of “With Measures” scenario at 1% change of each measure**



**Table 5.11. Change in total of “With additional Measures” scenario at 1% change of each measure**

	2015	2020
A1. Natural Gas	0.00%	0.28%
A2.1. RES-Electricity	0.13%	0.12%
A2.2. RES-Heating/ cooling	0.07%	0.03%
A2.3. RES-Transport	0.04%	0.02%
A3.1. Savings from energy efficiency in residential buildings	0.32%	0.26%
A3.2. Savings from energy efficiency in tertiary buildings	0.12%	0.11%
A3.3. Savings from efficient bulbs	0.08%	0.02%
A3.4. Savings from housing insulation	0.06%	0.03%
A3.5. Savings in existing companies	0.07%	0.03%
A4. Improvement of production and distribution systems	0.00%	0.00%
A5. Promotion of waste to energy in industry	0.01%	0.01%
B1. Promotion of public transport	0.06%	0.05%
B2. Promotion of low CO <sub>2</sub> vehicles	0.03%	0.04%
C1. Methane recovery	0.03%	0.08%
C2. Management of uncontrolled disposal sites	0.02%	0.01%
C3. Promotion of anaerobic digestion - sewage sludge	0.00%	0.00%
D1. Promotion of anaerobic digestion – animal waste	0.00%	0.00%



**Figure 5.5. Change in total of “With additional Measures” scenario at 1% change of each measure**

## 6. VULNERABILITY ASSESSMENT, CLIMATE CHANGE IMPACTS AND ADAPTATION MEASURES <sup>15</sup>

### 6.1. INTRODUCTION

The information presented in this Chapter has been collected through the project “Development of a national strategy for adaptation to climate change adverse impacts in Cyprus” or CYPADAPT. CYPADAPT is co-financed (50:50) by the government of Cyprus and the European Union through the programme LIFE+ (LIFE10ENV/CY/000723). The CYPADAPT main aim is to strengthen and increase Cyprus adaptive capacity to climate change impacts through the development of a National Adaptation Strategy. Further information is available at the website of the project <http://uest.ntua.gr/cypadapt/>.

### 6.2. OBSERVED PATTERNS OF CLIMATE CHANGE ACROSS AND PROJECTIONS FOR THE FUTURE

Cyprus lies at the south-eastern end of the Mediterranean Sea and Europe, which is one of the most sensitive hot-spots and most vulnerable regions in the world regarding climate change (Alcamo et al., 2007, Giannakopoulos et al., 2009).

Climate in Cyprus is generally characterized by mild rainy winters, occasional droughts, and long, hot and dry summers. In winter, the average daytime temperature ranges from 12–15°C while the wet season extends from November to March, with most (approx. 60%) of the rain falling between December and February (Pashiardis, 2002). Precipitation is generally associated with the movement of moist maritime flows to the North, occurring particularly over areas of high elevation (Kostopoulou and Jones, 2007a). Winter precipitation is closely related to cyclogenesis in the region (Maheras et al., 2001). In summer, the average maximum temperature in coastal regions is 32°C and often reaches 40°C in lowland continental areas. This is attributed to the extension of the summer Asian Thermal Low which is

evident throughout the eastern Mediterranean in all seasonal circulation patterns (Kostopoulou and Jones, 2007a,b) and associated high temperatures and abundant sunshine. The characteristic summer aridity of the region has significant implications in several socio-economic sectors (Giannakopoulos et al., 2010).

Recent studies on present and future climate have shown that this semi-arid island has been affected and is expected to be relatively strongly affected by the projected warming and related changes (Christensen et al. 2007). Therefore, Cyprus, where diverse and extreme climate conditions already common, is likely to face increases in the frequency and intensity of droughts and hot weather conditions in the near future, with probably disproportional impacts.

The observed and potential future climate changes in Cyprus described in this report have been produced as part of the CYPADAPT project. The future climate changes were projected by using PRECIS<sup>16</sup> as the main Regional Climate Model and the A1B scenario of the Special Report on Emissions Scenarios (SRES) of the Intergovernmental Panel on Climate Change (Nakićenović and Swart 2000) which provides a good mid-line scenario for carbon dioxide emissions and economic growth.

The predictions of future climate change were examined in two future periods i.e. the near future period 2021-2050 and the distant future period 2071-2100. The derived values of various climatic parameters in Cyprus for both future stages were compared to the reference values during the period 1960-1990 (control period). The projected climate changes for the 2021-2050 period were made by using six additional simulation models of the ENSEMBLES prediction system<sup>17</sup> beside PRECIS, whereas for the 2071-2100 period the emissions scenarios A2 and B2 were used in addition to the A1B.

The future period 2021-2050 has been chosen specifically and examined in detail for the needs of stakeholders and policy makers, in order to assist their planning in relation to adaptation measures, impacts and vulnerability assessment.

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<sup>16</sup> PRECIS: generated by The Cyprus Institute with the collaboration of the UK Met. Office Hadley Centre, <http://www.metoffice.gov.uk/precis/>

<sup>17</sup> ENSEMBLES prediction system: analysed by the National Observatory of Athens and accessed from <http://ensemblesrt3.dmi.dk>

In general, regional climate models consistently predict an overall warming and drying of Cyprus with significant impacts in human health, energy use, water resources and other socio-economic sectors. Pronounced warming and precipitation reductions are also detected from time series of temperature and precipitation parameters, regarding representative locations of Cyprus during the period 1951-2100.

### 6.2.1. OBSERVED AND PROJECTED CHANGE IN TEMPERATURE

#### OBSERVED CHANGES

Temperature records, for the period 1892 – 2010, from the Department of Meteorology (Pashiardis, 2011) and other studies (Hadjinicolaou et al. 2011) show an increase in the annual mean air temperature of the atmosphere of the order of 1.4°C in Nicosia (Figure 6.1) and 2.3°C in Lemesos (Figure 6.2). This increase is higher than the rise in the global mean surface temperature, which was ranging between 0.74°C ± 0.18°C over the last 100 years (1906 – 2005), according to the Intergovernmental Panel on Climate Change (IPCC, 2007).

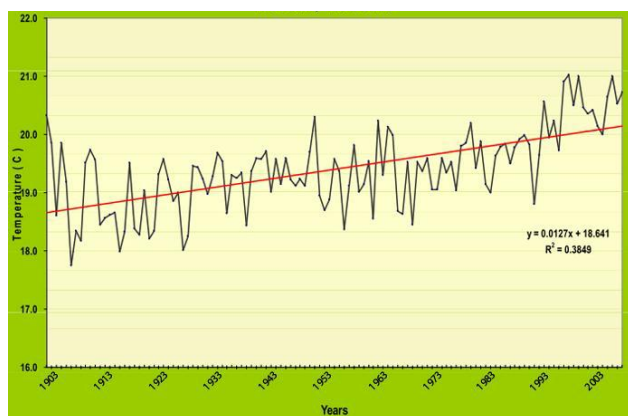


Figure 6.1. Observed changes in the annual mean air temperature (°C) from 1892 till 2010 in Nicosia

Moreover, as regards the annual mean air maximum and minimum temperature, the former varies depending on the location, while the latter show an increase for the whole area. However, a less rapid warming in T<sub>min</sub> over the mountains compared to inland and coastal areas.

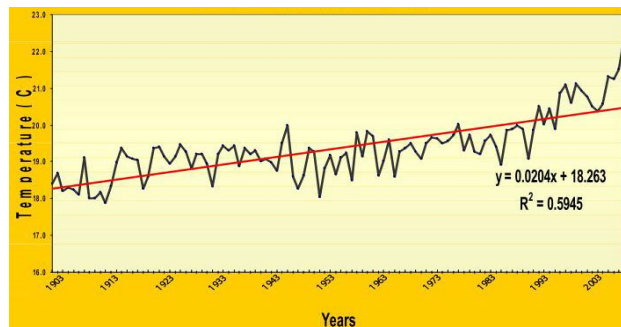


Figure 6.2. Observed changes in the annual mean air temperature (°C) from 1903 till 2010 in Lemesos

The 1961-1990 reference temperature patterns generally illustrate the different climatic zones within Cyprus, from the cool higher elevation regions to the hot and dry lowlands and the warm and humid coasts. Regarding this reference period, the average maximum temperature range is 10-16°C in winter and 25-35°C in summer. The summertime maximum TX in coastal regions is about 33°C, while further inland it often exceeds 40°C.

The average minimum temperature (TN) during winter (DJF) ranges between 2-14°C and in summer ranges between 15-25°C, showing the contrast between the coastal and the continental areas. Winter average TN does not fall below 2°C, even in continental parts of the country, whereas minimum temperatures above 7°C are typical of the Cyprus milder coastal climate.

#### PROJECTED CHANGES

In the period 2021-2050, the projected changes in temperature are remarkable and in agreement with previous work that shows that heat stress is expected to intensify. In particular a continual, gradual and relatively strong warming, as is shown from the projected changes of the average annual maximum temperature (TX) range from 1.0°C to 2.0°C with spatial variations in comparison to the 1961-1990 reference period. Similarly, the average annual minimum temperature (TN) changes are ranged from 1.0°C at the eastern and northern coasts to 2.0°C in higher elevation areas.

Maximum and minimum seasonal temperatures appear to increase most in the continental part of Cyprus. Hot summer conditions that rarely occurred in the reference period may become the norm by the middle of the 21st century. In summer the increase of maximum temperature will exceed 2.5°C. During winter, the

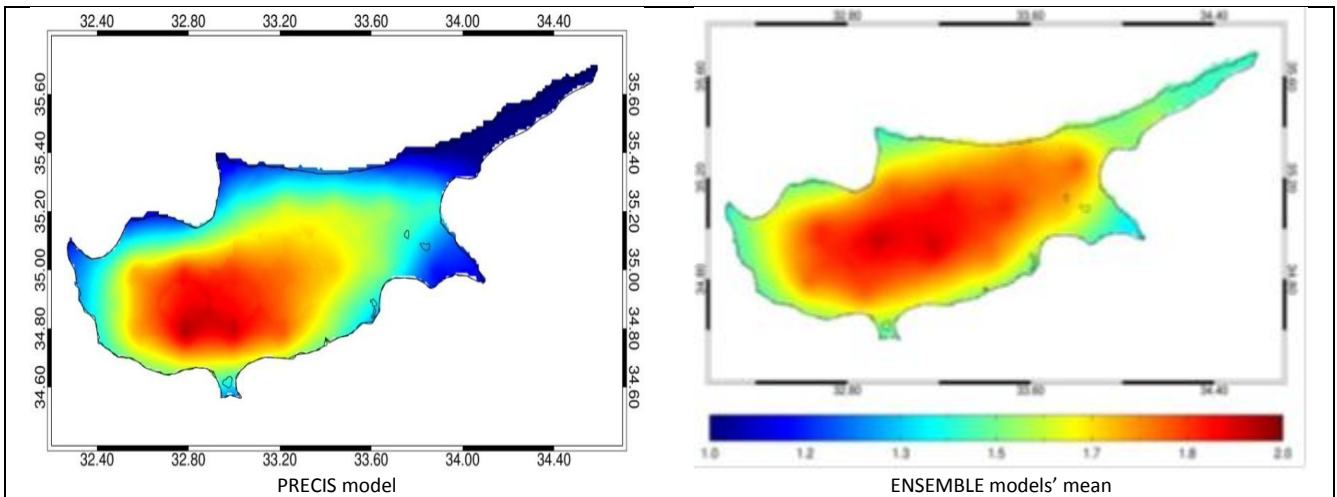


Figure 6.3. Changes in average annual maximum temperature between the future (2021-2050) and the control period (1961-1990)

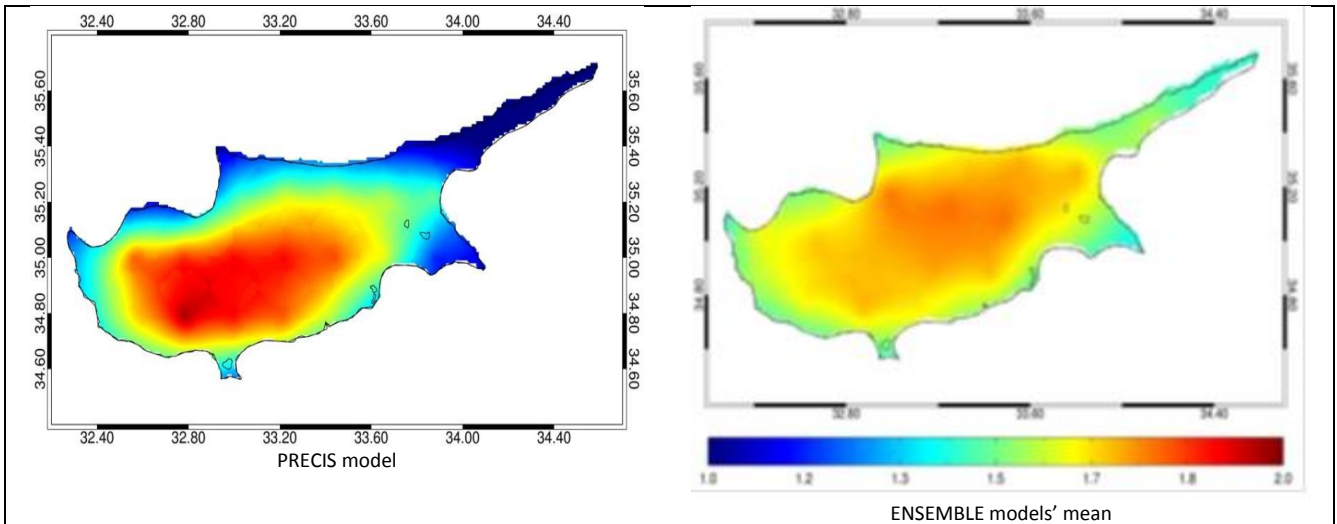


Figure 6.4. Changes in average annual minimum temperature between the future (2021-2050) and the control period (1961-1990)

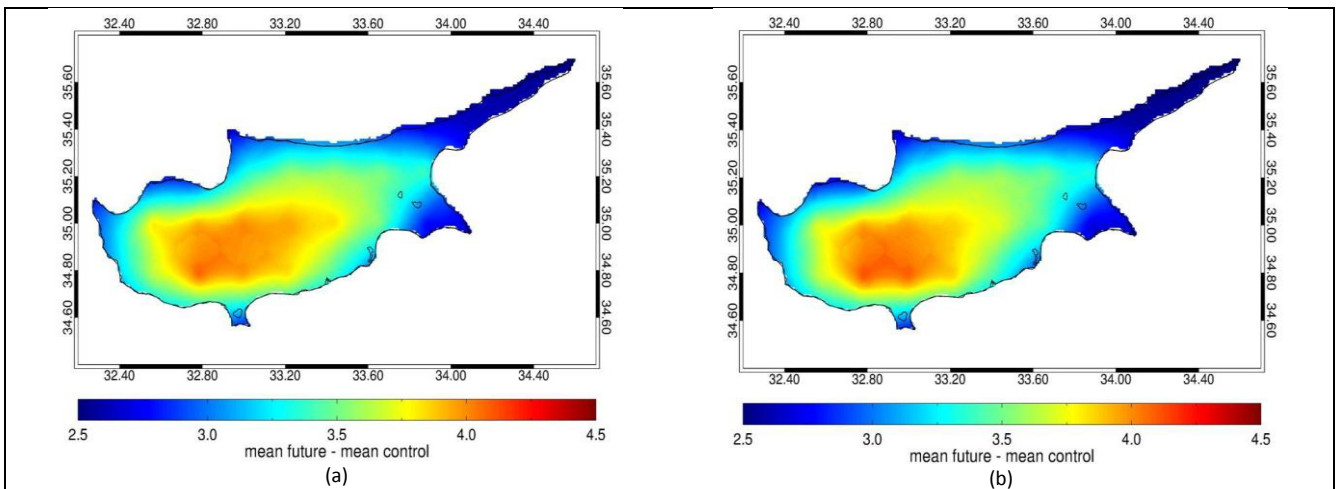


Figure 6.5. Changes in (a) average annual minimum temperature (TN), (b) average annual maximum temperature between the reference period (1961-1990) and the future period (2071-2100).

average maximum temperature change ranges from 0.5°C to 1.4°C.

Seasonal variations in temperature changes exist between the coastal, mountainous and the continental areas.

In the period 2071-2100, (Figure 6.5) the projected changes based on A1B scenario in temperature are remarkable. In particular, a very strong warming of about 2.5 to 4.5°C may occur between the 1961-1990 reference period and the future period 2071-2100, as shown by the annual maximum and minimum TX patterns.

annual average precipitation has reduced from 559 mm (1901 – 1930) to 463 mm (1971 to 2000), a decrease of 17%. The blue line in the diagram shows the declining trend in precipitation. According to Lange and Manfred (2009) the reduction in rainfall for the period 1905 to 2005 was around 170mm whereas, in 2008 the rainfall reduction which was by 45% lower than the average of the period 2000 – 2007 leading to a severe drought. The problem of the rainfall reduction in Cyprus is also depicted in Figure 6.7 which shows the water stress index in other words the availability of water. Cyprus ranks first among the European countries in terms of water stress index (Wintgens and Hochstrat, 2006).

### 6.2.2. OBSERVED AND PROJECTED CHANGE IN PRECIPITATION

#### OBSERVED CHANGES

Data from the Department of Meteorology (Pashiardis, 2011) indicate that the amount of rain which falls in the region has been declining year by year (Figure 6.6). The

The total annual precipitation is presented in Figure 6.8. The large east–west contrast is evident in both annual and seasonal precipitation patterns. The maximum annual total precipitation occurs at the western coasts and most precipitation occurs in winter and autumn, in similar patterns. The winter total precipitation ranges from about 75mm in the lowlands of central Cyprus to 270mm in the western higher elevation areas, woodlands and wetlands.

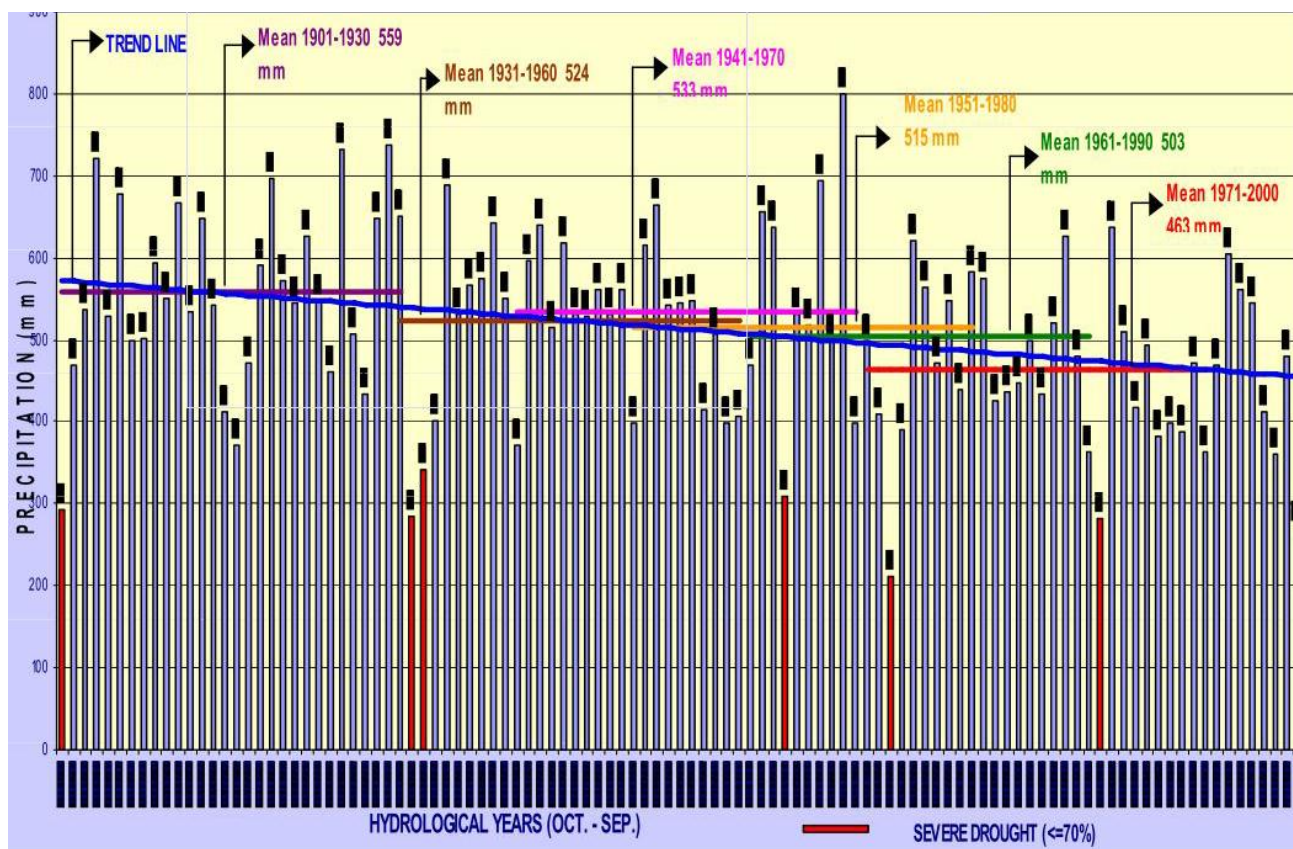


Figure 6.6. Annual average precipitation (mm) in Cyprus from hydrological year 1901-02 till 2007-08 (Pashiardis, 2011). Mean 1901-1930 559mm, mean 1971-2000 463mm, decrease 559-463 = 96mm (17%)

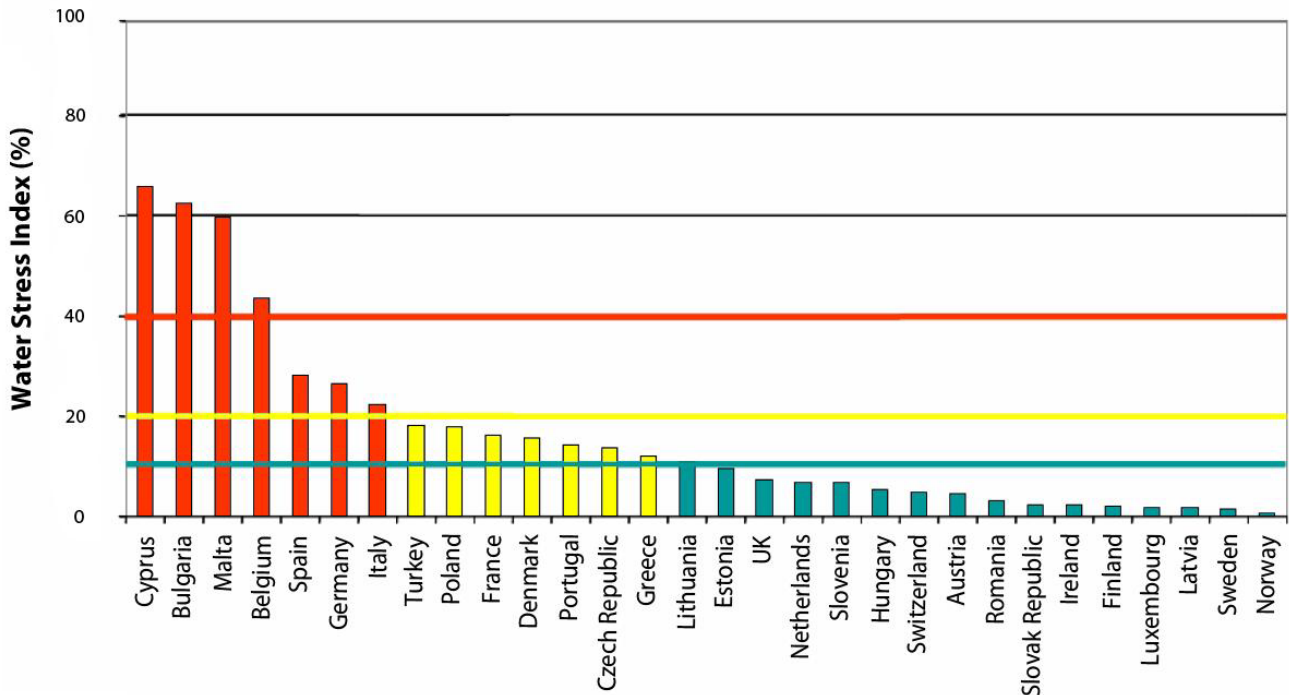


Figure 6.7. Water Stress Index among European countries. Cyprus ranks first

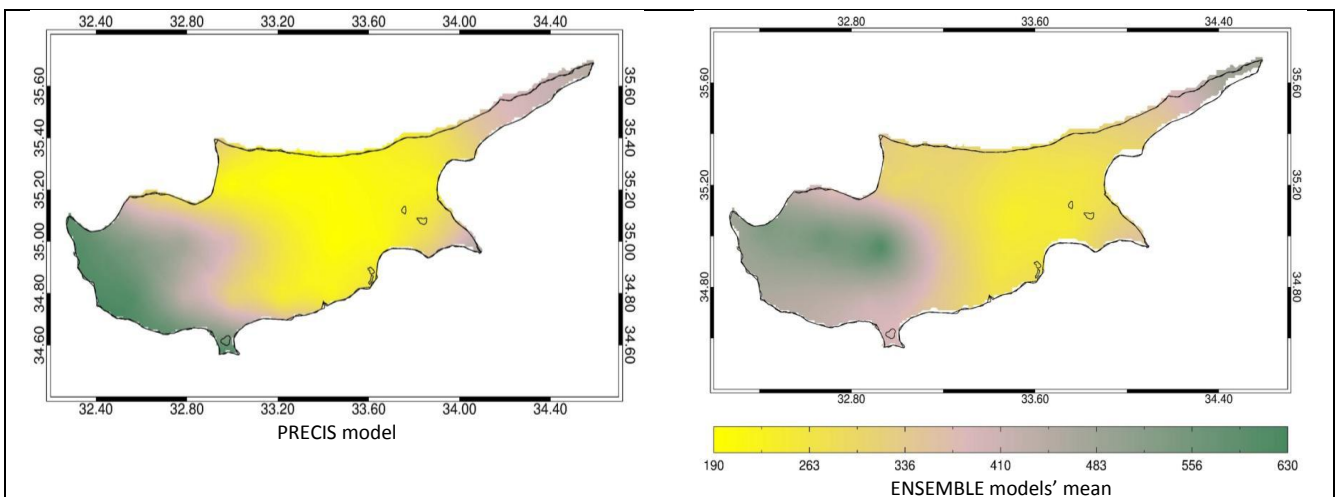


Figure 6.8. Annual total precipitation for the years 1961-1990 (control period)

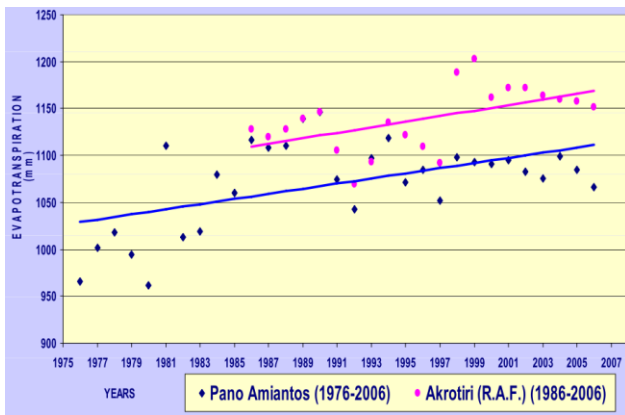
Another important parameter for Cyprus is the increase in evapotranspiration. As shown in Figure 6.9, evapotranspiration has increased by 60-80 mm in the period 1976 - 2006. This, combined with temperature rise and rainfall decrease, intensifies the drying of soils and leads gradually to their desertification.

The 1961-1990 precipitation patterns in Cyprus do not depend only upon the synoptic weather conditions but also on the pronounced topography. The dominance of local topography is also evident from the seasonal total precipitations. For example, winter total precipitation ranges from about 75mm in the lowlands of central

Cyprus to 270mm in the western higher elevation areas, woodlands and wetlands.

### PROJECTED CHANGES

Cyprus projected precipitation changes are quite variable among models. Therefore, Cyprus precipitation patterns must be interpreted with caution, owing to the large temporal variability of rainfall and the inherent limitations of climate models to simulate accurately the hydrological cycle and the large variations of future projected changes among models. Changes in annual



**Figure 6.9. Increasing trend in annual evapotranspiration as it testified by records at Pano Amiantos station (1976 – 2006) and Akrotiri station (1986 – 2006) of the Penman-Monteith evapotranspiration**

precipitation provide important information about occurrences of droughts and subsequent water shortages in Cyprus, expected in the near future (2021-2050).

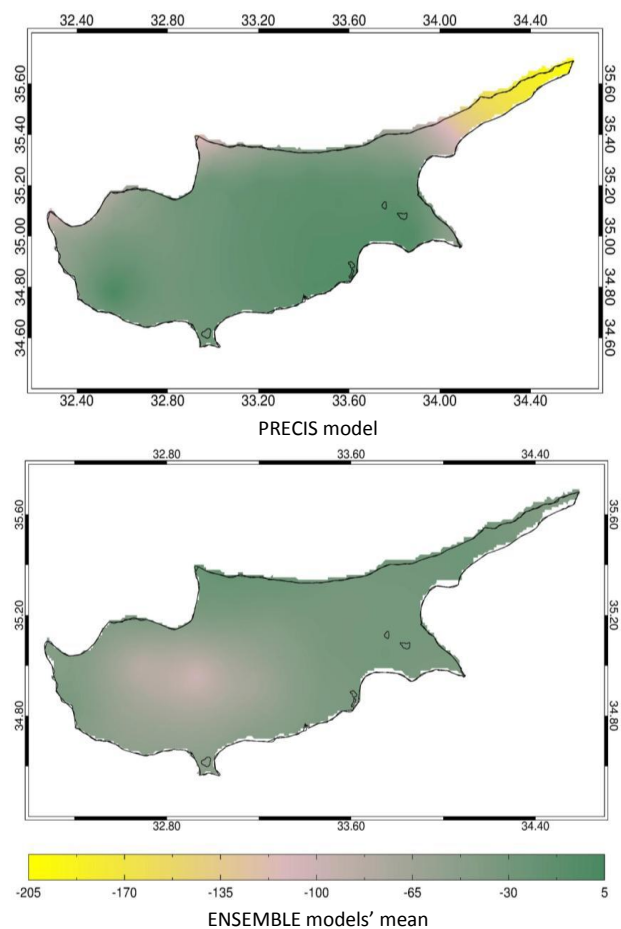
In the period 2021-2050, Cyprus projected precipitation will be decreased (though at different values among models) with seasonal and regional variations (Figure 6.10). The northern coasts, especially Karpasia peninsula, are expected to receive less annual total precipitation. In all other parts of Cyprus, the annual total precipitation appears to have minor decreases or no changes at all. In addition, models show that the relative humidity will decrease in the near future, except from the coastal areas of Cyprus where increases of relative humidity are expected (with an associated increase of heat stress).

The spatial distributions of seasonal precipitation changes over Cyprus exhibit a large spatial and temporal variability. Since most precipitation occurs in winter and autumn, the precipitation changes during these two seasons are very important for the study of droughts and associated water shortages.

The winter total precipitation changes, derived from PRECIS output, are negative or zero all over Cyprus, whereas the ENSEMBLE models' mean presents an almost reverse image from PRECIS. Similar to winter, the autumn total precipitation changes, derived from PRECIS output, are negative or zero all over Cyprus, whereas the ENSEMBLE models' mean gives a wetter projection of the near future. All Cyprus appears to receive more autumn total precipitation in the future than in the recent past (1961-1990), with the largest increases (up to 20 mm) in the western part of the country.

Changes in annual precipitation provide important information about the occurrences of droughts and subsequent water shortages in Cyprus, expected in the distant future (2071-2100).

As far as precipitation projections are concerned, all northern coasts are expected to receive less annual total precipitation in the distant future. In lowland and continental areas in the central part of the country, the annual total precipitation appears to have small decreases (up to 50mm). A significant increase of up to 30 days/year in the number of dry days is expected in the northern coastal areas (Ayia Irini Forest, Karpasia peninsula) by the end of the century.



**Figure 6.10. Changes in annual total precipitation between the future (2021-2050) and the control period (1961-1990)**

### 6.2.3. OBSERVED AND PROJECTED CHANGE IN EXTREME WEATHER EVENTS: HEAT WAVE, DROUGHT, FLOOD, HURRICANE

#### OBSERVED CHANGES

Since 1950 an increasing number of heat wave events have been observed in many regions around the world. An increase in the number of hot nights has also been recorded (IPCC, 2007). In addition, larger parts of the world have been affected by droughts as a combined effect of rainfall decline and evapotranspiration increase. Still, heavy rainfall events which lead to flooding have been intensified but this does not characterize a global trend. Finally, the number of tropical storms and hurricanes, although varying from year to year, has generally increased in terms of their intensity and duration since the 70s (IPCC, 2007).

In Cyprus, during the last decades the number of hot days and warm nights has increased, whereas the number of days with temperatures less than or equal to 0°C has greatly declined. There has been reported an increasing trend in the minimum temperatures in the island, as indicated from the increase in the number of days with temperature 40°C or higher (Figure 6.11) and the great reduction the number of days with temperatures less than or equal to 0°C (Figure 6.12).

In most patterns of projected changes in indices of climate extremes, there is a rather good agreement between PRECIS and the ENSEMBLE models' mean. The increase in the number of days with TN>25°C (tropical nights) is expected to be approximately 1 month, which is of great concern, in combination with the given remarkable increases of all indices of maximum temperature.

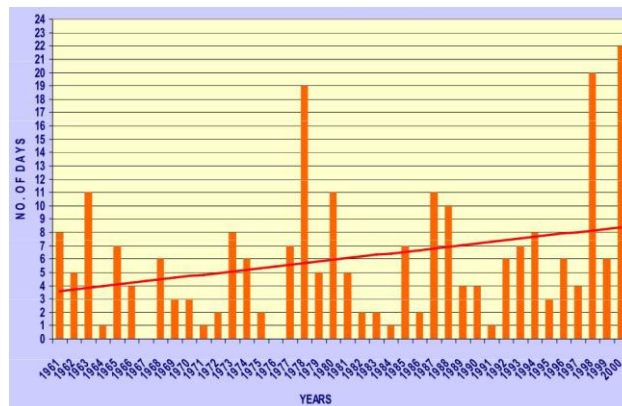


Figure 6.11. Number of days with temperature 40°C or higher from Nicosia station for the period 1961 - 2010

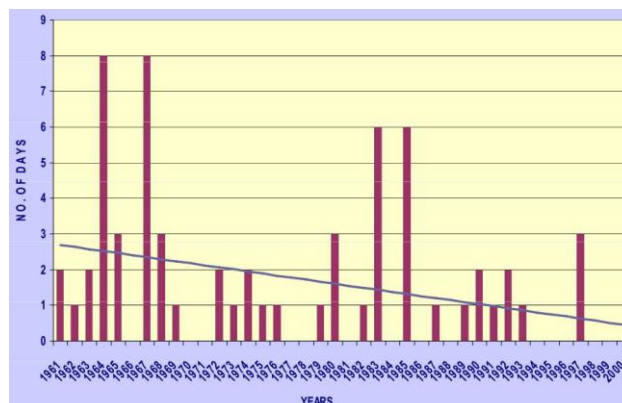


Figure 6.12. Number of days with temperatures less than or equal to 0°C from Nicosia station for the period 1961 - 2010

Furthermore, very important is the increase in the number of warm nights in almost all of Cyprus as evidenced in Figure 6.13 (Hadjinicolaou et al., 2011) and the annual mean temperature distributions present the temperature changes between the periods 1981-1990 and 2001-2008 (Figure 6.14). Over the last decade the greatest part of Cyprus has suffered from high temperatures and the largest part of the population residing in the three major cities, suffered high discomfort and serious socioeconomic problems such as increase in energy for cooling, water consumption and forest fire risk.



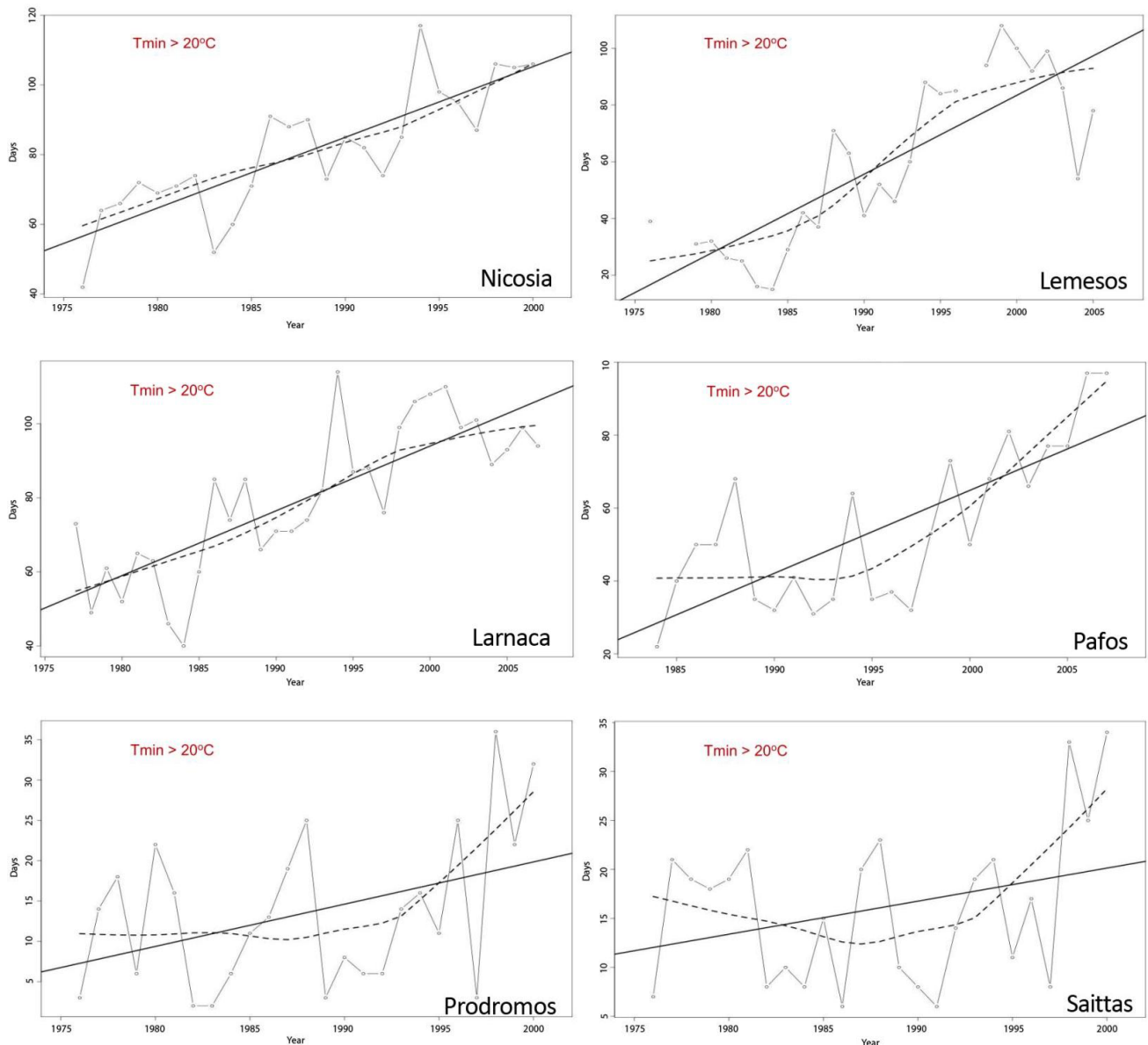


Figure 6.13. Increase in the number of warm nights in Cyprus as testified by stations' records at Nicosia (1976 – 2000), Lemesos (1976 – 2006), Larnaca (1977 – 2007), Pafos (1983 – 2007), Prodromos (1976 – 2000) and Saittas (1976 – 2000)

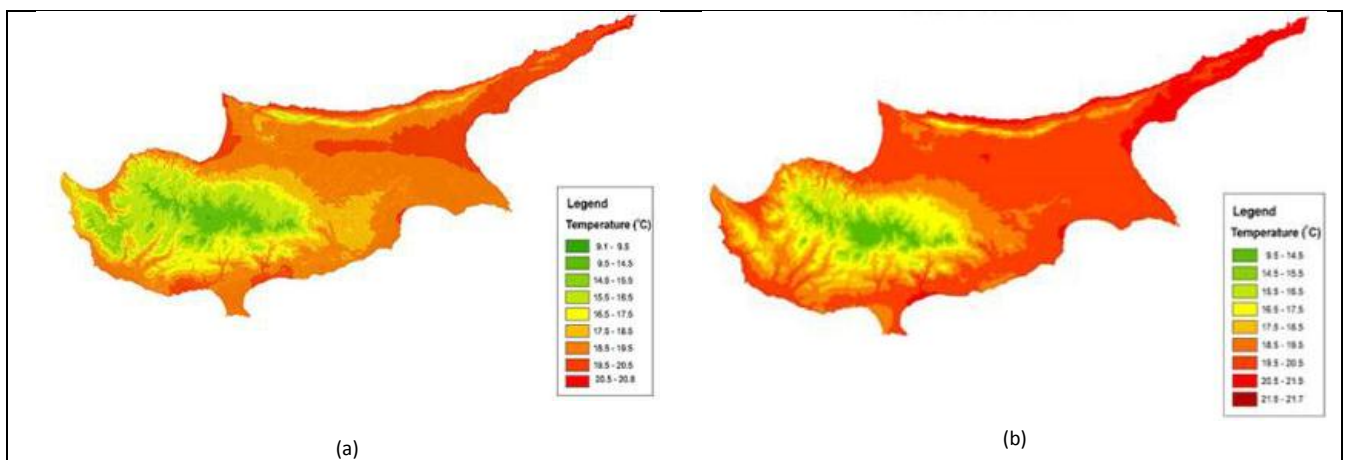
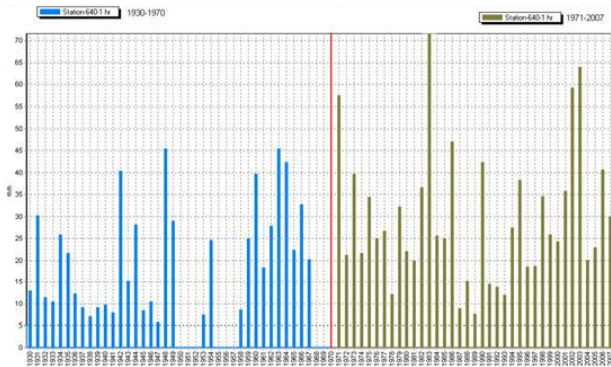


Figure 6.14. Spatial mean annual temperature distribution for period 1981 – 1990 (a) in contrast with the respective for period 2001 – 2008 (b)



**Figure 6.15. Increase in the highest amounts of rainfall in 1 hour for the period 1971 – 2007 in contrast with the respective for the period 1930 – 1970**

As mentioned above, Cyprus experienced periodically severe droughts due to the declining precipitation, the worst of which was in 2008. During that event the water reservoirs were filled in only 3% of their capacity, prompting the Cyprus government to spend millions of Euros for water import from Greece (Davenport, 2008). Figure 6.15 shows the observed increase in heavy rainfall which falls in 1 hour for the period 1930-2007 despite the decrease in the mean precipitation. These extreme rainfall events may potentially cause localized flooding phenomena with devastating impacts. Nevertheless, it is not uncommon for isolated summer thunderstorms to occur, which however contribute to less than 5% to the total annual precipitation amount (Pashiardis, 2002).

## PROJECTED CHANGES

As regards to extreme events in future, the combination of projected higher temperatures and reduced mean summer precipitation, as well as the increase intensity of precipitation, would enhance more the occurrence of heat waves and droughts, and the number heavy rainfall events.

Projections of future changes reveal increases in annual maximum temperature which may reach 2.4-2.6°C in continental and mountain areas and 2.0°C in coastal areas. Also, one additional month with maximum temperature higher than 35°C is expected in inland and mountain regions. Similar increases are also anticipated for tropical nights to the whole study domain.

Concerning precipitation extremes, an increase of about 8-10 days is expected in dry days as well as in the length of dry spell.

In distant future (2071-2100), the extreme temperature and precipitation conditions in Cyprus will be worse

- The expected increase of the number of summer days (TX>25°C) during the period 2071-2100, varies between 30-45 days per year (Figure 6.16a) to about 60 days in the northern coastal and continental lowlands areas, and the west southern areas of Cyprus respectively.
- The number of hot days (TX>30°C) per year will be increased by 25-45 days throughout Cyprus as seen in figure (Figure 6.16b) and the number of heat wave days (TX>35°C) will be also increased by 20-60 days in between coastal and continental regions (Figure 6.16c).
- The number tropical night index (TN>20°C) for the distant future is expected to increase by 35-50 days in most of the coastal areas and continental lowlands (Figure 6.16d), whereas higher elevation areas, are characterized by a maximum increase of 65-75 days per year.
- The annual max total rainfall over 3 days is expected to have a slight decrease of up to 10mm per year and the annual maximum total precipitation over 3 days in the lowland central regions is expected to have an increase of up to 15mm/year (Figure 6.16e)
- Furthermore, the annual number of dry days (with less than 0.5mm precipitation) for the 2071-2100 period is not expected to change much over the southern coastal part of the domain. A significant increase of up to 30 days/year is noted though in Ayia Irini Forest, Karpasia peninsula, as well as in some other highlands (Figure 6.16f).

In distant future 2071-2100 the number of tropical nights is expected to increase by up to 75 additional days per year in the western and south-western part of the country. Furthermore, the number of heat wave days may increase in the entire domain. The more pessimistic scenario A2 further enhances the number of heat wave days compared to the A1B projections, in Nicosia. The more optimistic scenario B2 slightly reduces their number, though they are still strongly enhanced compared to the reference period.

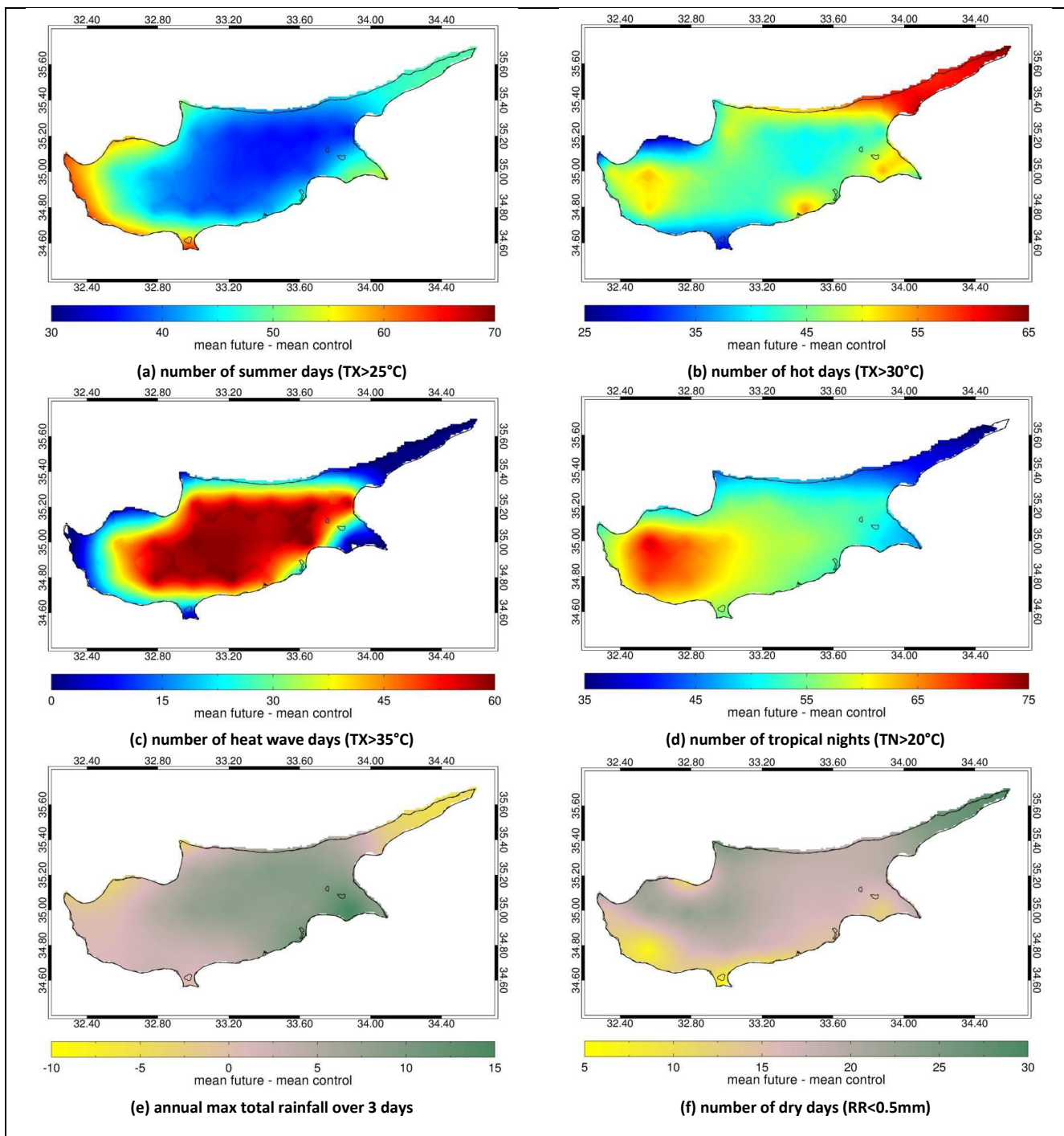


Figure 6.16. Changes between the reference period (1961-1990) and the future period (2071-2100)

### 6.3. EXPECTED IMPACTS AND VULNERABILITIES OF CLIMATE CHANGE IN CYPRUS

The following sections present the expected impacts and vulnerabilities of climate change in Cyprus for biodiversity, infrastructure, energy, health, forestry, agriculture and water.

#### 6.3.1. BIODIVERSITY

Climate change is likely to become one of the most significant drivers of biodiversity loss by the end of the century, as already evidenced from the very rapid increase over the last century, especially in dry lands, mountains and Polar Regions (Millennium Ecosystem Assessment- MA, 2005)

Projected changes in climate, combined with land use change and the spread of exotic or alien species are likely to limit the capability of some species to migrate and therefore will accelerate species loss (CBD, 2007).

Cyprus due to its geographical position in the eastern part of the Mediterranean Sea bears all the characteristics of a semi-arid climate and some of the deficits of the global climate change. The rich biodiversity of Cyprus is the result of the combination of the geographical structure, landscape isolation due to its insular character, surrounding sea, topographic relief, geological structure and of course climatic conditions. The flora and fauna of the island are adapted to the various natural biotopes and climatic conditions, resulting in a large number of endemic and rare species (DoE, 2000).

Direct impacts of climate change on Cyprus biodiversity arise mainly from decreased rainfall and increased temperature, droughts, fluctuations in intensified precipitation, sea level rise and increased atmospheric CO<sub>2</sub>. These impacts are expected to worsen in future period (2021–2050) as already projected PRECIS and ENSEMBLES prediction system.

Biodiversity is affected by numerous factors concerning the climate, ecology, society, culture, economy and technology (United Nations University, 2005). In terms of climate, the main factors affecting the biodiversity of Cyprus are among others the following: Variability (uneven geographic distribution and temporality of precipitation) - Reduction of frequency of precipitation - Increase of frequency of rainfall's intensity - Increase of temperature (and certain variables of temperature) - Heat-wave - Reduction of snow cover in Troodos - Increase of evapotranspiration (contributes to the intensification of soil drying).

The above mentioned pressures in combination with other factors such as the island's landscape fragmentations, the intrusion of harmful invasive alien species and the deteriorated freshwater quality, are expected to threaten further and in more complicated way, mainly the terrestrial, marine and freshwater biodiversity of Cyprus.

## FUTURE IMPACT ASSESSMENT

The climatic factors that may have an impact on the biodiversity of Cyprus include the decreased rainfall and increased temperature, droughts, fluctuations in intense precipitation events, sea level rise, increased atmospheric CO<sub>2</sub> and changes in fire regimes. According to PRECIS projections for the future period 2021-2050, the average annual temperature in Cyprus is expected to increase by 1-2°C, precipitation to decrease in seasonal level and in minor degree in annual level, the maximum length of dry spells (precipitation < 0.5mm) is expected to increase 10 to 12 days on average, heat wave days (temperature > 35°C) will be increased averagely about 10-30 days on annual basis, depending on the region. Concerning future changes of annual max total rainfall over 1 day, PRECIS projections show that a slight increase of about 1-4 mm is anticipated. Finally, regarding the highest annual total precipitation, falling in 3 consecutive days, a negligible increase of about 1-2 mm of rainfall is expected. For the purpose of this report, the future impacts of climate change are grouped in categories and assessed in the sections that follow.

- Terrestrial ecosystems
  - Distribution of plant species in terrestrial ecosystems
  - Plant phenology of terrestrial ecosystems
  - Distribution of animal species in terrestrial ecosystems
  - Animal phenology of terrestrial ecosystems
- Aquatic ecosystems
  - Marine biodiversity
  - Freshwater biodiversity
  - Phenology of aquatic ecosystems

### Impacts on terrestrial ecosystems

The distribution of plant species in terrestrial ecosystems, in terms of number of species, services of plants and plant communities, is expected to be affected even more with the projected milder winters in future. So far northward and uphill movements of plants and extinctions of species have been observed, emerging the concern about the resilience of wild plants to the rate of climate change. Another impact that is expected to be exacerbated is the invasion of alien species, having caused ecological changes throughout the world in the past few hundred years (Clout and Lowie, 1997; Unit of Environmental Studies), such as diseases of local species and alterations of keystone species. The invasive alien

species alter or even extinct populations and native species in the natural ecosystems. In Cyprus the already low plants species richness will be worsening in the future period (2021-2050) where droughts are anticipated to be increased.

Changes in phenological responses of plants have been noticed in several places of Europe, including Cyprus, as mentioned in the survey "Growing Season Temperatures in Europe and Climate Forcing over the Past 1400 Years".

In the future period (2021-2050) the expected temperature increases of about 1-2°C on average, as well as the milder winters, can affect biodiversity negatively, especially in Akamas area, Troodos mountain and Akrotiri peninsula, where the threatened plants located in a significant level. Both the winter minimum and summer maximum temperature is anticipated to have an increase of 0.8 - 1°C and 1-2°C, respectively, mainly in southern, inland and, western and mountain regions. Since there is no data available for on plant phenology, the extent of future climate impacts cannot be estimated at present.

The population and distribution of animal species in terrestrial ecosystems will be also changed with the temperature rise in the future; as a result of the decreased food availability and the expansion of invasive species and their associated diseases. The most typical example is the establishment of new pest species -such as migratory moths, butterflies, ticks and mosquitoes- due to warmer winters.

Furthermore, projections about the mammals of the Mediterranean regions- especially the threatened in terrestrial environments- suggest up to 9% risk of extinction (assuming no migration) during the 21st century (Andreou et al.).

As regard as the animal phenology of terrestrial ecosystems in Cyprus, there is no information available in relation with the increasing temperature, apart from the noticed increased populations of insects in the forests of Cyprus (DoF). However, the projected increase in temperature can affect animal phenology, due to the induced changes in the metabolic limits of animals, in the reduction of the thermoregulation capacity of warm blooded animal species, in the length of breeding seasons and the higher reproduction of temperature-sensitive insects and others.

## Impacts on aquatic ecosystems

The marine flora and fauna of Cyprus with the great diversity and low biomass are more vulnerable to climate change. Furthermore the surrounding environment, the Levantine basin (Eastern Mediterranean Sea) is characterized by high temperature and salinity, as well as low nutrient levels, making it a challenging biological niche which constantly tests species' tolerance limits to physical components (Parari, 2009).

The temperature in Cyprus is expected to increase about 1.0 – 2.0°C in winter and about 2.0 – 2.7°C in summer, (according to PRECIS projections, for the future period 2021-2050), resulting in lower nutrient levels (phytobenthos and phytoplankton), higher salinity and acidification and, displacement of the endemic species by the invasive species, that entering the Mediterranean Sea through the Gibraltar straits and the Suez Canal.

For example, marine habitats of neuralgic importance - such as *Posidonia oceanica* meadows- are very sensitive to salinity, temperature and sedimentation alterations. The meadows produced by this marine plant function as nursery grounds for juvenile fish, reproductive fields and fisheries stock replenishment areas are exceptionally important. A potential loss of these meadows would bring catastrophic consequences for the marine biodiversity of Cyprus and its commercial fisheries (Parari, 2009). Since there is no data available further research is required to assess the future impact on marine biodiversity due to changes in nutrient levels.

The inland aquatic biodiversity will be affected by future climate change, as they can cause enhanced phytoplankton bloom, favouring and stabilizing the dominance of harmful cyanobacteria in phytoplankton communities, resulting in increased threats to the ecological status of lakes and enhanced health risks, particularly in water bodies used for public water supply and bathing (EEA et al., 2008). The plants, fish and aquatic organisms of rivers and water storage reservoirs (dams) of Cyprus are threatened by the eutrophication, which can be deteriorated by temperature rise. One of the most important effects in aquatic phenology is the change in the size and growth of phytoplankton and the consequent influence on the light levels, surface temperature and magnitude of nutrient recycling. However information about phytoplankton growth and

bloom response to temperature rise is not available and further research is required.

## FUTURE VULNERABILITY ASSESSMENT

The future vulnerability of biodiversity to climate change impacts in terms of their sensitivity, exposure and adaptive capacity based on the available quantitative and qualitative data for Cyprus and the climate projections for the period 2021- 2050 is assessed for the impact categories as follows:

1. Distribution of plant species in terrestrial ecosystems
2. Distribution of animal species in terrestrial ecosystems
3. Marine biodiversity
4. Freshwater biodiversity

### Terrestrial ecosystems

It is noted that, the future vulnerability of “Plant phenology of terrestrial ecosystems”, “Animal phenology of terrestrial ecosystems” and “Phenology of marine ecosystems” was not assessed due to lack of relevant research findings.

The future vulnerability of biodiversity varies substantially as it is related to the different rate and magnitude of climate change in different parts of Cyprus due to the variability of the air pollution levels, altitude, temperature and rainfall variations, meteorological conditions (e.g. wind, moisture), local geomorphology and soil characteristics.

The general characteristics of the plant distribution in Cyprus which indicate a sensitive environment to climate change plant species are the following: (i) low species richness, (ii) sensitive endemic plant species and (iii) several invasive plant species. The number of plant species in Cyprus is generally considered low in

comparison with the levels in Europe, perhaps due to the semi-arid climate of the island and the more frequent presence of consecutive years of droughts according to Biosoil project (Hiederer and Durrant, 2010).

Nevertheless studies undertaken in Cyprus indicate that the percentage of endemism is 7.39% which is one of the highest in Europe (Hadjichambis and Della, 2007).

The more sensitive plant species are considered those that belong to relic populations and those that are less capable to adapt in the new environmental conditions. More specifically, according to the Red Book of Flora of Cyprus (Tsintides et al., 2007), 7% of the plant taxa in Cyprus is Regionally Extinct (RE), 14% of endemic plants of Cyprus is characterized as Critically Endangered (CR), 19.5% as Endangered (EN), 39% as Vulnerable (VU), 4,6% as Close Threatened (NT) and 2.2% as Low Danger (LC).

According to the studies of Hadjikyriakou and Hadjisterkotis (2002), 152 adventive species have been recorded. More specifically *Acacia saligna* (Labill.) (H.Wendl.) is described as the most dangerous invasive species in Cyprus, threatening many natural habitats, invading maquis, garigue, phrygana, marshy areas and agricultural land. It has been recorded as a serious threat to the habitat of the salt lake of Larnaca and it was considered necessary to remove a number of its population from the area (Atlantis Consulting Cyprus Ltd). Likewise, the *Robinia pseudoacacia* L. has spread in forests, maquis, garigue and phrygana vegetation. In addition, the observed for the first time *Ailantus altissima* (Mill.) Swingle and *Casuarina cunninghamiana* Miq. is also spreading, threatening natural habitats such as forests and maquis.

Considering the above, the sensitivity of the distribution of plant species (including Invasive Alien plant Species) in Cyprus for the future period (2021-2050) can be characterized high.

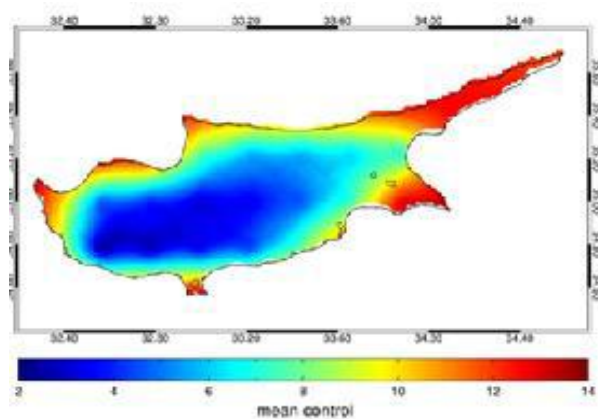
**Table 6.1. List with the Critically Endangered (CR) plants of Cyprus**

Species	Description
<i>Arabis kennedyae</i>	Troodos, Triptilos (in altitude 9001350m)
<i>Astragalus macrocarpus</i> subsp. <i>lefkarensis</i>	Only in Cyprus in Leykara, Asgata, Alaminos and Kelokedara
<i>Centaurea akamantis</i>	Only in Akamas of Cyprus
<i>Delphinium caseyi</i>	Only in Cyprus, in Pentadaktylos (tops of Saint Ilarionas and Kyparrissovouno)
<i>Scilla morrisii</i>	Exclusively at southwest of Cyprus (Monastiri, Agia Moni, Saint Neofytos)
<i>Salvia veneris</i>	West of Kithreas villages
<i>Erysimum kykkoticum</i>	One the rarest endemic species. It is located in the valley of Xeros (Argakin of Pissokremmou)

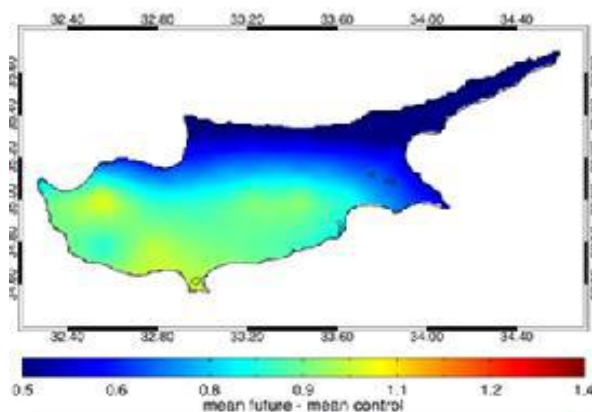
The distribution of the critically endangered plant species (Table 6.1), seems to be in many and scattered areas on the island. Though is no scientific data available concerning phenological responses of plants, these will be affected. In general the area that the majority of threatened plants are situated will face temperature increase of about 1-2 °C in future (2021-2050), increase in maximum length of dry spell and variations in precipitation and so will threaten even more these species. Combination of density, width and dry spell increase in these areas will determine the degree of its final exposure. Taking into consideration the above findings the distribution of plant terrestrial ecosystems for the future period (2021-2050) is preliminary assessed as high.

The resilience of plants towards climate change refers to their ability to genetically adjust to changing environmental conditions as well as to their ability for uphill migration. However, more research in this field is necessary to be done.

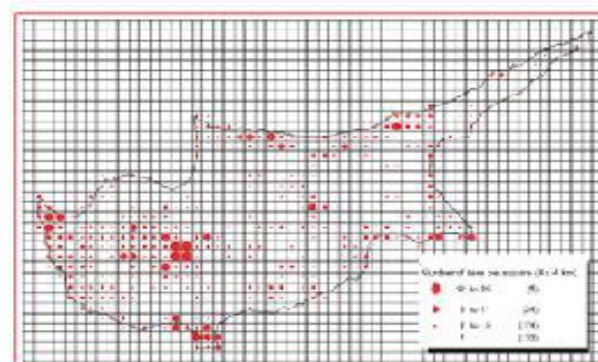
The existing national legislative framework among which the Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (with the Law 153(I)/2003), the ratification of the Bern Convention on the conservation of European wildlife and natural habitats (with the Law 24/1988), the Convention on International Trade in Endangered Species of Wild Fauna and Flora, the CITES (with the Law 20/1974) and the Convention on Biological Diversity (with the Law 4(III)/1996), aim mainly to reduce human pressures posed on biodiversity, while little can be done to reduce the effects from adverse climate conditions. As for example the Action Plan for the planting control and eradication of the Invasive Alien Species of *Acacia* in NATURA 2000 areas<sup>18</sup>, was completed with great success, regarding the spreading of harmful invasive species.



(a)



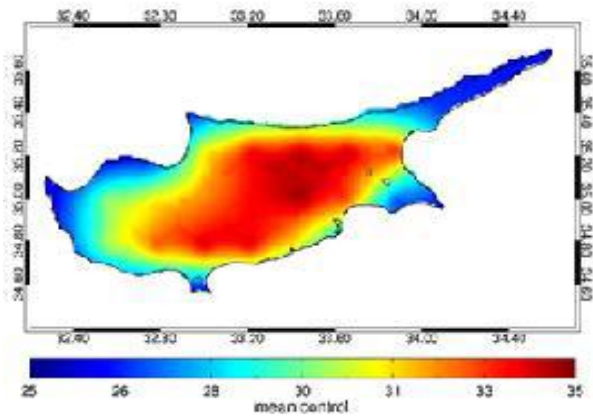
(b)



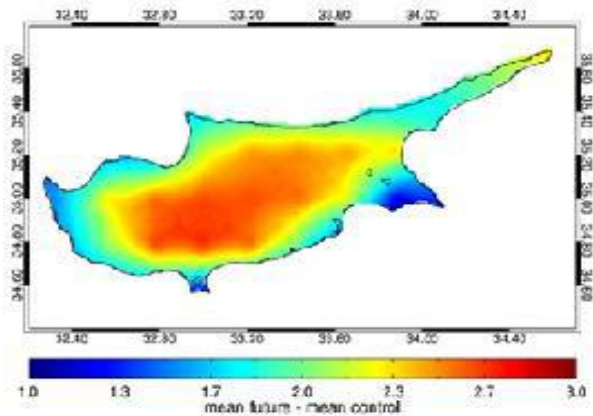
(c)

Figure 6.17. Average winter minimum temperature for control period (a) and in the near future using PRECIS RCM model (b) and, Geographic distribution of the threatened plants of Cyprus (c)

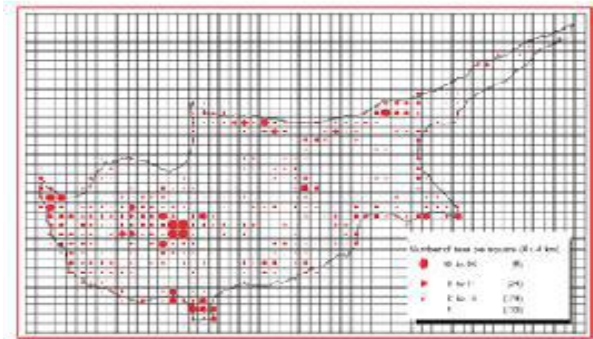
<sup>18</sup> An ecological network of protected areas in the territory of the European Union, regulated by Directive 92/43/EEC and Directive 2009/147/EC



(a)



(b)



(c)

Figure 6.18. Average summer maximum temperatures for control period (a) and in the near future using PRECIS RCM model (b) and, Geographic distribution of the threatened plants in Cyprus (c)

According to the studies conducted by Levinsky et al (2007) and Lemoine et al. (2007), widespread species may be less vulnerable while threatened endemics – which are already under pressure-, will be at greatest risk despite their spatial variation (EEA et al., 2008). In addition to the inability of many animal species in migrating to other habitats, either due to landscape fragmentations or because of their physical characteristics, an important constraint will be the soil droughts and the consequent food availability. To sum up

sensitivity of animal distribution to climate changes for the island of Cyprus for future period (2021-2050) is high.

Based on the conclusions of the World Resources Institute for the period 2002-2003, the most threatened species are located in terrestrial environments as shown in Figure 6.19.

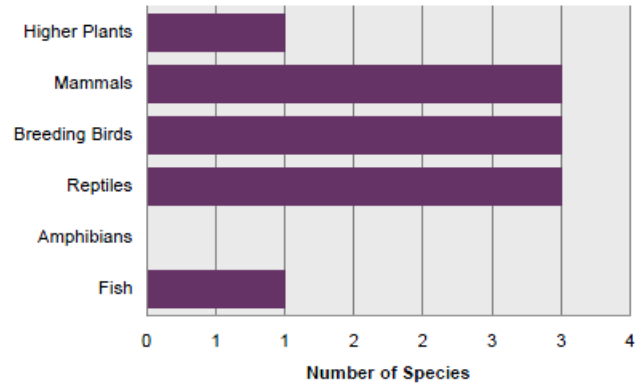
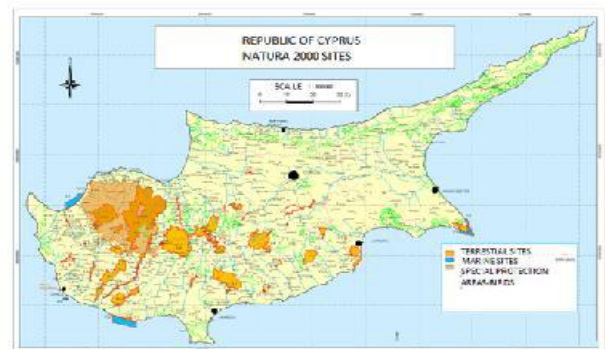


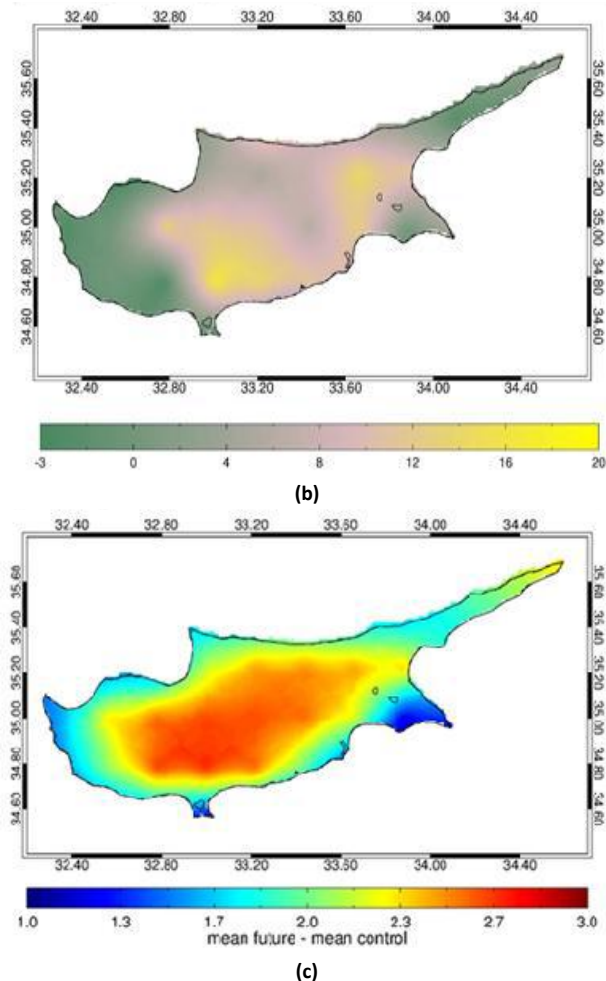
Figure 6.19. Threatened Species in Cyprus, 2002-03 (World Resources Institute)

Geographic movement of animal species may be affected by the anticipated increase in maximum length of dry spell (precipitation < 0.5mm). In specific, southeastern regions where a number of NATURA 2000 sites located are anticipated to have an increase about 2.3°C in summer maximum temperature and about 0.8°C in winter maximum temperature. In those areas the geographic movement of animal species and animal phenology is anticipated to be affected. In Pafos district and Troodos mountain range, that the majority of NATURA 2000 sites are situated, temperature is anticipated to increase about 1°C on average in winter respectively and 22.7°C on average in summer. In those areas the geographic movement of animal species and animal phenology is anticipated to be affected more (Figure 6.20).



(a)





**Figure 6.20. (a) NATURA 2000 areas in Cyprus, (b) Changes in maximum length of dry spell (RR<0.5mm) between the future (2021-2050), the control period (1961-1990), (c) Changes in average summer maximum temperature in the near future (Future – Control period) using PRECIS RCMmodel**

Consequently the exposure for the future period (2021-2050) can be considered as high.

The resilience of animals towards climate changes refers to their ability to genetically adjust to changing environmental conditions as well as to their ability for uphill migration. There are no data available for the animal population movements in Cyprus. In addition, the extensive existing national legislative framework is protective for many animal species as shown in Table 6.2.

Nevertheless, the genetic adjustment of animals and the measures taken are not enough for combating the increasing risk of terrestrial animals towards climate change and additional adaptation measures are needed.

## Aquatic ecosystems

The high Sea Surface Salinity (SSS) and Sea Surface Temperature (SST) of Cyprus, in comparison with the rest of the Mediterranean region, results in a relatively high species diversity and very low biomass. Temperature rise is the main reason for the northward movement of marine species, changing the composition of local and regional marine ecosystems. Thus both distribution of fish and the socioeconomic situation of local fishermen are affected heavily.

The increasing intrusion of exotic fish in the Mediterranean Sea has not yet been determined whether it constitutes a serious threat for the extinction of the endemic species. The number of invasive species introduced in the coastal and offshore waters of Cyprus has grown over the last 50 years (Katsanevakis et al., 2009). Studies have shown that the rate of new biological invasions in the Mediterranean Sea is as high as 1 new species every 9 days (Zenetos et al., 2008). Considering the above, the sensitivity for the future period (2021-2050) can be characterized moderate.

The number of alien biota in the Mediterranean Sea appears to be underestimated, especially the coasts of the Levantine basin, which is one of the hot spot areas for possible species introductions (Zenetos et al., 2005).

Cyprus is located near the manmade nautical channel of Suez which favours the migration and relocation of the Lessepsian species. However there is no data available for the anticipated effect of temperature increase on the displacement of marine biodiversity. Further research is required.

Anticipated changes in temperature, as already presented, may cause fluctuations in sea water temperatures which are responsible for changes in physiology and sex ratios of fished species, alteration in timing of spawning, migrations, and/or peak abundance and also, for the increasing of invasive species, diseases and algal blooms. These impacts are leading to reduced production of target species in marine systems. Considering the above, the exposure of marine species, for the future period (2021-2050) can be characterized high to very high.

**Table 6.2. Protection status of the endangered animal species of the terrestrial ecosystems in Cyprus**

Protected fauna species	Measures
<b>Reptiles</b>	
<i>Mauremys caspica</i>	Protected under Annex IV of Directive 92/43/EEC, Annex II of Bern Convention
<i>Coluber cypriensis</i> - EN	Protected under Annex II and IV of Directive 92/43/EEC, Annex II of Bern Convention
<i>Emys orbicularis</i>	Annex II of Bern Convention
10 other species	Protected under Annex II of Directive 92/43/EEC
<b>Birds</b>	
<i>Numenius tenuirostris</i>	Protected under Annex II of SPA <sup>19</sup> protocol, Annex II of Bern Convention
<i>Pelecanus crispus</i> - VU	Protected under Annex II of SPA protocol
<i>Oxyura leucocephala</i> - EN	Protected under Annex II of Bern Convention
<i>Branta ruficollis</i> - VU	Protected under Annex II of Bern Convention
<i>Crex crex</i> - LR	Protected under Annex II of Bern Convention
<i>Emberiza aureola</i>	Protected under Annex II of Bern Convention
<i>Gallinago media</i>	Protected under Annex II of Bern Convention
<i>Larus audouinii</i> - LR	Protected under Annex II of Bern Convention
<i>Emberiza cineracea</i>	Protected under Annex II of Bern Convention
<b>Mammals</b>	
<i>Ovis orientalis ophion</i> (Cyprus muflon) – VU	Protected under Annex II and IV of Directive 92/43/EEC
<i>Rhinolophus Euryale</i> - VU	Protected under Annex II and IV of Directive 92/43/EEC
<i>Capra aegagrus</i> (Cyprus goat) - VU	Protected under Annex II and IV of Directive 92/43/EEC, Annex II of Bern Convention
<i>Rousettus aegyptiacus</i>	Protected under Annex II and IV of Directive 92/43/EEC

Scientific recording of the populations of marine species reveals some of the extent of the threat for the marine host species. The genetic adjustments of the host organisms to new conditions need many reproductive

cycles, and as a result the most common way of survival is the migration to other latitudes.

In addition, there are numerous institutional measures for the protection of marine ecosystems in Cyprus, including the coastal protected area of Lara-Toxeftra, which encompasses the most important breeding biotope for the sea turtles (*Chelonia mydas* and *Caretta caretta*). (Fisheries Law and related regulations, NATURA 2000 network (DoE, 2010).

The protection of aquatic species of inland and marine waters, is implemented through the provisions of national law since 1971 and its related regulations, as well as through the Law 153(I)/2003 which harmonizes Directive 92/43/EEC on the Conservation of Natural Habitats and Wild Fauna and Flora. In addition, Cyprus has ratified the Barcelona Convention for the Protection of the Mediterranean Sea against Pollution and in particular the SPA Protocol concerning Specially Protected Areas and Biodiversity in the Mediterranean. Complementary to these are the Convention on Conservation of European Wildlife and Natural Habitats (Bern Convention), the Convention on the International Trade in Wild Fauna and Flora (CITES) and the Convention on Biological Diversity (CBD). In particular, protected marine species and habitats are those listed in the aforementioned Directives and Conventions, as well as those in the Fisheries Law and Regulations, including all species of sea turtles, dolphins, seals and a species of sand crab (DoE, 2010).

Though the important habitats along the coastal waters of Cyprus are well-preserved, could be threaten by the increased number of successful intrusions of marine species in the area (Ben Rais Lasram and Mouillot, 2009) due to climate change. Considering the above, the adaptive capacity in the future period (2021-2050) can be characterised as moderate.

The indigenous fish species richness in Cyprus is exceptionally poor and susceptible to numerous threats such as the landscape fragmentations, the environmental alterations (caused with the introduction of freshwater fish and crayfish in the artificial dams for recreation purposes) and the pollution caused by human activities. Additional stress on water quality and aquatic populations is expected as a result of further oxygen depletion and eutrophication, induced by the projected temperature increase. Based on the above facts the

<sup>19</sup> Specially Protected Areas

**Table 6.3. Overall vulnerability assessment of biodiversity in Cyprus to climate changes**

<b>Impact</b>	<b>Sensitivity</b>	<b>Exposure</b>	<b>Adaptive Capacity</b>	<b>Vulnerability</b>
<b>Distribution of plant species in terrestrial ecosystems</b>	High (5)	High (5)	Limited to Moderate (2)	Moderate (3)
<b>Distribution of animal species in terrestrial ecosystems</b>	High (5)	High (5)	Limited to Moderate (2)	Moderate (3)
<b>Marine biodiversity</b>	Moderate (3)	High to Very high (6)	Moderate (3)	Limited to Moderate (1.2)
<b>Freshwater biodiversity</b>	Moderate (3)	Moderate (3)	Moderate (3)	None (0)

sensitivity for the future period (2021-2050) can be considered as moderate.

In Cyprus, the plants, fish and aquatic organisms of rivers and lake dams of Cyprus are generally in good condition, whereas the organisms of groundwater are more strained. Climatic changes will have an impact mainly on the quality of the surface waters in Cyprus and consequently on the biodiversity. The nitrogen pollution from untreated sewage effluent and agricultural run-off carrying fertilisers is responsible for the phenomenon of eutrophication, which can possibly be deteriorated by climate change.

There is no data available to correlate the effect of water quality with the change of biodiversity in freshwater bodies. Nevertheless significant reduction in precipitation which is anticipated for the autumn period, may affect ecosystems of perennial rivers due to delayed flow and the intense reduction in recharge rates. Another factor influencing the water quality and thus the biodiversity in freshwater bodies is the number of heavy rain events due to drifting of fertilizers, sediments and other pollutants. Considering the above, the exposure of freshwater biodiversity and quality in Cyprus is considered as moderate

The resilience of the organisms of these habitats to climate change refers to their ability to genetically adjust to changing environmental conditions. Nevertheless, most of the times, due to landscape deterioration of this kind of habitats, the phenomena of extinction are inevitable.

Further to the needed adaptation measures, a limitation of the extinction phenomena is also achieved my means of several measures implemented for the protecting water resources and inland aquatic species, such as the Laws:13(I)/2004 on the protection and management of water, 34/2002 on the nitrogen pollution of waters (based on the European Directive 91/676/EEC), 42/2004

on the control of nitrogen polluted waters, 41/2004 on the control of water pollution, 517/2002 on the control of water pollution, 56(I)/2003 on waste management,1/1971 on sewerage systems, 108(I)/2004 about sewerage systems,772/2003 about urban astewater, 254/2003 about the nitrogen pollution of water bodies, 106(I)/2002 about the control of the water and soil pollution,45/1996 about the control of the water and soil pollution.

Consequently, the adaptive capacity of Cyprus' freshwater biodiversity and quality to climate changes is considered to be moderate.

#### **Assessment of overall future vulnerability**

The overall future vulnerability of biodiversity against a climatic change impact, in terms of sensitivity, exposure, adaptive capacity on the based on the available data for the above mentioned indicators are quantified as shown in Table 6.3.

The main indicator for assessing the vulnerability of the terrestrial biodiversity towards climate changes appears to be the landscape fragmentations of the island, as species cannot move neither northern nor higher after a certain point. Instead, the main advantage of the marine biodiversity is the ability of migration, which can also be counted as a disadvantage due to the intrusion of harmful invasive alien species. On the other hand, freshwater biodiversity is not threatened. Considering the above, it is assumed that the first vulnerability priority of the biodiversity in Cyprus to climate changes is the distribution of species in terrestrial ecosystems while the second priority is the biodiversity of aquatic ecosystems.

### **6.3.2. INFRASTRUCTURE**

The island of Cyprus is situated in the south-eastern part of the Mediterranean Sea. Administratively, Cyprus is

divided into the following six districts: (a) Lefkosia (capital), (b) Limassol, (c) Larnaca, (d) Paphos, (e) Famagusta and (f) Kyrenia. It has a total of 772 km of shoreline, of which: (a) 404 km in the occupied zone after the Turkish invasion in 1974; (b) 72 km within the British Military Bases; and (c) 296 km under Government control. The critical infrastructure of Cyprus has been developed near the coastal area, except for Lefkosia which is located near the centre of the island.

In general, the infrastructures in Cyprus are not considered very vulnerable to climate changes, which arise mainly from decreased rainfall and increased temperature, droughts, fluctuations in intense precipitation events, sea level rise, increased atmospheric CO<sub>2</sub> and changes in fire regimes.

The future impact, vulnerability and adaptation measures for the infrastructure sector in Cyprus regarding climatic changes were also assessed as part of the Life+ CYPADAPT project, by using PRECIS and six other regional of the ENSEMBLES prediction system and, the future period (2021–2050) against the control period (1961–1990).

The main vulnerability priority of the sector to climate changes observed until now has been related to the damages caused by urban floods and sea floods. It has to be noted that specific measures have been undertaken the last decades to reduce the severity of this impact (drainage works, town plans, SUDS etc.) and that Cyprus has not experienced any severe floods from the sea in the past. The point of this consideration is the great number of tourist units and other infrastructures, important to Cyprus economy are located in the coastal areas.

According to the Intergovernmental Panel on Climate Change (IPCC), the infrastructure is defined as ‘the basic equipment, utilities, productive enterprises, installations and services essential for the development, operation and growth of a city or nation’. Thus:

- Utility services; (Water supply; Energy supply (power plant and electricity networks); Wastewater and waste collection, treatment and disposal )
- Transport;
- Information and Communications Technology (ICT) infrastructure;
- Industry; and

- Buildings (residential and tourist accommodation units).

The main climate change impacts on the infrastructure sector include: (i) material damages to infrastructure, possibly linked with extreme events and flooding, (ii) disturbances in normal community function such as interruption and obstruction of passenger or freight transport, (iii) human safety.

## FUTURE IMPACT ASSESSMENT

The climatic factors that are likely to induce impact on Cyprus infrastructure system in the future are the extreme events, mainly the heavy rain, sea level rise, flooding and wind speed. Heavy rain may affect all types of infrastructure due to the risk of flooding, land sliding and collapsing. The relationship between potential climate changes and impacts on infrastructure is shown in Table 6.4.

Heavy rain is anticipated to have an impact on infrastructure. PRECIS predictions show that future changes of annual max total rainfall over 1 day, have a minor increase of about 2-4 mm in western and higher level regions. The heavy rain events have been monitored since 1917 by the Department of Meteorology and as shown in Figure 6.21 they follow a rising trend. There is evidence that this rising trend is related with climate change.

Flooding which is associated with heavy rain also follows the same pattern, thus an increase, both in terms of frequency and magnitude, especially in the last seven years (2000-2007).

As mentioned above, the infrastructure system is expected to be affected mainly by the following two main categories of impacts: material damages; and disruptive operation.

For the case of Cyprus, the above mentioned impacts are related with flooding events induced by heavy rain (flash floods). However, there is no evidence that these events are directly connected with climate change and as a result the impacts due to climate change on the infrastructure sector are limited to uncertain. The available data were not conclusive and could not be used as a basis for measuring the future impact of climate change on infrastructure. It is worth saying, however,

Table 6.4. Relationship between potential climate changes and impacts on the infrastructure sector

Potential climate change in Cyprus	Type of Infrastructure	Future impacts on infrastructure	Selected Indicators
<b>Heavy rain</b>	All types	- Flood - Landslides	Severity of material damages to infrastructure
	Water infrastructure (water treatment, wastewater collection and treatment)	- Risk for flooding of Sewerage Treatment Plants - Risk for sewer flooding	
	Transport infrastructure	- Increased demand for car use - Flooding of underground networks - Flood damage - Bridge collapse and associated implications	
	Communications	- Reliability of the signal - Disturbances to overhead networks	
<b>Storm surge</b>	(located at coast)	- Flood - Periodic flooding of coastal infrastructure	- Disruption frequency - Duration of disruption - Percentage of critical infrastructure located in or near coastal areas - Disruption frequency in daily operations (social activity and trade) - Duration of disruption
<b>Sea Level Rise</b>	All types (located at coast)	Permanent asset loss at coastal sites	Percentage of critical infrastructure located in or near coastal areas
	Transport infrastructure (ports)	- Limited access to ports - Threat to port operation	Coastal infrastructure asset losses due to Sea Level Rise
<b>High winds</b>	Transport	- Transport disruption (caused by blown down trees etc.) - Impede aircraft operation	- Disruption frequency in daily operations (social activity and trade) - Duration of disruption
<b>Temperature increase</b>	Transport	- Deformation of road and airport asphalt surfaces - Passenger discomfort	
	Communications	Decreased wireless transmission signal	
<b>Extreme events</b>	All types	Risks for human safety	- Number of accidents related to extreme weather events - Population living in disaster prone areas (areas prone to flooding and landslides) - Changes in the proportion of built-over land in disaster prone areas
	Transport infrastructure	- Asset failure due to long, hot, dry periods followed by intense rain causing flash floods. - Stability of foundations of transmission masts and towers, mostly attributable to increased risk of subsidence (more susceptible during drier summers and wetter winters) - Damage to underground cables (more susceptible during drier summers and wetter winters)	

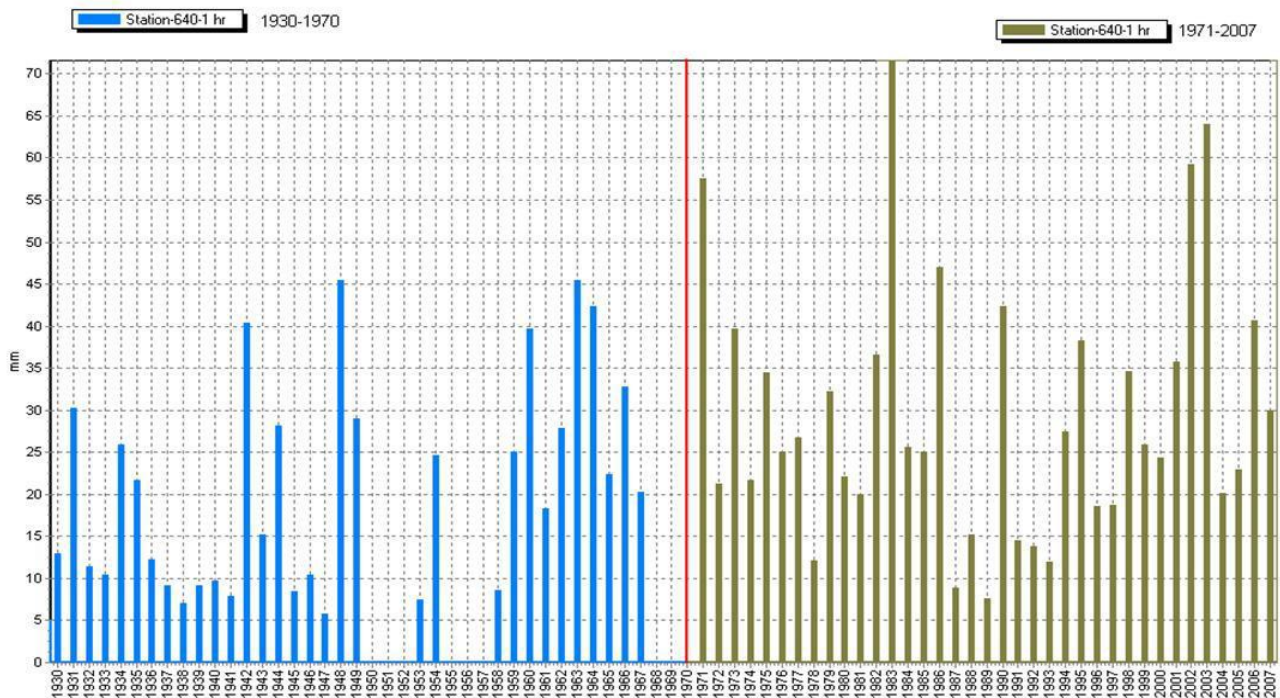


Figure 6.21. Highest amounts of rainfall in 1 hour, in Cyprus (Pashiardis, 2011)

that there is an increasing trend in the appearance of flooding events, the intensity of which, both in terms of frequency and severity, is likely to exacerbate due to climate change. In general, it must be noticed that sensitivity of the sector is increasing in flood and landslide prone areas (MoE, 2011).

#### FUTURE VULNERABILITY ASSESSMENT

The future vulnerability of the infrastructure sector is assessed in terms of its sensitivity, exposure and adaptive capacity based on the available quantitative and qualitative data for Cyprus and the climate projections for the period 2021-2050, presented in the CYPADAPT project.

It must be noted that, there are no sufficient scientific evidence and data to evaluate or correlate all impacts and indicators to future climate changes. Consequently, further research is required in order to provide concrete information for a more detailed and descriptive assessment of the future vulnerability of the sector. Nevertheless, an attempt was made to provide a preliminary assessment of the vulnerability for the following impacts: Infrastructure damage due to floods (urban and sea floods); and Infrastructure damage due to landslides.

#### Damages of infrastructure due to floods

The vulnerability of the Cypriot infrastructure was assessed regarding the sea floods and urban floods. The former type is caused by storm surge or sea-level and affects mainly the highly developed coastal infrastructure of the island. However, no significant sea flood events have been recorded while for future projections further research is required. The urban floods are directly connected with heavy rain and the consequent damages. According to the records of the flood events observed in Cyprus between 1859 and 2011, over 200 floods caused implications in multiple levels such as damages to road infrastructure, disruption of economic, social and cultural activities and in turn financial losses (WDD, 2011). To sum up, taking into account the current situation as well as the relative future climate changes the sensitivity of infrastructure due to floods was ranked as moderate to high.

The exposure to future sea floods depends on the importance of infrastructure which is located on or near the coastline. In Cyprus this infrastructure includes:

- Electricity supply (three power stations and the Energy centre)

- Water supply (Water treatment plants, Wastewater treatment plants, Desalination plants)
- The international airports of Larnaca and Pafos.
- Seaports;
- Marinas and fishing shelters;
- Industries (two cement plants)
- Buildings (hotels, tourist and residential accommodation units)

Sea-level rise, generally, may affect infrastructure located in or near coastal areas. For the case of Cyprus, however, sea level rise is expected to be moderate (EC, 2009).

Furthermore it must be added that, based on archaeological data, Cyprus appears to be experiencing long-term uplift of between 0 and 1 mm per year. This uplift is expected to counteract sea-level rise and given a global rise in sea level of 0.5m by 2100, relative sea-level rise in Cyprus will be in the range 0.4-0.5m (Nicholls and Hoozemans, 1996)

The general assessment of the effects of storminess changes on storm surge is not possible due to the limited geographical coverage of studies and the associated uncertainties (IPCC, 2012). However, according to the projections of the PRECIS climate model, the mean wind speed greater than 5 m/s in Cyprus during the future period 2021-2050 is not expected to present substantial changes, on the contrary, it presents minor decreases in general of the order of about 5-12 days for the number of days with mean wind speed greater than 5 m/s.

The urban centres of Larnaca, Limassol and Lefkosia are sensitive to flood risks mainly due to their dense structuring and the restriction of green space, the elimination of natural waterways for the construction of roads, the deficient or even absent storm-water drainage system and, the covering of waterways and drain entrances with garbage. On the other hand, mountain areas are less sensitive to floods, given that the inclination of terrain together with the infiltration capacity of forested areas do not allow for flooding events to take place.

The climate projection model used for the case of Cyprus does not provide estimates for the frequency and intensity of floods in the future. Nevertheless, there is an indicator referring to the annual maximum total precipitation over one day indicating heavy rainfall, which could also be associated with flood risk.

In compliance with the Floods Directive 2007/60/EC, the Water Development Department of MANRE through its report "Preliminary Flood Risk Assessment" identified 19 areas around the island as "Areas with Potential Significant Flood Risk" which are monitored.

In relation to the exposure of the infrastructure to flood events, future changes in land use and their implications should be considered. Land use changes can induce significant flood risk through changes in the runoff coefficient, (influenced by the percentage of precipitation, the ground cover of an area, ground slope).

To sum up, the exposure of the infrastructure sector to urban floods as the relative future climate changes the future exposure is ranked as high.

In order to reduce the impact of floods, the Cyprus Government has undertaken a series of flood protective measures including but not limited to the following:

- (a) Hard coastal defence works (for sea flood protection),
- (b) Fishing shelters and artificial reefs (for sea flood protection),
- (c) Dams (for urban flood protection)
- (d) Sustainable Urban Drainage systems (for urban flood protection).

Due to lack of sufficient data on the future impacts of climate change on the infrastructures of Cyprus, the analysis on the effectiveness of the already applied measures as well on the necessity for additional measures for the protection of infrastructure could not be conducted. Further research is suggested to take place on the subject. Taking everything into account, the adaptive capacity for urban floods was considered to be moderate.

#### **Damages of infrastructure due to landslide damage**

Cyprus is well-known for its interesting and often complex geology, particularly in the south-west part of the island. The reason for the increased susceptibility of this area to landslides is the remains of former sea-floor deposits and massive submarine slides, which tend to be heavily deformed and are rich in the types of clay minerals that are prone to land sliding. This tendency is exacerbated by the steep terrain and the long history of powerful earthquakes in the region (British Geological Survey). In addition, climate change increases the likelihood for land displacements. More specifically

**Table 6.5. Overall vulnerability assessment of the infrastructure sector in Cyprus to climate changes**

Impact	Sensitivity	Exposure	Adaptive Capacity	Vulnerability
Damage from urban floods	Moderate to High (4)	High (5)	Moderate (3)	Limited to Moderate (1.5)
Damage from sea floods	Limited (1)	Very High (7)	Limited to Moderate (2)	Limited (0.6)
Damage from landslides	Limited (1)	Limited (1)	Limited (1)	None (0)

changes in temperature and precipitation could be relevant for more landslides. In this regard the sensitivity was ranked as limited. However further research is required in order to provide concrete information for the future.

Variations in precipitation, temperature, heavy rain and heat wave days changes, can have an impact on landslide occurrence (Crozier, 2009) and therefore pose risk of infrastructure. However, due to the lack of data landslides in Cyprus and the issue should be investigated further.

A research project entitled ‘Study of landslides in areas of Pafos District’, has being undertaken aiming to minimize the landslide risk and, to promote a more efficient and secure urban development. It must be emphasized that it is appropriate such studies to be elaborated in order to allow the adaptive capacity to increase.

As few landslide protection measures have been undertaken such as road protection measures, retention walls and terraces and further research is suggested to take place on the subject. Considering the above, both the exposure and adaptive capacity of infrastructure to landslide damages for the future period (2021-2050) can be characterized as limited.

#### ASSESSMENT OF OVERALL VULNERABILITY

The overall future vulnerability of the infrastructure system against climatic change impacts, in terms of sensitivity, exposure, adaptive capacity, based on the available data is presented in Table 6.5.

In general, the infrastructures in Cyprus are not considered very vulnerable to future climate changes. In specific, the first vulnerability priority of the sector to climate changes is related to the damages caused by urban floods. However, it must be noticed that specific measures have been undertaken in order to reduce the severity of this impact (drainage works, SUDS etc.). The

second vulnerability priority is related to the damages to infrastructure caused by sea floods. Considering that a great number of infrastructures important for Cyprus is located in the coastal areas of the island and that Cyprus has not experienced any severe floods from the sea in the past, the vulnerability towards this impact is considered limited. The vulnerability of infrastructure systems to landslide cannot be evaluated due to limited availability of data.

#### 6.3.3. ENERGY

Cyprus as an island situated in the south-eastern part of the Mediterranean Sea, constitutes an isolated energy system. The energy requirements are covered mostly by oil imports, making Cyprus a highly energy dependent island (Koroneos et al., 2005; Zachariadis 2010). Until recently, renewable energy was considered to be as the sole indigenous form of energy, before the discovery of significant amount of fossil fuel resources in its Exclusive Economic Zone (EEZ). This is expected to change the energy mix profile and consequently to improve the energy sufficiency of the island.

On a worldwide basis, it is expected that the energy sector will experience different impacts due to climate change, including change of the heating/cooling degree days over year, reduction of the overall efficiency of the power stations associated with the increase in temperature of the cooling medium used in the energy production process, reduction in hydropower production etc.

According to EEA the Mediterranean basin has already been subjected to decrease precipitation something that is going to exacerbate as the climate change continues to persist and intensify. The decreased precipitation and stream flows will lead apart from low water availability, to decreased energy yield (regarding hydroelectricity). However, hydropower is not used in Cyprus and is not projected to be introduced to the energy mix of the



island in the coming years, due to limited water resources and intermittent river flows.

The main vulnerability priorities identified for the sector are related to the energy demand for cooling and heating, which is directly affected by climate changes and, to the efficiency of thermal power plants, which is not expected to be significantly affected by climate changes. With regard to the impact of climate changes on the various types of RES generation -except hydropower which is not exploited in Cyprus - this is minor.

The impacts of future climate change on the energy sector based on the climate projections output produced by the PRECIS and six other ENSEMBLES regional climate models, as well as on other socioeconomic projections for the period 2021-2050. The future period 2021-2050 has been chosen, instead of the end of the twenty-first century as frequently used in other climate impact studies, in order to assist investors and policy makers to develop near future plans.

The main pressure on the sector is the energy production cost. Cyprus shows particular vulnerability on the energy sector stemming from oil prices as the total amount of oil used is imported. Additional pressures -especially during the summer- are the energy demand for drinking water production from seawater desalination plants (to reduce the dependence of drinking water on rainfall) and for irrigation (for longer periods through pressurized irrigation systems and long conveyance pipe works) due to decreasing precipitation.

Climate change will affect both the supply and demand of energy profile in different ways.

**Table 6.6. Relationship between climate changes and impacts on the energy sector**

Potential climate changes	Impacts
Increase in temperature and relative humidity	- Increased cooling demand and decreased heating demand - Decreased thermal efficiency in thermal power plants
Precipitation	Change in Bio-power generation
Wind speed	Change in Wind power generation
Cloud cover	Change in Solar power generation

## FUTURE IMPACT ASSESSMENT

The climate change impacts on the energy sector as these have been identified and assessed in light of the climate projections for the future (2021-2050) are mainly connected to the change in the heating and the cooling loads.

The climatic factors that are likely to induce impacts on the energy sector as shown in Table 6.6 are the following: (a) temperature and relative humidity; (b) precipitation; (c) wind and cloud cover; (d) extreme events.

The future impacts of climate change on the energy sector are summarized below.

### 1. Renewable energy yield

The renewable energy sources that are likely to be affected by climate change are the (a) wind power; (b) solar power and (c) bio-power (Kirkinen et al., 2005).

The future climate change impact on the aforementioned sources is rather insignificant; since their contribution to the total electricity production is rather small. Thus:

a) Wind power, which is affected by the wind speed and the change in wind variability, was introduced to the Cypriot energy system in 2010. There are no available data for estimating the impact of climate change on wind power production in Cyprus. As concern the future potential in wind power yield in Cyprus, this follows the decreasing trend of the projected annual mean wind speed during the period 2021- 2050.

b) Solar energy is influenced by the cloudiness and atmospheric aerosol composition, but the magnitude of the potential impact is unknown, due complex relationship between these climate factors (Kirkinen, 2005). The energy production efficiency of photovoltaics or solar panels varies with the temperature and level of sunlight. Cyprus is one of the most favourable areas worldwide in terms of solar potential. The 92% of households and 53% of tourist accommodation units satisfy their hot water needs with the use of active solar systems while 1,039 PV units were installed by the end of 2012 all over Cyprus. According to projections for the period 2021-2050, the solar energy potential of Cyprus will increase due to the increase in annual sunshine duration (additional 60-160 hours), but will hindered to

some extent by the potential increase number of hot days per year (additional 17 to 24 days per year).

c) The use of biomass energy is limited for electricity production, heat generation and transportation fuel.

## 2. Efficiency of thermal power plants

Regarding future changes in the efficiency of thermal power plants, future changes in temperature may be used as an indicator. According to PRECIS projections for the future period 2021-2050, the average annual temperature in Cyprus is expected to increase by 1-2°C with respect to the control period 1960-1990. However, it is not known whether a change in temperature of this magnitude will have an impact on the efficiency of thermal power plants.

## 3. Energy demand

Energy consumption is particularly sensitive to weather (mainly air temperature).

In the Mediterranean basin, the expected change in energy demand is expected to change by 2050 as follows 2 to 3 fewer weeks per year will require heating; and additional 2 to 5 weeks will require cooling (Alcamo, 2007). According to PRECIS a further increase in the maximum and minimum temperature (by 1.3-1.9°C and 1.3- 1.8°C respectively) is expected in Cyprus during the period 2021-2050. Consequently, an increase in cooling demand and a decrease in heating demand are expected.

## FUTURE VULNERABILITY ASSESSMENT

The future vulnerability of the energy sector to climate change impacts is assessed in terms of its sensitivity, exposure and adaptive capacity based on the available quantitative and qualitative data for Cyprus and the climate projections for the period 2021- 2050, presented in the CYPADAPT project.

Due to the lack of sufficient scientific evidence and data, a preliminary assessment of the vulnerability of the following impacts on the energy sector, is attempted: 1. Renewable energy yield; 2. Efficiency of thermal power plants; 3. Energy demand.

## 1. Renewable energy yield

Renewable power production is considered sensitive to climate changes due to the reduction in renewable energy potential such as wind, solar and biomass. Given that the wind power is considered particularly sensitive to changes in wind speed and that solar energy potential is sensitive to changes in sunshine duration and higher temperatures and, that the use of biomass is limited, the sensitivity of RES energy production to climate changes can be characterised as limited to moderate.

The future exposure of RES energy potential and production to projected climate changes, rely mainly on the variations of wind and solar power potential. The annual mean wind speed changes will be slightly decreased of about 0.20 m/s in western, south-eastern and inland regions where the majority of wind parks are installed. Therefore the wind production is also expected to decrease in the near future. The solar energy yields are expected to be slightly increased in the future due to the projected increase in annual total sunshine duration (ranging between 60-75 hours for most of the domains and between 100-140 hours for the mountain areas).

The high temperatures, which are considered to be associated with reduced solar power potential in photovoltaics, or solar panels, will increase throughout Cyprus. According to PRECIS projections the hot day index (number of days with maximum temperature >30°C) seems to increase by 5–12 days over the northwestern and south-western coasts, by 20–24 days in continental lowlands, and by 26-28 days over Troodos mountains. Considering that the renewable energy potential in Cyprus is not significant, the future exposure of RES yield is ranked as limited.

The main policy action related to renewable energy deployment in Cyprus is the Directive 2009/28/EC on the promotion of the use of energy from renewable sources. The variety of measures taken for fostering renewable power penetration to the energy production sector, make the adaptive capacity to be considered as moderate.

## 2. Efficiency of thermal power plants

Though the required condensing power is sensitive to temperature increase (air and water) and is expected to reduce the thermal efficiency of power plants, no such evidence is found (Electricity Authority of Cyprus).

Considering that the energy produced and delivered to balance the energy demand would slightly be affected, the sensitivity was ranked as limited, while the exposure of power plants to future increases in temperature is moderate. On the other hand, the modernization and replacement of old equipment and the implementation of the necessary maintenance activities are expected to increase or stabilize thermal efficiency of the plants and ranked its adaptive capacity as limited to moderate.

### 3. Energy demand

The energy consumption is sensitive to climatic conditions and it is expected to decrease in warmer winter, and to increase in summer. Moreover, peak energy demand will be considerably greater than net consumption due higher temperatures in summer, imposing the installation of additional generating capacity over and above that needed to cater for underlying economic growth.

Energy consumption shows a clearer upward trend compared to air temperature. The energy load variations are seasonal and yearly, as it reflects both the economic growth and the greater usage of air conditioners in residential and commercial situations. The former is mainly influenced by the prevailing weather conditions and the latter by economic, social and demographic factors. Conclusively, the sensitivity of power demand towards temperature changes is considered very high.

The exposure of energy demand to future climate changes, as indicated by the overall energy consumption variation, as well as the changes in the heating and cooling demand, due to temperature changes, is ranked as very high.

According to a study combining econometric models of electricity demand with climate projections of the regionally focused PRECIS model (Zachariadis and Hadjinicolaou, 2012), by the mid-21st century annual electricity demand is projected to rise by 5.6% due to climate change, causing annual welfare losses in Cyprus of more than 100 million Euros (at constant prices of year 2010). Although additional power requirements are not very remarkable on an annual basis, climate change is expected to exacerbate the already existing imbalance between winter and summer electricity demand in the country. This outlook indicates that a reasonable and cost-effective future energy path in regions with Mediterranean climate would involve substantial

deployment of solar-powered electricity generation, a zero-carbon energy source that can meet peak load requirements without increasing the country's dependency on imported fossil fuels. Moreover, this forecast highlights the need for adaptation to climate change through substantial investments in the improvement of the energy performance of the Mediterranean building stock.

The adaptive capacity of the sector to changing demand for electricity and heat is built up by means of the following:

- Installation of new power plants to satisfy future energy demand: The EAC's plan includes the installation of new power plants and the replacement of the old ones.
- Energy efficiency measures undertaken or underway: The established National Energy Efficiency Action Plan involves the implementation of measures for improving energy efficiency until 2020.
- Use of solar energy for heating and cooling. In Cyprus, solar thermal systems are widely used for the needs for hot water, while photovoltaic systems are increasingly used at household level reducing therefore the pressure on the energy supply sector; and
- Introduction of natural gas in the energy supply portfolio. The upcoming introduction of natural gas is a policy measure aiming to diversify the energy supply mix.

Based on the measures taken so far and those under way, the adaptive capacity of the cooling/heating energy demand was ranked as high.

## ASSESSMENT OF OVERALL VULNERABILITY

The overall vulnerability of the energy sector to climate changes, in terms of sensitivity, exposure and adaptive capacity is presented in Table 6.7.

As indicated, the energy sector of Cyprus is not considered very vulnerable to climate changes. In particular, the main vulnerability priority identified for the sector is related to the energy demand for cooling and heating, since it is directly affected by climate changes. However, given that there is potential for increasing energy supply in Cyprus to meet the increasing energy demand, the vulnerability towards this impact is

**Table 6.7. Overall vulnerability assessment of the energy sector in Cyprus to climate changes**

Impact	Sensitivity	Exposure	Adaptive Capacity	Vulnerability
Renewable energy yield	Limited to Moderate (2)	Limited (1)	Moderate (3)	None (-1.6)
Efficiency of thermal power plants	Limited (1)	Moderate (3)	Limited to Moderate (2)	None (-0.3)
Energy demand	Very High (7)	Very High (7)	High (5)	Limited to Moderate (2)

characterized as limited to moderate. The impact of climate changes on the efficiency of thermal power plants is not expected to be significant, while no vulnerability was identified on RES generation. The reason for this is that hydropower, which is the only type of RES being significantly affected by climate changes, is not exploited in Cyprus due to the already limited water resources, while the impact of climate changes on the other types of RES is minor.

#### 6.3.4. HEALTH

##### CLIMATE CHANGE AND PUBLIC HEALTH

In case of a continuous increase of current emissions, the next generations will face more diseases, deaths related to heat waves and natural disasters, higher rates of climate-related infections and morbidity /mortality associated with allergic and air pollution diseases. There is high possibility according to the IPCC (80% confidence) that in the future the increase in cardio-respiratory morbidity and mortality will be attributed to ground-level ozone. There is significant evidence that the Mediterranean Basin is already experiencing some of the impacts of climate change including those on public health. The main climate change related phenomena that have been recorded in Cyprus are temperature increase (especially during the summer months), an enhance in the frequency and intensity of heat waves, a reduction in the total precipitation amounts in parallel with increasing rainfall intensity and enhanced drought.

The impact, vulnerability and adaptation assessment of public health sector regarding the observed climate changes in recent years showed that public health in Cyprus has good adaptive capacity. The main vulnerability that was identified is related to the deaths and health problems, due to the frequent heat waves and high temperatures, especially during summer. In addition, human discomfort, in particular for elderly

people is getting worse when the humidity levels are high and when air is polluted with the particles of dust from Sahara desert.

Research on the climate change effects upon public health in Cyprus is performed by institutions and government departments in Cyprus concerning the study of climatological data and their possible health effects (CDC, 2009). Cyprus also participates in MedCLIVAR, which is an international network, aiming to study the climate change impacts and challenges pose to public health, as well as the occurrence of extreme events - closely related to climate variability in the Mediterranean and other regions around the world.

##### FUTURE IMPACT ASSESSMENT

Human beings are exposed to climate change both directly through changing weather patterns and indirectly through changes in the ecological and social systems (Confalonieri et al., 2007)

Changes in the frequency and severity of extreme events, particularly heatwaves, floods, droughts and intense rainfall, result in local air pollution and more aeroallergens affecting health directly. Other indirect health impacts may result from the effects of climate change on ecological and social systems, such as changes in the occurrence of infectious diseases, local food production and under-nutrition, and various health consequences of population displacement and economic disruption.

A summary of the potential impacts of climate change on human health in Cyprus per climate change factor is presented in Table 6.8.

There is increasing evidence of the importance of mental disorders as an impact of disasters (Ahern et al., 2005). A systematic review of post-traumatic stress disorder in high income countries found a small but significant effect following disasters, such as medium to long-term impacts

**Table 6.8. Relationship between climate changes and impacts on the public health sector**

Potential climate changes	Direct Impacts	Indirect Impacts
High temperatures and heat waves	<ul style="list-style-type: none"> <li>- Heat related stresses</li> <li>- Deaths due to heat strokes</li> <li>- Cardiovascular diseases</li> <li>- Respiratory and metabolic disorders</li> </ul>	<ul style="list-style-type: none"> <li>- Water-borne diseases due to increased algal blooms</li> <li>- Food-borne diseases due to food contamination</li> <li>- Vector-borne diseases due to the higher risk of transmission, geographical and seasonal distribution</li> </ul>
Increase in the intensity and frequency of extreme events (floods, storms)	<ul style="list-style-type: none"> <li>- Deaths and injuries from floods, storms, landslides and fires</li> <li>- Psychological morbidity (mental disorders) from floods, storms, landslides and fires</li> </ul>	<ul style="list-style-type: none"> <li>- Water-borne diseases caused by water contamination and poor sanitation</li> <li>- Vector-borne diseases (malaria, Leishmaniasis, Mosquitos) due to stagnant waters</li> <li>- Diarrhoea diseases (including cholera)</li> <li>- Reduced nutritional status</li> </ul>
Droughts	<ul style="list-style-type: none"> <li>- Deaths and injuries from fires caused by high temperatures combined by strong winds and drought</li> </ul>	<ul style="list-style-type: none"> <li>- Vector-borne diseases due to contamination of small rivers and drainage canals</li> <li>- Water-borne diseases</li> <li>- Respiratory diseases due to increased air-borne particulate matter</li> <li>- Child malnutrition and under-nutrition, due to loss of agricultural production</li> </ul>
Air pollution		<ul style="list-style-type: none"> <li>- Eye irritation</li> <li>- Respiratory tract irritation</li> <li>- Exacerbation of respiratory diseases</li> <li>- Exacerbation of asthma and irritation of bronchi</li> <li>- Exacerbation of allergic rhinitis, asthma and other atopic diseases</li> </ul>

on behavioural disorders in young children (Durkin et al., 1993; Becht et al., 1998; Bokszczanin, 2000).

However, the effects of climate change on existing environmental and public health problems are difficult to discern. The challenge is to identify their ‘additional’ effect, i.e., the increase in health problems that can be attributed to climate change as an additional risk factor.

The climate change impacts on the public health sector in Cyprus were assessed on the base of PRESIS projections for the future (2021-2050) within the CYPADAPT project, under the following categories:

**I. Direct impacts**

1. Deaths and health problems related to heat waves and high temperatures,
2. Deaths /injuries from floods,
3. Deaths /injuries from landslides,
4. Deaths /injuries from fires.

**II. Indirect impacts**

1. Vector-borne and rodent-borne diseases
2. Water- borne and food-borne diseases,
3. Climate-related effects upon nutrition,
4. Air pollution related diseases.

**I. Direct impacts**

Deaths and health problems related to heat waves and high temperatures are of primary concern in Cyprus, although these issues are also influenced by socio-economic changes such as population growth, the increased average age and migration. General predictions and observations in Mediterranean cities have shown that heat waves can have very strong effects on mortality, reporting an increase of 1-4% for each 1°C rise (IPCC 2007). In addition, mortality is associated to the timing of heat waves as indicated by the higher mortality found early in the summer than the mortality in late season.

Exposure to extreme and prolonged heat is associated with heat cramps, heat syncope, heat exhaustion and heat stroke (Faunt et al., 1995) and occupational health implications.

According to PRECIS projections, the annual number of hot days (Tmax exceeds 30°C) and the annual number of tropical nights (TNmax exceeds 20°C) are expected to increase all over Cyprus in the future, by 17 -24 days and

by 20-45 days per year, respectively. While the number of heat wave days per year (days with Tmax t over 35°C), is expected to present a wider range of changes from 2 to 34 days. In addition, humidity during summer in the coastal cities of Cyprus could reach high levels which in conjunction with high temperatures, cause great discomfort to people. However, there are no sufficient data for estimating heat related deaths and health problems which could be associated with climate changes in Cyprus.

Flood-related deaths and injuries are expected to increase with the anticipated increase in the frequency and intensity of extreme weather events such as heavy rainfall, storms and floods. Generally, the exposure to high-frequency flooding events can result in long-term problems such as increased rates of anxiety and depression stemming from the experience itself, troubles brought about by geographic displacement, damage to the home or loss of family possessions. Moreover, the persistence of flood-related health effects is directly related to flood intensity. The number of floods with recorded victims in Cyprus between 1970-2011 shows an increasing trend (WDD, 2011), but the data were not sufficient to assess the deaths and injuries from floods.

Landslide-related deaths and injuries are expected to increase with increasing extreme rainfall events (Confalonieri et al., 2007) and may also result in the displacement of communities and migration. However, there is no official record in Cyprus of victims affected.

The impacts of future climate changes on both the frequency and intensity of floods and the occurrence of landslides in Cyprus, could not be assessed as the only related indicator provided by PRECIS was the annual maximum total precipitation over one day, which is expected to have minor changes in the future period (2021-2050) ranging from 2 to 5 mm.

Fire-related deaths and injuries are expected to increase with increasing the risk of forest and rural fires due to climate change. Forest and bush fires may cause deaths of people trapped in them, burns and other injuries. Large fires are also accompanied by an increased number of patients seeking emergency services. In particular, forest fires in Cyprus are considered a major and permanent threat, causing enormous damage to forest ecosystems and in some cases threaten residential regions (Alker, 2009), taking into account, the high

temperatures, prolonged and severe drought periods, strong winds and the configuration of the ground and extremely flammable vegetation.

The future risk of fires in Cyprus, as assessed by means of the Fire Weather Index (FWI) and, the PRECIS climate model is high. In specific, there will be an increase in the number of days with high fire risk of 5-15 days/year, as well as an increase in the number of days with extreme fire risk of 1-10 days/year in the future period (2021-2050) compared to control period (1960-1990).

However, there are no sufficient data for estimating whether there is an increasing trend on the incidents of fire-related deaths and injuries which could be associated with the trend in fires in Cyprus.

## II. Indirect impacts

Vector-borne and rodent-borne diseases are among the well-studied diseases associated with climate change, due to their widespread occurrence and sensitivity to climatic factors. The former are transmitted by infected mosquitoes and other arthropod species, mainly during droughts, whereas the other are transmitted directly to humans by contact with rodent urine or other body fluids, mainly during floods or high rainfall events, droughts and introduction of exotic plant species

According to PRECIS climate projections in Cyprus for the period 2021-2050, the length of drought periods which is associated with the occurrence of both vector- and rodent-borne diseases is projected to increase up to 13 days/year on average. As for the heavy rainfall events, the most relative indicator provided by PRECIS refers to the annual maximum total precipitation over one day, which is expected to have minor increase.

In general, water-borne diseases are likely to increase with climate changes such as reduced rainfall, increased temperature, increase in the frequency of extreme weather events (droughts, heavy rainfall, floods), due to the possible risk of water deterioration and lack of good hygiene. Higher water temperatures and flooding may also lead to contamination of water with harmful algal blooms or runoff pollutants. Contamination of food may be induced by higher temperatures (surface and ocean) due to enhance the survival and proliferation of viruses, bacteria and pathogens in foodstuffs.

However, in Cyprus there many measures in place such as effective water and food legislation, high quality of health services, sanitation standards and drainage systems, to safeguard public health.

The future climate changes projected for Cyprus include minor changes in the annual average precipitation while the length of drought periods is projected to present an increase up to 13 days/year on average. It must be noted that although Cyprus is considered a dry region, the water availability is very satisfactory, with the substantial contribution of desalinated water to drinking water supply and the extensive waste water drainage system.

The causal chains through which climate variability and extreme weather influence human nutrition are complex and involve different pathways such as water scarcity, salinisation of agricultural lands, destruction of crops through flood events, wind storms, frosts and hail, disruption of food logistics through disasters, and increased burden of plant infectious diseases or pests (Confalonieri et al., 2007). Reduced food production may lead in diminished dietary diversity, reduction in overall food consumption and in malnutrition, especially in low-income countries.

In Cyprus the greatest climatic threats for the agricultural production (especially seasonal) and food availability, are droughts (through cuts in irrigation water) and frosts. Other extreme weather events such, heat waves, wind storms, hail and floods are, also related to damaged crop yields and have impacts upon nutrition.

According to PRECIS climate projections in Cyprus for the period 2021-2050, the length of drought periods (precipitation < 0,5mm) is projected to increase up to 13 days per year on average. However, as drinking water supply will be satisfied by desalinated water in a great extent (except for the areas not connected to government water works), the irrigation water availability will increase compared to the control period. Furthermore, the mean number of heat wave days per year (temperature > 35°C) is expected to increase from +2 to +34 days per year and the number of heavy rainfall events, as indicated by the annual maximum total precipitation over one day, is expected to have minor changes, ranging from 2 to 5 mm on average. Finally the frequency of damages to crops due to frosts and wind storms will decrease while as regards the damages due to heat waves it is expected that they will increase.

Concerning the frequency of damages by droughts and floods, it is not clear whether the effect will be negative, positive or none.

The diseases related to air pollution include exacerbation of respiratory diseases, tract irritation, exacerbation of asthma, irritation of bronchi, atopic diseases, exacerbation of allergic rhinitis, eye irritation. The air pollution health risks related to climate change are caused primarily from the increased concentrations in the atmosphere of particulate matter and ozone, related to forest fires, heat-waves, Sahara dust events, re-suspension from soils and other surfaces, as well as from traffic and other anthropogenic activities.

The future climate changes in Cyprus that are considered to be associated with the impact of air pollution-related diseases are according to PRECIS climate projections in Cyprus for the period 2021-2050: the mean number of heat wave days per year (temperature > 35°C) which is associated with increases of tropospheric ozone and particulates, is expected to increase from +2 to +34 days per year. In addition, it is expected that the already dry climate in Cyprus which contributes to the suspension of PM10 will be further intensified with the prolongation of drought periods (precipitation < 0,5mm) up to 13 days/year on average. However, wind speed which also associated with this effect is expected to decrease. As for the changes in the mean annual maximum temperature in Cyprus which is related to increased pathogen prevalence in air, this is expected to increase by 1 - 2°C with respect to the control period. 1960-1990. In general, it can be said that climate changes will have a negative impact on the air pollution related diseases in Cyprus.

## FUTURE VULNERABILITY ASSESSMENT

The future vulnerability of public health to climate change impacts is assessed in terms of its sensitivity, exposure and adaptive capacity, based on selected indicators and on the available quantitative and qualitative data for Cyprus as well as on the climate projections for the period 2021-2050 and presented in the CYPADAPT project.

The vulnerability of public health is assessed for each of the following impacts:

- Deaths and health problems related to heat waves and high temperatures

- Deaths and injuries from floods/storms
- Landslide-related deaths and injuries
- Fire- related deaths and injuries
- Vector-borne and Rodent-borne diseases
- Water-borne and food-borne diseases
- Climate-related effects upon nutrition
- Air pollution-related diseases

It must be noted that, there are no sufficient scientific evidence and data to evaluate or correlate all impacts and indicators to future climate changes. Consequently, further research is required in order to provide concrete information for a more detailed and descriptive assessment of the future vulnerability of the sector.

### 1. Deaths and health problems related to heat waves and high temperatures

Excessive heat is a well-known cause of heat stress, exacerbated illness and mortality. Heat waves have readily discernible health outcomes because they result in a large number of deaths and affect relatively large, heterogeneous areas simultaneously. However, not all heat waves have a similar impact on mortality. In addition to the intensity of a heat wave, the duration and the timing of the event are particularly important. Illnesses recognisable as the direct results of exposure to prolonged periods of high environmental temperature are heatstroke, heat exhaustion, and heat cramps.

Empirical-statistical models for heat stress are constructed for Cyprus during summer (June-August) for the period 2004-2011, in order to investigate the relationship between hot weather conditions and mortality for Cyprus since excessive heat is a well-known cause of heat stress, exacerbated illness and mortality. The calculated summer excess deaths (or the heat related mortality) per day for each maximum air temperature interval, as well as the frequency of occurrence of the temperature intervals during this period are presented in Figure 6.22.

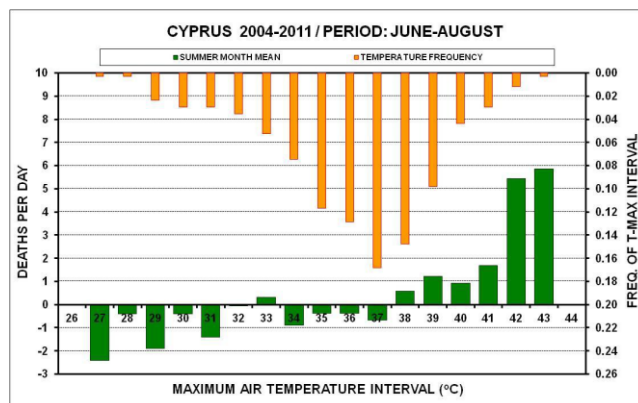


Figure 6.22. Daily excess summer deaths (green bars, left-hand axis) in Cyprus by maximum air temperature interval for the years 2004-2011. The frequency of occurrence of each temperature interval (right-hand axis) is shown using orange bars

A fairly linear increase of mortality with increasing temperature and thus high sensitivity is observed - with hotter days associated with greater mortality risk. Heat-related deaths start to be discernible when the maximum temperature is 38°C or above.

In addition, local factors, apart from climate, such as topography, heat-island magnitude, income, and the proportion of elderly people, are also important in determining the underlying temperature–mortality relationship in a population (Curriero et al., 2002). The population groups that are most vulnerable to heat waves are the elderly, persons with pre-existing chronic diseases, people confined to bed, children, population groups with low socio-economic status, workers in outdoor environments. Moreover, heat waves have a much bigger health impact in cities than in surrounding suburban and rural areas.

Generally, the risk period for heat waves in Cyprus is identified during the whole summer, that is, from June to August (three months). According to the WHO (2010), the 98.8% of Cyprus population is exposed to moderate heat wave hazard (32- 41°C). The heat-related mortality, as projected to the future climate of 2021-2050 using temperature output from the PRECIS and ENSEMBLES climate model simulations under the A1B emissions scenario, is expected to increase up to 10 excess deaths per day under very hot weather conditions (Figure 6.23).

To investigate the potential negative impacts of climate warming on human life, the humidity index or “Humidex” (Masterton and Richardson, 1979) was employed to express the temperature perceived by people (Figure 6.24).



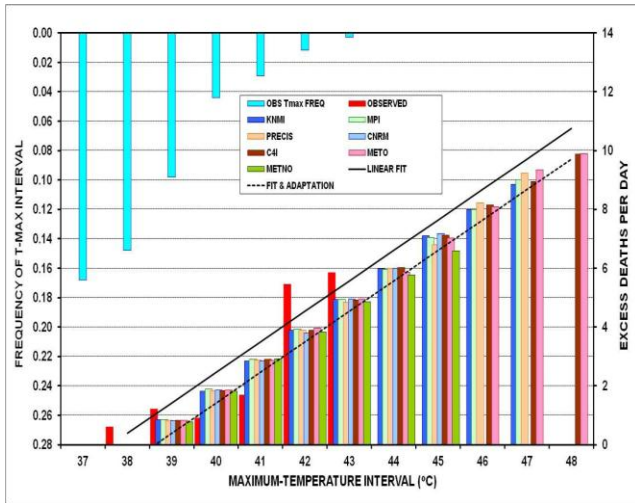


Figure 6.23. Excess deaths (right axis; model and observation bars for present and future climate with adaptation) and daily temperature frequencies (left axis; light blue bars) in Cyprus for the future period 2021-2050

The public health response of Cyprus in heat waves is based at forecasting heat waves, issuing warnings and providing advices for self-protection from heat waves, through the mass media (television, radio, newspapers, and public websites). Furthermore, to the sufficient ability of the health care system of Cyprus to respond to heat related incidents, there are working regulations prohibiting outdoor labour work when temperature exceeds 40°C and, though the majority of houses and buildings are fully air-conditioned, communal centres have been established to accommodate people with no access to an air-conditioned environment. Considering the above mentioned indicators, the adaptive capacity of Cyprus' public health to heat waves is characterized as limited to moderate.

## 2. Deaths and injuries from floods/storms

The main population groups that are considered sensitive to deaths and injuries from floods and storms are (i) the elderly over 65 (13.3%) which cannot move easily and fast in case of a flooding event and (ii) infants and young children (16.1%) especially if they are not under the protection of an adult. The following figures illustrate the level of severity for public health of recorded flooding events in Cyprus during the period 1859-2011.

The flood hazard distribution map of Cyprus (Figure 6.26) indicates that the risk ranges from very high levels (Lefkosia) to very low (Troodos) depending on the regions.

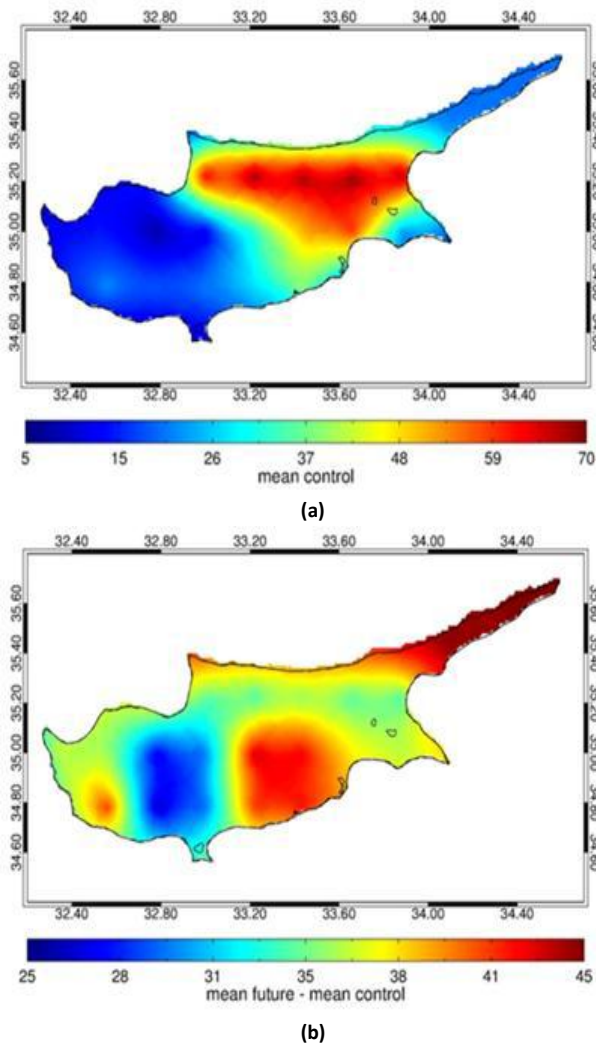


Figure 6.24. Maximum length of Humidex > 38°C (a) for the control period (1960-1990) and (b) the near future (Future – Control period), PRECIS RCM model

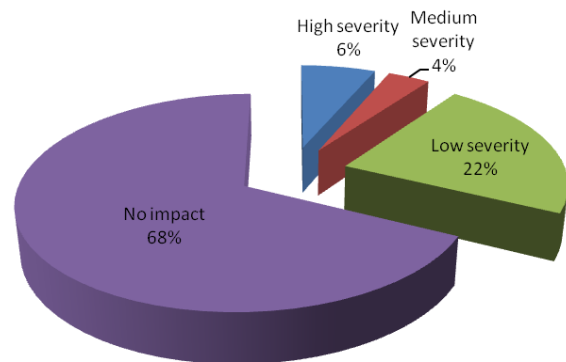


Figure 6.25. Impact of flooding events on public health (1859-2011) (WDD, 2011)

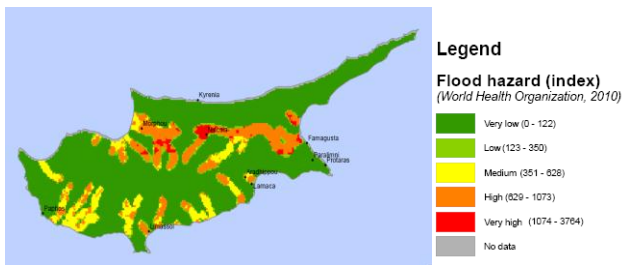


Figure 6.26. Flood hazard distribution map of Cyprus (WHO, 2010)

For the protection of people during a severe flooding event, the civil preparedness and defence service of Cyprus is in place and the health care system of Cyprus cherishes injured people. To prevent the occurrence of flooding events in Cyprus, a separate drainage system is being developed and expanded the last two decades in order to collect stormwater. Furthermore, it is expected that through the implementation of the Flood Risk Management Plans by the end of 2015 and the associated flood protection works, public health will be substantially safeguarded by the adverse effects of floods.

Taking into account the above, the sensitivity, exposure and the adaptive capacity of public health in Cyprus to floods and storms is considered limited to moderate, for the former and moderate for the rest aspects.

### 3. Landslide-related deaths and injuries

The main population groups that are considered sensitive to deaths and injuries from landslides are the elderly people and the young children, same as mentioned above. According to the landslide hazard map produced by the World Health Organization (2010) (Figure 6.27), Cyprus population is not at risk from landslides. Similarly, is the risk regarding future climate changes as the related the related indicator, the annual maximum total precipitation over one day, show a slight increase.

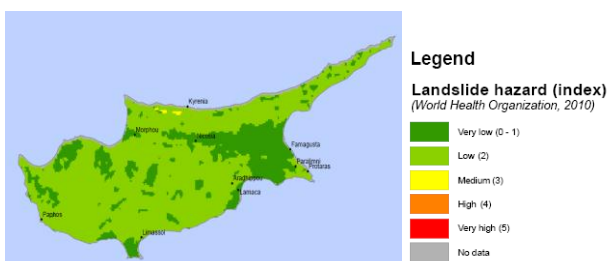


Figure 6.27. Landslide hazard distribution map of Cyprus (WHO, 2010)

Taking into account that above, the sensitivity and the exposure of public health in Cyprus to landslides is considered limited to moderate and, limited respectively.

Further to the preparedness of all responsible governmental departments for the protection of citizens living in landslide prone areas from future landslides, entire settlements have been relocated to safer places and technical structures were built. A research has been also undertaken to promote a more secure urban development

Considering the magnitude of the impact of landslides on public health which is estimated as limited to moderate, the developed adaptive capacity to cope with the impact, is characterized as moderate.

### 4. Fire-related deaths and injuries

Given that there are no data on the number of people killed or injured during fire events in Cyprus, the vulnerability of public health to fires is based on the fire risk areas in conjunction with the population density in these areas

According to PRECIS near future (2021-2050) the Fire Weather Index (FWI) projections rich the highest values during summer and is higher at the elevated forested areas, mainly at Troodos mountain which are not densely populated (Figures 6.28 and 6.29).

Considering that the total share of population, which is sensitive to fires is 29% (the elderly over 65 and infants and young children), the geographic distribution of high fire risk and the low population density of these areas, the sensitivity and exposure of the population in Cyprus to fire-related deaths and injuries, are characterized as moderate and, as limited to moderate, respectively.

Several measures for fires, even though no specific adaptive measures to public health, are taken by the Forestry Department of Cyprus aiming to eliminate forest fires including prevention, pre-suppression, detection and suppression measures. Among the measures concerning public health are the information campaigns on fire prevention and protection, fire danger mapping, installation of fire protection systems in areas where large numbers of people may concentrate. In addition, relative legislation and action plans have are applied by the Fire Brigade, the Civil Defence Service and the Health Care System to protect the population from fires.

Therefore, the adaptive capacity of Cyprus public health to fire-related deaths and injuries can be characterized as moderate.

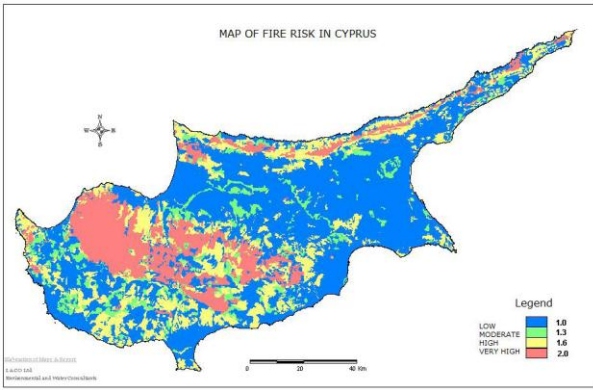


Figure 6.28. Map of fire risk in Cyprus (Department of Environment), 2007

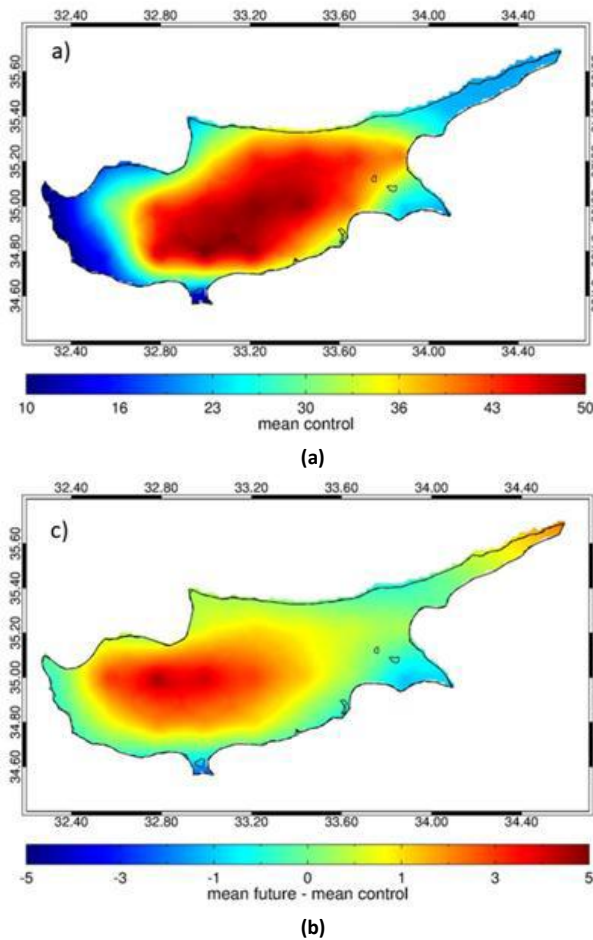


Figure 6.29. July average FWI in (a) the control period (1960-1990) and (b) the near future (Future – Control period)

**5. Vector-borne and Rodent-borne diseases**

All citizens in Cyprus, living either in urban or rural areas, have direct access to clean and safe water and are served with an efficient sanitation system (public wastewater network, septic tanks, waste disposal system) (Figure 6.30). According to data provided by the United Nations Environment Programme (UNEP), Cyprus presents the

lowest rate for vector-borne diseases among other countries (Cosmatos, 2009).

The exposure of public health to vector-borne and rodent-borne diseases is more possible during periods of increased temperatures, prolonged droughts or after floods. Projections for the period 2021-2050 according to the PRECIS model, indicate that the average annual maximum temperature (TX) will increase by 1.0 to 2.0 °C, while the increase of the maximum length of dry spell will be about 15 to 20 days/year and, the annual maximum total precipitation over one day will be slightly increased by about 2-5 mm. (Figure 6.31).

Taking into consideration the above, both the sensitivity and the exposure of public health in Cyprus to vector-borne and rodent-borne diseases is characterized as limited and as limited to moderate, respectively.

The measures currently available to control vector- and rodent-borne diseases are disease specific include diagnosis and treatment, vaccination, vector control, reservoir host control (spaying stagnant waters especially during summer), information and health education as well as disease surveillance and monitoring. Considering the above, the adaptive capacity of Cyprus public health to vector-borne and rodent-borne diseases can be characterized as moderate.

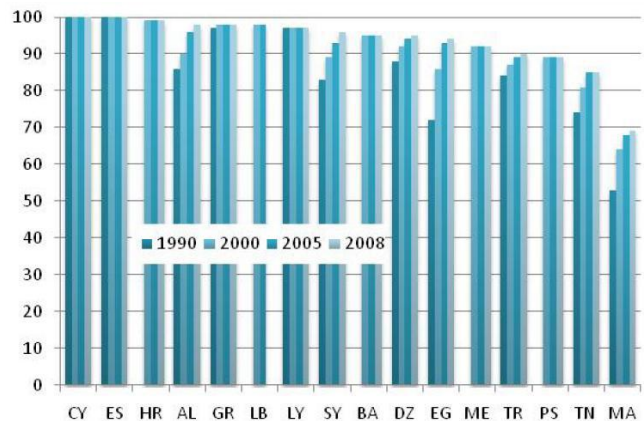
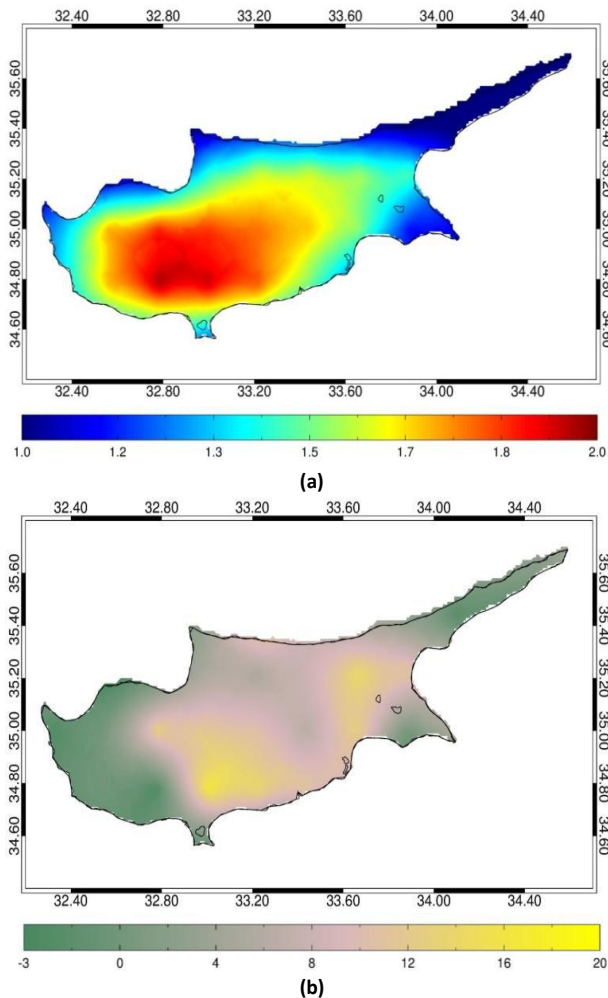


Figure 6.30. Share of population with access to an improved sanitation system, 1990 – 2006 (%)



**Figure 6.31. Changes in (a) average annual maximum temperature and (b) maximum length of dry spell (RR<0.5mm) between the future (2021-2050) and the control period (1961-1990)**

### 6. Water-borne and food-borne diseases

Provided that many waterborne diseases are associated either directly or indirectly, to the quantity and quality of the water supply, it is noted that all people living in Cyprus have direct access to clean and safe water and to adequate sanitation facilities.

The following facts are indicative of the exposure status of public health in Cyprus to water-borne and food-borne diseases:

- The estimated number of “healthy” life years lost (DALYs) attributable to water, sanitation and hygiene for 16 Member States of the EU27, shows that Cyprus is in the first place (reference year 2002)
- The recorded incidents of salmonellosis in Cyprus for the period 1984-2007 present a general increasing

trend, although they remain quite below the average respective values in the EU

- The incidents of Hepatitis A in Cyprus are quite low (less than 1 incident/100,000 capita per year) for the period 1980-2007 while the respective value for the EU was significantly higher until recently when it declined the current exposure level of population to water and food-borne diseases can be characterized as limited to moderate.

The expected changes of the climate factors influencing the exposure of public health in water-borne and food – borne diseases through drinking water contamination, according to the PRESIS model for the future period 2021-2050 are: the decreased rainfall, the increased temperature, the increase in the frequency and intensity of droughts.

Thus, the future sensitivity and exposure of population to water and food-borne diseases e can be characterized as limited and, as limited to moderate respectively.

The Ministry of Health, the Ministry of Agriculture, Natural Resources and Environment and the Ministry of Labour and Social Insurance jointly are responsible for environmental health. They apply and manage continuous control and monitoring programmes i) the food chains and drinking water supplies for ensuring quality and safety ii) the environmental pollution level of the water bodies, the wastewater solid waste systems.

There are also National Councils for Food and Water, for the effective implementation of the food-borne surveillance system, the food and drinking water safety and quality, in addition to the national legislation, which is in full compliance with all relevant international and European regulations, therefore the adaptive capacity of Cyprus to water-borne and food-borne diseases is considered as moderate to high.

### 7. Climate-related effects upon nutrition

Incidents of malnutrition are more likely to be detected in population groups with lower socio-economic status as well as to infants and young children. The population groups characterized by high risk of poverty in Cyprus amounted to 16% of the total population in the period 2005-2008 and the percentage of infants and young children amounts to 16.2% of the total population.

The agricultural sector is the first to suffer from the consequences of extreme climatic phenomena and their impact in farmers' seasonal yields as well as the availability of food. In Cyprus, nutrition is based on both agriculture and livestock national production but also on a great extent on imports.

Consequently, the sensitivity and exposure of public health in Cyprus to climate-related effects upon nutrition are considered as limited to moderate and, limited respectively.

The measures to protect public health from under-nutrition are associated with the measures to secure water availability for irrigation in periods of droughts (e.g. use of recycled water, increase water storage capacity, satisfaction of drinking water supply by desalination plants etc.) and the measures for the protection of crops from extreme climatic events (e.g. installation of hedgerows, green houses etc.). Last but not least, the economic ability of Cyprus to secure food availability even when national productivity is reduced through imports of agricultural, meat and dairy products substantially enhances the adaptive capacity of Cyprus. It must also be noted that, the National Committee for Nutrition, is responsible inter alia for safeguarding the production and distribution of food prod

Consequently, the adaptive capacity of Cyprus public health to the climate-related effects upon nutrition can be characterized as high.

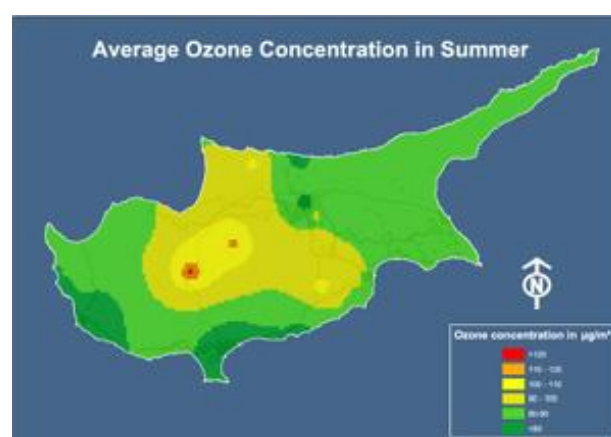
## 8. Air pollution-related diseases

**Table 6.9. Overall vulnerability assessment of public health in Cyprus to climate changes**

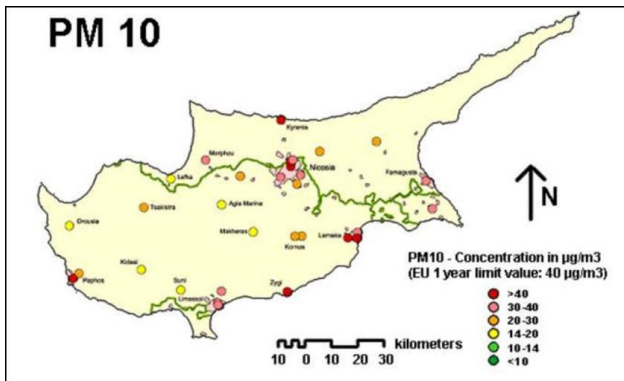
Impact	Sensitivity	Exposure	Adaptive Capacity	Vulnerability
Deaths and health problems related to heat waves and high temperatures	High (5)	Moderate to High (4)	Limited to moderate (2)	Moderate (2.5)
Flood-related deaths and injuries	Limited to moderate (2)	Moderate(3)	Moderate(3)	None (- 0.6)
Landslide-related deaths and injuries	Limited to moderate (2)	Limited (1)	Moderate(3)	None (-1.6)
Fire-related deaths and injuries	Moderate(3)	Limited to moderate (2)	Moderate(3)	None (-0.6)
Vector-borne and rodent-borne diseases	Limited (1)	Limited to moderate (2)	Moderate(3)	None (-1.6)
Water-borne and food-borne diseases	Limited (1)	Limited to moderate (2)	Moderate to High (4)	None (-2.6)
Climate-related effects upon nutrition	Limited to moderate (2)	Limited (1)	High (5)	None (-3.6)
Air pollution-related diseases	Moderate(3)	Moderate(3)	Moderate(3)	None (0)

Certain groups are potentially more vulnerable than others to air pollution, such as the children, pregnant women, people over 65 years of age, and persons suffering from cardiovascular and respiratory diseases (e.g. asthma). The data available on these groups in Cyprus show that comprise the 30% of the total population. Therefore, the sensitivity of Cyprus public health to air pollution is considered moderate.

The ground-level ozone in Cyprus constitutes an overall transboundary problem, being lower in the cities than high elevated background areas, because of the depletion by the primary emitted pollutants there. (Figure 6.32) Considering the fact that population density in those areas is low, the exposure of population to ozone is limited.



**Figure 6.32. Average Ozone Concentration in Cyprus (Department of Labour Inspection, Cyprus)**



**Figure 6.33. Annual PM10 concentrations in Cyprus including Sahara dust events (Department of Labour Inspection, 2007)**

In addition, the results of the “Preliminary Assessment of Ambient Air Quality and Drawing up of Zones of Pollution in Cyprus” indicate that the particulate matter (PM10) in Cyprus primarily originate from Sahara dust events and anthropogenic activities such as traffic and secondarily industrial activities.

As it can be seen from Figure 6.33, the higher values of PM10 have been recorded in the main urban centres (reaching the EU limit values), where approximately 70% of the population lives.

The future changes (2021-2050) in climate, according to the PRECIS model, which are associated with air-pollution related diseases are: the number of heat wave days ( $T_{max} > 35^{\circ}\text{C}$ ) will increase up to 20-35 days, the maximum length of dry spell will increase about 15-20 days/year and the average annual maximum temperature (TX) will increase by 1.0- 2.0°C. Considering the above, the exposure of the public health of Cyprus to atmospheric pollution is characterized as moderate.

The measures for controlling air-pollution related diseases are measures for the prevention of such diseases, with for the mitigation of air pollution and the provision of medical services by the health care system of Cyprus.

The measures for air pollution mitigation applied in Cyprus by the Ministry of Labour and Social Insurance include among others the enforcement of air quality EU directive, the implementation of national and regional plans for air quality and improvement of the Action Plan for the support of public transportation in Cyprus. Consequently, the adaptive capacity of Cyprus to deal with air pollution can be characterized as moderate.

## ASSESSMENT OF OVERALL VULNERABILITY

The overall future vulnerability of public health to future climate changes, in terms of sensitivity, exposure, adaptive capacity based on the available data is as presented in Table 6.9. As it can be seen from the table, the public health of Cyprus is not considered vulnerable to climate changes mainly due to the fact that it is characterized by a good adaptive capacity. The only vulnerability that was identified through the CYPADAPT project is related to the deaths and health problems from heat waves and high temperatures. Thus, the adaptive capacity should be enhanced with urgent and satisfactory measures for the effective protection of the population from heat waves.

### 6.3.5. FORESTRY

The total forest area in Cyprus, covering 390,944 ha, which is the 42.3% of the island, consists of forests (44.2%) and other wooded land (55.8%). The Cypriot forests are natural with the main forest species of pine (*Pinus brutia*, *Pinus nigra*), many endemic species such as the Golden oak (*Quercus alnifolia*) and Cyprus cedar (*Cedrus brevifolia*) species (DoF, 2011a).

The forest sector is highly dependent on climate. Direct impacts of climate change on Cyprus forests arise mainly from decreased rainfall and increased temperature, droughts, fluctuations in intensified precipitation and changes in fire regimes. Indirect impacts come from the interactions between changes in climatic variables and several abiotic and biotic factors (Lindner et al., 2008). Non climate related pressures are mainly associated with (i) unsustainable timber harvesting, (ii) overgrazing which causes degradation not only on the vegetation but also on the soil and water regime of the island and (iii) land development especially for tourism development and construction of holiday dwellings.

The future impact, vulnerability and adaptation measures for the forestry sector in Cyprus regarding climatic changes were also assessed as part of the Life+ CYPADAPT project, by using PRECIS and six other regional of the ENSEMBLES models and, the future period (2021–2050) against the control period (1961–1990).

The main vulnerability priorities for the forests of Cyprus as observed in the recent past, has been related to the

damages caused by fires as well as insect attacks and diseases on the dieback of tree species. These impacts are expected to worsen in future.

Cyprus has formulated a forest policy and a National Forest Programme, while starting a process of updating its forest legislation, laying the stress on environmental services and recreation rather than wood production.

## FUTURE IMPACT ASSESSMENT

The magnitude of the direct impacts on Cyprus' forests is expected to increase, as the relevant climate change factors are expected to intensify.

According to PRECIS projections for the future period 2021-2050, the average annual temperature in Cyprus is expected to increase by 1-2°C with respect to the control period 1960-1990, while precipitation is expected to decrease in seasonal level and in minor degree in annual level. In addition, the maximum length of dry spells (precipitation < 0.5mm) is expected to increase by 10 to 13 days on average, while heat wave days (temperature > 35°C) will be increased averagely about 10-30 days on annual basis. Concerning future changes of annual maximum total rainfall over 1 day, projections show that a slight increase of about 1-4 mm is anticipated. Finally, regarding the highest annual total precipitation, falling in 3 consecutive days, a negligible increase of about 1-2 mm of rainfall is expected.

In the context of the future impact assessment the indicators presented in Table 6.10 summarize the potential impacts of climate change on Cyprus' forests. The main direct and indirect impacts presented in the table were grouped in the following impact categories: 1. Dieback of tree species, insect attacks and diseases leading to desertification, 2. Fires, 3. Floods, wind throws and storm damages, and 4. Forest growth.

### **1. Dieback of tree species, insect attacks and diseases leading to desertification**

Climate change has an effect on insect development and diseases, which are the main harmful forest organisms in Cyprus forests. Faster development of insects due to rising temperature and low levels of soil moisture due to drought can lead to further necrosis of trees. The typical Mediterranean climate with mild winters and hot, dry

summers favours the breeding of harmful forest organisms in large populations (DoF).

The anticipated increase in temperature in the island and decrease in rainfall, as well as their related changes in heat wave days and maximum length of dry spell, will have a negative impact on forest organisms in Cyprus forests. This climatic change except from dieback of the tree species due to thermal stress has secondary results such as increase in the severity of future insect attacks.

The warm and dry climate conditions make pine stands in the forests of Cyprus vulnerable to pests such as the pine processionary caterpillar and bark beetle.

Projections of PRECIS regional climate model make evident that all forested areas of Cyprus will experience, in the near future, a warming of about 0.8 – 1.1°C. In specific, winter minimum temperature is expected to reach 6°C in mountains and, 7-9°C in forested area in coastal regions. Furthermore forested regions of Troodos Mountain will experience a significant warming of about 2.0 – 2.7°C reaching summer maximum temperatures of about 32 – 35.7°C in comparison with the control period.

As a conclusion rising temperature may enable some insect species to develop faster and endanger thus the forest growth. In this frame the predicted increase in winter minimum and summer maximum temperature in the future period can worsen current situation of dieback of tree species.

Increases in maximum length of dry spell can affect negatively forest species sensitive to soil moisture content causing the drying of trees, further stress on forest ecosystems, particularly those found in lowland and hilly areas, and possible necrosis of trees due to enhanced the activity of insects. In Cyprus, the necrosis of a significant number of pines and cypress in Stavrovouni forest during the dry period 2005 – 2008 was attributed to the impact of insects (DoF, 2011b; Cyprus Institute, 2011).

Number of heatwaves days is also a very important factor since in combination with the length of dry period can cause "thermal stress" to trees leading to extended necrosis mainly during the long hot summer period.

**Table 6.10. Relationship between potential climate changes and impacts on the forest sector**

Potential climate change in Cyprus	Potential Forest impacts	
	Direct Impacts	Indirect Impacts
<b>Drought</b>	Insect attacks Dieback of trees Pressure on fauna species Biodiversity loss Desertification	Reduction of forestry regeneration and growth Degradation of forest, impacts on forests' health and vitality Increase in number and severity of forest fires Soil erosion Increase of dust in the atmosphere Negative effect on reforestations and natural stands
<b>Higher mean annual temperatures – Hot spells</b>	Insect attacks Dieback of trees Pressure on fauna species Biodiversity loss Desertification	Increase in number and severity of forest fires Photosynthesis decrease Decrease of biomass growth and yield Decrease of forests' productivity Decrease of wood production Effect on carbon sequestration rates and net carbon balance
<b>Decreased rainfall</b>	Change in competition among - plant species Nutrient availability in soils Deficiency in water for fauna	
<b>Increase of extreme events (floods, wind throws and storm damages)</b>	Injuries Inhibition of seed germination Changes in plant anatomy Promotion of early senescence and mortality Nutrient availability in soils	
<b>Atmospheric CO<sub>2</sub> increase</b>	Increase in photosynthesis rates (varying with plant nitrogen status and species) Effects on forest growth, tree physiology Insect attacks	

An increase of about 20-30 days (temperature over 35°C) is expected for mountain regions and conversely 10 days for other areas. Concerning annual rainfall no increase is anticipated in the future period (2021-2050), but seasonal precipitation will decrease, inducing thermal stress on trees and increase in the severity of future insect attacks. Changes in the hydrological regime may also have serious implications for the forests' sustainability.

## 2. Fires

Forests of Cyprus are vulnerable to fire, primarily due to the long, hot and dry summers, mild winters, strong winds, intense relief and flammable xerophytic vegetation. These natural factors are further exacerbated by changing climatic conditions, which favour prolonged periods of drought and extreme weather events. Also, the accumulation of biomass due to the abandonment of rural areas and the increasing tourism and exodus of city residents to forested areas, are also important factors which contribute to an increased fire risk, especially during summer months.

In addition, as already mentioned above, forest fires are highly sensitive to climate change because fire behaviour responds immediately to fuel moisture, which is affected by precipitation, relative humidity, air temperature and wind speed. Thus, the projected increase in temperature will increase fuel dryness and reduce relative humidity and this effect will worsen in those regions where rainfall decreases. Accordingly, increases in climate extreme events are expected to have a great impact on forest fire vulnerability.

Mediterranean Europe, in general, has been identified as likely to suffer potentially increased fire risk. Among the climatic parameters with implication on fire risk, is the maximum length of dry spell (amount of rainfall less than 0.5 mm) because it is a parameter which not only increases fire risk but also highly influence forest species due to their sensitivity to soil moisture content. As mentioned this parameter is expected to increase by 8 to 12 days, in comparison to the control period.

The Canadian Fire Weather Index system (FWI) is one of the most widely used indices of fire risk. Regarding PRECIS results, FWI reaches extremely high values in forested areas of about 50 (extreme high risk) in the



control period, especially in summer, while a slight increase is projected for the future.

### 3. Floods, wind throws and storm damages

Forest damage by wind and snow are a continuing cause of economic loss in forestry throughout Europe and Cyprus (Lindner et al., 2008) because of reduction in the yield of recoverable timber, increased costs of unscheduled thinning and clear-cutting, and resulting problems in forestry planning. Despite the great severity of the particular climate change impact on forests, there are no available data for future estimation of wind throws and storm damages in Cyprus.

Flooding is harmful especially if it occurs during the growing season (Lindner et al., 2008). Extreme flooding events are expected to occur more frequently as a consequence of climate change. While the number of rain days is projected to decrease the number of days with heavy rain events is projected to increase (annual max total rainfall over 1 day show a slight increase of about 5mm is anticipated for forested areas and 2-4 mm is anticipated in western and inland regions).

### 4. Forest growth

Forest growth and productivity may be affected by projected climate change aspects such as increases in temperature, changes in precipitation and increases in air pollution. More specifically all forested areas of Cyprus will experience, in the near future, a warming of about 0.8 – 1.1°C and minor decreases in the annual total precipitation. Higher mean annual temperatures, decreases photosynthesis affecting thus the biomass growth and yield (Linder et al., 2010). Future changes in precipitation, in terms of frequency and availability, will have a significant effect on plant and forests' growth, as well on forestry species.

It is recognized that, rising concentrations of CO<sub>2</sub> in the atmosphere is believed to act as a fertilizer and increase photosynthesis rate, while higher ozone and nitrogen deposition affect tree physiology, carbon allocation and plant interactions, resulting in complex interactions with other climatic impact factors such as drought (Lindner et al., 2008).

In general, Cyprus, a region with already warm and dry conditions especially during summer, is likely to

experience decrease in forest growth while the projected climate conditions will magnify the already intense water stress circumstances provoking forest growth failure.

## FUTURE VULNERABILITY ASSESSMENT

The future vulnerability of forestry sector to climate change impacts in terms of their sensitivity, exposure and adaptive capacity based on the available quantitative and qualitative data for Cyprus and the climate projections for the period 2021- 2050 is assessed for the impact categories as follows: (1) Dieback of tree species, insect attacks and diseases, (2) Fires, (3) Floods, wind throws and storm damages, and (4) Forest growth.

### 1. Dieback of tree species, insect attacks and diseases

Increase in temperature is significant for the health of the forest ecosystem, enabling some insect species to develop faster and endanger thus the forest growth. Studies showed that the increased incidents of dieback of forest species in Cyprus are attributed to the adverse environmental conditions that prevailed and particularly the decrease in rainfall and increase in air temperature (Christou et al., 2001). A large number of tree species are affected by indigenous insects.

The summer maximum temperature is anticipated to increase about 2-2.7 °C in forested regions reaching 30-32 °C which may also lead to extinction of certain species in their current geographical range. Furthermore PRECIS predicts duplication of heat wave days in forested areas for the future period reaching 40-60 days. Increases in maximum length of dry spell can affect negatively forest species sensitive to soil moisture content.

The number of heatwaves days is a very important factor since in combination with the length of dry period can cause "thermal stress" to trees leading to extended necrosis mainly during the long hot summer period. As PRECIS predictions show, an increase of about 20-30 days is expected for Troodos mountain regions and conversely 10 days for western areas, in comparison to the control period (Figure 6.34).

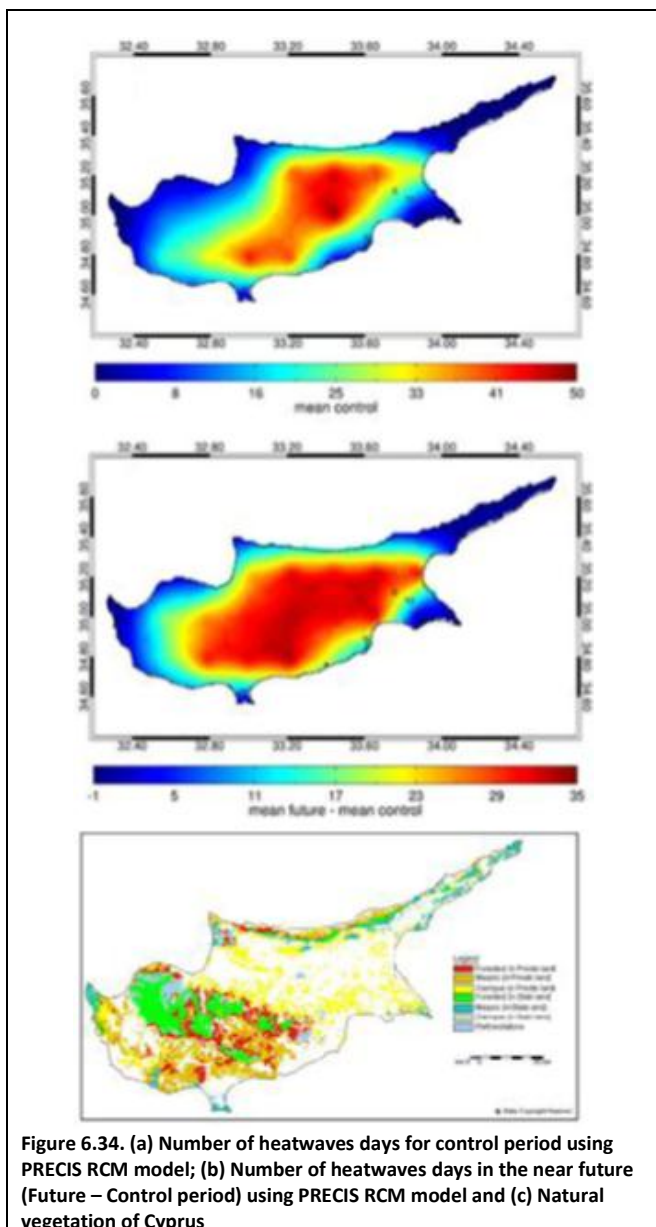


Figure 6.34. (a) Number of heatwaves days for control period using PRECIS RCM model; (b) Number of heatwaves days in the near future (Future – Control period) using PRECIS RCM model and (c) Natural vegetation of Cyprus

Precipitation is being geographically and seasonally, unevenly distributed, with maximum precipitation falling on the island's two mountainous masses during November and March. The overall decrease in precipitation for the future period is not significant, but it is most evident for winter and autumn seasons. The projected decrease of about 20mm in winter precipitation in combination with higher predicted temperatures in all forested areas may enhance the dieback of forest species (Figure 6.35).

Thus both the sensitivity and exposure of Cyprus' forests to increased diebacks and insect outbreaks is expected to be very high.

The Department of Forests in Cyprus has taken action considering the implications of droughts and high temperatures and prepared a "Short-term Action Plan for the Confrontation of the Implications of Drought in Cyprus state forests (2009-2010)". The measures and actions of the Plan address the dieback of tree species, insect attacks, biodiversity loss as well as fires (DoF, 2009b). Despite the numerous measures that are implemented in Cyprus for combating dieback of forests and insect attacks as well as for the protection of biodiversity, the effect can only be alleviated but not eliminated. Additional adaptation measures are needed to further enhance adaptive capacity towards this impact.

Thus the adaptive capacity of Cyprus' forests to increased diebacks is characterized as moderate.

## 2. Fires

Forests in Cyprus are sensitive to fires because of their composition which is dominated by flammable vegetation and the topography of the forested areas, which is mostly mountainous (DoF).

In Cyprus for the future period it is expected to have increase in temperature, decrease in total rainfall and increase in dry spell days. Nevertheless the overall Fire Weather Index is expected to have a small increase.

The Fire Weather Index for the control period has an extremely high value (about 50: extreme high risk), especially during July and August and will be higher in future of about 2-3 in all the forestry areas of Cyprus. The overall findings of the analysis (FWI) suggest that number of days with fire risk (FWI>15) will be increased from 5 to 15 days and number of days with extreme fire risk (FWI>30) will have an increase of 1 to 5 day for the future period. It was also found, that future exposure of almost all forested areas in Cyprus to fire risk is expected to be medium to high in spring period, whereas in autumn period is expected to be high.

Wind speed in summer, which is also a dominant factor of fire behaviour, is expected have a slight decrease of about 0.018-0.23 m/sec in the future period (2021-2050).

Considering the above, both the sensitivity and exposure of Cyprus' forests to fires are characterized as very high.

As far as concern the adaptive capacity of Cyprus forests to fires can be characterized as moderate, due to the

several measures which are taken by the Forestry Department of Cyprus aiming to eliminate forest fires. Particularly, these are (a) prevention, (b) pre-suppression, (c) detection and suppression measures.

In addition, under the framework of the Rural Development Programme 2007-2013 of Cyprus, various economic incentives were provided to individuals to apply measures in order to improve the existing protection system of forests from fire as well as the restoration of burned areas. Despite the great efforts and the good results of recent years, the problem of fires still exists and will always constitute a permanent threat for the forests of Cyprus. However further measures can increase the adaptive capacity.

### 3. Floods, wind throws and storm damages

The factors affecting the sensitivity of forests to floods are the slope of the area, the age of the plant species, their anatomy, the type of soils and others. In Cyprus slopes in excess of 18% and 12% cover 10% and 22% of the island (Geological Survey Department; I.A.CO Ltd, 2007). Maquis and garique vegetation, which consist 56% of the total forest and OWL area in Cyprus, are more generally sensitive to floods due to their lower height. However, are located in areas with inclination, thus they are not considered sensitive to flooding.

The Water Development Department of MANRE through its report "Preliminary Flood Risk Assessment" identified 19 areas around the island as "Areas with Potential Significant Flood Risk", which are mainly the urban centres. In the future period (2021-2050), annual max total rainfall over 1 day is anticipated to have a slight increase of about 2-4 mm in western, inland and mountain regions and the risk of floods will not be increased significantly. Consequently, both the sensitivity and exposure of Cyprus' forests to floods are considered to be limited.

The fact that there are limited flooding events in Cyprus forests without any human intervention for their protection, indicates that the forests themselves due to their topography (mountain areas) have the capacity to be self-protected from floods (autonomous adaptive capacity), as water run-off finds its way to the plains.

Therefore, the adaptive capacity of Cyprus can be characterized as high.

### 4. Forest growth

Forest growth and productivity may be affected by projected climate change aspects such as increases in temperature, decrease in precipitation and increases in air pollution.

According to PRECIS forested regions of Troodos Mountain (Troodos and Paphos forest) will experience a significant warming of about 2.0 – 2.7°C in comparison with the current situation (control period). Future increase in winter temperature will affect the biggest part of Cyprus and forested areas. However the impact on forest growth and productivity cannot be evaluated. Considering the fact that summer temperatures are already high, a further increase may result in increasing the risk of halting of forest growth in forested areas in the future. The most significant increase in number of heat wave days, of about 20-30 days, appears in the central part of Cyprus affecting significantly Troodos forest and increasing the risk of forest growth.

Decrease in precipitation for the future period are not significant however they are most evident for winter and autumn seasons. PRECIS results indicate that all forested areas in Cyprus will experience a decrease in rainfall during autumn season. The decrease in autumn rainfall may have an effect on forest growth since it follows a prolonged dry summer period which may put forested areas under stress.

Table 6.11. Overall vulnerability assessment of forests in Cyprus to climate changes Impact

Impact	Sensitivity	Exposure	Adaptive Capacity	Vulnerability
Dieback of tree species, insect attacks and diseases	Very high (7)	Very high (7)	Moderate (3)	Moderate to high (4)
Fires	Very high (7)	Very high (7)	Moderate (3)	Moderate to high (4)
Floods	Limited (1)	Limited (1)	High (5)	None (-5)
Forest growth	Not evaluated	Very high (7)	Moderate (3)	Not evaluated

In general, increase in CO<sub>2</sub> can lead to an extension of the growing season of plants (Chmielewski and Rotzer, 2001), which will positively contribute to the production of forests and meadows. In absence of relative data on CO<sub>2</sub> concentrations, an overall assessment of the exposure did not take place.

Taking into account the above, exposure of Cyprus forest to changes in temperature, precipitation and CO<sub>2</sub> level for the future period (2021-2050) can be characterized as very high. Further research is required.

Cyprus has joined the International Co-operative Program on the Assessment and Monitoring of Air Pollution Effects on Forests (ICP-Forests) in 2001 aiming at the better monitoring and understanding of ecosystems in Cyprus. Monitoring of the effect of air pollution to Cyprus forests is the first step in the adaptation planning process. However, as soon as the effects of air pollution become fully understood the necessary actions will be undertaken in order to reduce to the degree possible adverse effects. The future adaptive capacity of Cyprus can be characterized as moderate.

#### ASSESSMENT OF OVERALL VULNERABILITY

The overall future vulnerability of forests to climate changes, in terms of sensitivity, exposure, adaptive capacity on the based on the available data for the above mentioned indicators are quantified as shown in Table 6.11. As it can be seen from the table, the main future vulnerability priorities for the forests of Cyprus are the impact of climate changes on the dieback of tree species, insect attacks and diseases as a significant part of Cyprus' forests has already been affected and the effect of increased frequency and intensity of forest fires as the latter cause severe and extended damages on forests.

#### 6.3.6. AGRICULTURE

Agriculture has always been an economic activity of great importance in the Mediterranean basin and a major source of employment and income for the countries of the region, including Cyprus. Agriculture serves for the direct supply of safe, nutritious and affordable food to society and plays an important role in landscape

preservation and prevention of desertification (Demetriou, 2005).

According to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007), climatic condition patterns have brought and will bring about numerous changes concerning agricultural activities on a global scale and consequently will influence the world's food supply.

The agricultural sector is highly dependent on climate since temperature, sunlight and water sources are the key factors for plant growth. Although certain impacts of climate change may be beneficial, as for instance prolonged growing seasons and rise of temperatures, there will be also severe consequences that can put agricultural activities at significant risk, as well. Shifting weather conditions can cause variations in the sowing and harvest time of various crops. Moreover, extreme weather phenomena, such as heatwaves, droughts or hail can damage arable cultivations and reduce crop yields (Iglesias et al., 2007; IPCC, 2007).

At present, agriculture is still considered to be one of the major economic sectors of Cyprus due to the island's favourable climate and location near by its leading market, Europe. Additionally, it contributes to the social cohesion, the employment, the protection of the environment, as well as the general welfare of the society (Bruggeman et al., 2011a).

The main components of the agricultural sector, is agriculture and livestock. The most important crops in terms of production value are wheat, potatoes, grapes, citrus, vegetables and olives (Figure 6.36). The subsectors of the animal husbandry industry are mainly cattle, sheep and goats, pigs and poultry, while ostrich farming has been also recently established for commercial uses (Figure 6.37).

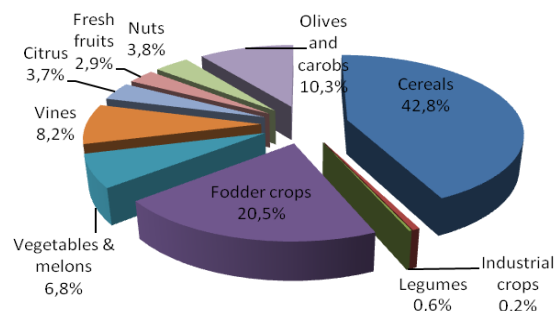


Figure 6.36. Area covered by type of crop as a per cent of total crop area, 2002-2008 (CYSTAT, 2010)

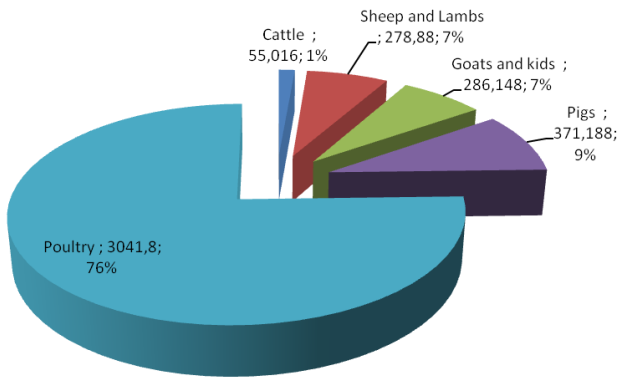


Figure 6.37. Animal population in husbandry (in thousands), average 1984-2008 (CYSTAT, 2010)

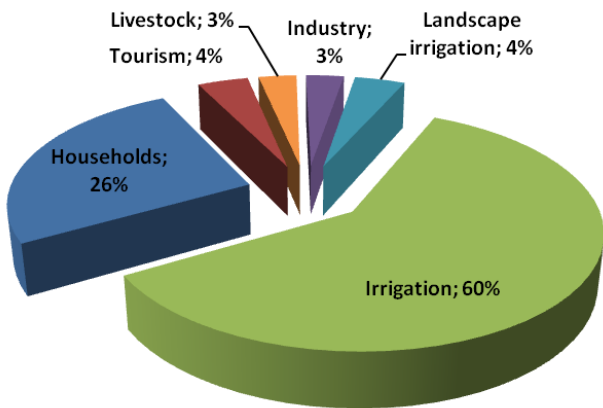


Figure 6.38. Allocation of total water consumption per sector for 2011 (WDD, 2011a)

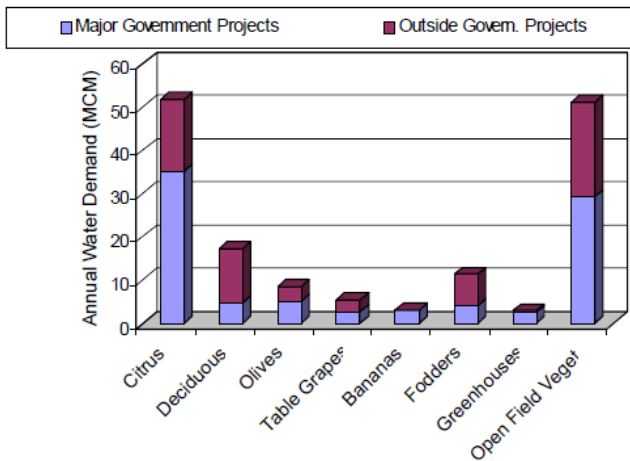


Figure 6.39. Annual water demand data for various crops (WDD – FAO, 2001)

The water consumption in agriculture and livestock represents the 60% and 3% of the total water demand in Cyprus respectively (Figure 6.38). As it can be seen in Figure 6.39 the most water-intensive crops are citrus and open-field vegetables.

In general, 24% of the total crop area is irrigated (mainly for vegetables, citrus, potatoes, melons, table grapes,

deciduous fruit, bananas), while the remaining 76% is non-irrigated (rain fed for cereals, fodders, olives, carobs, wine grapes, almonds) (CYSTAT, 2010). The irrigation water supply is provided by 73% of the demand, from non-Governmental Water Works (GWW), mainly private boreholes, and the remaining 27% from GWW, mainly surface water (WDD, 2009).

The water demand for livestock varies significantly among animal species (e.g. animal's size and growth) and is being influenced by environmental and other factors, such as air temperature, relative humidity and the level of animal exertion or production, the water content of the animal's feed or dietary needs etc. (OMAFRA, 2007).

The main vulnerability priorities for the agricultural sector of Cyprus as observed in the recent past, that have been related to impact of climate changes are the reduced crop yield/ productivity due to the limited water resources, the damages caused to crops due to extreme weather events, and the declining soil fertility.

The future impact, vulnerability and adaptation measures for the agricultural sector in Cyprus regarding climatic changes were also assessed as part of the Life+ CYPADAPT project, by using PRECIS and six other regional of the ENSEMBLES models and, the future period (2021–2050) against the control period (1961–1990).

## FUTURE IMPACT ASSESSMENT

The magnitude of the impacts on Cyprus' agricultural sector is expected to increase, as the relevant climate change factors are expected to intensify.

According to PRECIS projections for the future period 2021-2050, with respect to the control period 1960-1990: the average annual temperature in Cyprus is expected to increase by 1-2°C, while precipitation is expected to decrease in seasonal level and in minor degree in annual level. In addition, the maximum length of dry spells (precipitation < 0.5mm) is expected to increase by 10 to 13 days on average, while heat wave days (temperature > 35°C) will be increased averagely about 10-30 days on annual basis. Concerning future changes of annual max total rainfall over 1 day, projections show that a slight increase of about 1-4 mm is anticipated. Finally, regarding the highest annual total precipitation, falling in 3 consecutive days, a negligible increase of about 1-2 mm of rainfall is expected.

Even though the effects of climate change on the primary sector are generally difficult to be distinguished from non-climatic impacts associated with the management of natural resources, there are some basic impacts identified which are related to global change (IPCC, 2007).

According to FAO (2007), the principal climate change impacts on agriculture can be roughly divided into two categories, namely the biophysical impacts and the socio-economic impacts, as shown in Table 6.12.

The potential changes in climate and their respective impacts on the agricultural sector for the case of Cyprus are presented in Table 6.13.

**Table 6.12. Climate change impacts on the agricultural sector**

<b>Biophysical impacts</b>	<b>Socio-economic impacts</b>
Physiological effects on crops, pasture, forests and livestock (quantity, quality)	Decline in yields and production
Changes in land, soil, water resources (quantity, quality)	Reduced marginal GDP from agriculture
Increased weed and pest challenges	Fluctuations in world market prices
Shifts in spatial and temporal distribution of impacts	Changes in geographical distribution of trade regimes
Sea level rise, changes to ocean salinity	Increased number of people at risk of hunger and food insecurity; Migration and civil unrest

**Table 6.13. Potential changes in climate and their respective impacts on the agricultural sector in Cyprus**

<b>Potential climate changes</b>	<b>Impacts</b>
<b>Increased Temperature</b>	<ul style="list-style-type: none"> <li>- Reduction of crop suitability and productivity</li> <li>- Changes in crop quality</li> <li>- Increased challenges of weeds, crop pests and diseases</li> <li>- Increased water requirements for irrigation</li> <li>- Water scarcity intensification</li> <li>- Water quality deterioration</li> <li>- Intensification of desertification</li> </ul>
<b>Decreased Precipitation</b>	<ul style="list-style-type: none"> <li>- Decreased crop productivity</li> <li>- Intensification of desertification</li> <li>- Decreased soil fertility</li> </ul>
<b>Increase of atmospheric CO<sub>2</sub></b>	<ul style="list-style-type: none"> <li>- Increased biomass production and increased potential efficiency of physiological water use in crops and weeds</li> <li>- Modified hydrologic balance of soils due to C/N ratio modification</li> <li>- Changed weed ecology with potential for increased weed competitive crops</li> <li>- Increased water use efficiency of some plants and as a result altered competitive interactions of species</li> <li>- Changes in the distribution of animal species</li> </ul>
<b>Increase of atmospheric O<sub>3</sub></b>	<ul style="list-style-type: none"> <li>- Crop yield decrease</li> </ul>
<b>Sea level rise</b>	<ul style="list-style-type: none"> <li>- Loss of arable land in coastal agricultural areas</li> <li>- Soil salinization in coastal agricultural areas</li> <li>- Salinization of groundwater aquifers resulting in low water quality for irrigation</li> </ul>
<b>Increased frequency of extreme weather events (heat waves, droughts, hail, floods)</b>	<ul style="list-style-type: none"> <li>- Crop failure</li> <li>- Damages to crops</li> <li>- Decrease in crop yield</li> <li>- Competition for water between different sectors (irrigation, tourism, domestic etc.) due to extended drought periods</li> <li>- Damage to grain formation</li> <li>- Increase in pests</li> <li>- Heat stress for animals</li> </ul>

The extent of climate change impacts varies upon different ecosystems, regions and countries. In warmer regions like the Mediterranean basin, the majority of impacts are likely to have a negative influence, resulting in economic losses, especially significant in areas which are already under pressure due to socio-economic and other environmental problems, for instance water scarcity (EEA, 2008b).

The main direct and indirect impacts presented in the table above were grouped in the following impact categories and analysed in brief below: 1. Crop yield alterations, 2. Soil fertility alteration, 3. Increase in pests and diseases, 4. Damages to crops from extreme weather events, 5. Alterations in livestock productivity, 6. Increase in costs for livestock catering.

### **1. Crop yield alterations**

The increases in ambient CO<sub>2</sub> seem to have positive impacts on plant growth and lengthening of the growing season, through the enhancement of photosynthesis and plant respiration (EAA, 2008a). However, these potential positive impacts, in southern and warmer latitudes are less significant than the potential negative impacts, which include reduced crop yields due to high temperatures, increased water demand for irrigation and reduced water availability due to periods of prolonged droughts, water scarcity, rainfall decrease and increased competition for water between sectors, which will in turn be much more intense (Behrens et al., 2010).

In Cyprus, the anticipated increase in temperature and evapotranspiration, and the decrease in rainfall, as well as their related changes in heat wave days and maximum length of dry spell, will decrease the crop yield.

Furthermore, the projected climate conditions will magnify the already intense water stress circumstances (drought, water shortage problems) on the agricultural sector, provoking crop failure (Bruggeman et al, 2011c). The combination of decreased rainfall and increased drought periods are expected to decrease water availability for irrigation and to increase crop moisture stress and thus further decrease crop yields. In particular, the traditional irrigated farming is the first to receive water cuts during drought years, leading to a significant decrease of the lands covered with annual crops such as vegetables and potatoes.

### **2. Soil fertility alteration**

The principal soil aspects that affect soil fertility and are susceptible to climate change are soil biodiversity, organic carbon content, available soil moisture, erosion, salinization and desertification.

Soil fertility in Cyprus experiences a declining trend in recent years, mainly due to the erosion which has affected specifically the arable land and the land used for permanent crops (MANRE, 2007).

The expected higher temperature and lower precipitation may intensify the loss in soil organic carbon and soil moisture, the reduced water availability and the increase and variations in fires and desertification. It has been shown that the occurred desertification and loss of productive land in Cyprus are being exacerbated in recent past, because of the deterioration of soil quality with the expansion of droughts (IACO Ltd, 2007).

Regarding the fire risk in Cyprus, it is expected to be higher in forested areas, increasing so the risk for extended land erosion and the loss of cultivated areas (Behrens et al., 2010).

A further reduction in surface water availability may lead to the overexploitation and depletion of aquifers, which will result in sea intrusion to coastal aquifers, extended soil salinization and erosion, reducing so the fertility of agricultural land in particular the irrigated farms.

### **3. Increase in pests and diseases**

Additional risk for crop production, as secondary effects induced by higher temperatures and prolonged growing season, will be posed by pest outbreaks, emergence of new pests and pathogens, weeds cycle acceleration and an increase in the frequency of diseases. There are no sufficient data to assess this issue and further research is needed.

### **4. Damages to crops from extreme weather events**

The increasing trend in the occurrence of extreme weather phenomena will be more frequent and intense in the future, causing more damages to crops yields. In addition, the magnitude of damage caused to crops depends highly on the timing of the cycle of crops when the extreme weather events take place. More frequent, occurrence of dry spells, heat waves, and frost and hail incidents will potentially damage agriculture more than

changes in the annual average temperature (Behrens et al., 2010).

Considering the above, damages to crops due to extreme weather events in Cyprus are expected to be further intensified in the future, mainly due to the increase in the number of heat wave days and to a lesser extent due to the increase in drought periods, while the damages to crops due to frosts, are expected to be reduced.

As mentioned earlier, the PRECIS climate projections in Cyprus for the period 2021-2050, indicate increases in the mean number of heat wave days per year (temperature >35°C) up to 34 days, and up to 12 days per year on average in the length of drought periods (precipitation <0,5mm). On the other hand, the mean number of frost nights per year (temperature <0°C) is expected to decrease up to 8 days on average, while the heavy rainfall and flooding events, will slightly decrease as the annual maximum total precipitation over one day shows minor changes in the future.

## 5. Alterations in livestock productivity

The projected increase in temperatures and heat waves are expected to reduce livestock productivity due to diseases outbreaks and heat stress suffered by animals, causing among others reduction in the feed intake, conception, growth and productivity rates.

In addition, warmer and drier climate conditions may reduce forage production resulting in shortage of animal feed which could modify animal diets and reduce growth and reproduction rates.

Changes in precipitation patterns and in particular the increase in flooding events may also cause the spreading of animal diseases, thus putting additional constraints to livestock productivity (IFAD, 2009).

The most important constraints of the livestock sector in Cyprus encompass the insufficient production of animal feed, as the reduced rainfall and increased drought periods in Cyprus will have also a negative effect on livestock feed productivity.

## 6. Increase in costs for livestock catering

The livestock sector in Cyprus depends mainly on imports due to the insufficient production of animal feed.

Rising temperatures and decreasing rainfall, resulting in reduced yields of forage crops and increased costs for farmers for providing other sources of feeding.

Increased risk for heat stress and unproductive grazing land during the summer months, as well as, the increase in extreme weather events may lead to increased housing requirements. Increased mechanical ventilation of both housing and transportation for livestock in order to reduce the risk of thermal discomfort in animals and, the risk of spreading of diseases is also expected to increase the cost for livestock catering. Additional research is needed to gather information and data regarding the climate change impact in the sector.

## FUTURE VULNERABILITY ASSESSMENT

The future vulnerability of the agricultural sector to climate change impacts is assessed in terms of its sensitivity, exposure and adaptive capacity, based on the available quantitative and qualitative data for Cyprus and the climate projections for the period 2021- 2050, as follows: 1. Crop yield alterations, 2. Soil fertility alteration, 3. Increase in pests and diseases, 4. Damages to crops from extreme weather events, 5. Alterations in livestock productivity, 6. Increase in costs for livestock catering

### 1. Crop yield

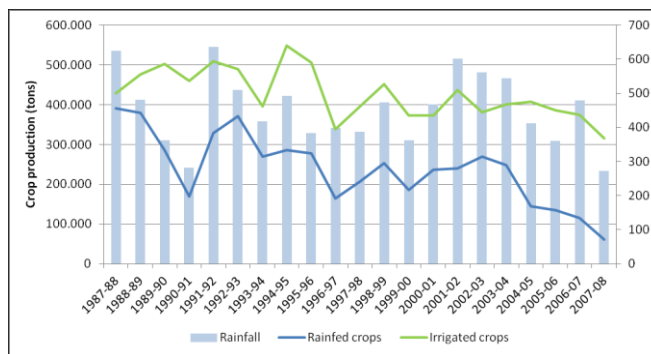
In general, crop yield is favoured by the positive effect of increased CO<sub>2</sub> concentrations for the majority plants. However, this is counterbalanced by the negative effects, such as the decreased photosynthetic and water use efficiency, induced by the hot and dry conditions as in Cyprus. Crop production, both rainfed and irrigated, is highly sensitive to precipitation as crops, as shown in Figure 6.40.

During the studied period 1988-208, the lack of water caused an extensive reduction of crop production, with rainfed crops such as cereals, straw and green fodder being mostly affected, with a reduction of 90%, 85% and 87.6% respectively (CYSTAT, 2010).

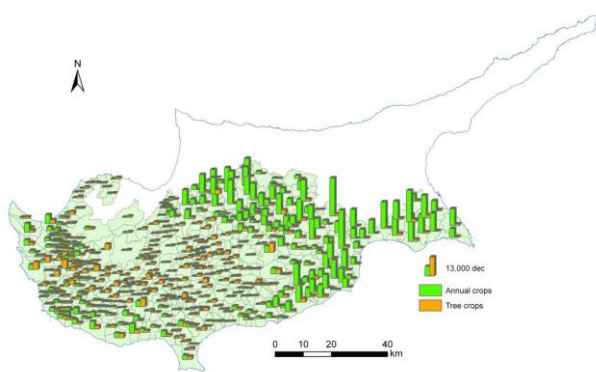
Considering the percentage of rainfed crops in the total crop production, the exposure of crop yields regarding this indicator, is characterized as moderate.



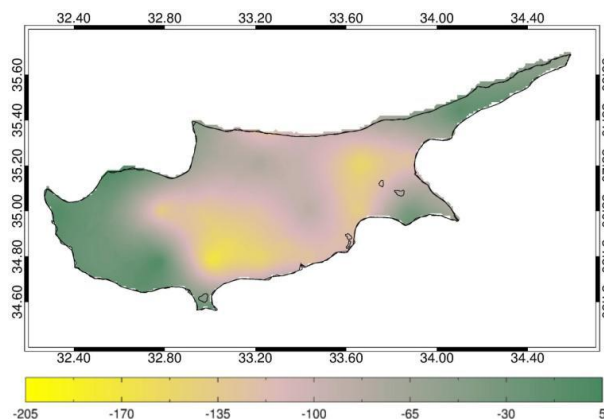
In addition, the sensitivity of crop production to water availability especially for irrigated crops depends on the water allocation policy of Cyprus under drought conditions (water rationing) and the prioritization of water uses, as their water requirements are the last to be satisfied (WDD, 2011b). In addition, which the loss in irrigated production is mainly due to the reduction in irrigation water supply, whereas the loss in rainfed production is both due to climate change and an overall decrease in agricultural land use (Bruggeman et al, 2011c).



**Figure 6.40. Rainfed and irrigated crop production and precipitation during the period 1987/88- 2007/8 (CYSTAT, 2010; MSC, 2012)**



**Figure 6.41. Distribution of the annual and tree crops (Bruggeman et al., 2011d)**



**Figure 6.42. Changes in maximum length of dry spell (RR<0.5mm) between the future (2021-2050) and the control period (1961-1990)**

Consequently, irrigated temporary crops are more exposed to the reduced water availability under drought conditions, and considering their percentage in the total crop production, the exposure of crops to reduced water availability, is characterized as high to very high.

The geographical distribution of crops is also linked with reduced water availability and crop yields under climate changes (Figure 6.41).

The crops located in the mountain areas, although at limited extent, are irrigated only from groundwater resources. Thus apart from the risk of their overexploitation, they depend on climate parameters such as precipitation and evapotranspiration, as well as on climate-related parameters such as soil moisture and run-off. Therefore the crops located in the mountain areas very sensitive to climate changes, especially during prolonged drought periods (>1year).

On the other hand, although flat plain areas and coastal regions have less precipitation than mountainous regions, they are irrigated mainly by the Government Water Works, which are also connected to desalination plants. It must be noted that some coastal areas are irrigated with low quality (saline) water from private boreholes.

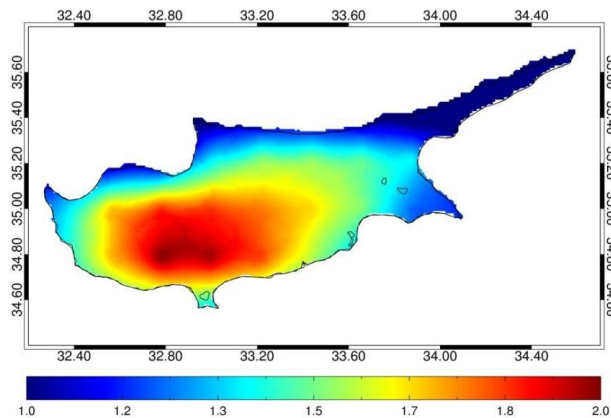
With climate changes, the aforementioned effects on the crops located at the mountain and coastal areas are expected to be exacerbated, thus making them highly sensitive to climate changes.

Another factor associated with crop yields is the water availability. Although a minor reduction in precipitation of 5% is estimated based on the PRECIS model, the future total dam inflow will be decreased by 23% while the available groundwater resources are estimated to be reduced by approximately 29%.

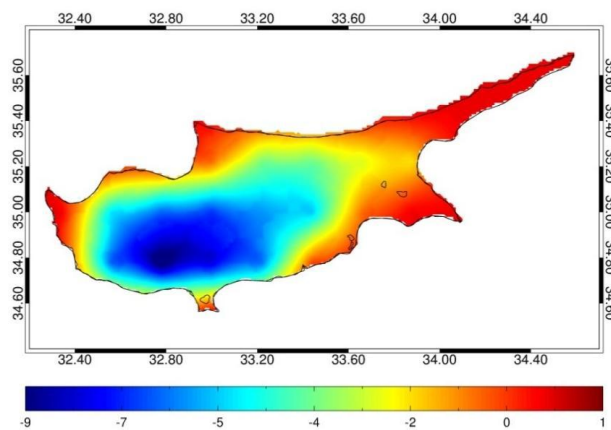
As far as the length of drought periods in the future (2021-2050) is concerned, the central part of Cyprus will face an increase in the maximum length of dry spell, between 15 -20 days/year in the continental agricultural areas in the eastern part of Troodos mountain, respectively (Figure 6.42).

The length of the growing season will be influenced mainly by the increase in temperatures in autumn and spring (Ainsworth and Long, 2005) and the decrease in the number of frost days. According to the PRECIS

projections in the future period 2021-2050 (Figure 6.43), the expected increase in the average autumn maximum temperature (TX) ranges between 1.0-2.0°C in the northern coasts and south-eastern area, and the in the area around southern Troodos, respectively. A similar pattern is also projected for the spring season, where TX increase is between 1.0-1.8°C. Furthermore, the number of frost nights (temperature < 0°C), is expected to decrease up to the maximum 6-9 days in the greater area around central and southern Troodos.



**Figure 6.43. Changes in average autumn maximum temperature between the future (2021-2050) and the control period (1961-1990)**



**Figure 6.28. Changes in the annual number of frost nights (TN < 0°C) between the future (2021-2050) and the control period (1961-1990)**

Considering the above, it is highly likely that the length of the growing season will be extended and crops yield on mountains is expected to increase. Therefore, the sensitivity of crop yields to climate change is characterized as very high and the exposure as high.

#### Assessment of adaptive capacity

The practices applied in Cyprus in order to reduce the impact of reduced crop yields are:

- (a) increasing water availability for irrigation. This is achieved by increasing water availability from Government Water Works, and by applying on-farm practices.
- (b) reducing water demand for irrigation This is achieved through (i) increasing water use efficiency in irrigation (Redistribution of irrigated land, Use of advanced irrigation system, Irrigation scheduling, (ii) reducing run-off (Minimum soil cover, Minimum land management reflecting site-specific conditions, Terracing) and (iii) using less water intensive crops
- (c) increasing crop productivity, The increase in crop productivity is achieved through (i) the application of crop rotation, (ii) fertilization and (iii) using crops more resistant to hot and dry climates.

## **2. Soil fertility**

Soil fertility is sensitive to increasing temperatures as they intensify the loss of soil organic carbon and soil moisture and increase wildfires and desertification. According to the PRECIS model, the change in the average annual maximum temperature (TX) for the period 2021-2050 will increase by 1.0 –2.0°C at the eastern and western coastal agricultural area, and in higher elevation areas, respectively.

To sum up, all agricultural areas are expected to be exposed to increased temperatures and especially the mountain areas, followed by the continental lowland agricultural areas and the coastal agricultural areas.

Soils are sensitive to long dry periods along with regular strong seasonal winds as they causes wind erosion. In addition, soil erosion by rain is caused by intense precipitation and river flooding. However, the agricultural land in Cyprus and especially arable land and land used for permanent crops which constitutes approximately 70% of the total agricultural land, is sensitive to erosion mainly due to the intensive cultivation and overexploitation of land resources, which overburden the soil and reduce its productivity.

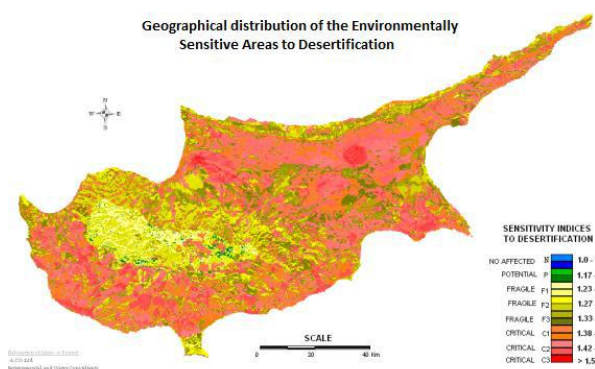
As for the future changes in droughts and strong winds, affecting the exposure of soils to wind erosion it is mentioned that the maximum increase in the length of dry spell, will be between 15 -20 days/year in the central part of Cyprus (Figure 6.44), while the number of days with mean wind speed greater than 5 m/s will decrease up to 12 days/year. In general, all agricultural areas are characterized by decreases in strong winds and the

exposure to soil erosion by wind in the future due to climate changes will not further intensify.

As regards the future exposure of agricultural land to erosion by rain, since the future changes in the maximum amount of rainwater that falls in a short period of time (1 day in this case) within the year is insignificant, it is expected that the exposure to soil erosion by rain in the future due to climate changes will not be further intensified. The agricultural land located at the coasts, which represents the higher percentage of cultivated land, is mainly irrigated with good water quality from Government Water Works and in lesser degree from private boreholes, becoming so more sensitive to soil salinization due to overexploitation and sea intrusion.

The future changes in precipitation and in the periods of drought, which are associated with the salinization of coastal agricultural land, are expected to be minor and thus the future exposure of crops to the risk of soil salinization is moderate.

Desertification is a result of erosion by wind and rain, reduced soil moisture and chemical degradation of land (e.g. salinization) (IACO, 2007). The combined evaluation of Figure 6.45 and Figure 6.41, showed that the majority of crops cultivated in Cyprus are located in areas which



**Figure 6.45. Geographical distribution of the Environmentally Sensitive Areas to Desertification (IACO, 2007)**

are considered as fragile or critical to desertification, and therefore their current exposure to desertification is characterized as high.

Considering the abovementioned climate change impact indicators on soil fertility, it is concluded that the agricultural sector of Cyprus has moderate sensitivity and high exposure to climate changes.

### Assessment of adaptive capacity

Measures to minimize the degradation of arable land are provided, including economic incentives under the Rural Development Programme of Cyprus (2007-2013) such as for the use (i) mechanical instead of chemical destruction of weeds, (ii) integrated production management and (iii) organic production.

Additionally, guidance and technical support is provided to farmers regarding salinity and infiltration problems, irrigation management methods for overcoming them, as well as a plethora of measures and different approaches which could be employed by farmers for mitigating risk of reduced soil fertility. Thus, the current adaptive capacity of Cyprus' agriculture towards this impact is considered as limited to moderate.

### **3. Pests and diseases**

The assessment of the sensitivity and exposure of the agriculture in Cyprus to pests and diseases due to climate changes is not yet possible, because of the lack of data. Further research is needed regarding the number of pest outbreaks, the areas covered by weeds, the recorded incidents of plant diseases as well as the exposure of crops to climate changes and other aspects.

### Assessment of adaptive capacity

The measures that have been undertaken in Cyprus to support farmers in order to reduce the proliferation of new pests and diseases are categorized into four groups: (a) promotion of indigenous and locally adapted plants and animals, (b) development of an Integrated Pest Management Strategy, (c) application of crop rotation and (d) resistance enhancement of existing plants and animals against pests and diseases.

However, in absence of data on the magnitude of the impact of climate changes on pests and diseases on crops, the adaptive capacity towards this impact cannot be evaluated.

### **4. Damages to crops from extreme weather events**

The sensitivity of crops to extreme weather events is evaluated based on the extent of the damage caused in the recent past, in terms of crop species and type of extreme event, while the exposure is assessed based on the current and future frequency of the extreme climatic events causing damages to crops in Cyprus. The major

losses to crops, because of these damages, for the period 1978-2009 is possessed by cereal and dry fodder crops, followed by potato crops deciduous crops, vines with 9.2% and citrus as illustrated in Figure 6.46. The common damaging extreme climatic event is hail, since when it occurs almost all crops are affected with extensive damages (Ioannou, 2010).

Therefore, it is estimated that the sensitivity of crops cultivated in Cyprus to extreme climatic events is high.

With regard to exposure it was observed that compensations for damages by hail events were paid

every year from the establishment of the Agriculture Insurance Organisation in 1978 until 2007 with a frequency of occurrence 100%, followed by compensations for frosts with a frequency of occurrence 83%, droughts with 70%, heatwaves and windstorms with 53% each and floods with 47%.

Considering the above and their related future climate changes was mentioned earlier, the exposure of the agricultural sector of Cyprus to extreme climatic events is characterized as moderate to high.

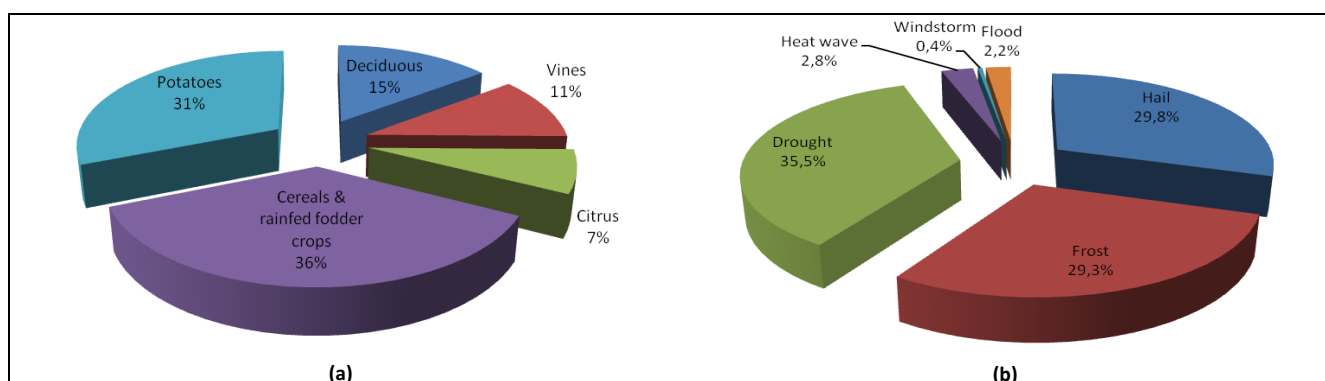


Figure 6.46. Contribution of the compensations (a) paid to main crops affected and (b) paid for the main extreme weather events to the total compensations provided in Cyprus during the period 1987-2007 (AIO, 2008a)

Table 6.14. Overall vulnerability assessment of the agricultural sector in Cyprus to climate changes

Impact	Sensitivity	Exposure	Adaptive Capacity	Vulnerability
Crop yield alterations	Very high (7)	High (5)	Limited to Moderate (2)	Moderate to high (3.9)
Soil fertility alterations	Moderate (3)	High (5)	Limited to Moderate (2)	Limited to Moderate (1.9)
Increase in pests and diseases	Not evaluated	Not evaluated	Not evaluated	---
Damages to crops from extreme weather events	High (5)	Moderate to high (4)	Limited to Moderate (2)	Moderate (2.5)
Alterations in livestock productivity	Not evaluated	Not evaluated	Not evaluated	---
Increase in costs for livestock catering	Not evaluated	Not evaluated	Not evaluated	---

#### Assessment of adaptive capacity

For the protection of crops against droughts, a plethora of measures have been undertaken or promoted, in order to increase water availability for irrigation and reduce run-off. However, in spite of the measures, water demand for irrigation during drought events is not fully met in most cases, and thus the adaptive capacity of crops to droughts is considered limited to moderate.

In general, the abovementioned measures for the protection of crops from extreme events are applied on farm level and hence their implementation depends on the private initiative of farmers. Considering the above the adaptive capacity to this impact is characterized as limited to moderate.

#### 5. Livestock productivity

There are no available data for the determination of the sensitivity and exposure of livestock productivity in

Cyprus to climate changes. Further research is needed concerning for example, the animal species which are more resilience to increased temperatures and heat waves, production of animal feed, the reduction of incidents of diseases outbreaks etc.

#### Assessment of adaptive capacity

Catering for animal welfare under adverse weather conditions can be enhanced by increasing the amount of shade and shelter or by keeping livestock indoors, such as shelterbelts, planting tall, fast-growing, trees on the southern edge of pastures. The implementation of this measure is promoted through the Rural Development Programme with the provision of economic incentives for the plantation of hedgerows of forest trees.

Another measure adopted, which also contributes to the increase of the sector's adaptive capacity, is the establishment of a gene bank for animal species in order to protect genetic diversity. Guidance and advice is also provided by the Ministry of Agriculture, Natural Resources and Environment of Cyprus to farmers, in increasing of animal productivity by promoting improved breeding and management methods, improving veterinary services for animal disease control and treatment, local production of animal feed, and upgrading of farm units through mechanization and enhancing their management skills.

However, in absence of data on the magnitude of the impact of climate changes on livestock productivity, the adaptive capacity towards this impact cannot be evaluated.

#### **6. Costs for livestock catering**

There are no available data for the determination of the sensitivity and exposure of costs for livestock catering in Cyprus to climate change. Further research is needed concerning the increase in costs for livestock catering during extended warm periods in Cyprus, the deficit in local animal feed production and the excess costs for importing animal feed, for providing housing, ventilation, etc.

#### Assessment of adaptive capacity

The measures for enhancing adaptive capacity to increased costs for livestock catering are related mainly to the financial support provided by the Rural

Development Programme of Cyprus for improving outdoor and indoor conditions for livestock.

In absence of data on the magnitude of the impact of climate changes on the costs for livestock catering, the adaptive capacity towards this impact cannot be evaluated.

#### **Assessment of overall vulnerability**

The overall future vulnerability of the agricultural sector of Cyprus to future to climate changes, in terms of sensitivity, exposure, adaptive capacity on the based on the available data for the above mentioned indicators are quantified as shown in Table 6.14. The first vulnerability priority of the sector is the impact of climate changes on crop yield, which is expected to be significantly reduced. The second priority of the sector regarding its vulnerability to climate changes is related to the damages caused to crops due to extreme weather events, taking into account the magnitude, frequency and intensity of these effects on crops, especially of droughts and heat waves. The last priority refers to the impact of climate changes on soil fertility, is expected to magnify the existing deterioration. For the rest of the identified impacts, no evaluation took place due to lack of sufficient data.

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#### **6.3.7. WATER RESOURCES**

Freshwater resources, their systems and management are strongly depended on climate changes such as increases in temperature, sea level and precipitation variability (Kundzewicz et al., 2007), with a potential of high vulnerability not only for water resources but also to human societies and ecosystems as a consequence (Bates et al., 2008).

Water resources are closely interrelated with climate as the physical processes, through which the water cycle takes place, strongly depends on climate factors. Thus, the processes of evaporation, condensation, precipitation, infiltration, runoff, and subsurface flow strongly dependant on climatic factors such as temperature, radiation, sea level rise, vapour pressure and wind. In addition, climate affects the soil moisture and consequently the infiltration of water to groundwater bodies. Extreme climatic events such as droughts, heavy rainfall and flooding hamper water storage, resulting in significant water losses and

deterioration of water quality. Increased temperatures and decreased precipitation lead to increased evapotranspiration, condensation and eutrophication, while sea level rise threatens coastal groundwater bodies with salinization.

The water resources of Cyprus are considered vulnerable to climate changes, since they are limited due to the semi-arid climate that characterizes this Mediterranean island. Freshwater availability depends almost entirely on rainfall which is highly variable with frequent prolonged periods of drought. The Republic of Cyprus in order to satisfy drinking water and irrigation demand, continue deliver a number of water works for the exploitation of the available freshwater resources (both surface and groundwater) and no- freshwater resources (sea water, recycled water). According to the standards of the International Commission of Large Dams (ICOLD), Cyprus is the first in Europe regarding the number of dams per square kilometre, having 108 dams and reservoirs with a combined storage capacity of 332 Mm<sup>3</sup> (WDD, 2011a).

The water sector currently experiences both quantitative and qualitative pressures from several environmental and socio-economic activities and practices. In specific, the impact, vulnerability and adaptation assessment for water resources in Cyprus, regarding the observed climate changes in recent past, showed the following key vulnerabilities: i) Water availability for irrigation, ii) Frequent occurrence of droughts, iii) Groundwater quality, and iv) Water availability for domestic water supply.

These impacts are expected to worsen in future period 2021–2050 as already projected by the PRECIS and ENSEMBLES regional climate models with respect to the control period 1960-1990.

## FUTURE IMPACT ASSESSMENT

The climatic factors that may have an impact on the water resources of Cyprus include the decreased rainfall and increased temperature, droughts, fluctuations in intense precipitation events.

According to PRECIS projections for the future period 2021-2050, the average annual temperature in Cyprus is expected to increase by 1-2°C, while the average annual total precipitation will be slightly decreased with seasonal variations. The maximum length of dry spells

(precipitation<0.5mm) is expected to increase by 10 to 12 days on average, while the heat wave days (temperature >35°C) will be increased averagely by 10-30 days on annual basis, depending on the region. Concerning future changes of annual max total rainfall over 1 day, PRECIS projections show that a slight increase of about 1-4 mm is anticipated. Finally, regarding the highest annual total precipitation, falling in 3 consecutive days, a negligible increase of about 1-2 mm of rainfall is expected.

The potential changes in climate and their respective impacts on water resources for the case of Cyprus are presented in Table 6.15.

The future impacts of climate change on water resources are analysed in brief under the following categories: 1. Decrease in water availability, 2. Deterioration of water quality, 3. Increase in flood frequency and intensity, and 4. Increase in drought frequency and severity.

### 1. Decrease in water availability

Climate changes such as changes in temperature, precipitation patterns and snowmelt is projected to lead to major changes in yearly and seasonal water availability across Europe. More specifically, southern and south-eastern regions, which already suffer most from water stress, will be particularly exposed to reductions in water resources. Decreased summer precipitation results to a reduction of water stored in reservoirs fed with seasonal rivers. There is very high probability (80% confidence) that many regions in the Mediterranean basin will suffer a decrease in surface and groundwater resources due to climate change (Kundzewicz et al., 2007).

According to PRECIS projections for the future period 2021-2050, the average annual temperature in Cyprus is expected to increase by 1 - 2°C, while annual precipitation will have minor changes and discerned seasonal changes in precipitation. The total winter and autumn precipitation present decrease of 10-20mm per year and, a minor increase in summer precipitation reaching 5 mm on average. Considering this, increased temperatures play a more significant role in potential future changes in water availability.

The main natural source of water in Cyprus is rainfall. The rainfall is unevenly distributed geographically with the highest in the two mountain ranges and the lowest in the eastern lowlands and coastal areas.

**Table 6.15. Relationship between climate changes and impacts on the water sector**

Potential climate changes	Impact
Increased temperature	<ul style="list-style-type: none"> <li>- Increased water temperatures</li> <li>- Increase in evaporation</li> </ul>
Increased evapotranspiration	<ul style="list-style-type: none"> <li>- Water availability reduction</li> <li>- Lower replenishments rates (lower groundwater levels)</li> <li>- Salinisation of water resources</li> </ul>
Decreased precipitation, including increased droughts	<ul style="list-style-type: none"> <li>- Decrease in runoff</li> <li>- More widespread water stress</li> <li>- Increased water pollution and deterioration of water quality due to lower dissolution of sediments, nutrients, dissolved organic carbon, pathogens, pesticides and salt</li> <li>- Decreased rates of groundwater recharge</li> <li>- Salinisation of coastal aquifers due to overpumping motivated by insufficient water supply</li> </ul>
Increase in interannual precipitation variability	<ul style="list-style-type: none"> <li>- Increase in the difficulty of flood control and reservoir utilization during the flooding season</li> </ul>
Increase in heavy precipitation events	<ul style="list-style-type: none"> <li>- Flooding</li> <li>- Adverse effects in quality of surface water and groundwater</li> <li>- Contamination of water supply</li> <li>- Lower replenishment rates in the aquifers of the mountain areas due to steep slopes</li> </ul>
Increase in surface water temperature	<ul style="list-style-type: none"> <li>- Increased algae growth and reduced dissolved oxygen levels in water bodies which may lead to eutrophication and loss of fish</li> <li>- Prolonged lake stratification with decreases in surface layer nutrient concentration and prolonged depletion of oxygen in deeper layers</li> <li>- Changes in mixing patterns and self-purification capacity</li> <li>- Salinisation of water resources</li> </ul>
Sea level rise	<ul style="list-style-type: none"> <li>- Salinisation of coastal aquifers (minor effect)</li> </ul>

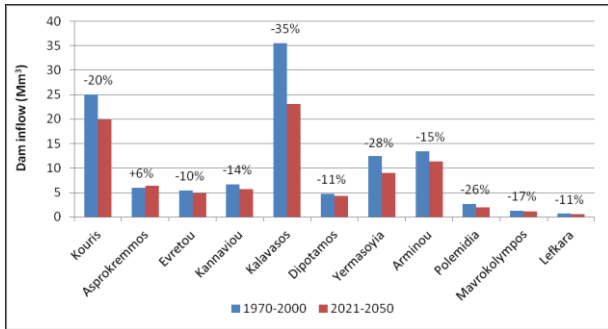
The climate changes are anticipated to have also an effect on evapotranspiration as well as on soil moisture, infiltration and runoff, together with the increase in water demand will in turn have a significant effect on water availability.

In general, evapotranspiration tends to decrease with reduced precipitation, but it increases with higher temperatures. It is estimated that during the period 1971-2000, 86% of rainfall returned to the atmosphere as evapotranspiration. The KNMI model predicted a general decrease in annual evapotranspiration ranging from -3% to -7% for the period 2021-2050 compared to the period 1970-2000 (CYPADAPT project).

As mentioned above, the changes in evapotranspiration and in the heavy rain events are expected to have an

additional impact on river flows and thus the quantity and quality of surface water, inbounded in dams and reservoirs.

The average annual inflow to the dams during the period 1971-2000 was approximately 130Mm<sup>3</sup>, while the respective future total dam inflow in the period 2021-2050 is expected to decrease by 23% , while the total average precipitation, according to PRECIS, is estimated to decrease only by 5%. In Figure 6.31 the change in the inflow to the main dams of Cyprus for the period 1970-2050 is presented.



\* 1970-2000: Actual dam inflow (WDD, 2011a), 2021-2050: Projection  
**Figure 6.47. Change in inflow to the main dams of Cyprus for the period 1970-2050**

The reduction in precipitation and the increase in evaporative demand will also lead to a reduction in groundwater levels. Also a change in the amount of effective rainfall and in the duration of the recharge season will alter recharge rates (Kundzewicz et al., 2007). In addition, high intensity precipitation favours runoff against groundwater recharge. Regarding future changes in high intensity precipitation, minor increases ranging from 2 to 5 mm in the annual maximum total precipitation over one day are expected in the future period (2021-2050) according to PRECIS.

The available groundwater resources in the future, as mentioned above, are estimated to be reduced by 23% on average. Again, it must be mentioned that this method does not account for future changes in runoff which could increase runoff and water losses and decrease water storage.

At this point, it has to be noted that, the water availability to rainfall continue, beside the substantial contribution of the desalination plants to domestic water

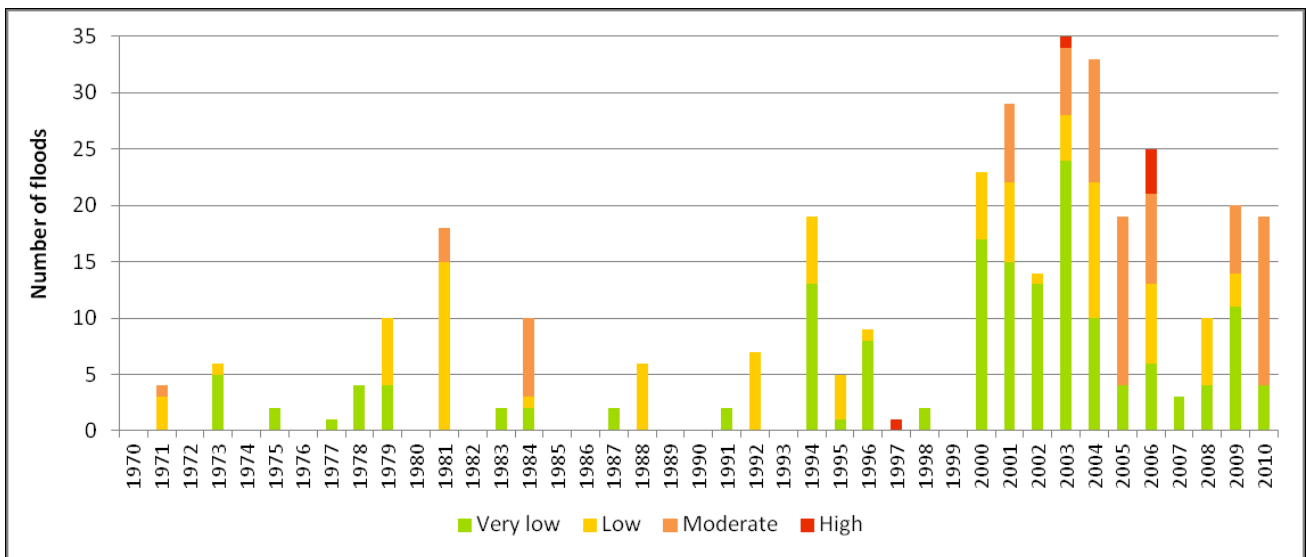
demand, and of the recycled water to the agricultural demand. However, the existing and planned investments for the supply of non-freshwater resources are expected to minimize the future marginal difference between water supply and demand.

## 2. Deterioration of water quality

According to the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC), it is believed that higher water temperatures, increased precipitation intensity, and longer periods of low flows exacerbate many forms of water pollution. However, there is no evidence for climate related trend in water quality (Parry et al., 2007).

Surface water bodies in Cyprus are mainly the storage reservoirs with no inflows during the summer months. As a result there is no dilution and in combination with the high evapotranspiration rates, their quality will be deteriorated. In addition the increasing temperatures enhance eutrophication rates, stratification and low levels of dissolved oxygen.

A trend in water quality deterioration is mainly observed in groundwater resources, due to the low recharge rate in combination with the low permeability of some sedimentary aquifers in Cyprus, which results in the dissolution of soluble salts and the increase in salinity (WDD, 2008). The rapid urbanization in various parts of Cyprus during the last 30 years, the uncontrolled waste discharge, the excessive use of fertilizers and pesticides, the overexploitation of many coastal aquifers gradually deteriorated the quality of Cyprus' groundwater.



**Figure 6.48. Number of flooding events per year in Cyprus (1971-2010) (WDD, 2011d)**



The future climate changes that are anticipated to intensify the impact of water quality deterioration are the changes in water temperature, (related to the changes in air temperature), low flows or dry spells. According to PRECIS projections, for the future period 2021-2050 with respect to the control period 1960-1990, the annual maximum total precipitation over one day show minor increases ranging from 2 to 5 mm on average, while the average annual temperature in Cyprus is expected to increase by 1-2°C. As far as the periods of low flows or dry spells in the future (2021-2050), it is projected that there will be a range of changes from slight decreases to an increase of up to 12 days/year on average.

### 3. Increase in flood frequency and intensity

According to the IPCC, increases in the intensity of precipitation, may result in more frequent and hazardous flooding events. In particular, flash and urban floods, triggered by local intense precipitation events, are likely to be more frequent throughout Europe (Christensen and Christensen, 2007; Kundzewicz et al., 2006)

Cyprus in spite of the fact that is characterized by long and frequent dry periods, also suffers from flooding events. As illustrated in Figure 6.48, the frequency of flooding events has increased considerably during the

period 2000-2010 with respect to the period 1970-2000, as 61% of the total flooding events refer to that period.

In addition, the related hazard for each flooding event (ranked very low, low, moderate, high) in terms of adverse consequences for human health, the environment, cultural heritage and economic activity are presented.

Although a minor increase in the precipitation intensity is projected in the future, it is expected that it will further intensify the phenomenon.

### 4. Increase in drought frequency and severity

Droughts affect significantly both the water availability and water quality. In the future period 2021-2050, the impact of droughts will be intensified, since according to the PRECIS results the length of the drought periods is projected to increase up to 12 days/year on average.

In a study of the European Commission (2008) Cyprus is registered among the areas with highest frequencies of droughts in Europe during the period 1976 to 2006, with a large part of its territory being affected whenever droughts occurred (Figure 6.49).

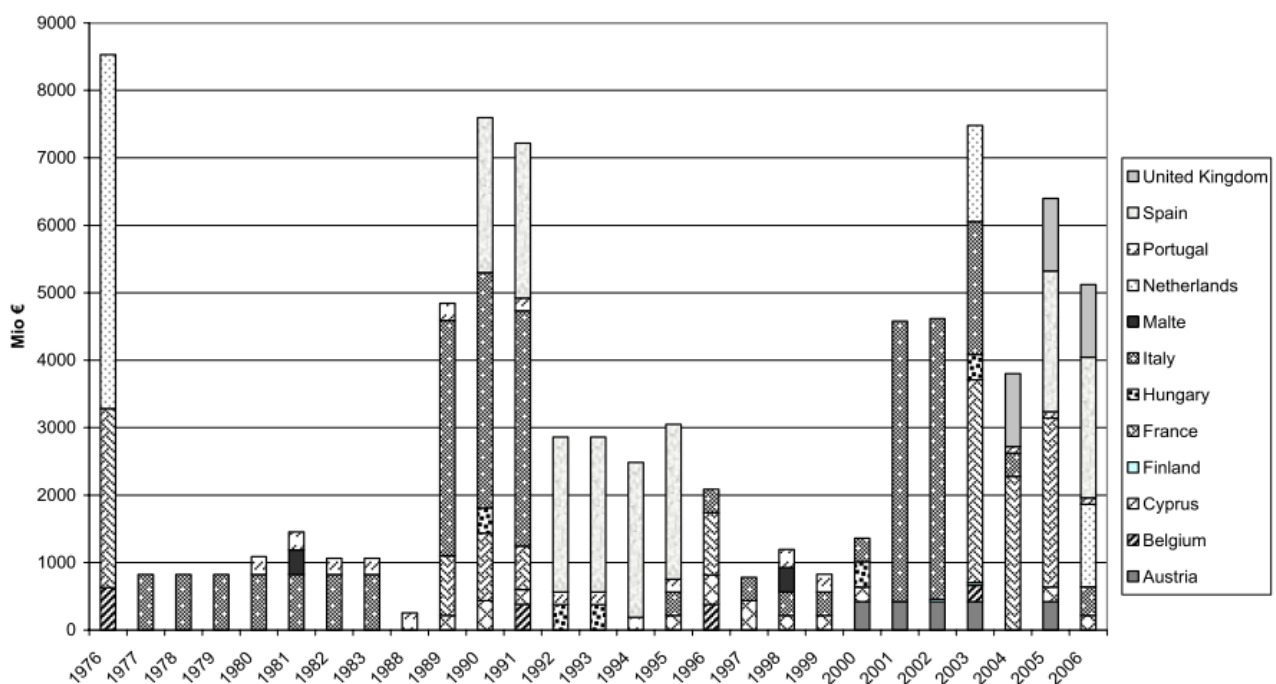
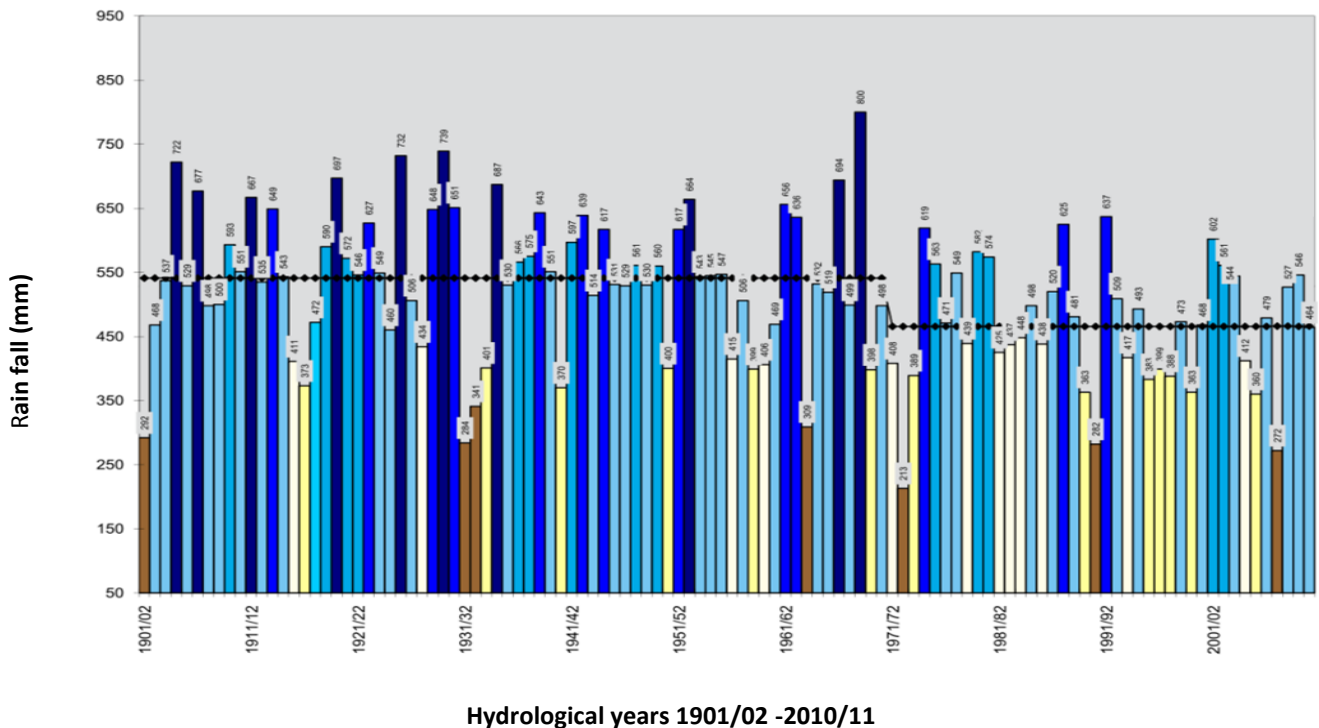


Figure 6.49. Drought impact per year and Member State (1976 – 2006) Source: EC, 2007



- Extreme wet (>130% normal)
- Wet (121-130% normal)
- Above normal (111-120% normal)
- Around normal (91-110% normal)
- Below normal (81-90% normal)
- Drought (71-80% normal)
- Severe drought (<70% normal)
- Average

Figure 6.50. Mean annual precipitation in Cyprus (area under Government control) (WDD)

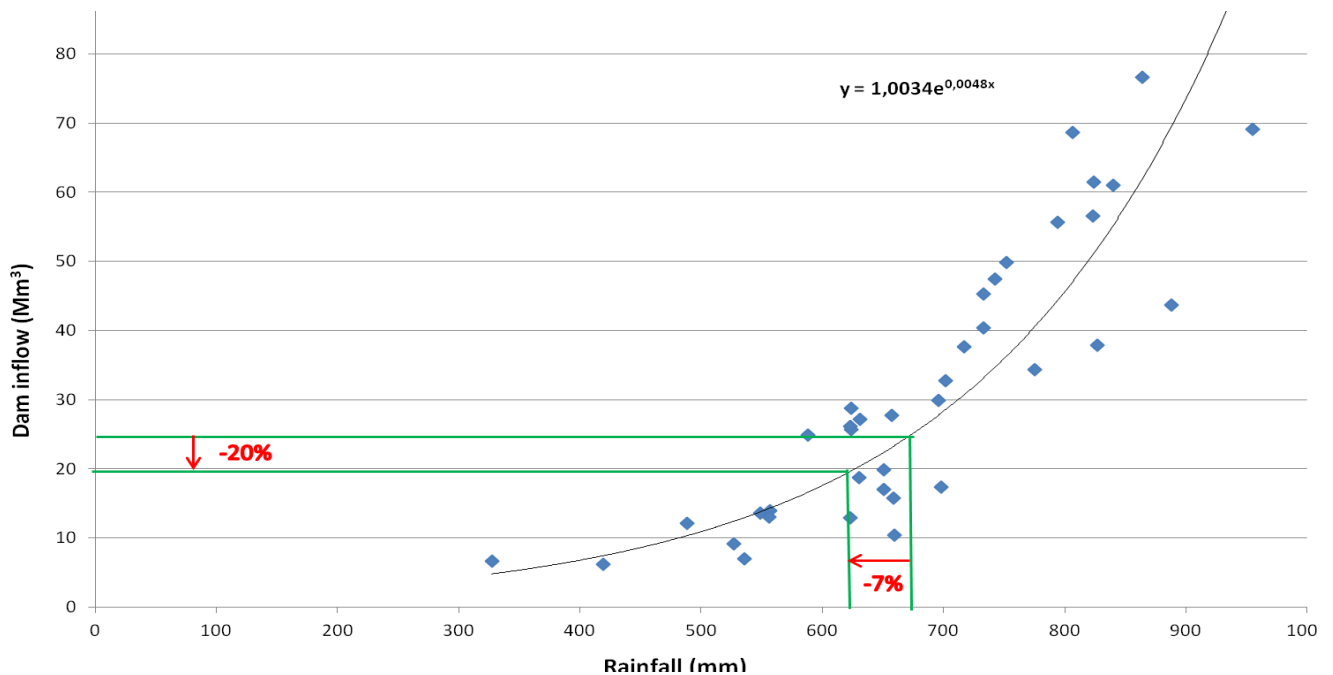


Figure 6.51. Relation between annual precipitation and annual inflow to the catchment area of the Kouris dam for the period (1970-2000)-(2021-2050)

In Cyprus, droughts may last one or several years, the most critical of which was in the summer of 2008, with four consecutive years of low rainfall (EEA, 2010a). As can be seen in Figure 6.50, the years with precipitation above normal appear to decline, while many years with precipitation below normal were observed during the last decade with the year 2007-08 being characterized as a year of severe drought (<70% normal) and 2005-06 as a year of drought (71-80% normal).

## FUTURE VULNERABILITY ASSESSMENT

The future vulnerability of water resources to climate change impacts is assessed in terms of their sensitivity, exposure and adaptive capacity, based on the available quantitative and qualitative data for Cyprus and the climate projections for the period 2021- 2050. The vulnerability is assessed for each of the follow impact categories: 1. Water availability, 2. Water quality, 3. Floods, 4. Droughts.

### 1. Water availability

The sensitivity and exposure of water availability to future climate changes in Cyprus is assessed by the sensitivity of runoff/ dam inflow to changes towards the rainfall and the consequent flow variability, and by the degree of exposure to limited water supply. Additional exposure to pressures, imposed on freshwater resources by non-climatic factors, such as water demand and groundwater overexploitation also increase the vulnerability of the sector.

The relationship between rainfall and dam inflow for the future period 2021-2050, based on PRECIS projections was compared to the respective data for the period 1971-2000. The results showed: i) A decrease of 23% in the future average total dam inflow, although the average precipitation decrease is only 5%. As an example, the above relation for the catchment of the Kouris dam is given in Figure 6.51, and ii) A high variability of dam inflow, indicating so a high sensitivity of Cyprus surface water resources to climate changes. The magnitude of exposure for all the 15 main dams in Cyprus ranges from -35% to +6% in the future period 2021-2050 in comparison with the period 1970-2000.

Table 6.16. List of measures to adapt Cyprus' water management to climate change impacts

Adaptation measures	Implemented	Planned
<b>Measures to increase Fresh water supply</b>		
Reservoirs	X	
Inter-basin water transfer	X	
Artificial recharge of aquifers	X	X
Water import	X	
<b>Diversification of water resources utilisation</b>		
Water reuse	X	X
Desalination		X
Stormwater harvesting		
<b>Measures to decrease water consumption</b>		
Replacement of networks	X	X
Water allocation/cuts	X	X
Use of water meters	X	X
Land consolidation	X	X
Increasing efficiency of irrigation	X	
Control groundwater abstractions		X
Changes in crop patterns	X	
Awareness raising campaigns		
<b>Economic/legal instruments</b>		
Subsidies	X	X
Water pricing	X	X
Over consumption penalties		
<b>Other instruments</b>		
Improving forecasting, monitoring, information -alert system	X	X

In the recent past, the direct climate change effects observed include the diminishing precipitation and increased evapotranspiration with consecutive years of drought, which led to the depletion of surface water stored in reservoirs and the overexploitation of many aquifers especially for the irrigation of the agricultural land. The decreasing trend in ground water levels is expected to continue in future, and given that a large percent of groundwater bodies already being exposed directly or indirectly to climate changes (WDD, 2008, WDD 2011a) the Cyprus' groundwater resources exposure to climate change characterized high.

Freshwater stress, in terms of both quantity and quality, due to the decreased quantity of available freshwater resources will be worst in the future period 2021-2050 in comparison to the period 200-2010 as indicated from the following estimated indicators:

- The estimated current and future Water Stress Indicator per capita (WSI) was  $284 \text{ m}^3/\text{c}/\text{y}$  and  $195 \text{ m}^3/\text{c}/\text{y}$  respectively, both of which are considered very low, indicating that it is not possible for the case of Cyprus to rely exclusively on freshwater resources in the current situation and even more in the future
- The Water Availability Index, WAI is estimated to be approximately -0.26 and -0.1 respectively, indicating that the demand is higher than the availability of freshwater sources and that this inadequacy will be magnified in the future.
- The Water Exploitation Index (WEI) of Cyprus for the year 2007 was 64%, which is by far the highest WEI value among the European countries (EEA, 2010c). A WEI above 20 % implies that a water resource is under stress and values above 40 % indicate severe water stress and clearly unsustainable use of the water resource (Raskin et al. 1997).

Water stress is often related to the deterioration of fresh water resources in terms of both quantity and quality (Hochstrat and Kazner, 2009). Already stressed water resources are considered more vulnerable to climate changes. The difficulty facing Cyprus in order to meet water demand either for satisfying drinking water supply or for other purposes such as agriculture, tourism and industry, due to water stress, indicates the sensitivity of the sector to climate changes.

Following, the indicators used for the quantification of future water stress caused by the decreased quantity of

available freshwater resources in Cyprus are presented. It is noted that, these indicators refer exclusively to the exploitation of freshwater resources, while non-freshwater resources (desalinated water, recycled water) are not taken into account

Already stressed water resources are considered more vulnerable to climate changes. The projected decreased precipitation and increased evapotranspiration due to future temperature increase will affect negatively the water availability, while the increase in demand due to population increase and the rising of living standards added an extra pressure in the already limited freshwater resources.

Taking into consideration the above, water availability is considered to have very high sensitivity and very high exposure to current and future climate changes.

#### Assessment of adaptive capacity

In order to combat this gap, between the increasing demands for water and the reducing water supply, due to the impacts of climate change, several adaptation measures, plans and water works have been implemented or planned by the Government. The Programme of Measures defined in the Cyprus River Basin Management Plan includes inter alia measures which are expected to reinforce Cyprus' adaptive capacity to the decreasing availability of freshwater resources and thus to climate change, are presented in Table 6.16.

Many of the measures adopted have already alleviated the problem of water scarcity. Thus the domestic water supply is continuous with the supplement of desalinated water. As for the future situation is concerned, the sum of the average estimated freshwater and non-freshwater resources for the period 2021-2050 ( $341 \text{ Mm}^3$ ) is expected to fully satisfy future water demand from all sectors. However desalinated water is distributed mainly in the urban centers of Cyprus through Government Water Works (GWW), while other areas, such as the mountain communities, depend solely on freshwater resources (mainly groundwater) for meeting their drinking water needs (WDD, 2009a).

As shown in Figure 6.52, total water use efficiency in Cyprus rose from 65% in 1995 to 82% in 2005-2010,

placing the island among the first two countries as regards water use efficiency (Plan Bleu, 2011).

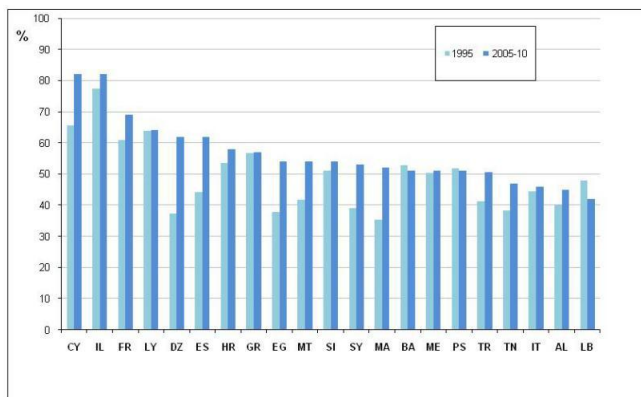


Figure 6.52a. Total water use efficiency in Mediterranean countries (1995, 2005-2010) (Plan Bleu, 2011)

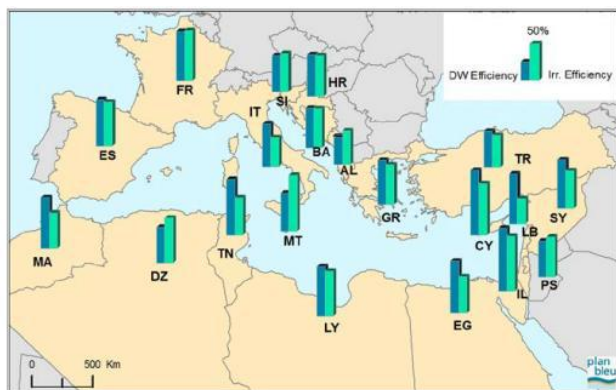


Figure 6.52b. Water use efficiency in drinking water and irrigation sectors in 2010 (Plan Bleu, 2011)

The future adaptive capacity to water availability for domestic water supply in the plain and coastal areas, and in the mountain areas, is considered to be high to very high, and limited to moderate, respectively.

On the other hand, the measures applied have not yet managed to fully satisfy water demand for irrigation as agriculture constitutes the main water consumer in Cyprus. In addition water is not evenly distributed whether it is freshwater or recycled water. In particular, recycled water for irrigation is distributed only in the plain and coastal areas. While the irrigation in mountain areas depends on the water available in the storage reservoirs which are of limited capacity and during drought periods their reserves are depleted, and on private boreholes, thus resulting in the overexploitation of aquifers.

Therefore, the future adaptive capacity of Cyprus to water availability for irrigation in the plain coastal areas

and in the mountain areas is considered as moderate and as limited to moderate, respectively.

Additional recommended adaptation measures (Shoukri and Zachariadis, 2012) that are considered to further enhance adaptive capacity towards this impact, include: Maintenance and repair of the water distribution systems and related infrastructure (adoption of technologies for leakage detection and control), Collection and use of rainwater, Review of the Water Policy etc.

## 2. Water quality

Water bodies in Cyprus are sensitive to eutrophication, stratification and low levels of dissolved oxygen as a result of increased water temperatures and decreased water flows due to reduced precipitation. In addition, heavy precipitation events and flooding adversely affect water quality. The reduction in the recharge rates due to reduced precipitation is more intense in the case of groundwater bodies, thus being more sensitive to climate changes. In addition, coastal aquifers are highly sensitive to salinization due to sea intrusion caused by their over-exploitation.

Considering the above, it was estimated that surface water bodies have moderate to high sensitivity to pollution due to climate changes while groundwater bodies have high to very high sensitivity.

The degree of water quality deterioration is mainly defined by the future climate changes, such as decreased precipitation and increased droughts, the increase in heavy precipitation events, the increase in surface water temperature and the sea level rise in Cyprus as projected in the future (2021-2050).

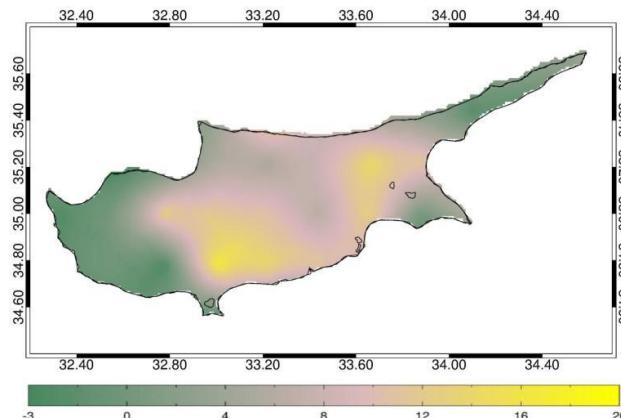
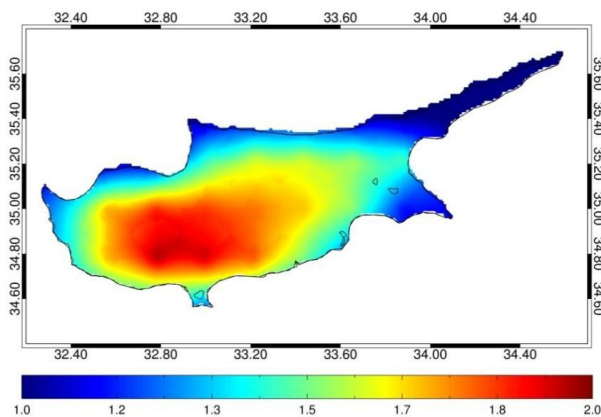


Figure 6.53. Changes in maximum length of dry spell (RR<0.5mm) between the future (2021-2050) and the control period (1961-1990)



**Figure 6.54. Changes in average annual maximum TX between the future (2021-2050) and the control period (1961-1990)**

According to PRECIS the projections in the future period 2021-2050 (Figure 6.54), in brief are: The total annual precipitation will decrease with regional and seasonal variations. The maximum length of drought periods (consecutive days with precipitation < 0.5 mm) is anticipated the central part of Cyprus by 15 days/year in the continental areas and approximately 20 days/year in the eastern part of Troodos mountain. The heavy precipitation events in the future will be without significant changes, as the annual maximum total precipitation over one day (heavy rainfall index) is expected to have a slight increase of about 2-4 mm in western, inland and mountain regions. As for changes in water temperature, these were related to the changes in air temperature. The average change in annual maximum temperature (TX) will range from +1.0°C at the eastern and northern coasts to +2.0°C in higher elevation areas and especially at the southwestern side of Troodos. Sea level changes in Cyprus are not expected to be significant.

The exposure of the quality of water bodies in Cyprus (which, are already in bad qualitative condition) are considered more vulnerable to climate change impacts

Based on the results of the monitoring program of Cyprus' water bodies, within the implementation of the Water Frame Directive the qualitative status of the water bodies is as follows:

a) Surface water bodies: The majority of river and lake bodies of Cyprus were classified in a good or moderate ecological and chemical status (Source: WDD (7) and (8)) and all the 25 coastal water bodies were found in good or high ecological status or good ecological potential (Fisheries Department), and in good chemical status (WDD, 2011a). Furthermore, two surface water areas, in which direct or indirect

disposal of urban waste water takes place, have been identified as sensitive and the surface waters with the greater relative pollution potential and thus most vulnerable are located in the central and north-western part of Cyprus (WDD, 2011a; PigWasteMan, 2007). Considering the above, it is estimated that the exposure of surface water bodies to pollution is limited to moderate.

b) Groundwater bodies: The main causes of groundwater bodies' pollution in Cyprus are agriculture, seawater intrusion, wastewater disposal and certain geological formations. From the monitoring of the 19 groundwater bodies during the period 2000-2008, 8 groundwater bodies (42%) were characterized according to the Water Framework Directive as in bad qualitative condition, based on the results of chemical analysis in the salinity levels and/or the levels of pollutants present in the groundwater bodies. In other words, the quality of groundwater bodies can be characterized as moderate to bad. Taking into account the above, the exposure of the groundwater bodies in Cyprus to deterioration of their quality is characterized as high to very high.

#### Assessment of adaptive capacity

To protect freshwater from pollution, a wide range of legislation which has been established in Europe, most notably the Water Framework Directive (WFD), is implemented in Cyprus.

The Programme of Measures defined in the annual report of the Cyprus River Basin Management Plan (WDD, 2011a – Annex III) includes the establishment of regulations or basic measures that should be implemented in order to achieve the objectives set out for 2015. Protected areas, Protection from point source discharges likely to cause pollution to water, Protection of groundwater bodies from salinization.

The legislation of the Cypriot Government referred as "Water Pollution Control Laws 2002- 2009" is the main tool with which all issues related to water pollution control from industrial and other activities are regulated.

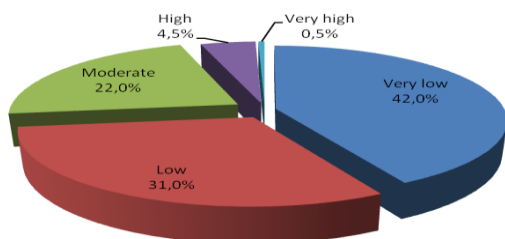
Furthermore, aiming for compliance with the Urban Wastewater Treatment Directive (91/271/EEC) requirements, the wastewater collection and treatment infrastructure is being significantly expanded and upgraded.

The water policy of Cyprus on the salinization of groundwater bodies is based mainly on the prevention of seawater intrusion with the achievement of a positive balance between the abstractions and recharge, by setting proposed volumes of abstraction for each of its aquifers according to their quantitative condition. Furthermore, the measures foreseen for the achievement of a good chemical status of Cyprus groundwater bodies until 2015, in compliance with the Water Framework Directive, also contribute to this direction.

Consequently, it was estimated that the future adaptive capacity of water quality to climate changes is moderate for the case of surface water and limited to moderate for groundwater.

### 3. Floods

The climate projection model used for the case of Cyprus does not provide estimates for the frequency and intensity of floods in the future. Nevertheless, the annual maximum total precipitation over one day indicating heavy rainfall, which could also be associated with flood risk, will be not significantly changed, as projected the PRECIS model for the future period (2021-2050).



**Figure 6.55. Hazard ranking of flooding events during the period 1859-2011**

According to the Water Development Department (WDD), the recorded floods in Cyprus for the period 1859-2011 are characterized as urban floods (37%), flash floods (20%), river or fluvial floods (16%), pluvial floods (13%), or a combination of the above (WDD, 2011d). The distribution of floods according to their flood hazard in Cyprus in terms of adverse consequences for human health, environment, cultural heritage and economic activity for this period is presented in Figure 6.55.

The current vulnerability of Cyprus regarding flooding events will worsen with climate changes (WDD, 2011d).

The urban centers are sensitive to flood risks mainly due to their dense structuring and the restriction of green

space, the elimination of natural waterways for the construction of roads, the deficient or even absent stormwater drainage system and the covering of waterways and drain entrances with garbage. On the other hand, mountain areas are less sensitive to floods, given that the inclination of terrain together with the infiltration capacity of forested areas do not allow for flooding events to take place.

This is also indicated in the “Preliminary Flood Risk Assessment” report (prepared by WDD for the compliance with the Floods Directive 2007/60/EC), where 19 areas around the island identified as “Areas with Potential Significant Flood Risk”. They mainly refer to river parts that pass through built-up areas and are characterized by frequent and significant flash floods.

To sum up, it is considered that the exposure to floods of the mountain areas of Cyprus is expected to be moderate while the exposure of urban areas is considered to be limited.

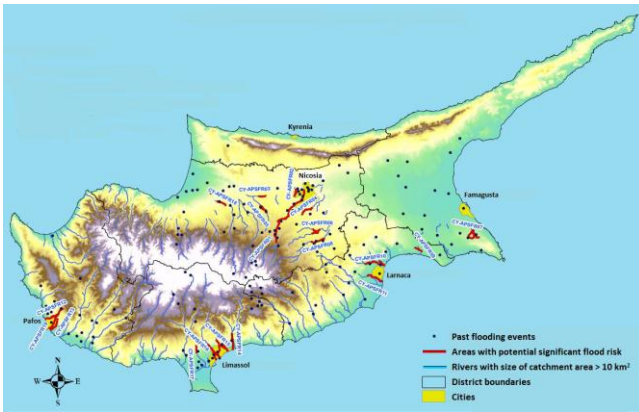
#### Assessment of adaptive capacity

Cyprus’ adaptive capacity to the increasing frequency and intensity of flooding events can be estimated by the existing flood protection works and the river protection zones as well as by the projected plans for the management of future flood risks. The last two decades, a separate drainage system is being developed in Cyprus in order to collect storm water.

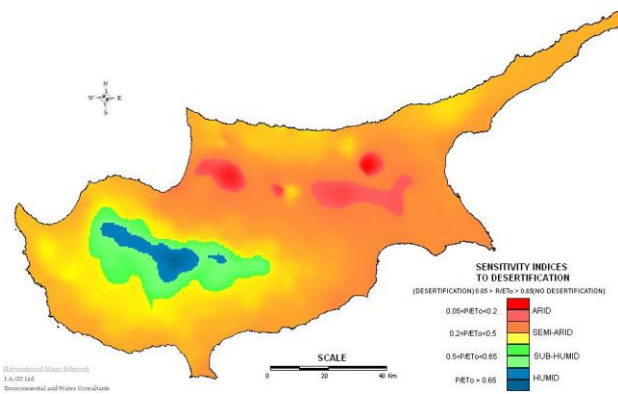
In addition, it must be mentioned storage reservoirs act as a flood control measure as the water is impounded in the dam and its downstream release is regulated even in the case of an overflow.

The Law 70(I)2010 on the Flood Risk Assessment, Management and Preparedness, which harmonizes the Floods Directive 2007/60/EC with the Cypriot legislative framework states that Flood Hazard maps and Flood Risk maps must be prepared by the end of 2013, while Flood Risk Management Plans must be prepared by the end of 2015.

Considering the above, the adaptive capacity of Cyprus to urban floods is estimated as moderate.



**Figure 6.56. Areas with potential significant flood risk in Cyprus**  
Source: WDD (10)



**Figure 6.57. Environmentally Sensitive Areas to Desertification (IACO Ltd, 2007)**

In addition, the adaptive capacity of mountain areas to floods is estimated by their inherent ability to absorb water due to the high infiltration capacity of vegetated areas and thus to prevent flooding. Thus the adaptive capacity of mountain areas to floods in mountain areas is considered high.

The maintenance and restoration of wetlands and riverbeds as natural defense against floods constitute an additional recommended adaptation measure that is considered to further enhance adaptive capacity towards this impact.

#### 4. Droughts

Cyprus with very limited water resources is vulnerable to droughts as it has exploited most of all its natural water resources, with most of its aquifers depleted, and no perennial rivers. In order to estimate the sensitivity to droughts in Cyprus, the Department of Environment in 2007 has assigned to I.A.C.O. Ltd to define the areas threatened by desertification, by analyzing factors and

processes leading to desertification and propose corrective measures. As shown in Figure 6.57 the 91% of the total area of Cyprus was characterized as critical or sensitive.

With the use of PRECIS regional climate model, the future changes (2021-2050) in the maximum length of the period with consecutive dry days (precipitation < 0.5mm) per year will be increased by 10-12 days in comparison to the control period 1961-1990.

Consequently, the future exposure of Cyprus to droughts mainly is expected to be very high.

#### Assessment of adaptive capacity

Drought management is an essential element of water resources policy and strategies in EU but especially in drought prone areas, such as Cyprus. The Cyprus Drought Management Plan (DMP) has been prepared according to the guidelines of the European Commission (EC, 2008) Drought Management Plans (DMP), aiming to minimize the adverse impacts on the economy, social life and environment when drought appears.

Furthermore, it focuses on developing comprehensive, long-term drought preparedness policies and plans of actions that place emphasis on monitoring and managing emerging stress conditions and other hazards associated with climate variability in order to significantly reduce the risks and vulnerabilities to extreme weather events (WDD, 2011a).

Cyprus has considerably increased its adaptive capacity in coping with drought by adopting the EU guidelines on water and drought management. However, the Cyprus DMP and its Water Policy have recently implemented and have yet to be tested to prove their efficiency in achieving the abovementioned goals. For these reasons, Cyprus future adaptive capacity to droughts is considered moderate.

#### ASSESSMENT OF OVERALL FUTURE VULNERABILITY

The overall future vulnerability of forests to climate changes, in terms of sensitivity, exposure, adaptive capacity is presented in Table 6.17.



Table 6.17. Overall future vulnerability assessment of the water resources in Cyprus to climate changes

Impact		Sensitivity	Exposure	Adaptive Capacity	Vulnerability
<b>Water availability for domestic water supply</b>	in urban areas	Very high (7)	Very high (7)	High to Very high (6)	Limited (1)
	in mountain areas	Very high (7)	Very high (7)	Limited to Moderate (2)	High (5)
<b>Water availability for irrigation</b>	in plain & coastal areas	Very high (7)	Very high (7)	Moderate (3)	Moderate to High (4)
	in mountain areas	Very high (7)	Very high (7)	Limited to Moderate (2)	High (5)
<b>Water quality</b>	of surface water bodies	Moderate to High (4)	Limited to Moderate (2)	Moderate (3)	None (-0.2)
	of groundwater bodies	High to Very high (6)	High to Very high (6)	Limited to Moderate (2)	Moderate to High (4)
<b>Floods</b>	in urban areas	Moderate to High (4)	Limited (1)	Moderate (3)	None (-1)
	in mountain areas	Limited (1)	Moderate (3)	High (5)	None (-3.3)
<b>Droughts</b>		Very high (7)	Very high (7)	Moderate (3)	Moderate to High (4)

As it can be seen from the table above, the main vulnerability for the water sector in Cyprus is related to the water availability for domestic water supply and irrigation in mountain areas. Water supply in mountain areas characterized by very high sensitivity and exposure to climate changes, while they have low adaptive capacity to cope with these changes mainly due to the insufficiency of government water works attributed to techno-economic reasons.

The other important vulnerabilities of the sector are related to the water availability for irrigation in plain and coastal areas, the groundwater quality and droughts. Additional adaptation measures are requested in order to eliminate all adverse consequences.

## 6.4. ACTIONS FOR ADAPTATION TO CLIMATE CHANGE

### 6.4.1. NATIONAL LEVEL ACTIONS

Cyprus is formulating its climate policy within the framework of the of the United Nations Framework Convention on Climate Change (UNFCCC) and related policies as well as the relevant legislation set by the European Community (EC).

Climate change will continue to affect all sectors of society and the environment at all scales, ranging from

the global and continental to the national and local. Adaptation to climate change is increasingly on the policy agenda in Europe and internationally and has been recently promoted as an action to anticipate the adverse effects of climate change. Adapting to these changes is one of the most fundamental challenges. It has been shown that well planned, early adaptation action saves money and lives later.

Apart from the recently established European adaptation policy in April 2013, sectoral or case specific policies that also address climate change impacts, such as the Water Framework Directive, Floods Directive, Agricultural Policy, Cohesion Policy, Rural Development et al have been transposed into the national legislation and are implemented. The measures reviewed are in the form of policy plans, strategies, legislative actions, guidelines, economic incentives, knowledge dissemination activities or research.

In this context and spirit, Cyprus has initiated two main actions, concerning the development of its national adaptation strategy and the related national adaptation platform.

### NATIONAL ADAPTATION STRATEGY

The strategy's objective is to reinforce and increase the adaptive capacity of the society and the environment of Cyprus, by taking appropriate measures to prevent or

minimize the negative impacts and the damage they can cause, while taking advantage of opportunities that may arise.

Furthermore, this strategy will provide a holistic framework which intends to help the decision-makers, stakeholders and citizens to respond successfully to climate change risks and assess the potential cross-sectional impacts of, and the vulnerability to, climate change and how it might be reduced by various cost-effective adaptation options

The development of Cyprus National Adaptation Strategy to Climate Change is being implemented by means of the CYPADAPT project under co-finance of the European Union through the financial instrument for the Environment (LIFE+). The CYPADAPT project started in September 2011 and is to be completed in March 2014.

The strategy beside the detailed analysis of observed and potential impacts and their vulnerabilities, will also propose adaptation measures that should be taken immediately, as well as policies for future actions, for different sectors of economy. The selected sectors of importance in which climate change is significant for Cyprus are the following: Water resources, Agriculture, Coastal zones, Tourism, Biodiversity, Energy, Fisheries and Aquaculture, Soils, Forests, Public Health and Infrastructure.

The various applied and potential adaptation options and measures identified during the CYPADAPT project, aiming at reinforcing the adaptive capacity of the individual sectors in Cyprus to the adverse climate change impacts. They were reviewed and evaluated on the basis of their effectiveness, viability and their contribution to climate change adaptation. These measures are of different character, ranging from policy plans, strategies, legislative actions, guidelines, economic incentives to new infrastructure, knowledge dissemination activities or research. In order to prioritize them and facilitate the choice of the most appropriate options for implementation per sector, a Multi-criteria analysis (MCA) tool was also developed. The outcome of this evaluation will be subject to public consultation before being finalized and used for the elaboration of the National Adaptation Plan for Cyprus.

A draft list of categories /types of the referred adaptation measures are listed below per selected socioeconomic sector, including also those that are already applied and

need further enhancement, as well as the measure categories that may not address climate change impacts directly or those that may not have been developed for this purpose, but are contributing towards this direction.

#### Water

- Measures to increase water availability
- Measures for the diversification of water resources utilisation
- Measures to decrease water demand
- Measure to protect water quality
- Measures for the protection from floods
- Measure for the protection from droughts in water sector

#### Agriculture

- Measures to reduce risk of crops due to drought and water scarcity
- Measures to increase soil fertility
- Measures to reduce risk of reduced crop productivity
- Measures to reduce increased agricultural pests, diseases, weeds
- Measures to reduce risk for livestock
- Measures to reduce risk of extreme weather events

#### Soil Resources

- Measures to improve soil moisture
- Measures to face landslides
- Measures to improve soil fertility
- Measures to reduce soil contamination
- Measures to reduce soil salinization

#### Fisheries and Aquaculture

- Measures for strengthening the capacity of fishermen
- Measures for the diversification of aquaculture

#### Forestry

- Measures against forest fires
- Measures against insects attacks and diseases
- Measures against biodiversity loss
- Measures against dieback of tree species
- General measure to protect forests
- Storage of genetic propagation material in forest nurseries

#### Biodiversity (indicative measures)

- Provision of subsidies for the development of organic agricultural products
- Providing support for the conservation of natural habitats and wildlife

- Provision of subsidies for afforestation of non-agricultural land
- Measures to enhance biodiversity and ecological function of forests
- Apply cross-compliance measures
- Horizontal integration of ecosystem based adaptation to other policies
- Marine ecosystems: Funding scheme for investments on board fishing vessels
- Marine ecosystems: Funding scheme for productive investments in aquaculture
- Construction of fishing ports, landing sites and shelters
- Promote research on biodiversity and ecosystems
- Protection and management of salt lakes and of other wetlands
- Protection of biodiversity through Fisheries Policy: withdrawal of trawlers
- Maintain or strengthen ecological coherence
- Monitoring and control of non-indigenous species into / from Cyprus
- Creation of an inventory of species populations, distribution and genetics
- Enhance/strengthen the Seed Bank and Ex situ conservation
- Prepare and implement a Strategic Plan on Biodiversity
- Preparation of Management Plans for all areas of the environment protection network "NATURA 2000"
- Management plans for the protection of priority /threatened species
- Monitoring of highly sensitive species as indicators of climate change
- Avoid planting and releasing of alien animal species
- Protection of coastal and marine ecosystems from invasive species
- Restoration of damaged ecosystems

#### Public Health

- Measures to prevent heat mortality and morbidity
- Measures to control food – borne and water-borne diseases
- Measures to control human health risk from natural hazards
- Measures to control air-pollution related diseases
- Measures for the protection from infectious diseases

#### Tourism

- Measures against decreased tourism during summer months

- Measures against coastal erosion
- Measures against deterioration of biodiversity attractions
- Measures against heat waves
- Measures against storms, waves and floods
- Measures against risk of drought and water scarcity

#### Coastal Zones

- Measures to reduce risk from coastal storm flooding and inundation
- Measures to control coastal erosion
- General measure to improve coastal zones

#### Energy

- Measures for increasing energy supply
- Measures to reduce energy demand

#### Infrastructure

- Measures against damage in infrastructure due to flood and landslides

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### NATIONAL ADAPTATION PLATFORM

This initiative, which is at the early stages of its development aims to support Cyprus in adapting to climate change. It is a knowledge base and communication platform for adaptation and will be linked to the European adaptation platform the (CLIMATE-ADAPT) and other platforms. The potential users, government, local authorities, universities, research institutions, NGO's and other stakeholders and citizens, will access and share information and views on many different issues concerning adaptation options, climate impacts on, and vulnerability of, regions and sectors, case studies, research activities, legislation, financing opportunities, tools for adaptation planning, useful links and others

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#### 6.4.2. EU LEVEL ACTIONS

A consensus is emerging amongst a wide range of policy-makers and stakeholders that climate change is an increasingly important strategic, economic and political concern. A solid framework for promoting and enhancing climate change action is being systematically constructed during the last decades with the UN and EC being the pioneers in this field. Climate change mitigation policies and goals have been developed and set at European and international level, while climate change adaptation

policies, strategies, action plans and other tools are being progressively promoted in recent years.

These tools set goals for the future and seek to ensure that climate change adaptation will be taken into consideration when developing new policies while only a few of them have led to their actual enactment through legislation. For example the Water Framework Directive, the Floods Directive, the New Agricultural Policy and the Marine Strategy Framework Directive, foresee inter alia the implementation of several measures that are considered to contribute towards climate change adaptation.

Adaptation to the adverse effects of global warming is however complementary to mitigation measures and necessary to anticipate the significant impacts of current and future climate change and to reduce the vulnerability of natural and human systems.

The role of the EU is seen as supporting and strengthening actions taken at other levels of governance (national, regional and local) by establishing coordination and dissemination mechanisms for knowledge transfer to improve the effectiveness of adaptation and to ensure solidarity amongst Member states.

## THE EU POLICY CONTEXT

### Green Paper

The increasingly extreme weather phenomena taking place in Europe as well, such as heat waves, floods and forest fires focus the attention to the need to reduce the risks from harmful global warming impacts by defining Europe's adaptation policy framework.

Thus, in June 2007, the European Commission adopted the Green Paper "Adapting to climate change in Europe – options for EU action" (COM(2007)354 ) proposing several options for action to deal with the effects of climate change. The green paper defined adaptation as "the actions being taken to cope with or anticipate to a changing climate and to reduce the risk and damage from current and future harmful impacts cost-effectively or exploited potential benefits". Adaptation applies to natural as well as to human systems.

The Green Paper looks at the impacts of climate change effects on both natural human systems, in several

European regions and attempts to specify the possible adaptation actions to be taken at European level, while recognizing that cooperation with member states and regions will be essential.

### White Paper

Two years later in April 2009, and building on the wide-ranging public consultation and the amazing research taken, the European Commission introduced the White Paper on 'Adapting to climate change: Towards a European framework for action' (E C 2009). This is a key policy document for climate adaptation at the EU level. This White Paper pointed out that climate change requires two types of response: mitigation actions to reduce the greenhouse gas emissions in order to keep the increase in the global average temperature below 2o C and, adaptation actions to deal with the unavoidable impacts of the greenhouse effects. Bearing in mind the time which is needed for our planet's recovery from the accumulated gases, despite the reduction of gas emissions.

The objective of the EU's Adaptation Framework is to improve the EU's resilience to deal with the impact of climate change, with respect to the principle of subsidiarity and, to support overarching EU objectives on sustainable development

This document provides the framework for MS to promote strategies to increase the resilience to, and to reduce the vulnerability to the impacts of, climate change at local, national and at EU level. Furthermore is a valuable tool in designing and implementing plans to adverse impacts of the changing climate, by choosing the best solutions to the benefit of their citizens.

The EU's framework adopted a two- phases approach for both the preparation of a comprehensive EU adaptation strategy (Phase 1, 2009-2012) and its implementation during phase 2, commencing in 2013.

Phase 1 (2009-2012) focused on four pillars of action: 1) building a solid knowledge base on the impact and consequences of climate change for the EU, 2) integrating adaptation into EU key policy areas; 3) employing a combination of policy instruments (market-based instruments, guidelines, public-private partnerships) to ensure effective delivery of adaptation and 4) stepping up international cooperation on adaptation.

## The Climate-ADAPT

The European climate adaptation platform Climate-ADAPT launched in March 2012 aiming to address knowledge gaps and support Europe in adapting to climate change. This is the advanced form of the adaptation clearinghouse mechanism, as the White Papers' targets created in collaboration with the European Environment Agency (EEA).

Is not just a solid knowledge base on the impact and consequences of climate change for the EU or a database for projects and case studies that can be selectively consulted (e.g. for similar risks or sectors). It provides several useful resources to support adaptation policy and decision making, such as a toolset for adaptation planning; vulnerability of regions and sectors, expected climate change and impacts, information on adaptation action at all levels, financing opportunities; and other useful information. It proved to be also, a reference for many other adaptation knowledge platforms worldwide and is linked with the relative Member States national platforms.

## THE EU STRATEGY ON ADAPTATION TO CLIMATE CHANGE

The EU Strategy on Adaptation to Climate Change, adopted by the Commission in April 2013, aims at contributing to a more climate resilient Europe. The strategy is enhancing the preparedness and capacity to respond to the impacts of climate change at local, regional, national and EU level and offers a coherent integrated approach and improved coordination. Furthermore supports and promotes greater cooperation and information-sharing between Member States, while ensuring that adaptation considerations are addressed in all relevant EU policies.

The strategy sets out the framework and mechanisms that encourage Member States to revise or develop and implement their national adaptation strategies, to speed up the EU's preparedness for current and future climate impacts to a new level and meet the challenges for territorial development in Europe. The main characteristics of the EU's Adaptation Strategy are the strong emphasis given on low-cost and good for the economy adaptation options, the promotion of

sustainable growth, the stimulation of climate-resilient investment and the creation of new jobs.

The EU Adaptation Strategy focuses on three key objectives:

- Promoting action by Member States: The Commission supports the adoption of comprehensive adaptation strategies at the local, regional, national, level, due to the varying severity and nature of climate impacts, the different ability to cope and adapt across populations, economic sectors and regions within Europe. Furthermore, it will provide funding under various schemes to help Member States to build up their adaptation capacities and take action in specific areas too.
- 'Climate-proofing' action at EU level : Ensuring the sustainability of investments by further promoting adaptation in key vulnerable sectors such as agriculture, fisheries and cohesion policy, ensuring that Europe's infrastructure is made more resilient, and promoting the use of insurance against natural and man-made disasters.
- Better informed decision-making by addressing gaps in knowledge about adaptation and further developing the European climate adaptation platform (Climate-ADAPT) as the 'one-stop shop' for adaptation information in Europe.

## OTHER EU ADAPTATION ACTIONS

It is apparent that adaptation is long and continuous process and EU is determined to support and coordinate national adaptation efforts and international ensuring that there are adequate resources for efficient and cost-effective adaptation action.

EU adaptation actions include also mainstreaming of climate change, both mitigation and adaptation, into other sector policies and funds, such as marine and inland water, forestry, agriculture, biodiversity, cohesion policy, rural development, infrastructure and buildings, but also migration, disaster management and social issues.

The EU is providing guidelines on integrating climate into policies and investments and on how to use the instruments and funds provided by the Commission for climate change adaptation. For instance, the EU-Cities Adapt (which is an EU initiative to train and exchange

knowledge among stakeholders at city level) and the Covenant of Mayors (which is the mainstream European movement involving local and regional authorities, voluntarily committing to increase energy efficiency).

Research and development on climate change adaptation has been financed through the FP7 programme and will be now funded by the Horizon 2020 (the new financial instrument that combines all research and innovation funding). In addition the Life+ financial instrument will extend funding on adaptation issues.

The Joint Research Centre's (JRC) Institute for Prospective Technological Studies (IPTS) based in Seville and the Institute for Environment and Sustainability (IES) in Ispra continue to provide research knowledge on climate change impacts, adaptation and mitigation.

The European Environment Agency also has a significant role in carrying out extensive EC-funded research on climate change in recent years, such the key reports: Adaptation in Europe - Addressing risks and opportunities from climate change in the context of socio-economic developments (2013), Climate change, impacts and vulnerability in Europe (2012), Adapting to climate change - SOER 2010 thematic assessment (2010), Impacts of Europe's changing climate - 2008 indicator-based assessment (2008), Vulnerability and adaptation to climate change in Europe (2005) et.al.

#### **Green Paper on the “Insurance of natural and man-made disasters”**

In addition to the above, a related measure adopted by the Commission recently, is the Green Paper on “Insurance of natural and man-made disasters”. The Green Paper on Disasters poses a number of questions concerning the adequacy and availability of appropriate disaster insurance. The objective is to raise risk awareness, mainstream disaster-proofing in economic and financial decisions and to assess the need for action.

Like many other regions of the world, the European Union and in particular the Mediterranean basin, are vulnerable to nearly all types of natural disasters, with many human losses and damages of billions of euros every year, affecting economic stability and growth. Disasters may also have cross-border effects and can potentially threaten entire areas in neighbouring countries. The responses received, through public consultation, are being examined for deciding on the

most appropriate follow-up and which legislative and non-legislative forms are the most effective.

#### **Green Paper “A framework for EU on climate and energy towards 2030”**

The European Commission on 27th of March 2013 took the first step towards developing a 2030 framework for EU climate change and energy policies and succeeding a low-carbon society for 2050.

The Green Paper is expected to be launched by the end of this year, when the evaluation of all responses and views expressed by the various stakeholders, is completed.

The Green Paper on a 2030 framework for EU climate change and energy policies raises the issues of the climate and energy targets that should be set for 2030, the competitiveness of EU's energy system, the coherence between different policy instruments etc.

## 7. FINANCIAL RESOURCES AND TRANSFER OF TECHNOLOGY

### 7.1. INTRODUCTION

Cyprus was a non-Annex I party to the UNFCCC until 1/1/2013 and a non-Annex B party to the Kyoto Protocol. Consequently, Cyprus had no obligations to allocate financial resources for assistance to developing country parties that are particularly vulnerable to climate change. Nevertheless, in 2009, along with the rest of the member states of the EU, Cyprus committed to provide finance for climate change to developing countries.

### 7.2. PROVISION OF NEW AND ADDITIONAL RESOURCES

CyprusAid is the Development Cooperation Service of the Republic of Cyprus, established in its current form by the Council of Ministers in 2005. CyprusAid functions within the framework of a policy making mechanism that has been put in place in order to steer Cyprus' Official Development Assistance. This policy mechanism is one that retains a high degree of centralisation in the decision making process, while at the same time allows for a more decentralized approach in the aid delivery arrangements. The mechanism comprises of a Coordination Body (CB) headed by the Minister of Foreign Affairs and having the Minister of Finance and the Permanent Secretary of the Planning Bureau as members. The CB is responsible for the setting of targets (quantitative, territorial and sectoral) on the basis of international obligations, EU policy recommendations and national priorities. The Planning Bureau is responsible for the preparation of policy preparation, as well as the management and implementation of the decisions of the CB while the MFA is responsible for representing the Republic abroad and also for publicizing the Republic of Cyprus ODA activities. A second body, headed by the Permanent Secretary of the Ministry of Foreign Affairs (MFA) and comprised of representatives of the Ministries of Finance, Commerce, Industry and Tourism, Agriculture, Natural Resources and Environment, Labour and Social Insurance, Education and Culture and the Planning Bureau, as well as representatives of civil society, acts in a consultative capacity to the Coordination Body.

According to the relevant EU ministerial decision and the necessary decision from the national council of ministers,

Cyprus was going to provide €1.8 million as fast start finance. The amount was new and additional. The €1.8 million were going to be given in three years 2010-2011-2012, €0.6 million annually.

Funding was provided for the years 2010 and 2012.

### 7.3. ASSISTANCE TO DEVELOPING COUNTRY PARTIES THAT ARE PARTICULARLY VULNERABLE TO CLIMATE CHANGE

CyprusAid after studying options funds and organizations implementing projects on climate change, and with the consent of the Ministry of Finance promoted cooperation with the "Global Climate Change Alliance-GCCA", a funding mechanism coordinated by the European Commission. This mechanism acts as an intermediary / coordinator for contributions and projects to tackle climate change. The choice of "GCCA" as a means of disposing of contribution of Cyprus based on that provides recognition to donors. Furthermore, the "GCCA" is an initiative of the European Commission and the substantial and political support of Member States in this, strengthens and makes this mechanism valuable in the international arena on climate change. Moreover, GCCA focuses climate support on LDCs and SIDS.

#### 7.3.1. FUNDING PROVIDED IN 2010

Project name: "Building Climate Resilience in Nepal"

The estimated costs of the project amounted to €19,400,000 (European Union: €8,000,000, Development Cooperation Service of the United Kingdom €10,800,000 and Cyprus €600,000). The project is implemented by the method of award of centralized management to the local office of the Office for Development Cooperation of the United Kingdom in Nepal.

The main objectives of the project are: (a) the development of an administrative infrastructure in Nepal, both at national and local level to enable the implementation of the National Adaptation Programme of Nepal to climate change and (b) promote the integration policy on climate change programs and projects of the government at national and local level and develop mechanisms to promote initiatives for climate adaptation.

The institutionalization of cooperation has been the signing of a Credit "Transfer Agreement" between the Cyprus and the European Union represented by the European Commission.

### 7.3.2. FUNDING PROVIDED IN 2012

Project name: "Climate Change Adaptation and Sustainable Land Management in the Eastern Caribbean"

For 2012 the Planning Bureau has negotiated a Credit "Transfer Agreement", for funding the project in the Caribbean (Antigua & Barbuda, Dominica, Grenada, Saint Lucia, St. Christopher (St. Kitts) & Nevis St. Vincent, Grenadines, Montserrat, British Virgin Islands, Anguilla).

This project was funded by the European Commission with a contribution of €10,000,000 and the Republic of Cyprus with a contribution of €600,000.

The overall project objective was to contribute to the implementation of the provisions laid down in Article 24 of the Revised Treaty of Basseterre, which makes reference to implementation by each State Party "St. George Declaration" on the Declaration of Principles for Environmental Sustainability, which aims, among others, to achieve long-term conservation and sustainable productivity of the region's natural resources and the ecosystem.

The immediate goal of the project is to improve the resilience of the natural resources base in the region to the impacts of climate change through: (a) promoting efficient and sustainable practices and frameworks of land management and (b) promoting concrete pilot projects in order to adapt the field ( especially in terms of land management ) to climate change.

### 7.4. ACTIVITIES RELATED TO TRANSFER OF TECHNOLOGY

No activities related to transfer of technology have been implemented.



## 8. RESEARCH AND SYSTEMIC OBSERVATION

### 8.1. INTRODUCTION

Until the early nineties, research activities in Cyprus were quite limited, not only by international standards, but also in relation to the comparatively high level of development of the Cyprus economy. Despite the high educational level of the population, the absence of a local University impeded the development of research. In addition, the small size of enterprises also acted as a serious constraint to the development of research activity in Cyprus.

Apart from the establishment of the University of Cyprus in 1992, several steps have been taken towards the upgrading of research activities. The most significant ones are:

- the establishment of the Research Promotion Foundation in 1996. RPF is a non-profit organisation established by the Government with the mission to develop, implement and manage all national research programmes.
- the expansion of research activities of internationally recognised research organisations of Cyprus, namely, the Institute of Neurology and Genetics, the Agricultural Research Institute and the State General Laboratory.
- the establishment of Cyprus University of Technology in September 2007, and of the Cyprus Institute in September 2007
- the establishment of the new research institutions, the 3 biggest private colleges of Cyprus upgraded into Universities in 2007.

## 8.2. GENERAL POLICY ON AND FUNDING OF RESEARCH AND SYSTEMATIC OBSERVATION

### 8.2.1. INSTITUTIONAL MAPPING, ACTORS AND ROLES AND RESPONSIBILITIES<sup>20</sup>

At political level, the National Council for Research and Innovation (NCRI) and the Cyprus Scientific Council (CSC), are the main bodies responsible for strategy and planning. The NCRI has exclusive responsibility for the adoption of long-term strategies in research and innovation, while the CSC constitutes the advisory scientific board to the government.

The **Planning Bureau** is the Government agency engaged in the formulation of strategy, the identification of objectives and the introduction of policy measures aiming at the promotion of research activities in Cyprus. It's also represents Cyprus in a number of EU fora for research policy. The Planning Bureau, in collaboration with the **Ministry of Finance**, provides direct financing for research initiatives undertaken by the state research institutions / departments, through the annual Development Budget of the Republic. The Planning Bureau coordinates the programming and implementation of European Structural and investment funds while allocation science and research issues form a part of its portfolio

The **Research Promotion Foundation (RPF)** is responsible for policy implementation. It was established in 1996 in order to channel the public funds for research. Its Board of Directors is chaired by the Permanent Secretary of the Planning Bureau. The RPF is responsible for establishing the network of National Contact Points for Cyprus' participation in the EU Framework Programmes. Thus it provides assistance to applicants for research funding and implements international agreements in S&T.

**The National Research Council (NRC)** is formed as the highest-level organisation with exclusive responsibility for adopting long-term strategies in research and innovation. The Council is chaired by the President of the

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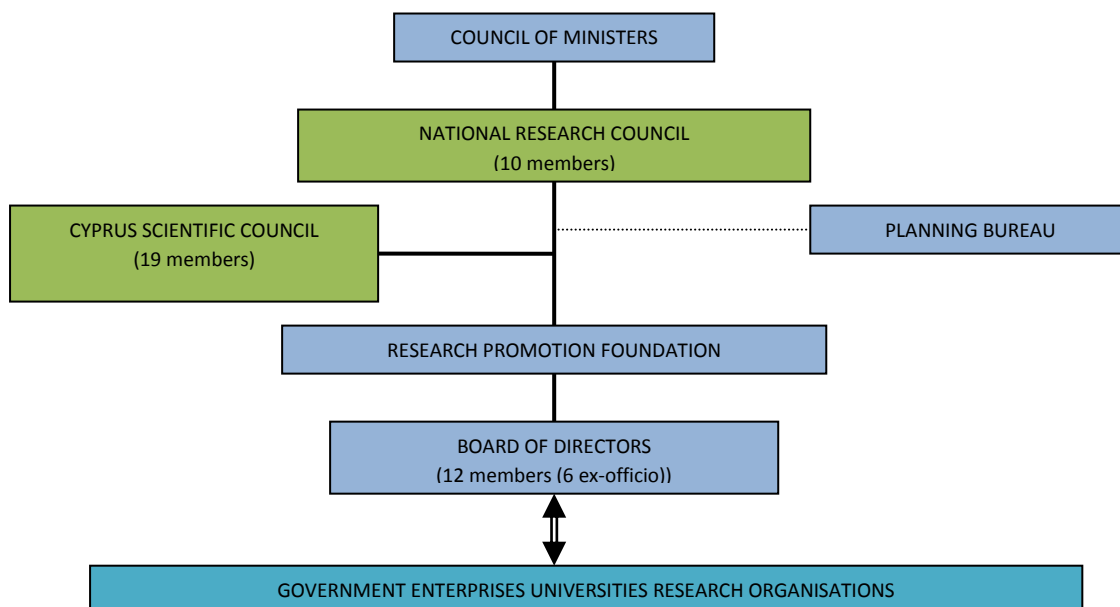


Figure 8.1. Key players associated with research in Cyprus

Republic (deputed by the Minister of Finance). The Planning Bureau provides secretarial support to the NRC.

**The Cyprus Scientific Council (CSC)**, is an advisory board to the NRC and its mandate is to formulate research strategy proposals. Its Board is composed of 19 members, all of whom are qualified scientists, though not necessarily of Cypriot nationality. The RPF provides secretarial support to the CSC.

In an effort to render the national system more efficient, the government will proceed with Structural reform in the near future. To this end a National Committee on Research Innovation and Technological Development was appointed by the Council of Minister in September of 2013 with a view to presenting, within 6 months a proposal to the Government for the adjustment and upgrading of the whole system.

### 8.2.2. MAIN INSTRUMENTS, POLICIES AND PROGRAMMES

Research is among the key priorities of the National Strategic Development Plan (NSDP) 2007-2013, the main strategy document currently reflecting guidelines for R&D and innovation policy. The promotion of research and development constitutes one of the eight strategic development pillars highlighted in the document.

Specific multi-annual Research strategy, however, is still not in place. The main delivery instrument is the multi-annual and multi-thematic National Framework Programme for Research and Technological Development (DESMI), designed and managed by the RPF. The last DESMI 2009-2010 builds on the previous one without major shifts in goals and priorities. It is based on five pillars, which include a broad spectrum of measures through which it supports multi-thematic research projects in pre-selected fields, promotes research activities among young population, provides for the upgrading of existing and the built up of new research infrastructure, supports international collaboration as well as research and innovation in enterprises. Each new DESMI outperforms the previous in terms of budget and number of measures.

The major shift over the recent past was a new focus on innovation support. Since 2008, the RPF included in its framework programme new initiatives targeting cluster framework policies and innovation, the development of the innovation culture among economic actors, linking university and the business sector as well as the enhancement of endogenous capacity of enterprises to innovate. This much stronger emphasis on innovation and utilising existing research results is driven by the evidence of better performance of Cyprus in innovation rather than in Research.

Since March 2013 the Planning Bureau in cooperation with the RPF and the Cyprus University of Technology is

preparing the Smart Specialization Strategy which is a new innovation policy concept designed to promote the efficient and effective use of investment in research, including the European, Structural and investment funds. The outcomes of the Smart Specialization Strategy, which are expected in December 2013, will be utilised for the formulation of the new national Strategy in research.

## RESEARCH PROMOTION FOUNDATION

Founded in 1996, the Research Promotion Foundation (RPF) was established at the initiative of the Government of the Republic of Cyprus, to promote the development of scientific and technological research in Cyprus, due to the fundamental importance of research in contemporary societies. The Foundation's core objective is the promotion of scientific and technological research and innovation in Cyprus. The specific objectives and priorities defined by the Foundation's Statute and the decisions of its Board of Directors are as follows:

- To monitor and coordinate the scientific and technological research and innovation in Cyprus.
- To identify appropriate thematic areas for conducting demand-driven research, taking into consideration the developmental needs of Cyprus.
- To provide funding for the implementation of research and technological development projects and innovation activities.
- To promote the participation of Cypriot research organisations in European research programmes.
- To evaluate the potential of organisations or individual researchers for carrying out research.
- To advise the government on research issues.
- To upgrade the infrastructure for research activities.
- To promote awareness of the Cypriot public for the importance of research in contemporary societies.

The Foundation has developed a wide range of activities throughout its presence in the research area of Cyprus. These fall into two main categories:

- Financing Research Projects through the Development and Monitoring of Competitive Programmes. The first category aims primarily at enhancing research, technological development and innovation activities in Cyprus and moreover at increasing the critical mass of researchers and research projects undertaken in Cyprus. The main instruments for achieving these

goals involve competitive programmes developed and monitored by RPF and the related funds come from the Cyprus government budget and, as from 2007, also from the Structural Funds of the European Union.

- Managing European Research and Innovation Projects and Promotion of International Cooperation in Research and Innovation. The second category encompasses the development of several activities to facilitate the creation of networks between Cypriot and foreign scientists. Most of these activities relate to the involvement of Cypriot scientists in European research and innovation programmes, the cooperation with international organisations supporting research and innovation activities and the preparation and implementation of bilateral agreements between Cyprus and other countries in the field of research and technological development.

Since 1996, the RPF has announced many Calls for Proposals but for the present report more emphasis will be given to the last Framework Programme for Research, Technological Development and Innovation, called "Desmi 2009-2010", as well as other recent Transnational Calls for Proposals the RPF participates in.

### 8.2.3. INTERNATIONAL COOPERATION

Cyprus participates in all EU research related programmes. Co-ordination of participation is carried out by the Planning Bureau and the Research Promotion Foundation. The RPF has developed several initiatives in order to promote the participation of Cypriot researchers in international research activities and encourage collaboration between Cypriot and international institutions. These include:

EU Framework Programmes: The participation of Cyprus in the 5<sup>th</sup> and 6<sup>th</sup> EU Framework Programmes for Research and Technological Development is considered quite successful if compared to the small of the Cypriot research community, as the funds raised were €20mIn and €27mIn respectively. Approximately half of them were projects in the field of Information and Communication Technologies (ICT). The participation of the Cypriot research community in the 7th Framework Programme of EU for Research and Technological Development 2007-2013 (FP7) was also satisfactory, as in the calls announced, 301 projects managed to secure

**Table 8.1. Research expenditure - by sector of performance (Source: Cystat)**

	€000's	2008	2009	2010	2011
GDP % (GERD)		0.43	0.49	0.50	0.49
Government	"	16,809	16,942	16,891	14,731
Business enterprises	"	16,732	16,434	14,796	12,765
Higher education	"	32,068	38,278	42,944	47,511
Private non-profit	"	7,756	11,334	11,567	13,876
Total	"	73,365	82,988	86,198	88,883

financing of €71.3 mln from which €21.3 mln relate projects from the SME's.

The COST Initiative: The COST Programme created many opportunities for networking. In 1999, Cyprus was represented in only 4 actions of the Programme, while until now Cyprus researchers have been participating in a total of 132 actions.

The European Science Foundation: The programmes launched by the European Science Foundation (ESF) were instrumental in promoting the integration of Cypriot researchers in the European Research Area. Apart from participating in the ESF's "traditional" activities, the Foundation is currently supporting 10 Research Networking Programmes as well as 5 EUROCORES initiatives.

The EUREKA and other Initiatives: The Membership of Cyprus in the EUREKA Initiative in 2002 and the launching of a "Eureka Cyprus" Specific Action, with a dedicated budget for the financing of industrial research projects, has played a catalytic role in the involvement of enterprises in research activities. So far, Cypriot Organisations have participated in 20 EUREKA projects.

In addition to the above programmes, the Research Promotion Foundation participates in the, the initiative under article 169, EUROSTARS, and in various ERA-Net projects, such as Cornet, eTranet, Safefoodera, Marifish, Urbanet, MNT-EraNet and Eracobuild. A specific program is included the RPF Framework Programme for Research, Technological Development and Innovation 2009-10 (RPF FP for RTDI 2009-10) for these participations.

Another activity aiming at the promotion of international cooperation is the signing of bilateral agreements in the field of science and research. So far, agreements have been signed with Greece, Italy, Egypt, France, Slovenia, Romania, UK, Cuba and USA, whereas preliminary

discussions are under way with various European and Arab Countries.

#### 8.2.4. FUNDING OF RESEARCH AND SYSTEMATIC OBSERVATION

The national target for R&D expenditures as a percentage of GDP is set to reach 0.50% by the year 2020, from 0.49% in 2011. This target is based on statistical analysis of historical data on R&D expenditures, taking seriously into consideration the particularities of Cyprus in terms of both the size of the research community, as well as the structure of industry (lack of big manufacturing firms) and the very small size of the Cypriot enterprises. It is important mentioning that the target of 0.50% implies annual research spending of €140 mln in 2020, which is almost double the current expenditure (€88.8 mln in 2011).

Public sector, by subsectors (HE, GOV, PNP) if relevant; private sector; shares of most important players.

Cyprus ranks very low in terms of R&D expenditure, as it counts only for 0.49% of GDP for 2011 which equals to 1/4 of the EU average. However, in absolute figures a positive trend has been observed over the past years, attributed mainly to a considerable expansion of research activities in the public sector. Enterprises perform 14.3% of total GERD and the share is further decreasing. The higher education sector was and remains the major R&D performer. Its share increased to 53.4% of GERD over the last three years. The Government sector contributes 16.5% but with a significant downward trend. These figures reflect the late creation of a national innovation system with the first systematic steps adopted in the '90s. Since then progress is very rapid in the adoption and funding of national R&D policies.

**Table 8.2. Distribution of funding between the fields of sciences**  
(Source: Research Promotion Foundation)

Programme	% of Funding
Health and Biological Sciences	19,5%
Technology	14%
Sustainable Development	17,5%
Information and Telecommunication Technologies	27 %
Social and Economic Sciences and the Humanities	22 %
Total	100%

The proportions among fields of science have not changed significantly over the years. Information and Telecommunication Technologies and Social and Economic Sciences and the Humanities have traditionally received almost half of the Pillar's budget followed by other sciences which shares are also stable during the last period.

### 8.3. SUMMARY INFORMATION ON GCOS ACTIVITIES

#### 8.3.1. ATMOSPHERIC OBSERVATION

##### Measurements of meteorological parameters<sup>21</sup>

The Department of Meteorology is a department of the Ministry of Agriculture, Natural Resources and Environment and handles issues concerning the weather and climate of Cyprus.

In order for the Sector of Climatology to achieve its goals of measuring all the meteorological parameters, it operates a dense network of Meteorological Stations which includes 143 rainfall stations, 22 climatological stations, 3 synoptic station, 1 upper air station, 40 automatic stations, 2 stations measuring UV radiation and 17 radiation stations.

The Department of Meteorology also was operating a Meteorological Doppler Radar in Troodos mountains (Kykkos area), in progress of replacement by two x-band (one in Rizoelia area in Larnaca and one in St. Neophytos, Tsada area in Paphos).

<sup>21</sup> Panayiotis Michael, Met officer, Department of Meteorology, Nikis 28, 1086 Nicosia; Tel.: +35722802915, e-mail: mpanayiotis@ms.moa.gov.cy

For information regarding the network of stations, see the map in Figure 8.2 and the tables below.

**Table 8.3. Type of meteorological stations in Cyprus**

Type	Number
Rainfall Stations	143
Conventional Climatological Stations	22
Automatic Weather Stations	40
Automatic Weather Stations (Forest Dpt)	6
Radiation Stations	17
UV	2
Synoptic	3

**Table 8.4. Types of automatic weather stations in Cyprus**

Type	Number
LASTEM	8
LASTEM-Rain	5
LASTEM (e-Logger)	6
CAMPBELL-analyzer	14
AWS-Server	5
AWOS (AURIA-E)	2
Forest Department Stations (Campbell Envieu)	6

##### Ground level air pollutants<sup>22</sup>

The Ministry of Labour & Social Security is responsible for Air Quality and Emissions Inventory in Cyprus. The Air Quality Section of the Department of Labour Inspection operates a network of 13 ambient air monitoring stations all over Cyprus as shown in Figure 8.3. The results, together with other useful information on air quality, are given to the public, on-line, through the website [www.airquality.gov.cy](http://www.airquality.gov.cy) and through indoor/outdoor information panels.

#### 8.3.2. OCEANIC OBSERVATION

Oceanic observation is performed by the following programmes of the Cyprus Oceanography Centre<sup>23</sup>:

**Hydrochanges:** The CIESM body coordinates and brings together all kinds of marine scientists from the Mediterranean and Black Seas. It has encouraged this initiative to increase the number of sensors in the very deep ocean for detecting climatic changes. Currently, it is

<sup>22</sup> Mr Savvas Kleanthous, Senior Labour Inspection Officer, Head of Air Quality Section, Department of Labour Inspection; 12, Apelli Street, 1080 Nicosia, Cyprus; Tel: +357-22405639; e-mail: [skleanthous@dli.mlsi.gov.cy](mailto:skleanthous@dli.mlsi.gov.cy)

<sup>23</sup> [www.oceanography.ucy.ac.cy](http://www.oceanography.ucy.ac.cy)

an umbrella and networking agent for countries and institutions who wish to develop such long-term observing programs in the deep sea. In situ measurements of temperature and salinity, collected with adequate spatial and temporal resolutions, and with particular attention to sensitive, often long-neglected Mediterranean areas (straits and channels, zones of dense water formation, deeper parts of the basins), constitute a priority, particularly in the current context of global climate change. To this effect, our CIESM program is deploying/ monitoring an array of stations that could be viewed in time as the marine counterpart of meteorological stations. A station is composed of a short (~10 m high) subsurface mooring equipped with an autonomous CTD (1 to 2-hr sampling interval) and usually a current-meter. Moorings are set in place close to the seabed at depths ranging from 300 to 2,500 m, for periods of 1-2 years before recovery (for maintenance and calibration) and re-deployment, by scientific teams

and/ or hydrographic services of participating countries. More than twenty stations are already in operation, plus those susceptible to be deployed soon, are indicated on the map below. The partner from Cyprus is the Oceanography centre.

**MEDship:** The CIESM body coordinates and brings together all kinds of marine scientists from the Mediterranean and Black Seas. It has encouraged this initiative to increase the number and quality of ship-based observations of physical, chemical, and biological in the Mediterranean. Special emphasis is given on the deepest layers and longest (climatic) time scales. A link has been made with a similar global initiative called 'GO-SHIP', in which high standards for data collection, analysis, and distribution are set for the global oceans. This program is actively seeking funding to be implemented, but already coordination between partners is taking place. The partner from Cyprus is the Oceanography centre.

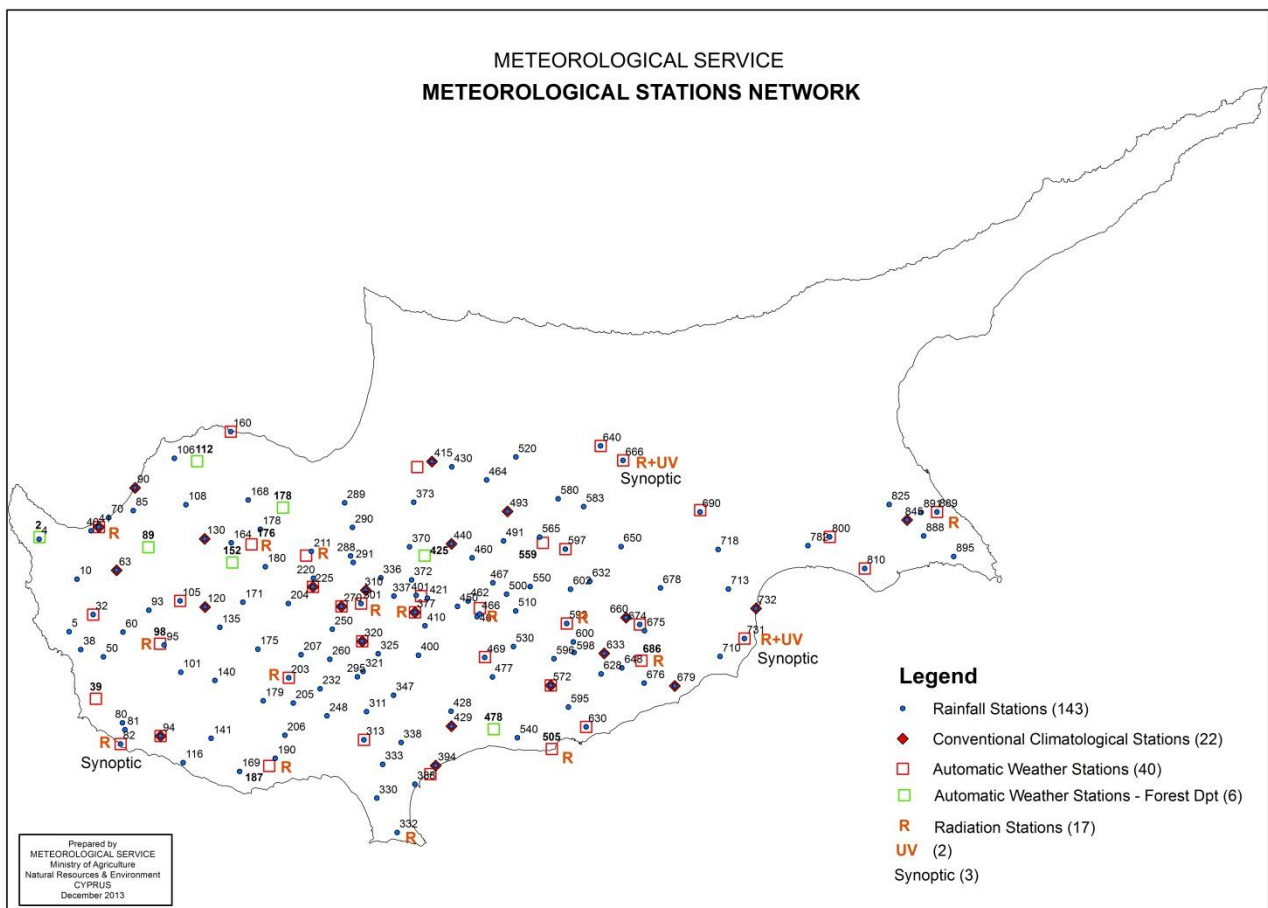


Figure 8.2. Cyprus meteorological stations network



Figure 8.3. Cyprus air quality monitoring stations

**CYBO-Cyprus Basin Oceanography:** The Centre performs scientific open sea cruises, periodically, in the EEZ of Cyprus in the Levantine Basin. These cruises measure primarily physical parameters, such as temperature, salinity, depth (CTD), plus some biogeochemical parameters such as dissolved oxygen, nutrients, chlorophyll. A large portion of the EEZ is covered, as is a large portion of the depths (upper 1000 m of the ocean). Cruises are typically carried out every summer. The CYBO project is a multiyear project aimed to study the seasonal and inter-annual variability of the general circulation of the Cyprus-SE Levantine basins, Eastern Mediterranean Sea, simultaneously at the coastal and open deep sea areas around Cyprus. The CYBO cruises are aimed at obtaining reliable and high spatial resolution CTD data from a telescopic grid of stations, with 5-10 nm in the near coastal waters of Cyprus and 15-30 nm at the open sea. The research is carried out by the Oceanography centre.

**MedGLOSS: Sea Level Stations.....:** The MedGLOSS programme of sea level monitoring network in the Mediterranean and Black seas was established jointly by CIESM and IOC/UNESCO in 1997, upon a bi-lateral agreement signed by the two organizations in response to the forecasted global climate change and sea level

rise. The Paphos MedGLOSS Cyprus station was funded by CIESM within the CIESM-IOC-MedGLOSS pilot network programme: <http://medgloss.ocean.org.il/> and <http://www.ciesm.org/marine/programs/medgloss.htm>. The sea-level stand was designed to enable simple and long lifetime of the equipment and its maintenance. We continue to operate and maintain the station using our own funding, since the project funding has stopped. The partner from Cyprus is the Oceanography centre.

### 8.3.3. TERRESTRIAL OBSERVATION

#### Observation System on quantity/quality of surface water<sup>24</sup>

The Water Development Department (WDD) is responsible for implementing the water policy of the Ministry of Agriculture, Natural Resources and Environment, to provide effective protection, rational development and sustainable management of water resources in Cyprus. In this context, the WDD implements the necessary measures to prevent the qualitative and

<sup>24</sup> Water development department website, [www.moa.gov.cy/wdd](http://www.moa.gov.cy/wdd)

quantitative deterioration of water bodies from contamination, pollution and uncontrolled exploitation. The WDD is also responsible for the feasibility studies, design, implementation, operation and maintenance of infrastructure, such as dams, ponds, irrigation, domestic water supply and sewerage schemes, water and wastewater treatment and recycling systems, as well as desalination plants.

In order to fulfil its mission, the Department systematically collects, classifies, archives, analyses and evaluates hydrological, hydro-geological, geotechnical and other data necessary for the protection and sustainable management of water resources in Cyprus.

In the field of quantitative monitoring of surface waters, continuous stream flow monitoring takes place at 52 hydrometric stations. In addition, the flows of 45 springs are measured on a regular basis.

Qualitative monitoring of surface waters, takes place at 45 river monitoring stations at a frequency of 9 times annually and 13 lake (reservoir) monitoring stations at a frequency of 4 and 6 times annually. Elements for biological monitoring: macroinvertebrates, phytobenthos, macrophytes and chlorophyll a. Parameters for chemical monitoring: Metals, VOCs, Pesticides, PCBs and PAHs. Additional monitoring parameters are nutrients, microbiology, ecotoxicology and physico-chemical parameters (Temp., pH, EC, DO, Turbidity).

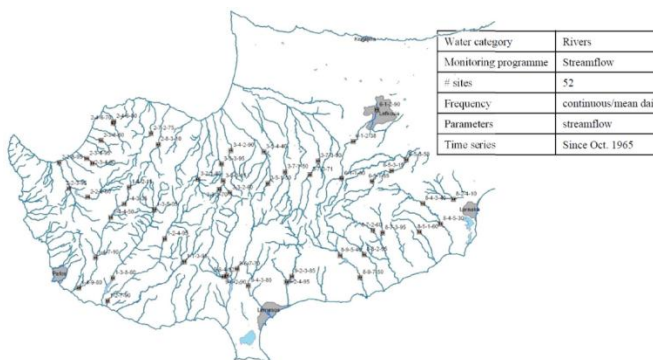


Figure 8.4. Surface waters quantitative monitoring stations<sup>25</sup>

<sup>25</sup> Gerald Dörflinger, 2011.

The Cyprus Water Development Department: Water data collection, data bases, access and utilization of data by third parties; presented at Data Repositories and Computational Infrastructure for

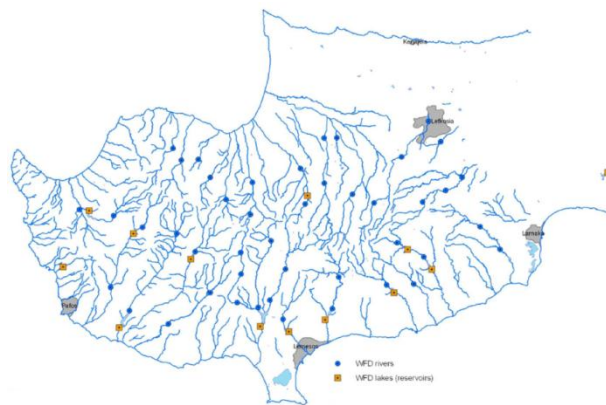


Figure 8.5. Surface waters qualitative monitoring stations<sup>25</sup>

### Forest ecosystem health observation<sup>26</sup>

Forest ecosystem health observation belongs to the responsibility of the Department of Forests. It is accomplished through the monitoring programs implemented in forest ecosystems of Cyprus. These programs are classified into three categories, depending on the agent which threatens the stability of forest ecosystems:

- Annual surveys for quarantine harmful organisms. The survey is carried out for specific harmful organisms which are described under the Council Directive 2000/29/EC. The survey aims to the verification of the absence of pests which their introduction into the Community will cause extensive damages to forest plants and products. Surveys are carried out by plant health inspectors and the results are submitted annually to the EU.
- Monitoring Program for Pine Processionary Caterpillar (*Thaumetopoea wilkinsonii*). Pine processionary caterpillar is a very common harmful insect (defoliator) causing extensive damages to the pine ecosystems of Cyprus. Monitoring program includes the establishment of permanent plots and the annual data are very useful in application control measures.

Environmental and Climate Studies in the Eastern Mediterranean 2<sup>nd</sup> DARECLIMED Workshop; available from [http://www.moa.gov.cy/moa/wdd/WDD.nsf/All/24A949C666A15BF5C22579DB0028205E/\\$file/DARECLIMED\\_G\\_Dorflinger\\_15Dec2011.pdf](http://www.moa.gov.cy/moa/wdd/WDD.nsf/All/24A949C666A15BF5C22579DB0028205E/$file/DARECLIMED_G_Dorflinger_15Dec2011.pdf)

<sup>26</sup> Dr. Andreas K. Christou, Senior Forest Conservator, Head of Research, Publicity & Silviculture Sector, Department of Forests, 1414, Nicosia, Cyprus, Tel.: 22819490, e-mail: achristou@fd.moa.gov.cy.



(c) ICP Forests-Biomonitoring Program. The Department of Forests participates in the program which is one of the world's largest biomonitoring networks, where more than 40 countries are involved. Its aims are:

- to provide a periodic overview on the spatial and temporal variation of forest condition in relation to anthropogenic and natural stress factors (in particular air pollution) by means of European-wide and national large-scale representative monitoring on a systematic network;
- to gain a better understanding of the cause-effect relationships between the condition of forest ecosystems and anthropogenic as well as natural stress factors (in particular air pollution) by means of intensive monitoring on a number of selected permanent observation plots spread over Europe and to study the development of important forest ecosystems in Europe.

The results of the program provide information on forest health, air pollution, climate change and biodiversity

#### 8.3.4. SATELITE OBSERVATION

##### GMES

The Republic of Cyprus as a European Union member state participates in the European program Copernicus (ex GMES). The "Regulation (EU) No 911/2010 of the European Parliament and of the Council of 22 September 2010 on the European Earth monitoring programme (GMES) and its initial operations (2011 to 2013)" set the framework of the programme.

The GMES programme is built on the research activities carried out under Decision No 1982/2006/EC of the European Parliament and of the Council of 18 December 2006 concerning the Seventh Framework Programme of the European Community for research, technological development and demonstration activities (2007 to 2013) and the GMES Space Component Programme of ESA.

The GMES programme is comprised the following:

- (a) a service component ensuring access to information in support of the following areas:
- atmosphere monitoring,

- climate change monitoring in support of adaptation and mitigation policies,
- emergency management,
- land monitoring,
- marine environment monitoring,
- security;

(b) a space component ensuring sustainable spaceborne observations for the service areas referred to in point (a);

(c) an in-situ component ensuring observations through airborne, seaborne and ground-based installations for the service areas referred to in point (a).

##### COPERNICUS

The Copernicus programme is the continuation program of GMES and shall be a civil, user driven programme under civil control, building on the existing national and European capacities, as well as ensuring continuity with the activities achieved under the Global Monitoring for Environment and Security (GMES). The maximum amount allocated by the European Union to implement its activities shall be EUR 3.786 million at 2011 prices for the period from 1 January 2014 to 31 December 2020.

##### COPERNICUS CLIMATE CHANGE SERVICE

The Copernicus climate change service, to be developed, shall provide information to increase the knowledge base to support adaptation and mitigation policies. It shall in particular contribute to the provision of Essential Climate Variables (ECVs), climate analyses, projections and indicators at temporal and spatial scales relevant to adaptation and mitigation strategies for the various European Union's sectorial and societal benefit areas.

The Climate Change (CC) service<sup>27</sup> is designed to increase the knowledge base in support of adaptation and mitigation policies. The Climate Change service will contribute to the observations, reanalyses and projections of Essential Climate Variables (ECVs) among other quantities. Series of climate impact indicators will be generated on the basis of these geophysical field and

<sup>27</sup> Copernicus Progress Report October 2013 – Updated status on the services - Entr.g.2 12/11/2013 – GC-GMES-2013/22

regularly updated and will then feed into various types of products (maps, reports, etc.) tailored to policy applications.

The service is organized around four complementary blocks: A Consistent Climate Data store (CDS), a Sectoral Information System (SIS), an Evaluation and Quality Control (EQC) platform and, finally, an Outreach and Dissemination (OD) platform. It will be established and its performance routinely assessed according to common practice for an operational service. The success of the implementation of the proposed service largely relies on the quality of the information flow and the overall coordination between the various blocks. Series of precise, well-defined and operational procedures have to be defined and established such that the information delivered to the end-user is fully traceable, quality controlled and disseminated within the most appropriate time. The articulation between the different public national and international institutions and the private sector to be involved in the Climate Change service through the entire production and dissemination chain is a critical element of the operations.

The logical view of the architecture of the Climate Change service has been developed and presented to the GMES Committee of December 10, 2012 and discussed in detail during the Climate Change workshop held on June 4, 2013. The latter event, where national climate experts were invited, was organized around two sessions addressing 1) the European and International initiatives related to the topic and, 2) the proposed design of the Climate Change service, respectively. The workshop was concluded with a positive evaluation of the Commission proposal by the Member States and with a shared concern to put the monitoring architecture and the operational service in place as soon as possible not to risk losing precious time and information.

The 6th FP7 space call for 2013 has prioritized research activities in support of the Climate Change service for a total budget of about 26 M€. This call was organized around five major topics and the projects under negotiation are the following:

- ERA-CLIM2: European Reanalysis of the Global Climate System (to provide consistent datasets of climate relevant parameters on a global scale for all of the 20th century).

- UERRA: Uncertainties in Ensembles of Regional Re-Analysis (to provide consistent long term datasets of climate relevant parameters on a regional scale).
- QA4ECV: Quality Assurance for Essential Climate Variables (to augment the number of available quality-assured long term ECV records and to provide methods suitable for reliable assessments of the climate quality of ECVs).
- CLIPC: Climate Information Platform for Copernicus (to enable the development, generation, comparison and ranking of climate impact indicators).
- EUCLEIA: European Climate and weather events: interpretation and attribution (To provide information on how likely high impact environmental disasters are attributable to natural climate variability or human-induced effects).

More information on the Copernicus climate change service is available at <http://www.copernicus.eu/pages-principales/services/climate-change/>

### **National Coordination**

The Department of Electronic Communications (DEC) of the Ministry of Communications and Works, as the responsible department for space policy, is the national coordinator of the Copernicus programme, one of the flagship programmes for the European Space Policy sector. The role of the DEC is to coordinate the relevant governmental departments that have the knowledge and the expertise of the various services of the programme. The DEC will also contribute in the area of radiofrequencies that are related to the programme, as it is also the national frequency manager.

The services of the programme relevant to climate change issues have been allocated as follows:

- Atmosphere monitoring service: Department of Meteorology and Department of Labour Inspection
- Climate change monitoring service: Department of Environment
- Land monitoring service: Department of Lands and Surveys
- Marine environment monitoring service: Department of Fisheries and Marine Research, Department of Environment, Department of Meteorology, Cyprus Police and University of Cyprus (Cyprus Oceanography Centre)

In October 2008 the Council of Ministers (Decision of No. 67.802) gave the political responsibility of the space policy sector to the Minister of the Communication and Works and tasked the DEC to be the Executive Body to formulate and implement the national policies. DEC was also appointed as ESA counterpart for the implementation of the ESA – Cyprus cooperation.

The ESA – Cyprus Cooperation Agreement was signed by Mr Peter Hulsroj, ESA Director of Legal Affairs and External Relations and, Mr Michael Constantinides, Permanent Secretary of the Ministry of Communications and Works of Cyprus on 27 August 2009. The said agreement was ratified by Law N. 1(III)/2010 and was published in the Official Gazette of the Republic on 5/3/2010.

In 2011 technical experts from ESA visited Cyprus in order:

- to support the creation of a database of companies/institutes/universities that are interested in participating in space activities;
- to map the existing capabilities of the country;
- to facilitate the identification of areas where a specific intervention will lead to an effective participation of the industry and academia through the European Cooperating State Agreement with the European Space Agency if so requested by Cyprus.

In their analysis report the ESA experts stated that the overall assessment following the exercise is that Cyprus is a country with intellectual infrastructure and technical capabilities pertinent to space.

Existing capabilities could be used as leverage for space related activities in the areas of Earth observation, navigation and telecommunication downstream added services, possibly in ground-based long-term testing and characterization of solar generators and niche material research and turbulent flow modelling.

The mechanism for implementing the findings of the assessment will be discussed with Cyprus in order to appropriately support the conclusion of an ECS Agreement. It is recognized by both sides that the conclusion of an ECS Agreement should take place as soon as possible. However, a smooth transition between the Cooperation Agreement and the ECS Agreement should be ensured.

## 8.4. RESEARCH<sup>28</sup>

Desmi 2009-2010, in continuation of the Framework Programme for Research, Technological Development and Innovation 2008 is a medium-term developmental mechanism that is part of a broader strategy for the development of Cyprus. It functions in a parallel and complementary way with other policies and programmes, and specialises in promoting research, technological development and innovation. Within this context, “Desmi 2009-2010” aims at the effective contribution towards the:

- promotion of the development process in a number of sectors of the Cypriot society,
- improvement of the quality of life of the citizens, and
- enhancement of the competitiveness of the economy of Cyprus.

The RPF’s Framework Programme 2009-2010 relates to five (5) Priority Pillars that reflect the strategic pursuits, eighteen (18) Programmes and specific Actions, for each of which specific objectives and rules of management and completion have been formed. The five Priority Pillars are the following and will be analysed below:

- Strategic and Multithematic Research
- Development of Human Research Resources
- Development of Research and Innovation Enterprises
- Development of Research Infrastructure
- Development of International Networking and Cooperation

Since 2006, 69 projects directly or indirectly relevant to climate change have been funded by various Programmes and Actions of Desmi. The total contribution of the RPF for these projects was €8.8 mln.

### **Pillar I: Strategic and Multithematic Research**

Pillar 1 concerns the implementation of research projects of high scientific level, in a wide range of themes. The basic objective of Pillar I is the overall upgrading of research activities and through this the promotion of the developmental process in the wider socio-economic body of Cyprus. This Pillar includes the following five Programmes: (a) “Technology”, (b) “Information and

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Communication Technologies”, (c) “Sustainable Development”, (d) “Health and Biological Sciences” and (e) “Socio-Economic Sciences and Humanities”.

#### (a) Programme “Technology”

Technology is one of the most basic factors for the development of contemporary economies and societies as the rapid change that characterises the most economically powerful societies and industries is due, largely, to the leading role that the technological factor has towards the whole procedure of the economic and social change.

The Programme “Technology” supports the development of research activities within a series of scientific areas that are considered as fundamental for the development of a more contemporary high-level technology. It covers projects in the areas of materials, nanotechnology, energy, pure and applied sciences and mechanics, as well as interscientific areas, which are not completely classified to one of the aforementioned areas.

The Programme “Technology” consists of the following four actions: “Materials- Nanosciences- Nanotechnologies”, “Energy”, “Pure and Applied Sciences”, and “Engineering Applications”.

#### (b) Programme “Information and Communication Technologies”

The role of the Information and Communication Technologies (ICT) in the global and domestic development is extremely crucial as they are affecting almost all the aspects of contemporary political, economic, social and cultural life. The ICT are characterised by the rapid differentiation and continuous development and are the main source of frequent change in the way enterprises operate, the implementation of transactions, the access to information and services, the daily communication, entertainment, the services to citizens and so on.

The main aims of the Programme are to increase the competitiveness and productivity of the business world in all the areas of the economy and improve the services provided to the citizens, the communities, the enterprises and government authorities and organisations. Particular emphasis is placed on the dissemination of the use of ICT and their integration into other activities such as education, health, culture,

governance, trade and labor. Additionally, it seeks to exploit the high-levels of domestic scientific potential and create networks of cooperation between academic and research institutions and enterprises in the public and private sectors.

The Programme “Information and Communication Technologies” consists of the following three Actions: “Information Technologies”, “Communication Technologies”, and “ICT Applications”.

#### (c) Programme “Sustainable Development”

Sustainable development is a strategic priority for the development of Cyprus, which does not limit to the issues of management natural environment but also has a horizontal character and covers all the aspects of social and economic life of the country.

The programme “Sustainable Development” covers the main pillars of sustainability, namely those of the environment, society and economy. The programme supports the development of cooperation of research organisations, competent authorities, public benefit organisations and enterprises in research projects of high standard, in order to produce innovative products or services, deal with the environmental problems in a rational way, promote sustainable development at a national level, improve the quality of life, provide viable management of natural resources and prevent natural disasters. In parallel, the Programme aims to contribute to the implementation, updating and development of the environmental policy, especially with regard to the integration of environmental research in policy decisions for the viable development of Cyprus as well as convergence with the structures and strategies of the EU.

The Programme “Sustainable Development” includes the following four Actions: “Natural Environment”, Action “Urban and Built Environment”, “Agriculture, Animal Farming, Fisheries and Aquaculture”, and “Social and Economic Sustainability”

#### (d) Programme “Health and Biological Sciences”

The programme “Health and Biological Sciences” provides the research community, the competent authorities and the business world with a tool of collaboration for addressing some of the modern challenges in the wider health sector.

The main objective of the programme is to implement high-level research projects, to improve and develop innovative methods and strategies that contribute to the protection of public health, the improvement of the quality of life of citizens, the assurance for a healthy food chain and the upgrade of health services. Additionally, it aims to build on the comparative advantages of Cyprus, in a way that serves the broader developmental policy for rendering the country as a regional service centre, with emphasis on specialised secondary and tertiary healthcare and the economic and long-term viability of healthcare.

The Programme “Health and Biological Sciences” consists of the following three Actions: “Public Health”, “Biomedical Sciences and Biotechnology”, and “Food Science and Biotechnology”.

#### (e) Programme “Socio-Economic Sciences and Humanities”.

The Programme focuses on topics such as history, culture, contemporary arts, education and educational reform, and covers issues on philosophy, political science and law. Additionally, it covers issues related to the basic aspects of the economic science, such as economic growth in a knowledge-based society, the economics of labour and enterprises, econometric models and indicators.

Moreover, emphasis is placed on applied research related to the improvement of employment and competitiveness of the economy, especially after the accession of Cyprus to the European Union and the Euro zone, the improvement of the productivity of enterprises and public services, as well as issues related to the combination of economic, social and environmental objectives and corporate governance.

The programme aspires to exploit the multiple potential of the academic and research community of Cyprus and specifically the accumulated experience of major research and academic institutions in the public and private sectors and the wealth of knowledge of a large number of researchers working in the areas of socio-economic sciences and humanities.

The Programme “Socio-economic Sciences and Humanities” consists of the following four Actions: “Education”, “Economic Sciences”, “Social Sciences”, and “Humanities”.

### **Pillar II: Development of Human Research Resources**

Pillar II aims to expand over time, the human resources employed in promotional activities in RTDI through:

- attracting and integrating into the RTDI system young researchers, who have recently completed their PhD studies
- training and guiding young scientists who are at the stage of their PhD thesis, in order to become the next generation of young researchers, and
- the preparation of the younger generation and establishment of the perception that a researcher’s career may constitute a remarkable selection of professional development.

Additionally, it aims to contribute substantially to the achievement of the specific objectives of the National Reform Programme for the Lisbon Strategy, for strengthening the scientific base of the country.

Pillar II includes the following three Programmes: (a) “DIDAKTOR”, (b) “Young Researchers of Cyprus – PENEK” and (c) “Development of Research and Innovative Culture”.

### **Pillar III: Development of Research and Innovation Enterprises**

The central objective of this Pillar is the improvement of competitiveness, viability and development of Cypriot enterprises, and hence the creation of new jobs, through the involvement of the enterprises in activities of research and innovation and the development of new or the improvement of existing products / services, methods and processes of production and organisation.

Pillar III is addressed to Cypriot enterprises of all sectors of the economy. The distinctive difference between the Programmes of Pillar III as compared to Thematic Programmes is that the “motivational force” for the designing of the proposed projects is the enterprises themselves, as the projects are formulated by taking into account their needs, problems, capacities and particularities.

Pillar III includes the following three Programmes: (a) “Research for Enterprises”, (b) “Eureka Cyprus” and (c) “Innovation”.

#### **Pillar IV: Development of Research Infrastructure**

Pillar IV aims to develop new research infrastructure, upgrade and enrich the existing research laboratories and create opportunities for access to important research infrastructures abroad.

The ultimate aim of the Programmes under Pillar IV is to maximise the exploitation of the research infrastructures and to strengthen the Cypriot research network with particular emphasis on emerging scientific frontier areas.

The term “research infrastructure”, for the purposes of the Programmes under Pillar IV, includes the physical and virtual infrastructures which offer to the research community the necessary tools and services for the development of high-level research activities.

Pillar IV includes the following three Programmes: (a) “New Infrastructure”, (b) “Upgrade of Existing Infrastructure” and (c) “Access to Cern”.

#### **Pillar V: Development of International Networking and Cooperation**

Pillar V, pursues the penetration of Cypriot enterprises, research centres and researchers into international networks, and their cooperation with corresponding organisations abroad, aiming to create strong links with these organisations that will lead to the upgrade of the quality of the country’s research level.

Pillar V includes the following four Programmes: (a) “Bilateral Cooperation”, (b) “International Cooperation”, (c) “Hosting of Researchers Based Abroad” and (d) “Measures for Supporting International Cooperation”.

The tables that follow summarise recent and current research projects that governmental, non-governmental and private organisations from Cyprus participate. The projects are grouped into seven themes, according to the topic of the research.

The information was collected through the distribution of questionnaires.

Additional research is performed by the University of Cyprus and the Technical University of Cyprus, particularly on subjects related to mitigation. However, the necessary information has not been submitted by the relevant organisations and therefore is not presented in the following tables.

**Table 8.5. Research projects related to adaptation**

<b>Institution</b>	<b>Project</b>	<b>Description</b>	<b>Partners</b>
Department of Meteorology	MOWE-IT	The goal of the MOWE-IT project is to identify existing best practices and to develop methodologies to assist transport operators, authorities and transport system users to mitigate the impact of natural disasters and extreme weather phenomena on transport system performance. <b>Funding:</b> EU <b>Website:</b> <a href="http://www.mowe-it.eu">http://www.mowe-it.eu</a>	Technical Research Centre (Finland), Research and Technology (Hellas), DLR (Germany), Finnish Meteorological Institute, Fraunhofer (Germany)
Cyprus University of Technology	Options for sustainable agricultural production and water use in Cyprus under global change	The overall goals of this project are (1) to provide recommendations for climate change adaptation for the agricultural sector in Cyprus and the wider Mediterranean region; (2) to establish a consortium of excellence in natural resource management research in Cyprus for tackling the challenges imposed by climate change. <b>Funding:</b> National (€120,000) <b>Duration:</b> 24 months	The Cyprus Institute, Department of Geological Survey, Agricultural Research Institute, Department of Meteorology
Agricultural Research Institute	Genetics and breeding of important Cyprus crops for adaptation to climate change – studies with barley and cowpea	The program aims at the creation of improved genotypes through innovative breeding methodology, the development of precision phenotyping procedures, and the in-depth study of underlying genetic or epigenetic phenomena. <b>Funding:</b> National (€10,000/ year)	Cyprus Institute, Adelaide University (Australia), Cyprus University of Technology
Agricultural Research Institute	National genebank	The main activities of the genebank of the Agricultural Research Institute are the collection, ex situ conservation, characterization and evaluation of local plant genetic resources. Their enormous genetic diversity and adaptability make crop wild relatives and landraces a crucial source of genes to combat adverse abiotic and biotic conditions imposed by climate change. <b>Funding:</b> National <b>Website:</b> <a href="http://www.ari.gov.cy">www.ari.gov.cy</a>	
Agricultural Research Institute	Ensuring the survival of endangered plants in the Mediterranean (MAVA)	The key outcomes of the project will include the protection of 900 endangered plant taxa, the development of seed specialists in the region, increased collaboration between plant conservation agencies and public awareness of the value and vulnerability of the local flora. These outcomes are in line with the mission and aims of the MAVA Foundation for conservation work and networking in the Mediterranean. <b>Funding:</b> National (€101,522) <b>Duration:</b> 36 months <b>Website:</b> <a href="http://www.medilandplant.eu/">http://www.medilandplant.eu/</a>	The Royal Botanic Gardens, Kew (UK), Soller Botanic Garden, Mallorca (Spain), The Mediterranean Agronomic Institute, Maich (Greece), Conservatoire Botanique National De Corse (France), Università Di Cagliari (Italy), University Of Catania (Italy)
Frederic University	Vulnerability of the narrow endemic <i>Cedrus brevifolia</i> from Cyprus: Detection of genes and phenotypic trait diversity linked to adaptation	The scientific objective of this project is the investigation of adaptation and adaptability of <i>Cedrus brevifolia</i> (Cyprus cedar) through the correlation of various datasets: genes diversity, morphological / anatomic traits and ecological indexes (soil conditions and climatic measurements). Hence, outcomes from this project aim to shed light on the adaptation process of Cyprus cedar in the course of many generations due to the interaction of several evolutionary processes (mostly selection owing to glaciations and demographic factors). <b>Funding:</b> National + EU (€149,937) <b>Duration:</b> 36 months <b>Website:</b> <a href="http://www.ncu.org.cy/genocedar">http://www.ncu.org.cy/genocedar</a>	French National Institute for Agriculture Research (INRA) - Avignon Unit (France), Demokritos University of Thrace (Greece), Department of Forests, Department of Environment

Institution	Project	Description	Partners
Department of Environment	Strengthening the scientific foundation of water quality programs (WATER)	<p>The overall goal of the project was to strengthen the scientific foundation of water management programmes, including criteria development for pollutants of high potential impact on environmental quality and biodiversity. As such the project established and demonstrated an innovative set of methods and tools for the design and implementation of programmes for the preservation of high environmental quality and good ecological status of water bodies. In particular the proposed tools increase the scientific basis for constructing, communicating and evaluating water management plans and measures. Further the project helped to establish Policy, Scientific and Technical integration between programmes for the development of water quality standards and criteria and regulations relevant to pollution prevention such as the issuance of emission permits and implementation of EIAs.</p> <p><b>Funding:</b> National + EU (€829,775)  <b>Duration:</b> 42 months  <b>Website:</b> <a href="http://www.life-water.eu/">http://www.life-water.eu/</a></p>	Atlantis consulting Cyprus Ltd, Frederick University (Cyprus)
The Cyprus Institute	ENORASIS: ENvironmental Optimization of IRrigAtion Management with the Combined uSe and Integration of High Precision Satellite Data, Advanced Modeling, Process Control and Business Innovation	<p>ENORASIS system will target to motivate irrigation farmers to optimize the use of water, whereas it will also provide to (irrigation) water management organizations intelligent tools and services to effectively forecast and manage irrigation water resources, cover irrigation demand and charge customers (farmers) on the basis of an intelligent system of motives and incentives that exploits irrigation demand side fluctuations.</p> <p><b>Funding:</b> EU (€179,440)  <b>Duration:</b> 36 months  <b>Website:</b> <a href="http://www.enorasis.eu/">http://www.enorasis.eu/</a></p>	



**Table 8.6. Research projects related to climate change education**

Institution	Project	Description	Partners
Frederic University	Development of an Interdisciplinary Programme on Climate Change and Sustainability Policy	<p>The wider objectives are to transform current unsustainable practices with respect to interdisciplinary collaboration and promote interdisciplinary climate change curricula in the partners' countries universities. Specific objectives are to: 1) develop capacity-building workshops for building interdisciplinary and multi-stakeholder driven climate change curricula responsive to societal needs; 2) develop an undergraduate interdisciplinary program on climate change and sustainability policy (CLIMASP) in each partner country university; 3) integrate, implement and assess the CLIMASP program as an integral part to existing undergraduate academic degrees and 4) contextualise the Europass supplement diploma in the partner universities and the region.</p> <p><b>Funding:</b> National (€1,080,000)  <b>Duration:</b> 36 months  <b>Website:</b> <a href="http://www.ncu.org.cy/climasp.html">http://www.ncu.org.cy/climasp.html</a></p>	University of Crete (Greece), Leuphana University Lueneburg (Germany), Heliopolis University for Sustainable Development (Egypt), Suez Canal University (Egypt), University of Jordan (Jordan) et al.
Technical Chamber of Cyprus	Training of Photovoltaic Installers in Europe 5 (PVTRIN)	<p>The European Energy and Climate Change policies, as well as the supporting EU Member States' legislations have resulted in high market growth for photovoltaics. Applying PV technologies however, requires highly-qualified technicians to install, repair and maintain them. Until today, national markets have been growing faster than the qualified PV installers force can satisfy. Furthermore, the interested parties (manufacturers, developers, investors) seek skills certification and quality assurance in all phases of a PV installation (design, installation and maintenance).</p> <p><b>Funding:</b> EU (€500,000)  <b>Duration:</b> 36 months  <b>Website:</b> <a href="http://www.pvtrin.eu/home/index.html">http://www.pvtrin.eu/home/index.html</a></p>	Technical University of Crete (Greece), Agency of Brasov for the Management of Energy and Environment, Building Research Establishment Ltd, European Photovoltaic Industry Association, Tecnalía Research & Innovation

**Table 8.7. Research projects related to climate change impacts**

<b>Institution</b>	<b>Project</b>	<b>Description</b>	<b>Partners</b>
Department of Meteorology	EWENT	<p>The objective of the EWENT project is to assess the impacts and consequences of extreme weather events on EU transport system. These impacts will be monetised. EWENT will also evaluate the efficiency, applicability and finance needs for adoption and mitigation measures which will dampen and reduce the costs of weather impacts.</p> <p><b>Funding:</b> EU  <b>Duration:</b> 36 months  <b>Website:</b> <a href="http://ewent.vtt.fi/index.htm">http://ewent.vtt.fi/index.htm</a></p>	VTT (Finland), German Aerospace Center, Institute of Transport Economics (Norway), European Severe Storms Laboratory (Denmark), Osterreichische Wasserstrabben (Austria)
Cyprus University of Technology	Economic impacts from the implementation of the European Union's energy and climate change legislation package in Cyprus	<p>The European Union adopted ambitious climate policies for the period 2013-2020. These legally binding measures may have significant effects on households, firms and the public sector of Cyprus. Therefore, this project used innovative economic methods and detailed national data to assess the impacts of these policies on the economy of Cyprus. It involved the development of two innovative economic models, one for the production side (for different sectors of the economy of Cyprus) and one for the consumption side, i.e. for households.</p> <p><b>Funding:</b> National (€ 120,000)  <b>Duration:</b> 24 months</p>	University of Cyprus, Europrism Research Ltd. (Cyprus)
Open University of Cyprus	SCALES	<p>Human actions, motivated by social and economic driving forces, generate various pressures on biodiversity, such as habitat loss and fragmentation, climate change, land use related disturbance patterns, or species invasions that have an impact on biodiversity from the genetic to the ecosystem level. Each of these factors acts at characteristic scales, and the scales of social and economic demands, of environmental pressures, of biodiversity impacts, of scientific analysis, and of governmental responses do not necessarily match. SCALES will seek ways to build the issue of scale into policy and decision-making and biodiversity management. It will advance our knowledge of how anthropogenic and natural processes interact across scales and affect biodiversity. It will evaluate how this knowledge can be used to improve the scale-sensitivity and effectiveness of policy instruments for conservation and sustainable use of biodiversity.</p> <p><b>Funding:</b> EU (€ 1,000,000)  <b>Duration:</b> 60 months  <b>Website:</b> <a href="http://www.scales-project.net/">http://www.scales-project.net/</a></p>	31 partners from Europe, Australia and Asia
The Cyprus Institute	CIVMME: Climate impacts on vector-borne diseases in the Eastern Mediterranean and the Middle East	<p>The threat to human health posed by mosquito transmitted viruses, coupled with a drive in the scientific community to map the current presence of Ae. albopictus and develop knowledge of both mosquito/pathogen biology, has led to the current project, which is focused on developing tools to predict the likelihood of Ae. albopictus-borne viral disease transmission in the EMME as a function of projected climate change. These tools will be invaluable for focusing both vector surveillance and control strategies, and health programmes in the region.</p> <p><b>Funding:</b> EU (€ 174,489)  <b>Duration:</b> 24 months  <b>Website:</b> <a href="http://www.cyi.ac.cy/civmme-project-overview.html">http://www.cyi.ac.cy/civmme-project-overview.html</a></p>	Department of Medical and Public Health Services (Cyprus), Imperial College London (UK)

Institution	Project	Description	Partners
The Cyprus Institute	CHIMENA: Climate Change and Health Impacts in the Middle East and North Africa	<p>Address the links between climate change and public health issues with a focus on the Middle East and North Africa (MENA). The main rationale for this follow-up project is to leverage the regional climate modelling tools and results, combined with appropriate biomedical and public health expertise, to assess health impacts, support the management of the associated risks, and explore policy issues. The following components are planned: 1. Climate change and vector borne diseases; 2. Air pollution, dispersion of toxic substances and public health; 3. Extreme weather events due to climate change, focusing on heat waves; The aim is to develop a modelling framework for assessments of climate impact on health issues, inform public health services, establish surveillance programmes and strategies, support health education, develop preventive measures and mitigate negative consequences for human health and society.</p> <p><b>Funding:</b> Own (€450,000)  <b>Duration:</b> 36 months  <b>Website:</b> <a href="http://www.cyi.ac.cy/climatechangeandimpact-ongoing/item/385-chimena-climate-change-and-health-impacts-in-the-middle-east-and-north-africa.html">http://www.cyi.ac.cy/climatechangeandimpact-ongoing/item/385-chimena-climate-change-and-health-impacts-in-the-middle-east-and-north-africa.html</a></p>	Imperial College London (UK), Tel-Aviv University (Israel)
Oceanography Centre	Tropical Signals	<p>The programme Tropical Signals aims to track and evaluate the effects of tropicalization of the Mediterranean Sea using reliable and representative biological macrodescriptors of climate warming. To this end an international network of 21 research teams from 15 different countries has been established to monitor over the long term of geographic shifts and changes of temperature-sensitive species across the Basin and neighbouring areas.</p> <p><b>Duration:</b> continuous  <b>Website:</b> <a href="http://www.ciesm.org/marine/programs/tropicalization.htm">http://www.ciesm.org/marine/programs/tropicalization.htm</a></p>	CIESM
Oceanography Centre	CYCO	<p>In the framework of the exploration of the eastern Mediterranean and the estimation of the extent of climate change, we are recording the composition of zooplanktonic communities by collecting frequent samples, in the marine area of coastal Limassol (Cyprus) during daily oceanographic research cruises. Physical parameters (temperature, salinity, pressure) are also being recorded with a CTD (Conductivity-Temperature-Depth) instrument.</p>	
The Cyprus Institute	CIMME: Climate Change and Impacts in the Eastern Mediterranean and Middle East	<p>To understand the implications of EMME's shifting weather patterns, researchers have projected climate change for the 21st Century, using a regional climate model based on an intermediate emission scenario, and predicted impacts on the environment. The research suggests substantial regional climate changes, with significantly dryer and warmer conditions. The predicted warming and drying of the EMME region will have major consequences for both humans and natural ecosystems, especially from the increased heat stress and reduced rainfall.</p> <p><b>Funding:</b> own (€500,000)  <b>Duration:</b> 36 months  <b>Website:</b> <a href="http://www.cyi.ac.cy/completed-research-projects-clima/item/201-cimme-climate-change-and-impacts-in-the-eastern-mediterranean-and-middle-east-project-completed.html">http://www.cyi.ac.cy/completed-research-projects-clima/item/201-cimme-climate-change-and-impacts-in-the-eastern-mediterranean-and-middle-east-project-completed.html</a></p>	
The Cyprus Institute	CLICO: Climate Change, Hydro-conflicts and Human Security	<p>Ten cases of hydro-conflicts will be studied ranging from Niger, Sudan, the Jordan and Nile basins to Cyprus, Italy and the Sinai desert. A large dataset – the first of its kind – of hydro-conflicts in the Mediterranean, Middle East and Sahel will be regressed against climatic, hydrological and socio-economic variables. Policies and institutions at the national, international and transboundary levels will be investigated and their ability to face climate change and ensure human security will be assessed. Project results will be synthesised in a report that will identify potential security hotspots in the region and provide fresh policy ideas for promoting peace and security under changing hydro-climatic conditions.</p> <p><b>Funding:</b> EU (€226,560)  <b>Duration:</b> 36 months  <b>Website:</b> <a href="http://www.clico.org/">http://www.clico.org/</a></p>	

**Table 8.8. Research projects related to climate change impacts and adaptation**

Institution	Project	Description	Partners
Cyprus University of Technology	Effect of climate variability and climate change on crop production and water resources in Cyprus	The main aims of this study were (i) to assess trends in climate parameters during the past 30 years; (ii) to assess the effect of climate variability on changes in agricultural land use, production and irrigation water demand; and (iii) to assess the effect of possible climate change on crop production for the rest of this decade. <b>Funding:</b> national (€10,000) <b>Duration:</b> 6 months	The Cyprus Institute
Agricultural Research Institute	Economic impact of climate change on the Cypriot agricultural sector	The principal aim of the current study is to measure in a scientific manner the cost of climate change on Cypriot agriculture. In order to achieve this target three different approaches have been employed. Crop production in Cyprus is constrained by a highly variable climate, limited precipitation and high temperatures. In addition, global climate change and water management policies that support the sustainable use of water resources are also reducing irrigation water supply. The main aims of the climatic model were (i) to assess trends in climate parameters during the past 30 years; (ii) to assess the effect of climate variability on changes in agricultural land use, production and irrigation water demand; and (iii) to assess the effect of possible climate change scenarios and reduced irrigation water supply on crop production for the last seven seasons of this decade (2013/14-2019/20). <b>Funding:</b> national (€15,000) <b>Duration:</b> 12 months	Cyprus Institute, Cyprus University of Technology, Department of Meteorology, Aristotle University of Thessaloniki (Greece)
Agricultural Research Institute	Adapt2change - Adapt agricultural production to climate change and limited water supply	Adapt2change involves the construction and operation of a pilot greenhouse plant, and demonstration of methods to ensure the optimal utilization of natural resources in greenhouse cultivations, increasing agricultural production and reducing production costs. The overall project objective is to show the adjustment of agricultural production to climate change and limited water supply. In particular, it aims to reduce the water used in agricultural production by introducing a method of recycling water through a closed, fully automated hydroponic greenhouse system while at the same time reducing the fossil fuel energy demands by using renewable shallow geothermal energy sources. <b>Funding:</b> EU + national (€ 2,576,548) <b>Duration:</b> 48 months <b>Website:</b> <a href="http://www.adapt2change.eu">http://www.adapt2change.eu</a>	T.E.I Larissa (Greece), T.E.I Piraeus (Greece), Europliroforissi S.A. (Greece)
Open University of Cyprus	Priority Habitats, Protected Sites and Climate Change: Three Investigations to Inform Policy and Management for Adaptation and Mitigation	This project carried out for Defra has three objectives which address the issues outlined above, namely: (1) To assess whether the current UK network of protected sites and the legal framework for it will be able to continue delivery of the intended objectives for biodiversity under climate change; (2) To determine the implications of climate change on implementation of Common Standards Monitoring of protected sites; (3) To provide a quantitative estimate of, and to review the contribution of Priority Habitats to mitigation of climate change. <b>Funding:</b> UK (€ 150,000) <b>Duration:</b> 48 months	University of Reading (UK), University of Aberdeen (UK), Institute for European Environmental Policy (UK), Treweek Environmental Consultants (UK), Bodsey Ecology (UK)

Institution	Project	Description	Partners
Open University of Cyprus	Forest fires under climate, social and economic changes in Europe, the Mediterranean and other fire-affected areas of the world (FUME)	<p>FUME will learn from the past to understand future impacts. Mod. 1 we will study how LULC and socioeconomics changed and how climate and weather affected fire in dynamically changing landscapes. Fires will be mapped throughout Europe to determine hazard burning functions for LULC types. Since climate has changed, an attempt to attribute (sensu IPCC) fire regime change to climate, differentiating it from socioeconomic change, will be made. Mod. 2 will produce scenarios of change (climate, including extremes, land-use land-cover, socioeconomics, vegetation) for various emissions pathways and three time-slices during this century. With these and results from Mod.1, models and field experiments projected impacts on fire-regime and vegetation vulnerabilities will be calculated, including climate extremes (drought, heat-waves). Mod. 3 will investigate adaptation options in fire- and land-management, including restoration. Fire prevention and fire fighting protocols will be tested/ developed under the new conditions to mitigating fire risks. A company managing fire will be a key player. Costs and policy impacts of changes in fire will be studied.</p> <p><b>Funding:</b> EU (€7,351,825)  <b>Duration:</b> 36 months  <b>Website:</b> <a href="http://climate-adapt.eea.europa.eu/projects1?ace_project_id=1405">http://climate-adapt.eea.europa.eu/projects1?ace_project_id=1405</a>  <a href="http://www.fumeproject.eu/">http://www.fumeproject.eu/</a></p>	Universidad de Castilla-La Mancha (ES), Centro de Estudios Ambientales del Mediterráneo (ES), Università degli Studi della Tuscia (IT), Centre National de la Recherche Scientifique (FR), Fundação da Faculdade de Ciências da Universidade de Lisboa (PT), National and Kapodistrian University of Athens (GR) et al.
Frederic University	The impact of climate change on the local endemic plants of Troodos National Forest Park	<p>The project's main objective was the investigation of the climate change effects on critical parameters of the reproductive biology of local endemic plant species of the Troodos National Forest Park in Cyprus. In the framework of this study, a recording of the locations of the subpopulations of the species took place, along with the reproductive potential and relative reproductive success of individuals from three altitudinal positions (low, medium and high altitude). Emphasis was placed on investigating the seed germination from subpopulations from different altitudes, in existing and "future" conditions of temperature (estimations for the period from 2071 to 2100).</p> <p><b>Funding:</b> national (€109,715)  <b>Duration:</b> 38 months  <b>Website:</b> <a href="http://www.ncu.org.cy/troodos/lang1/index.html">http://www.ncu.org.cy/troodos/lang1/index.html</a></p>	National and Kapodistrian University of Athens (Greece), Department of Forests
Frederic University	Biodiversity patterns (flora and invertebrate fauna) regarding local climate change in Cyprus	<p>The project's main objective was the ecological study of the flora, the Orthoptera and the hemerobious Lepidoptera in two mountainous areas of Cyprus which are included in the NATURA 2000 network (National Forest Park of Troodos and Madari area).Development of an Interdisciplinary Programme on Climate Change and Sustainability Policy</p> <p><b>Funding:</b> EU + national (€104,758)  <b>Duration:</b> 38 months  <b>Website:</b> <a href="http://www.ncu.org.cy/biodiversity_patterns.html">http://www.ncu.org.cy/biodiversity_patterns.html</a></p>	Ioannina University (Greece), Exeter University (UK), Department of Forests, Department of Environment
Department of Environment	Development of a national strategy for adaptation to climate change adverse impacts in Cyprus (CYPADAPT)	<p>The project's main aim is to strengthen and increase Cyprus adaptive capacity to climate change impacts through the development of a National Adaptation Strategy. This is expected to be achieved through the following specific objectives: Describing climate change and its impacts; Projecting future climate changes and providing estimates of potential impacts; Assessing the sensitivity of different systems, sectors or communities to climate change; Assessing adaptive capacity, vulnerability and opportunities associated with climate change; Proposing appropriate actions that should be taken immediately as well as policies for future actions</p> <p><b>Funding:</b> EU + national (€1,358,847)  <b>Duration:</b> 31 months  <b>Website:</b> <a href="http://uest.ntua.gr/cypadapt/">http://uest.ntua.gr/cypadapt/</a></p>	National Technical University of Athens (Greece), National Observatory of Athens (Greece)

**Table 8.9. Research projects related to climate change mitigation**

Institution	Project	Description	Partners
Cyprus University of Technology	Energy data analysis for Cyprus in the framework of projects “ODYSSEE-MURE 2010” & ODYSSEE-MURE 2012” – Monitoring of EU and national energy efficiency targets	These studies have contributed to a detailed collection of appropriate energy data and information about national energy efficiency policies and measures in Cyprus. As a result, detailed national energy balances for Cyprus were compiled, and a detailed analysis of the evolution of aggregate and sectoral energy efficiency indices was prepared – for the first time in Cyprus. <b>Funding:</b> EU (€17,000) <b>Duration:</b> 60 months <b>Website:</b> <a href="http://www.odyssee-indicators.org">www.odyssee-indicators.org</a>	Cyprus Institute of Energy
Cyprus University of Technology	Ground Source Heat Pump systems for nearly zero energy buildings: Energy, environmental and economic assessment for Cyprus	The aim of this project is to assess the use of a combination of ground source heat pump (GSHP) systems with photovoltaic (PV) systems for the building sector of Cyprus from an energy, environmental and economic viewpoint, and to explore their potential to contribute to the achievement of nearly zero energy buildings for the country’s climate conditions. <b>Funding:</b> national (€97,500) <b>Duration:</b> 24 months	
Cyprus University of Technology	Long-term energy planning of Cyprus: Update of the National Renewable Energy and Energy Efficiency Action Plans	With the aid of specialised long-term energy forecast models developed in the Cyprus University of Technology, the national Action Plans for Renewable Energy Sources and Energy Efficiency will be updated in order to assist official authorities of the Republic of Cyprus to fulfil their formal reporting obligations to the European Commission. For this purpose, up-to-date projections of macroeconomic variables and international energy prices will be taken into account, along with recent technical and economic data for energy technologies and national policies and measures. <b>Funding:</b> national (€4,700) <b>Duration:</b> 3 months	
Cyprus University of Technology	GREENFILM	The project intends to fabricate a low-cost, low-weight, reproducible, homogeneous, durable, flexible, smooth surfaced, transparent greenhouse cover with increased albeit regulated insulation capability through the use of a liquid-based polymer nanocomposite. The end goal is that the new cover will regulate the energy flow to the greenhouse, thus leading to considerable energy savings in greenhouse production. <b>Funding:</b> national (€187,729) <b>Duration:</b> 30 months <b>Website:</b> <a href="http://nanogreenfilm.com/">http://nanogreenfilm.com/</a>	Agricultural Research Institute, University of Patras (Greece), CNE Technology Center, Elysee Irrigation Ltd
Agricultural Research Institute	KE.Δ.ΕΛ.Ε.Α	Therefore, goals of this program are the construction and operation of a management center for the collection, processing and disposal of olive husk for energy recovery purposes, sustainable development of areas, promotion of a renewable energy, as well as the development of a comprehensive framework for the operation of olive husk management centres in Greece and Cyprus. <b>Funding:</b> EU + national + Greece (€534,500) <b>Duration:</b> 24 months <b>Website:</b> <a href="http://olive-energy.eu/">http://olive-energy.eu/</a>	Frederick Research Center, NAGREF-institute for olive tree & subtropical plants of Chania (Greece), Municipality of Yeri

Institution	Project	Description	Partners
Lakatamia Municipality	Green Partnerships	<p>MED cities and regions have adopted local energy strategies for achieving the energy efficiency targets set by the EU. In Green Partnerships we will propose specific recommendations and solutions to overcome the obstacles the local authorities are facing in implementing the strategic plans. Lakatamia Municipality will run a pilot action valorising greenwaste waste and clippings (biowaste) to heat up the municipal pool during winter months.</p> <p><b>Funding:</b> EU (€1,976,060)</p> <p><b>Duration:</b> 29 months</p> <p><b>Website:</b> <a href="http://www.greenpartnerships.eu">www.greenpartnerships.eu</a></p>	Slovene Chamber of Agriculture & Forestry (Slovenia), GERES (France), Kyoto Club (Italy), Granollers city council (Spain), Energy Agency North Alentejo (Portugal), Insitute of Spatial Planning (Croatia)
Frederic University	Design and development of collection, management and distribution centers for the exploitation of olive solid waste energy purposes	<p>Objectives: •The identification of best technical practices for processing olive husk for energy recovery purposes; •The design and development of a pilot center that will serve as a pre-treatment and managing centre for the introduction of olive husk as a biofuel into the biofuel market. The determination of the minimum requirements for the development of collection and transport network to integrated management centres; •The development of a permanent olive husk price observatory; •The definition of a mechanism for the estimation of the annual olive husk potential that can be utilized for energy purposes in Cyprus and in Crete as well as the potential contribution of the olive husk to the energy mix of the involved countries.</p> <p><b>Funding:</b> EU (€534,500)</p> <p><b>Duration:</b> 24 months</p> <p><b>Website:</b> <a href="http://olive-energy.eu">http://olive-energy.eu</a></p>	Agricultural Research Institute, Yeri Municipality, NAGREF Institute for Olive Tree & Subtropical Plants of Chania (Greece)
Frederic University	Development of an innovative, forced regulation, high efficiency, solar heating system to operate autonomously without electricity	<p>The project concerns: • The design and development of a new autonomous forced circulation solar thermal system; • The upgrading of the existing production procedures with the use of advanced technologies and simulation software.</p> <p><b>Funding:</b> EU + national (€192,846)</p> <p><b>Duration:</b> 24 months</p> <p><b>Website:</b> <a href="http://www.theocollector.com">http://www.theocollector.com</a></p>	THEOHALKO Solar Energy Industry Ltd, CNE Technology Ltd
Frederic University	Urban Greening Systems for the Mediterranean Region	<p>Urban Greening uses technologies that are widely known to mitigate urban heat island effects, storm-water runoff, as well as provide thermal conditioning for buildings, thus significantly contributing to sustainable construction and development. The main objective of this project is to capitalize on the existing knowledge of partner organizations, and transfer this know-how to practitioners in Cyprus. The specific tasks to of this effort include 1) the development of technical-nature instructional material on UG technologies, and 2) the training of a small number of engineers and scientists to subsequently act as a nucleus for further dissemination such technologies.</p> <p><b>Funding:</b> EU + national (€332,405)</p>	University of Seville (Spain), Agricultural University of Athens (Greece), University of Malta (Malta), P. Papadopoulos Consulting Engineers Ltd, Agricultural Research Institute et al.
Frederic University	Wave energy converter mechanism by transmitting reciprocating, variable amplitude and direction wave motion into uni-rotational motion	<p>The basic objective of this project is to develop a high efficiency WEC, incorporating a novel and patented mechanism that allows capturing and subsequently converting, all of the entire exploitable wave energy, which by nature is unpredictable, irregular and random.</p> <p><b>Funding:</b> EU + national (€1,399,456)</p> <p><b>Duration:</b> 24 months</p>	University of Cyprus, Department of Public Works, Department of Sea Works, Energy Service

Institution	Project	Description	Partners
Frederic University	Development of a database and of software for the study and construction of low energy buildings in Cyprus	The main goal is the development of a database and software for the study and construction of low energy buildings in Cyprus <b>Funding:</b> EU + national (€177,001) <b>Duration:</b> 30 months <b>Website:</b> <a href="http://www.audesy.com/Research.html">http://www.audesy.com/Research.html</a>	Audesy Ltd, Kentro Ananeosimon Pigon Energieas (Greece), 4M A.E. (Greece)
Frederic University	Grid-connected Photovoltaic substation with parallel electricity storage in the form of hydrogen	<b>Funding:</b> national (€180,512) <b>Duration:</b> 24 months	Hystore Technologies Ltd, SavCo Technical Services Ltd
Frederic University	Hydrogen production, purification and storage with the use of Renewable Energy Sources, such as Solar and Wind Energy	<b>Funding:</b> national (€124,904) <b>Duration:</b> 60 months	Hystore Technologies Ltd
Frederic University	Distributed electricity generation with the use of H2/Fuel Cells, with zero CO <sub>2</sub> emissions	The main objective of this project was the development of a hydrogen fuel cell distributed generation technology. A pilot plant was installed and the behaviour of the technology when grid connected had been investigated. <b>Funding:</b> national (€170,862) <b>Duration:</b> 36 months <b>Website:</b> <a href="http://www.eac.com.cy/EN/Pages/DistributedGeneration.aspx">http://www.eac.com.cy/EN/Pages/DistributedGeneration.aspx</a>	Electricity Authority of Cyprus, National Technical University of Athens (Greece), Hystore Technologies Ltd
Frederic University	Cluster Pilot Project for the Integration of Renewable Energies into European Energy Sectors Using Hydrogen	The objective of the Project was to prove that this clean production of hydrogen is feasible at industrial level, and that the problem of temporary energy storage that is usually inherent in many renewable energy sources, can likewise be overcome. Therefore, the integration of renewable energy sources with the recently promoted "hydrogen vector" is what is being presented through this European project. <b>Funding:</b> EU (€6,000,000) <b>Duration:</b> 60 months <b>Website:</b> <a href="http://www.res2h2.com/">http://www.res2h2.com/</a>	University of Las Palmas (Spain), Inabensa (Spain), Electricity Authority of Cyprus, PLANET -Planungsgruppe Energie und Technik GbR (Germany), INTA (Spain) et al.
Timber Training & Research Centre	Short Rotation Forestry in Cyprus	The purpose of this research project is to establish the feasibility and sustainability of using the SRF practice as a source for raw material. Also this study aims to establish output and information for operational scale establishment of SRF in Cyprus and in parallel to secure the implementation of National and European Union targets in the fields of wood supply, carbon sequestration and generally the protection of the environment. <b>Funding:</b> own (€300,000) <b>Duration:</b> 96 months	



Institution	Project	Description	Partners
Technical Chamber of Cyprus	Sustainable Construction in Public and Private Works through IPP approach	<p>The main objective of SUSCON project is the adoption and application of “sustainable construction” concept in the practices of construction industries, engineering consulting companies which draft technical specification of civil works, public authorities which issue technical tenders, suppliers of construction materials and other stakeholders involved in this field</p> <p><b>Funding:</b> national + EU  <b>Duration:</b> 36 months  <b>Website:</b> <a href="http://www.uest.gr/suscon/suscon.html">http://www.uest.gr/suscon/suscon.html</a></p>	University of Cyprus, Cybarco Ltd, Edrasis, National Technical University of Athens
Cyprus University of Technology	Novel Abundant Semiconductor Materials for Thin Film Photovoltaics	<p>The interest in thin Cu<sub>2</sub>ZnSnS<sub>4</sub> films has increased in recent years due to their potential applications in thin film solar cells as the constituent elements are abundant in nature, and therefore if this compound can be made into an efficient solar cell it will be able to address the large volume production required to meet future energy demands from renewable energy sources. The ultimate objective of this project will be the development of efficient (&gt;12%) Cu<sub>2</sub>ZnSnS<sub>4</sub>-based solar cells a feat yet to be accomplished, as today’s best devices are in the 6-7% range.</p> <p><b>Funding:</b> national + EU (€117,019)  <b>Duration:</b> 30 months</p>	University of South Florida, University of Cyprus
The Cyprus Institute	CSP-DSW: Cogeneration of Electricity and Desalinated Sea Water using Concentrated Solar Power	<p>Design and installation of a pilot (demonstration) plant will utilize solar power technology and tested desalination methods in a more efficient and environmental-friendly combined thermodynamical cycle for the production of water and simultaneous production of economically competitive, green energy.</p> <p><b>Funding:</b> national (€258,750)  <b>Duration:</b> 16 months  <b>Website:</b> <a href="http://www.cyi.ac.cy/index.php/csp-dsw-overview.html">http://www.cyi.ac.cy/index.php/csp-dsw-overview.html</a></p>	MIT (USA), University of Illinois at Urbana Champagne (USA), Electricity Authority of Cyprus
The Cyprus Institute	EU-SOLARIS: The European Solar Research Infrastructure for Concentrated Solar Power	<p>EU-SOLARIS aims to create a new legal entity to explore and implement new and improved rules and procedures for research infrastructures (RI) for Solar Thermal Electricity (STE) technology, in order to optimize RI development and RTD coordination. The success of this initiative-specifically addressed during the PP-will be the establishment of a new governance body, aided by sustainable financial models.</p> <p><b>Funding:</b> EU (€154,500)  <b>Duration:</b> 48 months</p>	
The Cyprus Institute	MED-CSD: Combined solar power and desalination plants: technico-economic potential in Mediterranean Partner countries	<p>The main objectives of the project are: To carry out feasibility studies of power plants combining Concentrating Solar Power (CSP) technology with seawater desalination in the Mediterranean region; To make a technology review and a selection of concentrated solar power and desalination configurations adapted for application in the Mediterranean partner countries; To assess the technico-economic potential of this type of combined generation in the region.</p> <p><b>Funding:</b> EU (€31,030)  <b>Duration:</b> 48 months</p>	

Institution	Project	Description	Partners
The Cyprus Institute	STEP - EW:	<p>The project's objective is to build an experimental solar thermal cogeneration unit in Cyprus, which will be based on the feasibility study already carried out by the Cyprus Institute for a similar pilot plant. The construction will confirm the technical feasibility of the innovative idea of cogeneration of desalinated water and electricity by using concentrated solar energy on a small scale and realistic environmental and operating conditions. The cogeneration units have the ability to reliably and consistently produce water and electricity according to specific needs.</p> <p><b>Funding:</b> EU (€698,800)  <b>Duration:</b> 24 months</p>	Electricity Authority of Cyprus, Water Development Department, Foundation for Research and Technology (Hellas)
The Cyprus Institute	STS-MED: Small scale Thermal Solar district units for Mediterranean Communities	<p>STS-Med focuses on the development, implementation and diffusion of pioneering technologies to improve energy efficiency in public buildings. The project also intends to create new business opportunities, notably by supporting the involvement of SMEs in local solar energy supply chains generated by the construction of the 4 pilot plants.</p> <p><b>Funding:</b> EU (€555,573)  <b>Duration:</b> 36 months  <b>Website:</b> <a href="http://www.stsmed.eu/">http://www.stsmed.eu/</a></p>	
The Cyprus Institute	OPTS: OPTimization of a Thermal energy Storage system with integrated Steam Generator	<p>OPTS project aims at developing a new Thermal Energy Storage (TES) system based on single tank configuration using stratifying Molten Salts as a heat storage medium with an integrated Steam Generator (SG). The goal is to provide efficient, reliable and economic energy storage and steam production for the next generation of trough and tower plants.</p> <p><b>Funding:</b> EU (€516,702)  <b>Duration:</b> 36 months  <b>Website:</b> <a href="http://www.opts.enea.it/">http://www.opts.enea.it/</a></p>	
University of Cyprus	THERMOFILM	<p>The project is based on the novel idea that the proposed structures should have resistivity characteristic of a metal and thermopower characteristic of a semiconductor. Theoretical studies have examined similar structures and predict significant enhancements in the thermoelectric power factor. Recent experimental studies in bulk materials and thin film structures have provided evidence in support of these predictions and hence, the impetus for further systematic studies.</p> <p><b>Funding:</b> national (€386,810)  <b>Duration:</b> 36 months  <b>Website:</b> <a href="http://www.eng.ucy.ac.cy/mme/cfo_pld_group/thermofilm/">http://www.eng.ucy.ac.cy/mme/cfo_pld_group/thermofilm/</a></p>	Aristotle University of Thessaloniki (Hellas)
Cyprus Energy Agency	SEAP +	<p>SEAP-PLUS aims at the enhancement of the CoM results and impact in both quantitative and qualitative terms: bring more Signatories and Supporting Structures in CoM, help in the preparation of more and better SEAP, but also trigger cooperation of Local Authorities with Regional Authorities and Energy Stakeholders and cooperation between experienced and learning CoM participants.</p> <p><b>Funding:</b> EU (€1,986,189)  <b>Duration:</b> 30 months  <b>Website:</b> <a href="http://www.seap-plus.eu">www.seap-plus.eu</a></p>	Technical Chamber of Greece, ICLEI Europasekretariat GmbH (Germany), Diputacio de Barcelona (Spain), Jokkmokks kommun (Sweden), Agenzia regionale per l' Energia della Liguria spa (Italy), et al.

Institution	Project	Description	Partners
Cyprus Energy Agency	'Sustainable Energy Action Plans in Support of the Islands Pact' – [ISLE-PACT]	The ISLE-PACT project is an initiative of 12 groups of European island authorities aiming to achieve an overall objective of more than 20% CO <sub>2</sub> emissions reduction by 2020. Develop Island Sustainable Energy Action Plans (ISEAPs). <b>Funding:</b> EU (€3,737,493) <b>Duration:</b> 40 months <b>Website:</b> www.islepact.eu	Western Isles – Comhairle Nan Eilean Siar (UK), Municipality of Gotland (Sweden), The Regional Agency for Energy and Environment of Madeira (Portugal), The Canary Islands Institute of Technology (Spain), Network of Aegean Islands for Sustainability (Greece), Punto Energia Provincia di Sassari (Italy), et al.
Cyprus Energy Agency	MEDEEA Transfer and adaptation of the European energy award to Mediterranean cities	"The "European Energy Award" (EEA) rewards cities and towns with a label for outstanding efforts in the governance of energy related fields (especially energy efficiency). EEA rewards municipal integrated energy planning & activities with the aim to reach and go beyond the "20-20-20" EU energy objectives in the Mediterranean regions. <b>Funding:</b> EU (€1,456,714) <b>Duration:</b> 36 months <b>Website:</b> www.interregmedeea.eu	Regional Energy Agency of Liguria (Italy), Regional Energy Agency of Crete (Greece), Malta Intelligent Energy Management Agency, Association of Municipalities and Towns of Slovenia, Agency of Energy management of the province of Jaen (Spain), et al.
Cyprus Energy Agency	MESHARTILITY - Improve local authorities participation in local energy planning	One of the main weaknesses of the Med area is that its regions have an energy efficiency level that is lower than the EU average. The aim of this project is to promote energy planning to increase the efficiency. This will reduce the emission of greenhouse gases which are very harmful to the environment and the costs related to energy. The Med region has a high potential with regards to renewable energy, such a solar energy." <b>Funding:</b> EU (€2,425,850) <b>Duration:</b> 36 months <b>Website:</b> www.meshartility.eu	Save Energy Agency of Region de Murcia (Spain), ENEL Distribution (Italy), ICLEI European Secretariat GmbH (Germany), Energiaextremadura (Spain), KSEENA (Slovenia), et al.
Cyprus Energy Agency	SMILEGOV	The MESHARTILITY (Measure and share data with utilities for the Covenant of Mayors) project aims at the development of solutions and tools facilitating exchange of energy data between energy utilities and local authorities that are busy assessing local greenhouse gas (GHG) emissions and planning action to address this through energy savings, energy efficiency and the use of renewable energy. These solutions and tools will help cities, who are signatories of the Covenant of Mayors, to develop their Sustainable Energy Action Plans (SEAPs). <b>Funding:</b> EU (€1,521,738) <b>Duration:</b> 30 months <b>Website:</b> www.smilegov.eu	Network of Aegean Islands for Sustainability (Greece), Conference of Peripheral Maritime Regions of Europe (Belgium), Region Gotland (Sweden), et al.

**Table 8.10. Research projects related to climate change modelling**

<b>Institution</b>	<b>Project</b>	<b>Description</b>	<b>Partners</b>
Frederic University	Study of the extreme changes of the future climate in the Cyprus region	The project's main objective was to use models to predict possible extreme climatic changes in the Eastern Mediterranean, by the end of the 21st century. <b>Funding:</b> national (€104,384) <b>Duration:</b> 26 months <b>Website:</b> <a href="http://www.ncu.org.cy/extreme_changes_climate.html">http://www.ncu.org.cy/extreme_changes_climate.html</a>	
The Cyprus Institute	Consistent computation of the chemistry-cloud continuum and climate change in Cyprus	The project aims to improve the understanding of aerosol and cloud processes and their representation in regional and global climate models. We have developed a new numerical method that consistently computes atmospheric trace gas and aerosol chemistry, and can be applied to compute the initial stage of cloud formation. It will allow for a direct coupling in climate models between aerosol chemical composition, being influenced by pollution emissions, and the continuum between hazes and clouds. The project focuses on the Mediterranean region because it is a hot spot in climate change exposed to drying and air pollution. <b>Funding:</b> EU (€2,196,000) <b>Duration:</b> 72 months <b>Website:</b> <a href="http://www.cyi.ac.cy/climatechangeandimpact-ongoing/item/202-c8-consistent-computation-of-the-chemistry-cloud-continuum-and-climate-change-in-cyprus.html">http://www.cyi.ac.cy/climatechangeandimpact-ongoing/item/202-c8-consistent-computation-of-the-chemistry-cloud-continuum-and-climate-change-in-cyprus.html</a>	Max Planck Institute for Atmospheric Chemistry (Germany)
The Cyprus Institute	DARECLIMED: Data Repositories and Computational Infrastructure for Environmental and Climate Studies in the Eastern Mediterranean	The purpose of DARECLIMED is to create the appropriate environment for the formation of a regional data infrastructure devoted to paleo-, current- and future climate, energy and water related data. <b>Funding:</b> own (€188,272) <b>Duration:</b> 30 months <b>Website:</b> <a href="http://www.cyi.ac.cy/climatechangeandimpact-ongoing/item/210-dareclimed-data-repositories-and-computational-infrastructure-for-environmental-and-climate-studies-in-the-eastern-mediterranean.html">http://www.cyi.ac.cy/climatechangeandimpact-ongoing/item/210-dareclimed-data-repositories-and-computational-infrastructure-for-environmental-and-climate-studies-in-the-eastern-mediterranean.html</a>	Academy of Athens (Hellas), Tel-Aviv University (Israel), Weizmann Institute of Science (Israel), University of Crete (Hellas), Istanbul Technical University (Turkey), Jordan Meteorological Department (Jordan)
The Cyprus Institute	AGWATER: Options for sustainable agricultural production and water use in Cyprus under global change	The project will make use of an intelligent predictive modelling and mapping approach to generate a 1:50,000 soil map for Cyprus with the necessary soil physical properties required by the model. Agro-climatic zones will be mapped and an agro-meteorological database will be developed with daily data for the period 1981-2010. Policy and economic scenarios will be developed, representing 3 levels of water prices, 3 levels of subsidy measures, and 3 agricultural input/output price scenarios. Climate change projections for 2021-2050 will be developed for Cyprus, using a combination of dynamical and statistical downscaling. <b>Funding:</b> national (€68,440) <b>Duration:</b> 24 months	Cyprus Geological Survey, Cyprus Department of Meteorology, Agricultural Research Institute, Cyprus University of Technology
The Cyprus Institute	COMBINE: Comprehensive Modelling of the Earth System for Better Climate Prediction and Projection	COMBINE proposes to improve ESMs by including key physical and biogeochemical processes to model more accurately the forcing mechanisms and the feedbacks determining the magnitude of climate change in the 21st century. For this purpose the project will incorporate carbon and nitrogen cycle, aerosols coupled to cloud microphysics and chemistry, proper stratospheric dynamics and increased resolution, ice sheets and permafrost in current Earth system models. <b>Funding:</b> EU (€90,000) <b>Duration:</b> 48 months	

Institution	Project	Description	Partners
The Cyprus Institute	CLIMRUN: Climate Local Information in the Mediterranean region: Responding to User Needs	<p>CLIMRUN aims at developing a protocol for applying new methodologies and improved modelling and downscaling tools for the provision of adequate climate information at regional to local scale that is relevant to and usable by different sectors of society (policymakers, industry, cities, etc.). The protocol is assessed by application to relevant case studies involving interdependent sectors, primarily tourism and energy, and natural hazards (wild fires) for representative target areas (mountainous regions, coastal areas, islands).</p> <p><b>Funding:</b> EU (€299,200)</p> <p><b>Duration:</b> 36 months</p> <p><b>Website:</b> <a href="http://www.climrun.eu/">http://www.climrun.eu/</a></p>	

**Table 8.11. Research projects related to climate change monitoring**

<b>Institution</b>	<b>Project</b>	<b>Description</b>	<b>Partners</b>
Frederic University	Cyprus Ionospheric Forecasting service	Project to establish a High Frequency (HF) operational service for real-time specification (now-casting) and short-term forecasting of the state of the ionosphere over the eastern Mediterranean region. This real-time service will be based on ionosonde measurements from Cyprus and will involve the application of existing modelling techniques and the development of mathematical methods and visualisation tools for the forecasting and regional mapping of ionospheric characteristics and provision of associated warning information to enhance HF communication systems operating in the region. <b>Funding:</b> National + EU (€150,000) <b>Duration:</b> 24 months	National Institute of Geophysics and Volcanology (Italy), Ministry of Defense, Centre of Applied Research and Technology
Frederic University	Installation and operation of an ionospheric monitoring station	Project for supporting the acquisition, elaboration, evaluation, dissemination and archiving of ionospheric observations above Cyprus. <b>Funding:</b> National + EU (€230,000) <b>Duration:</b> 54 months	National Observatory of Athens (Greece), Leibniz Institute of Atmospheric Physics (Germany)
Oceanography Centre	MedGLOSS: Sea Level Stations....	The MedGLOSS programme of sea level monitoring network in the Mediterranean and Black seas was established jointly by CIESM and IOC/UNESCO in 1997, upon a bi-lateral agreement signed by the two organizations in response to the forecasted global climate change and sea level rise. The Paphos MedGLOSS Cyprus station was funded by CIESM within the CIESM-IOC-MedGLOSS pilot network programme. We continue to operate and maintain the station. <b>Funding:</b> Own <b>Duration:</b> ongoing <b>Website:</b> <a href="http://www.oceanography.ucy.ac.cy/cycofos/MEDGloss.html">http://www.oceanography.ucy.ac.cy/cycofos/MEDGloss.html</a>	Israel
Oceanography Centre	CYBO-Cyprus Basin Oceanography	The Centre performs scientific open sea cruises, periodically, in the EEZ of Cyprus in the Levantine Basin. These cruises measure primarily physical parameters, such as temperature, salinity, depth (CTD), plus some biogeochemical parameters such as dissolved oxygen, nutrients, chlorophyll. A large portion of the EEZ is covered, as is a large portion of the depths (upper 1000 m of the ocean). The CYBO project is a multiyear project aimed to study the seasonal and inter-annual variability of the general circulation of the Cyprus-SE Levantine basins, Eastern Mediterranean Sea, simultaneously at the coastal and open deep sea areas around Cyprus. <b>Funding:</b> Own <b>Duration:</b> 18 years, ongoing <b>Website:</b> <a href="http://www.oceanography.ucy.ac.cy">http://www.oceanography.ucy.ac.cy</a>	Israel
Oceanography Centre	GROOM: Gliders for Research, Observing, and Ocean Management	The objective of the GROOM project is to design a new European Research Infrastructure that uses underwater gliders for collecting oceanographic data. This new infrastructure shall be beneficial for a large number of marine activities and societal applications, which can be related to climate change, marine ecosystems, resources, or security and which rely on academic oceanographic research and/or operational oceanography systems. Gliders will be part of the ocean observing systems in the future, both at regional and global scales, both at synoptic and climatic time scales. GROOM will define the scientific, technological, and legal framework of this European glider capacity. This study will lay out the groundwork on how to establish such a system, and demonstrate the capability through pilot experiments. <b>Funding:</b> EU (€3,500,000) <b>Duration:</b> 36 months <b>Website:</b> <a href="http://www.groom-fp7.eu">http://www.groom-fp7.eu</a>	LOCEAN (France), GEOMAR (Germany), CSIC (Spain), OGS (Italy)

Institution	Project	Description	Partners
Oceanography Centre	Hydrochanges	<p>In situ measurements of temperature and salinity, collected with adequate spatial and temporal resolutions, and with particular attention to sensitive, often long-neglected Mediterranean areas (straits and channels, zones of dense water formation, deeper parts of the basins), constitute a priority, particularly in the current context of global climate change. To this effect, our CIESM program is deploying/monitoring an array of stations that could be viewed in time as the marine counterpart of meteorological stations. A station is composed of a short (~10 m high) subsurface mooring equipped with an autonomous CTD (1 to 2-hr sampling interval) and usually a current-meter.</p> <p><b>Funding:</b> Own  <b>Duration:</b> ongoing  <b>Website:</b> <a href="http://www.ciesm.org/marine/programs/hydrochanges.htm">http://www.ciesm.org/marine/programs/hydrochanges.htm</a></p>	Italy
Oceanography Centre	MEDship	<p>The CIESM body coordinates and brings together all kinds of marine scientists from the Mediterranean and Black Seas. It has encouraged this initiative to increase the number and quality of ship-based observations of physical, chemical, and biological in the Mediterranean. Special emphasis is given on the deepest layers and longest (climatic) time scales. A link has been made with a similar global initiative called 'GO-SHIP', in which high standards for data collection, analysis, and distribution are set for the global oceans. This program is actively seeking funding to be implemented, but already coordination between partners is taking place.</p> <p><b>Funding:</b> Own  <b>Duration:</b> ongoing  <b>Website:</b> <a href="http://www.ciesm.org/news/ciesm/170611.htm">http://www.ciesm.org/news/ciesm/170611.htm</a></p>	CIESM
Oceanography Centre	JellyWatch	<p>The CIESM Jelly Watch Program was set up to gather for the first time baseline data on the frequency and extent of jellyfish outbreaks across the Mediterranean Sea. After a successful pilot test phase involving a few countries, a common, standardized protocol including systematic recording of presence/absence data has been adopted for both coastal and open sea sightings of jellyfish swarms in the whole Basin, enabling an unbiased assessment of the geographic and temporal scale of these mass events so as to allow in time trend analysis and short term forecasting of jellyfish bloom transport.</p> <p><b>Funding:</b> Own  <b>Duration:</b> ongoing  <b>Website:</b> <a href="http://www.ciesm.org/marine/programs/jellywatch.htm">http://www.ciesm.org/marine/programs/jellywatch.htm</a></p>	CIESM

## 9. EDUCATION, TRAINING AND PUBLIC AWARENESS<sup>29</sup>

### 9.1. INTRODUCTION

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, Cyprus 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.

### 9.2. GENERAL POLICY TOWARD EDUCATION, TRAINING AND PUBLIC AWARENESS

Climate change in the context of formal and non - formal education is an issue of interdisciplinary investigation and interconnected with all the issues of environment and sustainable development as a matter of national, regional and international interest. The consideration of climate change in this context relies on the fact that climate change is not a mono-dimensional problem, cut off from the rest of the issues, but could be the apparent cause and consequence of a chain of direct and indirect human effects on all environmental issues. Within this context the issue of climate change is examined and treated in the following ways in the Cypriot educational system.

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, Cyprus has posed legal obligations for the access of information regarding the

state of the Environment. In addition, law no. 119(I)/2004 by which Cyprus 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 law, “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 Cypriot 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.

### 9.3. PRIMARY, SECONDARY AND HIGHER EDUCATION

#### 9.3.1. CURRICULUM ON ENVIRONMENTAL EDUCATION (EE) AND EDUCATION FOR SUSTAINABLE DEVELOPMENT (ESD).

Through the Curriculum of EE/ESD which is an important innovation in the educational system of Cyprus and is formatted in a uniform and systematic way for all educational levels, the issue of climate change examined through all the other related thematic units such as energy, production and consumption, urbanization, waste, water, transportation. Specifically, it is aimed that students understand in a systematic and holistic way that the problem of climate change is complex, has multiple causes and effects both locally and globally. For this purpose within the education process the issue is viewed through the social, political and cultural aspects, along with the environmental. Climate change is first examined in the immediate local environment of students and then extends through various teaching techniques, applications and examples globally.

For this purpose in the learning process a variety of methodological and pedagogical approaches (experiential learning, simulations, investigations etc.) applied in order to help students understand the impact of climate change on a local and global level. Also, the pedagogical principles of Environmental Education and

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Education for Sustainable Development as intergenerational communication, interaction with place, holistic investigation and action community are applied for studying climate changes.

Examples of issues that are approached through the curriculum on climate change are:

- Study of the effects of water scarcity at local and global level and awareness of the extent and complexity of the problem across the globe.
- Correlation of water shortage with other issues such as climate change and desertification.
- A study of the factors that contributed to the intensity of the problem of climate change.
- Reflection upon our responsibility on addressing the phenomenon of climate change and suggestion of measures to alleviate the problem.
- Investigation of the measures and actions taken at national and global level to address climate change.
- Interconnection of climate change around the world with the decline of biodiversity.
- Interconnection of the greenhouse effect and global climate change through energy consumption.
- Study of the impact of the increasing use of motorized vehicles on the environment at local and global levels (air pollution, climate change, etc.).
- Awareness of the impact of climate change on social, economic and political level.
- Cooperation of students with agencies and organizations to promote information measures, information and participation in intervention programs on climate change.

It is noted that the above issues are indicative regarding the investigation of environmental issues, since as mentioned above, the twelve thematic units of the curriculum concerning all educational levels approach systematically the issue of climate change.

### 9.3.2. EDUCATIONAL TOOLS FOR THE STUDY OF CLIMATE CHANGE

Specific educational tools for the study of climate change have not been produced at the national level, but all materials that have been authored to support the themes of the curriculum, approach interdisciplinary and holistically the issue of climate change. Indicatively, the educational tools "Issues in Education for Sustainable

Development " and "Rational waste management", are supporting tools for the teacher and the student to study the issues of production and consumption, transportation, desertification, tourism, poverty, waste, where there is special emphasis on the study of climate change. It is noted that the study of the issue of climate change is through the application of pedagogical techniques of Environmental Education and Education for Sustainable Development such as debate, simulations, use of new technologies, moral dilemma, concept maps, experimental investigations, bibliographic research, field study, etc. The above tools concern Primary and Secondary Education as a means to support the curriculum of EE/ESD.

In Secondary Education, where the curriculum on EE/ESD has not yet been introduced, the issue of climate change is examined and studied through various subjects. For example, it is referred to the subjects of Biology and Geography.

#### 1st Grade Biology: Activity Book

Examination of Greenhouse effect

- The importance of plants to maintain stable amounts of carbon dioxide in the atmosphere
- Relationship of photosynthesis and greenhouse
- How the increase the amount of carbon dioxide in the atmosphere causes a rise in the average temperature of the Earth
- How humans can cope with the increase in the average temperature of the Earth
- Activity which refers to changing the behaviour of mouflon in times of scarcity

#### 2nd Grade Biology Gymnasium: Activity Book

Topics included:

- Examination of the problem of climate change
- Investigation of the increase in average temperature in Cyprus from 1893 until today
- Investigation of the reduction of average rainfall in Cyprus from 1893 until today
- Investigation the impact of climate change on species' populations, ecosystems and ecological balance
- Human's role on the environmental of the problem of climate change

- Possible solutions, actions and behaviour changes on climate change that we can take individually or collectively
- Other environmental problems caused secondarily by climate change

#### Geography, Grade A Gymnasium: Book and workbook

- "The Earth and Man "
- Emphasis in anthropogenic systems.
- The global problems and challenges to be faced by humankind as expressed by the UN.
- Understanding and interpretation of human interactions with the environment and managing the challenges facing humanity, as is climate change.

#### Geography, Grade B Gymnasium: Book and workbook

The curriculum of Gymnasium Grade B Geography explores locally and internationally issues related to climate change as natural, urban and rural environments, natural hazards, natural resources management energy, management waste etc. The main issues which concern the curriculum of Grade B Geography are the ways in which they relate the above influencing factors, the patterns and the changes that occur and what will be the impact on the present and future generations.

### 9.3.3. HIGHER EDUCATION

Several undergraduate and postgraduate programmes in Cypriot Universities deal with diverse aspects of climate change. Undergraduate programmes in Civil & Environmental Engineering and Environmental Science & Technology as well as postgraduate and doctoral programmes in Environmental Engineering, Energy Resource Management, Environmental Science, Environmental Management, and Education for Sustainable Development, contain numerous courses on climate change impacts, economics and mitigation.

### 9.4. PUBLIC INFORMATION CAMPAIGNS

In addition to the information campaigns ran by NGOs (which are presented in later sections), there are a number of international campaigns in which the Department of Environment participates. An example is the "a world you like" campaign. This campaign is a European wide communication campaign that puts practical solutions at the centre of the climate change

debate. It shows how climate action can increase welfare and bring economic benefits. Discuss, promote and upload your low-carbon solutions on the campaign website, on social networks.

## 9.5. TRAINING PROGRAMMES

### 9.5.1. EDUCATION AND TRAINING OF TEACHERS ON CLIMATE CHANGE

The Ministry of Education and Culture emphasizes the importance of education and training for teachers on Environmental Education and Education for Sustainable Development. Regarding the issue of climate change at the level of teacher education and training, emphasis is given both through mandatory education and through training of teachers to implement the curriculum of the EE/ESD. Also, optional training seminars are offered, with emphasis on the interconnection and systemic examination of environmental issues and sustainable development issues, in which climate change is a key issue for discussion and analysis. Moreover, through the training seminars, special attention is given to familiarize teachers with teaching techniques that they can apply inside and outside the school in order to study the issue of climate change. Training seminars aiming to familiarize teachers with additional educational tools and resources which assist in the implementation of the curriculum of the EE/ESD are offered, with particular emphasis on climate change. Finally, the training of teachers on the issue of climate change is experiential and is conducted in specific areas of environmental interest, through two-day and three-day training seminars at the Environmental Education Centres. The Cyprus Pedagogical Institute, as the responsible institution of the Ministry of Education and Culture for the education and training of teachers is planning to provide educational seminars specifically on climate change, with the cooperation of other agencies and services involved in the issue (Department of Environment, Meteorology Service, Energy Service, Forestry Department etc.).

### 9.5.2. ENVIRONMENTAL EDUCATION PROGRAMS

All environmental education programs applied in all educational levels (Pre-primary, Primary, Secondary, Vocational and Technical Education) coordinated ( Gold-Leaf, Eco Schools, Young Reporters for the Environment, Globe, Semep, Litter less, Learning about Forests) approach climate change according to the theme processed by each participating school. Climate change is approached as a separate, independent study topic or incorporated dimensions of climate change on other related issues such as for example in the study of biodiversity.

Each program has its own objectives, but the ultimate purpose of all is the development of positive attitudes and behaviours concerning the environment and sustainable development, as well as their awareness on climate change.

## 9.6. RESOURCE OR INFORMATION CENTRES

### Environmental Education Centres

The issue of climate change in terms of non-formal education is approached systematically through the Network of Environmental Education Centres of the Cyprus Ministry of Education and Culture, which operates as a complementary structure of schools, with the aim of bringing environmental issues into fields of environmental interest and of transferring the learning process in terms of the environmental issues beyond and outside the context of the classroom. Specifically the issue of climate change is studied through all the Environmental Education Centres' Network (Pedoulas, Akrotiri, Athalassa and Salamiou) under specific environmental educational programs implemented at each centre. For example, at Pedoulas Environmental Education Centre climate change is discussed through environmental education programs concerning the biodiversity of the forests of the Troodos, the Amiantos mine field and desertification in the region, the degradation of soils. At the Athalassa Environmental Education Centre, climate change is examined in relation to urbanization, transport and Athalassa National Forest Park. At the Akrotiri Community Environmental Education Centre, climatic changes are discussed in relation to the wetland and flora and fauna of the region. Finally, at the Salamiou Environmental Education Centre, the issue of climate change is discussed in relation to local cultivations. An important element in the study of climate change at the non - formal level is the fact that

the issue is approached through field studies, where special attention is given to experimental investigation, the interaction of students with space and with local populations. Specifically, all the programs through which the issue of climate change is examined are presented in the website of the Network for Environmental Education Centres (<http://www.moec.gov.cy/dkpe/>).

## 9.7. INVOLVEMENT OF THE PUBLIC AND NON-GOVERNMENTAL ORGANISATIONS<sup>30</sup>

One of the most active campaigners for activities mainly associated with GHG mitigation is the Cyprus Energy Agency.

### 9.7.1. EDUCATIONAL PRESENTATIONS AT SCHOOLS

One of the main objectives of the Energy Agency is the systematic education/ information/ training and special attention is given to educational presentations at schools in Cyprus. Since April 2009, when the Energy Agency began its activities of education, the Energy Agency has visited more than 232 schools of all levels for educational presentations, where attended 29.453 students and 2.295 teachers on the issues of renewable energy, energy saving and environmental protection. Different presentations were prepared for different levels mainly divided according to the age of students. These presentations are being regularly updated.

#### Printed posters with energy saving tips

CEA continues the distribution of the poster for kids with energy saving tips to schools that educational activities take place and in other events. More than 40,000 posters have been distributed (out of 72,000).

#### Annual Kids Drawing Competition

The Cyprus Energy Agency since its date of establishment (2009) has been organising the annual kids drawing competition "I draw for renewable energy, energy saving and environmental protection", which is approved by the Ministry of Education and Culture. Every year CEA

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organizes the award ceremony for children who participated in painting competition. The chosen date for the ceremony is every June during the celebrations of the Environment Day. In 2013 the competition did not take place due to financial restrictions.

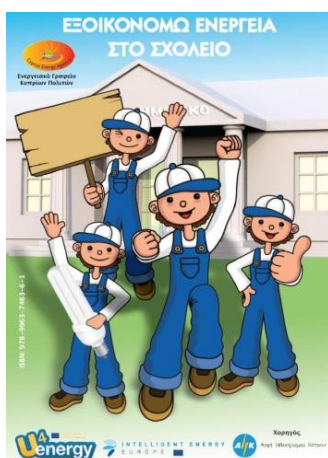
### Monthly Educational Quiz

The Monthly Quiz is available online since October 2009. The creation and operation of the monthly quiz is sponsored by the Electricity Authority of Cyprus. The quiz is available in the Kids Educational Corner on the website of CEA [www.cea.org.cy](http://www.cea.org.cy).



In the competition can participate children aged between 6 to 12 years old. They can register and respond correctly to 10 questions on renewable energy, energy saving and energy production. At the end of each month a winner emerges who responded correctly to 10 questions and CEA sends an educational award.

Since the date of launching the on-line quiz competition many pupils participated and 24 winners have been awarded.



### Training materials for teachers

CEA created two reports: “Notes for the elementary education teacher on RES and Energy Saving Techniques” and “Notes for the high school teachers on RES and Energy Saving Techniques”. Due to lack

of financial resources, both publications are available electronically only on the website of the Energy Agency [www.cea.org.cy](http://www.cea.org.cy) at the educational corner.

### Energy Saving at schools competition

The CEA launched a new competition at schools since September 2011 which was approved by the Ministry of Education and Culture. In the energy saving competition participate 5 schools of elementary education (Aradippou B, Pefkios Georgiadis, Soterias C, Geroskipou B and Limassol A) that are located at 5 different districts of Cyprus. The students of selected schools will be asked to write down about the electricity consumption in their schools and electricity meters will be placed to metering the consumption. After an educational session of simple methods on how to save energy at schools and at home, they will be asked to implement this method for a specific period. The students that will prove the greater energy saving according to electricity bills of their school will receive an educational personal award as well as for their school. A special guide was developed that is available on the web of CEA on the kids’ corner (educational corner).

The competition is organised by the Cyprus Energy Agency and approved by the Ministry of Education and Culture, with the valuable help of the Cyprus University of Technology and sponsored by the Electricity Authority of Cyprus.

**Working sheets** (that distributed during the educational presentations and working together with kids for better understanding of the educational presentations)



The Cyprus Energy Agency created the working booklets with drowns, crosswords, word search puzzle, drowning the slogan, text completion exercises. The working booklets distributed to teachers to use it as a supplementary educational material or distributed to students as a supplementary educational material.

### U4Energy – Schools in Action

The Cyprus Energy Agency has been appointed to be the National Contact Point to promote the U4Energy initiative in Cyprus.

Has promoted the U4Energy school competitions and has



been moderator for 2011-2012.

The U4energy competition is a unique opportunity for teachers and students to learn more about the efficient use of energy, making both short and long term actions.

For the second consecutive year elementary and secondary schools were invited to participate in this innovative competition and to contribute actively to the development of a more sustainable future. The second round of the competition U4energy has officially re-launched in September 2011 and completed in May 2012. After evaluation of applications, the schools emerged winners at both European and national level.

The schools were awarded in the award ceremony of the U4energy in Brussels, on Tuesday, November 28, 2012, in Belgian Comic Strip Centre.

The ceremony awarded the National Winners of each country and Europeans Winners. Teachers and students from Cyprus and from all European countries travelled to Brussels to attend the awards ceremony and receive their awards.

### **Energiochi 8**

The Cyprus Energy Agency was the National Contact Point to promote the Energiochi 8 initiative in Cyprus. Within the European Competition ENERGIACHI 8, held on May 28, 2013 in Abruzzo, Italy, the Awards Ceremony. Participated in the competition two schools of Cyprus, Agios Andreas Elementary School and the First Technical School of Nicosia, while the School of Agios Andreas rewarded for its hard work. The European Competition ENERGIACHI 8 is a special program that engages students of all classes for the academic year 2012-13. The funding is done by the Office of Energy Policy in the region of Abruzzo, in collaboration with the Ministry of Education, the Research University, the Regional Office of Education, Universities L'Aquila, Teramo, Chieti and the agency ENEA. The goal is the students to present their concerns and their sensitivity to the issues of renewable energy, energy saving and environmental protection.

## **9.7.2. PUBLIC INFORMATION CAMPAIGNS**

### **Printing of posters with energy saving tips**

The Cyprus Energy Agency designed and printed 4.000 posters for energy saving in offices and is being

distributed during the presentations contacted for municipalities office staff, governmental departments and in general for people working in offices.

The poster includes simple tips on how to save energy e.g. computer, during printing, lighting, and finally by heating and air conditioning.

### **RES and RUE training of targeted groups**

The Cyprus Energy Agency continues conducting presentations to the citizens either to rural or urban areas in order to informed about energy efficiency and RES applications in the domestic sector, energy saving at home, bioclimatic design and garden and Smart meters.

The presentations have specific target to inform people on these matters and these presentations are also available on-line. These presentations have been updated regularly. Since the date of establishment of the Cyprus Energy Agency more than 40 Communities/Municipalities were visited by CEA staff in organised events and more than 500 people attended CEA presentations.

Moreover, the Cyprus Energy Agency has developed one new presentation about the “Eco House – A house of almost zero energy”, that was presented with great success at Larnaca, Limassol and Pafos districts in collaboration with the Environment Commissioner and the Youth Boards. These presentations to the public were attended by more than 150 people.

Within 2011 the Cyprus Energy Agency has also developed two new presentations, the first one about eco-driving and the second one about energy saving practices at offices. These two presentations are conducted after requests from Municipalities or other public authorities. This new material has been commented by participants positively as they are conducted and distributed informative material. More than 175 people that belong either to municipalities’ staff or to public administration have attended those presentations.

### **Educational DVD**

The Cyprus Energy Agency in the context of its activities



and actions and particular in education, public information, undertook the initiative to create an educational documentary, which was presented for first time to the public on Wednesday 6 June 2012 in a public event in the context of celebrations of World Environment Day.

The educational documentary highlights the current electricity generation in Cyprus from fossil fuels in power stations in Cyprus, the impact of fossil fuels on the environment and the need for a shift in the use of Renewable Energy savings and environmental protection and contribution to the fight against climate change. Essentially, the film presents the most representative figures of Cyprus, written in plain language and addresses a wide range of audience. Those who are interested can receive free educational documentary from the Cyprus Energy Agency premises.



### **Radio spots**

Moreover, CEA has created 13 radio spots for sensitisation of all Cyprus citizens on energy saving issues. The radio spots have been on air on 3 radio channels with national coverage for 1,5 months (May-June 2012).

### **Media relationships**

CEA has very good relations with media and was invited by the CyBC (Cyprus Broadcasting, RIK 1) several times for live interviews as well as to the other national radio emissions, local TV etc.

### **Outdoor Activities**

The CEA participates in outdoor activities that are organized by local authorities or other organizations, events related with environmental protection or energy days. The Cyprus Energy Agency participates in the

events with the giant game "energy snake" where children participated with enthusiasm. The giant game is based on res, energy saving and climate questions.

### **9.7.3. RESOURCE OR INFORMATION CENTRES**

The project Buy Smart + establishes green procurement support offices in 15 countries participating in the project, delivering a national language guidance, education, good practice and well-tested tools. Buy Smart+ is supported by the program "Intelligent Energy Europe". The main objectives of Buy Smart+ are to consolidate and mainstream green procurement in 7 member states and to transfer the know-how to 8 member states where green procurement is still at an early stage. The main focus is to be on energy related technologies. The Cyprus Energy Agency is the information centre for 5 products: lighting, office equipment, vehicles, air conditions, household appliances, where citizens can visit and get informed.

Within Buy Smart+ CEA is the helpdesk for green public procurement, delivering in national language consultation, training, good practice, and well-tested tools. The latter include technical guidelines on several product groups (criteria from the GPP toolkit, adapted to each member state), life cycle cost calculation tools, and training material. A wider uptake of green procurement will be achieved through directly consulting and training purchasers. Through assisting pilot projects, a critical mass of successful green procurement cases will be achieved and subsequently communicated broadly.

The major steps are:

- Green procurement helpdesks providing assistance, know-how and tools in national language
- Dedicated training offers in collaboration with national networks for the private and public sector
- Twinning approach for effective transfer of know-how to newer member states
- Assistance to green procurement pilot projects; addressing of innovative technologies in experienced countries
- Monitoring of the green procurement experiences; policy recommendations for the NEEAPs updates in June 2014

#### 9.7.4. INTERNATIONAL COOPERATION ON EDUCATION, TRAINING AND PUBLIC AWARENESS

The CEA is partner in more than 20 European projects, details for which are available on CEA web site. Two projects have been selected for the European cooperation.

- SERPENTE- Surpassing Energy Targets through Efficient Public Buildings which co-financed by the European Regional Development Fund through the Interregional Cooperation Programme INTERREG IV C. The duration of the programme are 36 months. SERPENTE focuses on publicly owned and managed buildings. Exchange is carried out in 5 subgroups on specific building typologies and functions: historical buildings, social housing, sports facilities, schools, offices. The main goal of SERPENTE is to improve energy efficiency in publicly owned and managed buildings, through improved public policies ([www.serpente-project.eu](http://www.serpente-project.eu))
- EURONET 50/50 max builds upon the experiences and results of the IEE project EURONET 50/50 (IEE/08/710) which tested and transferred the 50/50 methodology from Germany to around 50 schools in 8 other EU Member States. The EURONET 50/50 project ([www.euronet50-50.eu](http://www.euronet50-50.eu)) successfully demonstrated how energy saving potentials in school buildings can be mobilised through addressing split incentive barriers and through strong collaboration between schools (user) and their municipalities (property manager and payer of energy bills): 50% of energy savings achieved from the energy efficiency measures taken by the pupils and teachers are returned through a financial pay-out. The other 50% will be a net saving for the public authority that pays the bills. As a result everyone wins. The concept can make a considerable contribution towards the implementation of local SEAP's in general and energy efficiency in public buildings in particular. The key objectives of EURONET 50/50 max are focused on wider dissemination of the 50/50 concept to at least six new countries around Europe and its strategic roll out, which means uptake of the concept by local, regional and national authorities and its integration into relevant strategies or plans (e.g. local or regional climate or sustainable energy

strategies or plans, educational plans at all governance levels, national energy efficiency action plans or other relevant national strategies).

#### 9.8. INTERNATIONAL COOPERATION ON EDUCATION, TRAINING AND PUBLIC AWARENESS

Please see previous sections.

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## A1. INTRODUCTION

Following provisions of decision 2/CP.17 developed country Parties are requested to submit their first biennial report (BR1) to the secretariat by 1 January 2014. They have two options to report information in the BR1: Parties could present the BR1 as an annex to the NC or as a separate report. The BR1 of Cyprus is presented as an annex to the NC.

According to the relevant decision, when a Party choose to present its BR as an annex to the NC, it may choose to avoid duplication of information on similar topics by following two approaches: (1) detailed reporting of the information on the similar topics in the NC, and cross-referencing to summary of this information in the BR or (2) provision of summary information on such similar topics in the NC and cross-referencing to detailed information being provided in the BR. Notwithstanding the differences in these two approaches, the BR when presented as an annex to the NC, should be possible to be read as a stand-alone document and should meet all requirements of the UNFCCC biennial reporting guidelines for developed country Parties (Annex, decision 2/CP.17).

According to decision 2/CP.17, developed country Parties shall use the UNFCCC reporting guidelines for the preparation of their first biennial reports (BR), as contained in annex I to decision 2/CP.17, taking into account their national circumstances, and shall submit their first BR to the UNFCCC secretariat by 1 January 2014. Decision 19/CP.18, indicates that developed country Parties shall use the electronic reporting application when preparing and submitting their BR and in particular the tables of the common tabular format (CTF). The CTF as contained in the annex to decision 19/CP.18 consists of 27 tables designed to facilitate the provision of information by developed country Parties.

The BR CTF application developed by the UNFCCC secretariat according to 19/CP.18, is a web-based system designed to enable Annex I Parties to report the tables of the CTF from the BRs. The application allows reporting of numerical and textual information in a structured way and provides a certain level of flexibility in terms of generated output tables (e.g. tables and years to be reported).

The BR CTF application developed by the UNFCCC secretariat has been used for the submission of the required information.

## A2. INFORMATION ON GHG EMISSIONS AND TRENDS, GHG INVENTORY INCLUDING INFORMATION ON NATIONAL INVENTORY SYSTEM

### A2.1. INTRODUCTION AND SUMMARY INFORMATION FROM THE NATIONAL GHG INVENTORY

The latest national greenhouse gas emissions inventory was prepared in early 2013 and was submitted to the UNFCCC secretariat in April 2013<sup>31</sup>. The following sections present the most important findings presented in the report.

Emissions estimates were calculated according to the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (henceforth IPCC Guidelines) and the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (henceforth IPCC Good Practice Guidance). It is noted that base year emissions are calculated using 1990 as the base year for carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O), and 1994 for fluorinated gases (F-gases: Hydrofluorocarbons, HFC / Perfluorocarbons, PFC / Sulphur hexafluoride, SF<sub>6</sub>).

Base year GHG emissions for Cyprus (1990) were estimated at 6091 Gg CO<sub>2</sub> eq. LULUCF emissions are not considered in estimating base year emissions for Cyprus. In 2011, GHG emissions (without LULUCF) amounted to 9154 Gg CO<sub>2</sub> eq. showing an increase of 50% compared to base year emissions. If emissions /removals from LULUCF were to be included then the increase would be 53%.

<sup>31</sup> Department of Environment, 2013. Cyprus National Greenhouse Gas Inventory Report 1990 – 2011. Ministry of Agriculture, Natural Resources and Environment (available from [https://unfccc.int/national\\_reports/annex\\_i\\_ghg\\_inventories/national\\_inventories\\_submissions/items/7383.php](https://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/7383.php))

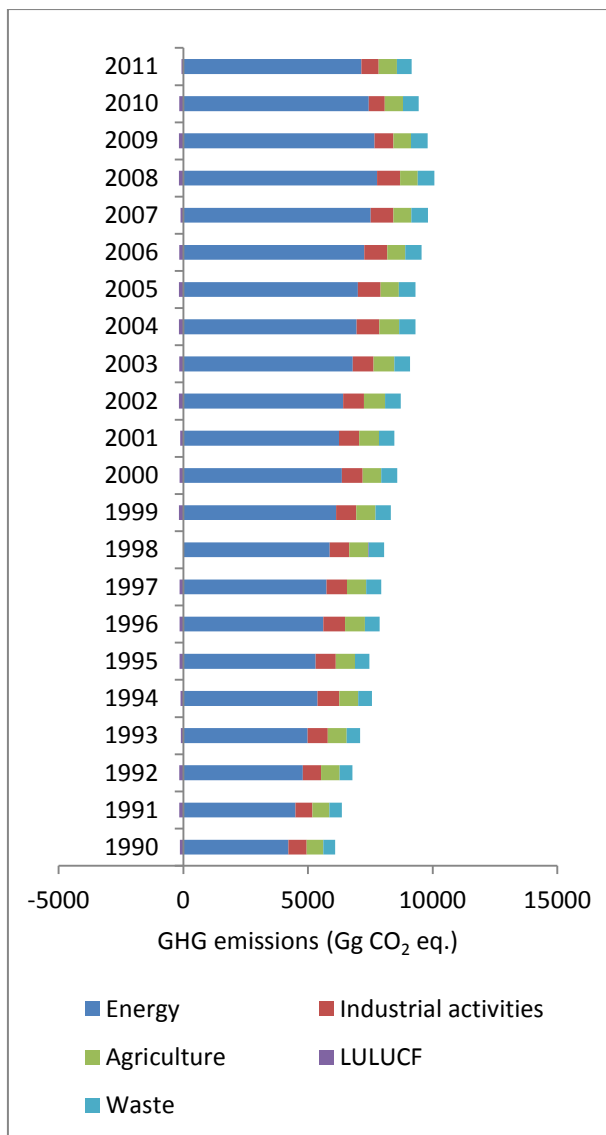


Figure A1. Contribution of activity sectors to total GHG emissions during the period 1990-2011 (including LULUCF)

### Energy

Emissions from Energy in 2011 accounted for 78% of total GHG emissions (without LULUCF) and increased by 69% compared to 1990 levels. After robust growth rates in the 1980s (average annual growth was 6.1%), economic performance in the 1990s was mixed: real GDP growth was 9.7% in 1992, 1.7% in 1993, 6.0% in 1994, 6.0% in 1995, 1.9% in 1996 and 2.3% in 1997. This pattern underlined the economy's vulnerability to swings in tourist arrivals (i.e., to economic and political conditions in Cyprus, Western Europe, and the Middle East) and the need to diversify the economy. This behaviour of economic growth was also reflected in the emission trends.

The majority of energy related GHG emissions (52.2%) in 2011 was derived from energy industries, while the contribution of transport, manufacturing industries and construction and other sectors is estimated at 32%, 7.2% and 8.9% respectively. The substantial increase of GHG emissions from road transport is directly linked to the increase of vehicles fleet but also to the increase of transportation activity. The renewal of the passenger car fleet and the implied improvement of energy efficiency, limit the increase of GHG emissions. The implemented, adopted and planned measures for the improvement of public transport are expected to moderate the high use of passenger cars.

### Industrial Processes

Emissions from Industrial processes in 2011 accounted for 8% of the total emissions (without LULUCF) and decreased by 4% compared to 1990 levels. Between 1990 and 2008 the emissions of the sector were increasing (mainly depicted in the CO<sub>2</sub> emissions) and are mainly attributed to the growth of the constructions sector. However, during 2008-2010, the constructions sector experienced the same impact as all economic activities and the emissions of the sector in 2010 decreased by 24% compared to 2008. An additional cause of the increase between 1990 and 2008 is that emissions from consumption of f-gases, was mainly available for years after 2005. Total emissions of the sector in 2011 are higher than emissions of 2010 by 9% due to a better estimation of the emissions from consumption of f-gases.

### Solvents and other products use

Emissions from Solvents and other products use have not been estimated due to lack of IPCC methodology.

Table A1. Emission for greenhouse gases (in Gg) for the period 1990-2011

Sector	1990	2000	2010	2011
Energy	4214	6361	7441	7137
Industry	728	831	642	697
Solvents	NE	NE	NE	NE
Agriculture	679	744	722	730
Waste	470	639	639	590
<b>TOTAL excl. LULUCF</b>	<b>6091</b>	<b>8574</b>	<b>9444</b>	<b>9154</b>
LULUCF	-139	-150	-166	-76
<b>TOTAL incl. LULUCF</b>	<b>5952</b>	<b>8424</b>	<b>9278</b>	<b>9078</b>



## Agriculture

Emissions from Agriculture accounted for 8% of total emissions in 2011 (without LULUCF), and increased by approximately 7% compared to 1990 levels. The peak of Agriculture emissions was in 2002 when an increase of 26% compared to 1990 was observed. Since 2002 a reduction in emissions was observed, due to the reduction of N<sub>2</sub>O emissions from agricultural soils, because of the reduction in the use of synthetic nitrogen fertilizers. The reduction of the use of fertilisers was caused by the drought that was taking place during the same period that had an extreme in 2008. Further reduction was caused by the recent changes in manure management and the reduction in the animal population.

## Waste

Emissions from the Waste Sector in 2011 contributed 6% of the total emissions (without LULUCF). Even though waste management of both liquid and solid wastes improved significantly since 1990, due to the increase in population and solid waste production per capita due to the changes in social conditions, the emissions of the sector increased by 26% between 1990 and 2011.

## Land Use, Land Use Change and Forestry

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 about 1% of the total national emissions (without LULUCF). The magnitude of this sink decreased from approximately 139 Gg CO<sub>2</sub> eq. in 1990, to 76 Gg CO<sub>2</sub> eq. in 2011, i.e. a decrease of 45%. Even though during 2011 there was an increase of the area covered with forests by 211 ha, the CO<sub>2</sub> balance is reduced due to a large wildfire (1974 ha burnt).

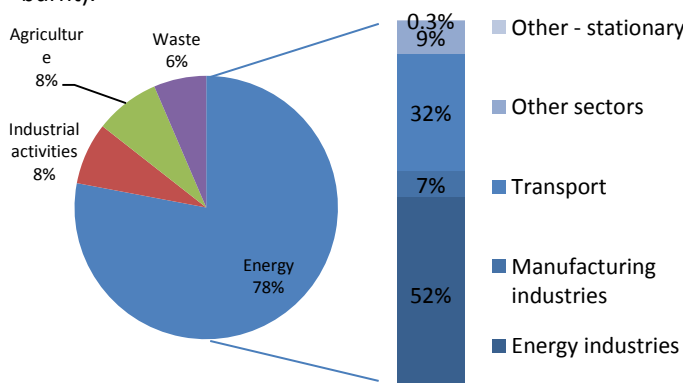


Figure A2. Relative contribution of activity sectors to total GHG emissions in 2011 excluding LULUCF

## 9.8.1. EMISSION TRENDS BY GAS

The GHG emissions (CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, HFC) for the period 1990 - 2011 are presented in Figure 2.1 (in Gg CO<sub>2</sub> eq.). Carbon dioxide emissions accounted for 84% of total GHG emissions in 2011 (without LULUCF) and increased by 56% from 1990. Methane emissions accounted for 10% of total GHG emissions in 2011 (without LULUCF) and increased by 25% from 1990, while nitrous oxide emissions accounted for 2% of the total GHG emissions in 2011 (without LULUCF) and increased by 2% from 1990. Finally, F-gases and SF<sub>6</sub> emissions accounted for 1% of total GHG emissions in 2011.

## A2.2. NATIONAL INVENTORY ARRANGEMENTS

### A2.2.1. SUMMARY INFORMATION ON NATIONAL INVENTORY ARRANGEMENTS

The Ministry of Agriculture, Natural Resources and Environment (MANRE) is the governmental body responsible for the development and implementation of the majority of the environmental policy in Cyprus. The MANRE is responsible for the co-ordination of all involved ministries, as well as any relevant public or private organisation, in relation to the implementation of the provisions of the European legislation associated with climate change.

In this context, the MANRE has the overall responsibility for the national GHG inventory, and the official preparation and approval of the inventory prior to its submission<sup>32</sup>. The Figure below provides an overview of the organisational structure of the National Inventory System. The entities participating are:

- The MANRE, designated as the national entity responsible for the national inventory, which keeps the overall responsibility, plays an active role in the inventory planning, preparation and management, and also compiles the annual inventory.

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- Governmental ministries and agencies, and non-governmental organisations through their appointed focal persons, ensure the data provision.

No legal framework is available defining the roles-responsibilities and the co-operation between the MANRE and contact points of the involved ministries and agencies.

The preparation of the Cypriot 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 checks for all source / sink categories. The main data sources used are the National Statistical Service, the national energy balance, the government ministries / agencies involved, 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. National Statistical Service, ETS reports and energy balance) 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 entering the data in the CRF Reporter.

**Stage 3:** The last stage involves the compilation of the NIR and its internal check. During this period, the Inventory Team has to revise the report according to the observations and recommendations of the supervisor of the team. On the basis of this interaction process, the

final version of the report is compiled. The Director of the Department of Environment approves the inventory and then the MANRE submits the NIR.

Data from all the involved parties come in MS Excel spread-sheets. The main database maintained by the inventory compiler is also in the form of MS Excel spread-sheets. The collected data is transferred to the main database of the inventory compiler. No special software is used or applied for processing or storage of the data used in the inventory. The inventory compiler has one MS Excel spread-sheet containing all the data collected and one MS Excel spread-sheet containing the calculations performed for the estimation of the GHGs emissions.

#### A2.2.2. SUMMARY INFORMATION ON CHANGES TO NATIONAL INVENTORY ARRANGEMENTS SINCE THE LAST NATIONAL COMMUNICATION OR BIENNIAL REPORT

Not applicable. This is the first National Communication and first Biennial Report submitted by Cyprus.

#### A3. QUANTIFIED ECONOMY-WIDE EMISSION REDUCTION TARGET

Not applicable. Cyprus has ratified the first commitment period of the Kyoto Protocol as a non-Annex B party. Therefore, Cyprus does not have a quantified economy-wide emission reduction target for the first commitment period of the Kyoto Protocol.

#### A4. PROGRESS IN ACHIEVEMENT OF THE QUANTIFIED ECONOMY-WIDE EMISSION REDUCTION TARGETS

Not applicable. Cyprus has ratified the first commitment period of the Kyoto Protocol as a non-Annex B party. Therefore, Cyprus does not have a quantified economy-wide emission reduction target for the first commitment period of the Kyoto Protocol.

## A5. PROJECTIONS

### A5.1. INTRODUCTION

The national policies are prepared, updated, monitored and updated by the Ministry of Agriculture, Natural Resources and Environment, in collaboration with the responsible ministry for each measure or policy. Currently, the main focus of the policy related to reduction of greenhouse gas emissions is energy. Energy in 2011 accounted for 78% of total GHG emissions (without LULUCF) and increased by 69% compared to 1990 levels. The sector of energy for which most measures are implemented is energy production.

#### Policy making process

The Ministry of Agriculture, Natural Resources and Environment is the main governmental body entrusted with the development and implementation of environmental policy in Cyprus. MANRE 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, MANRE 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 Cypriot strategy for sustainable development launched by MANRE in 2007. 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 with other involved ministries.

### A5.2. PROJECTIONS

This section describes a “without measures” or “business as usual” (BaU) scenario, a “with measures” or “with existing measures” (WEM) scenario and a “with additional measures” (WAM) scenario concerning the national projections of greenhouse gas emissions by sources and their removals by sinks for the years 2010, 2015 and 2020. The “without measures” scenario assumes that no emission reduction policies are implemented. 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” scenarios assume the implementation of additional policies (planned). The three scenarios are presented in the following section.

The projections of GHG emissions in the “without measures” scenario disaggregated by sector and by gas are presented in Tables A2 and A3. The “with measures” scenario, disaggregated by sector and by gas is presented in Tables A4 and A5. The “with additional measures” scenario disaggregated by sector and by gas is presented in Tables A6 and A7. In Figure A2 the evolution of GHG emission projections is also illustrated.

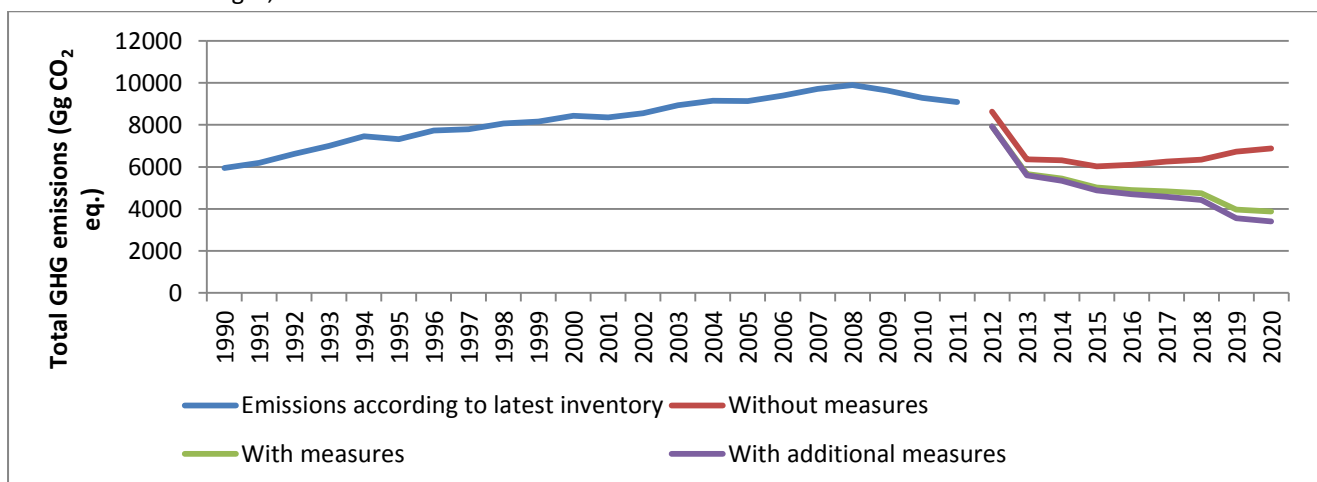


Figure A2. GHG emissions projections

Table A2. Projection of GHG emissions according to the "without measures" scenario, disaggregated by sector (Gg CO<sub>2</sub> eq.)

	Energy	Industrial activities	Agriculture	Waste	Total excl. LULUCF	LULUCF	Total incl. LULUCF
1990	4214	728	679	470	6091	-139	5952
1995	5308	805	779	574	7466	-149	7317
2000	6361	831	744	639	8575	-150	8424
2005	6995	915	738	663	9311	-174	9137
2010	7441	642	722	639	9444	-166	9278
2015	4731	462	484	391	6068	-51	6017
2020	5410	528	553	448	6939	-58	6881

Table A3. Projections of GHG emissions (excluding LULUCF) according to the "without measures" scenario, disaggregated by gas (Gg CO<sub>2</sub> eq.)

	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	Total excl. LULUCF
1990	4922	719	450	0	6091
1995	6088	868	510	0	7465
2000	7144	927	484	19	8574
2005	7857	960	472	22	9311
2010	7992	945	450	56	9444
2015	4741	555	283	78	5657
2020	5422	634	324	89	6470

Table A4. Projection of GHG emissions according to the "with measures" scenario, disaggregated by sector (Gg CO<sub>2</sub> eq.)

	Energy	Industrial activities	Agriculture	Waste	Total excl. LULUCF	LULUCF	Total incl. LULUCF
1990	4214	728	679	470	6091	-139	5952
1995	5308	805	779	574	7466	-149	7317
2000	6361	831	744	639	8575	-150	8424
2005	6995	915	738	663	9311	-174	9137
2010	7441	642	722	639	9444	-166	9278
2015	3779	462	484	350	5075	-51	5024
2020	2689	528	553	167	3937	-58	3879

Table A5. Projections of GHG emissions (excluding LULUCF) according to the "with measures" scenario, disaggregated by gas (Gg CO<sub>2</sub> eq.)

	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	Total excl. LULUCF
1990	4922	719	450	0	6091
1995	6088	868	510	0	7465
2000	7144	927	484	19	8574
2005	7857	960	472	22	9311
2010	7992	945	450	56	9444
2015	4138	551	301	84	5075
2020	3105	395	340	96	3937

Table A6. Projection of GHG emissions according to the "with additional measures" scenario, disaggregated by sector (Gg CO<sub>2</sub> eq.)

	Energy	Industrial activities	Agriculture	Waste	Total excl. LULUCF	LULUCF	Total incl. LULUCF
1990	4214	728	679	470	6091	-139	5952
1995	5308	805	779	574	7466	-149	7317
2000	6361	831	744	639	8575	-150	8424
2005	6995	915	738	663	9311	-174	9137
2010	7441	642	722	639	9444	-166	9278
2015	3641	462	484	344	4931	-51	4880
2020	2251	528	553	125	3458	-58	3400

Table A7. Projections of GHG emissions (excluding LULUCF) according to the "with additional measures" scenario, disaggregated by gas (Gg CO<sub>2</sub> eq.)

	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	Total excl. LULUCF
1990	4922	719	450	0	6091
1995	6088	868	510	0	7465
2000	7144	927	484	19	8574
2005	7857	960	472	22	9311
2010	7992	945	450	56	9444
2015	4000	546	301	84	4978
2020	2669	354	339	96	3779

### A5.2.3. PROJECTIONS OF INDIRECT GHG

Not available.

### A5.3. CHANGES IN PROJECTION METHODOLOGIES

Not applicable. This is the first National Communication and first Biennial Report submitted by Cyprus.

## A6. PROVISION OF FINANCIAL, TECHNOLOGICAL AND CAPACITY BUILDING SUPPORT TO DEVELOPING COUNTRIES

### A6.1. INTRODUCTION

Cyprus was a non-Annex I party to the UNFCCC until 1/1/2013 and a non-Annex B party to the Kyoto Protocol. Consequently, Cyprus had no obligations to allocate financial resources for assistance to developing country parties that are particularly vulnerable to climate change. Nevertheless, in 2009, along with the rest of the member states of the EU, Cyprus committed to provide finance for climate change to developing countries.

### A6.2. GENERAL INFORMATION

The public funding provided by the Republic of Cyprus to developing countries is presented below. No private funding, technology and capacity building have been provided to developing countries.

The next sections present a descriptive summary of the information, and the information in the common reporting format according to FCCC/SBSTA/2012/L.33 that was agreed in COP18.

It should be noted that Cyprus provided funding to developing countries for 2010 and 2012. No funding was provided for 2011, therefore no information is reported to the particular year.

### A6.3. FINANCIAL RESOURCES

CyprusAid is the Development Cooperation Service of the Republic of Cyprus, established in its current form by the Council of Ministers in 2005. CyprusAid functions within the framework of a policy making mechanism that has been put in place in order to steer Cyprus' Official Development Assistance. This policy mechanism is one that retains a high degree of centralisation in the decision making process, while at the same time allows for a more decentralized approach in the aid delivery arrangements. The mechanism comprises of a Coordination Body (CB) headed by the Minister of Foreign Affairs and having the Minister of Finance and the Permanent Secretary of the Planning Bureau as members. The CB is responsible for the setting of targets (quantitative, territorial and sectoral) on the basis of international obligations, EU policy recommendations and national priorities. The Planning Bureau is responsible for the preparation of policy preparation, as well as the management and implementation of the decisions of the CB while the MFA is responsible for representing the Republic abroad and also for publicizing the Republic of Cyprus ODA activities. A second body, headed by the Permanent Secretary of the Ministry of Foreign Affairs (MFA) and comprised of representatives of the Ministries of Finance, Commerce, Industry and Tourism, Agriculture, Natural Resources and Environment, Labour and Social Insurance, Education and Culture and the Planning Bureau, as well as representatives of civil society, acts in a consultative capacity to the Coordination Body.

CyprusAid after studying options funds and organizations implementing projects on climate change, and with the consent of the Ministry of Finance promoted cooperation with the "Global Climate Change Alliance-GCCA", a funding mechanism coordinated by the European Commission. This mechanism is acts as an intermediary / coordinator for contributions and projects to tackle climate change. The choice of "GCCA" as a means of disposing of contribution of Cyprus based on that provides recognition to donors. Furthermore, the "GCCA" is an initiative of the European Commission and the substantial and political support of Member States in this, strengthens and makes this mechanism valuable in the international arena on climate change.

### A6.3.1. PROVISION OF FINANCIAL SUPPORT THROUGH MULTILATERAL CHANNELS

#### Funding provided in 2010

Project name: "Building Climate Resilience in Nepal"

The estimated costs of the project amounted to €19,400,000 (European Union: €8,000,000, Development Cooperation Service of the United Kingdom €10,800,000 and Cyprus €600,000). The project is implemented by the method of award of centralized management to the local office of the Office for Development Cooperation of the United Kingdom in Nepal.

The main objectives of the project are: (a) the development of an administrative infrastructure in Nepal, both at national and local level to enable the implementation of the National Adaptation Programme of Nepal to climate change and (b) promote the integration policy on climate change programs and projects of the government at national and local level and develop mechanisms to promote initiatives for climate adaptation.

The institutionalization of cooperation has been the signing of a Credit "Transfer Agreement" between the Cyprus and the European Union represented by the European Commission.

#### Funding provided in 2012

Project name: "Climate Change Adaptation and Sustainable Land Management in the Eastern Caribbean"

For 2012 the Planning Bureau has negotiated a Credit "Transfer Agreement", for funding the project in the Caribbean (Antigua & Barbuda, Dominica, Grenada, Saint Lucia, St. Christopher (St. Kitts) & Nevis St. Vincent, Grenadines, Montserrat, British Virgin Islands, Anguilla).

This project was funded by the European Commission with a contribution of €10,000,000 and the Republic of Cyprus with a contribution of €600,000.

The overall project objective was to contribute to the implementation of the provisions laid down in Article 24 of the Revised Treaty of Basseterre, which makes reference to implementation by each State Party "St. George Declaration" on the Declaration of Principles for Environmental Sustainability, which aims, among others, to achieve long-term conservation and sustainable productivity of the region's natural resources and the ecosystem.

The immediate goal of the project is to improve the resilience of the natural resources base in the region to the impacts of climate change through:

- (a) promoting efficient and sustainable practices and frameworks of land management and
- (b) promoting concrete pilot projects in order to adapt the field ( especially in terms of land management ) to climate change.

### A6.4. COMMON REPORTING FORMAT TABLES

Information in the common reporting format according to FCCC/SBSTA/2012/L.33 that was agreed in COP18 (Tables 7,8 and 9) are presented in the pages that follow.

TABLE 7. PROVISION OF PUBLIC FINANCIAL SUPPORT: SUMMARY INFORMATION

Year	2010						
	Domestic currency			USD			Type of contribution
Allocation channels	Mitigation	Adaptation	Mitigation and Adaptation	Mitigation	Adaptation	Mitigation and Adaptation	Core Climate finance
Total contributions through multilateral channels:		€600,000			\$811,359.50		Climate Finance
0Multilateral climate change funds							
Other multilateral climate change funds							
Multilateral financial institutions, including regional development banks							
Specialized United Nations bodies							
Total contributions through bilateral, regional and other channels							
<b>Total</b>		€600,000			\$811,359.50		
Contribution in the total Official Development Aid (ODA)							

Year	2011						
	Domestic currency			USD			Type of contribution
Allocation channels	Mitigation	Adaptation	Mitigation and Adaptation	Mitigation	Adaptation	Mitigation and Adaptation	Core Climate finance
Total contributions through multilateral channels:							
0Multilateral climate change funds							
Other multilateral climate change funds							
Multilateral financial institutions, including regional development banks							
Specialized United Nations bodies							
Total contributions through bilateral, regional and other channels							
<b>Total</b>							
Contribution in the total Official Development Aid (ODA)							

Year	2012						
	Domestic currency			USD			Type of contribution
Allocation channels	Mitigation	Adaptation	Mitigation and Adaptation	Mitigation	Adaptation	Mitigation and Adaptation	Core Climate finance
Total contributions through multilateral channels:		€600,000			\$811,359.50		CORE
0Multilateral climate change funds							
Other multilateral climate change funds							
Multilateral financial institutions, including regional development banks							
Specialized United Nations bodies							
Total contributions through bilateral, regional and other channels							
<b>Total</b>		€600,000			\$811,359.50		
Contribution in the total Official Development Aid (ODA)							CYPRUS AID



TABLE 7(A). PROVISION OF PUBLIC FINANCIAL SUPPORT: CONTRIBUTION THROUGH MULTILATERAL CHANNELS

Year	2010							
	Type of Contribution	Total amount		Status	Funding Source	Financial Instrument	Type of Support	Sector
Donor funding	Core Climate finance	Domestic currency	USD	[Provided, Pledged, committed]	ODA, OOF, Other	Grant, Concesional loan, Nonconcessional loan, Equity loan, Other	Mitigation, Adaptation, Core/general, Climate-specific, Other	Energy, Transport, Industry, Agriculture, Forestry, Water and sanitation, Cross-cutting, Other, Not applicable
<b>Multilateral climate change funds</b>								
1. Global Environment Facility								
2. Least Developed Countries Fund								
3. Special Climate Change Fund								
4. Adaptation Fund								
5. Green Climate Fund								
6. Trust Fund for Supplementary Activities								
7. Other multilateral climate change funds	€600,000		\$811,359.50	Provided	ODA	Grant	Adaptation	Other
<b>Subtotal</b>								
<b>Multilateral financial institutions, including regional development banks</b>								
1. World Bank								
2. International Finance Corporation								
3. African Development Bank								
4. Asian Development Bank								
5. European Bank for Reconstruction and Development								
6. Inter-American Development Bank								
7. Other								
<b>Subtotal</b>								
Specialized United Nations bodies								
1. United Nations Development Programme (specific programmes)								
2. United Nations Environment Programme (specific programmes)								
3. Other								
<b>Subtotal</b>								
<b>TOTAL</b>	<b>€600,000</b>		<b>\$811,359.50</b>					

Year	2011							
	Type of Contribution	Total amount		Status	Funding Source	Financial Instrument	Type of Support	Sector
Donor funding	Core Climate finance	Domestic currency	USD	[Provided, Pledged, committed]	ODA, OOF, Other	Grant, Concessional loan, Nonconcessional loan, Equity loan, Other	Mitigation, Adaptation, Core/general, Climate-specific, Other	Energy, Transport, Industry, Agriculture, Forestry, Water and sanitation, Cross-cutting, Other, Not applicable
<b>Multilateral climate change funds</b>								
1. Global Environment Facility								
2. Least Developed Countries Fund								
3. Special Climate Change Fund								
4. Adaptation Fund								
5. Green Climate Fund								
6. Trust Fund for Supplementary Activities								
7. Other multilateral climate change funds								
<b>Subtotal</b>								
<b>Multilateral financial institutions, including regional development banks</b>								
1. World Bank								
2. International Finance Corporation								
3. African Development Bank								
4. Asian Development Bank								
5. European Bank for Reconstruction and Development								
6. Inter-American Development Bank								
7. Other								
<b>Subtotal</b>								
Specialized United Nations bodies								
1. United Nations Development Programme (specific programmes)								
2. United Nations Environment Programme (specific programmes)								
3. Other								
<b>Subtotal</b>								
<b>TOTAL</b>								

Year	2012							
	Type of Contribution	Total amount		Status	Funding Source	Financial Instrument	Type of Support	Sector
Donor funding	Core Climate finance	Domestic currency	USD	[Provided, Pledged, committed]	ODA, OOF, Other	Grant, Concesional loan, Nonconcesional loan, Equity loan, Other	Mitigation, Adaptation, Core/general, Climate-specific, Other	Energy, Transport, Industry, Agriculture, Forestry, Water and sanitation, Cross-cutting, Other, Not applicable
<b>Multilateral climate change funds</b>								
1. Global Environment Facility								
2. Least Developed Countries Fund								
3. Special Climate Change Fund								
4. Adaptation Fund								
5. Green Climate Fund								
6. Trust Fund for Supplementary Activities								
7. Other multilateral climate change funds	€600,000		\$811,359.50	Provided	ODA	Grant	Adaptation	Cross-cutting
<b>Subtotal</b>								
<b>Multilateral financial institutions, including regional development banks</b>								
1. World Bank								
2. International Finance Corporation								
3. African Development Bank								
4. Asian Development Bank								
5. European Bank for Reconstruction and Development								
6. Inter-American Development Bank								
7. Other								
<b>Subtotal</b>								
Specialized United Nations bodies								
1. United Nations Development Programme (specific programmes)								
2. United Nations Environment Programme (specific programmes)								
3. Other								
<b>Subtotal</b>								
<b>TOTAL</b>	<b>€600,000</b>		<b>\$811,359.50</b>					

TABLE 7(B). PROVISION OF PUBLIC FINANCIAL SUPPORT: CONTRIBUTION THROUGH BILATERAL, REGIONAL AND OTHER CHANNELS

Year	2010						
	Total amount		Status	Funding Source	Financial Instrument	Type of Support	Sector
Recipient country/ region/ programme	Domestic Currency	USD	[Provided, Pledged, committed]	ODA, OOF, Other	Grant, Concesional loan, Nonconcessional loan, Equity loan, Other	Mitigation, Adaptation, Core/general, Climate-specific, Other	Energy, Transport, Industry, Agriculture, Forestry, Water and sanitation, Cross-cutting, Other, Not applicable
Nepal/ Building Climate Resilience in Nepal	€600,000	\$811,359.50	Provided	ODA	Grant	Adaptation	Other

Year	2011						
	Total amount		Status	Funding Source	Financial Instrument	Type of Support	Sector
Recipient country/ region/ programme	Domestic Currency	USD	[Provided, Pledged, committed]	ODA, OOF, Other	Grant, Concesional loan, Nonconcessional loan, Equity loan, Other	Mitigation, Adaptation, Core/general, Climate-specific, Other	Energy, Transport, Industry, Agriculture, Forestry, Water and sanitation, Cross-cutting, Other, Not applicable

Year	2012						
	Total amount		Status	Funding Source	Financial Instrument	Type of Support	Sector
Recipient country/ region/ programme	Domestic Currency	USD	[Provided, Pledged, committed]	ODA, OOF, Other	Grant, Concesional loan, Nonconcessional loan, Equity loan, Other	Mitigation, Adaptation, Core/general, Climate-specific, Other	Energy, Transport, Industry, Agriculture, Forestry, Water and sanitation, Cross-cutting, Other, Not applicable
Eastern Caribbean/ Global Climate Change Alliance (GCCA) project on Climate Change Adaptation and Sustainable Land Management in the Eastern Caribbean	€600,000	\$811,359.50	Provided	ODA	Grant	Adaptation	Cross-cutting

TABLE 8. PROVISION OF TECHNOLOGY DEVELOPMENT AND TRANSFER SUPPORT

Year	2010								
	Targeted Area	Measures and activities related to technology transfer	Sector	Source of the funding for technology transfer	Activities undertaken /implemented by,	Total funding for technology transfer provided		Status	Additional information
Recipient country and/or region	Mitigation, Adaptation, Mitigation and Adaptation		Energy, Transport, Industry, Agriculture, Water and sanitation, Other	Private Public	Private Public	Domestic currency	USD	Implemented Planned	

Year	2011								
	Targeted Area	Measures and activities related to technology transfer	Sector	Source of the funding for technology transfer	Activities undertaken /implemented by,	Total funding for technology transfer provided		Status	Additional information
Recipient country and/or region	Mitigation, Adaptation, Mitigation and Adaptation		Energy, Transport, Industry, Agriculture, Water and sanitation, Other	Private Public	Private Public	Domestic currency	USD	Implemented Planned	

Year	2012								
	Targeted Area	Measures and activities related to technology transfer	Sector	Source of the funding for technology transfer	Activities undertaken /implemented by,	Total funding for technology transfer provided		Status	Additional information
Recipient country and/or region	Mitigation, Adaptation, Mitigation and Adaptation		Energy, Transport, Industry, Agriculture, Water and sanitation, Other	Private Public	Private Public	Domestic currency	USD	Implemented Planned	

**TABLE 9. PROVISION OF CAPACITY BUILDING SUPPORT**

Year	<b>2010</b>		
	Targeted Area	Programme or project title	Description of programme or project
Recipient country and/or region	Mitigation, Adaptation Mitigation and Adaptation		
Nepal	Adaptation		Overall objective

Year	<b>2011</b>		
	Targeted Area	Programme or project title	Description of programme or project
Recipient country and/or region	Mitigation, Adaptation Mitigation and Adaptation		

Year	<b>2012</b>		
	Targeted Area	Programme or project title	Description of programme or project
Recipient country and/or region	Mitigation, Adaptation Mitigation and Adaptation		