Development of a national strategy for adaptation to climate change adverse impacts in Cyprus

CYPADAPT

LIFE10 ENV/CY/000723

Assessment of past responses to adapt to the adverse climate change impacts in Cyprus

DELIVERABLE 2.3

Acknowledgements

This report was produced under co-finance of the European financial instrument for the Environment (LIFE+) as the third Deliverable of the second Action (Action 2) of the CYPADAPT project (LIFE10ENV/CY/000723) during the implementation of its second Activity (Activity 2.b) on the "Assessment of past responses to adapt to adverse climate change impacts in Cyprus".

The CYPADAPT team would like to acknowledge the European financial instrument for the Environment (LIFE+) for the financial support.

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Acronyms

ARI	Agricultural Research Institute
CAMP	Coastal Area Management Programme
CAP	Common Agricultural Policy
CBD	Convention on Biological Diversity
CITES	Convention on International Trade in Endangered Species
CTO	Cyprus Tourism Organization
DFMR	Department of Fisheries and Marine Research
DMP	Drought Management Plan
DPW	Department of Public Works
EAC	Electricity Authority of Cyprus
EIA	Environmental Impact Assessment
FAS	Farm Advisory System
FMP	Fisheries Management Plan
GAEC	Good Agricultural and Environmental Conditions
GIS	Geographic Information System
GWW	Government Water Works
IAS	Invasive Alien Species
ICAM	Integrated Coastal Area Management
ICAMSF	Integrated Coastal Area Management Strategic Framework
ICZM	Integrated Coastal Zone Management
IUCN	International Union for Conservation of Nature
MANRE	Ministry of Agriculture, Natural Resources and Environment of the Republic of Cyprus
PAP/RAC	Priority Actions Programme/Regional Activity Centre
RDP	Rural Development Programme
RES	Renewable Energy Sources
SCI	Site of Community Interest
SEA	Strategic Environmental Assessment
SMR	Statutory Management Requirements
SPA	Special Protected Areas
SUDS	Sustainable Urban Drainage Systems
WDD	Water Development Department
WFD	Water Framework Directive

Executive summary

In the framework of this report entitled "*Assessment of past responses to adapt to the adverse climate change impacts in Cyprus*", existing adaptation measures implemented in Cyprus aiming at reinforcing the adaptive capacity of different sectors in Cyprus are reviewed and evaluated on the basis of their effectiveness, viability and their contribution to climate change adaptation. The adaptation measures reviewed in this report, include also those measures 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.

Given that there is no integrated adaptation policy established on an international/European level as well as in Cyprus, sectoral or case specific policies that also address climate change impacts (e.g. Water Framework Directive, Floods Directive) constituted the basis of the evaluation. The measures reviewed are in the form of policy plans, strategies, legislative actions, guidelines, economic incentives, knowledge dissemination activities or research. Potential barriers to implementing adaptation measures were identified, such as legal and policy-level inadequacies or inconsistencies, institutional, social, economic and cultural barriers as well as lack of awareness of climate change issues.

The measures are presented per climate change impact and sector, as these have been identified in Deliverable 1.2 of the CYPADAPT project. In specific, each chapter of this report constitutes a sector of Cyprus where climate change impacts have been identified. These sectors are: Water resources, Agriculture, Coastal zones, Tourism, Biodiversity, Energy, Fisheries and aquaculture, Soils, Forests, Public Health, Infrastructure. In each sector/chapter, the measures are categorized and presented per climate change impact on the sector, according to their objective. At the end of each chapter, additional measures or measures that are already applied and need further enhancement in order to reinforce the adaptive capacity of Cyprus against climate changes, are presented.

1. Water resources

Water scarcity and drought as well as the declining levels of water in reservoirs are among the most pronounced climate change impacts on the water resources in Cyprus. Other impacts, such as the salinization of coastal aquifers and the water quality have not yet been directly linked to climate change as there is a number of human factors affecting their condition as well. Furthermore, there are not sufficient data yet in all cases to estimate the contribution of each factor to the generation of the problem.

As a result of the limited water availability of the island, it is essential to protect the quantity and quality of water resources in order to be able to satisfy water demand in a sustainable way in the future, taking into consideration climate changes.

The government water policy of Cyprus is inextricably linked with the measures required for adapting to climate change impacts on water resources. According to the Water Development Department (WDD) of the Ministry of Agriculture, Natural Resources and Environment of the Republic of Cyprus (MANRE), the government water policy focuses on the maximum potential exploitation of non-conventional water resources, such as desalinated and recycled water. The exploitation of sea water was prioritized at first in order to face intense and urgent water scarcity problems, as it constitutes a rather short to medium term solution with direct results in comparison with the exploitation of recycled water. Full exploitation of recycled water on the other hand, is a long-term costly process, the success of which will decrease or even eliminate the necessity to build more desalination plants.

The construction of additional water supply works foreseen in the Strategic Water Development Plan for the period up to 2015 is also in progress. In addition to the implementation and subsidization of water conservation measures and the enhancement of water consciousness regarding the proper use of this precious resource, a systematic approach is made to decrease water demand.

Furthermore, the enforcement of the Water Framework Directive constitutes an integral part of the government policy. Within this framework, the River Basin Management Plan, the Drought Management Plan, the Strategic Environmental Assessment Report, as well as the Water Policy Plan have been finalized and are implemented since 2011. The implementation of the Programme of Measures is now being carried out and is expected to be finalised by 2015 (WDD).

In the following sections, the measures implemented in Cyprus and that are considered contributing – directly or indirectly - towards the adaptation to climate change impacts on the water resources of Cyprus are being presented and evaluated.

1.1. Measures to increase water availability

Increase storage capacity

The capacity of dams has significantly increased since 1960 from 6 Mm^3 to 332 Mm^3. As a result, the accumulated storage capacity in 2010 was able to cover 4 times the average annual dam inflow of the period 1987-2010 (78.5 Mm^3). Main aim of the construction of a plethora of dams is to capture as much as possible of the surface runoff and to eliminate water losses to sea. This practice has reached physical limits as all major rivers and streams with adequate flows have already been dammed and even more because, there is no increasing trend in precipitation and natural run-off expected.

Control groundwater exploitation

In the past, the control exercised over illegal borehole drilling and over-pumping was inadequate. As a result, only 2 from the 19 groundwater bodies in Cyprus are not over-pumped (non sustainable abstraction) revealing the intense pressure posed on them. According to the provisions of the Water Framework Directive, which takes into consideration the trends in groundwater bodies level as well as the amount of unsustainable groundwater abstraction, 11 out of 19 groundwater bodies on which the Government of Cyprus exercises effective control, have been characterized as in bad quantitative condition, according to the Water Framework Directive. The Law on the Integrated Water Management 79(I)/2010 which has been enforced in Cyprus since 2010, sets new requirements for granting permissions regarding borehole drilling and pumping. Furthermore, the Law foresees the installation and monitoring of water meters in boreholes, in order for the quantities of water pumped not to exceed the limits set. It is expected that with the new Law, a considerable number of violations that have been made in the past, will be eliminated.

Inter-basin water transfer

The interconnection of reservoirs and conveyor systems allows distribution of water across the island and offer some flexibility in operation. Existing water infrastructure involves large inter-basin transfers in the South-South-eastern (South Conveyor Project - SCP) and in the South West-Western (Pafos Irrigation Project) parts of the island.

This allows for considerable flexibility in water management and allocation in most areas. However, especially during the drought periods conflicts and demonstrations arise against inter-basin transfers of water. Local farmers demand full coverage of their water needs before any transfer is made (INECO).

1.2. Measures for the diversification of water resources utilisation

The use of non conventional water resources such as desalinated water, treated water from Wastewater Treatment Plants (WWTPs), grey water and stormwater in water supply for various uses can substantially alleviate the pressures on the freshwater resources which are already high in Cyprus. Following, the progress made so far in Cyprus regarding the use of non conventional water resources is presented.

Construction of desalination plants

Desalination constitutes a secure source for safe drinking water supply, once demand management measures are fully implemented. After the failure of the Government of Cyprus to meet drinking water demand during the intense drought year of 2008, when severe water cuts were imposed to many households, the Government decided to completely decouple water supply of the urban and tourist areas from rainfall and the satisfaction of the maximum demand during the summer period, with the construction of additional desalination plants. Within this framework, the Water Development Department has prepared a Desalination Plan which foresees the operation of 5 Permanent Desalination Plants by 2012, with a total production of 252,000 m^3/day. The contribution of desalination plants to domestic water supply for 2010 amounted to 65% which equals 55.5 Mm^3, while is expected to reach 100% after the operation of the additional desalination plants.

The desalination capacity has increased from 40.000 m^3/d in 1997, when the first desalination plant in Cyprus operated, to 182,000 m^3/d in 2011 and is expected to reach a capacity of 252,000 m^3/d in 2012.

However, desalination is an energy intensive process producing a residue (brine) that must be carefully treated and disposed in order to prevent environmental degradation. Hence, desalination could be considered a mal-adaptation measure unless certain requirements are taken into account, such as the use of renewable energy and the proper treatment and disposal of brine produced. In Cyprus, programmes of systematic monitoring have shown local increase in salinity near to the bottom, without particular problems on the marine flora and fauna in most cases.

Reuse of municipal wastewater

Water reuse provides additional drought-proof water supply, favours a more local sourcing of water and avoids the use of high quality water sources where this is not necessary. The potential for water reuse depends on the availability and accessibility of wastewater, i.e. the wastewater infrastructure, and the acceptability by potential end-users and consumers.

There is an immense potential for growth of water reuse practices driven by both the demand for water and the increasing volumes of treated effluent. 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. Providing recycled water for irrigation through Government Water Works, began in 1998, with a small amount of around 1.3 Mm^3 and reached 12 Mm^3 in 2010, from which 9 Mm^3 were supplied for irrigation and about 3 Mm^3 for artificial recharge of aquifers. The capacity of the new Waste Water Treatment Plants in 2012 amounted to 59 Mm^3 per year and will reach up to 65 Mm^3 per year over the medium term (2015)

and 85 Mm^3 for long-term (2025). The annual water recycling is expected to reach 28.5% of today's agricultural water demand (WDD, 2011a – Annex VII).

For the use of recycled water in agriculture, specific quality standards have been established as well as measures for the protection of public health. The compliance with both quality standards and protection measures is mandatory.

In general, the treatment of wastewater in Cyprus includes tertiary processes followed by filtration. Treated wastewater is used for the irrigation of green spaces, athletic fields and crops (excl. edible raw vegetables) as well as for aquifer recharge.

Further treatment of certain quantities of the effluent with the process of reverse osmosis (RO) is under consideration, in order for water salinity to be reduced and the final effluent to be used for the irrigation of sensitive soils and crops. At the same time, the reverse osmosis process is expected to enable the integrated management of all irrigation water resources. However, the application of reverse osmosis presents some disadvantages, such as the high costs for the construction and operation of RO plants, and more significantly, the difficulty in selecting a management option for the brine produced which will be both techno-economically feasible and socially accepted. For example, the suggestion for thermal treatment of the brine from the RO plant, which is going to be constructed in the area of Aradippou, is socially acceptable but is quite expensive, while the conventional disposal of the untreated brine is not considered (WDD, 2011A – Annex VII).

General aim is to use the increasing quantities of treated effluents produced for the irrigation of the agricultural crops thus substantially alleviating the pressures posed to the agricultural sector due to water scarcity.

The acceptance of the use of treated wastewater from farmers was, at first, slow and reluctant. However, the water cuts imposed on agriculture during the recent drought periods in conjunction with the lower water prices set for recycled water in comparison with those of freshwater, led the farmers to turn to the use of recycled water, thus increasing the exploitation of this source. In the beginning, the recycled water was applied in fodder crops while after the experience gained from its application, its use was expanded to other crops such as flowers, olives, citrus, grapes, potatoes and dry onions (WDD, 2011A – Annex VII).

Furthermore, treated wastewater is also used in Cyprus for aquifer recharge. So far treated wastewater from Paphos is used for the recharge of Ezousa's aquifer. The expansion of this measure to the aquifer of Kiti and Kokkinochoria is under investigation as well. This will be decided on the basis of the quality of the treated (WDD, 2011A – Annex VII).

Artificial aquifer recharge

Artificial aquifer recharge offers an opportunity to store water in order to use it in periods of decreased availability and/or increased demand. This measure has begun to be applied during the recent years in Cyprus, by using treated effluent produced from the municipal Wastewater Treatment Plants for recharging the aquifers. It must be noted that no industrial wastewater discharge is allowed in the municipal sewers and thus the water used for artificial aquifer recharge

comes from the treatment of pure domestic wastewater. However, there is stakeholder opposition to groundwater recharge due to water quality concerns related to the risk of drinking water resources pollution. Quality of reclaimed water has always been an issue, but to date, the problem of micro-pollutants has not been considered yet. Though reclaimed water has to be analysed for bulk parameters and selected metals, no organic micropollutants are being monitored so far (Hochstrat & Kazner, 2009).

Stormwater use

The collection and use of storm water can result in further savings in fresh water consumption. In Cyprus, until recently there were no drainage systems and stormwater was collected in the sewage system. However, the last two decades, a separate drainage system is being developed In Cyprus in order to separately collect stormwater. So far, the drainage network in the majority of the big urban centres of Cyprus has been completed.

Furthermore, the Sewerage Board of Limassol-Amathus in cooperation with the five municipalities of the Greater Limassol area as well as the wider area of Paphos began the implementation of Sustainable Urban Drainage Systems (SUDS). SUDS are actually a sequence of management practices, control structures and strategies designed to efficiently and sustainably drain surface water. Up to now, no suitable measures have been identified for the case of Larnaca due to its topography (low-lying area).

Further research must be made on this field for the evaluation of the potential use of storm water. In this framework, a study was conducted by the WDD (WDD, 2009) in order to explore the potential use of storm water.

1.3. Measures to decrease water demand

Replacement of water distribution networks

Water losses in domestic water distribution networks, mainly in rural areas, are quite high. The “unaccounted for” water in the main urban domestic supply distribution networks is estimated in the range from 15 to 20% and about 20 to 30% in the rural areas. Therefore, an additional effort should be made for the timely identification and replacement of defective pipes and for developing a more conscious attitude towards water conservation.

Water saving from the replacement of networks is expected to be substantially important compared to other possible water saving measures. From research conducted during the period 2009 – 2010 on the Water Supply networks of the municipalities that do not belong to Water Supply Boards, more than 80% of the networks have been replaced for the 63.4% of the municipalities (WDD, 2011b).

Water allocation

Water allocation mechanisms under drought conditions (water rationing) have been established to provide priority to maintaining domestic and municipal water supplies. The second priority is to maintain supplies to perennial crops at 80% of the recommended application levels. Seasonal vegetable crops constitute the third priority. The water cuts in irrigation from the South Conveyor System during the period 2000-2010 ranged from 10% to 90% with the exception of 2004 where the water cuts were equal to zero. The cuts in the drinking water supply ranged from 13% to 23% for the same period (WDD, 2011b).

Use of water supply meters

Metered supply allows users to observe their consumption and to follow up effects of water saving measures. The installation of individual water supply meters from the drinking water consumers in Cyprus is almost catholic, while for irrigation purposes it is restricted mainly in areas supplied with water from Government Water Works or from boreholes in certain groundwater bodies that are under Special Water Savings Measures. It has been observed that the introduction of water meters could achieve water savings of 10 – 25% of the total consumption (WDD, 2011b).

Redistribution of irrigated land

Land redistribution constitutes another measure which is directly linked with the decrease in water demand, through the reduction in the fragmentation of agricultural holdings, the opportunity for scale economies in irrigation works and the achievement of significant water savings. Since 1969, 62 out of 73 submitted redistribution plans referred in irrigated land and 3 in mixed, irrigated and rainfed land. In addition, another 12 plans are in progress and 27 under examination, both referring in irrigated land.

It is difficult to estimate the efficiency of the redistribution of small holdings of irrigated land and its contribution as a water saving measure. However, irrigated areas that have been redistributed have shown increased irrigating efficiency mainly because the application of improved irrigation systems is more feasible in that case, thus resulting in savings in irrigation water (WDD, 2011b).

Water pricing

The water pricing system, as applied today in Cyprus, is not considered to be an effective tool for achieving water savings. It was found that there is no elasticity in water demand in relation to its current price, both in drinking and irrigation water, as the variations in water prices have not affected so far average water demand. Actually, reductions in water demand were observed during periods of intense water scarcity, which is attributed mainly to the raising awareness campaigns. It must also be mentioned that with the introduction of the new desalination plants, the costs of water production and supply will change significantly and the pricing system will move to a new balance. For these reasons, the Water Development Department in compliance with the WFD, has assigned a study for the implementation of appropriate pricing policies of water services as well as for the implementation of penalty charges for overconsumption (quota system). The current pricing system as well as the proposed one is presented below (WDD, 2011a – Annex II):

- Supply of drinking water from Government Water Works: So far, drinking water is supplied from Government Water Works to all Districts for a fixed price (the same price was charged to all Districts except Pafos District). The Water Supply Boards, Municipalities and Municipal Boards in their turn charged different block tariffs for the further distribution of water. The new pricing policy is based on increasing block rates and on the full recovery of cost (including the environmental and resource cost).
- Supply of freshwater for irrigation from Government Water Works: For the supply of irrigation water, lower prices have been set for uses of high social value (e.g. agriculture) and higher prices for uses of lower social value (e.g. golf courses). The pricing system of irrigation water is based on a two part tariff, the first one being a fixed price reflecting the fixed costs and the second one being a variable cost (volumetric pricing) reflecting the variable costs. However, as a large part of the charge could be covered from the fixed charge, the system was considered ineffective in preventing excessive water use. For that reason, the charges with the new pricing policy were adjusted, reducing fixed cost to 15% of the initial price.
  However, the introduction of higher irrigation water prices, always provokes opposition of the politically strong agricultural lobby in spite of the fact that the increase is accompanied by various compensational financial measures. The lobby's argument is that agriculture is important because it ensures the supply of strategic food and raw materials to the nation and for social and even environmental considerations agriculture should be further subsidized and nor penalized with higher water prices (INECO).
- Supply of recycled water for irrigation from Government Water Works: The use of recycled water in irrigation is encouraged, as the charging of this source does not enhance the cost of its production and supply. In order to further promote the use of recycled water with the new pricing system, its price is proposed to be set at 75% of the freshwater price.
- Drinking water outside Government Water Works: So far water from private boreholes was not charged. With the new pricing policy, the abstraction of groundwater will be charged, taking into account the environmental and resource cost of groundwater.

It is expected that with the implementation of the new pricing policy additional water savings will be achieved.

Subsidies for drinking water savings

The WDD has been offering subsidies in order to reduce drinking water consumption mainly in households with the use of untreated groundwater or greywater in certain uses as well as the recycling of hot water. The water-saving subsidies are for (i) the drilling of boreholes for watering gardens, car wash etc, (ii) the installation of a grey water treatment system for watering gardens, (iii) the installation of a hot water recirculator and (iv) the connection of boreholes with toilet cisterns. In 2009, 1331 applications were approved, from which approximately 45% referred to drilling boreholes (WDD, 2011b).

Awareness campaigns

Awareness campaigns are essential in order to achieve water savings. During the last decade the awareness campaigns have been intensified by the WDD, with lectures in schools, advertisements, distribution of informative leaflets and other initiatives. It is difficult to estimate their efficiency in actual water savings, however a downward trend in water consumption was observed during the period 2004-2009 when the campaigns have intensified (WDD, 2011b). However, more emphasis must be given in order for the public to disassociate the efforts made for achieving water savings with the periods when water stocks are limited, and to adopt a steady sustainable behaviour towards water consumption. Furthermore, more information campaigns must be conducted in order to inform farmers on the sustainable use of water in agriculture and to eliminate bias regarding the use of recycled water.

Table 1-1 lists the demand management measures along with the estimated savings (Mm^3/yr) and the time period (years) used for the estimations. It was estimated that these measures could save a total of 91.4 Mm^3/yr.

Table 1-1: Water demand management measures and estimated savings

Measure	Water savings (Mm^3/yr)	Data coverage (years)
Replacement of water supply networks	3.3	2000-2010
Use of non-conventional water resources		2005-2008
Recycled water	12.5	
Desalinated water	55.5[1]	
Stormwater	0	
Subsidies for reducing domestic water demand		1997-2010
Borehole drilling	1.3	
Borehole connections with toilets	0.3	
Grey water recycling	0.03	
Hot water circulators	0.05	
Water allocation and cuts	41.5	2000-2010
Use of water meters	8	1986-2009
Redistribution of irrigated land	4.4	1991-2009
Irrigation systems	20	1960-2000[2]
Total	**91.4**	

[1] Desalinated water supply was not included in the demand savings total.

[2] The period 1960-1974 include also the Turkish occupied areas.

Source: WDD, 2011b

Many of the measures adopted have already alleviated the problem of water scarcity, as continuous water supply has been secured by desalination plants and significant savings have been achieved in

water consumption. However, there is still potential for further improvement on increasing water availability in order to satisfy human, environmental and social demands.

1.4. Measures for the protection of water quality

To protect freshwater from pollution, a wide range of legislation has been established in Europe. Most notably, the Water Framework Directive (WFD), aims to attain good ecological and chemical status of fresh and coastal waters by 2015. The Programme of Measures defined in 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. Following, all measures applied in Cyprus that are considered to contribute to the protection of water quality are being presented.

1.4.1. Designation of protected areas

In compliance with the Article 6 of the Water Framework Directive (WFD), Cyprus has created a register of all areas lying within its river basin district, which were considered requiring special protection under specific Community legislation for the protection of surface water and groundwater or for the conservation of habitats and species directly depending on water. The register includes all water bodies identified under Article 7 of the WFD and all protected areas covered by Annex IV of the WFD, namely:

i) Areas designated for the abstraction of water for human consumption in accordance with the Article 7 of the WFD;
ii) Areas designated to protect economically significant aquatic species (areas protected under Freshwater Fish Directive 78/659/EEC and Shellfish Directive 79/923/EEC);
iii) Water bodies designated as recreational waters, including areas designated as bathing waters, in accordance with the Directive 2006/7/EC;
iv) Areas designated as sensitive to nutrient pollution, including areas designated as vulnerable zones under the Nitrates Directive 91/676/EEC and areas designated as sensitive areas under the Urban Wastewater Treatment Directive 91/271/EEC;
v) Areas designated for the protection of habitats or species where maintaining or improving water status is important for their protection, including the sites of the "NATURA 2000" network, established under the Directives 92/43/EEC and 79/409/EEC.

Following, each of the aforementioned protected areas in Cyprus are presented.

(i) Areas designated for the abstraction of water for human consumption

The water resources used in Cyprus for drinking water abstraction are surface waters (dams-reservoirs) and groundwater. The protected areas under Article 7 of the WFD are presented in the following table.

Table 1-2: Protected water bodies used for drinking water abstraction

Category	Water body code	Protected area code
Surface water	CY_I-3-9_23_L4-HM	CY_PR-DRW_S-19
	CY_9-6-9_27_L4-HM	CY_PR-DRW_S-1
	CY_8-9-5_30_L4-HM	CY_PR-DRW_S-2
	CY_8-7-4_31_L4-HM	CY_PR-DRW_S-3
	CY_8-7-2_32_L4-HM	CY_PR-DRW_S-4
Groundwater	CY_1	CY_PR-DRW_GW-7
	CY_3	CY_PR-DRW_GW-8
	CY_6	CY_PR-DRW_GW-6
	CY_7	CY_PR-DRW_GW-9
	CY_9	CY_PR-DRW_GW-10
	CY_10	CY_PR-DRW_GW-11
	CY_11	CY_PR-DRW_GW-12
	CY_13	CY_PR-DRW_GW-13
	CY_14	CY_PR-DRW_GW-14
	CY_15	CY_PR-DRW_GW-15
	CY_16	CY_PR-DRW_GW-16
	CY_17	CY_PR-DRW_GW-17
	CY_19	CY_PR-DRW_GW-18

Source: WDD, 2011a – Annex I

For each of the protected areas presented in Table 1-2, in addition to meeting the objectives of Article 4 of the WFD for surface water bodies, Cyprus is engaged to ensure that, in the applied water treatment regime and in accordance with Community legislation, the resulting water will meet the requirements of Directive 80/778/EEC as amended by Directive 98/83/EC on the quality of water intended for human consumption.

(ii) Areas designated to protect economically significant aquatic species

No such areas have been identified in the river basin district of Cyprus.

(iii) Areas designated as recreational waters, including bathing waters

The harmonization of the national legislation of Cyprus with the Directives 76/160/EEC and 2006/7/EC on the management of bathing water quality was made by the Law on Water Pollution Control 106(I)/2002, the Decree on Water Pollution Control (Quality of Bathing Water) 99/2000 and

the Law on the management of bathing water quality 57(I)/2008. For the implementation of Directive 2006/7/EC, Cyprus designated in 2010, 113 bathing water areas. These bathing water areas refer to almost all coastal water bodies of Cyprus (WDD, 2011a – Annex I).

(iv) Areas designated as sensitive to nutrient pollution, including vulnerable and sensitive areas

The Directive 91/676/EEC on the protection of waters against pollution caused by nitrates has been harmonized in the legislation of Cyprus with the Law on Water Pollution Control No. 106(I)/2002. For the protection of the Vulnerable Nitrate Zones identified in Cyprus, the Department of Agriculture of MANRE has established (a) a Code of Good Agricultural Practice as well as (b) an Action Programme to prevent or reduce water pollution from nitrates.

a) Code of Good Agricultural Practice
   The Code of Good Agricultural Practice which has been enacted in Cyprus by the Presidential Decree No. 263/2007 aims to reduce nitrate pollution from fertilizer use and livestock waste and the introduction of acceptable practices for the use of recycled water in irrigation and municipal sludge in agriculture that protect public health and the environment. However, the compliance with the guidelines of the code is prescriptive.

b) Action Programme to prevent or reduce water pollution from nitrates
   The implementation of the Action Programme to prevent or reduce pollution is already mandatory in the designated Nitrate Vulnerable Zones (NVZ) in compliance with the Directive 91/676/EEC. The NVZ are designated in areas where groundwater have been or may be contaminated, due to various agricultural activities. Consequently, farmers who use agricultural land which is located within nitrate vulnerable zones are required to comply with the relevant provisions of the Action Programme concerning the use, storage and transport of fertilizers, the use and storage of livestock waste / sludge, the monitoring and control, the irrigation methods as well as the chemical analyses.

For the protection of the two sensitive areas designated in Cyprus in compliance with the Directive 91/271/EEC on Urban Wastewater Treatment, a more stringent treatment of urban waste water entering collecting systems before discharge into the sensitive areas is required (WDD, 2011a – Annex I).

(v) Areas designated for the protection of habitats or species depending on water

These protected areas include the areas of Natura 2000 network, when the maintenance or improvement of water status is important for their protection, and the areas protected by national legislation. The Natura 2000 network consists of two types of areas, namely the Special Protection Areas (SPAs) for birds as defined in Directive 79/409/EEC, and the Sites of Community Importance (SCIs) as defined in Directive 92/43/EEC. The following table lists the areas of the Natura 2000 network, which include habitats or species directly depending on water (WDD, 2011a – Annex I).

Table 1-3: List of Natura 2000 areas in Cyprus depending on water

Code of protected area	NATURA 2000 code	Type
CY_PR-NP-01	CY2000002	SCI
CY_PR-NP-04	CY2000005	SCI
CY_PR-NP-06	CY2000007	SCI
CY_PR-NP-07	CY3000005	SPA/SCI
CY_PR-NP-08	CY3000006	SCI
CY_PR-NP-10	CY4000002	SCI
CY_PR-NP-11	CY4000003	SCI
CY_PR-NP-12	CY4000005	SCI
CY_PR-NP-13	CY4000006	SCI
CY_PR-NP-15	CY4000008	SCI
CY_PR-NP-16	CY4000009	SCI
CY_PR-NP-17	CY4000011	SCI
CY_PR-NP-19	CY5000001	SCI
CY_PR-NP-20	CY5000004	SPA/SCI
CY_PR-NP-22	CY5000006	SCI
CY_PR-NP-23	CY6000002	SPA/SCI
CY_PR-NP-24	CY2000010	SCI
CY_PR-NP-25	CY2000011	SCI
CY_PR-NP-26	CY2000012	SCI
CY_PR-NP-27	CY3000007	SPA
CY_PR-NP-28	CY3000008	SPA
CY_PR-NP-29	CY4000001	SCI
CY_PR-NP-30	CY4000007	SPA/SCI
CY_PR-NP-31	CY4000018	SPA
CY_PR-NP-32	CY4000019	SPA
CY_PR-NP-33	CY4000020	SPA
CY_PR-NP-34	CY4000021	SPA
CY_PR-NP-35	CY4000023	SPA
CY_PR-NP-36	CY5000005	SPA/SCI
CY_PR-NP-37	CY5000008	SPA
CY_PR-NP-38	CY5000009	SPA
CY_PR-NP-39	CY5000010	SPA
CY_PR-NP-40	CY6000007	SPA

Code of protected area	NATURA 2000 code	Type
CY_PR-NP-41	CY6000008	SPA
CY_PR-NP-42	CY6000010	SPA

Figure 1-1 depicts these Natura 2000 areas on the map of Cyprus.

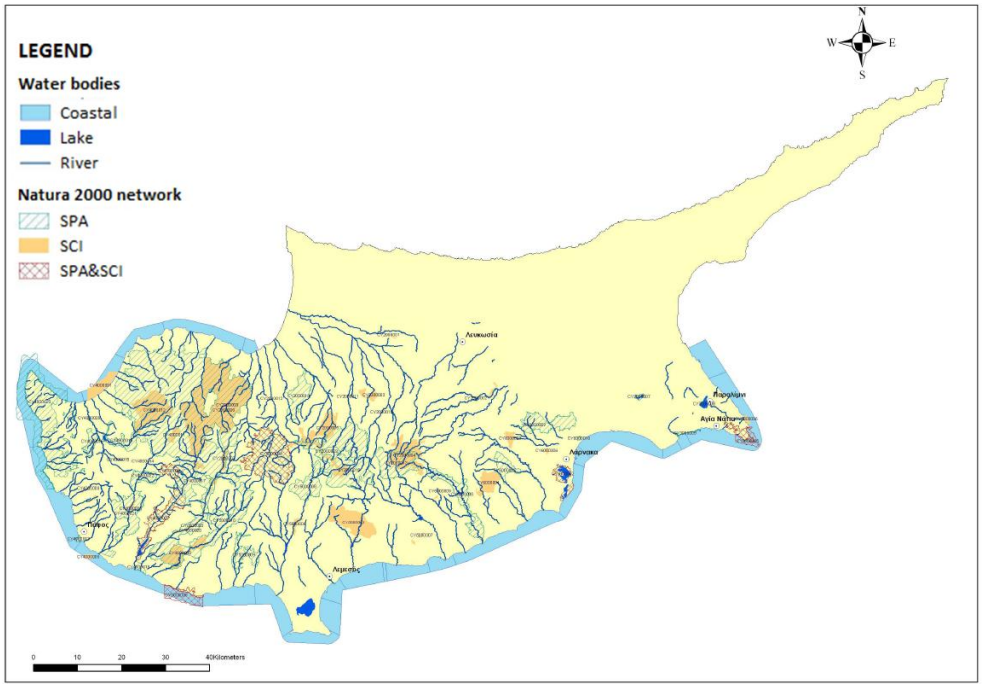

Figure 1-1: Map of Natura 2000 areas in Cyprus depending on water

As it can be seen, a considerable number of river, lake and coastal bodies in Cyprus are included in the Natura 2000 network.

1.4.2. Protection from point source discharges likely to cause pollution to water

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. Article 6 of the Water Pollution Control Law (No. 106(I)/2002) prescribes that the discharge or disposal of any substances potential to cause pollution to water and soil is illegal without previous permission. Especially for installations included in the provisions of the IPPC Directive (large units with significant pollution potential), the Law No. 56(I)/2003 for Integrated Prevention and Pollution Control is applied.

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 capacity of the new Wastewater Treatment Plans in 2012 amounts to 59 Mm^3 per year and will reach up to 65 Mm^3 per year over the medium term (2015) and 85 Mm^3 for long-term (2025)(WDD, 2011a – Annex VII).

The pollution load to be treated is set to 675,000 population equivalent (p.e.) of which 80% are generated in urban agglomerations, which are the greater areas of Nicosia, Larnaca, Limassol and Paphos, and the municipalities of Ayia Napa and Paralimini. Existing sewage treatment plants have been extended recently. The Limassol-Amathus sewage treatment work has been enlarged from a treatment capacity of 70,000 p.e. to 272,000 p.e. and is now able to handle 40,000m^3 per day. Such upgrades correct the overload under which some plants have been working for years and eventually improve effluent quality (WDD, 2011a – Annex VII).

1.4.3. Protection of groundwater bodies from salinization

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.

However, it must be noted that the rehabilitation of a groundwater body heavily affected by sea intrusion is a very slow process and sometimes almost impossible (Voudouris et al., 2005) and prerequisites the moratorium of abstractions which is not always possible to be imposed especially in the case of private drillings.

1.4.4. Farm-level measures

The main threat to water quality is posed through pollution from intense agricultural activities. Farm-level measures need to be encouraged that reduce run-off from agricultural land, especially when fertilizers and livestock manures have been applied. Fertilizer efficiency and application methods need to be improved. Hence farmers need to be made aware of the best practices both with respect to the application of manures and fertilizers and controlling soil erosion. The use of buffer strips (hedgerows, vegetative rows) beside water courses can be effective in reducing nutrient leaching. However, the adoption of such measures depends mainly on the farmers' awareness, willingness and economic ability to implement them. Following, the measures undertaken by the Cypriot Government through the Rural Development Programme 2007-2013 in compliance with the European Common Agricultural Policy (CAP), to encourage the implementation of such measures on farm-level, are being presented.

Cross compliance (Rural Development Programme 2007-2013)

Cross compliance constitutes the minimum requirements that farmers receiving direct payments from the Cyprus Rural Development Programme (RDP) must comply with. These requirements are divided in the (i) Statutory Management Requirements (SMRs) and the (ii) Good Agricultural and Environmental Conditions (GAECs).

i) Statutory Management Requirements (SMRs)

The SMRs are regulations and directives of the European Union which farmers have to apply in order to get direct payments. Among these, the Directive 80/68/EEC on the protection of groundwater against pollution caused by certain dangerous substances and the Directive 91/676/EEC on the protection of waters against pollution by nitrates from agricultural sources, are included.

ii) Good Agricultural and Environmental Conditions (GAECs)

The GAECs include guidelines for the protection against pollution and run-off such as the establishment of buffer strips along water courses. In general, the use of nitrogen fertilizers is prohibited in a distance closer than 10 meters from streams, 50 meters from lakes and rivers and 300 meters from springs or boreholes used for water supply, unless protection zones for the specific borehole are designated based on the Water Pollution Control Decree No. 45/1996 “Measures for the protection of groundwater”.

In Cyprus, the compliance with SMR’s and GAEC’s are required from all beneficiaries of the Axis 2 measures of the Rural Development Programme 2007-2013, as well as from the beneficiaries of the Area Payment Schemes and other direct payment schemes. Hence, their enforcement is obligatory only for those farmers receiving financial assistance under the abovementioned schemes and do not have a catholic application to all farmers.

Economic incentives for the reduction/substitution of the use of chemical products in agriculture (Rural Development Programme 2007-2013)

The substitution of the use of chemical products in agriculture is encouraged with the provision of economic incentives for the application of the following eligible activities foreseen under the RDP: (i) mechanical destruction of weeds, (ii) integrated production management and (iii) organic production.

i) The mechanical destruction of weeds is promoted through the following measures of the RDP:
   - Submeasure 2.3.1 "Agri-environmental commitments in wine / table grapes"
   - Submeasure 2.3.3 "Agri-environmental commitments in citrus "
   - Submeasure 2.3.5 "Preservation and maintenance of traditional varieties of wine grapes "
   - Submeasure 2.3.6 "Agri-environmental commitments in traditional plantations of trees and shrubs, with emphasis on less favoured areas "

ii) The integrated production management which involves inter alia the application of integrated pest management (pheromones, traps, natural predators) without the use of chemical pesticides is promoted through the following measures of the RDP:
   - Submeasure 2.3.2 "Agri-environmental commitments in potatoes"
   - Submeasure 2.3.3 "Agri-environmental commitments in citrus "

iii) The organic production which involves inter alia the production of agricultural products, without the use of chemical fertilizers and pesticides, in accordance with the provisions of Regulations 2092/91 is promoted through the following measures of the RDP:
   - Submeasure 2.3.7 " Development of organic production of agricultural products "

1.5. Measures for the protection from floods

The main adaptation measures towards the increasing frequency and intensity of flooding events require the separate collection of stormwater, the establishment of riverbed protection zones as well as the construction of flood protection works. In Cyprus, until recently stormwater was collected in the sewage system, which was not designed to accept stormwater and as result, when heavy rainfalls occurred, the capacity of the sewage systems was frequently exceeded causing flooding events. However, during the last two decades, a separate drainage system is being developed In Cyprus in order to collect stormwater. So far, the drainage network in the majority of the big urban centres of Cyprus has been completed. As for the riverbed protection zones, these have been established by law in several areas located next to rivers indicating that no building is allowed, but due to the lack of effective control these zones have been violated. Several flood protection works have been made in Cyprus such as bridges and retaining walls but they do not consist an integrated approach to flood management.

It is worth mentioning that, Sustainable Urban Drainage Systems (SUDS) have started to be implemented in some urban centres of Cyprus for the reduction of flood risks and the exploitation of stormwater for aquifer recharge. For example, in Limassol the construction of four stormwater retention ponds is promoted, with a total capacity of 200,000 m^3. The first pond has already been formed in part of the flood protection work west of the port. The second pond has been scheduled as part of the flood protection works in the area west of the A'Industrial Zone of Limassol. In the Paralimni lake there is a channel system which controls the water outflow from the lake (flood protection work), recharges the aquifer and sends water to the dam. Moreover, the area of Paphos has been identified as a suitable area for the implementation of SUDS while for the case of Larnaca due to its topography, no suitable measures have been identified. In Nicosia, no such initiatives have been implemented yet (WDD, 2009).

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. The WDD has already implemented preparatory steps in

conformity with the EU Directive for the Preliminary Assessment of Flood Risks and has identified 19 areas in Cyprus, as areas for which Potential Significant Flood Risks exist or might be considered likely to occur. It is expected that the identification of those areas will motivate the relevant authorities in order to implement all the necessary flood protection works.

1.6. Measures for the protection from droughts

Drought management is an essential element of water resources policy and strategies in the EU and especially in drought prone areas, like Cyprus. Following the recent drought management of 2008 in Cyprus, it was found that adaptive strategies were limited. Dealing with the shortfall of water resources consisted of corrective and emergency measures with the implementation of drought mitigation plans. Decision makers have reacted to drought episodes mainly through a crisis-management approach by declaring a national or regional drought emergency programme to alleviate drought impacts. Nevertheless, nothing can be done to reduce the recurrence of drought events in a region. Therefore, drought management should not be regarded as managing a temporary crisis. Rather, focus must be given on developing comprehensive, long-term drought preparedness policies and action plans 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.

According to the European Commission (EC, 2008), a Drought Management Plan should provide a dynamic framework for an ongoing set of actions to prepare for, and effectively respond to drought, including periodic reviews of the achievements and priorities, readjustment of goals, means and resources, as well as strengthening institutional arrangements, planning, and policy-making mechanisms for drought mitigation. Effective information, early warning systems and drought risk maps are the foundation for effective drought policies and plans, as well as effective networking and coordination between competent authorities in water management at different levels. In addition to an effective early warning system, the drought management strategy should include sufficient capacity for contingency planning before the onset of drought, and appropriate policies to reduce vulnerability and increase resilience to drought. When working towards a long-term drought management strategy, it is necessary to establish the institutional capacity to assess the frequency, severity and localisation of droughts and their various effects and impacts on crops, livestock, the environment and specific drought impacts on populations. This is rather a complex process that requires increased capacity, strong institutional structure as well as active administrative and public involvement. . The specific objectives of a DMP include(EC, 2008):

- Guarantee water availability in sufficient quantities to meet essential human needs to ensure population's health and life.
- Avoid or minimize negative drought impacts on the status of water bodies, especially on ecological flows and quantitative status for groundwater and in particular, in case of prolonged drought, as stated in article 4.6. of the WFD.

- Minimize negative effects on economic activities, according to the priority given to established uses in the River Basin Management Plans, in the linked plans and strategies (e.g. land use planning).

The Water Development Department of Cyprus in conformity with the EU guidelines has elaborated a Drought Management Plan in 2010 (WDD, 2011a – Annex VIII) in order to address these issues. The DMP of Cyprus structures upon the EU policy on drought management and is closely linked with the Government Water Policy which is based on the Water Framework Directive (WFD) criteria and objectives. The main elements of the Cyprus DMP are:

- An early warning system based on hydrological indicators
- A correlation of indicators with thresholds for different drought stages and alert levels to trigger action
- A set of phase-specific measures to achieve objectives

The actions against drought according to the level of alert may include the notification of responsible operators, raising awareness for sustainable water use, notification of users for consumption reduction, increase in desalinated water production, intensive controls of abstractions and leakages, limits to the abstractions from dams, releases from dams only for river ecosystem protection. In Table 1-4 the actions against drought corresponding to certain stand-by levels are presented.

Table 1-4: Correspondence of Alert Level and Actions

Alert Level	Actions
Mild	Notification of responsible operators. Notification of users for increased consumption awareness. Increase of water supply served from desalination plants. Abstractions from large projects according to the storage capacity index.
Moderate	Notification of responsible operators. Notification of users for increased consumption awareness. Increase of water supply served from desalination plants. Status announcement and intensive public notification program. Intensive controls for restrictions to uncontrollable abstractions and pumping, as well as for wastage limitations. Abstractions from large projects according to the storage capacity index.
High	Notification of responsible operators. Notification of users for consumption reduction. Increase of water supply served from desalination plants. Status announcement and intensive public notification program. Intensive controls for restrictions to uncontrollable abstractions and pumping, as well as for wastage limitations. Abstractions from large projects, according to the storage capacity index, but not more than those that correspond to the action “significant shortage”. Monthly regime index calculation and measures received relevant to the upstream abstractions, if this is necessary (index smaller than 5%).
Extremely High	Notification of responsible operators. Notification of users for consumption reduction. Maximization of desalination plants production, when excess quantities storage is possible.

Alert Level	Actions
	Status announcement and intensive public notification program. Intensive controls for restrictions to uncontrollable abstractions and pumping, as well as for wasting limitations. Abstractions from large projects, according to the storage capacity index, but not more than those that correspond to the action "extreme shortage". Monthly regime index calculation and measures received relevant to the upstream abstractions, if this is necessary (index smaller than 5%). The environmental releases from dams will be limited to the absolutely necessary for the river ecosystem protection and not for groundwater body recharge.

Source: WDD, 2011a – Annex VIII

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 been recently implemented and have yet to be tested to prove their efficiency in achieving the abovementioned goals.

1.7. Gap analysis

The government water policy in Cyprus as reformed in 2011, encompasses a wide range of adaptation measures that are feasible for the case of Cyprus. However, it remains for those measures to be applied and evaluated in the long-term in order to estimate whether these measures are efficient and sufficient for adapting to climate change impacts on the water resources. Furthermore, the following administrative, institutional and economic adaptation measures should also be taken into account or further promoted in order to ensure the proper enforcement of the water policy in Cyprus related to adaptation:

(Shoukri and Zachariadis, 2012; I.A.C.O. Ltd, 2008)

- Maintain and restore wetlands and riverbeds as natural defense against floods
- Proper waste management to avoid surface and ground water pollution
- Maintenance and repair of the water distribution systems and related infrastructure (adoption of technologies for leakage detection and control)
- Prioritization of sea water desalination as an ultimate solution and preferably by renewable energy
- Control over the amount of the desalinated water produced in order to avoid disposal of large amounts of brine.
- Installation of water saving equipment (set as mandatory in new buildings)
- Adoption of efficient water consumption standards
- Mandatory greywater recycling for new houses/ buildings
- Collection and use of rainwater
- Enhance water use efficiency in agriculture, households and buildings

- Prevent irrigation with brackish water
- Sound use of fertilisers and pesticides to protect surface and ground water quality
- Replenishment of coastal aquifers
- Review of the Water Policy and enhance the Drought Management Plan
- Incentives for the reuse of “grey water” in industry
- Control of high water demanding developments in areas of inadequate water resources (golf courses and tourist developments)
- Preparation of risk assessment studies for water-poor areas threatened by desertification
- Feasibility studies for water transfer in areas threatened by desertification
- Reduction of irrigated areas on the basis of the potential of each area

2. Agriculture

The climate changes observed during the recent years in Cyprus related to the increased temperature and evapotranspiration as well as the decreased precipitation have created numerous adverse impacts for the agricultural sector such as increased water requirements for irrigation, decreased water availability for irrigation, increase in run-off, deterioration of water and soil quality, increase in pests, diseases and weeds and decreased crop and feedstock productivity. Hence, the development and enforcement of measures and incentives that enhance crop adaptation to global warming, water shortages and other biotic and abiotic stress factors.

This section aims to identify those measures undertaken in Cyprus that have contributed to the adaptation of the Cypriot agriculture sector to climate changes. As the adaptation measures for the agricultural sector depend mainly on farm level action, incentives are provided through the Rural Development Programme of Cyprus, which is structured upon the Common Agricultural Policy of the EU, in order to make the implementation of these measures more attractive to farmers. Furthermore, research activities on adaptation are on-going in order to promote those adaptation measures that best fit to the specific characteristics of agriculture in Cyprus.

Cyprus' Rural Development Plan 2007-2013

The Cyprus' 2007-2013 Rural Development Plan is based on the Guidelines set in the European Common Agricultural Policy (CAP). The overall aim of the Cyprus Rural Development Plan, which has been prepared and implemented after the accession of Cyprus to EU, is to promote the sustainable development of rural areas, through the implementation of an integrated set of coherent and consistent measures, taking into account existing weaknesses, opportunities and strengths. The principal goals of this plan are:

- **Improving the competitiveness of the farm and forestry sector (PRIORITY AXIS 1):** Reinforce the competitiveness of the primary and secondary agricultural sector in Cyprus. It supports training, modernization, post-harvest processing, improvement of food quality, and establishment of Producer Groups.
- **Improving the environment and the countryside (PRIORITY AXIS 2):** Protect the environment and the countryside. It supports the agricultural production in less favourable areas, agro-environmental commitments such as integrated crop management and rotations, organic farming, agro-biodiversity conservation, afforestation and forest management.
- **Quality of life in rural areas and diversification of rural economy (PRIORITY AXIS 3):** Improve the quality of life in rural areas and diversification of the rural economy.

Following, the existing adaptation measures are categorized and presented per climate change impact on the agricultural sector.

2.1. Measures to reduce risk of drought and water scarcity

The measures to adapt to the expected decrease in water availability and drought risk in the agricultural sector may be categorized in three groups: (i) increase water supply, (ii) reduce water demand and (iii) improve the efficiency of irrigation.

2.1.1. Increase water supply

As also mentioned in the Section "Water Resources" of the current report, the reduced water availability due to reduced rainfall and the increased evapotranspiration has led the Government of Cyprus to adopt a series of measures such as the increase of water reservoirs and the use of non conventional water resources, which have significantly alleviated water stress. However, as water demand for agriculture may not be always satisfied completely by government water works, farmers may explore other ways to supplement water supply and secure sufficient and continuous irrigation of crops. This may be achieved by on-farm rainwater harvesting and establishing small-scale water reservoirs on farmland while ensuring the sustainable use of water resources and avoiding groundwater overexploitation. The Rural Development Programme 2007-2013 of Cyprus is providing incentives to farmers for the implementation of these measures through the following measure:

- Submeasure 1.5 "Modernisation of agricultural holdings". Through this measure financial support is provided to farmers for the modernisation of their agricultural holdings, including the installation of stormwater collection tanks.

2.1.2. Reduce water demand

Water demand in agriculture may be reduced by adopting less water intensive crops, increasing water retention in soils, soil moisture and reducing run-off.

Use less water intensive crop patterns

The existing crop patterns in Cyprus have been developed many years ago, when water availability was substantially higher. The decrease of water availability during the last years highlights the need to turn to less water intensive crops. However, this is a rather time-consuming process as most farmers have been adjusted to certain crops in terms of experience, know-how and equipment.

Among the proposed measures in the Programme of Measures of the Cyprus River Basin Management Plan (WDD, 2011a, - Annex III), the carrying of a study on the readjustment of crops towards a less water intensive crop mix in collaboration with the Department of Agriculture, the Agricultural Research Institute, the Ministry of Commerce, agricultural organizations, etc was proposed.

Increase soil moisture, water retention and reduce run-off

The measures applied in Cyprus for the improvement of soil moisture, water retention and the reduction of surface run-off also apply for the case of preventing soil erosion. For these measures the reader can refer to Section 8: Soils.

2.1.3. Improve water use efficiency in irrigation

Use of advanced irrigation systems

A Water Use Improvement Project has been implemented by the Department of Agriculture since 1965. According to this project the government provided farmers with technical and financial assistance to turn from traditional surface irrigation methods to modern irrigation methods. Due to the relatively high installation costs, the drip method was initially used for irrigation of high value crops, such as greenhouse vegetables and flowers. At a later stage, the installation cost was reduced, and the use of drippers, mini sprinklers and low capacity sprinklers was expanded for irrigating trees and field vegetables. As a result, during the last decades farmers have extensively adopted modern irrigation systems. The new technology introduced is continuously being tested by the Agricultural Research Institute in order to evaluate the different systems under local conditions and select the appropriate irrigation method for each cultivation. The progress in the irrigation efficiency from less than 45% in 1960, reached 71% in 1980, 80% in 1990, 84% in 2000 and 90–95% in 2010. The on-farm irrigation systems comprise 90% micro-irrigation, 5% sprinkler irrigation and 5% surface irrigation (WDD, 2011b).

Furthermore, the Agricultural Research Institute is conducting research for the design and application of hydroponics systems and the production of irrigation water through air condensation, in order for further savings in irrigation water to be achieved.

Irrigation scheduling

Decisions on when and how much to irrigate are critical both to water use efficiency and to crop health. Irrigation scheduling aims at determining the exact amount of water to irrigate and the exact timing for application. Irrigation scheduling offers an opportunity for improving water efficiency at farm level. The Rural Development Programme 2007-2013 of Cyprus is providing incentives to farmers for the implementation of this measure through the following measures:

- Submeasure 2.3.2 "Agri-environmental commitments in potatoes"
- Submeasure 2.3.3 "Agri-environmental commitments in citrus"
  One of the eligible actions for funding under these measures includes the application of integrated production management which inter alia foresees the sustainable use of water by following certain irrigation programmes and irrigation schedules.

2.2. Measures to reduce risk of reduced crop productivity

The increase in temperatures in critical periods in conjunction with the reduction in precipitation and the loss of soil water retention capacity are expected to have a negative impact in crop productivity. In this section the measures undertaken in Cyprus for addressing the risk of declines in crop and pasture yields are presented.

2.2.1. Increase soil fertility

Management practices that enhance soil fertility include the application of organic residues which are rich in nutrients (e.g. humus) to soil. Furthermore, the application of crop rotation and fallow to the cultivated land is also associated with greater soil organic matter, soil structure and aggregation compared to simple rotations or mono-cropping. Both practices also reduce soil erosion potential due to increased water infiltration and water holding capacity. Next, relative actions that have been applied/promoted in Cyprus are presented.

Application of organic residues on soils

The Good Agricultural and Environmental Conditions set the standards for managing crop residues and suggest that depending on weather conditions, producers have to follow one or more of the following practices regarding plant residues: a) use for grazing purposes, b) use as soil cover or integration in the soil for annual crops.

Crop rotation

The application of crop rotation in Cyprus is encouraged through the Rural Development Programme with the provision of economic incentives. The related measures of the RDP are:

- Submeasure 2.3.2 "Agri-environmental commitments in potatoes"
  One of the eligible actions of this measure for the provision of financial support to farmers is the implementation of a three-year crop rotation system.
- Submeasure 2.3.4 "Agri-environmental commitments in arables". With this scheme financial aid is provided for the implementation of a two-year crop rotation system or a three-year rotation system.

2.2.2. Diversify crops - polyculture

Improvement of soil quality and productivity may also be achieved through the diversification of crops cultivated in a farm, as the variety of crops (and manure) on the same piece of land over a number of years typically is associated with greater soil organic matter, soil structure and aggregation compared to mono-cropping. Diversification also spreads the risk of losing an entire year's production since different crops respond differently under adverse climatic conditions. The simplest form of crop diversification is crop rotation while there are other more complex forms such

as multi-cropping and inter-cropping that can yield even better productivity with a right combination of crops. The Rural Development Programme 2007-2013 of Cyprus is providing incentives to farmers for the implementation of crop rotation through the following measures:

- Submeasure 2.3.2 "Agri-environmental commitments in potatoes"
  One of the eligible actions of this measure for the provision of financial support to farmers is the implementation of a three-year crop rotation system.
- Submeasure 2.3.4 "Agri-environmental commitments in arables"
  With this scheme financial aid is provided for the implementation of a two-year crop rotation system or a three-year rotation system.

2.2.3. Genetic improvement of plants

Crop productivity under adverse climatic conditions may be ensured by the genetic improvement of plants in order to increase their resistance to those conditions and reinforce their adaptive capacity to climate change. The Agricultural Research Institute of Cyprus is conducting a project on the genetic improvement of plants for adaptation to climate change. In specific, the objectives of this research are the increase in crop yields, the increase of the resistance to abiotic and biotic stresses and the genetic improvement of a local variety of beans (*Iouvi*) and barley for increased adaptability to the warm and dry environment of Cyprus. These varieties were selected due to their substantial economic importance for Cyprus.

2.3. Measures to reduce increased agricultural pests, diseases, weeds

A changing climate and associated warming is likely to lead to the introduction of new pests and diseases as well as changes to the intensity/occurrence of current infestations. The measures that have been undertaken in Cyprus to support farmers in order to reduce the proliferation of new pests and diseases are presented below.

2.3.1. Promote indigenous and locally adapted plants and animals

The concept of this measure relating to climate change adaptation lies on the fact that indigenous and locally-adapted plants and animals of Cyprus are more resistant to the climatic conditions of Cyprus and therefore they are less likely to be susceptible to infestations. The Rural Development Programme 2007-2013 of Cyprus is providing incentives to farmers for the implementation of this measure through the following measure:

- "Preservation and maintenance of traditional varieties of wine grapes and protection of traditional animal breeds" (Submeasure 2.3.5).

This scheme provides financial support to farmers for the cultivation of traditional wine grapes and the breeding of indigenous cattle and sheep breeds.

In addition, the Agricultural Research Institute of Cyprus has conducted a research programme called "ΕΝΔΗΜΑΝΘΗ" (2001-2006), whose main aim was to promote the use of selected endemic species of flora of Cyprus that are already adapted to the soil conditions of Cyprus, they have small requirements in water and fertilization and are resistant to high temperatures.

2.3.2. Develop an Integrated Pest Management Strategy

The role of an Integrated Pest Management Strategy towards the reduction of pests is mainly preventive, as it includes measures for the prevention of infestation by promoting plant varieties which best adapt to local growing conditions, as well as for the monitoring of pests patterns to prevent damages.

Relative adaptation actions applied in Cyprus are:

- Integrated and biological treatment of insects and mites in annual and perennial crops (Agricultural Research Institute of Cyprus). This project has not been applied yet in Cyprus as it is still in research level.

2.3.3. Apply crop rotation

Pest and pathogens may also be reduced by applying crop rotation in cultivated land, as the changing of crops in a sequence disrupts the pest (weeds and insects) and pathogen life cycles. Thus, the build-up of pest and pathogen populations is obstructed. As mentioned also above, the Rural Development Programme 2007-2013 of Cyprus is providing incentives to farmers for the implementation of crop rotation through the following two measures:

- Submeasure 2.3.2 "Agri-environmental commitments in potatoes"
- Submeasure 2.3.4 "Agri-environmental commitments in arables"

2.3.4. Reinforce resistance of existing plants and animals against pests and diseases

The resistance of plants and animals against pests and diseases can be reinforced by the application of biotechnology for the health improvement of plants and animals and their strengthening against future health risks.

Relative adaptation actions applied in Cyprus are:

- Improvement of cultivars of citrus, grapes, potatoes, stone fruits etc with application of meristematic cultivation or micro-vaccination in vitro (Agricultural Research Institute of Cyprus). The Agricultural Research Institute is investigating the local production of healthy propagating material of various cultivars which will enable inter alia the elimination of infestations. For that reason, an *in vitro* Seed Bank has been created for the preservation of healthy propagating material.

2.4. Measures to reduce risk of extreme weather events

Improving water retention in soils, absorption and run-off via restoring natural features such as hedgerows, floodplains and woodlands will buffer agricultural land from extreme weather events. The majority of adaptation measures regarding this issue require action at the farm level. Consequently, the government measures to assist adaptation mainly refer to the provision of economic incentives to farmers in order to implement adaptation measures.

2.4.1. Install hedgerows

The plantation of hedgerows of shrubs or trees helps protect agricultural crops from external factors such as floods, winds and frosts, thereby reducing damage to crops while improving the quality and quantity of agricultural production. Relative measures that have been promoted in Cyprus through the Rural Development Programme 2007-2013 to motivate the installation of hedgerows are:

- Submeasure 2.4.2 "Installation of agri-silvicultural systems". This measure provides financial incentives for the installation of windbreaks, which are actually hedgerows of forest trees, around agricultural crops.

2.4.2. Establish woodlands

Woodlands help buffer peak rainfall events, prevent flooding and waterlogging by slowing the movement of water from soil to watercourses. Relative measures that have been promoted through the Rural Development Programme 2007-2013 in Cyprus to motivate farmers for the establishment of woodlands are:

- Submeasure 2.4.1 "Afforestation of agricultural land" & Submeasure 2.4.3 "Afforestation of non agricultural land"
  Eligible activities and projects foreseen under these measures are separated into two groups: a) Installation and protection of forest plantations and b) Care / Maintenance of plantation forest.

2.5. Measures to reduce risk for livestock

Increased temperatures are reported to cause disease outbreaks as well as heat stress to animals. Extended warm periods will increase cases of heat stress amongst livestock. Thermal stress reduces productivity (as animals tend to eat less), conception rates and can ultimately threat livestock life. Catering for animal welfare under extreme weather conditions can be enhanced by increasing the amount of shade and shelter or keeping livestock indoors.

2.5.1. Improve outdoor conditions

Shelterbelts provide protection from heat and wind for livestock, and can increase the heat units in adjacent fields. Planting tall, fast-growing, trees on the southern edge of pastures is one method of increasing shade. Relative measures promoted through the Rural Development Programme in order to motivate the installation of shelterbelts are:

- Submeasure 2.4.2 "Installation of agri-silvicultural systems". This measure provides financial incentives for the installation of windbreaks, which are actually hedgerows of forest trees, around agricultural crops.

2.5.2. Improve indoor conditions

The use of thermostats, cooling and ventilation systems within animal housing areas may be used to maintain temperature in acceptable levels and thus reduce heat stress and disease outbreaks. The Rural Development Programme 2007-2013 of Cyprus is providing incentives to farmers for the implementation of these measures through the following measure:

- Measure 1.5 "Modernisation of agricultural holdings". Through this measure financial support is provided to farmers for the modernisation of their agricultural holdings. The eligible investment that could be used for the reduction of diseases and heat stress in animals is the installation of ventilation systems in animal housing areas.

2.6. Other measures

2.6.1. Raise awareness of farmers

Raising awareness is essential in order for the farmers to be aware of how and why sustainable agricultural practices are applied. Relative measures foreseen in the Rural Development Programme are:

- Measure 1.1 "Vocational training and information, including dissemination of scientific knowledge and innovative practices for persons engaged in agriculture, food and forestry " .

Through the actions of this measure, the opportunity is provided to farmers to be trained on issues such as the integrated and sustainable management of natural resources, the application of production practices compatible with conservation and enhancement of landscape and the environmental protection and proper implementation of agri-environmental measures.

- Measure 1.4 " Use of Farm Advisory Service (FAS) ". The Farm Advisory System (FAS) is a system for advising farmers on land and farm management. Farmers are encouraged to take part with a facility to claim for financial assistance to use the provided service.

2.6.2. Prevent rural depopulation

Rural depopulation and subsequently land abandonment may be prevented by providing incentives to young farmers to work in agriculture. Following, the relative measures foreseen in Cyprus through the Rural Development Programme 2007-2013 are presented.

- Measure 1.2 " Reinforcing installation of young farmers ". The measure aims to provide special incentives to retain young people in rural areas (under 40 years) to work in agriculture while contributing to age-renewal of the rural population, and reducing the effect of rural depopulation and land abandonment. This measure in conjunction with Measure 1.3 of the RDP is considered to contribute to climate change adaptation as young people are more susceptible to changes that may be required in order to adapt to climate change (e.g. new crop patterns, cultivation practices and technology) in contrast with older people, which are therefore considered more vulnerable.
- Measure 1.3 " Early retirement of farmers ". The measure aims to provide special incentives for early retirement of farmers in order to transfer their holdings to young people while contributing to age-renewal of the rural population. This measure in conjunction with Measure 1.2 of the RDP is considered to contribute to climate change adaptation as the elderly are less susceptible to changes that may be required in order to adapt to climate change (e.g. new crop patterns, cultivation practices and technology) in contrast with young people, which are therefore considered less vulnerable.

2.6.3. Strengthen vulnerable areas

Less favoured areas due to physical disadvantages of the land (reduced fertility, increased inclination) remaining unexploited, are considered more vulnerable to climate change impacts. The Rural Development Programme 2007-2013 provides financial support to farmers in order to maintain sustainable land management through the following measure.

- Measure 2.1 "Compensatory Allowances in Less Favoured Areas". This measure aims to strengthen farmers in less favoured areas (mainly mountain areas) for the partly offset of income loss due to permanent physical disadvantages of land. Eligible activity is the exploitation of agricultural or fallow land. This will help maintain areas of high environmental and/or amenity value.

However, present support levels may not be sufficient to maintain agricultural practices in light of climate change impacts. Furthermore, natural handicap areas could be expanded to include those areas that will be particularly negatively affected by climate change. With limited production capacity due to changes in temperature and precipitation or increased frequency of significant events, these areas will become particularly vulnerable.

2.7. Gap analysis

After reviewing the measures applied in Cyprus which contribute to climate change adaptation, it was found that there are certain measures that have not been promoted yet or need further promotion. Following, these measures are presented in brief:

(Iglesias, 2007; Shoukri & Zachariadis, 2012; I.A.C.O. Ltd, 2008)

- Selection of breeds more suited to warmer temperatures in order to reduce the occurrence of heat stress.
- Provide incentives through the measures of agri-environmental commitments to encourage farmers to maintain floodplain lands with appropriate compensation.
- Recommending farmers to move crops and stock from fields vulnerable to waterlogging in order to reduce consequent impacts on stock health and crop yields.
- Coordination of efforts in planning measures / projects to reduce risks from flooding
- Identification and introduction of new pest resistant varieties
- Monitoring of diseases patterns in livestock in order to prevent outbreaks
- Installation of thermostats and cooling systems in greenhouses
- Strengthening animal health against diseases, such as the vaccination of both domestic and wild populations
- Changing land use in areas that are more susceptible to drought
- Use of new crops more tolerant of drought and heat
- Use of new drought and heat resistant cultivars of current crops
- Application of multi-cropping or inter-cropping
- Adjust cropping calendar (sowing-planting) - earlier planting, so that maturation occurs before the summer when temperatures are higher
- Making increasing use of forage grown during early spring and late autumn in order to compensate for reduced yield during summer
- Increase rainwater harvesting and use in agriculture
- Increase the use of recycled water in agriculture
- Irrigating at night when evapotranspiration is reduced
- Support farmers for animal feed production to reduce the need for grazing

3. Coastal areas

The most notable climatic changes reported are the sea level rise, the rise of sea surface temperatures, the decrease in precipitation, the increase of sea water intrusion and an the increase of extreme weather events. The coastal areas of Cyprus are expected to be exposed to an increasing risk of flooding and erosion. The main measures that have been implemented in Cyprus related to climate change impacts on the coastal areas can be categorized as coastal erosion control and coastal storm flooding and inundation control, although these effects are mainly attributed to human pressures such as the mining activities and the development of the tourist industry. Following, the measures that have been implemented in Cyprus in order to address those issues are being presented.

3.1. Measures to reduce erosion

The problem of erosion in Cyprus was identified for the first time in the early 1970's, when the consequences of the sand and gravel mining activities during 1955-1970 became visible. As soon as the extent of the problem was realized, it was decided to prohibit by law sand and gravel mining.

In order to improve coasts and the tourist industry that began to develop along the coasts of Cyprus after the Turkish invasion in 1974, a number of hard defense structures were constructed for enhancing depositional processes along the coast. The main type was groynes which were constructed illegally by hotel owners in an attempt to create more attractive sandy beaches. In addition, a number of breakwaters were constructed by the government. However, these measures were undertaken without any comprehensive prior study and without taking into consideration any potential adverse impacts.

In 1992, the Government decided to adopt a moratorium in the construction of the hard structures and assigned the implementation of a project entitled 'Coastal Protection Management for Cyprus' (1993-1996). The project was carried out by the Coastal Section of the Department of Public Works (DPW) of the Ministry of Communications and Works, and Delft Hydraulics with the objective to identify proper protection methods and improve the quality of beaches without causing serious impacts on the environment. The entire coastline of the Republic of Cyprus was divided in twelve 'sections' or coastal areas based on their morphology. Two hundred (200) profiles were established along the coast with the application of a Coastal Zone Information System. The profiles are measured once a year in order to record the seabed and the shoreline position and, to assess the rate of erosion. Master Plans, as well as conceptual and detailed designs, were developed for three of the twelve coastal areas (Limassol, Larnaca and Paphos South). These sections were selected based on a multi-criteria analysis and a cost comparison between alternative erosion solutions was carried out.

In 1998 the Cyprus government started with the implementation of these Master Plans. The DPW in cooperation with the National Technical University of Athens, also implemented a project (2000-2006), which was a continuation of the previous one that deals with three (3) new coastal areas in

Paphos (Kato Pyrgos Tillirias, Crysochou Bay and Zygi-Kiti). The goal was to identify the proper methods to protect the coastline. The following years, Cyprus has prepared and implemented a number of additional Master Plans and intends to do the same for the rest of the coastal areas that is deemed necessary (Coccossis et al., 2008).

In addition, a number of illegal groynes have been removed (mainly built by private parties, such as hotel owners) as many of them, often relocated the problem to another part of the coast. The coastal defense works constructed in Cyprus during the period 1980-2011 are summarized in the following table.

Table 3-1: Coastal hard defense works

Site	Type of intervention	Year
Larnaca	10 breakwaters 6 breakwaters	1980-1990 2001
Zygi	5 breakwaters 1 fishing shelter	2009-2011
Limassol	30 breakwaters 6 breakwaters 10 breakwaters	1980-1990 2001 2005-2007
Pafos	1 breakwater	1980-1990
Geroskipou	6 breakwaters	2010–2012
Poli Chrysochous	4 breakwaters	2009-2010
Kato Pyrgos	5 breakwaters	2010-2011
Maroni	3 groynes (illegal)	-
Vrisoudhia	1 groyne (illegal)	-
Kambourias	coastal road revetment	2008
Niolima	2 groynes (illegal)	-
Pentaschinos	2 groynes (illegal)	-
Yanoudhia	2 groynes (illegal)	-
Yanoudhia	coastal road revetment	2008
Platy	3 groynes (illegal)	-
Platy	coastal road revetment	2007
Alaminos	4 breakwaters 1 fishing shelter	2000
Softades	2 groynes (illegal)	-
Kokkinadhia	coastal road revetment	2004/08

(Montanari, 2010; DPW)

Hotel owners and the society/stakeholders in general prefer hard defense works because they think they are more effective while the government and private companies try to pursue them that they are not environmentally friendly. Hard coastal structures have been considered for several decades the remedy for combating coastal erosion. The years proved that in the long run, hard interventions

can have serious negative impacts both on coastal morphology and coastal environment. The sustainable development of the coastal areas asks for combining erosion control and good environmental practices, within the framework of Integrated Coastal Zone Management schemes. Coastal defense and protection structures are usually constructed as emergency measures, without taking into consideration environmental and social impacts (Loizidou and Loizides, 2007). Furthermore, hard defense works are considered mal-adaptation due to ecosystem/environmental damage they cause primarily in the quarrying areas.

In addition, Non Governmental Organizations (NGO's) in Cyprus focused on coastal zone protection (like CYMEPA and AKTI) organized several awareness raining campaigns for the public. Local Authorities hosted workshops and happenings. The effort was and is to give people and the Local Authorities the information on the alternative, environmental friendly coastal protection methods and promote the need for integration. The Environmental Service and Coastal Unit of the Ministry of Agriculture, Natural Resources and Environment of Cyprus support this effort (Loizidou and Loizides, 2007).

Another measure to protect coastal erosion is beach nourishment. Beach nourishment is considered a good solution and from aesthetic point of view as well, but it is costly and many times is not economically feasible due to lack of funding. Beach nourishment was firstly applied on a specific area in Limassol. The material was brought from the extension works in Limassol Port. The total amount of sand brought was 20.000 m^3. In addition, in a certain area of the Famagusta region a number of hotel owners used sand nourishment to improve the quality of the beach and create more friendly access to the beach (in rocky areas). In addition small pilot nourishment projects with sand were carried out in Larnaca and Pafos District. However, the responsible Municipality/Local Authority did not have the financial resources to continue the project and replace any sand losses undertaken during the year.

3.2. Measures to reduce risk from coastal storm flooding and inundation

The adaptation measures for the protection of coasts in Cyprus from flooding and inundation consist mainly of hard engineering structures such as seawalls and coastal revetments. In addition, the measures applied in Cyprus for the protection from erosion, help prevent coastal flooding as well, by enhancing depositional processes along the coast. Structures such as groynes and breakwaters promote the deposition of sediment on the beach thus helping to buffer against storm waves and surges as the wave energy is spent on moving the sediments in the beach than on moving water inland (Short and Masselink, 1999). However, seawalls and revetments are not considered attractive for bathing beaches and thus breakwaters and groynes are the predominant defense works, although the latter are considered less drastic measures in case of a severe storm or flooding event. The coastal hard defense works constructed in Cyprus during the period 1980-2011 are summarized in Table 3-1.

Fishing shelters, which are constructed for the protection of fishing boats against extreme events such as storm and large waves, also protect the coast. Currently in Cyprus there are 11 fishing shelters in operation.

Furthermore, artificial reefs which are actually submerged breakwaters provide protection from flooding by absorbing part of the incident wave energy before it reaches the coast. According to the Strategy for the creation of artificial reefs, the DMFR is expected to create up to four artificial reefs in the marine areas of Famagusta, Limassol and Paphos.

In addition, there are certain legislative measures regarding the protection of the coastal zone (Foreshore Protection Law) that can be considered to act as adaptation measures as well, in case of a sea level rise. The foreshore set back line is one of the main issues elaborated in the *ICZM protocol* (2007) under Article 8 – *Protection and sustainable use of the coastal zone*. The Foreshore Protection Law of Cyprus defines the "foreshore" as "all land located within 100 yards (91,44m) of the high water mark". The foreshore area in Cyprus is public property falling under the jurisdiction of this Law. Within this zone no building development is allowed except for light structures (sheds, footpaths, etc.), after approval by the Council of Ministers following recommendation by the District Officer and on advice by the Director of the Department of Town Planning and Housing (Coccossis et al., 2008).

However, the implementation of the Foreshore Protection Law is not adequately monitored, resulting in numerous violations and interventions in the foreshore zone.

3.3. Constraints

The existing policy mechanisms impacting on the coastal environment are exercised by a variety of Ministries and Departments. There is fragmentation of responsibilities and limited effective coordination at different levels of decision making. Particular difficulties are encountered in reconciling local level development expectations with national level planning objectives. It is generally agreed that policy coordination and implementation difficulties constrain the potentials for a more rational management of coastal resources which are the core of the Cyprus economy. What is more, public participation is a rather weak process giving rise to multiple responses rather than building up a common perception of problems, conflicts and possible solutions (Coccossis et al., 2008).

3.4. The proposed Integrated Coastal Zone Management Framework

An first important step in the direction for introducing integration in coastal protection actions was the Environmental Impact Law of 2001 (Law 57(I)/2001), through which it is necessary to proceed with an Environmental Impact Study before the construction of any coastal protection work (Loizidou and Loizides, 2007).

Following, Cyprus recognizing the need to adopt an Integrated Coastal Zone Management (ICZM), decided to initiate a Coastal Area Management Programme (CAMP) within the Priority Actions Programme. The project which was signed on 2005 and completed on 2008, had as an objective to set out changes for initiating a continuous, proactive and adaptive process of resource management of coastal areas in Cyprus based on closer integration of policies and decision-making modalities and a set of guiding or framework objectives.

Within the broad principles of ICAM methodology and the existing conditions in Cyprus, the main objectives of the project were to elaborate and implement selected tools of coastal area management with a view to:

• introduce the ICAM as the basic tool

• strengthen synergies between policies

• increase collaboration between the competent Departments

• improve public awareness of the scope and significance of coastal area management

• harmonize national / local level development visions and reconcile planning policies with local community income aspirations.

The activities undertaken with this project focused on the elaboration and participatory application of three important tools of coastal zone management (Strategic Environmental Assessment, Carrying Capacity Assessment and Resource Valuation) within the context of Mediterranean Action Plan's Integrated Coastal Zone Management (ICZM) methodological framework.

The *Integrated Coastal Area Strategic Framework (ICAMSF)* proposed under this project, defined the main guiding goals and objectives pertaining to an integrated approach to coastal areas cutting across the various sectors, centered around four overriding axes:

- Protection, preservation and management of coastal areas through sustainable use of resources;
- Promotion of economic development through synergies between environmental quality and economic activities that rely on environmental quality;
- Restoration of balanced coastal and hinterland development;
- Improvement of governance at the local, district and national level.

In the following table, the proposed measures of the ICAMSF relating to the protection of coastal areas and their adaptation to climate change impacts, are presented.

Table 3-2: Adaptation measures proposed under the ICAMSF regarding coastal areas

Policy sector	ICAMSF proposed measures
Spatial planning	Adopt ICZM Protocol guideline on foreshore protection Incorporate biodiversity strategy in the Development Plans (including marine, coastal and

Policy sector	ICAMSF proposed measures
	terrestrial biodiversity) Protect coastal agricultural land and heritage sites from the expansion of designated development zones, and observe Carrying Capacity and Strategic Environmental Assessments Introduce and apply resource valuation assessment and economic instruments in plan preparation and implementation Planning decisions and zoning changes that create "betterment" of property values and increased development rights should be taxed to "internalize" development costs, encourage resource conservation and raise revenues for coastal and other environmental expenditure for protection and monitoring
Tourism	Restrain the growth of accommodation facilities and encourage diversity through development of sport, cultural, recreational facilities and nature destinations Protect and promote open coastal areas as a complementary element of tourism attraction Tourism strategy defining development areas should take into account Carrying Capacity constraints and impeding Strategic Environmental impacts, particularly the need for the protection of coastal ecology and the integrity of coastal and marine biodiversity
Infrastructure / Traffic	Protect the marine environment and the land/sea interface shore area from interventions and constructions that cause erosion
	Avoid interventions that alter beach morphology and beach quality and restore area suffering from erosion areas with actions that secure pedestrian accessibility and recreation
	Prevent vehicular road construction within a distance of at least 100 m from the shore and other road and accesses to the beach that may fragment coastal landscapes
	Adhere to the conclusions reached by Carrying Capacity and Strategic Environmental Assessments

Source: Coccossis et al., 2008

The establishment and operation of the proposed ICAMSF requires a strong linkage within the national level policy framework to act as the mechanism for supporting the achievement of its objectives. The proposal put forward by the ICAM Activity on this issue is the incorporation of the ICAMSF into the *Island Plan*. The *Island Plan*, according to the Cyprus' Town and Country Planning Law of 1972, is the highest level Development Plan document within the hierarchy of Development Plans (Island Plan, Local Development Plans and Area Schemes) the responsibility for which has been given to the Minister of Finance due to the strong linkages between spatial and socio-economic development parameters and goals. Due to the political crisis in Cyprus of 1974, the *Island Plan* prepared in 1968-70 had since remained inactive, temporarily substituted by a *Policy Statement for the Countryside*. Unfortunately, the Policy Statement for the Countryside lacks the comprehensiveness and integrated scope envisaged by the *Island Plan*. The absence of a comprehensive spatial development strategy has, among other things, prevented the integration of coastal development with the country's economic development strategy, resulting in a geographically and thematically segmented approach to coastal resource dominated by the localized spatial Development Plans. The Minister of Finance, and the Cyprus Government, recognizing the need for fulfilling this deficiency, proposed the reactivation of the *Island Plan*, a proposal referred also in the Strategic Development Plan of Cyprus for the period 2007-13.

(Coccossis et al., 2008)

3.5. Gap analysis

In view of the adaptation measures that have already been undertaken for the protection of the coastal areas of Cyprus, additional adaptation measures that should be taken into consideration are:

(Shoukri & Zachariadis, 2012; DoE, 2010a)

- Prepare an inventory of coastal areas already suffering from erosion as well as those vulnerable to erosion and evaluate the measures already taken
- Examine the possibility of other measures to combat coastal erosion
- Protection of wetlands and sand dunes as a measure to combat erosion
- Sea level rise considerations in existing and new coastal developments/ infrastructure
- Relocation of infrastructure and houses inland to allow coastal ecosystems to recover
- Research on sea level rise, increase monitoring sites and apply model simulations
- Enforcement of the framework strategy "Integrated Management of Coastal Areas"
- Integration of the tool "Imagine"[1] in the framework of politics in Cyprus
- Inclusion of the tool "Evaluation of Carrying Capacity" proposed under the CAMP project in the Construction Spatial Planning System and in the Tourism Policy
- Integration of environmental assessment economic instruments and of specific tax measures in the development plans

[1] *The "Imagine" methodology was developed by the Blue Plan and Dr Simon Bell in order to assist stakeholder groups in gaining insights and have control over their own sustainable development, by means of sustainability indicators, scenarios and graphic, easy to understand representation of the past, present and future sustainability situation. For more information on this methodology see "A Practitioners guide to Imagine – The Systemic and Prospective Sustainability Analysis. Bleu Plan"*

4. Tourism

The main impacts of increasing temperatures, heat waves and water scarcity in the tourism sector of Cyprus are the increase of the tourist discomfort during the hot summer months, the decreased tourist arrivals and the lengthening of the summer season to spring and autumn as well. Following, the measures that have been implemented in Cyprus in order to address those issues are being presented.

4.1. Measures against decreased tourism during summer months

The main aim of the Cyprus' tourism policy in order to address the increased temperatures is to extend the tourist season and to establish Cyprus as a tourist destination throughout the year. It is recognized that there have been made important steps in developing the tourism product in Cyprus to offer choices and meet the needs of different market segments that travel throughout the year. For example, the Cyprus Tourism Organization (CTO) has undertaken a number of initiatives towards the diversification of Cyprus' tourist product as it can be seen from its Strategy Plans for tourism, by promoting additional tourist products apart from beach and ski tourism, such as conference tourism, sport tourism, cycling, golf, weddings and honeymoon trips, hiking, religious and cultural tourism, health tourism (medical and wellness), countryside tourism, training and educational tourism, cruising, gastronomic and wine tourism.

Thus it is considered that there is the ability to extend the tourist season in Cyprus, aiming at its establishment as a "12 months tourism" destination. However, it must be mentioned that the product and the corresponding segment have not integrated approached so far. It is therefore necessary to make a thorough investigation and analysis to provide a complete picture of the needs of potential visitors regarding the "12 months tourism" and the existing tourism status in Cyprus in order to undertake the necessary measures.

To achieve this, the CTO proposed a programme of measures in its Tourism Strategy for 2011-2015. This programme is based on the comparative advantages of Cyprus in relation to other tourist destinations of the Mediterranean, due to its mild winter climate and its substantial infrastructure that has been created in recent years, in terms of improvement works and activities appropriate for the "entire year" visitor. The relative strategic actions that have been identified in the Cyprus' Tourism Strategy are:

1. Analysis of existing products and services

Recording and analysis of existing products and services offered in order to identify the strengths and weaknesses, as well as the related opportunities and risks.

2. Analysis of segments

Identification and analysis of market segments (existing and new) that are considered appropriate to support this product ("12 month destination"). Specific analysis of the following segments: (i) Social

Tourism, e.g. through social insurance schemes , (ii) Elderly tourism, 65 + (as a segment), (iii) Internal tourism. The domestic tourism is the third largest market of tourism in Cyprus and contribute about 10% in overnight stays in hotels and other tourist accommodation. It also has a significant contribution to the turnover of the leisure centers. Special emphasis is given on expanding and strengthening "weekend breaks".

3. Information

Extensive measures to inform stakeholders on the objectives and implementation actions for lengthening the tourist season.

4. Organizing and networking

Organization and commitment of stakeholders to work towards the success of the program, prioritizing the implementation actions. The networking of stakeholders is considered necessary for the coordination of implementation actions and the dissemination of information and knowledge.

5. Develop an action plan

Develop an action plan to implement the program based on the results of the analysis, which will consist of hierarchical actions and activities to be undertaken in the sectors of tourism product, marketing, quality in service and tourist experience, as well as to the identification of responsibilities and timetables for implementation.

(A) Product

Activities mainly in the accommodation, catering, special products, improvement projects, events, inside travel and technology. Focus on development, upgrade, enrichment, organizing, creating packages, developing partnerships between stakeholders (inside and outside Cyprus), etc., with particular attention to meeting the needs of targeted market segments.

(B) Marketing

Actions mainly on the Branding and creating the image of the specific product, identifying priority markets, accessibility, visibility and cooperation within and outside Cyprus to attract targeted groups of visitors.

(C) Services Offered

Actions in the main themes of service, cleanliness, and pricing (including establishing joint partnerships and packages).

(D) Allowances for Personnel

Review the institutional framework for the payment of allowances to staff that inhibit their function during the winter. Challenge, encourage tourist accommodations to operate in conjunction with the training of staff at work during the winter months.

(E) Social Tourism

Economic expansion of successfully implemented projects involving pensioners and recipients of public assistance, disabled and special project for the low paid.

(F) Improvement of Competitiveness

Contribution of all stakeholders to improve the competitiveness of the destination and of the final price of the package during the low tourist season. The uniformity in charges is necessary.

6. Support Measures

Include targeted support measures to maximize the feasibility of actions where appropriate.

7. Critical Success Factor

In the process of project implementation the involvement and coordination of a large number of stakeholders is required (CTO departments, public agencies, private sector, local authorities), an issue which prerequisites taking responsibility of project management by a commonly accepted authority.

4.2. Measures against coastal erosion

During the period 1974 - 1980 a number of hard defense structures were constructed in Cyprus. The main type was groynes which were constructed illegally by hotel owners in an attempt to create more attractive protected sandy beaches. In addition, a number of breakwaters were constructed by the government.

Beach nourishment was applied on a specific area of Limassol. Furthermore, in a certain area of Famagusta region, a number of hotel owners used sand nourishment to improve the quality of the beach and create more friendly access to the beach (in rocky areas). In addition, small pilot nourishment projects with sand were carried out in Larnaca and Pafos District (Coccossis et al., 2008). More detailed information on these works is presented in Section 3: Coastal areas.

4.3. Measures against heat waves

The adaptation measures of the tourism sector against heat waves refer mainly to the provision of equipment such as cooling systems for the reduction of tourist discomfort in the tourist accommodations and in leisure centers. According to the CARBONTOUR database of the tourist accommodation in Cyprus (CARBONTOUR, 2010), 89% of the tourist accommodations had air conditioning systems installed in the rooms as well as in the common areas.

4.4. Measures against drought and water scarcity

Cyprus has considerably increased its adaptive capacity in coping with drought by adopting the EU guidelines on water and drought management. However, the tourism sector of Cyprus must implement water conservation techniques, such as rainwater storage, use of water-saving devices, or wastewater treatment and recycling. Some of the measures have already been implemented by tourist accommodations and especially large size hotels, while some measures are not economic for all tourist accommodations.

It is worth mentioning that, according to the Decision of the Ministerial Council of 2005, 14 golf courts were approved under the precondition to use only non conventional water sources (desalinated water, recycled water) for irrigation. However, due to the severe drought conditions of 2008 in Cyprus, the Ministerial Council decided on 2009 to prohibit water supply from government water works to golf courts and that their irrigation needs should be covered from private desalination plants which use renewable energy. As some of the approved golf courts have already been operative under the previous Decision, it was considered unfair to partially implement the new decision and thus remained inactive (WDD, 2011a – Annex III).

4.5. Measures against deterioration of biodiversity attractions

The CTO has promoted the application of Carrying Capacity Assessments [2] (CCA) for the Hill resorts of Cyprus and has integrated its results into the Regional Tourism Strategy for the Hill Resorts. Another carrying capacity assessment has been made for the case of Larnaca, which constituted a pilot study under the framework of the Project CAMP-Cyprus promoted within the wider activities of the Mediterranean Action Plan of the United Nations Environmental Programme (MAP-UNEP). However, CCAs should be applied for all the tourism centers of Cyprus and their results should be binding for the tourism sector.

Although there is a variety of measures and tools for the protection of nature-based tourist attractions, they are not implemented at the degree required due to conflicting interests for the development of beach attractions.

[2] The maximum number of people that may visit a tourist destination at the same time, without causing destruction of the physical, economic, socio-cultural environment and an unacceptable decrease in the quality of visitors' satisfaction (World Tourism Organization)

4.6. Gap analysis

The review of the measures and policies applied in Cyprus relating to the adaptation of the sector to climate change, showed that there are certain measures that have not been promoted yet or need further enhancement. These measures include:

(Shoukri and Zachariadis, 2012)

- Take action to combat the emerged competitiveness of other destinations in Europe (exc. Mediterranean), which will be favoured by climate change
- Investments in infrastructure/technologies to upgrade facilities to face increased temperature and water shortage
- Implementation of additional measures to counteract possible extreme weather events and flooding
- Increase water conservation, efficient use and re-use
- Insurance cover (or alternative schemes) for the recovery of infrastructural and other damage
- Improved provision of climatic information to the tourism sector through cooperation with national meteorological services

5. Biodiversity

Climate factors as well as human activities in Cyprus have caused changes in species distribution, severe declining in the population of certain species, reduced habitat availability as well as increasing species and populations of invasive alien species. In this section, the measures that have implemented in Cyprus in order to face these phenomena, are presented.

Cyprus has ratified and incorporated in Cyprus legislation the following international agreements and directives in respect with the protection of biodiversity:

- Barcelona Convention for the Protection of the Mediterranean
- Convention on Biological Diversity (CBD) – Law 4(III)/1996
- Directive 2009/147/EC on the protection of wild birds - Law 152(I)/2003
- Directive 92/43/EEC on the protection and management of natural habitats and wild fauna and flora - Law 153(I)/2003
- Convention on internationally important wetlands (RAMSAR) – Law 8(III)/2001
- Convention to Combat Desertification (Desertification) – Law 23(III)/99
- Convention on International Trade in Endangered Species (CITES) – Law 20/1974
- Convention on European Wildlife and Natural Habitats (Bern Convention) – Law 24/1988
- Convention for the Protection of Migratory Species of Wild Fauna (Bonn Convention)- Law 17(III)/2001

Although Cyprus does not have yet a National Strategy on Biodiversity (the strategy is now at the stage of preparation), related national policies such as the Sustainable Development Strategy, the Forest Policy, the Agriculture Policy, the Water Policy, the Fisheries Policy etc., promote the protection of the biodiversity and address several threats posed by climate changes.

5.1. Measures for the conservation of biodiversity

Cyprus has designated 40 Sites of Community Interest (SCI) under the Habitats Directive 92/43/EEC, 29 Special Protected Areas (SPA) under the Birds Directive 2009/147/EC and 1 Wetland of International Importance under the RAMSAR convention. Monitoring scheme initiated in some protected areas for both habitats and species. Protected areas increased from 11.8% to 19% (2006-2010) while these have been further increased due to the designation of marine areas. Also in the island there are 10 National Parks, (15627 ha), 4 Nature Reserves (4788 ha) and 350 game reserves covering about 33% of the government controlled area of Cyprus. Cyprus prepared 25 draft Conservation Management Plans for SCI areas and another 7 for forest protected areas are under preparation, covering more than half of the Natura 2000 areas.

Furthermore, there are several measures foreseen under sectoral government policies, such as the Agriculture Policy, the Forestry Policy, the Marine and Fisheries Policy, and the Water Policy, aiming

at the protection of biodiversity of protected and non-protected areas, thus strengthening the resilience of biodiversity against climate changes. The research activities that are being implemented by the Agricultural Research Institute as well as other institutes contribute to the achievement of the goals promoted under the aforementioned policies and hence, are supporting the conservation of biodiversity.

Agriculture Policy

The agriculture policy through the Rural Development Programme 2007-2013 of Cyprus provides economic incentives to farmers in order to promote the implementation of measures concerning the conservation of biodiversity. More particular, those measures are:

- Measure 2.2 "Enhancing biodiversity and provision of compensatory payments in Natura 2000 areas". This measure aims to strengthen farms included in Natura 2000 areas in compensation for the income loss due to the implementation of Plans, Regulations or other provisions required by the Birds Directive 2009/147/EC and the Habitats Directive 92/43/EEC. Eligible actions include the implementation of relevant Management Plans of each area in order for farmers to adopt methods for the conservation and protection of these areas, as required by the Directive 92/43/EEC as well as the enforcement of regulations and other provisions related to SPA areas according to Directive 2009/147/EC.
- Submeasure 2.3.7 "Development of organic production of agricultural products". The aim of this scheme is to implement a holistic agricultural production system which integrates environmentally friendly practices (cultural, biological and mechanical) for the protection of ecosystems and biodiversity as well as the sustainable use of natural resources, without the use of chemical fertilizers and pesticides, in accordance with the provisions of Regulations 2092/91.
- Submeasure 2.3.8 "Providing support for the conservation of natural habitats and wildlife". The scheme aims to make use of agricultural land in rural areas through actions designed to conserve wildlife species including wild fowl fauna (Annex I of Directive 79/409/EEC), birds - indicators of agro-ecosystems and mammals (Annex II of Directive 92/43/EC).
- Submeasure 2.4.3 "Afforestation of non agricultural land". The exploitation of non agricultural land with tree planting is expected to reduce environmental degradation and to enhance biodiversity.
- Submeasure 2.6.2 "Forest-environment payments". The main purpose of this scheme is to maintain and enhance biodiversity and the overall ecological function of forests outside Natura 2000 areas. At this stage, the only commitment defined refers to the prevention of timber in certain habitats.
- Submeasure 2.6.3 "Natura 2000 payments". The main purpose of this scheme is to maintain and enhance biodiversity, the overall ecological function of forest preservation and the high value of forest ecosystems. This scheme provides financial assistance to private forest owners as compensation for loss of income or cost due to constraints imposed on the use of forests and other wooded land in the framework of management plans or other directives of relevant government authorities designed to achieve the objectives for Natura 2000 areas. At this stage, the only commitment defined refers to the prevention of timber in certain habitats.

- Cross-compliance. The recently introduced cross-compliance measures through the Common Agricultural Policy are intended to benefit biodiversity. Cross compliance constitutes the minimum requirements that farmers receiving direct payments from the RDP must comply with. These requirements are divided in the Statutory Management Requirements (SMR) and the Good Agricultural and Environmental Conditions (GAEC). Those include inter alia measures for the conservation of wild birds, the conservation of natural habitats and of wild fauna and flora, the attainment of a minimum level of maintenance of habitats and the prevention of their deterioration.

Forest policy

The National Forest Policy of Cyprus (2001-2010) proposes among others the implementation of projects and activities aiming to preserve ecosystems, flora and fauna. In the Short-term Action Plan for the Confrontation of the Implications of Drought in Cyprus' Forests (2009-2010), there are also measures for the protection of biodiversity against drought, such as the storage of genetic propagation material in forest nurseries (Measure 11) and the installation of watering troughs in forests for covering fauna needs (Measure 13). The control of grazing in the state forests of the Republic of Cyprus was established since 1950 with the 'Statement of Forest Policy' (replaced by the 2001-2010 Forest Policy). Furthermore, planning tools such as the Environmental Impact Assessment (EIA), Geographic Information System (GIS), guidance documents and biodiversity surveys are used for plans, programmes and projects regarding afforestation and deforestation operations. SEA is used in deforestation operations only. Legislation regarding Strategic Environmental Assessment (SEA) and EIA ensures that biodiversity is taken into consideration for any potential deforestation operations.

Marine and Fisheries Policy

The marine and fisheries policy aims at the protection and conservation of the fish stock as well as of marine biodiversity. The foreseen measures within the National Strategy Plan for Fisheries 2007-2013, such as the reduction of fishing effort, the use of more selective fishing gear, and the withdrawal of trawlers, incorporate the ecosystem approach. These measures are undertaken in accordance with the EU Common Fisheries Policy and contribute to the minimization of the impact of fishing activities on the marine ecosystem and aim at promoting sustainability of marine resources.

There is a number of Laws and Regulations set in Cyprus that focus on issues such as the reduction of fishing intensity (hours and periods of fishing, types of networks, minimum allowable sizes for fishing marine organisms, technical restrictions on gear - number of hooks, length and height of nets - minimum distances from shore fishing and bottom fishing etc), the creation of protected fishing areas and habitats, the ban of certain fishing gear and practices, the application of restrictions on recreational fishing, the development of Management Plans and the management control of fishing shelters.

Furthermore, the Regulation (EC) 1967/2006 concerning management measures for the sustainable exploitation of fisheries resources in the Mediterranean Sea, has been gradually integrated to the Cyprus legislation. This is the most important Regulation containing technical measures, whose implementation has important consequences in the Cyprus fisheries. This include inter alia, improvement of the fishing gear, the creation of management plans for specific fisheries (e.g. trawling) and the creation of protected areas for fisheries.

The Department of Fisheries and Marine Research (DFMR) has prepared a Fisheries Management Plan (FMP) in 2010, entitled 'Fishing Effort Adjustment Plan of the Cyprus Fleet targeting demersal and mesopelagic stocks in the coastal zone of the Republic of Cyprus'. The FMP includes measures programmed by the DFMR, which are aimed at reducing the fishing effort for all categories of professional vessels that are active in the territorial waters, under the exclusive control of the Republic of Cyprus. The FMP has a duration of three years and is the first intergraded FMP which has been prepared and came into force since Cyprus accession to the EU. The main measures, which have been programmed, include the permanent withdrawal of vessels, the use of more selective fishing methods, the reduction in the number of fishing licenses, the reduction in the permitted fishing tools, the creation of fishing protected areas and stricter control measures. Those measures are implemented on a collective basis, and when combined, are expected to result in the recovery of the demersal and the mesopelagic species and improve in the long-term the low income of Cypriot fishermen.

Following, the relative measures funded under the Operational Programme for Fisheries 2007-2013 of Cyprus, are presented.

Measure 1.1: Permanent cessation of fishing activities of bottom trawlers. The goal of this measure is the permanent cessation of fishing activities of fishing vessels, provided that such cessations forms are part of a fishing adjustment plan for management of the fisheries resources.

Measure 1.3: Funding scheme for investments on board fishing vessels and selectivity. This measure aims to the modernization of fishing vessels under the condition not to increase their ability to catch fish. Public aid is granted for (a) equipment and labor work for modernization in order to improve safety on board, working conditions, hygiene, product quality and the protection of catches and gear from wild predators (b) use of more selective gear on fishing vessels and (c) replacement of the vessels engines.

Regarding aquaculture development, Cyprus follows the precautionary approach principle. In addition, for issuing an aquaculture license an Environmental Impact Assessment Study needs to be submitted and approved. As from 2010, offshore aquaculture farms are obliged to perform environmental monitoring studies based on Monitoring Program Protocol drafted by the Department of Fisheries and Marine Research (DMFR).

Following, the relative measures funded under the Operational Programme for Fisheries 2007-2013 of Cyprus, are presented.

Measure 2.1: Funding scheme for productive investments in aquaculture. This measure targets the development of the aquaculture industry especially to the coastal areas with a view of promoting environmental friendly businesses. The measure supports two actions (a) investments in aquaculture for construction, extension, acquiring new technologically advanced equipment and modernization of the aquaculture facilities and (b) aqua-environmental measures, where aid is granted for using productive aquaculture methods such as organic aquaculture.

Measure 3.2: Protection and development of aquatic fauna and flora. Measure 3.2 targets the protection and development of the fisheries resources at the coastal fishing areas under particular measures that concern directly the fishing activities. In particular, this measure includes the construction and installation of artificial reefs. Artificial reefs are very important as they provide shelter, food, environment suitable for reproduction, growth and increase in size and number of populations of living marine organisms and of the fishing productivity. The DMFR will create up to 4 artificial reefs in marine areas of Famagusta, Limassol and Paphos (Source: Strategy for the creation of artificial reefs, Cyprus).

Measure 3.3: Fishing ports, landing sites and shelters. This measure promotes operations that have to do with safe fishing vessel positioning in ports as well as hygienic and high quality fisheries products. Fishing shelters are constructed for the protection of fishing boats against extreme events such as storm and large waves. Currently in Cyprus there are 11 fishing shelters in operation.

Among the most important tools for the conservation of marine biodiversity and the sustainable development of marine resources is the creation of marine protected areas. The marine protected areas have been designated in order to protect fragile ecosystems, endangered species and in general marine biodiversity. In Cyprus there are six marine protected areas.

(DoE, 2010b; DFMR, 2007; DFMR, 2010)

Coastal policy

The methodology framework proposed under the Integrated Coastal Area Management (CAMP Cyprus) also takes into consideration biodiversity. More specific, it proposes that protection and development of coastal and marine areas should be integrated into special development strategies for larger areas, under the umbrella of Integrated Marine and Coastal Area Management (IMCAM). Moreover, it proposes the establishment of the obligation for carrying out Environmental Impact Assessments (EIA) of all major marine and coastal development activities as well as Strategic Environmental Assessments (SEA) for certain plans and programmes (Coccossis et al., 2008).

Water policy

Several measures are foreseen in the water policy of Cyprus in order to attain a good ecological status of all fresh and coastal waters. A monitoring programme for all water bodies has been established in order to access progress of the measures implemented. The policy is compliant with the EU Water Framework Directive as well as with the Directive 91/676/EEC on the protection of waters against point and diffuse pollution caused by nitrates.

Research

Modeling is taking place in several research institutes in order to identify measures for biodiversity conservation and adaptation to climate change. The Cyprus' Agricultural Research Institute (ARI) is involved in several projects and programmes at the national level, aiming at the conservation of genetic resources. These include for example the programme for collecting, conserving and utilising the genetic variability existing in local germplasm, as well as the programme for the conservation of the local breed of cattle. *Ex-situ* conservation is being carried out at the National Seed Bank, which was founded in 1985 at the Agricultural Research Institute, where approximately 12,000 samples are conserved, mainly cereals, food and forage legumes as well as wild relatives, endemic and rare plants.

5.2. Measures for the protection of threatened species

Species that are already characterized as threatened, independently of the cause, are more vulnerable to climate changes as their population is reduced. Measures for their protection, such as their inclusion in a legal protective status (Habitats Directive, Birds DIrective, Bern Convention, Barcelona Convention etc) ensure their safeguard from human activities, however further measures are needed for their sustainable management, such as management plans for each species. Furthermore, in situ protection (e.g. designation of their living environment as protected area) and ex situ protection (e.g. genetic conservation) is required. All the aforementioned measures can be also considered as adaptation measures.

The Rural Development Programme 2007-2013 through the Submeasure 2.3.5 "Preservation and maintenance of traditional varieties of wine grapes and protection of traditional animal breeds which are under the danger of extinction" provides incentives to farmers in order to conserve endangered species in their farms, by cultivating traditional wine grapes and breeding indigenous cattle and sheep breeds.

5.2.1. Flora species

As mentioned in the Red Data Book of the flora of Cyprus (Tsintides et al., 2007), 238 plant species are characterized as threatened. According to the list of "The top 50 plants of the Mediterranean islands" (Montmollin & Strahm, 2005), five wild plant species of the Republic of Cyprus are considered critical to extinction and have been categorized as Critically Endangered (CR) under the criteria of the International Union for Conservation of Nature (IUCN). Following, the existing measures for their protection, as well as proposals for additional measures needed, are presented.

1. Troodos rockcress *(Arabis kennedyae)*
   Legal protection: Bern Convention (Appendix I), priority species in Annexes II and IV of the EC Habitats Directive.

In situ protection: The entire population of this species occurs in Troodos National Forest Park and Paphos State Forest, which are designated as SCI and SPA in the European Natura 2000 Network. Part of Tripylos Mountain is already a Nature Reserve where species protection laws are enforced.
Ex situ protection: Seeds were collected from cultivated plants at the University of Athens in 1994 and stored in the Seed Bank of the Department of Botany at the University of Athens.
Additional protection required: Although the entire population occurs within the Troodos National Forest Park, only one subpopulation grows in a Nature Reserve. The areas where the two other subpopulations occur need to be declared as Nature Reserves by the Cyprus Council of Ministers. According to Cyprus Forest Law, flora and fauna is totally protected within a Nature Reserve.

2. Lefkara milk-vetch *(Astragalus macrocarpus subsp. Lefkarensis)*

Legal protection: Bern Convention (Appendix I), priority species in Annexes II and IV of the EC Habitats Directive.
In situ protection: Three sites with populations of this taxon have been nominated as SCI by the European Natura 2000 Network.
Ex situ protection: A small number of seeds collected from the Lefkara and Asgata populations are stored in the seedbank of the Department of Botany at the University of Athens.
Additional protection required: The reproductive success of this taxon must be increased by reducing seed predators through biological control. Moreover, the Government of Cyprus needs to inform landholders about the presence of this rare taxon on their property and encourage its protection.

3. Akamas centaury *(Centaurea akamantis)*
Legal protection: Bern Convention (Appendix I), priority species in Annexes II and IV of the EC Habitats Directive.
In situ protection: The Forestry Department is responsible for the site where Centaurea akamantis grows and has published a plan aimed at protecting the area. The area is designated as SCI by the European Natura 2000 Network and was proposed to be nominated as a National Park but this was approved due to opposition from local communities.
Ex situ protection: Small numbers of seeds have been collected from the Avakas Gorge and stored in the seedbank at the Department of Botany at the University of Athens. The species has been successfully cultivated at the Cyprus Agricultural Research Institute.
Additional protection required: The National Park project should be approved by the Cyprus Council of Ministers. The species' habitat should be nominated as a Nature Reserve, which according to the Forest Law, will provide complete and permanent protection to this site and reduce grazing pressure. Wild seeds of a sufficient genetic range need to be collected and stored in a seedbank. The species would also benefit from cultivation in botanical gardens.

4. Erysimum kykkoticum

Legal protection: This species grows within the Paphos State Forest which gives it legal protection.
In situ protection: The entire population of this species occurs in the Paphos State Forest, which is designated as SCI and SPA in the European Natura 2000 Network.
Ex situ protection: No measures taken yet.
Additional protection required: More research is needed to monitor the population dynamics of this species including its biology and ecology, so that better management plans can be drawn up. In addition, the plant should be cultivated into botanical gardens and seeds should be collected and stored in seedbanks.

5. Kythrean sage *(Salvia veneris)*
Legal protection: Bern Convention (Appendix I), priority species in Annexes II and IV of the EC Habitats Directive. Part of the area in which this species grows lies within the "Lakkovounara State Forest", which is protected by Forest Law from any private interference, while the rest of the area is private or government land.
In situ protection: No measures taken yet.
Ex situ protection: No measures taken yet.
Additional protection required: Most importantly, the habitat (particularly that outside the State Forest), as well as the species itself deserves legal protection at the local level. The site should be managed in a way that the species is not endangered by the expansion of the nearby village of Kythrea. Though well-adapted to grazing by goats (and probably not able to compete with faster-growing competitors in the absence of grazing), the site should be managed so that it is not overgrazed. Storage of seeds in seedbanks and ex situ cultivation in botanical gardens is recommended. Research is needed to monitor the population dynamics of this species.

Other flora species of Cyprus protected by the Bern Convention (Annex I) are:

- Alyssum akamasicum
- Brassica hilarionis Post
- Centaurea akamantis
- Chinodoxa lochiae
- Crocus cyprius Boiss.
- Crocus harmannianus
- Delphinium caseyi
- Onosma troodi kotschy
- Ophrys kotschyi
- Orchis Punctulata
- Origanum cordifolium
- Phlomis cypria
- Phlomis cypria
- Pinguicula crystallina
- Posidonia oceanica
- Ranunculus kykkoensis
- Sideritis cypria Post
- Tulipa cypria

It must also be mentioned that, a regional Action Plan for marine plants i.e. macrophytes and plant assemblages seen as natural monuments, like Posidonia barrier reefs, has been adopted within the Mediterranean Action Plan context.

5.3. Fauna species

According to the Red List of the International Union for Conservation of Nature (IUCN), 44 of the fauna species found in Cyprus are categorized as endangered. From those species, 16 are protected under either the Habitats Directive, or the Barcelona Convention or the Bern Convention or other national regulation. Following, the majority of fauna species protected in Cyprus is presented.

Table 5-1: Protected fauna species in Cyprus

Protected fauna species		Measures
Reptiles	Chelonia mydas - CR	Protected under Annex II of SPA protocol [1], Annex IV of Habitats Directive 92/43/EEC, Annex II of Bern Convention
	Caretta caretta - EN	Protected under Annex II of SPA protocol [1], Annex IV of Habitats Directive 92/43/EEC, Annex II of Bern Convention
	Natrix natrix cypriaca	Protected as freshwater fauna under the Fisheries Regulations (Reg. 273/90)
	Mauremys caspica	Protected under Annex IV of Habitats Directive 92/43/EEC, Annex II of Bern Convention
	Coluber cypriensis - EN	Protected under Annex II* and IV of Habitats Directive 92/43/EEC, Annex II of Bern Convention
	Emys orbicularis	Annex II of Bern Convention
	10 other species	Protected under Annex II of Habitats Directive 92/43/EEC
Birds	Numenius tenuirostris	Protected under Annex II of SPA protocol [1], Annex II of Bern Convention
	Pelecanus crispus - VU	Protected under Annex II of SPA protocol [1]
	Oxyura leucocephala - EN	Protected under Annex II of Bern Convention
	Branta ruficollis - VU	Protected under Annex II of Bern Convention
	Crex crex - LR	Protected under Annex II of Bern Convention
	Emberiza aureola	Protected under Annex II of Bern Convention
	Gallinago media	Protected under Annex II of Bern Convention
	Larus audouinii - LR	Protected under Annex II of Bern Convention
	Emberiza cineracea	Protected under Annex II of Bern Convention
Fish	Aphanius fasciatus	Protected under Annex II of SPA protocol [1], Annex II of Bern Convention
	Hippocampus hippocampus	Protected under Annex II of SPA protocol [1], Annex II of Bern Convention
	Hippocampus ramulosus	Protected under Annex II of SPA protocol [1], Annex II of Bern Convention
	Mobula mobular - VU	Protected under Annex II of SPA protocol [1], Annex II of Bern Convention
	Carcharodon carcharias - VU	Annex II of SPA protocol [1], Annex II of Bern Convention

Protected fauna species		Measures
Mammals	Monachus monachus – CR	Annex II of SPA protocol [1], Annex II of Bern Convention
	Ovis orientalis ophion (Cyprus muflon) – VU	Protected under Annex II* and IV of Habitats Directive 92/43/EEC
	Rhinolophus Euryale - VU	Protected under Annex II of Habitats Directive 92/43/EEC
	Capra aegagrus (Cyprus goat) - VU	Protected under Annex II and IV of Habitats Directive 92/43/EEC, Annex II of Bern Convention
	Rousettus aegyptiacus	Protected under Annex II and IV of Habitats Directive 92/43/EEC
	Delphinus delphis – EN	Annex II of SPA protocol [1], Annex II of Bern Convention
	Stenella coeruleoalba	Annex II of SPA protocol [1], Annex II of Bern Convention
	Tursiops truncatus	Annex II of SPA protocol [1], Annex II of Habitats Directive 92/43/EEC, Annex II of Bern Convention
Amphibia	Bufo viridis	Protected under Annex IV of Habitats Directive 92/43/EEC, Annex II of Bern Convention, Fisheries Regulations (Reg. 273/90)
	Hyla savignyi	Protected as freshwater fauna under the Fisheries Regulations (Reg. 273/90)
Arthropods	Ocypode cursor	Protected under Annex II of SPA protocol [1], Annex II of Bern Convention
	Potamon potamios	Specifically protected under national legislation
	Artemia salina	Specifically protected under national legislation
Molluscs	Charonia tritonis	Protected under Annex II of SPA protocol [1], Annex II of Bern Convention
	Erosaria spurca (Cypraea spurca)	Protected under Annex II of SPA protocol [1], Annex II of Bern Convention
	Luria lurida	Protected under Annex II of SPA protocol [1], Annex II of Bern Convention
	Tonna galea	Protected under Annex II of SPA protocol [1], Annex II of Bern Convention
	Lithophaga lithophaga	Protected under Annex II of SPA protocol [1], Annex II of Bern Convention
	Pholas dactylus	Protected under Annex II of SPA protocol [1], Annex II of Bern Convention
	Pinna nobilis	Protected under Annex II of SPA protocol[1], Annex IV of Habitats Directive 92/43/EEC
Echinoderms	Asterina panceri	Protected under Annex II of SPA protocol [1], Annex II of Bern Convention
	Ophidiaster ophidianus	Protected under Annex II of SPA protocol [1], Annex II of Bern Convention
	Centrostephanus longispinus	Protected under Annex II of SPA protocol[1], Annex IV of Habitats Directive 92/43/EEC, Annex II of Bern Convention
Porifera	Axinella polypoides	Protected under Annex II of SPA protocol [1]
	Axinella cannabina	Protected under Annex II of SPA protocol [1]
	Geodia cydonium	Protected under Annex II of SPA protocol [1]

IUCN categorization: Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Low Risk (LR)

[1] *Protocol concerning Specially Protected Areas and Biodiversity in the Mediterranean –Barcelona Convention*

Source: Hadjichristophorou M., 2000; DoE, 2010b; USAID, 2006

Cyprus has adopted the Action Plan for the Conservation of Mediterranean Turtles within the context of the Mediterranean Action Plan (Barcelona Convention). The objectives of this Marine Turtle Action Plan are: (1) the protection, conservation and, where possible, enhancing of the populations of marine turtles in the Mediterranean; (2) the appropriate protection, conservation and management of the marine turtle habitats including nesting, feeding, and wintering areas and migration routes; (3) improvement of the scientific knowledge by research and monitoring.

In addition, four other regional Action Plans have been adopted within the MAP context. These directly concern species conservation for the most threatened and most emblematic species in the Mediterranean. Species included are: monk seal, cetaceans (especially bottlenose dolphin), seabirds such as Audouin's gull, cartilaginous fishes like the great white shark and the saw-shark.

5.4. Measures for controlling invasive alien species

The Department of Environment of MANRE is currently preparing a proposal regarding a ban on the import on certain Invasive Alien Species (IAS) that may harm Cyprus' biodiversity. Furthermore, the Department of Fisheries and Marine Research (DFMR) in collaboration with the Hellenic Centre for Marine Research published a scientific report on marine invasive species in Cyprus which includes an inventory of 126 alien marine species reported in the country's territory (Katsanevakis et al., 2009).

The Department of Fisheries and Marine Research, taking into account the reports from fishermen regarding the substantial increase and spread of the population of the IAS of Lagocephalus and the damage caused to the fishing gear and catches, prepared a study on the species in the coastal waters of Cyprus. After evaluating the results of the study, the DMFR developed a management plan entitled "Plan for the control of the population of Lagocephalus sceleratus in the coastal waters of Cyprus" and in 2012 announced the call for proposals for the implementation of the plan in the framework of the "Project Grants for collective actions in the Fisheries Sector." The purpose of the call is to eliminate the populations of lagocephalus from the coastal commercial fleet of Cyprus, with the exercise of intense fishing pressure on breeding population of the species, just before and during the breeding season, in the main breeding areas of the species.

Furthermore, an Action Plan was developed for the planting control and eradication of the Invasive Alien Species of Acasia in Natura 2000 areas. The plan was completed with great success.

However, no dedicated national/subnational legislation addresses IAS. For that reason, an action plan is needed in order to control all alien species in Cyprus that pose risk in biodiversity or cause damage to economic activities.

5.5. Measures for adapting to altered species phenology

Changes in plant phenology for agricultural crops may have as a result earlier maturation in the year or even two growing seasons in one year. Adjusting cropping calendar (earlier sowing and planting) constitutes a simple adaptation measure for compensating for the losses caused during the summer.

Altered phenology in animal species may cause the increase of harmful pest populations. The practises used for their reduction both in forests and in agriculture are the intensification of the application of chemical and biological pesticides.

5.6. Gap analysis

The review of the measures and policies applied in Cyprus relating to the adaptation of the sector to climate change, showed that there are certain measures that have not been promoted yet or need further enhancement. These measures include:

(Shoukri and Zachariadis, 2012; DoE, 2010a)

- Inclusion of the tool "Evaluation of Carrying Capacity" in the Construction Spatial Planning System and in the Tourism Policy
- Control entering / exiting of non-indigenous species into / from the Republic of Cyprus
- Control of the premises in which non-indigenous species live (nurseries, florists, aquariums, fish farms, research labs, zoos gardens, circuses and pet shops)
- Precise recording of licensed non-native species and development of a database that includes details on the types and their geographical distribution / dispersion
- Resolve any problems caused by non-native species found in Cyprus and effective management
- Creation of ecological data file and database (BIOCYPRUS) for the Network "Natura 2000"
- Creation of an inventory of species populations, distribution and genetics
- Preparation of Management Plans for all areas of the network "Natura 2000"
- Protection and sustainable use of local flora and fauna populations
- Coordination of the management measures relating to prevention and control of terrestrial and offshore sources of marine pollution, combating pollution accidents and the protection and management of marine biodiversity
- Protection and management of Larnaca salt lakes (area RAMSAR) and of other wetlands
- Promote research on biodiversity and ecosystems, monitoring of biotic and abiotic parameters
- Maintain or strengthen ecological coherence, primarily through providing for connectivity.
- Establishment of ecological networks (protected sites and corridors)
- Prepare and implement a Strategic Plan on Biodiversity
- Incorporate in other policies and plans [Local Plans, Environmental Impact Assessment (EIA), Strategic Environmental Assessment (SEA)] the priority of biodiversity and ecosystems protection in relation to climate change

- Horizontal integration of ecosystem based adaptation to other policies and plans
- Sustainable use of ecosystem services and natural resources, particularly in areas of importance to biodiversity conservation
- Special attention to the protection of priority and threatened species and their habitats
- Enhance/strengthen the Seed Bank and Ex situ conservation
- Monitoring of highly sensitive species should be monitored as indicators of climate change, i.e. amphibians and reptiles
- Avoid planting and releasing of alien animal species
- Avoid overfishing and any destructive fishing practices
- Protection of coastal and marine ecosystems from invasive species (prevention-detection control)
- Legislative actions to protect the artificial reefs areas that will serve as fish shelters and will contribute to the increase in biodiversity and in fisheries production
- Restoration of damaged ecosystems (i.e. artificial dispersal of seeds, restore water bodies/flows, soil quality, remove alien species etc),
- Assessment of the impacts of pollination disruptions on plant reproduction, protection of pollinators
- Waste management to avoid pollution, ecosystem degradation and surface and ground water deterioration
- Control overgrazing
- Control overmining and quarrying activities

6. Energy

In Cyprus, increased temperatures during the last decades have affected the energy sector by increasing the energy demand for cooling and increasing the risk of electricity shortages during summer. The energy demand has also significantly increased due to the continuous rise in seawater desalination needs due to freshwater scarcity.

The adaptive capacity of the energy sector of Cyprus to changing demand in power and heat due to climate changes is depended on the implementation of the following three (3) adaptation options:

- Installation of new power plants for following future energy demand of the island
- Increase power production from renewable energy sources (RES)
- Energy efficiency measures

The first two options lead to the increase of the total energy supply, while the third option leads to the reduction of energy demand. The relative activities undertaken in Cyprus are presented in the following sections.

6.1. Measures for increasing energy supply

6.1.1. Increase conventional power production

Following the increase in the energy demand, the Electricity Authority of Cyprus has increased the energy supply with the commissioning of new power plants and the decommissioning of old, existing plants. The increase in the installed capacity of the power plants from 2004 to 2012 as well as the future plans until 2016 are presented in Figure 6-1.

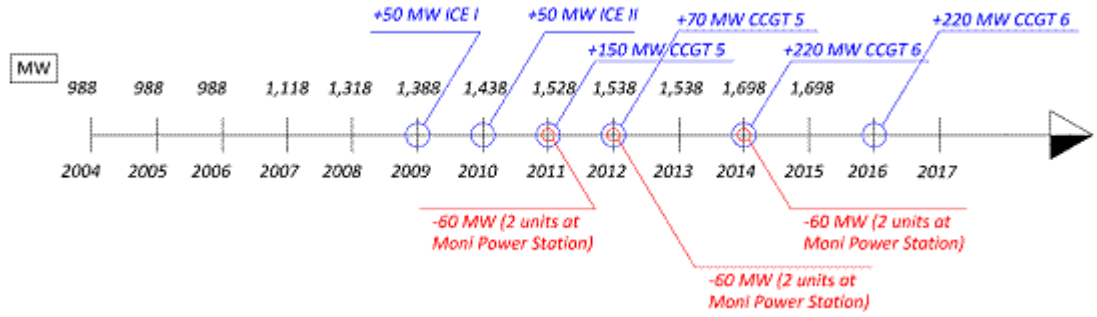

Figure 6-1: Installation of new power plants and decommissioning of existing units until 2016

It must be noticed, that while there exists a sufficient follow-up between supply and demand, meaning that EAC has developed a plan to guarantee the succesfull delivery of power in order to meet the increasing demand (lowering down the sensitivity), there is a sustained challenge which needs to be addressed. The current electricity production regime is dependent on imported oil, fact that implies concern over the energy dependence of the island, which in turn implies questions about how secure is the energy system and capable of delivering electrical energy independently of the external political and economic circumstances.

6.1.2. Increase RES power production

Increased RES installed capacity leads to increased RES power production whatever the changes in RES potential due to climate change. The main policy measure related to renewable energy deployment in Cyprus is the Directive 2009/28/EC on the promotion of the use of energy from renewable sources. According to this Directive, each Member State has a specific target for the overall share of renewable sources in the gross final energy consumption, as well as it is obliged to form a national renewable action plan in order for these targets to be achieved. For the case of Cyprus, the target for the share of renewable energy in the final energy consumption has been set at 13% for 2020[3].

The progress of the RES penetration to the power production system of Cyprus so far is presented in Table 6-1.

Table 6-1: RES penetration to the power production system of Cyprus

RES category	Initial capacity	Current capacity
Wind	82 MW (July 2010)	133.5 MW (December 2011)
Solar PV	474.34 kW (December 2006)	9,329.35 kW (December 2011)
Biomass (biogas plants)	250 kW (December 2007)	7,964 kW (December 2011)
Hydro	0 MW	0 MW

Moreover, an indicative list of measures (regulatory) undertaken up to the present for the promotion of renewable energy sources is given below:

Administrative measures

[3] Whereas the corresponding share of RES in the electricity production sector is set at 16%

- Establishment of Cyprus institute of energy (2000)
- Establishment of Cyprus Energy Regulator Authority (August 2003)
- Establishment of Cyprus Transmission System Operator (2003)
- Support Scheme Plans (2004-2008 & 2009-2013)
- Establishment of the "Energy office for the citizens of Cyprus" (9/2/2009)
- Adoption of the "One Stop Shop" principle (2002)

Legal measures

- Law 174/2006: "Promotion of Combined Heat and Power"
- Obligation of the Electricity Authority of Cyprus (EAC) to purchase electricity using RES (2002)
- Licensing exemption (from CERA) for the construction and operation of wind power systems up to 30kW, and photovoltaic systems and biomass systems up to 20 kW

Economic measures

- Special fund for the promotion of RES and energy conservation (August 2003), the revenue of which comes from an additional charge per kWh consumed by all electricity consumers categories (0.0022€/kWh)
- Reduced application fee of very small PV, Wind and Biomass units

Social measures

- Organization of information campaigns, seminars and workshops on renewable power production.

Regarding the economic incentives, it can be said that the subsidy for RES installed at household level is up to 55%, while for larger scale systems there exists a feed-in tariff system 'subsidizing' the price of sold electricity (€/kWh).

6.1.3. Diversification of energy supply mix

In order to diversify the energy supply mix, the introduction of natural gas was investigated and the appropriate preparatory works have been made. By 2014 new gas-fired plants are scheduled to operate. The natural gas will be transported to the onshore receiver terminal at Vasilikos in liquefied form (EAC, 2010). The use of natural gas in power generation is estimated to lead savings of up to 271,000toe (MCIT, 2011).

It is expected that the introduction of natural gas in the energy mix will provide a diversified, safer energy profile for Cyprus and that will gradually be used in the electricity production, industry and

household sector (DoE, 2010a), making the energy sector less sensitive to increasing energy demand patterns.

6.2. Measures for reducing energy demand

Cyprus has established a National Energy Efficiency Action Plan, which involves the implementation of a set of measures for improving energy efficiency until 2020 and thus reducing energy demand. The indicative intermediate target for 2016 was set at 185,000 toe[4], while the contribution by sector is as follows (MCIT, 2011):

- Residential sector: 161,877 toe (87.5%);
- Tertiary sector (public sector, general government and enterprises): 23,681 (12.8%);
- Industrial sector: 1,284 toe (0.69%) and
- Transport sector: 3,909 toe (2.11%).

The Republic of Cyprus in compliance with Article 14 of Directive 2006/32/EC of the European Parliament has submitted its 2nd National Energy efficiency Action Plan in 19/07/2011. In this report all energy efficiency measures that have already been implemented or/and are expected to be implemented by 2020, are recorded and analyzed. A comprehensive summary of these measures is given by sector next.

Primary energy savings

- Penetration of natural gas in power generation (combined cycle generation) from 2015 and onwards
- Reduction of transmission and distribution losses (improvement of the power factor of substations, development of new interconnections with increased capacity such as rubus twin type etc.)
- Grant scheme for promoting the cogeneration of electricity and heat

End use energy savings

(a) Residential sector (9 measures: 4 implemented, 5 not implemented yet)

1. Energy efficiency of new dwellings (building codes and enforcement), *Implemented*
2. Grants Scheme for energy savings in the residential sector (existing dwellings) 2004-2009 (Grants Scheme for energy savings in the residential sector (existing dwellings)) , *Implemented*
3. Distribution of free compact fluorescent lamps (Budget: € 2,713,138) , *Implemented*

[4] Reflecting 10% energy savings comparing to the energy consumption of the reference year.

4. Grants scheme to encourage the use of RES in the residential sector, 2004-2010 (Budget: € 14,658,440) , *Implemented*

5. Energy efficiency of dwellings undergoing major renovation (building codes and enforcement) , *Not Implemented yet*

6. Maintenance and inspection of boilers and heating installations (building codes and enforcement) , *Not Implemented yet*

7. Maintenance and inspection of air conditioning systems of an effective rated output of more than 12 kW (building codes and enforcement) , *Not Implemented yet*

8. Grants Scheme for energy savings in the residential sector (existing dwellings) 2011-2020 (Budget: € 52,680,000) , *Not Implemented yet*

9. Grants scheme to encourage the use of RES in the residential sector, 2011-2020, *Not Implemented yet*

(b) <u>Tertiary sector:</u>

1. National action plan for Green Public Procurement, 2007-2009 (Budget: € 24,300 for purchasing fluorescent lamps, € 328,880 for purchasing new air conditioners installed where a new need has come up, € 301,167 for purchasing new air conditioners in replacement of existing ones, € 3,988,321 for purchasing office computers, € 265,226 for purchasing new LCD monitors) , *Implemented*

2. Government grants scheme for energy savings/RES for the public and wider public sector, 2004-2009 (Budget: € 37,908) , *Implemented*

3. Energy efficiency of new buildings in the tertiary sector, *Implemented*

4. Grants Scheme for (end-use) energy savings in the tertiary sector (existing enterprises) 2004-2009 (Budget: € 2,141,440) , *Implemented*

5. Grants scheme to encourage the use of RES (end use) in the tertiary sector, 2004-2010 (Budget: € 1,399,503) , *Implemented*

6. Energy efficiency of tertiary buildings undergoing major renovation, *Not Implemented yet*

7. Maintenance and inspection of boilers and heating installations in the tertiary sector, *Not Implemented yet*

8. Maintenance and inspection of air conditioning systems of an effective rated output of more than 12 kW in the Tertiary Sector, *Not Implemented yet*

9. National action plan for Green Public Procurement, 2010-2020, *Not Implemented yet*

10. Grants Scheme for (end-use) energy savings in the tertiary sector (existing enterprises) 2011-2020 (Budget: € 5,791,464) , *Not Implemented yet*

11. Grants scheme to encourage the use of RES (end use) in the tertiary sector, 2011-2020 (Budget: € 2,600,000) , *Not Implemented yet*

12. Grants Scheme for cogeneration of high efficiency heat and power in the Tertiary Sector, 2011-2020 (Budget: € 7,700,000) , *Not Implemented yet*

13. Action Plans of Municipalities and Communities, 2010-2020, *Not Implemented yet*

(c) <u>Industrial sector</u>

1. Grants Scheme for energy savings (in existing industrial enterprises), 2004-2009 (Budget: € 653,054) , *Implemented*

2. Grants scheme to encourage the use of RES (end use) in the industrial sector and agriculture, 2004-2010 (Budget: € 187,597) , *Implemented*

3. Grants Scheme for energy savings (in existing industrial enterprises), 2011-2020 (Budget: € 2,591,813) , *Not Implemented yet*

4. Grants scheme to encourage the use of RES (end use) in the industrial sector and agriculture, 2011-2020 (Budget: € 424,000) , *Not Implemented yet*

5. Grants Scheme for cogeneration of high efficiency heat and power in the Industrial Sector, 2011-2020 (Budget: € 8,500,000) , *Not Implemented yet*

(d) <u>Transport sector</u>

1. Grants Scheme for energy saving in transport (purchase of hybrid vehicles, electric vehicles and low-emissions vehicles), 2004-2009 (Budget: € 2,596,823) , *Implemented*

2. Scrapping of Vehicles, 2008-2010 (Budget: € 5,785,055) , *Implemented*

3. Scrapping of Vehicles, 2011-2020, *Not Implemented yet*

4. Action plan to strengthen public transport, *Not Implemented yet*

(e) <u>Horizontal measures</u> (*all implemented*)

1. Information campaign on energy saving issues (Budget: € 210,000)

2. Online student training programmes

3. Publishing educational books for students

4. Publishing 2 special information publications for young children

5. Publishing and distributing posters and stickers on energy saving

6. Establishing a student competition for students' projects on RES and ES, with 3 monetary awards (Budget: € 1,700 annually)

7. Lectures on RES and ES at schools

8. Publishing and distributing various information publications and guides on RES and ES investment

9. Energy saving report (Information campaign)

10. Energy Saving Award (Information campaign)
11. Organizing training seminars and day events for citizens and organized groups of people
12. Energy Awareness and reducing energy consumption program in buildings in the Public sector and general government

6.3. Gap analysis

The review of the measures and policies applied in Cyprus relating to the adaptation of the sector to climate change, showed that there are certain measures that have not been promoted yet or need further enhancement. These measures include:

(Shoukri & Zachariadis, 2012)

- Increased contribution of renewable sources in the final use of energy
- Increased contribution of bio-fuels in the road transport sector
- Introduction of natural gas to the energy mix/ diversification of energy resources;
- Increased energy efficiency
- Exploitation of indigenous fossil fuel energy potential
- Accelerated adoption of 'near-zero' energy new buildings, in conjunction with biophilic and bioclimatic architecture
- Investments in improving the energy efficiency of existing buildings
- Adjustment of long-term electricity generation plans in order to account for additional capacity needed while prioritizing renewable electricity generation
- Implementation of proper carbon pricing of all energy forms in order to encourage energy conservation
- Proper maintenance of electricity transmission lines to reduce losses
- Raise awareness for energy saving (i.e. energy saving appliances, controlled use of air conditioning)
- Greening of towns to avoid/reduce urban heat island phenomenon, aiming to decrease energy consumption for cooling

7. Fisheries and aquaculture

While the fishery sector cannot do much to impede or seriously affect global climate change, it could contribute to its stabilization or reduction, and to mitigating its effects. Many of the principles and strategies developed to deal with 'unstable' stocks will be of use when having to deal with climate change.

Several of the aims set in the National Fishery Strategy Plan 2007-2013 which are considered to contribute to climate change adaptation of the fisheries sector in Cyprus are presented below.

Fishery:

- Modernisation and upgrading of existing fishing technology (provided there in no increase in the ability to catch fish). The use of appropriate fishing equipment and of environmentally friendly methods may contribute to more effective control of fishing activities and thus enhancing preparedness under climate changes.
- Sustainable management of fish stocks in order to prevent overfishing. Sustainable management such as the use of more selective fishing gear, the reduction of fishing efforts and the establishment of fishing shelters and artificial reefs may contribute to the conservation of fishstock under climate changes.
- Encouraging the occupation of young fishermen with the provision of relevant incentives. The employment of young fishermen is expected to improve adaptive capacity of the fishery sector, as young people are more susceptible to the application of new practices in contrast with the older fishermen.
- Provision of compensatory allowances for income lost due to natural hazards. This is also expected to reinforce fishermen against climate changes as, in this case, they may be more exposed to such extreme phenomena.

Aquaculture:

- Modernisation of existing aquaculture units. Modernisation may improve the environmental impact on the marine environment and at the same time increase the productive capacity, thus enhancing adaptive capacity.
- Diversification of production. The diversification of aquaculture production may reduce risk due to reduced productivity of certain less climate resilient fishes by compensating with the increased productivity of some other fishes that may benefit from climate changes.
- Production of high value added quality products. These products strengthen the adaptive capacity of the fishery sector by increasing the income of fishermen

These goals are also in line with the Common Fishery Policy of the EU, the Cyprus' Sustainable Development Plan and have also been promoted by the Operational Programme for Fisheries 2007-2013, the financial support tool for the achievement of the goals of the National Fishery Strategy Plan.

Following, all measures undertaken in Cyprus that are considered to contribute to climate change adaptation of the sector are presented.

7.1. Measures for strengthening the capacity of fishermen

Following, the measures promoted through the Operational Programme for Fisheries 2007-2013 of Cyprus for strengthening the capacity of fishermen, are presented.

Measure 1.2: Temporary cessation of fishing activities. Under this measure, the beneficiaries shall get aid in case of natural disasters or other exceptional occurrence which pose a hazard to the public health and cause the suspension of fishing activities for a limited time.

Measure 1.5: Socio-economic compensation for the management of the fishing fleet (1. Scheme for providing support to young fishermen for acquiring ownership of a fishing vessel, 2. Early retirement scheme for fishermen). This measure contributes to the financing of socio-economic actions such as support for young fishermen to acquire for the first time part or total ownership of a fishing vessel, a chance for them to upgrade their skills and receive professional training, the chance for their activities´ diversification and finally early retirement from the fishing sector. For the early retirement measure, the beneficiaries are fishermen between the age of 55 to 65 who meet certain criteria.

Measure 2.3: Funding scheme for investments in the marketing and processing of fisheries products. This measure aims to the development of the processing and marketing of fishery and aquaculture products sector. The funds are given in order to encourage and promote investments in this sector, to improve the quality of the products, to produce high quality fishery and aquaculture products, to adapt and apply new technologies, to preserve and increase the number of job positions and reduce the negative impacts on the environment.

7.2. Measures for the diversification of aquaculture

The research programmes that have been undertaken at the Meneou Marine Aquaculture Research Station (MeMARS) focused mainly on new candidate species for fish farming, such as rabbit fish (Siganus rivulatus), common pandora (Pagellus erythrinus), common dentex (Dentex dentex), greater amberjack (Seriola dumerili) and meagre (Argyrosomus regius). The main objective of the research was the diversification of aquaculture production with new species. The main projects during 2010 were:

i) Reproduction and larval rearing protocols for the mass production of fry of the rabbitfish (Siganus rivulatus) and fattening in sea cages of market size fish,

ii) The effect of illumination in the ability of capturing live feed in rabbitfish larvae ,

iii) Study of the effect of temperature and oxygen concentration on the metabolism of rabbitfish,

iv) Evaluation of vitamin C and astaxanthin supplementation in broodstock diet on reproductive performance and egg and larval quality in common pandora (Pagellus erythrinus),

v) Evaluation of different feeds for the fattening of greater amberjack and observation of its feeding behaviour,

vi) Management of amberjack broodstock, performing a trial on reproduction using LHRHa hormone implants,

vii) Fattening of meagre in tanks and observation of its feeding behaviour, and

viii) Evaluation of the culture of rotifers with different feeds and determination of their nutritional value.

Moreover, the MeMARS is participating in a) the European Thematic Educational Network AQUA-TNET, which is funded from the European Commission Socrates Erasmus Programme, b) the European Network Programme COST Action 867 “Welfare of fish in European aquaculture”, c) the European Network Programme COST Action FA0801 “Critical success factors for fish larval production in European Aquaculture: a multidisciplinary network (LARVANET)” and d) the project “The future of research on aquaculture in the Mediterranean region” which was approved under the 7th Framework Programme of the EU. Other activities of MeMARS in 2010 included the support of private fish farms and the information of students of primary and secondary education on aquaculture in Cyprus.

7.3. Gap analysis

Additional measures that can be taken against climate change impacts on the fisheries sector of Cyprus include the following:

(FAO, 2008; DoE, 2010a)

- Develop training programs and technical guidance for fishermen
- Implementation of new regulations governing the professional and particularly recreational fishing
- Use better feeds in aquaculture, more care in handling, selective breeding and genetic improvements for higher temperature tolerance (and other related conditions),
- Increasing feeding input in order to adjust harvest and market schedules
- Focus management to reduce stress by setting up biosecurity measures, monitoring to reduce health risks by improving treatments and making genetic improvements for higher resistance
- Provision of alternative livelihoods through aquaculture, building capacity and infrastructure
- Using different and faster growing fish species
- Shifting to artificially propagated seed, improving seed quality and production efficiency, closing the life cycle of more farmed species
- Encouraging uptake of individual/cluster insurance

8. Soils

In Cyprus, soils have already been adversely affected by climate changes such as the reduction of precipitation, the increase in the frequency and length of drought periods, the increased temperature and evapotranspiration as well as the flooding events and the fire outbreaks. These climatic factors in combination with factors of geomorphology (unfavorable topography of steep slopes and/or high elevation) and human factors (intense agriculture, land abandonment in mountain areas, overgrazing, intense tourism development in coastal areas) have contributed to land degradation, soil erosion, landslides and desertification. The coastal areas of Cyprus also suffer from salinization, mainly caused so far by the overexploitation of coastal aquifers and not sea level rise, as is generally expected for the case of the Mediterranean region.

The measures that have been applied so far in Cyprus for addressing the issue of soil degradation focus on maintaining and improving soil fertility and residual soil moisture and on preventing soil salination and erosion. Relative measures can be found in various sectoral policies of Cyprus, such as the Agriculture Policy, the Forestry Policy, the Water Policy as well as in other proposed policies, e.g. the Action Plan to Combat Desertification and the Integrated Coastal Area Management Strategic Framework.

8.1. Measures to improve soil moisture

The measures to improve soil moisture are mainly associated with the reduction of run-off and soil erosion, the maintenance of the soil structure as well as the improvement of soil fertility.

8.1.1. Reduce run-off

A number of practices are applied in Cyprus which contributes to the reduction of run-off, such as the increase in land cover, terracing, contour plowing, installation of hedgerows, application of advanced irrigation systems, prevention of overgrazing and fires protection measures. Following, the relative actions are presented.

The Good Agricultural and Environmental Conditions, a group of measures under Cross Compliance[5] of the RDP, foresees a number of standards for reducing run-off and soil erosion, which include:

• Minimum soil cover: There should be a natural / plant vegetation for the cover of land with a slope greater than 10% during the period of rainfalls.

• Minimum land management reflecting site-specific conditions: In a land with a slope greater than 10%, contour plowing must be exercised. Soil cultivating during periods of heavy rain should be avoided, especially in clay and heavy soils.

[5] Minimum requirements that farmers receiving direct payments must comply with

• Terracing: Terraces / stone walls and natural slopes at the boundaries of the crop holdings should be maintained in a condition to prevent erosion. The construction of terraces is also financially supported by the Rural Development Programme.

The increase in vegetation cover, especially in mountain areas is essential for reducing run-off. This is being promoted through the Rural Development Programme and in particular through the following measures:

- Measure 2.1 "Compensatory Allowances in Less Favoured Areas". Eligible activities under this measure are the exploitation of agricultural or fallow land mainly in mountain areas with permanent, semi-permanent or perennial crops and prevent land abandonment.
- Submeasure 2.3.6 "Agri-environmental commitments in traditional plantations of trees and shrubs, with emphasis on less favoured areas ". The scheme aims to reduce pollution of groundwater and soil from the use of chemical fertilizers, to protect biodiversity and preserve traditional landscape, by simultaneously contributing to soil protection from erosion and to retain the population in mountainous areas. The eligible action foreseen under this scheme is the mechanical destruction of weeds instead of the use of chemical means.

Run-off is also reduced by forest cover activities, as trees have the capacity to retain water through their deep roots. Following, such organized activities that take place in Cyprus are presented.

- The National Programme of Forests foresees the expansion of forest cover through afforestation of hali and other abandoned private land and the reforestation of burnt areas.
- The Rural Development Programme provides incentives for the afforestation of agricultural and non-agricultural lands (Submeasures 2.4.1 & 2.4.3).

The application of Advanced Irrigation Systems reduce run-off and increase soil moisture, as irrigation is applied in such a way that the soil can better absorb water without losses. A Water Use Improvement Project has been implemented in Cyprus by the Department of Agriculture since 1965. Proper hydraulic design of the irrigation systems, offered free of charge by the Ministry, coupled by a subsidy of the installation cost, resulted in a rapid expansion of the new irrigation systems. The progress in the irrigation efficiency from less than 45% in 1960, reached 71% in 1980, 80% in 1990, 84% in 2000 and 90–95% in 2010 (WDD, 2011b).

Control grazing is another measure for preventing soil erosion and thus run-off. In Cyprus, the Forests Law prohibits grazing in the forests since 1913, while the Goats Law of 1988 determined the maximum number of animals, especially goats, which is permitted to graze in order to prevent overgrazing and identified the areas where grazing is allowed. However this Law is not applied in most cases, as there no sufficient control.

The protection of forests from fires also contributes to the reduction of soil erosion and run-off. The Department of Forests has elaborated and continuously upgrades an extensive programme of fire protection measures. However, fire protection measures have not been enforced for private forest-covered lands which cover 23,12% of the island.

8.1.2. Maintain soil structure

In order to maintain soil structure, the Good Agricultural and Environmental Conditions of the RDP foresee a number of relative standards, which include:

• Appropriate use of agricultural machinery: The cultivation of soil should take place only when it's the appropriate time and when required.

• Avoidance of large lumps and soil trimming.

• Avoidance of the use of heavy machinery, as they can cause soil compaction, especially in clay and heavy soils.

8.2. Measures to improve soil fertility

Management practices that enhance soil fertility include the application of organic residues which are rich in nutrients (e.g. humus) to soil. Furthermore, the application of crop rotation and fallow to the cultivated land is also associated with greater soil organic matter, soil structure and aggregation compared to simple rotations or mono-cropping. Both practices also reduce soil erosion potential due to increased water infiltration and water holding capacity. Next, relative actions that have been applied/promoted in Cyprus are presented.

8.2.1. Application of organic residues on soils

The Good Agricultural and Environmental Conditions set the standards for managing crop residues and suggest that depending on weather conditions, producers have to follow one or more of the following practices regarding plant residues: a) use for grazing purposes, b) use as soil cover or integration in the soil for annual crops.

8.2.2. Crop rotation

The application of crop rotation in Cyprus is encouraged through the Rural Development Programme with the provision of economic incentives. The related measures of the RDP are:

- Submeasure 2.3.2 "Agri-environmental commitments in potatoes"
  One of the eligible actions of this measure for the provision of financial support to farmers is the implementation of a three-year crop rotation system.
- Submeasure 2.3.4 "Agri-environmental commitments in arables". With this scheme financial aid is provided for the implementation of a two-year crop rotation system or a three-year rotation system.

8.3. Landslides

In places where landslides have occurred, technical structures were built in order to prevent human accidents and damages to infrastructure. Currently, there is an ongoing effort to create a database with the recorded landslides. Given the serious risk of landslides faced in Pafos, the Geological Survey Department of Cyprus has undertaken a research project entitled 'Study of landslides in areas of Pafos District', the main purpose being to promote a more secure urban development.

However no action plans have been developed to date for the prevention and management of landslides.

8.4. Measures to reduce coastal erosion

For the measures undertaken in Cyprus to reduce coastal erosion, the reader can see Section 3.1: Coastal areas of the current report, where extensive reference on the subject is being made.

8.5. Measures to reduce soil contamination

The measures that have been undertaken in Cyprus in order to reduce water pollution also apply for the case of soil contamination, as these are inextricably linked. The reader is encouraged to see Section 1.4: Water resources of the current report where the relative measures are presented.

8.6. Measures to reduce soil salinization

The overexploitation of coastal aquifers in Cyprus due to inadequate control over the drilling of boreholes and over the quantities of water pumped, led to the sea intrusion and the salinization of groundwater and soils. The Law on the Integrated Water Management 79(I)/2010 which has been enforced in Cyprus since 2010, sets strict requirements on the granting of permissions for the drilling of boreholes and the pumping of groundwater. Furthermore, the Law foresees the installation and monitoring of water meters in boreholes, in order for the quantities of water pumped not to exceed the limits set. It is expected that with the new Law a considerable number of violations, that have been made in the past, will be eliminated. What is more, the salinity of the water used for irrigation and recharge is monitored in order to avoid further deterioration of the groundwater bodies.

8.7. Gap analysis

Some of the measures presented in the previous sections have been applied in Cyprus for several decades, however the majority of the measures have been recently applied and their effectiveness has not been evaluated yet. The proposed Action Plan for Combating Desertification, implies that the existing measures may be sufficient in areas which are not sensitive to desertification while on the other hand, for the areas that are more sensitive to desertification, more intensive measures are required. Following, these measures are being presented.

(I.A.C.O. Ltd, 2008)

- Mandatory implementation of the Code of Good Agricultural Practice
- Continuation and increase agri-environmental measures within the RDP with emphasis on erosion control
- Grants and incentives for maintenance of terracing, and protection walls in sloping lands even in areas where farming has been abandoned
- Control of abandonment of farming and support of traditional agricultural practices
- Incentives for terracing in burnt areas and intervention for prevention of increased erosion
- Implementation of a plan for the sustainable use of land (on the basis of slope and type, structure, depth and resilience of soil to erosion)
- Extension of the Goats Law to cover all the areas in Cyprus. The objective is the control of grazing by license on the basis of the carrying capacity of each area.
- Studies and research for the definition of number of animals that could be accepted by each area without detrimental impact on its ecosystem. For each area the productive capacity, the time and intensity of grazing should be evaluated for securing sustainability
- Reinstatement of the institution of the Rural Constable for the control of illegal and free grazing
- Control the use of marginal quality water and proper advising on the impact of soils
- Provision of good quality irrigation water for leaching purposes where possible
- Regular monitoring of the salinity and salinization of soils and of the quality of irrigation water
- Ensuring drainage of irrigated soils
- The irrigation should cover leaching requirements in addition to the plant's needs especially where the water has an increased salinity
- Further reduction of water losses
- Proper soil cultivation
- Enhancement of land surface cover

- Implementation of a special plan for incentives and support to farmers for the installation of improved irrigation systems in the mountainous and semi-mountainous areas that fall under the sensitive areas to desertification

9. Forests

The forests of Cyprus have already been affected by increased temperatures, decreased precipitation and prolonged drought periods. Among the most pronounced impacts for forests so far were forest mortality, species necrocis and increased pest populations. Forest fires in Cyprus have been attributed mainly to arson. The Government of Cyprus has undertaken a number of actions for addressing these issues and protecting the country's forest resources, thus enhancing the capacity of the forest sector to adapt to climate change.

9.1. Measures against dieback of tree species, insects attacks and diseases

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 Plan consists of 8 sectors which contain 20 measures and 35 actions in total.

The aims of Cyprus Short-term Action Plan are summarized as follows: (i) The planning of measures and infrastructure projects with a defined implementation schedule, so that the Cyprus Forestry could react quickly to any negative effects of drought, (ii) The creation of infrastructure projects addressing the impacts of climate change, as anticipated by various scenarios on climate change, (iii) To provide the aid for a future medium – term strategic planning for adaptation of the Cypriot forestry to climate change.

The measures and actions include all those projects and activities that should be planned and implemented by the Forestry Department in order to mitigate the adverse impacts of drought in state forests. The measures address the dieback of tree species, insect attacks, biodiversity loss as well as fires. Although the draft contains all the actions to be undertaken / implemented the years 2009 -2010, the Plan has flexibility and can be adjusted depending on the progress of drought and the new data that may arise. Also, some of the actions will be implemented gradually until 2013 (DoF, 2009). Next, the plan's measures for combating dieback of forests and insect attacks as well as for the protection of biodiversity are presented in brief.

Table 9-1: Dieback and insect attack prevention and reduction measures, Short-term Action Plan

Measure	Dieback	Insect attacks	Biodiversity	Comments
Systematic monitoring of the problems caused by drought with annual recording of forest damage	X			First year of implementation: 2007-2008
Exploitation of the gathered information from the implementation of the program «ICP - Forests»	X	X		Monitoring of insect attacks Collection of temperature and rain data for monitoring risk for dieback

Measure	Dieback	Insect attacks	Biodiversity	Comments
Install surface monitoring of the impact of the thinning in forest clusters	X	X		Increase in soil moisture Control spreading of insects and avoid population build-up
Removal of dead trees		X		Control of insect populations
Control of harmful insect populations		X		Insect traps
Irrigation program	X			Apply irrigation at stressed trees
Thinning program	X	X		Increase in soil moisture Control spreading of insects and avoid population build-up
Cultivating care	X			Appropriate ploughing to retain water in roots
Restriction of reforestation and afforestation programs	X			Decrease competition of water demand between trees Increase water uptake per tree Implementation in areas affected by water scarcity (excl. burnt areas, highways, cities)
Reduce the production of new forest planting on forest nurseries			X	Emphasis on dry-resistant species
Storage genetic propagation material in forest nurseries			X	
Limit timber			X	Exercise timber only in areas not affected by drought
Installation program of watering troughs in forests for covering fauna needs			X	
Utilization of the water resources/boreholes in the state forest			X	
Cleaning programme of natural springs in forests			X	
Awareness raising	X	X	X	

Source: DoF, 2009

Apart from clean forest practices for controlling pest populations, natural controls including the introduction of insect parasites and predators as well as aerial and ground application of chemical and biological insecticides are widely used in Cyprus. In recent years only biological insecticides have

been used in Cyprus to prevent defoliation and the annoying effects of the pests (Department of Forests).

Last but not least, the Forest Department taking into consideration the serious problems caused by droughts in the Cyprus Forestry and the negative impact climate change is expected to have on forests, has decided to prepare a "Mid Term Strategic Plan for the Adaptation of Cypriot Forestry to Climate Change" (DoF, 2009).

This set of measures had already faced the problems caused in Cyprus' forests in a great extent and is expected to enhance preparedness for future drought periods. However the effect can only be alleviated but not eliminated.

9.2. Measures against forest fires

Several measures are taken by the Forestry Department of Cyprus aiming to eliminate forest fires. In particular those measures are categorized in four groups (i) prevention measures, (ii) pre-suppression measures, (iii) detection measures and (iv) suppression measures are presented below:

(i) Fire Prevention measures

Fire prevention measures include all actions and measures aimed at reducing or eliminating the potential for a fire outbreak. The main prevention measures taken are the following (Boustras et al., 2008):

- *Law enforcement*
  The Forest Law prohibits the lighting of fires and throwing of burning cigarette ends or matches in the State forest or within a radius of one kilometer from the State forest boundaries.
- *Information campaigns*
  An information campaign aiming at educating the public, particularly young people is organised annually. Moreover, during the fire season messages are broadcasted through radio and television, to raise public awareness.
- *Picnic and camping sites*
  In order to avoid the risk of uncontrolled fire ignitions by people visiting forested areas for recreation purposes, numerous picnic and camping sites had been established.
- *Patrolling*
  Throughout the fire season, regular patrols are organized, mostly along the boundaries of the State forest where most fires start. The aims of patrols are public information, enforcement of the law and detection and timely intervention in case of fire.
- *Fire danger mapping*
  Fire danger mapping is done on a daily basis, using meteorological data that are collected from a network of automatic weather stations installed for this purpose in different locations all over Cyprus.

(ii) Fire pre-suppression measures

Fire pre-supression measures include all actions and measures aimed at reducing the likelihood of spread of a potential fire and at facilitating the efforts of effective fire suppression. The main pre-suppression measures taken are the following (Department of Forests, 2012):

- *Fire breaks*
  Fire breaks are designed to interrupt the continuity of fuels. In case of fire, the fire breaks normally will slow the rate of spread, thus enabling the ground fire fighting forces to reach the head of the fire and suppress it easily and with relative safety.

- *Forest roads*
  Within State forests there is a good road network. Forest roads are necessary and extremely important both for forest management and fire protection purposes.

- *Forest telecommunications*
  The Forestry Department maintains its own independent telephone network, mainly used for the coordination of prevention, detection and suppression activities. This network includes repeaters and radiotelephones placed in all forest stations, fire lookout stations, fire engines and personnel vehicles. In addition, all forest officers are equipped with portable radiotelephones.

- *Forest stations*
  Forest stations are located in forested areas all over the island and are manned by both permanent and seasonal staff.

- *Silvicultural treatments*
  Silvicultural treatments aim at reducing the risk of ignition and spreading rate of fires. These include pruning, thinning and clearing of vegetation along forest and intercity roads, as well as, in areas where there is a high risk of fire ignition.

(iii) Detection and reporting of forest fires

Detection and reporting of forest fires include all actions and measures aimed at forming a mechanism able to quickly detect, locate and report a potential fire, enhancing timely attack and extinction. The main detection and reporting measures taken are the following (Department of Forests, 2012):

- *Fire lookout stations*
  Fire lookout stations are placed in strategic locations, usually at the top of mountains. During the fire season these stations are staffed with experienced observers and enable continues monitoring for potential fires on a 24-hour basis.

- *Automatic fire detection system*
  For the systematic monitoring for potential fires within the Akamas National Forest Park, an Automatic fire detection system had been installed. This system was installed on a pilot basis with the financial support of the European Union.

- *Reporting of forest fires through telephone*
  The public may report the existence of forest fires through the telephone number 1407, which operates free of charge on a 24-hour basis.

(iv) Suppression measures

The suppression of forest fires is a complex, difficult and dangerous work that requires specialized knowledge, education and organisation. Suppression includes all actions and measures aimed at facilitating rapid intervention and effective suppression of a potential fire. The main suppression measures taken are the following (Department of Forests, 2012):

- *Forest fire fighting task force*
  At the beginning of every fire season, the body of forest fire fighting task force is organized. Forest fire fighters, split-up into groups of 6-15 individuals and are then positioned into different forest stations. Each group is provided with fire engines, personnel vehicles, radiotelephones and fire fighting tools and equipment.

- *Stand-by of forest officers*
  Throughout the fire season, a number of forest officers remain on duty on a rotation basis. In case of a fire, they lead the forest fire fighting task force to the scene of the fire and organise and coordinate the suppression operation.

- *The Cyprus Forestry College*
  The lecturers, students and forest fire fighters of the Cyprus Forestry College, form a well-organised firefighting force. Similarly to forest officers, the personnel of the college remain on duty on a rotation basis during the fire season. The college is equipped with cross country vehicles, fire engines, radiotelephones and fire fighting tools.

- *Fire engines*
  The Department of Forests has a significant number of fire engines which are manned by experienced forest fire fighters. These fire engines are distributed to the different forest stations.

- *Personnel vehicles*
  Cross country vehicles are used in case of fire for the transfer of forest officers and the forest fire fighting task force. Most of these are 4 wheel drive vehicles, which makes them very agile on forest roads and off-road conditions as well, but also on accessible fire breaks. They are equipped with radio telephones and fire fighting tools.

- *Tractors*
  The Department of Forests owns a number of tractors (bulldozers). These, are mainly used for the construction and maintenance of forest roads and fire breaks. In case of a fire incident they are used in active fire fighting through the construction of fire breaks.

- *Warehouses*
  In almost all forest stations, warehouses can be found in which the necessary fire fighting tools and equipment are stored.

- *Fire protection systems*
  Fire protection systems are installed in forested areas where large numbers of people may concentrate, such as picnic and camping sites. These systems consist of a number of fire nests which are continually supplied with water from existing pipes or water tanks (water reservoirs).

- *Water tanks and hydrants*
  In case of a forest fire, it is of great importance the fast refilling of the fire engines with water. For this purpose, a network of water tanks is constructed in most forested areas and hydrants and water valves are installed.

- *Heliports*
  Numerous heliports can be found within or near forested areas. These, in case of emergency can be used for the landing of helicopters transferring fire fighters, supplies and people injured during fire fighting.

- *Aerial means*
  Fighting of fires using aerial means such as aeroplanes and helicopters has been practised with good results during the last decade. For the suppression of forest fires, the two aeroplanes owned by the Department of Forests are used. Additionally a number of fire fighting helicopters leased by the Government of Cyprus, are also used. The police helicopters and helicopters of the British Base in Cyprus are also used whenever needed. In the case of large fires, aerial firefighting is further reinforced with air means from countries of the European Union and other neighboring countries.

As a result of the measures mentioned above it was managed to reduce both the time of intervention and the area burnt each year. The average time of response during fire incidents for the period 2000 - 2003 was only 12.5 minutes.

In addition, the Short-term Action Plan for the Confrontation of the Implications of Drought in Cyprus state forests (2009-2010), foresees a number of measures for the protection from fires:

- Measure 16: Forestry Measures – Pruning and cleaning of herbaceous and woody vegetation along roads in order to reduce the risk of ignition and the spreading rate of forest fires
- Measure 17: Increase in Water Supply Points for Use by Fire Helicopters
- Measure 18: Development of Early Warning System for Forest Fire Outbreak and Expansion for all state forests
- Measure 19: Alert and readiness for fire protection

However, it must be mentioned that in contrast to state forests and OWL for which the Department of Forests undertakes the full responsibility for their protection from fires, in private forests and OWL, which account for the 50% of the forest and OWL area of the island, there is no infrastructure such us fire breaks, forest roads, water tanks, forest stations etc making the protection of these areas from fires insufficient.

Economic incentives

The EU through its Regulation (EEC) 2158/92, which refers to the protection of Community forests against fires, finances a series of actions aiming at the reduction of the number of fires and the burnt areas. The funded actions include infrastructure for fire fighting and improvement of degraded forests.

Moreover, in the framework of the Rural Development Programme 2007-2013, economic incentives are provided to individuals through the **Measure 2.5 "Protection of forests from fires and reforestation areas"**. The main purpose of the measure is to improve the existing protection system of forests and other forest areas from fire as well as the restoration of burned areas. The measure includes the following two actions: (i) fire prevention, (ii) reforestation of burnt areas.

(i) Fire prevention. This action is limited in prevention measures and foresees the provision of financial support for the construction / installation of fire protection infrastructure, maintenance of fire belts, and the development and improvement of fire detection and communication equipment.

(ii) Reforestation of burnt areas. This action involves the rehabilitation of burned forest areas.

This measure enhances the protection of private forests which are not covered by the national forest protection programme.

9.3. Measures against air pollution

Given the fact that atmospheric pollution constitutes a major cause of forests' decline, in 1985 United Nations developed a world program for the monitoring of effects of atmospheric pollution on the forests (International Co-operative Program on the Assessment and Monitoring of Air Pollution Effects on Forests, ICP-FORESTS). Additionally the European Union has developed a similar program (Protection of Communal Forest against Atmospheric Pollution), the activities of which are included in regulation 2152/03 EC (Monitoring of Forests and Environmental Interactions in the Community, Forest Focus).

Cyprus has joined the ICP-Forests program in 2001 aiming at the better monitoring and understanding of ecosystems in Cyprus. The Cyprus Department of Forests has been nominated as the National Focal Centre of the ICP-Program in Cyprus, being responsible for the collection, validation, evaluation, storage and management of the monitoring data. In the context of this Program, 19 permanent plots have been established in Cyprus State forests aiming at the collection of the necessary data, relevant to the abovementioned activities. In monitoring plots, covering an area of 0.1 hectare each, the following ecosystems were monitored: Calabrian pine (Pinus brutia), Black pine (Pinus nigra), and Cyprus cedar (Cedrus brevifolia) ecosystems.

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 must be undertaken in order to reduce to the degree possible adverse effects. From the

European experience in the implementation of mitigation measures, it was seen that acidity has successfully abated, while increased concentrations of nutrient nitrogen in soils has not abated and it is expected to continue constitute a problem in the future based on current legislative framework.

9.4. Gap analysis

The review of the measures and policies applied in Cyprus relating to the adaptation of the sector to climate change, showed that there are certain measures that have not been promoted yet or need further enhancement. These measures include:

(DoE, 2010a; Shoukri & Zachariadis, 2012; I.A.C.O. Ltd, 2008)

- Further increase forest areas through afforestation of bare lands and reforestation of abandoned agricultural lands
- Use of species with higher carbon sequestration ability (for plantations) and well adapted to hard climatic conditions
- Minimize tillage and associated practices
- Protection of forests against their enemies, mainly fires, with the investment/availability of vital national resources and the implementation of a national fire protection plan
- Prevent non forest uses to state forest land, with the exception of specific cases and only for the public interest
- Immediate reforestation / restoration of areas destroyed by fire and implementation of appropriate silvicultural measures
- Preparation of management plans for all state forests within 10 years, taking into account national needs, climate changes and the provisions of relevant EU directives
- Meeting the requirements in timber of wood industries and at the same time establishing annual quantity of timber harvested well below the annual increment, in order to improve the quality and land cover of forests
- Creation of a permanent committee with the responsibility of identifying suitable land for the expansion of forests
- Research, data collection and monitoring of biotic and abiotic parameters
- Identification and promotion of micro- climatic benefits and environmental services of trees and forests
- Infrastructure to improve forest resilience to fires
- Classification of forests according to the risk of fire, designation of high-risk areas
- Stricter control on grazing in the Akamas and other forest areas. Grazing in the remaining forest covered areas, outside the State Forests, should be limited to the least possible
- Set up of infrastructure in the private forest areas for protection from fires
- Control of land use change in private forests with relevant incentives and reimbursements
- Purchase by the State private forest areas enclosed or wedging into state forests

- Inclusion of the private forest covered areas in the fire fighting schemes of the Department of Forests
- Planning and development of forest ecosystems that would make the start and speed of expansion of fires more difficult (less flammable plant communities, thinning down and maintenance of suitable structure of forests, cleaning and suitable arrangement or disposal of remains)

10. Public health

Higher temperatures and heat waves in Cyprus are quite intense during summer in Cyprus and are often related to increased mortality rates, especially in the elderly people. In combination with the above, increased humidity worsens the situation. Other climate change related impacts on public health have not yet clearly identified. These may include declined air quality in urban areas as well as the outbreak of water, food and vector borne diseases.

Next, the measures that are applied in Cyprus in order to address those impacts are presented.

10.1. Measures to prevent heat mortality and morbidity

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, public web sites). In addition, during severe heat waves in Cyprus (as in summer 2003), the government in order to protect its citizens from adverse health effects, recommends a curfew between the high risk hours of the day. Furthermore, working regulations prohibit outdoor labour work when temperature exceeds 40 ^{o}C. However, people frequently ignore curfews out of negligence, with all the adverse effects that may follow. The majority of houses and indoor public areas as well as private trade facilities in Cyprus, are fully air-conditioned. Furthermore, there are communal centers fully air-conditioned to accommodate people with no access to an air-conditioned environment during days of elevated temperatures. However, the protection of the population from heat waves is not always possible.

Consequently, it is considered that there is need to enhance the preparedness to heat waves by improving the collaborative mechanisms between research institutions and lead bodies to coordinate emergency responses, the accurate and timely meteorological forecasts, the reduction of exposure to heat, particular care for vulnerable populations, the provision of health care, social services and infrastructure, risk communication mechanisms, urban planning, energy and transport policies, monitoring and evaluation.

In 2011 the project "Climate Change and Public Health: Assessment of the Effects of Extreme Weather and Development of Innovative Prevention and Mitigation Strategies" of the Research Promotion Foundation was launched. It is expected that its findings will enhance the adaptive capacity of public health to climate changes and in particular to heat waves.

10.2. Measures to control vector- and rodent- borne diseases

The measures currently available to control vector-and rodent-borne diseases are disease-specific and can be broadly classified into diagnosis and treatment, vaccination, vector control, reservoir host control, information and health education and disease surveillance and monitoring.

Monitoring and identification of mosquito species is an important component of the Public Health Service's commitment to protecting the health of residents and preventing the spread of vector-borne diseases." Twenty-three species belonging to 6 genera and 10 subgenera have been recorded to date, including species documented from earlier surveys. As a result of this program, new mosquito species for Cyprus have been recorded, including Anopheles marteri, Culex theileri, Cx. impudicus, Culiseta subochrea, and Uranotaenia unguiculata.

10.3. Measures to control food – borne and water-borne diseases

Notification system represents the main resource of data on food-borne diseases in Cyprus. The food-borne Disease Surveillance System in Cyprus is illustrated in Figure 10-1. The system involves the collaboration between physicians and health care services. Notification of food-borne diseases by the attending physician is usually followed by laboratory confirmation of the infection. Because of this, it is not always possible to secure prompt action which would allow for the proper investigation and control of the disease.

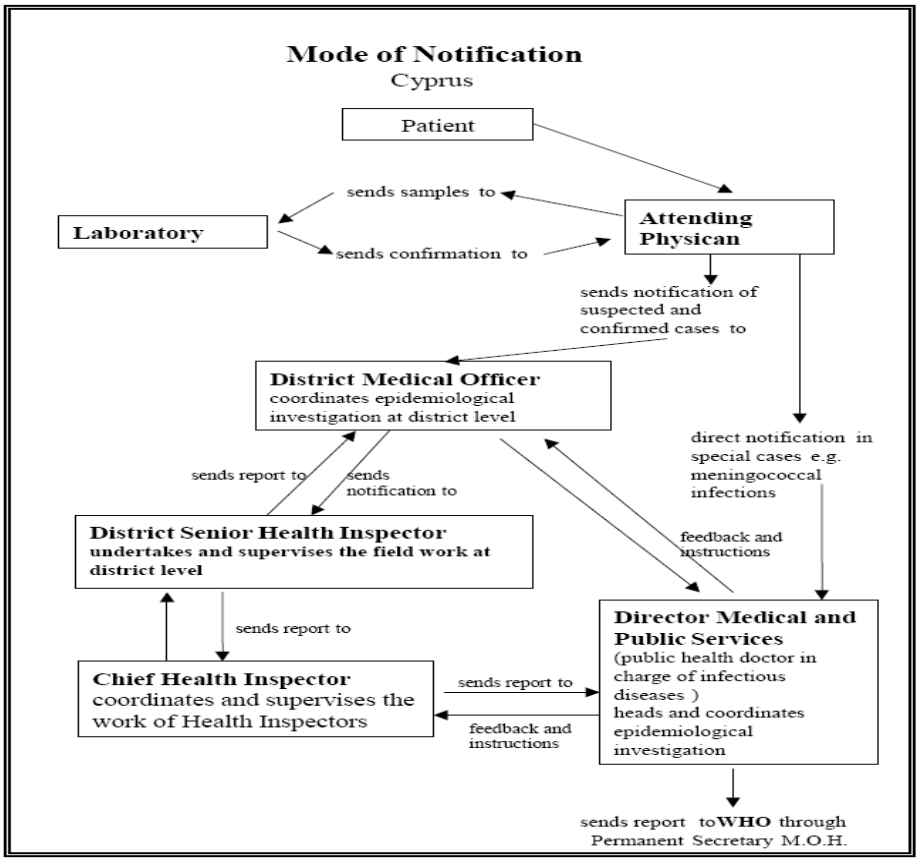

Figure 10-1: Cyprus notification mode of food-borne diseases

The Republic of Cyprus has elaborated an extensive network of sanitation facilities in order for every citizen to have access to clean water. According to *Plan Bleu, 2011,* the share of population with access to an improved water source in Cyprus for the period 1990-2008 was 100%.

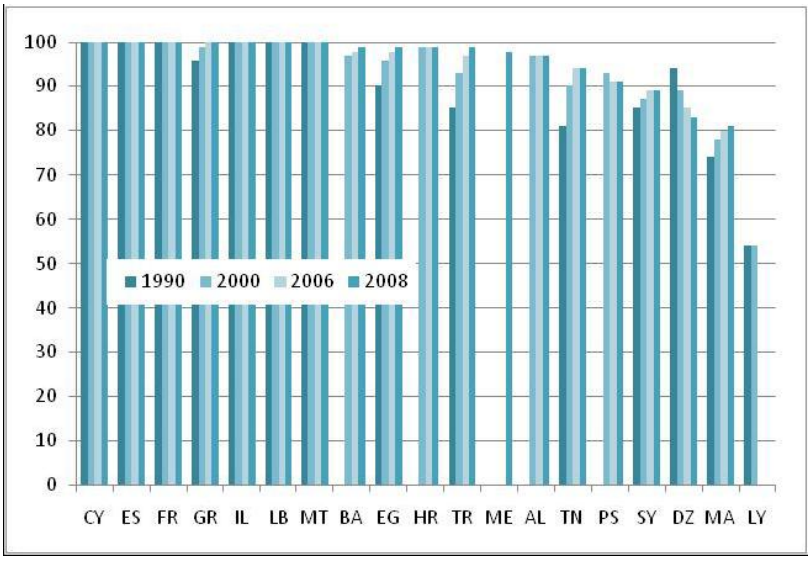

Table 10-1: Share of population with access to an improved water source, 1990-2008 (%)

Source: Plan Bleu, 2011

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. Their responsibilities include inter alia the monitoring of pollution levels and the monitoring of the environmental pollution level of drinking water supplies from pesticides and other micro pollutants. The General Laboratory of the Ministry of Health is responsible for performing controls on food and water samples for ensuring quality and safety. In addition, the National Committee for Nutrition which was established by the Ministry of Health in 1992 is responsible inter alia for monitoring compliance with state legislation on food safety and quality. In line with this a comprehensive list of controls is performed on food and water samples.

10.4. Measures to control human health risk from natural hazards

Preparedness and response to natural and man-made disasters (e.g. floods, fires) provided by the Civil Protection Service of Cyprus also constitutes an adaptation measure towards the increase in the intensity and frequency of extreme events under climate changes. However, it is not known whether the sufficiency of the capacity of the Civil Defense force will be adequate in order to face increased incidents of such events.

10.5. Measures to control air-pollution related diseases

The measures for controlling air-pollution related diseases are mainly related to the provision of medical services by the health care system of Cyprus for facing such diseases as well as measures for

the prevention of such diseases, with the mitigation of air pollution. In specific, the Department of Labour Inspection of the Ministry of Labour and Social Insurance of Cyprus, operates a national network of nine stations for monitoring air quality (Ministry of Labour and Social Insurance, 2007).

The measures for air pollution mitigation applied in Cyprus are:

- Enforcement of air quality EU directive
- National and regional plans for air quality improvement
- Action Plan for the support of public transportation in Cyprus

10.6. Gap analysis

Taking into consideration the lack of preparedness and weak response of Cyprus in climate change impacts and their hazardous effects on human health, further policy measures and actions have to be taken. These actions must aim at the prevention, reduction and adaptation to climate-related threats. Among the required adaptation measures are (Shoukri and Zachariadis, 2012):

- Strengthening public health system's ability to respond quickly to disease outbreaks
- Develop guidelines and proper training for medical doctors (private and public sector).
- Implement a coherent early warning system
- Data collection and creation of inventories on vector, water and food borne diseases
- Increase monitoring and disease control
- Further research on disease control and prevention
- Establishment of a General Health Scheme and horizontal integration of the climate change adaptation priority in all sectors
- Improve health infrastructure (hospitals, laboratories etc.)
- Development of contingency plans in health and social care systems to cope with increasing numbers of patients
- Preparation of an emergency plan in order to specify the responsibilities of various health and social service bodies
- Enhanced implementation of measures for air quality improvement in urban areas
- Creation and protection of urban parks to reduce the urban heat island phenomenon and improve air quality
- Apply strict controls/health inspection in food industry and food service industry

11. Infrastructure

The climatic factors that are likely to induce impact on the infrastructure sector are the extreme events. In particular, heavy rain and sea level rise comprise the most important climatic factors among extreme events affecting infrastructure. The adaptation measures presented in the current section refer to the protection of infrastructure from flood and landslide damage.

11.1. Measures against flood damage

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 defense works** such as seawalls, coastal revetments and breakwaters (*sea flood protection*).

Hard engineering structures such as seawalls, coastal revetments and breakwaters, help prevent coastal flooding. However, seawalls and revetments are not considered attractive for bathing beaches where the tourism infrastructure is located and thus breakwaters and groynes are the predominant defense works, although the latter are considered less drastic measures in case of a severe storm or flooding event. For more information of the coastal defense works constructed in Cyprus, one may refer to Section 3.1: Measures to reduce erosion.

(b) **Fishing shelters and artificial reefs** (*sea flood protection*).

Fishing shelters are constructed for the protection of fishing boats against extreme events such as storms and large waves, also provide for the protection of coastal infrastructure. Currently, there are eleven fishing shelters in operation in Cyprus.

Artificial reefs which are actually submerged breakwaters also provide protection from flooding by absorbing part of the incident wave energy before it reaches the coast. The DMFR will create up to 4 artificial reefs in the marine areas of Famagusta, Limassol and Paphos (Source: Strategy for the creation of artificial reefs, Cyprus).

(c) **Dams** (*urban flood protection*)

The purpose of dams is not limited to water supply but also for flood risk minimization, as its storage contributes to the attenuation of flood peaks. According to the detailed river basin management plan (Annex I) of the Water Development Department (WDD, 2011a), 36 out of the 107 constructed dams in Cyprus are designed for flood risk minimization. These have been designed according to high flood protection standards (1 to 500 or 1 to 1000 chance of flooding). It is stressed that even if dams do not comprise vulnerable infrastructure, their monitoring is considered of particular importance as they may induce safety risks.

(d) **Sustainable Urban Drainage Systems** (*urban flood protection*).

Regarding urban floods, the Cyprus government has taken measures for the reduction of urban flood risks, by developing Sustainable Urban Drainage Systems (SUDS). When referring to these systems, it must be noticed that they comprise stormwater retention ponds which are used both for flood protection and for aquifer recharge. In Cyprus, such systems have been installed at Limassol and Paramilimni. Finally, Paphos has been identified as a suitable area for the implementation of SUDS (WDD, 2009).

What is more, the complete separation of the sewerage and drainage system is underway, as the latter is being expanded in most urban centers, providing therefore the basis for reducing to a large degree the flooding risk of the sewerage system.

11.2. Measures against landslide damage

Given the serious risk of landslides[6], GSD has undertaken a research project entitled 'Study of landslides in areas of Pafos District', the main purpose being 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.

Also, several landslide protection measures have been undertaken such as road protection measures, retention walls and terraces.

11.3. Gap analysis

Due to lack of sufficient data on the 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.

[6] It has been recorded that some villages have been relocated to safer places in the past

12. Conclusions

In Cyprus, there is no specific policy in place for adapting to climate change impacts. All measures presented in this report, refer to measures undertaken in Cyprus that have not been developed for addressing climate changes per se, but are considered to contribute towards this direction as well.

The magnitude of contribution of those measures to addressing climate changes varies according to their effectiveness, their relation to climate change impacts (direct, indirect), their range of implementation (government level, private level), the obligation for implementation (legally binding, optional) while some climate change impacts may not be adequately addressed.

In addition, in some cases it is noticed that although some measures applied in one sector may act beneficially or negatively towards climate change adaptation in another sector, there is no coordinated action between sectors to promote or avoid, respectively, these measures.

Finally, this report highlights the need for the development of an integrated national adaptation strategy in Cyprus through which the coordination and intensification of existing good practices towards climate change adaptation will be achieved while bad practices will be rescinded, the identified weaknesses and inadequacies will be addressed and the additional suggested measures will be incorporated.

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