National Report on
« Monitoring progress and promotion of water demand management policies in Cyprus »

(Under the aegis of the Water Development Department and Plan Bleu)

Prepared by

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1. Introduction

The report presents the water situation in Cyprus, its current evolution and the likely consequences. It elaborates on the necessity and the expected benefits of water demand management. Sets of indicators and objectives are presented that are essential in the design of the "efficiency plans" announced at the Johannesburg Summit and the « water » section of national sustainable development strategies. It aims to contribute to the Mediterranean reflection on the problem and to regional sharing of experiences about water demand management.

This report is in accord to the first priority field of action of the "Mediterranean Strategy for Sustainable Development" (MSSD) adopted in November 2005 by the Contracting Parties to the Barcelona Convention and the Barcelona Euro-Mediterranean Summit, which is "integrated water resources and demand management".

Cyprus is the third largest island in the Mediterranean with an area of 9 251 km^2. Some 63 percent of the island is under the control of the Government of Cyprus, with the remainder being under Turkish occupation since 1974. Unless specified the figures used refer to the areas under government control.

Two mountain ranges run east to west. The Troodos mountain range covers approximately 3 500 km^2 in the central part and rises to nearly 2 000 m. The Kyrenia mountain range, along the northern coast, covers 400 km^2 and rises to 950 m. In between these two mountain ranges lies the central plain of Mesaoria covering 2 500 km^2. The remaining land forms narrow coastal plains which are good for agriculture. There are no perennial streams. Most of the winter streams traversing these plains have deep alluvial beds in which substantial volumes of groundwater can be stored.

The population of the island excluding tourism based on the year 2000 census[2] is 672500 of which 74% live in the 5 main urban centres and 26% in the villages. Low population growth rates, around 1 percent, suggest the population in 2020 to reach 800 000. The number of tourists in 2006 is estimated to be 3.2 million reaching 4.3 million by 2020 at an average 11.3 overnight stays for each tourist as per estimates of the Cyprus Tourism Organization.

Cyprus with a semi arid climate has always been confronted with the problem of inadequate water both for its domestic and its irrigation needs. At present, and after most of the water resources of the island have been developed, the problem still persists. Since 1960, the freshwater storage capacity was increased 50 times from 0.006 km^3 to 0.300 km^3. Due to aggravated water scarcity in the 1990's seawater desalination was brought into stream. More recently, a substantial amount of water is recycled.

The responsibility for water policy lies with the Council of Ministers. Executive power is divided between the Ministry of Agriculture, Natural Resources and Environment (MANRE) and the Ministry of Interior. MANRE has technical responsibility for water resources policy, assessment and monitoring, but also for development and bulk selling water to end users. The Ministry of Interior through its District Office administration (DO) is responsible for implementing and enforcing water-related laws including the issue of groundwater permits and chairs the District Water Boards, Irrigation Divisions, Municipal Water Boards and Village Water Commissions.

The Water Development Department (WDD) is responsible for implementing the water policy of MANRE aiming to rational development and management of water resources both for the supply and for the use. The role of WDD includes the mapping of water resources, the planning, design, construction and operation of water supply infrastructure (including

domestic water supply and irrigation systems), sewerage and wastewater treatment (outside the major urban areas) and the monitoring of the quality and quantity of water resources.

Since 2004 Cyprus has joined the European Community and has harmonized its legislation to the EU acquis. At present Cyprus strives to implement the Water Framework Directive and other directives.

2. Major changes in the water situation in the country

2.1 Resources, their mobilization and unconventional water production

The estimated[3] average annual renewable water resources per capita (island-wide), excluding the quantities lost to the sea and the over-pumping) are 383 m^3/inhab/year. This represents the maximum potential of water resources "offered by nature" on average. A part only of these natural resources is exploitable because of various technical-economic and environmental constraints.

Some 65% of the total annual water crop appears as surface runoff and 35% as direct groundwater recharge. Of the total surface runoff only 45 percent, or 0.23 km^3, (or 29 percent of the total water crop) is lost to the sea. This indicates the high level of surface runoff utilization and control achieved in Cyprus over the last 45 years. A large proportion of the losses to the sea include overland flow and flow from minor streams which do not render themselves for regulation and control.

Average island-wide renewable natural water resources based[3] on the period of 1951-1980[a] in km^3/year.

Surface Runoff	Infiltrating into aquifers	Spate irrigation	Lost to the sea	Stored in reservoirs	Average Annual water crop
	0.14	0.04	0.23	0.10	0.51
Groundwater	Irrigation and Domestic use		Lost to the sea	Deficit created by over-exploitation	Direct recharge of aquifers(b)
	0.22		0.23	-0.04	0.27
Total water crop					**0.78**

(a) This is the last 30-year period for which data are available island-wide
(b) Not including infiltration from surface runoff

Since the 1960's, Cyprus embarked in a program to increase water supply by constructing dams and conveyance infrastructure. In the last 46 years the freshwater storage capacity was increased from 0.006 to 0.327 km^3 being the total capacity of 108 dams varying from small ponds to major dams.

The water storage capacity in Cyprus is about twice the average annual runoff and a good degree of national water security was achieved in the face of unreliable rainfall. Many of the dams spilt water over their spillways only during the very wet period of 2003-4 owing to their large capacity with respect to annual runoff and the persistent dry spell that lasted during the 1990's.

Of all possible dams that engineering can construct in Cyprus, a large list taken from the more attractive opportunities has already been implemented. More dams are possible but carry a high price tag: the cost of water from new sources is higher than the cost of water that has already been developed. Currently a small dam (0.004 km^3 capacity) and two other anti-flood dams are being planned (0.001 and 0.00002 km^3).

For the ten major dams or groups of dams of total capacity of 0.279 km^3 the Regulation Index WAT_CO1[1] being the average flow of water resources controlled[4] compared to natural irregular flow, has been calculated as being 69.7% (100x148/212). This indicator measures the efforts made for the control of the irregular water resources by the construction of dams, i.e. the annual security of supply[1].

Artificial recharge of aquifers is an ongoing practice but one that heavily depends on the availability of surplus water. It is estimated that some 0.01km^3/year on the average are mobilized for this purpose.

Two desalination plants are presently in operation, one built on 1997 with a daily production rate of 40000 cubic meters and the second since 2001, producing 51000 cubic meters per day. Both are under the BOOT financial arrangement and use the Reverse Osmosis method. The annual volume produced is 0.031km^3.

A substantial amount of recycled water is reused and has become available for agriculture and the urban and rural environment. Currently some 0.007 km^3/year of tertiary treated sewage effluent is used for agriculture and landscape irrigation. It is estimated that by the year 2012 an amount of approximately 0.030 km^3 of treated sewage effluent will be available for use.

2.2 Water demand and pressure on resources

The total annual water demand is estimated[2] to be 0.266 km^3. Agriculture is the main user with 69% of the total water use. Domestic supply accounts for 25% analysed into 20% for the residents and 5% for tourists. Industry consumes 1% , and 5% is considered to be used for environmental reasons such as landscape irrigation and protection of special ecological areas.

The water demand, total and by sector, and compared to the GDP, total and by sector as per the MSSD-WAT_PO2 indicator[1] is as follows:

The WAT_PO2 for the total water demand is 0.266 km^3/year, for agriculture is 0.182 km^3/year, for domestic is 0.067 km^3/year, for industry is 0.0035 km^3/year and for the environment is 0.0125 km^3/year.

On the basis of the GDP of US$15.4 billion* (est. for 2005)[5], the water demand compared to GDP for agriculture (3.5% of GDP) and industry (19.8% of GDP), have been calculated as per the MSSD-WAT_PO2 indicator by computing the ratio of the demand for the agricultural and the industrial water respectively over the agricultural and industrial contribution to the GDP. The resulting figures are $0.338x10^{-9}$ km^3/US$ for the water demand for agriculture and $0.0011x10^{-9}$ km^3/US$ for the industrial water demand.

The portion (in %) of abstraction from surface water (mainly from dams), from ground water and from other sources of supply for each sector of water demand is shown in the Table below (est. for 2000)[2] :

* 1 US$ = 0.436 CY£

Water demand by sector and source of supply (in %)

Sector/Source	Surface water	Groundwater	Springs	Desalination
Agriculture	43	57		
Domestic	22	23	5	50
Industry		100		
Environment	42	58		
Total demand	**37**	**49**	**1**	**13**

Groundwater is still the main source of water supply, particularly for the agricultural sector and in particular in areas outside the government-owned irrigation schemes.

The pressures exerted on the resources are measured by:

a) The Exploitation index of renewable natural resources (MSSDWAT_P03)[1] which measures the relative pressure of annual abstraction, including volume losses during transport, over traditional renewable natural water flow volume, surface and groundwater.

If the use of water in the non-government controlled area, grossly estimated to be about 0.063 km^3, is added to that of the government controlled area of 0.266 km^3 then the island-wide exploitation index can be estimated.

The WAT_PO3 is estimated to be 42% or [(0.266 +0.063 km^3/0.780 km^3) x100].

Bearing in mind, and as mentioned earlier, that the quoted renewable natural water volume represents the maximum potential of water resources “offered by nature” on average and that a part only of these natural resources is exploitable because of various technical-economic and environmental constraints, this indicator would be about 60% if only some 0.70 of the above annual water crop is deemed as available.

Countries are said to be facing water shortage when the volumes consumed represent over 50% of available water resources. When figures exceed 70%, the situation is qualified as «critical ».

b) The non-sustainable water production index (WAT_C03)[1] illustrates the importance of non renewable groundwater de-stocking (fossil water) coming up to water demand. It corresponds to the proportion of the total annual water withdrawals (including losses during transport) deriving from fossil aquifer reserves and from the overexploitation of water tables, expressed as a percentage.

In Cyprus there is no any significant abstraction from fossil water but there is an estimated annual over-exploitation of 0.04 km^3 in certain aquifers. Thus WAT_CO3 is estimated to be 15% or 100 x (zero fossil water+ 40 hm^3/year)/266 hm^3/year.

c) The emissions of organic water pollutants indicator (WAT_C09)[1] is the BOD_5 measured in industrial wastewaters multiplied by the average annual flow of the industrial wastewater discharges (in kg per day). The magnitude of industries in Cyprus is rather small to moderate, comparing to the magnitude of relevant industries in most European countries. Nevertheless, a large number of small or medium size industries are spread out all over the country. The pollution loads to the water resources of the significant industries is estimated[6] to be 750 kg per day.

The Pollution load potentially reaching surface waters from urban wastes for an equivalent population of 857 600 is estimated[6] to be 3500 kg/day, having in mind that some 45% is treated, and the pollution load from animal husbandry activities is estimated to be of the order of 20000 kg/day.

2.3 Degradations and threats affecting water resources, facilities, ecosystems and population

The main degradations and threats affecting the water resources of the island (point source and diffuse pollution) in order of importance are[7]: livestock waste, agriculture runoff and infiltration (nitrogen, phosphorus, pesticides), climatic conditions (high); urban waste water (5 large waste water treatment plants), industrial waste water (10 major industries and 31 other industries) and solid waste (5 major landfills) (medium); storm water and mines and quarries (1 active copper mine, 9 abandoned mines) (low).

The most common water quality problem is the contamination of groundwater caused by seawater intrusion[8]. The majority of the groundwater bodies have been overexploited for many years, resulting in observed seawater intrusion in the coastal ones. Thirteen of the 19 groundwater bodies (68%) have been intruded to some extent or are at risk to sea water intrusion. Low mean precipitation together with the great water demand and reduced recharge caused by the construction of dams on streams feeding the coastal aquifers have caused the decline of water levels and sea intrusion in most of them.

Major government irrigation schemes allowed intensive agriculture which due to excessive use of fertilizers resulted in nitrate pollution. Also, aquifers in proximity to inhabited areas receive direct sewage disposal in absorption pits. Nitrate ion concentration in these cases usually exceeds 100 mg/l.

While groundwater is of very good quality in igneous rocks, in sedimentary rocks water is generally hard ($CaCO_3$ of about 450-500 mg/l).

The climatic conditions affect directly the availability of water resources and their quality especially when causing over-pumping. A statistical analysis of the records available over the hydrological years 1916-2000 demonstrated[6] that the precipitation time series display a step change or shift around 1970. After 1970 the precipitation is significantly lower than over the previous decades. The average annual precipitation of the recent period is 100 mm or more lower than the average annual precipitation of the earlier period.

No specific Country objectives have been set up for 2015/2025 in regard to the water resources other than the continuous effort for better management and conservation and meeting the requirement of the Water Framework Directive which calls for the development of River Basin Management Plans to maintain or bring the waters to good status by 2015. Towards this goal, Cyprus has started implementation of the WFD (Articles 3, 5 and 6 have been completed whilst 8 and 14 are currently being implemented).

A water general quality index (WAT_C08)[1] indicating the percentage of control points affected by the presence of pollution (organic, nutritive substances, heavy

metals, pesticides, etc.) is not readily available currently although extensive monitoring is being carried out for nitrates, sea intrusion and quality of water in reservoirs, the water of which is used for human consumption. Currently a monitoring program is being established to operate as of 2007 within the context of the WFD (surveillance and operational monitoring) of all water bodies in the island.

The wetlands constitute economic, scientific and entertaining resources of great value. They are subjected to many threats and their degradation leads to increasing risks of floods or droughts, and to a deterioration of the natural environment. The indicator WAT_CO6[1] measures the total area of wetlands in the country. The total area of wetlands included in the RAMSAR Convention[9] as significant is 3756 hectares (Akrotiri Marshes area of 2171 hectares and the Larnaka Salt Lake of 1585 hectares).

Another threat of the water resources is the silting up of dam reserves which causes loss of the original volume and life span of a dam. An indication of such problems is the "rate of silting up of dam reserves (WAT_CO2)[1]. This indicator is calculated as the volume of the mud (solid contributions) compared to the initial total reserve capacity of dams.

Although, there are a large number of dams in Cyprus and the water resources management is very much controlled by their condition and water stored, no definitive study has been made to date about their rate of silting up. This is probably due to the fact that for smaller dams de-silting is often practised and most of the larger dams have been in operation for less than 20 years a period which has observed reduced input due to low rainfall.

On the basis of studies performed on two reservoirs[10] an estimate has been made for the needs of this report. This estimate is based on 100tns/km^2/year for the silting up rate of dam reserves which amounts to about 180000tons/year which for a total of dam capacity of 0.290km^3 amounts to 0.06% per year. For all the major dams of a total capacity of 0.290km^3 built in the period of 1953 to 2005 the estimated loss of storage amounts only to about 2% (WAT_CO2). For small dams the silting at the above rate is serious and de-silting is often carried out. For larger dams this rate appears not to create serious problem.

There are no studies permitting the evaluation of the degradation cost of water resources as a % GDP. The same applies for an evaluation of human and economic impacts of floods. The booming of constructions in floodable areas (riparian areas) but also within the catchments affecting runoff through the increase of paved areas and infringement on drainage areas is causing some concern. No estimates are available of the portion (%) of such constructions in such areas in the last 30/40 years.

A number of measures[11] have been proposed to help improve the situation as regards the degradation and threats on water resources such as:

- Levying a tax on mineral nitrogen fertilizers
- Levying of a tax on pesticides
- Subsidizing organic farming
- Subsidizing livestock waste management
- Set Abstraction Charges
- Upgrade of existing wastewater treatment plants

- Desalination Plants to mitigate water stress
- Artificial Recharge
- Advice farmers on optimum operation from a water protection viewpoint

2.4 Access to drinking water and sanitation and collection and treatment of waste water

The indicator of the proportion of the population having a durable access to an improved water source (total, urban, rural) (MSSD-WAT_P04)[1] covers the share of population supplied with or having reasonable access to sufficient volumes of drinking water. The volume required to satisfy metabolic, hygienic and domestic requirements is estimated at a minimum of 20 litres per day and per capita. According to the Water Development Department[12], in 2005 all households in the part of Cyprus under government control had access to continuous and wholesome supply of drinking water. All areas, urban and rural, have a house to house water connection. Thus the MSSD-WAT_PO4 is practically equal to 100%.

The average water demand was calculated[2] in 2001 to be for the urban areas as 215 litres/day/capita (gross) or (180 net), and for the rural areas 180 litres/day/capita (gross) or (150 net). The per tourist per stay night water demand is 465 litres, being the weighted average of a survey over 65 hotels of various categories for the years 1996 to 1998.

It must be noted though that on many occasions the water supply depends on the vagaries of weather as during the prolonged drought of 1997 -2000 when water was made available on a number of days per week. The situation has improved and no shortage has been experienced since the start of the operation of the second desalination plant. In the year 2000 the average shortage was of the order of 23.4% of the normal demand.

The indicator of the proportion of the population having an access to an improved sanitation system (total, urban, rural) (MSSD-WAT_P05)[1] represents the share of population having access to basic sanitation systems, installed in homes or in the immediate vicinity, for the evacuation of human faeces (public sanitation network, septic tank…). The whole of the population has access to such sanitation facilities as defined by WHO[1]. Thus the MSSD-WAT_PO5 is equal to 100%.

The share of collected and treated wastewater by the public sewerage system (WAT_C10)[1] being the proportion of wastewater produced that has been subjected both to collection from a collective network (from households, local authorities or industries) and has been adequately treated to allow its discharge into the environment without impact on human health or on the ecosystems is reported[13, 14] to be by 2005 as 60%. This is further analyzed as follows:

- For the 6 main urban agglomerations of 473000 population (census of 2001) and estimated 545000 population equivalent, 395830 are connected or 73%.
- For 36 rural agglomerations of 91750 (census of 2001) and estimated 130000 population equivalent, 11500 are connected or 9%.

Thus the total population connected is 407330 out of 675000 or 60%. In this regard, urban waste water is domestic wastewater or the mixture of domestic wastewater with industrial wastewater and/or run-off water, and an agglomeration is an area where the population and/or economic activities are sufficiently concentrated for urban wastewater to be collected and conducted to a treatment plant or to a focal discharge point.

The share of industrial wastewater treated on site (WAT_C11)[1] refers to the proportion of wastewater produced by industry and receiving autonomous treatment that is adequate to allow it to be discharged into the environment without impact on human health or ecosystems.

It represents the ratio of the volume of industrial wastewater treated by non-public treatment plants to the total volume of wastewater produced by industry.

The magnitude of industries in Cyprus, according to their production rate and consequently to their wastewater flow rate, is rather small to moderate, estimated[6] at 0.003-0.004 km^3/year. In the database of the Environment Service, 262 industries are listed. A large number of them are established within designated industrial areas and others are spread out all over the country. Some 41 industries are considered as being significant.

One wastewater treatment plant located in the area of Vathia Gonia of a capacity of 2200 m^3/d, treats industrial sewage transported by trucks mainly from the areas of Nicosia and Larnaka (0.0008 km^3/year). Some 62 industries dispose their wastewater to this plant. Twelve industries have their own treatment plant and dispose only their sludge to Vathia Gonia. Moreover, there is also an industrial wastewater treatment plant in the Ypsonas Industrial area at Limassol for chemical and biological treatment for different industries in the area. The sludge from this treatment Plant goes to Vati 5 km north of Limassol. This sewage plant of capacity of about 550 m^3/d of wastewater (domestic or industrial) receives 0.0002 km^3/year.

The total industrial production including the Vathia Gonia and Vati, but excluding the cooling water used by the three Power plants which is returned to the sea, is estimated to be about 0.0034km^3/year. Also the wastewater produced by animal husbandry activities is excluded (for example the wastewater from piggeries alone is estimated to be 0.0016 km^3/year). To this figure a 10% is added to cover other smaller industries with insignificant flows. Thus the total industrial production is estimated to be 0.0038km^3/year.

The industries with an autonomous treatment plant including cooling water for wine producing industries but excluding that of the Power Plants and the production of the Vathia Gonia and Vati, amounts to 0.0014 or 0.0024 km^3/year, if cooling water is included, except for the Power Plants.

Thus and although exact figures are not readily available, it is roughly estimated that WAT_C11 is of the order of 40-60%.

3. Improve efficiency in the sectors of activity using the water demand management policies

3.1 Data and indicators

Water for agriculture (irrigation water)

The total water demand for agriculture (as per indicator WAT_PO2)[1] is 0.182 km^3/year, and the water demand for agriculture compared to the GDP $0.338x10^{-9}$ km^3/US$.

The permanent crops consume 59% of the total agricultural irrigation water demand[2], whereas vegetables consume 41%. The latter are reduced in years of low rainfall and limited water supply. Of the permanent crops, 32% of the total water demand is taken up by Citrus and 11% by deciduous crops followed by Olives (5%), Table Grapes (3%), Bananas (2% and other crops (6%). Of the annual crops, open-field vegetables take up 22.5%, Potatoes 9.5% followed by Fodders (7%) and Greenhouses (2%).

Detailed information needed to calculate the Efficiency index of irrigation water use (MSSD-WAT_PO1)[1] is not readily available. Assessments suggest that the irrigation network in

Cyprus is highly efficient[15]. It generally consists of closed systems with an overall conveyance efficiency averaging 90 to 95% when newly installed. Field application efficiency averages 80 to 90%. Incentives to farmers in the form of subsidies and long-term low interest loans for the purchase and installation of improved irrigation systems together with an extensive demonstration program convinced farmers that improved irrigation methods, initially sprinklers for vegetables and the hose/basin method for tree crops, to be followed by micro-irrigation systems, not only saved water but also led to increased yields. As a result, the area irrigated by surface irrigation methods has declined from about 13400 ha in 1974 to less than 2000 by 1995 while the area equipped for micro-irrigation has increased over the same period from about 2700 ha to almost 35600 ha. There are few margins for further improvement in water application efficiency. The areas irrigated by surface irrigation methods are mostly cropped with deciduous trees and are found in the hilly areas of the country. They are usually irrigated from small springs which do not lend themselves easily to the adoption of improved irrigation techniques.

Detailed information as to the surface equipped with modern irrigation systems (indicator WAT_C04)[1] is not readily available but it is estimated[16] that currently the on farm irrigation systems comprise 90% micro-irrigation, 5% sprinkler irrigation and 5% surface irrigation.

The total unit cost for irrigation water supplied through the Government Water Works has been estimated[17] at 0.264 US$/m^3 (or 0.115 C£/m^3) for 2005. This corresponds to financial costs only since for that year environmental and resource costs were set to zero.

The Cost Recovery Rate (CRR) for irrigation supply provision by the Government Water Works (2005) has been estimated[17] to be 76.62%. This has been calculated as follows:

For each of Government irrigation project, financial costs (including capital cost, operation and maintenance costs, and administrative costs of the Water Development Department), environmental costs and resource costs were assessed, and related to irrigation supply and use. The financial unit cost associated with the provision of irrigation water has been estimated at 0.264 US$/m^3 (or 0.115 C£/m^3) for 2005, on the basis of the projected volume of sales. For the same year, environmental costs associated with water supply for irrigation from the Government Water Works was assumed to be zero. These in general constitute a minor amount of the total cost (only computed for groundwater abstractions). Resource costs allocated to irrigation water were equal to 0.071 US$/m^3 (or 0.031 C£/m^3) in 2001 and zero afterwards, given the fact that after 2001 no domestic deficit is experienced.

Considering the water demand for agriculture compared to the contribution of agriculture to the GDP of 0.338×10^{-9} km^3/US$ and the volume produced per US$ cost of irrigation water supplied by the Government works of 3.78×10^{-9} km^3/US$, on the basis of the unit cost of 0.264US$/m^3, (or 0.115 C£/m^3), it is deduced that the value added is negative and it amounts to 3.44×10^{-9} km^3/US$ which for 2005 corresponds to some 52.9 million US$ loss. The latter indicates that economic growth on the basis of irrigated agriculture is inversely proportional to the water demand for irrigation.

It should be noted that a significant amount of irrigation demand (i.e. 57% - 0.1 km^3/year) occurs[2] within the Government Irrigation Schemes. In general, some 43% of the average annual water demand for agriculture is from surface water, mainly from dams, and 57% from groundwater sources, mainly wells and boreholes. Only a very small proportion is derived from waste water.

Domestic water (including for tourism)

The total domestic water demand based on the estimations[2] for the year 2001is 0.067 km^3/year (MSSD-WAT_PO2), being 25% of the total annual water demand and analyzed into 20% for

the residents and 5% for tourists. The domestic demand is met from surface water stored in dams (22%), groundwater (23%), springs (5%) and from desalination (50%). The per capita consumption for the urban areas is 215litres/day (gross) or 180 net, and for rural areas 180 litres/day (gross) or 150 net. The calculated demand per tourist per stay night is 465 litres.

Bulk water supply provision for domestic use falls under the responsibility of the Water Development Department (WDD) of the Ministry of Agriculture, Natural Resources and the Environment. On the user level, domestic water supplies are managed by the Town Water Boards in the major metropolitan areas, by Municipal Authorities in other municipalities, and by Community Boards for village water supplies.

The Efficiency index of drinking water use (MSSD-WAT_P01)[1] varies between the major cities where the water distribution is controlled by Water Boards to that of some major towns where the municipalities manage the distribution of water and to village water supplies where the village authorities are responsible. The quoted rates[18] for unaccounted water in 2005 are 19 -28% for the main cities, 24 -46% for the Municipalities and 28 – 47% for some major villages. Thus, the efficiency index is 81 to 72%, 76 to 54%, and 72 to 53% for the main cities, the municipalities and the villages respectively (see a case study in Box).

A CASE STUDY[a] – "Limassol Water Board (LWD)"

The LWD established in 1951 is a non-profit, semi-government organization responsible for the supply of potable water at affordable prices that would provide enough revenues for its operations and projects, to the town and environs of Limassol of 150000 people.
Any increase in the water rates charged by the Board requires the approval of the Government first and then of the Parliament.
The Board maintains a comprehensive database for all its consumers, which allows quick and accurate issuing of water bills and retrieval of consumer information.
In 1985, the LWB embarked on network improvement and a major extension of the distribution system (pressure zones with adequate storage reservoir capacity). A comprehensive Supervisory Control and Data Acquisition system (SCADA) with remote terminal units installed at all sources of water, reservoir and pumping station sites with its central control room at the offices of the Water Board was commissioned in 1988.
In late 1980 the Water Board embarked on a detailed programme of leakage management. The reduction of the non-revenue water over the years is very impressive, from 25% in 1987 to about 16% in 2002.
The demand management of the LWB includes:

- promotional campaign through television, radio and leaflets to increase public awareness for water conservation;
- production and distribution of 100000 plastic water bags for use in toilet cisterns;
- hosepipe ban for washing cars, pavements, patios, etc.;
- public awareness programs to promote water conservation;
- promotional leaflets on water conservation sent with water bills.
- Application of the restriction measures on the supply of domestic water as stipulated by Government on the occasion of droughts.

The above actions resulted in an overall reduction in the use of domestic water of approximately only 15% per annum, proving that the supply of water to the domestic sector is to a large extent inelastic.

[a] C.N. Charalambous (2003): "Effective Water Utility Management" A Case study – Limassol Water Board (Conference on "Integrated Water Management, Policy Aspects 19-21 June 2003 ARI, Nicosia-Cyprus)

In 2004, bulk domestic water tariffs increased[19] from 0.768 US$/m^3 to 1.032 US$/m^3 (or 0.335 C£/m^3 to 0.45 C£/m^3) for the Water Boards of the metropolitan areas. The Water Boards follow their own billings following approval by the House of Representatives and depending on their own costs for the distribution and maintenance of the network. This price per household includes fixed and maintenance cost of 12 to 14 US $ per quarter of the year and a scaled structure depending on consumption varying from 0.22 to 0.9 US$ for the first 40 m^3 to 1 to 2.5 US$ for more than 60 m^3 per quarter.

The total unit cost of the domestic water supplied by the Government Water Works for 2005 has been estimated[19, 20] to be 1.612 US$/m3 (or 0.705C£/m3) analyzed into financial unit cost of 1.37, environmental unit cost of 0.02 and resource unit cost of 0.222 US$/m^3.

The cost recovery rate for financial costs has been estimated[19,20] to be 73.07 % in 2005. Incorporating environmental and resource costs, this percentage equals 62.07 % (or indicator WAT_C12)[1].

All the Water Boards and most of the main rural towns have their own efficiency plans for conserving water as a result of increased awareness of the problem of water shortage experienced in the last decade due to the prolonged drought (see box with a Case Study). This is reflected in the pricing structure for water consumption that is followed, the conservation campaigns and the continuous effort for renovating the water distribution systems. The same policy is followed in most of the hotels where recycled water is used for gardening and stickers placed for water saving.

Water for industry (including energy)

The broader industrial sector mainly consists of light manufacturing, mining and electricity. The industrial sector uses the lowest volume of water, compared to the agriculture, domestic and tourism sectors. It is estimated[2] that the total annual water demand of the Industry in the year 2000 did not exceed 0.0035 km^3.

The price of water for commercial-industrial establishments varies from one Water Board area to another. In Limassol the fixed and maintenance fee is 96 US$ and the first 400 m^3 per quarter of the year are charged at 0.43 US$/m^3 and 0.66/m^3 for consumption higher than 400 m^3.

There are no estimates for the efficiency index of industrial water use (MSSD-WAT_PO1) but these are expected to be of the same order as for the domestic supply as indicated above. The same applies for the marketable industrial water cost recovery rate (WAT-C12).

3.2 Retrospective analysis

The scarcity of water on the island, the high cost of new water development projects and the frequent occurrence of serious droughts led all concerned to recognize early on the value of water demand management including the reduction of demand, control of water losses and the control of user wastage.

Statistically serious droughts occur every 10 years or so and last from 1 to 3 years. An extended relatively dry spell is on-going in Cyprus since 1991. An analysis of rainfall[4] has shown that the mean island-wide rainfall has abruptly dropped by 100 mm during the 30 years of the period of 1970 to 2000 from the long-term average of 515 mm (1916-1970).

The basic objectives of the water policy as described in the Development Plans of the island for 1994 to 2006 regarding improved efficiency in water use includes[3]:

- Securing a sustainable balance between supply and demand at the least possible cost;
- Promotion of demand management through technical and pricing mechanisms and through appropriate information to the end users to keep in check increasing demands for water;
- Application of irrigation water more in line with the actual crop water requirements;
- Change of cropping patterns in favor of crops with less water requirements and to annual winter grown crops;
- Improvement of the operation, maintenance and control of the water works to ensure the optimal exploitation of the existing works;
- Reduction of losses of domestic water from distribution systems and increase of the efficiency of domestic water use;
- Emphasizing on high value crops;
- The protection of water resources from pollution, contamination, irrational use and sea intrusion;
- Application of a Good Agricultural Practice Code;
- Re-use of recycled water from sewage systems;
- Creation of a correct water conscience and application of a policy and incentives scheme for saving water;
- The promotion of the institutional, legal and administrative reorganization for the effective management of water resources, through the establishment of a single Water Entity; and
- Harmonization to the extent possible of the water policy to the corresponding existing policy of the European Union.

The objectives of the water policy have in the last 25 years shifted more towards water demand management and to the use of non-conventional water resources in view of the diminishing natural water resources remaining to be developed.

A lot of the above objectives have been accomplished to varying degrees such as: improved irrigation systems, control of the growing demand through price mechanisms, gradual replacement of distribution networks, creation of water awareness, reuse of recycled water and harmonization of legislation to the EU acquis. The water resources management is still not considered efficient since the main technical responsibility rests with the Water Development Department of the Ministry of Agriculture Resources, Natural Resources and Environment while the legal enforcement responsibility rests with the District Officers of the Ministry of Interior.

A selected number of implemented effective strategies towards improving water use efficiency in the main sectors were:

Water for agriculture:

a) Water conservation in irrigation techniques (micro-irrigation)

For the promotion of modern on-farm irrigation systems the "Improved on-Farm Irrigation Systems" Project was adopted as early as 1965. Incentives such as subsidies and long-term low interest loans towards the purchase and installation of improved irrigation systems encouraged farmers to adopt such systems. The grant amounted up to 15% of the total cost of the on farm irrigation system with the remaining given as a soft loan. Farmers were convinced in using improved irrigation systems through extensive field demonstrations.

As a result of these efforts the flood-irrigated area has declined from about 13400 ha in 1974 to just over 2000 ha in 2000 while the land equipped with micro irrigation has increased over the same period from about 2700 ha to 35600 ha.

There are few margins for further improvement in the water application technology. The 2000 ha, still irrigated by flooding are mostly cropped with deciduous trees in the hilly areas of the country. Irrigation in these areas relies on small springs and does not lend itself easily to improved irrigation techniques.

The success of this project was such that almost all irrigation water is currently applied through modern on-farm irrigation systems. The on-farm irrigation systems comprise 90% micro-irrigation, 5% sprinkler irrigation and 5% surface irrigation.

b) Water rationing

This has been extensively applied in an attempt to curtail the demand in periods of drought. With the reduction of the extent of seasonal crops and provision of only sufficient water to sustain permanent crops, irrigation demand was on certain occasions reduced to 67%. A penalty for over-consumption was enforced. A subsidy of US$225 per unit of greenhouse collecting rainwater was applied. Furthermore, funding of 20% was extended to the expenses for installation of improved irrigation systems.

The current water situation (January 2007) as a result of an exceptional dry winter to date and with the water stored in the Government reservoirs being only 22% of their capacity compared to 47% at the same time last year led to new measures. The new restrictive measures on the use of water for irrigation are implemented for 2007 (See box that follows). These could be later adjusted depending on the weather conditions of the months to follow until irrigation starts.

Restrictive measures by the Council of Ministers on the use of water for irrigation due to this year (2006) drought.

Type of crop	Demand coverage (%)		
	Paphos. Chrysokhou Irrigation Project	SCP except Kokkinochoria	Kokkinochoria*
Permanent	75	50	50
Seasonal	75	20	20
Fodder	100	100	100
Greenhouses	100	50	50
Playing fields (golf etc)	75	20	20

* until 5/6/2007 water will be provided beyond the scenario. On this date the water used will be measured. After this date the restrictive scenario will be followed. Any use beyond the approved quantities as above (+10%) will be considered as over-use and will be charged accordingly

c) Conservation of groundwater

Water conservation measures are also enforced to whole groundwater areas. An aquifer, where a serious shortage of water exists or is likely to exist, is declared by the Government to be a controlled area. In this area “special measures” for the conservation of the water resources and maintenance of water supplies are enforced and conditions are imposed periodically on every

permit for the extraction and use of groundwater. Water-meters have to be installed on every well.

All the aquifers are monitored for water-level fluctuation, quality (sea-intrusion), groundwater extraction and use. In addition, groundwater artificial recharge activities are carried out on a permanent basis in areas where there is a problem of over-extraction and where upstream dams have reduced the natural replenishment.

d) Water pricing

Irrigation water is heavily subsidized, by as much as 77 percent. The Government's policy towards agriculture is very generous and this has contributed to the selection of non-efficient cropping patterns and even to the wastage of water. The present price (2006) of the water for agriculture is US$ 0.23/m^3.

In the Waterworks Law it is specified that irrigation water fees may be limited to 40% of the average total cost of water. For non-governmental schemes, users such as Irrigation Divisions, grants for an average of 65% of the construction costs are provided. The Irrigation Divisions then set tariffs to cover O&M and the remaining capital costs. For government schemes, tariffs are currently set to cover 34% of the weighted average cost of water delivery. This translates into a tariff of US$0.23 per m^3 (or C£ 0.10/m3). These tariffs are sufficiently high for farmers to use water-conserving technologies, but nonetheless are equivalent to a considerable budgetary subsidy annually, which is the only direct subsidy to irrigated agriculture.

Although the current tariffs may be encouraging the cultivation of high water consuming crops, increase of prices to recover the full average unit costs would render the cultivation of many crops, such as citrus, unprofitable. Furthermore, expensive surface water could lead to excessive use of local groundwater supplies. This would result to saline intrusion and further degradation of the aquifer reserves and also cause larger inequities between farmers depending on government and those on non-government schemes. Raising tariffs to 38%, and higher, of the average unit cost of water, could well discourage irrigated agriculture and lead to further urbanization with all its associated social problems[3].

e) Cropping patterns

In the period of 1970 to 1985 a large number of irrigation projects (dam construction and irrigation networks) were studied and implemented. At the planning stage of each project and depending on the water supply reliability and the economics of the project as well as land resources and climatic conditions, a cropping pattern was selected and proposed to the land owners. This has ensured to a high degree a water demand management at the farm level. Nonetheless, certain crops were not profitable at the fixed water charges and farmers avoided planting such crops replacing them with higher profit but more water consuming crops (for example bananas).

f) Raising "water awareness" and educating farmers

Public awareness campaigns are promoted through advertisements, spots and articles in the media, publication of pamphlets, posters etc. Additionally, weekly half-hour television and radio programs of the Ministry of Agriculture for the farmers and spots on water conservation have proved to be very effective. The daily contents in the reservoirs are published in the daily press. Also, through the extension service of the Department of Agriculture training for the farmers on the use of irrigation water scheduling and frequency has been provided. This has resulted to an effective water demand management.

g) Reuse of treated sewage effluent

The reuse of tertiary treated effluents for irrigation purposes releases good quality water for domestic purposes. This has been practiced for quite some time for the irrigation of the amenity areas of the hotels. A very small amount of treated effluent is also used for the irrigation of sports grounds, for ground water recharge, and for the irrigation of agricultural lands for research purposes.

For the establishment of water reuse projects, the Government undertakes all the costs concerning the construction and operation of the tertiary treatment facilities and the conveyance of the treated effluent to the farms. Reuse depends upon the readiness of the farmers to accept it. A campaign to convince farmers to accept treated sewage effluent has been undertaken. Use of this extra resource is gathering momentum.

Water for domestic supply, including for tourism

a) Reduction of unaccounted water

The Water Boards of the major urban areas made serious efforts in recent years to minimize unaccounted for water. These resulted in a reduction of this percentage from around 29% to less than 20%. A telemetry based Management Information System has also been introduced that enables them to supervise the distribution system on a continuous on-line basis and to optimize the operation of the distribution system taking immediate action on suspected leaks.

Old distribution networks in major urban areas and in particular in rural areas are being gradually replaced. The Auditor General of the Republic records the discrepancy between water bought by water distributors (Water Boards, Municipalities, and Village Water Authorities) and the water sold. This is presented in the annual report to the Government with suggestions as to the extent of water and income lost.

An ingenious approach of some Water Boards directed to the individual consumer has been to include with their water bills a graphical presentation of their water consumption registered in the monitoring periods of the last year. This has been very effective in letting the consumer realize any abnormal consumption that might be due to faulty plumbing.

b) Legislative measures for water conservation ("hose ban")

The water conservation (Special Measures) Law of 1991 applied within Water Board areas, Municipalities and Village water supply areas, stipulates that any person using water through a hose for washing sidewalks or streets, verandas and vehicles is guilty of a criminal offence and could be imprisoned for up to 3 months and or be fined up to 700 US$ or both. Policemen or other licensed persons (WDD personnel) having grounds to believe that a person is committing such an offence could issue a fine (extra-judicial) of up to 35 US$ (adjusted to 70 US$ in 1998) in lieu of taking this person to court.

c) Water pricing

Water for municipal including industrial, commercial and tourist purposes is sold at full cost. It should be noted that in the last seven years the water tariff for the domestic sector does not reflect the full cost as formed with the recent introduction of the comparatively expensive desalinated water. This in effect constitutes a subsidy of as high as 34 %. The present price (2006) of the water to the domestic sector is US$ 1.03/m^3 (C£0.45 /m^3).

The water tariff structure imposed by the Water Boards for all major urban areas is made of two parts: a fixed charge and a volumetric charge. Tariff rates are progressive; e.g. the

volumetric charge increases as consumption increases. This progressively promotes water conservation.

Metering at individual household level is universal in Cyprus.

Rural water supply is partially subsidized for capital expenditures to a degree varying according to the population and other factors, varying from 83% for communities with less than 100 people, to 50-75% for more.

d) Incentives for the use of marginal water for gardening and other purposes

The encouragement through subsidies for the use of lower grade water for non-potable needs has been quite successful (e.g. subsidy for the drilling of wells within urban aquifers of marginal water quality for garden watering and other household uses, connection of low grade water sources to WCs and for the installation of systems for recycling "grey" water).

It is estimated[12] that the domestic water that is saved every year from the connected private wells to lavatories since 1997 is 0.002 km^3. The annual water saved from the treatment and reuse of "grey" water since 1999 is 0.001 km^3.

The subsidies scheme for using lower grade water is shown below (see box):

Subsidies for water conservation

a) Well drilling for garden irrigation (670 US$)
Subsidy for well drilling for home gardens for households connected to the water distribution networks of all municipalities and villages (subject to well permit and inspection of site after permit and before drilling).

b) Connection of well with lavatories (200 to 700 US$ depending on the number of households connected)
The subsidy covers connection of wells with home lavatories, schools, offices, shops, institutes etc connected with distribution networks of all municipalities and villages for the purpose of conserving drinking water (estimated up to 28%) that is used for lavatories (subject to application , inspection and provision of technical advise by WDD)

c) Installation of a system for the recycling of grey water (1375 US$ for each homestead and 60% of the cost for the installation of such a system for the rest of the cases.)
The subsidy covers installation of a system for the treatment of grey water and its reuse in lavatories and garden irrigation of a household, school, playing grounds, swimming pools, gyms, hotels, industries etc., connected with distribution networks of all municipalities and villages. Grey water is the water that comes from bathtubs, shower, wash-basins, cloth-washing machines, water from vegetable and fruit washing. The saving of water is expected to be about 33% (subject to application, inspection and provision of technical advice by WDD)

e) Water rationing

On the occasion of drought, very frequent in the last 20 years, water rationing measures were implemented such that water was supplied to households for as little as two or three days per week and this for only a few hours each time. Enforced interrupted supply allowed the reduction of water supplied for domestic purposes by as much as 20% of the normal demand. This measure has not been applied in the recent years after the operation of the second desalination plant.

f) Raising "water awareness" and educating consumers

The continued campaign through schools (classes, competitions, handouts, etc.), the media (television and radio), posters, letter franking, stickers etc., encourages water saving by the consumers. During 2005 Officers of the Water Development Department provided lectures to 26 public elementary schools. Water saving information documents was distributed to elementary and high schools, Municipalities and Communities.

Water for industry, including energy (industries not served separately)

As mentioned earlier, the industrial sector uses the lowest volume of water of all economic sectors. No particular effort regarding water demand management has been made towards this sector except those applying for the domestic sector.

Main obstacles encountered for better efficiency in water management are:

- Fragmentation of responsibility in water management (technical matters versus legal and management responsibilities). Need for the establishment of a single authority for water management;

- Lack of an umbrella law covering water. Legislation on water has evolved on an ad hoc basis resulting to numerous, complex, often duplicated statutory water laws with divided authority. Recent laws harmonizing with the EU legislation is improving the situation.

- Relaxed supervision and control, light penalties, issuing of covering permits and interference in the process by non-technical lobbies has caused a large number of illegal drilling of wells.

- The water pricing; a uniform rate is charged for all government schemes. Bulk drinking water tariffs are reviewed periodically in order to recover full operating costs, depreciation, working capital and debt servicing in excess of depreciation. Changes to water tariffs by the Water Boards, Municipalities and Village communities, especially uniform domestic water tariffs, are difficult since these depend on local cost structures. Although current tariffs may encourage cultivation of high water consuming crops, increasing the tariffs would make many crops unprofitable. Furthermore as surface water becomes more expensive, it could lead to excessive use of local groundwater and result to further degradation of the aquifers. Parliament is reluctant to raise tariffs of irrigation water for political and economic reasons since this might discourage irrigated agriculture and lead to further urbanization with all its associated social problems.

3.3 Prospective analysis

In the Water Development Plan that has been worked out[21] for the period until 2015, among other items, a systematic effort is to be made for the reduction of water demand by the implementation and extend of subsidy for measures for water saving, and the development of water awareness for the proper use of water. Additionally, the implementation of the Water Framework Directive constitutes an integral part of the Government's policy. The aim of this Directive is the maintenance, improvement and securing the good status of waters by 2015 and the development of a River Basin Management Plan for this purpose.

Recent studies [2, 7] point out the need for reallocation of the water resources within the various sectors considering that agriculture uses the greatest part whereas its GNP contribution is very

low. Cropping patterns need to be changed to high yielding crops and least water consuming. Water subsidies for both agriculture and domestic use should be phased out to promote water economy by the consumers. Conveyance and distribution losses in irrigation and domestic networks need to be further reduced and water use efficiency to be further improved. The water awareness campaign should continue at various levels. Consideration should be made about charging groundwater, spring water and river diversions for spade irrigation. Increase of the use of the treated sewage effluent for agricultural purposes should be implemented.

Water charges when wisely applied, encourage profitable and efficient use of water and discourage wasteful use. Currently, the water charges are flat for all the crops for normal water demand while excess use of water is charged at full cost which is three to four times the subsidized charge. The pricing mechanism for water is very important within water demand management and should be integral to the water policy.

The WFD article 9 stipulates that account of the principle of cost recovery of water services, including environmental and resource costs, in accordance with the economic analysis and the polluter pays principle should be taken. Member states need to ensure by 2010 that a) water-pricing policies provide adequate incentives for users to use water resources efficiently, and b) adequate contribution of the different water uses, disaggregated, at least, into industry, households and agriculture, to the recovery of the costs of water services, based on the economic analysis.

The cost recovery of water services (domestic water) after the tariff increase of 2004 has been assessed[7] to reach approximately 73% in 2005. Currently, tariffs for irrigation freshwater are differentiated on a local basis. Since 2004, a gradual increase of tariffs is being implemented. These are expected to reach the uniform charge of 0.25 US$/m^3 (or 0.11 C£/m^3) for all Government Water Works by 2007. The first effects of this reform are evident, since recovery of financial costs has much improved and expected to have reached 77% in 2005.

Considering the various indicators as described in this report and the Plan Bleu's baseline and alternative scenarios[22], a measure of the "pool of savings" possible by better water demand management on current and forecasted water requirements is put forward for the main sectors:

Water for Agriculture:

On the basis of Plan Bleu's alternative scenario[22] for transport losses brought to 10% and of efficiency of irrigation brought to 80% the savings that could be expected in this sector are nil since the irrigation network in Cyprus is highly efficient[15]. It generally consists of closed systems with an overall conveyance efficiency averaging 90-95 % when the systems are newly established. Research may be needed to establish the efficiency of such systems after being in operation for specified time periods. Field application efficiency averages 80-90%.

There are few margins for further improvements in water application efficiency in the hilly areas of the country. These areas, still irrigated by surface irrigation methods, are mostly cropped with deciduous trees with water from small springs which do not lend themselves easily to the adoption of improved irrigation techniques. Thus, there are little margins for further savings.

The forecast for the agricultural sector is that it is declining, in spite of the recent stabilizing trends. However, the most probable assumption is that the agricultural sector, as a whole, will continue to exhibit a stabilizing trend as the one observed in the past few years. The total water demand for agriculture is currently 0.182 km^3/yr and no significant changes are expected[23] up to 2015.

The total water supplied for irrigation from all sources[20] for the Major Government Irrigation Schemes was considerably smaller than the water demand, reaching a 46 % shortage in 2000. Recycled water could cover some of the needs in agriculture and save precious freshwater for domestic purposes. At present about 0.003 km^3/yr of treated sewage effluent is used for agriculture and landscape irrigation. It is estimated that by the year 2012 approximately 0.040 km^3/yr of recycled water will be available for agriculture and landscape irrigation. Efforts and demonstrations should be made for farmer acceptance and effective use of this new source of water.

Domestic water and for tourism

On the basis of Plan Bleu's alternative scenario[22] for losses in the domestic water sector brought to 15% and leakage by users brought to 10%, the savings that could be expected both for the current estimated losses and on the forecasted demand are as follows:

The quoted rates[18] for unaccounted water in 2005 are 19 -28% for the main cities, 24 -46% for the Municipalities and 28 – 47% for some major villages. Thus, the efficiency index of drinking water use (MSSD-WAT_P01)[1] is 81 to 72%, 76 to 54%, and 72 to 53% for the main cities, the municipalities and the villages respectively.

At an assumed population annual average growth rate of approximately 2.0 % and an overall positive trend of tourism growth, the water demand for urban and tourism uses is expected[2,21] to increase significantly from 0.067 km^3/yr in 2000 to 0.083 by 2010 and 0.100 km^3/yr by 2020.

Reducing these losses to 15%, the overall savings on the current demand of 0.067 km^3/yr could be in the range of 0.004 to 0.012 km^3/yr. The savings increase to 0.006 to 0.018 km^3/yr for the projected demand of 0.100 km^3/yr by 2020.

Savings could also be materialized by the continued policy of subsidizing the installation of reuse systems of grey water in lavatories and the irrigation of gardens of houses. It is estimated[23] that currently an amount of 0.0004 km^3/yr of potable water is conserved from the recycling systems installed (2003 Annual Report of the WDD[12]).

Industrial water

In general, and in spite of temporary fluctuations, the industrial sector seems[23] to follow a stabilising trend, both in terms of employment, as well as in terms of economic output. The total annual water demand of the industrial sector may increase[23] from 0.004 in 2005 to 0.005 by the year 2010 and 0.007 km^3/yr by the year 2020.

By applying the same rates of current losses as for the domestic supply, the savings that could accrue if these losses are reduced to 15% would amount to 0.0002 to 0.0005 km^3/yr for current use to 0.0003 to 0.001 km^3/yr by 2020.

4. Towards integrated policies for water resources and demand management

4.1 Taking into account of the environmental objectives in water policies

a) Water policies and the environment

A major forward water resources strategic planning was carried out on a large scale in the mid-1960s. The national water plan prepared at that time, being project oriented, provided a guide for projects development over the next 25 years. These activities have proved effective in expanding the needed infrastructure and in developing strong technical capability and extensive monitoring and data collection programs[24]. The entire infrastructure was planned, designed and implemented at a time that environmental concerns were not as prominent as at present, the main goal being at the time to increase the availability of supply and reduce the loss to the sea to the minimum. As a result many environmental problems have been created especially to downstream aquifers, ecosystems and users.

Most of the environmental problems on the water resources of the island are largely attributable to a considerable extent to these past macroeconomic policies. Water resources development policies in this period overlooked environmental considerations, and were characterized by protectionism on agricultural produce, distorted resource valuation and insufficient control, thereby discouraging "environmentally friendly" behaviour on water resources by farmers, developers and public water utility agencies[24].

The main environmental problems which are mainly associated with the water resources management are: sea intrusion into the coastal aquifers mainly caused by over-abstraction and occasionally by the reduction of natural recharge having been cut off by major surface reservoirs; the deterioration of the groundwater quality of aquifers downstream major surface reservoirs due to the reduction of the flashing effect of recharge; and the built up of nitrates[25] due to increased agricultural activities as a result of increased surface water availability for irrigation from surface reservoirs. Groundwater pumping from areas controlled by upstream reservoirs continued to be at the same level as before the construction of the dams due to the water pricing policy which charged surface water provided from the dams but not groundwater developed by farmers. This has added to the environmental problems such as reduction of ground water levels affecting in certain areas natural marsh areas and aggravated sea intrusion further.

Changes in policies strengthening and taking into account environmental objectives in water policies were formulated as early as 1991 with the enactment of the law on the Control of Water Pollution (Law of 69/1991). In general the environmental policy in Cyprus has been substantially revised as a result of the process of harmonization and with the accession to the European Union[26]. A large number of environmental laws and regulations formulate today the new policy.

The Ministry of Agriculture, Natural Resources and Environment through the Water Development Department and the Environment Service is gradually implementing the EU Water Framework Directive which will strive to maintain the good status of waters and improve those bodies of water that have shown indications of deterioration. Nonetheless and although the commitment and interest to improving environmental management is currently strong, the institutional framework is, as yet, fragmented and weak.

b) The ecosystems' water requirements

The ecosystem's water requirements have been measured and the ecological pressures acting on them have been considered and are integrated within the new policy that is being formulated under the Water Framework Directive implementation.

The overall environmental demand has been estimated[2] to 0.019 km^3/year made up of 0.014 km^3/year for landscape irrigated areas and 0.005 for natural ecological areas. Some 0.005 km^3/year of the landscape demand is covered from the domestic demand and 0.001 from tertiary treated wastewater. Thus the actual additional water needed for the environment is estimated to be 0.0125 km^3/year made up of 0.0075 km^3/year for landscape (groundwater) and 0.005 for ecological areas.

Landscape irrigation exists within the main towns and is covered from municipal water, groundwater and treated sewage effluent and is made up of household and hotel gardens, municipal parks and playgrounds. Subsidized drilling within the towns has helped in meeting this demand from local marginal groundwater. Hotels and major playgrounds use recycled water.

Ecological water demand other than that covered by rainfall is required in special ecological areas which include the flora and fauna of riverbeds, lakes and marshes. Besides the main rivers, important ecological areas are the Lemesos and Larnaka lakes and marshes.

The study[7] for Articles 5 & 6 of the Water Framework Directive (WFD) for the Republic of Cyprus identified only 5 natural lakes, which are all brackish or salt lakes as a result of the dry Mediterranean climate of the island. These are of a high ecological value. The natural salt and brackish lakes dry up regularly, but not every year. Both the salt and brackish lakes contain typical species for these conditions.

The main natural lakes are the salt and brackish water bodies of Akrotiri and Larnaka. The lakes of Larnaka are monitored and better studied. Data on Akrotiri are summarised in the WDD' s "Environmental study of the Akrotiri Salt Lake and wetlands and assessment of the environmental impacts of the proposed water development works in Limnatis, Dhiarizos and Ezousas watersheds" (1992). All the lakes lie within proposed Natura2000 sites but they all suffer from human pressure.

The Akrotiri and Fasouri marshes ecosystem depends directly on the Akrotiri groundwater body. There are no areas designated for the protection of economically significant species. All other lakes are created by human as a result of damming of a river or the creation of storage basins.

c) Instruments in water policies for ecosystems

Identifying these water bodies under the WFD presumes taking them into account within the River Basin Water Management Plan for protecting, maintaining and or improving their quality to keep them in "good" status.

The instruments that will be implemented within the water policy to ensure the safekeeping of the resources as well as the good ecological state of the ecosystems are part of the measures to be taken within the River Basin Management Plan that is currently being developed, the draft of which is expected by the end of 2008 and start being implemented by 2009. This will be the result of the ongoing studies and the quantitative, surveillance and operational monitoring that has been designed and is to start within 2007.

The success of the implementation of the River basin Management Plan will depend on the political will and commitment of the government, the support of sustainability issues by all political parties, the involvement and participation of local authorities and stakeholders and NGOs and the realization by the private sector that there is no inherent contradiction between economic development and the protection of the environment in general.

4.2 Taking into account of water demand management in the water policies

Past changes in water demand

The competitive tension between agriculture, urban growth including tourism, and the environment is becoming quite apparent and more so during periods of drought[27]. This competitive pressure on the limited water resources of the island, and the conflicting use of it, calls for a significant reallocation of this valuable resource.

The developed large irrigation demand has basically been the result of the large irrigation projects constructed in the island. The built water infrastructure (large surface reservoirs and irrigation projects) has been the result of master-plans, extensive and comprehensive feasibility studies and sound workmanship. These structures needed to achieve a sufficiently high internal rate of return to have a sound project for finance. This was accomplished by including new lands for irrigation, creating thus a water demand that did not exist before. Political lobbying and pressure from local farmers resulted also to including larger areas under the commanded area of each project. To this, one should also add the changed cropping pattern, from the one envisaged at the planning stage, such as high water demanding bananas rather than table-grapes. These adjustments and non-technical allowances are not uncommon for development works but this policy should have been more prudent in view of the arid to semi – arid nature of the climate of the island. The results of this expansion of irrigation become more pronounced on the occasion of droughts.

At the same time the successful policy of the Government for establishing Cyprus as a quality tourist destination has developed a significant water demand for this very important economic sector of activity.

Currently the total water demand is 0.266 km^3/year made up of 0.182 km^3/year for agriculture, 0.067 km^3/year for domestic and tourism, 0.0035 km^3/year for industry and 0.0125 km^3/year for the environment.

Trends for water demand with possible consequences

The forecast for the agricultural sector is that it is declining, in spite of the recent stabilizing trends. The current demand for agriculture of 0.182 km^3/yr is expected to continue without significant changes up to 2015. The water demand for urban and tourism uses is expected[2, 21] to increase significantly from 0.067 km^3/yr in 2000 to 0.083 by 2010 and 0.100 km^3/yr by 2020. The industrial sector seems[23] to follow a stabilizing trend, both in terms of employment, as well as in terms of economic output but it may increase from 0.004 in 2005 to 0.005 by the year 2010 and 0.007 km^3/yr by the year 2020. Thus the total water demand by 2020 may increase by 13%. Meeting this demand will put an extra stress on the water resources or on the economy if further desalination is put into stream.

The surface water resources have already all been practically developed. Of all possible dams that engineering can construct in Cyprus, a large list taken from the more attractive opportunities has already been implemented. More dams are possible but carry a high price tag: the cost of water from new sources is higher than the cost of water that has already been developed.

The groundwater resources are all over-pumped[28] and the coastal aquifers exhibit sea intrusion something that causes them to have been characterized as at being "at risk" under the WFD definition[7] and will need to be managed in such a way so as to achieve good quantitative status and good water quality.

Overall range of possible savings

The overall range of possible savings on the current and future demand by reference to the hypotheses proposed by Plan Bleu is as follows:

The quoted water efficiency indexes WAT_PO1 for domestic water averages to 76% for the cities and 64% for some major municipalities and the villages. Bringing this index to 85% by reference to the hypotheses proposed by Plan Bleu, the possible savings in water through this measure are expected to be of the order of 0.004 to 0.012 km^3/yr on the current demand of 0.067 km^3/yr increasing to 0.006 to 0.018 km^3/yr for the projected demand of 0.100 km^3/yr by 2020.

For the irrigation water the water efficiency index is already quite high. It generally consists of closed systems with an overall conveyance efficiency averaging 90-95 % and the field application efficiency averages 80-90%. Thus, with the present technology no significant additional savings could be expected.

Evolution of water policies

It can be said[3] that Cyprus is now entering a third era of water policy: The first having been for water development and which prevailed through the period of 1960 to 1990; the second being water conservation, which prevailed from the 1970s onwards; and the third being water reallocation, the wave of the future. The sustainability of water resources and the maintenance of their "good quality status" is also becoming of significant importance in view of the need for the successful implementation of the Water Framework Directive.

The water resource development in Cyprus initially focused on groundwater because of the high cost of surface water development. However, depletion of key aquifers, together with rising overall demand necessitated a revision of this strategy. With independence in 1960, the slogan, "not a drop of water to the sea", determined the water policy of the Government.

In the 1960s the island's water resources were comprehensively surveyed paving the way for implementation of five major development projects. These projects, comprising ten dams and using a number of local aquifers, provided 0.17 km^3 of water. Present storage capacity in Cyprus is just over 0.300 km^3. Schemes toward the replenishment and protection of groundwater resources were also worked out and piped water to all towns and villages for domestic and industrial uses was provided.

The basic objectives of Cyprus's present water policy are to secure a sustainable balance between supply and demand at the least possible cost; to keep in check increasing demands for water by appropriate pricing mechanisms and information being passed onto the end users; to apply irrigation water in line with the actual crops water requirements; to modify, as much as possible, cropping patterns in favour of crops with lower water requirements or annual winter grown crops; to reduce losses from the urban water distribution systems and to increase the efficiency of domestic water use, and to emphasize high value crops.

In 1995 the World Bank conducted[29] the "Cyprus Water Planning and Management Strategy study" instigated by the critical situation of water availability in the island resulting from a series of dry years in the early 1990s. Recommendations from this study constitute a platform

for the developments in water planning and management and were reflected in the Development Plan of 1999 to 2003.

This Development Plan includes construction of major and secondary water works (mobilization of the water resources of the northern part of the Troodos Mountains that could yield 0.018 km^3/yr); improve operation, maintenance and control of water works to ensure their optimal exploitation; endeavor on the reuse of treated effluent; suppress evaporation from reservoirs; improve domestic supply securing 180 and 135 litres/cap/day for the urban and village population respectively; to remove dependency on the weather conditions through using non-conventional sources; to promote demand management through technical and pricing mechanisms; to promote institutional reorganization; protect water resources from pollution and to harmonize with EU's water policy.

Setting a price mechanism for groundwater will promote equity between the utilization of surface water from irrigation projects which has a charge, to that of private tapping of aquifers, promoting thus a reduction of overexploitation of groundwater.

Overall or local cost-effective studies

Water Banking[30] has been studied in 1999 and was suggested as a water management strategy option facilitating voluntary temporary reallocation of water from farmers to domestic water users and tourism. This would constitute an emergency drought water bank encouraging farmers to exchange for compensation their irrigation water to be allocated to cities and tourism that are in need. This will allow critical and high-value water demands to be met by sectors that add significant value to the economy in contrast to irrigating farming, but large water demanding, that makes a smaller contribution to the economy, without the need for construction of additional capital intensive infrastructure (desalination plants).

Farmers have invested heavily in farming, and so even if Government legally retains all water rights, it is not politically feasible to unilaterally reallocate water away from agriculture. A Water Bank will seek the cooperation of farmers willing to take cash in lieu of irrigation water. The price to be paid to farmers will be set based on the quantity of water required for reallocation and the profit that the farmer would normally have expected from his produce. In years when reservoir storage is ample and irrigation water available, farmers may put their fields back into production.

The study showed as a case study, a 13% increase in the reliability of the major Southern Conveyor Project water supply system (0.176 km^3 total capacity of all dams included) when considering its capacity to meet the full domestic demand of 1999.

The Regulation of the Market for Irrigation Water in Cyprus –Facts, Policies and Options has been studied[31] in 2001 on the request of the Department of Agriculture providing expert advice and consultation in the area of pricing of irrigation water supplied by government works only, and the subsidy involved.

The basic recommendations are: a study for the possible selective bias of current water pricing in connection to farmers using ground water; a more aggregate way of calculating the cost of domestic water to be worked out including the scarcity of the resource; application of the Balance Budget Method for the irrigation water costing as for the domestic water; use of one cost for all waterworks in the island; the cost of the persistent under-utilization of the reservoirs not to be charged only on the farmer; to work out as a pilot study the new costs for domestic and for irrigation water as suggested for 1995 and 2005; increase of the price of irrigation water by 35% to reach US$ 0.20/m^3, a price which may still be deemed by the EU that it contains subsidy, something that will need to be supported; announce the raise in price together with a raise in price of domestic water and the set up of a Water Entity; rationing of

water on the occasion of drought to continue on the basis of existing criteria associated with auction for the remaining available quantities of water to the users; a Drought Contingency Plan to be incorporated in the legislation; increase of the irrigation water price by 35% may not be considered sufficient to cover the full economic cost on the long run as preferred by the WFD unless local conditions can allow for this; an annual publication "Water in Cyprus" is suggested which would include time series data on demand, supply, cost and prices for all sources of water; this publication to be discussed annually by the House of Representatives at a specified date.

Other recent studies (2004) regarding the overall cost for irrigation water[17], domestic water[19] and recycled water[32] as well as cost effectiveness analysis[11] and economic analysis of water uses[20] have been carried out within the study for the implementation of Articles 5 and 6 of the Water Framework Directive in the island. These studies provide the calculated cost of surface water provided from Government Works for irrigation water and for domestic supply together with the cost recovery rates for the same.

The total unit cost for bulk domestic water supplied by the Government through the Government Water Works in 2005 has been estimated[19] at 1.6 US$/m^3. This corresponds to 1.37 US$/m^3 for financial cost, 0.22 for resource cost. The environmental cost has been estimated to be 0.21 US$/m^3. The total unit cost for irrigation water provision has been estimated at 0.26 US$/m^3, corresponding to financial costs only. The financial unit cost associated with the provision of recycled water has been estimated at 0.60 US$/m^3 in 2005, being approximately equal to the average financial unit cost for the period 2001-2005.

The Cost Recovery Rate (CRR) for irrigation supply provision by the Government Water Works (2005) has been estimated[17] to be 76.6% and for domestic supply 73.1 %, and 62.1 % if environmental and resource costs are incorporated. For recycled water the recovery of financial costs in 2005 was low, reaching 15.4% due to the reduction of tariffs in 2004 (to 0.09 US$/m^3). The studies indicate that for recycle water pricing policies should be disconnected from its financial cost as an incentive to promote its use and improve social acceptance. Currently, the main aim of the Government policy is to promote the use of recycled water in an effort to conserve freshwater resources where and when this is possible.

The reports[11] also suggest that a study on affordability issues, complemented with estimates on price elasticity and demand curves is conducted. This will be particularly useful when judging the economic implications of measures, in order to identify measures with disproportionate costs.

Prominent place among the list of supplementary measures to be considered within the River Management Plans required under Article 11 of the WFD are: legislative and administrative instruments; economic or fiscal instruments; codes of good practice; abstraction controls; demand management measures (inter alia, promotion of adapted agricultural production such as low water requiring crops in areas affected by drought); efficiency and reuse measures (inter alia, promotion of water-efficient technologies in industry and water-saving irrigation techniques), and educational projects.

Main economic and financial indicators related to water demand management

The public expenditure and investment devoted purely to water demand management as indicated in the Development Expenditure budget of the Water Development Department for 2006 of US$ 37.8 million was US$ 0.28 million or 0.7%. This amount was devoted to the subsidies for drilling of private wells for non-potable uses, installation of household treatment plants for "grey" water, connection of private wells to lavatories and for the water saving campaign.

If on the above, the expenditure for training of staff on integrated water management, implementation of the WFD and participation to EU programs on sustainable water resources management (US$ 0.48 million) is added, then the percentage devoted to WDM becomes 2%.

Furthermore, if the expenditure for improving Village Water supply systems (US$ 9.2 million) and the expenditure for development and exploitation of treated effluent (US$1.4 million) are considered and added to the above, then the percentage devoted to WDM becomes 30%.

The collection on costs derived from the revenue from treated effluent sales represents 0.6% of the total revenue. If on this, the revenue from regional village water supply is added then the total revenue becomes 9.2%.

Integration of water demand management in the programmes of the Higher Level training and Research establishments

Efforts should be made to integrate water demand management in the programmes of the University of Cyprus and other private Institutions of higher level. The Agricultural Research Institute a Department of the Ministry of Agriculture, Natural Resources and Environment, conducts applied and basic research, with the objective to increase yield and improve quality of agricultural production by methods that are environmentally and socially acceptable. Among its interests is the "water use and environment" and has been involved in research of developing methods for efficient and effective use of water and fertilizers and for the safe use of treated domestic waste for irrigation. These activities could continue and expand to include other aspects of water demand management especially for agriculture.

Possible actions to reach Water Demand Management objectives

The possible actions in an order of priority to reach the objectives set or proposed in terms of water demand management are as follows:

a) Control of leakages

The efficiency index WAT_PO1 for domestic water averages to 76% for the cities and 64% for some major municipalities and the villages. Bringing this index to 85% is generally considered as economical. Further control leakage may be uneconomic due to diminishing marginal benefits. The possible savings in water through this measure are expected to be of the order of 0.004 to 0.012 km^3/yr on the current demand of 0.067 km^3/yr increasing to 0.006 to 0.018 km^3/yr for the projected demand of 0.100 km^3/yr by 2020.

b) Increase of Water Prices

The "water pricing" is an important component of the integrated water resources management process. It is the most effective tool of "demand management" as the price of water approaches its full cost. The highly subsidized irrigation water which accounts for nearly 70% of the water consumed while the sector's contribution to the gross domestic product is less than 4%, needs to be checked. Thus, a review of the prevailing water allocation and pricing policies should constitute a good response to demand management in the effort to make the demand meet the supply available. In the same context, the impact of uniform water pricing per sector as compared to differentiated pricing among different regions and/or different uses needs to be evaluated.

According to the WFD, the irrigation water tariff needs to be increased to "adequate" cost recovery. However, this target will be very difficult as a result of social, environmental and

economic effects of full cost recovery. Water policy for the agricultural sector may consider a number of incentives and disincentives to conciliate water availability with demand and to ensure that adequate food production and rural targets are achieved in exchange for the substantial subsidy the sector is receiving. The matter is complicated by the traditional two-tiered nature of water rights: users of government owned water systems pay the established tariff, while owners of "old" water rights and wells do not pay. Under such circumstances, an increase in water tariffs in the public systems is bound to encourage further overexploitation and mismanagement of groundwater. Realizing a policy of uniform water rates over the island remains a difficult problem.

Pricing largely controls typical household water consumption. At the present per capita consumption rates demand may still be elastic. For lower demands it starts to become inelastic to prices. Agriculture users are expected to be far more elastic than domestic users.

For domestic water, the cost recovery rate for financial costs has been estimated[19, 20] to be 73.1 % in 2005. Incorporating environmental and resource costs, this percentage equals 62.1 % (or indicator WAT_C12). The Cost Recovery Rate (CRR) for irrigation supply provision by the Government Water Works (2005) has been estimated[17] to be 76.6%. These suggest room for price increase closer to the marginal costs which would control to some extent the demand.

c) Reduce Demand per Capita through conservation education

Water conservation campaigns are an ongoing practice which become intensive in years of drought and slacken decisively in years of plenty. People need to be educated with respect to the results of wasteful consumption habits and at the same time be made to understand of the existing water supply systems and the water resources of the country. The true value of water needs to be realized by the average citizen. The effective ongoing campaign of 'Save Water, It is precious" should also be taken to schools in a more formal way.

d) Reduce total area of irrigated crops

Reduction of irrigated crops will directly reduce irrigation water demand. This is practiced during periods of drought when water usage to farmers is restricted something that forces the farmer to reduce the area of irrigated land. This practice should be extended beyond the years of apparent drought since water scarcity is not a seasonal or occasional phenomenon but rather something more endemic in the arid to semi-arid climate of the island.

e) Change crop planting patterns to more efficient crops

Crops that have a higher financial yield per unit of water should be selected, water being the scarce resource. For example the case of the crop of "Colocasia esculanta– or Jerusalem potato" is a high value crop that uses significant amount of water. It has a very high financial yield per unit of land but very low per unit of water. The current cropping patterns should be reviewed and water intensive crops and summer vegetables should be substituted with less water demanding crops such as flowers, aromatic plants and winter crops which rely more on rainfall. Reallocation of water to more "efficient" crops is needed.

f) Improve Irrigation Efficiency

Irrigation efficiency is already high due to the wide use of drip irrigation and mini-sprinklers. Not much increase in efficiency may be expected.

g) Limit water uses

The water conservation (Special Measures) Law of 1991 applied within Water Board, Municipalities and Village water supply areas that limit wasteful water use, such as through a hose, for washing sidewalks or streets, verandas and vehicles should be more vigorously enforced. This could be extended to other wasteful uses of water such as grass lawns, swimming pools etc.

h) Use of marginal water for certain uses

Expansion on the use of treated effluent for irrigation and the subsidized installation of treatment facility and reuse of 'grey" water for household uses as well as the subsidized drilling of wells within urban areas for gardening and toilet flashing should be further pursued.

5. Taking into account of water demand management in the cooperation and development aid policies

Cyprus through the Water Development Department participates in a number of regional cooperation initiatives and programs that could assist in water demand management activities. The role of these cooperation and development aid programmes and initiatives to date remain at the level of information and knowledge exchange and to the training through participation in seminars and workshops of Officers of the Department.

Such program is the EMWIS (Euro-Mediterranean Information System on the know-how in the Water sector). EMWIS is an information and knowledge exchange tool between the Euro- Mediterranean partnership countries, necessary for the implementation of the Action Plan defined at the Euro Mediterranean Ministerial Conference on Local Water Management, (Turin, 1999).

The Euro-Mediterranean regional water programme for local water management (so called MEDA-Water), aims at the enhancement of regional cooperation in the areas of sustainable and integrated management of water resources. The MEDA programme is the principal financial instrument of the European Union for the implementation of the Euro-Mediterranean Partnership. The programme offers technical and financial support measures to accompany the reform of economic and social structures in the Mediterranean partners. The programme may apply to States, their local and regional authorities as well as actors of their civil society.

The Meda –Water areas of action include: integrated management of local drinking water supply, sanitation and sewage; local water resources and water demand management (quantity and quality) within catchment areas and islands; prevention and mitigation of the negative effects of drought and equitable management of water scarcity; irrigation water management; use of non-conventional water resources; preparation of national and local scenarios for the period until 2025 that enable precise objectives to be set and actions to be taken for sustainable water management.

Very little advantage has been taken so far of the funding possibilities and know-how exchange that these programs may provide. The WDD is active in a number of EU programs such as: the Institutional and Economic Instruments for Sustainable Water Management in the Mediterranean Region (INECO); the Development of Tools, Methods and Practices for the Sustainable Reuse of Treated Urban Wastewater (DEMETRA), and active interest in AquaStress an EU funded integrated project delivering interdisciplinary methodologies to mitigate water stress problems, and many other.

Considering the water scarcity problems facing the country and the relative small budget allocation for water demand management activities, proposals for strengthening the contribution of the cooperation and development aid policies for water demand management should be worked out.

Pilot projects demonstrating the viability of water demand management and efficiency policies and promoting a greater emphasis on water demand management and conservation within the framework of integrated water resources management would be useful. Pilot projects promoting simple water-saving devices (how such devices work, where to purchase them, how to install them and what they cost and of course how much water they save) would also be very applicable in the WDM efforts. At the same time regulatory authority over use of water and the installation of water-saving fixtures through construction codes, customs regulations and environmental issues, needs to be promoted.

Other projects that could have an impact on WDM efforts would be: a review of water demand and pollution control experience across the region and identification and examination of replicable strategies and techniques; and, a review of effective water saving and water conservation awareness campaigns and adaptation to local socio-economic and cultural conditions.

Admittedly, the water demand management sector shows a very poor attraction of international private capital. Public development assistance for water demand management should play a more significant role not only as a technical advisor but as a donor as well, by providing sufficient incentives to users to use low water consumption techniques and fixtures. Although, there is much interest and preoccupation of the public sector for water demand management, the public development assistance devoted to water and the proportion of this aid dedicated to programs of WDM (WAT_C14)[1] is very low.

The implementation of the E.U. WFD calls for measures to be taken for water management to maintain the good status of waters. Water demand management is one of the tools that can be used on this direction. Implementation of this Directive will develop a new impetus to WDM policies.

6. Overview and conclusion

Recapitulative summary

Cyprus with a semi arid climate has always been confronted with the problem of inadequate water both for its domestic and its irrigation needs. At present, and after most of the water resources of the island have been developed, the problem still persists. There is no one cause of water scarcity in Cyprus. A number of geographic, climatic, economic, and political factors all combine to exacerbate the water problems. Innovative strategies are needed to enable the continued growth and prosperity of Cyprus in the face of limited water resources and frequent drought.

Of all possible dams that engineering can construct in Cyprus, a large list taken from the more attractive opportunities has already been implemented. More dams are possible but carry a high price tag: the cost of water from new sources is higher than the cost of water that has already been developed.

The Regulation Index (average flow of water resources controlled compared to natural irregular flow) has been calculated as being 69.7%. This indicator measures the efforts made

and the extensive control of water resources by the construction of dams, i.e. the annual security of supply.

Two desalination plants are presently in operation producing 0.031km^3/year. A substantial amount of recycled water is reused and has become available for agriculture and the urban and rural environment. It is estimated that by the year 2012 an amount of approximately 0.03 km^3 of treated sewage effluent will be available for use.

Agriculture is the main user with 69% of the total water use. Domestic supply accounts for 25% analysed into 20% for the residents and 5% for tourists. Industry consumes 1%, and 5% is considered to be used for environmental reasons such as landscape irrigation and protection of special ecological areas.

The Exploitation index of renewable natural resources is 42%. As this is based on the maximum potential water resources "offered by nature" on average, and since only a part of these (about 0.70) are exploitable because of various technical-economic and environmental constraints, this indicator is estimated to be about 60% .

The most common water quality problem is the contamination of groundwater caused by seawater intrusion. The majority of the groundwater bodies have been over-exploited for many years, resulting in seawater intrusion of large parts of the coastal aquifers.

The estimated loss of storage due to the silting up of dams amounts only to about 2%.

All areas, urban and rural, have house to house water connection. Both the proportion of the population having a durable access to an improved water source and to an improved sanitation system (total, urban, rural) is practically 100%. The share of collected and treated wastewater by the public sewerage system is 60%.

The irrigation network in Cyprus is highly efficient. It generally consists of closed systems with an overall conveyance efficiency averaging 90-95%. Field application efficiency averages 80-90%.

The efficiency index of drinking water use is in the range of 76%, 65%, and 63% for the main cities, the municipalities and the villages respectively.

In retrospective, the high cost of water development projects and the frequent occurrence of serious droughts occurring every 10 years or so and lasting from 1 to 3 years, led all concerned to recognize early on the value of water demand management.

Effective strategies towards improving water use efficiency have been implemented, such as: improved irrigation systems; water rationing; conservation of groundwater; water pricing; cropping patterns; raising "water awareness" and educating consumers; reuse of treated sewage effluent; reduction of unaccounted domestic water; legislative measures for domestic water conservation ("hose ban") and, incentives for the use of marginal water for gardening and other purposes.

The main obstacles encountered for better efficiency in water management are: fragmentation of responsibility in water management; lack of an umbrella law covering water; relaxed supervision and control, and lack of effective water pricing.

In prospective, the Water Development Plan until 2015 places emphasis on water demand management to be considered together with the Water Framework Directive implementation. Basic targets of this Plan are: reallocation of the water resources; change of cropping patterns; subsidies to be faded out; adjustment of water prices; control of conveyance and distribution

losses and water awareness campaign. The forecast for the agricultural demand is that it will stabilize to the current levels of 0.182 km^3/yr and that it will be supplemented by some 0.040 km^3/yr of recycled water. The water demand for urban and tourism uses is expected to increase significantly from 0.067 km^3/yr in 2000 to 0.100 km^3/yr by 2020. The industrial sector demand may increase to 0.007 km^3/yr by the year 2020.

By reducing unaccounted water to 15%, the savings of 0.004 to 0.012 km^3/yr on the current demand will increase to 0.006 to 0.018 km^3/yr for the projected demand of 2020.

Considering the environmental objectives within an integrated policy for water resources in retrospective, point out that the past policies, which were carried out at a time when the environmental concerns were not as prominent, had as a main goal the increase of the availability of supply. Changes in water policies by strengthening and taking into account environmental objectives, were formulated as early as 1991 with the enactment of the law on the Control of Water Pollution and as result of the process of harmonization and the accession to the European Union. Estimates of the water needed for the environment of 0.0125 km^3/year have been presented. The instruments that will be implemented for the identified water bodies of ecological value under the WFD will be part of the River Basin Management Plan for protecting, maintaining and/or improving their quality to keep them in "good" status.

The consideration of water demand management within an integrated policy for water resources in retrospective, points out the "created" additional irrigation demand as a result of the major irrigation projects that were developed. At the same time, the successful policy for establishing Cyprus as a quality tourist destination has developed a significant water demand by this very important economic sector of activity.

The trends for water demand with possible consequences have been presented. With agriculture stabilizing to present levels and with domestic demand increasing to 0.100 km^3/year the overall demand may increase by 13%. Meeting this demand will put an extra stress on the water resources or on the economy if further desalination is put into stream since the surface water resources have already all been practically developed with the more attractive surface reservoirs having been already implemented and the aquifers already being over-pumped.

The overall range of possible savings through leakage control and increased efficiency of use may result up to 0.018 km^3/yr from the future domestic sector alone since irrigation is considered to be already highly efficient.

In examining the evolution of water policies in the island, three basic periods have been identified: the first (1960 to 1990) was for water supply development; the second (1970s onwards) was for water conservation and the third is for water reallocation and demand management. Sustainability and the "good quality status" of water resources is also becoming of significant importance with the Water Framework Directive.

A number of overall or local cost-effective studies carried out in the island have been outlined such as: Water Banking suggested as a water management strategy option facilitating voluntary reallocation of water from farmers to domestic water users and tourism; the Regulation of the Market for Irrigation Water in Cyprus – Facts, Policies and Options providing expert advice and consultation in the area of pricing of irrigation water; and, the studies (2004) regarding the overall cost for irrigation water, domestic water and recycled water as well as cost effectiveness analysis and economic analysis of water uses that have been carried out within the study for the implementation of Articles 5 and 6 of the Water Framework Directive in the island.

The total unit cost for bulk domestic water has been estimated[19] at 1.6 US$/m^3 for 2005 and for the total unit cost for irrigation water 0.26 US$/m^3. The financial unit cost associated with the provision of recycled water has been estimated at 0.60 US$/m^3. The cost recovery rate for domestic supply is calculated at 73.1%, and 62.1% if environmental and resource costs are incorporated while for irrigation supply this has been estimated[17] to be 76.6%. The same for the recycled water was low, reaching 15.4% due to the reduction of tariffs in 2004 (to 0.09 US$/m^3) mainly due to the aim of promoting its use.

The public expenditure and investment devoted purely to water demand management (subsidies for drilling and use of marginal water and awareness campaigns) as indicated in the Development Expenditure budget of the Water Development Department for 2006 of US$ 37.8 million was US$ 0.28 million or a low 0.7%. If training of staff on integrated water management and EU programs are considered, then this increases to 2%. Furthermore, if the expenditure for improving Village Water supply systems and the expenditure for development and exploitation of treated effluent are considered and added to the above, then the percentage devoted to WDM becomes 30%.

Integration of water demand management in the programmes of higher level training and research establishments is low and efforts in this direction should be increased.

The possible actions to reach the objectives set or proposed in terms of water demand management have been identified and are, in an order of priority: control of leakages; increase of water prices; reduction of demand per capita through conservation education; reduction of the total area of irrigated crops; change of crop planting patterns to more efficient crops; further improvement of irrigation efficiency; limit of water uses; and, use of marginal water for certain uses.

Cyprus participates in a number of regional cooperation initiatives and programs that could assist in water demand management activities. The role of these to date, remain at the level of information and knowledge exchange and to the training through participation in seminars and workshops. Considering the water scarcity problems facing the country and the relative small budget allocation for water demand management activities, proposals for strengthening the contribution of the cooperation and development aid policies for water demand management should be worked out. Pilot projects demonstrating the viability of water demand management and efficiency policies, promoting and regulating the installation of simple water-saving devices, would also be very applicable. Other projects on WDM could be: a review of water demand and pollution control experience across the region and identification and examination of replicable strategies and techniques, and a review of effective water saving and water conservation awareness campaigns and adaptation to local socio-economic and cultural conditions.

The implementation of the EU WFD is expected to develop a new impetus to WDM policies within the tools that can be used within the measures to be taken to maintain the good status of waters.

Main challenges on water and sustainable development

In Cyprus, water is a limiting factor to economic growth. As a semi-arid country with a highly variable climate, it is predicted that there will be increasing water shortages with the growing water demand in the years to come. It should be recognised that there are limits to the development of new dams and water transfers and that water conservation and demand management should be given more emphasis. Desalination of seawater is a reliable source of water that may relieve dependency on the vagaries of weather but it is very expensive and depends on the import of oil with unpredictable price variation which will have great impact on the economy.

The main challenge to be taken up in the medium and long-term horizon concerning the issue of water and sustainable development is for water resource planners to reconcile demand and supply.

Since the options for supply enhancement are diminishing or nearly exhausted due to the intensive amount of water resources development which has already occurred in Cyprus with most of the feasible reservoir locations having already been exploited and all groundwater reserves having been identified and over-exploited, Cyprus must turn to demand management which has as primary objective the rationalising and control of water use, reducing waste and increasing use efficiency and equity in view of limited supplies.

Water demand management refers to the implementation of policies or measures which serve to control or influence the amount of water used. It stresses on making better use of water already mobilised, thanks to a reduction in physical and/or economic waste.

There are a number of options and tasks that need to be addressed by water demand management such as: building up the water situation awareness to the public; reallocation of water among sectors; reduction of unaccounted water; change of cropping patterns; promotion of water prices to reflect the true cost of water production; reduction of the total area of irrigated crops; further improvement of irrigation efficiency; limit of water uses, and use of marginal water for certain uses.

Any potential solutions must deal fairly with farmers, domestic users, and the tourist industry while allowing each group to coexist and contribute to the economy.

Objectives for the period to 2015/2025

The main objectives for Cyprus that have been set or are needed to be set on the basis of the various controls and indicators examined may be the following:

The main objective will be to reconcile the demand to the supply.

It is imperative for water sustainability, that the adverse trend in groundwater exhibited by depletion, low water tables and sea intrusion at the coast, is checked and reversed. Allowing groundwater to recover to a reasonable level will be a cushion to mitigate future drought events.

Additional effort should be made to detect and replace defective pipes and to establish a caring attitude towards precious water. The efficiency index of drinking water use being in the range of 76%, 65%, and 63% for the main cities, the municipalities and the villages respectively, provides margins for water savings if raised to the level of 85%. Such savings that may accrue might be of the order of 0.018 km^3/year.

The irrigated agriculture uses some 69% of all the water resources of Cyprus while contributing a minor part to national wealth. In this context, a review of water allocation criteria and tariffs should be in order. Irrigation water use efficiency appears to be reasonably high and savings that could be expected from further improvement of irrigation systems does not appear to be significant.

Tertiary treated domestic water is a growing resource. Strengthening its role in enhancing the urban and rural environment, replacing committed irrigation water and in recharging groundwater reserves should be one of the major objectives.

The cost recovery rates should increase through proper water pricing with full cost recovery for domestic supply and adequate recovery for irrigation water as specified in the WFD. This will promote increased water efficiency and adjustment to more economic use of this precious resource.

Effective water saving and water conservation awareness campaigns should be a continuous concern to create and maintain appreciation of the value of water and efficient use by the public.

The institutional and legal framework of water management has to overcome its current fragmentation and jurisdiction problems through the creation of a single entity in order to be in a position to address the serious issues pertaining water management in an efficient and effective manner.

Pilot projects demonstrating the viability of water demand management and efficiency policies and, promotion and regulation in the installation of simple water-saving devices would also be very applicable. International cooperation and aid may be looked for in implementing such projects.

Water demand management should be fully incorporated in the forthcoming River Basin Management Plans that are being developed and are to be implemented as per the requirements of the Water Framework Directive.

Strong and weak points of the National situation

Some of the strong points of the national situation in Cyprus are:

- The powerful economy of the country;
- The educational level of its people both urban and farmers;
- The training that the Cypriots had by having to endure severe water rationing in the past due to frequent droughts and their awareness of the water shortage problem;
- The impressive water development works that have been implemented in the island;
- The inter-basin transfer of water and relative large flexibility for water mobilization;
- The operation of two desalination plants providing a secure, but alas expensive supply for domestic purposes;
- The house-to-house water connection and the high percentage of houses connected to sewage systems;
- The fact that water meters are installed in all water distribution systems;
- The island wide remarkable strides in the use of improved systems of irrigation;
- The high expertise available in water management and an effective public service;
- The well organized farmers unions, cooperative banks, consumers associations and other bodies of society;
- Political parties sensitive to water management problems;

Some of the weak points of the national situation in Cyprus are:

- The proportion of rural population to that of the urban;
- The need and wish to prevent further urbanization;
- The value of land and its large added incremental value when under irrigation;
- The traditional inclination of the rural population to agriculture;
- The high standard of living and the associated water consumption that accompanies it;
- The seasonal nature of tourism and its selective spatial distribution;
- The developed agricultural demand due to the large irrigation projects implemented;
- The small size of society and the effective extent of political lobbying;

- Being an island without possibility of tapping distant sources of water;
- The arid to semi-arid nature of the climate;
- The reluctance for social acceptability of recycled water;
- The relative sluggish enforcement of water legislation on the excuse of socio-economic conditions;
- The fragmented water management administration between technical issues and legislative enforcement;

Obstacles and Measures

The main obstacles that will have to be surpassed in order to reach the objectives set or proposed earlier would in effect be to work on the weak points mentioned above and build on the strong points of the national situation. The strong and weak points should be the guidelines for the development of measures that are needed and which will have to be implemented.

7. Appendices

7.1 Table with Indicators

7.2 References

1. MCSD, Mediterranean Strategy for Sustainable Development "Monitoring progress and promotion of water demand management policies", Terms of reference for the national reports, Appendix 2 Indicators descriptive files Plan Bleu, Regional Activity Centre, Sophia Antipolis, April 2006

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