FRAMEWORK FOR ACTION

MEDITERRANEAN ISLANDS

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The Framework for Action – Mediterranean Islands is part of the *Framework for Action for the Mediterranean: Achieving the Vision for the Mediterranean* (FFA), elaborated as part of the MEDTAC (now GWP-Med) preparation for the 2nd World Water Forum, The Hague, 2000.

The FFA aims to offer a framework action programme for achieving the "sustainable" scenario described in the *Mediterranean Vision on Water, Population and the Environment (Vision)*. Within the elaboration of the FFA, three sub-regional FFA were prepared on: North of the Mediterranean, Middle East and Mediterranean Islands, as well as, four country reports (for Egypt, Tunisia, Morocco and Algeria).

The elaboration of the FFA was coordinated by the Mediterranean Water Network (MWN) with contribution from a group of experts.

About GWP and GWP-Med

The **Global Water Partnership (GWP)** was established in 1996 to support countries in the sustainable management of their water resources. GWP is an independent network open to national governments, research and non-profit organisations, NGOs, UN agencies, multilateral banks, private companies, and other institutional stakeholders involved in water resources management. GWP facilitates the exchange of knowledge, experience and the practice of Integrated Water Resources Management (IWRM). The partnership has a decentralised, self-reliant character through its presently active nine Regional Water Partnership and twenty Country Water Partnerships. The GWP Associated Programmes (APs) provide services on the ground to assist solving problems encountered by stakeholders in water resources management. In this manner these operational, autonomous programmes support countries and regions to implement actions towards IWRM.

For more information visit : http://www.gwpforum.org/

The **Global Water Partnership – Mediterranean (GWP-Med)** is a Regional Water Partnership under the global GWP umbrella. The GWP-Med Partners (2001) are seven Mediterranean organisations / institutions with regional coverage and activity: Blue Plan (MAP/UNEP), CEDARE, CIHEAM, IME, MedWet, MIO-ECSDE, MWN.

The ultimate goal of GWP-Med is to promote the sustainable use of water resources in the Mediterranean region through their integrated management (IWRM), within the general framework of the GWP.

To achieve its goal, GWP-Med :

- Promotes and sustains a strong partnership in the Mediterranean among competent organisations, through their sectoral regional networks that have an impact on water management.
- Makes the principles of sustainable use and integrated management of water resources (IWRM) widely known, recognised and applied by all stakeholders in the Mediterranean, through appropriate mechanisms for sharing information and experience.
- Supports exemplary actions at local, national and regional level that demonstrate the value applicability and positive impact of the above principles.
- Seeks and facilitates the appropriate international funding and involvement of international institutions for activities.
- Introduces, helps to implement and adapts to the specificities of the Mediterranean region, global initiatives launched or adopted by the GWP.

The main GWP-Med (former MEDTAC) products (1999-2000) were :

- *Mediterranean Vision on Water, Population and the Environment* (Vision), prepared by Blue Plan (MAP/UNEP).
- *Framework for Action for the Mediterranean: Achieving the Vision for the Mediterranean* (FFA), prepared by the Mediterranean Water Network (MWN) with contribution from a group of experts.

- *Mapping*, prepared by the International Programme for Technology and Research in Irrigation and Drainage (IPTRID/FAO).
- *Core for Action Plan*, prepared by the Mediterranean Information Office for Environment, Culture and Sustainable Development (MIO-ECSDE) with contributions from a group of experts.

At present GWP-Med, while solidifying and expanding the regional partnership, is working to achieve its main goals through a detailed Work Programme for 2001 and is in the process of drafting its work plans for 2002.

The GWP-Med partners are:

- Blue Plan of MAP/UNEP
- Centre for Environment and Development of Arab Region and Europe (CEDARE)
- International Centre for Advance Mediterranean Agronomic Studies (CHIHEAM)
- Institut Méditerranéen de l'Eau (IME)
- MedWet - The Mediterranean Wetlands Initiative
- Mediterranean Information Office for Environment, Culture and Sustainable Development (MIO-ECSDE)
- Mediterranean Water Network (MWN)

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1. CHARACTERISTICS OF THE SUBREGION

1.1 General

The Mediterranean Sea is bounded by land belonging to three adjacent areas or sub-regions, with different demographic characteristics and development levels. These three areas are the North or greater Europe, the South or North Africa and the East or the Middle East countries. However there is a fourth area, not bounding the Mediterranean, but bounded by the Mediterranean which is called or sub-region, the Mediterranean Islands. This sub-region includes the islands/states shown on Table 1 on which the surface area and population are shown.

The sub-region includes more than four thousands of islands belonging to eight countries with a population estimated around 11 millions, and a surface area of 108,300. Square kilometers. Population of the islands accounts 2.6 % of the total population of the Mediterranean countries (401.5 millions), where population density is 98 persons per square kilometer compared to 47 persons per square kilometer for the whole Mediterranean region.

The islands make approximately 6% of the total Mediterranean watersheds of all Mediterranean countries; they receive about 6% of the total precipitation on the basins and account about 4.6% of the total flow to the sea.

Table 1 Mediterranean islands area and population data.

Island/Group	Country	Surface Area Km2	Population	Density People per sq. km
Dalmatian Islands	HR	6235	46000	7.4
Cyprus	CY	9251	734000	79.3
Corsica	FR	8722	753000	86.3
Greek islands	GR	28827	1303000	45.2
Italian Islands	IT	49547	6830000	137.8
Maltese Islands	MT	315	372000	1177.0
Balearic Islands	ES	4883	605000	123.9
Jerba	TN	514	20000	39.0
Totals/Averages		108298	10663000	98.5

The Natural renewable water resources of the Mediterranean islands, as shown in the publication "The Mediterranean in Figures" of the PLAN BLUE are shown on Table 2. The Table shows the measured or estimated rainfall, the estimated total precipitation, the estimated surface run-off and the water infiltrating to the underground. However it is understood that the figures given are very rough estimates and not measured quantities not even precipitation. On the other hand, the surface run-off estimates are the result of high intensity; short duration floods and only a very small percentage of this quantity can be captured and impounded for use. This is due to the fact that islands have steep slopes, they lack vegetative cover and rivers are very short, with most of the floodwater, after a storm resulting to the sea.

Table 2 Natural renewable water resources of the Mediterranean islands.

Island/country	Country	Precipitate/yr.		Water resources in km3/yr			M3/
		Mm	Km3	Surf.	GW	Total	Cap.
Dalmatian Isle's	HR	970	6.05	0.910	1.860	2.770	27700
Cyprus	CY	497	4.60	0.600	0.300	0.900	1226
Corsica	FR	917	8.00	5.400	0.600	6.000	7968
Greek Islands	GR	463	13.34	2.91	0.320	3.230	2478
Italian Islands	IT	749	37.10	16.45	2.650	19.100	2796
Malta	MT	634	0.20	0.0005	0.040	0.040	107
Balearic islands	ES	614	3.00	0.265	0.444	0.709	1172
Jerba	TN	214	0.11	0.000	0.000	0.000	6500
Total/Averages		668	72.40	26.535	6.214	32.749	3070

The Mediterranean islands have a population density twice that of the total Mediterranean region with great variations in the islands themselves. Malta is the most densely populated island with a density of 1177 persons per sq. km, then the Italian islands follow with a density of 138 persons per sq. km, and the third in order are the Balearic islands with a density of 124 persons per sq. km. However these are the average figures for the native population not taking into account the tourism which in the smaller islands may double in the summer months.

1.2 Physical and human setting

The Mediterranean islands share a series of environmental and development problems in particular concerning water resources management related to water development, water sufficiency, water pollution control and waste re-use and disposal. The parameters and their effect are discussed in the following paragraphs.

- Demographic burden

Dynamics of population is a very important factor in the economic, social and environmental evolution. Mediterranean islands population in generally is expected to increase at about one percent a year increasing from 10.663 millions in1995 to 14.0 million in 1995, not considering permanent tourism which is becoming a trend, resettlements of immigrants returning to homeland and population movements. Tourism is a major activity for most of the islands due to their tourist's attractions, which today amounts to more than 20 million staying for an average period of ten days. Tourism is expected to increase by at least 4% per year for the next 10 years, which will intensify urbanization and increase population concentration even further and particularly in the coastal zones.

- Level of economic activity

Economically there is a disparity between the big and the large islands. Large islands have a more balanced economic activity including agriculture, industry, services, etc. with interest from national and foreign investors where small island lack multiphase economic activity depending solely on one or two activities, basic agriculture, fisheries or summer tourism. Income of population in islands is relatively lower than mother mainland's in the case of Spain, Italy, France, Croatian, Tunisia and Greece.

- Living standards

With the level of economic activity varying in the different islands depending on their size, population and resources, it is obvious the standard of living would be varying. There is a gap between the island of Greece and the Croatian islands and the rest of the Mediterranean islands. The change on the standard of living is expected to be dramatically positive with the increase of tourism in the islands that have advantages over other areas. However this will occur only in islands that can develop and sustain activities that will encourage tourism.

- Physical frame: Strengths and weaknesses

The Mediterranean climate of the islands with hot, dry, long summer creates the favorable conditions for permanent and normal tourism but on the other hand create important water needs both for domestic and irrigation needs for food production. A contrast exists between the large and the smaller islands and some other islands, with favorable microclimate, that have water to meet domestic and irrigation demands where others have to import water to meet domestic demands. Islands like Sicily, Sardinia, Corsica and others with a surface area larger than 1000 sq. km. sustain agriculture while smaller island cannot satisfy domestic demand.

1.3 Water in the Mediterranean islands

Mediterranean islands water resources are very limited, fragile and threatened. Fresh water in the islands is derived from rainfall, which either recharges the aquifers or is impounded in manmade surface reservoirs, where feasible, during winter months for use during the whole year. Fresh water supplies are unequally distributed and unequally shared in the islands with big islands having more water than small islands as it is seen in Table 2. These supplies are even very irregular in time and space creating in most cases water shortages or even scarcity as a result of droughts. Islands water resources are characterized by the following.

- Water availability is solely depended on the amount of rainfall that falls on the specific island.

- The chances of water transportation, from areas with excess water to areas poor in water, are very small or non-existing.

- There are no permanent rivers flowing and springs do not yield high flows, so water for use during dry months must be stored either in surface or ground reservoirs.

- Ground slopes are very steep, with short length riverbeds, which make the impoundment of floodwater either impossible or even uneconomical. Dams must be high and spillways must have relatively high capacities to accommodate high flood flows.

- Steep ground slopes, combined with sparse or non-existing vegetation and short length riverbeds reduce the time of concentration of flood flows resulting to quick discharge of water to the sea. Thus floodwater, which is the only water available,
- is discharged very quickly to the sea depriving the aquifers of valuable quantities of water.

- Small island aquifers are mostly free surface coastal aquifers having an interface with seawater. This makes their operation very complicated since the water quality is a function of the abstraction relative to the recharge. If abstraction is higher than recharge then water becomes saline.

- Island's water resources consist mainly of groundwater and to a lesser degree from surface water usually impounded in man made reservoirs at a comparatively high cost.

Frame 1: ISLANDS OF ITALY

The Italian islands number around 20 the main of which are Sicily and Sardinia situated in the central Mediterranean Sea Sicily has an area of 25,709. Square km and Sardinia 23,813 square km. Sicily has a population around 5.172 million or a density of 201 persons per square km, where as Sardinia has a population of 1.655 million or a density of 69.5 persons per square km.

The climate of both islands is typical Mediterranean with average annual rainfall around 750 mm and average temperatures around 16-20° C. Water crop amounts to 18.8 Km3/year for Sicily and 18.3 km3/year for Sardinia. The available fresh water is 5.77 km3 for Sicily (3.52 surface and 2.25 groundwater) and that of Sardinia is estimated at 13.33 km3 (12.93 surface and 0.4 km3 groundwater). Sicily has two small desalination plants and the produced water is used for industrial purposes.

Water consumption in Sicily is estimated at 2.5 km3, 500-600 million for domestic and industrial uses (exclusively from groundwater), and 1.8 –1.9 km3 (mainly surface water) for irrigation. The area under irrigation is about 10-12% of the total area of Sicily planted with citrus, cereals, potatoes etc. Tourism is a major activity in both islands and it increases at a high annual growth. The domestic water supply systems are relatively old and 50% of the water produced is not accounted. Water billing is not yet generalized on a volumetric basis but other methods not encouraging water saving are used. Per capita water consumption in Catania town is 250 l/day).

Water systems are not provided with telemetry or tele-control systems. Irrigation works were built in the 1950-1960 and most of them are made of open canals with high losses during transportation, during distribution and during application with efficiencies around 40-50%. Sewage collection and treatment is not carried out at the desired level; only a small portion (25%) of the domestic effluent is collected and treated and either given for irrigation or thrown to the sea. Treated effluent is given free of charge where fresh irrigation water is charged per unit area irrigated and by volume. Aquifers mainly coastal aquifers are depleted with seawater intrusion taking place.

1.4 Level of exploitation of water resources

The level of exploitation of the available water resources varies from island to island depending on the population density, lifestyle, development level, water availability, the characteristics of water availability, the economic activity, sufficiency of funds, water demand etc. Each group of islands and even each island have its own characteristics and are utilizing its water resources accordingly. Table 3 shows the estimated water available the estimated amount of water now utilized and the exploitation index. Since it was not easy to get the figures on water utilized except in three cases, i.e. Cyprus, Malta and the Balearic Islands for the rest a hypotheses is made that all available groundwater is utilized.

Table 3 Level of exploitation of natural water resources

Island/country	Coun Try	Precip.	Water resources in km3/yr			Water In Use	Exploit Index
		Km3/y	Surf.	GW	Total	Km3/yr	%
Dalmatian Isle's	HR	6.05	0.910	1.860	2.770	?	
Cyprus	CY	4.60	0.600	0.300	0.900	0.270	30
Corsica	FR	8.00	5.400	0.600	6.000	>.600	>10
Greek Islands	GR	13.34	2.91	0.320	3.230	>0.32	>10
Italian Islands	IT	37.10	16.45	2.650	19.10	>2.65	>14
Malta	MT	0.20	0.0005	0.040	0.040	0.020	50
Balearic Isle's	ES	3.00	0.265	0.444	0.709	0.300	42
Jerba	TN	0.11	0.000	0.000	0.000	?	
Total/Averages		72.40	26.535	6.214	32.749		

From the data shown on Table 3 and from the discussions held at the meetings with the relevant authorities the following can be concluded.

- Dalmatian Islands: Not enough information is available at this stage to justify a conclusion.

- Cyprus: Building dams across the rivers has developed available surface water resources. Few rivers are left without dams but plans exist for dam construction. Groundwater is overexploited with coastal aquifers getting saline and inland aquifers depleted. Groundwater abstraction should be reduced for avoiding water quality deterioration. I think that Cyprus has reached the level of maximum utilization of its natural freshwater resources.

- Corsica: Not enough information available at this time to make a judgment. It is however deducted that groundwater resources are fully developed and surface water development will require comparatively high investment.

- Greek Islands: Greek islands have developed fully all groundwater resources and are now trying to develop the surface water resources for meeting increasing demands. However due to the special characteristics of the island's water resources it is not know how much and at what cost the additional water would be developed.

- Italian Islands: The Italian Islands have developed all the available groundwater and surface water resources. Additional water resources should come from water demand management.

- Malta Islands: Malta is utilizing all available groundwater resources. At this stage the abstraction from the groundwater causes water quality deterioration and possibly a reduction is necessary. Malta does not utilize any of the floodwater.

- Balearic Islands: From the information received all surface and ground fresh water resources of the Balearic islands are fully developed and utilized. According to a new plan ground water abstraction must be reduced for safeguarding groundwater quality and avoid aquifer destruction.

Frame 2: ISLANDS OF MALTA

The State of Malta is composed of a group of islands in the Mediterranean Sea lying between Italy and North Africa. The islands are MALTA, GOZO, COMINO and two uninhabited rocks the COMMINOTTO and FILFA. They have an area of 316 square kilometers and population 380000 persons giving a population density of 1188 persons per square kilometer.

The climate is typical Mediterranean with average temperatures 25° C in summer and 13 in winter. Rainfall is on the average 635 mm per year and winds are often violent. Total annual water crop is estimated at 200 MCM out of which 40 MCM recharge the aquifers where the remaining flows to the sea. Out of the 40 MCM 24 MCM are used for domestic needs (19 MCM) and irrigation (5 MCM). Domestic needs, that presently are estimated at 38 MCM, are satisfied by 50% from groundwater extracted by pumping from the sea level aquifer and the four desalination plants (reverse osmosis) which deliver another 18 MCM per year.

Water losses and unaccounted water in the domestic distribution systems is measured at 50 %. Irrigation uses around 6-7 MCM and around 1000-1200 hectares of land are irrigated, planted with fresh vegetables and deciduous for local consumption, and potatoes mainly for export. Domestic water is heavily subsidized where farmers abstracting water from boreholes pay all the cost. Re use systems exist servicing around 200 hectares and it is also subsidized.

Tourism is a major sector of the economy contributing 25% of the GDP, providing direct employment to 20000 people and indirect to another 21000 reaching 28% of the total labor force of the country. The tourists that visit the island every year for an average stay of 10 days, are 1,300,000 and further increases are expected. Groundwater quality is deteriorating due to overpumping and seawater intrusion.

1.5 Use of non-conventional water (re-use, desalination, and transportation)

Use of non-conventional water in few islands was or is the result of water scarcity due to droughts or structural deficiencies. In all cases water is used for domestic water supply or for industrial uses in the case of desalinated or transported water and for irrigation in the case of re-use water. In each group of the islands the following can be reported

- Dalmatian Islands: Not enough information is available at this stage to justify a conclusion.

- Cyprus: A seawater desalination plant was put into operation in 1997 for supplying water for domestic uses. A second seawater desalination plant is under construction due to operate in 2001 and a third is at tender stage. With the operation of the three plants it is estimated that 40 MCM per year will be supplied for domestic use. Re-use schemes are in operation and efforts are under way to speed up the house connections for increasing the quantities. All big towns have sewage schemes.

- Corsica: Not enough information available at this time.

- Greek Islands: In many islands water transportation is a practice carried out for many years. Few desalination plants are in operation and few more are in the process of planning. Re-use is not carried out although there are wastewater treatment plants but water is discharged to the sea.

- Italian Islands: The Italian Islands have small desalination plants whose water is used for industrial purposes. Re-use schemes are in use at a small scale and funds are necessary for investing more. There is a lot of room to re-use treated wastes but the necessary infrastructure must be provided.

- Malta Islands: Malta is using desalinated water from four desalination plants for domestic purposes. Approximately 18 MCM of water are desalinated every year which represent 50% of the water supplied for domestic uses. Re-use is also carried out at a smaller scale.

- Balearic Islands: Desalination of seawater is carried out in the Balearic Islands, and the water is used for domestic uses. The annual production is around 18 MCM representing around 15% of the total domestic supply. Transport of water was carried out in the period 1994-1997 at a rate of 7 MCM per year. Re-use is practiced but not on a big scale.

From the above it can be concluded that the islands are using non-conventional water to a varying degree.

1.6 Integrated water resources management and water demand management

The application of the principles of integrated water resources management and water Demand management was examined during the visit to islands. From the discussions held it seems that the islands applied one or the other or both depending on the existing conditions. The conclusions reached are the following.

- Dalmatian Islands: Not enough information is available at this stage to justify a conclusion.

- Cyprus: Cyprus adopted a master plan on water resources management in 1970, which was materialized in the period 1975-1998. The water resources management plans were based on the IWRM approach. Concerning water demand management Cyprus from the 1960's implements a water demand management concerning water conveyance and water application in the field. Since 1990 water demand management started is applied in the domestic water supply sector too by taking the necessary meseaures for reducing water losses, and avoids wasteful use of water.

- Corsica: Not enough information available at this time.

- Greek Islands: No IWRM is applied and no water demand management is exercised.

- Italian Islands: No IWRM is applied and no water demand management is exercised.

- Malta Islands: No IWRM is applied but water demand management is exercised to a great extend to reduce demand.

- Balearic Islands: No IWRM is applied and no water demand management is exercised.

From the above it seems that most islands do not apply IWRM in their water resources management and also do not exercise water demand management to reduce losses, demand and wasteful use of water.

1.7 Legal, institutional and financial problems

The existing legal and institutional framework in all countries does not expedite decisions and does not promote effective and efficient use of water. The legal framework is not precise, with many inconsistencies and vague articles, which need clarifications. A major deficiency of the existing legal frameworks is its failure to appoint a water owner with property rights. Water is declared as a public property, or a common property or a government property. This is a very inadequate and ineffective way to deal with a scarce, valuable commodity without taking the necessary legal steps to protect it or to avoid misuse or exploitation by few. A common property is usually misused and wasted.

The institutional framework is very fragmented and complicated with executive powers to those that do not have the technical, administrative know-how and/or financial capabilities, neither the political and social weight to take the right decisions. The authority is very fragmented both vertically and horizontally by authorities and by sector of use, resulting to confusion, who is doing what, what are the powers an institution has, what is the extend of activities and which are the responsibilities and to whom.

Frame 3: BALEARIC ISLANDS

The Balearic islands are composed of MAJORCA, MENORCA, IBIZA and other small islands situated in the Balearic Archipelagos of the Mediterranean Sea. The surface area of the islands is 4883 square kilometers with a population of 605,000 and density 124 inhabitants per square kilometer.

The average annual precipitation is 614 mm with total annual water crop 3.0 km3, Of which around 2.69 km3 evaporate. From the remaining 0.71 km3, 0.265 flow in the rivers as surface water and the remaining 0.444 recharge the aquifers. The water consumption in 1996 was 292.4 MCM out of which 111.6 MCM (38.2%) were used for domestic purposes and 174.5 MCM for irrigation. Almost all of the fresh water (97.5%) comes from the aquifer and only 2.5% from surface water. Desalination is also a source of water and in 1996 about 4 MCM was desalinated for domestic needs. Now the capacity and production of desalination plants is around 18 MCM. Irrigated agriculture using fresh water abstracted from the aquifers by the farmers at their own costs, and re-use water from treated effluents from Government projects given free of charge. Irrigation water is used to irrigate 23300 Hectares, planted mainly with forages for livestock food (13100 Has), fresh vegetable for local consumption (4650 Has), Citrus (2130 Has) and others.

Tourism is the main economic activity in the Balearic Islands receiving approximately 10.3 million tourists a year with an average period of stay 9.8 days. Tourism contributes about 71% to the GDP of the islands, and employment in the services that are mostly related to the tourist industry is also 71% of the total labor force. Since surface water is not utilized groundwater is overexploited resulting to seawater intrusion and salinization. Due to drought during the period 1994-1997 MAJORCA imported water from the mainland, Spain, at a rate of 7 MCM per year for satisfying its domestic needs. The Ministry of Environment has prepared an action plan on water, which provides for water demand management and groundwater abstraction reduction.

Generally there is confusion in the water sector as to who is doing what and to what extend. There is no integrated approach to water resources management, and no one authority to supervise and control the process. One ministry is responsible for domestic water supply, the other is responsible for the irrigation, a third is responsible for water pollution and water treatment, and possibly another is responsible for financing the works. On the operation level one authority is responsible for its operation and other for its maintenance and possibly another for billing and fees collection. Examples are found in all Mediterranean islands.

Financing of water projects is usually provided by the central Governments for major projects involving dams and main conveyors, where financing for local domestic or irrigation projects is done by the beneficiaries with certain subsidy by the central government. There are limitations to the financing of water resources projects in general as a result of the tarification policies adopted by many countries/governments. Water being heavily subsidized, has a low income to the government budgets, and in cases of budgetary constraints water is not given a priority.

Financing of operation and maintenance of projects, especially of irrigation projects, is not adequate due to the refusal of the beneficiaries to pay. Due to low water charges and to the inefficient maintenance of the works large quantities of water are wasted or lost without any benefit.

Frame 4: GREEK ISLANDS

The islands of Greece spread over the Mediterranean Sea number some 3000. From these, the most important are some 63, spread in the Aegean, the Ionian and in the Cretan Seas, with a total area of 28827 square km and a population around 1.30 million. The islands vary in size ranging from few square km to 8260 square km. The size distribution of the islands is the following: 36 islands have an area less than 100 square km, 20 nos. have an area 100-500 square km, 3 nos. have an area 500-1000 square km, 2 nos. have an area 1000-2000 square km, one island has an area 3654 square km and the largest one has an area of 8260 square km. The population density varies from a few inhabitants per square km to 234 inhabitants per square km with an average density of 45.2 inhabitants per square km.

The climate of the islands is typical Mediterranean with hot dry summers and mild wet winters with average annual temperature around 16.9° C in the northern end to 19.9° C at the southern end. Rainfall varies from 380 mm to 800 mm with an average around 600 mm. The total water crop is estimated at 18.43 Km3/year. Water availability is not known but some figures the raise it to 3.3 Km3/year. Of this 0.32 MCM is ground water stored in the aquifers, karstic, alluvial, or mixed aquifers and the remaining is surface water flows to the sea due to steep slopes, short length riverbeds. Water quality is good complying with the EU specifications.

The per capita all uses water availability is about 2478 m3/year, but distribution of water is very unequal with some islands having availability close to zero, whose domestic demands are satisfied by water transportation, where others have enough water for their domestic as well for agricultural needs. Domestic effluents are collected and treated but the treated water is disposed to the sea. Irrigated agriculture is practiced in the relatively big islands (> than 1000 km2) cultivating fresh vegetable for local consumption, abstracting water from the groundwater. Some of off-stream ponds were constructed where a larger number of similar ponds are at the planning stage for construction within a period of the next 10 years. In small islands and where conditions are favorable wind energy generators are promoted combined with the production of desalinated water.

2. MAJOR DRIVERS IN THE MEDITERRANEAN ISLANDS

The major drivers in the sub-region are the following

Demographic: The islands with the exception of Malta and Sicily are not densely populated. It is expected that population growth in the islands will be somewhat higher than in the mainland countries. Tourism is also expected to increase mainly the permanent tourism, with pensioners first. The pressure on the water resources will increase for domestic uses as well for food production. Irrigation in the islands may expand by the re use water. Urbanization most probably will increase in big islands where migration will take the form of tourism.

Economic changes: Economic changes are expected mainly from the point of view of tourism expansion, which will encourage investors to invest more. The water infrastructure will attract investors if conditions are made favorable. This will depend on the availability of the basic resources, including water.

Socioeconomic changes: Such changes are expected in the islands and the impact of tourism will be very decisive. Life style will change, standard of living will rise and population demands will be more, including water. Poverty is expected to decrease.

Education: Education by no means will be improved and higher education will become a part of life. Education of course means more understanding of the facts and awareness about the environmental needs including water.

Environmental changes: With population increase in small islands environment will be affected. Groundwater will be put under pressure (depletion and salinization) and pollution will be a possibility, were wetlands will be under pressure. Climate changes will depend mainly on the restrictions to be imposed on emissions not on the islands themselves but worldwide.

Technological changes: These changes will be inevitable and will be driving forces for the improvement of the efficiency of the economy. The information technology will contribute to the improvement of transfer and exchange of information and for the management of resources including water. New technology will be used for water treatment, water demand application, for water desalination etc.

Water resources economy: Water is a basic requirement and input to any activity. Water is required for economic and social development and for this purposes it must be managed wisely, efficiently and effectively. Water on the islands is very limited and scarce and its management must be made with the utmost care and must be considered both as an economic and social commodity. With the expected growth in the islands, water economy is a top priority and for this all means must be used.

3. SCENARIO FOR A SUSTAINABLE DEVELOPMENT

3.1 Unsustainable water economy

A prerequisite to sustainable water economy would be to avoid the creation of unbalance between the demand and the supply for water, which would have a negative impact on development, while stabilizing pressure on the natural environment at an acceptable level.

Frame 5: ISLAND OF CYPRUS

Cyprus is an island state in the eastern Mediterranean Sea, with an area of 9251 sq. km and population around 751,000 people. The climate is typical Mediterranean with hot dry summers and mild wet winters, with an average precipitation 500mm per year falling mostly in the winter months. The total annual water crop is estimated around 900 MCM out of which 600 MCM is surface water and the remaining 300 MCM is groundwater. However the water that can be used now is only 300 MCM per year 230 MCM in the area controlled by the Republic and 70 MCM under Turkish occupation since 1974*, which corresponds to 405 m3/cap/year. Out of the 300 MCM 75 MCM are used for domestic, industrial and commercial use which corresponds to around 100 m3/cap/year. The remaining is used for irrigation. For the area under control of the government with a tourism around 2.4 Millions a year and population around 663,000 the water domestic, industrial and commercial consumption is estimated at 60-65 millions m3 per year, where the irrigation water is around 165-170 millions per year.

Topographically Cyprus consists of two mountains one situated along the north coast and the other in the center of the island, a central lowland plain and the coastal plains around the island, which extends from few hundred meters up to few kilometers. The mountain along the north coast consists mainly of limestone where the central massive mountain is made up of volcanic and igneous rocks and reaches an elevation of 2000 meters.

The economy is basically tourism and services with a minor role from agriculture, mining etc. The tourism with an annual number of visitors around 2.4 millions with an average stay around 11,5 nights contributes around 20% to the GDP, where agriculture contributes only 5-6%.

In the last years Cyprus is suffering from water scarcity caused by repeated droughts. Since 1991 only in two cases rainfall was above average where the rest years it was near or much below the average. A gradual reduction in rainfall is observed which results to dramatic reduction in run-off. During the last 15 years the recorded rainfall gives an average rainfall which is 14% lower than the long-term average of the tears 1916 to 1985. In the same period the measured inflow to the existing dams (Cyprus has 101 dam reservoirs with a total capacity around 300MCM), was lower than the previous years average by 35-40%.

- In 1974 Turkey invaded the Republic of Cyprus and since then it occupies 37% of the area.

However the present water economy in most islands is not sustainable since it is supply oriented tending to satisfy current increases in water demand without trying to apply water demand management. This approach has increased the pressure on conventional resources, and promoted exploitation modes that are partly unsustainable in the medium and long term, because the development process was not based on sound economical and environmental accepted practices. Short-term development was achieved which created water needs but not sustainability. The approach adopted the dam policy for impounding flood flows, the exploitation of aquifers with renewable resources, the exploitation of non-renewable resources, not considering environmental needs and the long economics. Exploitation was a continuous process to satisfy increasing demand ignoring environmental or wildlife demands and not imposing a water demand policy. This resulted to damming almost all rivers, overexploiting renewable water aquifers, by mining inland and coastal aquifers, resulting to water quality deterioration, and by exploiting non renewable resources creating an unsustainable water production rating.

Frame 6:FRENCH ISLAND (ISLAND OF CORSICA)

Corsica constituting a region of France with its own elected assembly, is the fourth largest island in the Mediterranean Sea with an a surface area 8722 square km and a population of 753,000 inhabitants. Its density is around 90 persons per square km. It is situated 170 Km southeast of France, west of the Italian mainland.

It climate is typical Mediterranean with hot dry summer and mild wet winter. The average annual precipitation is 917 mm resulting to an annual water crop around 8.0 km3. From 8.0 km3 of water 2.0 Km3 evaporate 5.4 km3 flow through the rivers as surface water and 0.6 km3 recharge the aquifers. Topographically and geographically the island is a crystalline massive carved by the rivers Golo, Gravone and Tavognano with frequent gorges in the mountains. The most common vegetative cover is the Maquis a dense nearly impermeable scrub brush found in low and medium attitudes where forests of pine, beech, birch and chestnut are found in higher attitudes.

The economy is based on agriculture (citrus, tobacco, grapes), livestock (sheep are raised and cheese and milk is an important Corsican export) and tourism which is becoming very important.

The above policy has been applied in most Mediterranean islands resulting to aquifer depletion. The depletion of aquifers lead usually to second mistakes, such as the investment of large sums of money for the construction of other projects, including water transfer, for "saving the economy of the water scarcity area " which was created by the greediness of the water users.

The over-exploitation of surface and groundwater for many years has created water needs that cannot be met further unless high investments are made.

At the planning stages of most projects droughts were not taken into account for making them more attractive for financing. This resulted to over-sizing planned water supply and equipped area. In the process higher water needs were created which finally could not be met, creating an unsustainable development.

3.2 Sustainable water economy (Vision on water)

Here, unlike in the unsustainable water economy described above, the approach is anticipatory. It is a matter of determining a desirable situation which represents the objective to be met, in order to find using this objective, the ways and means that will allow the latter to be reached, that is to say, to deduce decisions to be taken at present. (See Mediterranean Vision on water, population and the environment for the XXIst century by Jean Margat, Domitille Vallee)

The core **objectives** of the water policies for a **sustainable development** would be:

- To avoid creating an unbalance between the offer and demand for water, which would have a negative impact on development, while stabilising pressure on the natural environment at an acceptable level.

This would imply:

- Identifying on a case by case basis the acceptable level of pressure on natural water, with quantity and quality objectives aiming at preserving renewable resources as well as preserving the water milieu: making social choices involving a broad participation on behalf of all the actors through discussions and arbitration.
- adapting the different forms of development, in particular in islands with scarce water resources and no availability or moving head first towards this situation; the economic sectors should strive to improve the water use performance ("*more jobs per drop, a better $ per drop ratio, more crop per drop, more users for the same resource and less drops per unitary production"*[1] *...*)

To reach this goal, the water resource and demand management would be considered as a whole.

- A **management aiming at preserving the ecosystem and natural water resources** would consist, according to the countries or territories and the conditions prevailing:

❖ In limiting the pressure increase on the natural surface and underground water – when and if possible based on socio-economical and technical criteria- at a maximum acceptable level, notably by not submitting the natural environment to an abusive impact and by limiting the non sustainable approaches regarding the irregular surface water.

❖ Or in stabilising the pressure at its present level (in islands where there is very little lee-way)

❖ Or lowering the pressure by reducing tapping and stopping the continuous over exploitation of the renewable underground reserves and by intensifying the wastewater treatment (countries featuring a non-sustainable production).

Consequently, beyond the stage where the expected stabilisation level as far as pressure on conventional resources are concerned is reached (right now in the two last instances) **any demand for additional water** would be **satisfied with non conventional resources** (wastewater reuse, desalination), even water imports.

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[1] Tony Allan, Consultation Water for Food, Bari, May 1999.

- **Demand management** would first aim at delaying having to turn to new supply sources – generally more costly- but also to modify the relationship between the different user sectors. This consists in:

- Limiting the increase and even lowering the demand through water saving incentives, by improving the efficiency.Water saving efforts would concern all sectors: the urban sector (reduction of losses in the distribution, leakage and poor user efficiency, development of recycling techniques in concentrated housing areas), agriculture (reduction in transport losses, gains in irrigation efficiency, re-use of treated effluents). They would also include a better adjustment of the volumes of water used at will including for domestic use.

Frame 7: Possible gains through water savings

Reducing by half the volume of water unaccounted in the Malta water supply network i.e. saving 50% of the 50% unaccounted would represent some 9.0 MCM/year which represent 25% of the total demand, enough to cover the increase up to the year 2015. This corresponds to what will be needed in terms of new natural resources. This comparison is somewhat harsh but it applies to most Mediterranean islands where unaccounted water in water distribution systems is as high as 50%.

- Reviewing the resource allocations to the benefit of more value-added uses, those capable of withstanding the growing direct and external costs of water production. This would entail implementing structural changes for the different water using sectors –as economic activity sectors- so that the scarceness of the resource in the islands does not hamper their development. Irrigation would of course be the most concerned.

- Thus, for water policies compatible with sustainable development, demand management would be as important as the management of the resource or more generally speaking, of the offer. Such an objective would however require an arbitration between the different contradictory objectives, e.g.:
  - Maximising the productivity of the quantity of water allocated to irrigation (subject to pressure on behalf of the market) and preserves a minimum standard of living for the active rural populations.
  - Maximising the productivity of the quantity of water allocated to all economic sectors and investing in water savings in agriculture.

  These policies would lie on a broad participation on behalf of all users for the decision making process and management. This implies a decentralised management at the level of hydraulic units (drainage areas, aquifer systems, etc.) or any other relevant management units.

  Lastly, sustainable development policies would imply imposing environment preservation conditions in all trade agreements and delegations of public services to the private sector. This implies strengthening the role of the government as a regulatory body.

4. FRAMEWORK FOR ACTION

4.1 Strategic options

Reaching the vision, while ensuring social stability requires the prevention of disruptions between water supply and water demand. The strategic options for achieving the vision shall be based on the findings concerning water development level (Exploitation index and margins for more development), the present water utilisation, the present efficiency level of water utilisation etc. Therefore considering that:

- ❖ All Mediterranean islands have developed fully or even over-exploited their groundwater resources and that further development will endanger the quality and capability to supply water,

- ❖ Almost all Mediterranean islands have developed their surface water resources by conventional dam building, with very limited possibility to develop more, due to physical, environmental and economical constraints,

- ❖ Most of the Mediterranean countries do not use the treated domestic effluents and instead it is discharge to the sea,

- ❖ Surface flood water may be intercepted and delayed for augmenting groundwater recharge,

- ❖ Water distribution systems have considerably high water losses which can be reduced,

- ❖ Water consumption for domestic and irrigation can be reduced by public awareness,

- ❖ Water consumption for domestic and irrigation uses can be reduced by the implementation of efficient conveyance and irrigation systems and by introducing water saving fixtures within the house,

- ❖ Food security for the islands is not and has never being secured by self sufficiency,

- ❖ Environmental requirements must be considered as one of the demands, like domestic and irrigation,

- ❖ Water demand will continue to increase,

- ❖ That opportunities for employment in other sectors of the economy than in agriculture,

- ❖ That tourism is a promising and not water demanding industry for the islands,

The strategic options proposed are the following:

a) **Reducing the pressure on the available water resources by adopting a water demand management** approach aiming at limiting the increase and even lowering the demand in all water sectors through ,

- Water saving incentives,

- By improving water use efficiency of irrigation water.

- By reducing losses in water conveyance and distribution water supply systems,

- By discouraging wasteful use of water,

- By public education and public awareness on water scarcity and value,

- Efficient re-use of treated domestic effluents thus releasing good quality water now used for irrigation to be used for domestic uses.

b) Augmenting water supply by,

- Re-use of treated domestic effluents,

- Use of lower quality water found underground the inhabited area for toilet flushing and gardening,

- Transport of water to meet water shortages due to short period droughts.

- Use non-conventional water such as desalination water depending on cost.

- Use soil and water conservation measures to utilise more floodwater and improve the environment.

- Develop conventional freshwater resources

c) Reallocating water resources

- By reallocation of water from one sector to another, more efficient sector,

d) Protecting quality of surface and groundwater

e) Preparation of Emergency plans for droughts mitigation

4.2 Actions to be taken to achieve the vision

It is obvious that the above framework is a general one and concerns all islands in the Mediterranean. However each country or islands has its specific ecosystem and water resources and the actions to be taken would vary in depth and priority. For example Cyprus has for many years carried out water demand management on the subject of irrigation water use efficiency, on water losses reduction etc.

To achieve the vision the following actions should be taken in the content of the above strategic options.

A. WATER RESOURCES AND WATER DEMAND MANAGEMENT

As a first assumption it must be considered that for water policies compatible with sustainable development water demand management is as important as water resources management. Therefore water resources management and water demand management should be considered simultaneously and in the context that the ecosystem is a part of the supply and demand system and it is also a demand on the system. Having said the above the actions that each and every country should are the following:

❖ Adopt the Integrated Water Resources Management (IWRM) approach on a River Basin level. This will enable the application of the holistic approach to the water resources management approach. This will require a legal framework and the formation of the respective institution(s), like the one now existing in most European countries. This legal framework would provide one water management and water owner, whose powers and responsibilities must be precisely defined and controlled by the democratically elected authorities, with all legal and executive powers to implement an integrated water resources management. The legal framework should also define the rights and responsibilities of the public and the users. Therefore political decisions must be taken, at the higher level to adopt a legal Framework for River Basin level, and to decide on the adoption of the IWRM approach.

❖ Evaluate and keep in an inventory on a river basin level the natural water resources. The evaluation should be carried and revised periodically for surface water, groundwater, treated sewage water and imported or desalinated water. The evaluation should be based on meteorological and hydrological data and if such data are not or not available provisions should be made for the installation and operation of a network of data collection. Groundwater extraction rates and volumes are known, in most cases and safe yields of aquifers are known and in most cases it is known that aquifers are overpumped and that pumpage must be reduced to reach the safe yield.

❖ Evaluate water demand for existing and projected environmental, domestic, industrial, commercial, irrigation and other uses defining minimum and maximum levels. Water demand should not be simple arithmetic figures but different figures should be considered under different conditions of supply and different level of development. This is an exercise taking into consideration the future development of the country or the island, considering the social, economic and environmental constraints, especially under conditions of water being the major limiting factor.

❖ **Reallocation of available water resources:** Reallocation of sustainable water resources must be a continuous process taking into consideration the changing volumes of available water, the changing water demand and the changing priorities due to environmental, social, economic and other changes. Climatic changes are also very important in the Mediterranean islands, being very vulnerable to droughts, and must be considered continuously. For example Cyprus is reallocating water almost the last 10 years in an effort to mitigate drought and minimise social, economic and environmental adverse effects.

❖ In the evaluations/estimations of the water demand of each sector the water savings from the following actions, to be adopted in the process of water demand management, should be taken into account with respect to time and level of success/or implementation of each measure:

➢ **Water saving incentives:** In house water saving incentives can be provided by the marketing of water saving fixtures, by providing legislation and economic incentives on the purchase and installation as well for the replacement of existing fixtures (subsidies or tax exemptions or reduced connection charges). Where necessary encourage the execution of research and development on such matters. Water tariffs either for domestic or irrigation water or for other uses, should be on a per unit volume of water consumed (there are places where water tariffs are on a per unit area irrigated or unit served per period or according to rate of supply). By saving a 5-10% of the total supply this can cover the increase in demand for the next 3-5 years.

➢ **By improving water use efficiency of irrigation water:** Irrigated agriculture being, even in most islands, the biggest consumer of water, improving the efficiency would save big quantities of water. This would require the investment on on-farm irrigation systems. This investment must be subsidised by the respective governments or irrigationists and water saved can be either used for irrigation or for satisfying increase in demand. For example in an area where irrigation consumes 60% of the total resources with efficiency around 60% and increase of 10% of the irrigation efficiency will increase the availability of water by 10% to take care of increasing demands. In some countries where irrigation efficiencies are low the irrigation water may be considered as the Bank for meeting increasing demands.

➢ **By reducing losses in water conveyance and distribution water supply systems and improving water measuring accuracy:** Water conveyance and distribution efficiencies in irrigation and distribution systems are very low. Losses occur through the channels or the old piped systems, or due to operational problems or due to change in style of life. For example domestic water supply systems in Malta and Catania show unaccounted water around 50%, out of which 35% are losses and the rest 15% is the difference in water meter measuring or water taken without being recorded. Similar conditions exist in irrigation distribution systems, where losses occur through conveyance and distribution channels or old pipe systems, or wasted in distribution systems which cannot be regulated. The reduction in losses can be achieved through the upgrading, modernising o replacing of old distribution systems and providing accurate water measuring meters. The unaccounted water can be reduced up to 15% from 50%, which means that a saving up to 35% of the supplied can be saved. This will require an investment on the part of the local water authorities in the case of domestic water supplies which will save them from developing more expensive water, where on the side of irrigation projects local authorities or the government will have to invest and supply saved water to domestic use or to expand irrigation. In both cases the benefits will be high.

- **By discouraging wasteful use of water:** For domestic water supply full recovery of cost must be sought and the tariff system should provide prices of water that will allow to all consumers, of all levels of society (rich and poor), to have enough quantities of water for a normal life. In the case of irrigated water prices should be such as to encourage use of water on productive crops and to discourage wasteful use. The tariff system should be such to have full recovery of costs and that economically weak parts of the population are given special consideration.

- **By public education and public awareness on water scarcity and value:** Education of population and public awareness should be given a priority. Education could start at the level of primary schools by a systematic way and including the importance and economy of water in the school curricula. Public awareness should be continuous through the mass media, newspapers, TV, radio etc. It must also be carried out by local authorities through leaflets with the water bills or by special publications, exhibitions, seminars, conferences, special discussions, forums or competitions etc.

- **Efficient re-use of treated domestic effluents thus releasing good quality water now used for irrigation to be used for domestic uses:** Domestic water effluents are collected and treated by local authorities and are either disposed to the sea, or not so often, are used for irrigation. This is so because in the islands the domestic effluents are found in the coastal areas and it is considered costly to pump water back to the irrigated areas inland. Since development of new water resources is going to be more costly than treated effluents it would more economical to use treated effluent for irrigation of areas now irrigated with good quality water. These irrigation projects to be undertaken by the local government.

B. AUGMENTING WATER SUPPLY

It is obvious that water demand will continue to increase both for domestic water supply and for food production due to population growth and improvement of the standard of living and change in life style. Even though water demand management approach will be a success augmentation of water supply can be achieved within the need for treatment and safe disposal of domestic effluents, or by developing lower quality water, or by other methods as described below.

- **Re-use of treated domestic effluents:** Domestic effluents according to an EU Directive must be collected, treated and disposed safely, by applying the principle “the polluter pays”. This gives a reliable supply of treated water of certain quality, which can be used for irrigation, thus augmenting the existing water supply. For use of such water, that is estimated to be as much as 50-70% of the total domestic consumption, can be treated further and put into a distribution system for conveyance and distribution to the fields for irrigation, either for new areas or for irrigated areas, thus relieving good quality water for domestic water supply. The tertiary treatment plants and the distribution systems shall be provided at the expense of the central governments and the re-use water given at special prices in case the irrigators are giving up good quality water. This practice is now applied in Majorca, Cyprus and other areas with some success.

- **Use of lower quality water found underground the inhabited areas for toilet flushing and gardening:** Underground water, where available, in inhabited areas is usually unsuitable for drinking purposes but it can be used for other uses, such as for toilet flashing, and for gardening. This water, which is found usually not very deep, is a considerable resource, usually recharged from rainwater, return water from irrigation and losses from water supply and sewage systems. It can be abstracted by drilling boreholes in the inhabited areas, installing pumps and providing the necessary plumbing systems for utilising the water for toilet flushing and for irrigation. This requires technical know how and high investments on behalf of the users which can be provided in full or partially by the government. By promotion and implementation of measures for the use of lower quality water, found in aquifers in the inhabited areas, and which cannot be used for drinking purposes, can save for each dwelling up to 30% of its water consumption, thus reducing the demand on the fresh water resources.

- **Transport of water to meet water demand:** Plans for water transportation should be prepared and ready for implementation in case of water shortage. This solution has been applied in Majorca for three years, where water was transported from the mainland to meet domestic demands that could not be met due to drought. Water transportation can be made on a permanent base by transporting water from areas with excess water to areas with water scarcity or from other country or from the mainland as occurs now in the islands of the Adriatic Sea.

- **Use non-conventional water such as desalination water depending on cost:** In areas where water is insufficient to cover domestic water demand and other vital important needs, and where water transportation is not possible, the desalination of sea or brackish water should be considered. This approach has been used in most large Mediterranean islands, Cyprus, Malta, Majorca, Sicily and few Greek islands. Of course promotion of this approach shall be based on the relative costs of the non-conventional methods of water supply (Desalination or transport) the economic development and ability to pay for high cost water etc. In Malta the desalination plants provide half of the total annual consumption, in Cyprus is now 5% with plans to be increased to 15% in the next year, and in Majorca 5%. The cost of desalinated water is relatively costly now being around one US Dollar with a downward trend as a result of technological improvements. On the other hand it is a high energy demanding process, increasing carbon dioxide emission to the atmosphere polluting the atmosphere and contributing to the green house effect and the price of fuel playing a decisive role on the cost of the desalinated water.

- **Use soil and water conservation measures to utilise more floodwater and improve the environment:** Soil and water conservation measures have been in the past and are now used in some areas. With the change in cultivation methods, and movement of the population areas the mountain areas have been depopulated and abandoned. With most islands having steep soil slopes and short length riverbeds runoff has very short travelling time, with most of the flood flow being discharged to the sea, depriving small islands from valuable water resources. Floodwater flow could be delayed for increasing groundwater recharge, for soil conservation and soil water recharge and for surface water impoundment. This approach has been applied in the Chios Island of the Aegean Sean with a great success. For this purposes large-scale land levelling and terracing on the steep slopes of the island, was carried out. In a period of two years the island turned green and the groundwater level is rising. This measure is a multi-purpose measure contributing towards soil and water conservation and ecological sustainability. Costs and economics of this measure are not well known and special studies need to be carried out on a case by case.

- **Develop conventional freshwater resources:** Depending on the availability of non developed water resources and the cost required for its development conventional water resources could be developed for augmenting water supply. Such water could be surface water resources in certain catchments, or groundwater in aquifers that still are not fully exploited. In some cases water has been set aside for environmental needs and if this is the case it must be respected.

C. REALLOCATING WATER RESOURCES

- **By reallocation of water from one sector to another more efficient sector:** The ratios of water quantities used by the different economic sectors should be better balanced with their contributions to development (measured by GNP), thus calling on their capacity to take over external and internal costs of water resources management. It is obvious that the present existing allocation of water to the irrigation sector is not proportional to its contribution to the GNP. On the other hand more competitive sectors of the economy demand more and more water creating an unequal competition among the various water sectors. Since a major aspect in the management of demand in some islands especially in the large islands, is reducing the share of the resource allocated to irrigation to the benefit of the urban demand, such reduction could be compensated by the increase in water conveyance, distribution and irrigation efficiency and the re-use of treated effluent of urban effluents by agriculture. Reduction in agriculture or income to agriculture could be avoided by improvement of irrigation methods or introducing higher water efficient crops. On the other hand food security can no longer be ensure by self sufficiency and food imports and high value and product exports (from the agricultural sector and tourism) should be put on the same perspective. Water reallocation would require a new irrigation policy to be developed with the joint perspective of integrated rural development and environmental polices in a global manner giving priority to social and environmental matters. The actions that need for water reallocation are the following:

- **Water resources evaluation**

- **Water demand evaluation**

- **Water allocation according to contribution to the national economy, to social stability, to environment for a sustainable development.**

- **Prepare long term plans for water demand management, modernisation of irrigation, training and transfer of technology and know how on the efficient use of fresh and treated wastewater. Carry out research for new more**

efficient water use crops, training and education of farmers on the practices of planting and growing the new crops if necessary, marketing of new crops, study social, economic and environmental repercussions from the proposed changes etc. Consider also the possibility of water augmentation by using non-conventional water

- **Implementation of such policy would require the consent and participation of those affected and would be considerably long in time and expensive to implement. Most probably a smooth transformation would require more than 20 years.**

- **Before implementation a complete feasibility study should be carried out based on strategies defined at the national level and a political decision should be taken at the highest level. If not long-term continuous process is achieved there is the possibility to end up with social and economic instability with adverse effects on the water resources management and the sustainable development in general.**

D. PROTECTING QUALITY OF SURFACE AND GROUNDWATER

Quality of surface and groundwater is threatened by the uncontrolled disposal of polluted effluents (domestic, industrial etc.), non-safe proper disposal of solid and toxic wastes and from agricultural and other human activities. Groundwater resources are also threatened especially in the coastal areas by seawater intrusion caused by overpumping and reduced recharge. Concerning surface and groundwater protection from liquid or solid waste pollution the islands must adopt and implement the relative EU Directives. Concerning groundwater uncontrolled abstraction, which in many cases leads to groundwater depletion or groundwater sea intrusion, resulting to quality deterioration this is a matter that must be dealt within the context of the safe yield of the aquifer and measures aimed at controlling pumpage in quantity and in location. Since in the island most of the water resources come from groundwater it is imperative that for sustainable development groundwater quality must be preserved and improved. Measures to improve the water quality of water are the following:

- Adopt and implement antipollution measures with which disposal of liquid and solid wastes are disposed in a safe non polluting manner both for surface and ground water even for sea water. EU Directives give a good framework for such measures.

- Limit groundwater abstraction by direct and indirect measures. Since direct measures over the years have not succeeded it would be more effectively to combine direct measures with indirect measure. Direct measures are to implement Special Measures to specific areas by limiting and controlling extraction to the level of safe yield. This measure is complicated and expensive and not very effective unless is accompanied by indirect measures such as imposing charge on the volume pumped, removing any subsidies that may have been given for high water consuming activities, limit the area that can be cultivated, and if necessary impose tax for causing environmental damage. A legal framework must be prepared and implemented if groundwater quality is to be safeguarded. In most coastal aquifers in Cyprus and other islands water quality is deteriorated because of overpumping and seawater intrusion. Artificial recharge with freshwater or treated effluent water is now in the process of averting permanent damage to aquifer.

E. PREPARATION OF EMERGENCY PLANS FOR DROUGHTS MITIGATION

The Mediterranean islands are susceptible to periodic and structural water shortages and this has been experienced in many occasions in the long and immediate past. These are likely to spread and increase in the coming years, especially in areas where they were significant and will wide the gap between supply and demand.

- **Periodic shortages** will become more frequent in areas where the index of water exploitation increases and where the more irregular water is mobilised. Water shortage is caused by climatic extremes mainly droughts, particularly consecutive droughts, mistakes in water management of water and deficiencies and inability to find remedies to frequent breakage's of old systems and obsolete equipment. Extreme events also cause the inability of the water systems to store and supply satisfactory and in a high reliability, the planned demand increasing the pressure on the water resources. Cyprus, Israel Jordan, Majorca (Spain), Italy, Morocco and other countries and islands have experienced periodic water shortages caused by drought with rainfall much less than that of a normal year.

- **Structural shortages** in normal years occur due to excessive demands, increased by population growth, or other activity, and due to permanent insufficient water availability. Such island is Malta where all freshwater is not enough to meet domestic needs even under normal climatic behaviour. This might develop in other areas if the climatic trends already recorded become permanent. In Cyprus the last 15 years the rainfall as recorded shows a decrease of 14% from the long-term average where runoff to the existing reservoirs and aquifers has decreased by 35-40%.

With water shortages now occurring, (periodic or structural) and with increasing water demand due to population growth, tourism and food production, it is more probable that shortage will occur more often and will be more critical unless plans are made ahead to combat and mitigate such events. The suggested action for water shortage mitigation is the preparation of a drought mitigation plan which can implemented at the right time before it is too late. For the preparation and implementation of such a plan the following need be made.

- Collect data and information on climatic behaviour with emphasis on droughts.

- Assessment of data and adoption of indicators for recognising when drought or water shortage is about to occur.

- Study of drought management tools, such as creation of strategic resources, the interconnection of different water supply systems and the use of non-conventional resources as well as adoption of tariff system and other tools.

- Study on Drought: actions, impacts, and strategies. Gather information and experience on a national level concerning monitoring of emergency situations, preventive measures adopted and their effectiveness, the resulting social, economic and environmental impact.

- Development of a legal framework to cope with drought.

The order of applying the actions to achieve the vision shall not in the order outline. For each country or island special studies must be carried to establish the level of water exploitation, the water transport, distribution and use efficiencies, the existing legal and institutional framework, the projected water demand and the margins for water saving, and water supply augmentation. From preliminary investigations the following can be stated for the various islands.

Cyprus: Surface freshwater resources have been almost fully developed, groundwater has been depleted, water conveyance and distribution efficiencies relatively high, irrigation water application efficiency is high, treated sewage re-use at starting stages but no big quantities are expected. Water demand methods extensively applied, non-conventional water (desalination) in use.

Greek Islands: Surface freshwater resources have not been fully developed, groundwater has been developed fully, water conveyance and distribution efficiencies not relatively high, irrigation water application efficiency not high, treated sewage re-use non carried out, water demand methods not extensively used.

Malta: No surface water resources developed, groundwater has been fully developed and to some extend overpumped, domestic water conveyance and distribution efficiencies relatively low (50%), irrigation water application efficiency is high, treated sewage re-use at starting stages but no big quantities used. Water demand methods not extensively applied, non-conventional water (desalination) in use, 50% of total consumption

Sicily: Surface freshwater resources have been almost fully developed, groundwater is fully developed, water conveyance and distribution efficiencies relatively low (50%), irrigation water application efficiency is low, treated sewage re-use at starting stages but big quantities are discharged to the sea, water demand methods are not extensively applied, small quantities of non-conventional water (desalination) in use.

Majorca: Surface freshwater resources have been almost fully developed, groundwater is fully developed, water conveyance and distribution efficiencies relatively low (50%), irrigation water application efficiency is low, treated sewage re-use at starting stages but big quantities are discharged to the sea, water demand methods are not extensively applied, small quantities of non-conventional water (desalination) in use.

Islands of Croatia: Surface freshwater resources non-existing, groundwater is fully developed, water is transported from mainland by pipes, water conveyance and distribution efficiencies relatively low (50%),

Table 4 Summary of FFA Strategic Options and Actions

1. WATER DEMAND MANAGEMENT

1.1 Water saving incentives
1.2 Improving irrigation water use efficiency
1.3 Reducing losses in conveyance and distribution systems
1.4 Discourage wasteful use of water
1.5 Public education and public awareness
1.6 Efficient Re-use of treated effluents

2. AUGMENTING WATER SUPPLY

2.1 Re-use of treated effluents
2.2 Use lower quality water for toilet flashing and gardening
2.3 Transport of water
2.4 Non conventional water
2.5 Use soil and water conservation practices
2.6 Develop conventional water

3. REALLOCATING WATER RESOURCES

4. PROTECTING QUALITY OF SURFACE AND GROUNDWATER

5. WATER POLICIES AND STAKEHOLDERS ROLE

The vision on water would be achievable if above tools are applied and each stakeholder plays the correct role. The role that each stakeholder will play, the government, the public, the private and the users is very important and critical.

In order to achieve the vision on water a real social and cultural revolution must be made so as to change the governmental, the managerial, the private sector methods of operation, and the consumers behaviour which have been used in the past. In particular the following change must be made:

- Change in individual and collective behaviours in water use by people and institutions. Public awareness, education, increasing building capacity.

- Co-operation in the management of waters resources, in research and development, in emergency plans such as drought mitigation plans, regional co-operation especially in common in water resources management within the same or shared basin.

- Community participation and management, decentralisation, reinforcement of institutions, transfer of management know how and experience to the appropriate levels, local or central government and community management.

- Participation of the private sector in the development and distribution of the scarce water resources, by transfer of know-how, experience, and funds both for construction of projects and for operation and maintenance.

- Improving water productivity and environmental and social performance of resources management by knowledge and not by tradition.

- The state's role as regulator and controller will be strengthened with the needed participation of the private sector for the commercial aspects of water, i.e. distribution, sanitation, dams and wells management. However the private's sector role must be subject to more and more constraints (social and environmental) which may make some markets less attractive.

The water policies and the role for the different stakeholders under the sustainable scenario or the Vision on water are outlined in Table 5.

6. FINANCIAL CONSEQUENCES

Although the sustainable development scenario will not have greater effect, than the crisis or trend scenarios, on water scarcity which will persist in countries and islands that now exist, it will bridge the supply and demand deficit, will increase reliability of supply and minimise the risk of water shortage, and will minimise the share of development born by nature (better environment). However to achieve the vision for **"a peaceful future where socially, economically and environmentally sensitive water allocation and management supports people's well-being with safe, permanent and fair access to safe water for everyone"**, transformation to the development and global participation are necessary, with great financial consequences. The financial consequences emanate from the following facts:

- More water has to be developed or saved to meet increasing demand due to population growth, and more food production. The investment should at least be in line with that of the economic growth.

- Additional investments have to be made to catch up on cumulated postponed investments and environment degradation due to the conservative policies in the past.

- Additional investments should be made to protect degrading water resources that have been neglected or overexploited to meet rapidly increasing demand.

- More investments need to be made to repair/upgrade/improve existing water projects for saving water and achieving a more equitable water supply to the users. Based on the principle of water supply management water projects were developed and extended without taking into consideration water demand management (under water scarcity or water saving) approach.

- More money has to be spent on raising public awareness, training and education of users, and training and education of water managers and water management professionals.

Table 5 Roles and water policies under sustainable Scenario for the different stakeholders.

Stakeholder	Water policy and role
State	**Legal:** Provide the legal framework for the **IWRM on the river basin level**; define authority and responsibilities of all stakeholders: **Legal:** Provide legal framework for **Drought Mitigation plans :** **Legal:** Provide legal framework for water quality protection and establish environmental objectives that limit access to the water resources and the volume to be withdrawn. **Legal:** Provide guidelines for economic and financial responsibilities of the various stakeholders; Apply the principles the "**beneficiary and the polluter pays";** **Legal:** Provide legal framework for water demand management and water saving as well economic and other incentives; **Financial:** Decide to make available the necessary financial means from **its own budgets or from the public or private sector for the implementation of the FFA**; **Investments will be high.** **Capacity Building:** Provide professional and other staff and build the necessary capacity building for implementing the FFA Water education, awareness and training: The state must decide to introduce water education in schools, undertake campaigns through the mass media for public awareness and train the managers and operators on effective and efficient water management.
Communal And Public Firms	**Legal:** Provide regulations for the proper management operation and maintenance of water projects to be undertaken by the communities, public firms and the private sector. Communities and public firms will take more active role in the management of water projects; **Costs:** Since investments will be very high the recovery should be made through proper tariff system that encourages water saving and discourages wasteful of water; Apply the principles **"the beneficiary and the polluter pays"** **Financial:** Make available directly or through loans or from the private sector the necessary amounts for implementing the FFA; **Public-Private sectors co-operation:** Prepare the legal and the administrative framework for closed, effective and mutually beneficial co-operation of public with the private sector; **Delegation of powers to private sector:** Communities and public firms must prepare for delegation of their powers to the private sector;
Private sector	**Private sector-Public co-operation:** The private sector must be ready to co-operate more and more with the public and State sectors on the operation and maintenance of water projects in urban and rural areas (domestic and irrigation). **Environmental, Social and performance constraints:** The projects will be economically less attractive due to environmental social and performance constraints to be imposed by the state and the communities; **Costs:** Costs will be higher and their recovery will be directly from the users.

Users	**Participation:** Participation in Basin, aquifer committees and other management committees; Participation in the formulation and decision making of planning, design, construction, management, operation and maintenance of projects and policies. **Delegation of powers:** Users will have to delegate powers to private firms and form public-private firms for management of water projects; **Direct involvement:** Users will be asked to participate in water saving, financial and otherwise. **Costs:** Users will have to pay directly higher costs for safeguarding high level service and save water; **Awareness and education:** Users will have to get aware of the water situation and undertake to use water wisely and avoid wasteful use, educate themselves and their children how to use water;

The state, the communities and the private sources will pay the increased economic costs. The private sources will be involved if the sector is profitable enough and this is stated in the conditions and specification of delegations. The sharing of the cost between the state, the communities and the users would be decided depending upon the socio-economic policies of the specific country. The tendency would be to apply the principles" the beneficiary and the polluter pays" with full recovery cost for domestic, industrial, and commercial use, with a partial recovery of the irrigation water where prices are fixed at such a level where efficient water use is encourage for productive purposes and wasteful use is discouraged. Efforts must be made to surpress all subsidies that encourage wasteful use of water and funds diverted towards water demand management policies.

7. IMPLEMENTATION OF SUSTAINABLE SCENARIO (Costs and benefits)

7.1 Projected water demand for domestic and tourism needs under Trend and Sustainable Scenarios.

The present water demand for the local population and the tourism purposes is estimated at 1.183 cubic kilometres. Considering the trend scenario for a population growth of 1% per year, the tourism growth at 3% per year, the increase of water demand due to the raising of the standard of living by 1%, and considering that the present consumption of water is 90 m3/year per person for the local population and 350 Lt/cap/day for the tourist, staying 10 nights per visit, the projected water demand for domestic needs is estimated as shown on Table 6. From the same table it is seen that the water demand will rise from 1.183 Km3 in 2000 to 1.60 Km3 in 2025. The increase in demand is estimated at 35.3% or a total of 0.417 Km3. By considering the Sustainable Development Scenario and applying water demand management procedures the water demand is estimated to be as shown on Table 7. This is achieved by the following measures.

- Water saving incentives
- Reducing losses in conveyance and distribution systems
- Discourage wasteful use of water
- Public education and public awareness
- Re-use of treated domestic effluents

Table 6. Mediterranean Islands-Projected population and tourism and domestic water demand under the Trend Scenario.

Year	Population millions	Tourism millions	Pop.Equiv millions	Popul. Dem Km3/year	Tour. Demand Km3/year	Total Demand Km3/year	% Increase from 2000
2000	11.000	23.700	0.649	1.100	0.083	1.183	0.00
2005	11.561	27.475	0.753	1.168	0.097	1.265	6.93
2010	12.152	31.851	0.873	1.227	0.113	1.340	13.27
2015	12.771	36.924	1.012	1.290	0.131	1.421	20.12
2020	13.422	42.805	1.173	1.356	0.151	1.507	27.39
2025	15.107	49.623	1.360	1.425	0.175	1.600	35.25

Parameters for estimating population and water demand projections.
Population growth 1%
Tourism growth 3%
Standard of living increase 1%
Annual water demand for local population: 90m3
Daily consumption for Tourism in l/day/cap: 350

By increasing water conveyance and distribution efficiency from 60% to 80%, discouraging wasteful use of water, and providing water saving incentives, water savings as much as 20% of the present water supply can be saved i.e. 0.238 Km3. By re-using around 0.179 km3 or 10% of the total domestic effluents and diverting water now used in irrigation for domestic use the projected water demand can be fully satisfied as is shown on Table 7.

Table 7. Projected population and tourism and water demand under the Sustainable Development Scenario.

No	Year	Population millions	Tourism millions	Total Demand Km3*	Water Demand Management Saving		Re-use Km3	Total water Saved	Cumulative Saving
					%	Km3		Km3	Km3
1	2000	11.000	23.700	1.183	0.00	0.000	0.000	0	0
2	2005	11.561	27.475	1.265	6.93	0.082	0.000	0.082	0.267
3	2010	12.152	31.851	1.340	13.27	0.075	0.000	0.075	0.899
4	2015	12.771	36.924	1.421	20.12	0.081	0.000	0.081	1.923
5	2020	13.422	42.805	1.507	20.12	0.000	0.090	0.090	3.367
6	2025	15.107	49.623	1.600	20.12	0.000	0.089	0.089	5.264
Additional quantities of water demand				0.417		0.238	0.179	0.417	

From Table 7 it is seen that to achieve the sustainable water Scenario the following procedure must be applied.

- Supply of water must remain at the same level as it is now up to the year 2015.
- Additional demand must be met by water demand management measures saving year after year around 80-90 millions cubic meters. By the year 2015 a quantity of

238 MCM must be annually saved by water demand management methods, representing 20% of the annual domestic demand in the year 2000.

- At the start of the year 2015 good quality water now used for irrigation shall be replaced by treated domestic effluent and an equivalent amount shall be diverted to domestic use. Up to year 2025 a total quantity of 179 MCM of treated domestic effluents must be diverted to irrigation and an equivalent amount of good quality water must be used for domestic needs.

- During the years 2000-2015 and thereafter it is estimated that measures must be taken to save annually 238 MCM. This will be achieved by technical, economic and public awareness measures involving high financial consequences.

- During the years 2015-2025 and thereafter it is estimated that 179 MCM of domestic effluents shall be collected, treated, conveyed and distributed to irrigators, who will give up there rights on an equivalent quantity of good quality water to enable the use of this water in satisfying domestic needs. The financial consequences include the construction of sewage collection and treatments plants, to be paid by the polluters, the construction of tertiary treatment plants for further treatment of the effluents and conveyance and irrigation distribution systems for supply of the treated effluents to the Farmers. The cost of the tertiary treatment plant and the conveyance and distribution systems shall be borne by the Government.

7.2 Irrigation water prospects

Assuming that irrigation water consumption at present is 70% of the total consumption then the annual irrigation consumption is approximately 3.333Km3. Generally the conveyance and distribution efficiency is around 60% since the systems used, with the exception of Cyprus, are mostly open channels. Since the margins for further increase, by development of natural water resources are very limited, increase of this volume can be effected by one or from a combination of the following measures.

- Increase efficiency of conveyance and distribution of irrigation water. A 5-10% increase of both efficiencies say from 60% today to 65-70% can increase the available water by an amount around 0.166 to 0.333 km3 per year.

- Increase irrigation application efficiencies by 5-10%. The introduction of modern pressurised distribution systems and the use of modern on farm irrigation systems will achieve this. Again exception to this is Cyprus where 95% of the irrigation is carried out by modern, very high efficiency on farm irrigation systems. The extra amount of irrigation water that will be made available by this measure is estimated around 0.166-0.333Km3.

- Re-use of domestic treated effluents. The total domestic effluents are estimated around 0.828km3 (70% of 1.183 Km3). If 50% of this quantity is collected and treated and used for irrigation the additional water for irrigation will be around 0.414 km3. Deducting the water to be exchanged for good quality water, as described in paragraph 7.1 above, 0.179 km3 the net additional volume for irrigation will be around 0.235km3.

7.3 Summary of volumes that can be saved.

The water that can be saved only from water demand management and the re-use of treated domestic effluents is estimated at 0.818km3 or 18% of the total present consumption as shown on Table 8.

Table 8 Volumes that can be saved.

No	Description	Domestic	Irrigation	Total
1	Present Demand Km3	1.183	3.333	4.516
2	Projected Demand in 2025	1.601	?	
3	Additional water	0.417	?	
4	Water Saving by: A. Water Demand Management: A1. Reducing conveyance and Distribution Losses, discouraging wasteful use of water, and providing water saving incentives in domestic water supply systems.	0.238	0.00	0.238
	A.2 Reducing conveyance and Distribution Losses, and use modern of farm irrigation systems, and providing water saving incentives in irrigation water supply system	0.000	0.166	0.166
5	Total water saved	0.238	0.166	0.404
	Percentage of water saved	20.1	5	9
6	B. Augment Supply by B.1Re-use of treated domestic effluents and exchange with good quality water from irrigation	0.179	0.235	0.414
7	Water Augmentation due to re-use	0.179	0.235	0.414
	Percentage of total domestic volume	15	20	35
8	Total additional available water	0.417	0.401	0.818
	Percentage of total	35.24	12	18.1

From the Table above it is seen that the future domestic water demand can be met by water saving approximately 20% of the water presently used, which is achievable and by the re-use of 15% of the domestic consumption.

Of course the above exercise is not valid for all islands since conditions are not similar. In islands where conditions are different additional measures may be taken such as desalination and water conservation for water augmentation.

7.4 Costs and Benefits by applying the Sustainable scenario for satisfying the domestic needs (Water demand Management and re-use of treated domestic effluents)

The Sustainable Scenario provides for the satisfaction of the increased water demand up to the year 2025 due to population growth and standard of living improvement, by implementing water demand measures and by the re-use of treated domestic effluents. Increasing the amount of domestic effluents to be collected and treated, or the desalination of seawater could develop additional quantities of water. In all cases investments must be incurred by the respective Governments, the public companies, by the private companies and/or directly by the consumers.

With the Sustainable Scenario for satisfying domestic demand there will be costs and savings and environmental benefits as outlined below.

Capital Costs: Capital costs must be invested on the following:

- Capital cost on raising public awareness through the mass media. The effect would to reduce waste of water and save on water. This cost shall be born by the Government. From this campaign it is estimated that a quantity of 0.059km3 of water per year could be saved.

- Capital cost on purchase and installation of water saving fixtures within the house such as flow limiters, two stage toilet flushing mechanism, automatic taps etc. The consumers most probably subsidised by the Government shall pay this cost. The expected quantities of water to be saved are estimated at 0.060 km3 per year.

- Capital cost on improving, upgrading and modernising of existing water conveyance and distribution systems, including the installation of pressurised systems, control valves, water meters etc. From domestic supply systems the savings expected are estimated at 0.119 km3 per year. These costs are to be born by the municipalities or public companies or private companies.

- Capital cost on the construction of tertiary treatment systems for upgrading the quality of the treated domestic effluents. It is assumed that the municipalities up to the secondary stage on their own cost treat domestic effluents. And the Government will pay for the tertiary treatment plants. The treatment plant must have a capacity to treat 0.179 km3 per year for water to be exchanged with good quality water and 0.235 km3 of water per year for direct re-use.

- Extra cost to convey and distribute the 0.179 km3, of tertiary treated domestic effluents, to existing irrigators. The Government must construct the conveyance and distribution systems and the water most probably will be given at a very low price.

The annual costs are the following:

- Tertiary treatment of treated domestic effluents. Annually an amount of 0.179 km3 of water shall be treated.

Benefits: The benefits from the implementation of the water demand management approach and the treated domestic effluents re-use are economical, environmental and social as follows.

Economical: There will be saving in capital investments and in annual expenditure.

- Capital saving on head-works: Since water will be saved from the conveyance and distribution systems and by the consumers, due to public awareness, there will be no need for additional headwork, such as dams, boreholes or other water development structures. From the above exercise the saving will correspond to the cost of headwork capable of developing 0.417 km3/year of water. If there were a need to develop this quantity of water the only alternative would be desalination which would cost more than 1.12 billion dollars.

- Saving on operation and maintenance of the modern conveyance and distribution systems.

- Saving on operation and maintenance of the municipal wastewater treatment plant having to treat 0.238 km3 of water less.

- Saving on capital investment for the municipal wastewater treatment plants which now will have a capacity of 0.238 km3/year less since the total water demand will be less due to water saving.

- Saving on operation, maintenance of the municipal wastewater treatment plant having to treat 0.238 km3 of water less.

Rates on costs and savings

To estimate the cost and savings as a result of the implementation of the sustainable scenario (water demand management and re-use of treated domestic effluents) the following rates will be used.

- Raising water awareness: The annual expenditure is estimated at 0.1 US dollar per capita per year In 25 years a total of 2.5 US dollars per capita will be spent.

- Water saving equipment in house. The purchase and installation of water saving equipment per house (3 inhabitants per house) is estimated approximately 60 US dollars, which means 20 US dollars per capita. For the total population the expenditure on this cost is estimated at 213.2 millions US dollars.

- Improvements of domestic conveyance and distribution systems estimated at 1 US dollar per cubic meter saved. This compares favourably with investment for developing new water resources.

- Capital investment for tertiary treatment sewage systems estimated at 1.0 US dollar per cubic meter.

- Capital cost to convey and distribute the 0.179 km3, of tertiary treated domestic effluents, to existing irrigators. The Government must construct the conveyance and distribution systems and the water most probably will be given at a very low price. The cost for such schemes is roughly estimated at 1. 0 USA dollar.

- Annual cost for the tertiary treatment of the domestic effluents at a cost of 0.03 USA cent per m3.

- Capital cost for development of additional water resources. These are estimated at 2.6 US dollars per cubic meters, equal to the capital cost for desalination.

- Saving on the operation, maintenance and energy required to produce one cubic meter of water estimated at .45 US dollars per cubic meter.

- Saving on the operation, maintenance and energy required to distribute the extra water estimated at 0.15 US dollars per cubic meter.

The additional costs and benefits for the water demand management and the re-use of the treated domestic effluents are summarised in Table 9. From the Table the following is seen.

Additional costs:

- Capital costs for the next 25 years: 824.5 million US dollars
- Annual Cost increasing from zero to 5.370 million US dollars per year

Savings to be made.
Capital cost on development of additional quantities of water: 1084.2 million US dollars
Annual costs to produce additional quantities of water: 247.15 millions US dollars.

On top of the above there are environmental benefits that result from the easement on the natural water resources and the less emissions of CO_2 to the atmosphere if desalination was chosen instead.

Obviously the sustainable scenario proves to be more economical if suitable conditions exist for implementation of the water demand management approach and there is margin to use more of the domestic effluents for irrigation purposes. The above exercise could be carried out country by country or region by region to examine if it is feasible to implement both for domestic water saving and for irrigation water saving.

Table 9 Costs and Savings estimates for domestic water

No	Description	Water Saved million	Rate In US dollar per m3	Amount In Millions US dollars
1	Additional Capital Investment for Water demand Management:			
	1.1 Raising water awareness.	59.0	2.50	147.5
	1.2 Purchase and installation of water saving equipment in the house for domestic use.	60.0	3.33	200.0
	1.3 Improvement of domestic conveyance and distribution systems.	119.0	1.00	119.0
	Sub total for Water demand Management	238.0		466.5
	Additional Capital Investment for Re-use of treated effluents			
	1.4 Capital investment on tertiary treatment plants to treat treated domestic effluents for irrigation.	179.0	1.00	179.00
	1.5 Capital investment for conveying treated domestic effluents for irrigation	(179.0)	1.00	179.00
	Sub totals	179.0		358.0
	Total (water saved and re-used and costs)	417.00		824.5
	1.6 Extra additional cost on O&M of wastewater treatment in tertiary system	179.00	0.03	5.370 million US dollar per year
2	Saving From water demand Management and Re-use of treated domestic effluents			
	2.1 Cost of developing additional water quantities. (Cost equal to capital cost of desalination plants)	417.00	2.6	1084.2
	2.2 Cost of operation, maintenance and energy in the desalination plant. This represents the annual cost for producing the water	417.00	0.45	187.65
	2.3 Cost of operation, maintenance and energy saved because of treating less water in the municipal wastewater treatment plant.	238.00	0.10	23.80
	2.4 O&M cost to distribute the saved water	238.00	0.15	35.70
3	Economic Benefits			
	3.1 Capital			259.7
	3.2 Annual cost in Operation, maintenance and Energy			241.8

Table 9, continued

4	Environmental Benefits. Less energy consumption, thus less environmental damage, less wastewater to be treated, leave the environment undisturbed since no additional waterworks are to be constructed and nature will continue to gets its share of water. Because pressure on water resources will be eased environment