MEDAWARE

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Development of Tools and Guidelines for the Promotion of the Sustainable Urban Wastewater Treatment and Reuse in the Agricultural Production in the Mediterranean Countries

(MEDAWARE)

Task 1: Determination of the Countries Profile

The Water Profile of the Med Countries and the Policies that need to be developed for the Sustainable Development of Non Conventional Water Resources

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Contents:

Introduction

Water is an environmental, social and economic asset and as such it needs to be managed with the objective of conserving a common patrimony in the interests of the community at large. Thus it is necessary and important to guarantee water availability over time by means of sustainable forms of management, which will allow the Mediterranean countries to cope with present demands without jeopardizing environmental balance and the needs of future generations. The North African and Middle East Countries are characterized by the lowest per capita amount of water supply in the world, unequally distributed in space and time. The Mediterranean Water Chapter established in Rome in 1992, [1], stressed the need to contribute towards the creation of new resources of water. The Declaration of the Euro-Mediterranean Ministerial Conference on local water management of Turin, [2], stressed the importance of integrating water resources management into sustainable development policies. Another main aspect of this declaration is the statement that water scarcity could be alleviated through mobilization of non-conventional water resources, such as reused wastewater. Another problem that these countries face is that there are no sufficient systems for the environmentally sound treatment of urban wastewater. Raw sewage is deposited into the sea, rivers, and pits or used for irrigation purposes endangering human health and environment as a whole. According to the Barcelona Declaration the Mediterranean cities that do not belong to EU and have a population of more than 100,000 inhabitants must have adequate water treatment systems to treat their sewage installed by the year 2005, while those having a population of more than 50,000 inhabitants must develop such systems by the year 2010, [3].

Following, an overview is made for some of the Med countries in regards waste resources, wastewater treatment and reuse. This overview refers to Cyprus, Jordan, Lebanon, Morocco, Palestine and Turkey. The aim is to reveal the problems associated with the water resources available, the wastewater treatment capacity and the treated wastewater reused for irrigation purposes.

The Countries Profile

The Mediterranean Sea is one of the rare borders in the world which separates two adjacent areas with opposite demographic characteristics and contrasted development levels. The Mediterranean region consists of three sub-regions as follows (with italics the countries examined in this project are indicated):

- the **North** or greater Europe: Portugal, Spain, France and Monaco, Italy, Malta, Bosnia-Herzegovina, Croatia, Slovenia, F.R. of Yugoslavia, Albania, Greece;
- the **East** : *Turkey, Cyprus*, Syria, *Lebanon*, Israel, *Palestinian territories of Gaza and the West Bank, Jordan*;
- the **South** : Egypt, Libya, Tunisia, Algeria, *Morocco*.

The total population of the Mediterranean countries in 2000 reached 427 million people. It was 285 million in 1970, presenting an increase of 142 million, or 50%, in thirty years. The latest projected demographic figures estimated in the Blue Plan estimates the population at 523.5 million by 2025, which demonstrates a certain decrease in the population growth rate with a little under 97 million (or 22,5% increase) additional inhabitants in 25 years, [4]. Presently the average rate of urbanisation is at 64.3 per cent, while it is expected to reach 72.4 per cent by 2025. This rise is mostly due to the urban growth in the southern and eastern countries. In absolute terms the urban population of all Mediterranean countries—274.5 million in 2000—will reach 379 million by 2025. In the same period, there will be 104.5 million additional urban dwellers, of which more than 98 million will reside in the South and East. The Blue Plan has always considered population and its physical distribution as a capital element in the Mediterranean system. Indeed, the Blue Plan's experience from the past twenty years in the Mediterranean region shows that the population dynamic is the main factor that influences the most basic needs, determining the consumption of all sorts of resources and provoking the most direct environmental pressures, [4]. In general, Mediterranean countries are currently undergoing intensive demographic, social, cultural, economic and environmental changes and hence the resources consumption and the consequent environmental effects are constantly changing.

Following, the most important information is summarized in table format (Tables 1-5) while detailed information is also provided. Table 1 gives information on the total area of the countries mentioned above, the total population according to the most recent census available and the % annual population growth.

Table 1: Area and Population in various Mediterranean countries

Country	**Total area km^2**	**Total population (year of census)**	**% Annual Population growth**
Cyprus	9,251	689.565 (2001)	1.45
Jordan	89,210	5,329,000 (2002)	3.45
Lebanon	10,422	3,614,000 (2002)	1.65
Morocco	710,850	28,705,000 (2000)	1.7
Palestine	6020	3,549,524 (2002)	3.1
Turkey	780,576	67,803,927 (2000)	1.83

Mediterranean demands for water are high. Two-thirds of Mediterranean countries currently use over 500 cubic metres per year per inhabitant – mainly because of heavy water use of irrigation. But these *per capita* demands are irregular and vary across a wide range – from a little over 100 to more than 1,000 cubic metres per year. Table 2 provides information on the average annual rainfall, the water resources available and the water demand for the countries under examination. Table 3 gives information on the ratio between water demand and the water resources available per country. From this information it is clear that in some countries like for example Cyprus, Palestine and Jordan water shortage is already a fact. Demand is growing in the other countries but it is actually falling on a *per capita* basis. In other countries the demand per inhabitant is still growing – either because demand is still low (e.g. Algeria) or because water development schemes and particularly water use for irrigation are developing more rapidly than the population (e.g. Lebanon, Libya and Turkey), [5].

Table 4 illustrates the treated wastewater produced in each country and the quantity of the treated wastewater that is reused (in million of cubic meters (MCM) per year).

Table 5 gives information on the total irrigated areas in each country and information on the proportion of the regions irrigated by non conventional resources, i.e. treated wastewater.

Table 2: Rainfall, Water Resources Available and Water Demand

Country	Average Annual Rainfall (mm)	Water resources available (surface, groundwater) MCM/yr	Water demand MCM/yr
Cyprus	465	300	265.9
Jordan	semi desert <200	780	810
	Arid 200-350		
	Semi arid 350 - 500		
	Semi humid > 500		
Lebanon	Coastal Areas: 700 – 800	Surface Water: 2600 Ground Water: 400 – 1000 Average 3300	1400
	Mountain areas: 1200 –2000		
Morocco	NW > 500	30000	11000
	High points in the med region >1500		
	East < 200		
	South <100		
Palestine	Mountain areas 700	295	354
	N and W 400		
	S 200		
Turkey	580-1300 mm	110000	42000

Table 3: Water Demand Versus Water Resources Available

Country	Water Demand / Water Resources Available*
Cyprus	0.89
Jordan	1.04
Lebanon	0.42
Morocco	0.37
Palestine	1.2
Turkey	0.38

***** *Surface plus groundwater resources*

Table 4: Treated Wastewater Produced and Reused

Country	Treated wastewater produced MCM/yr	Wastewater reused MCM/yr	Treated Wastewater Reused / Treated Wastewater Produced
Cyprus	20	5	0.25
Jordan	73	73	1
Lebanon	6	No data available	No data available
Morocco	40	70 (Not treated)	Not applicable
Palestine	30	5.44	0.18
Turkey	1245	No data available	No data available

Table 5: Total Irrigated Areas and Area of the Regions Irrigated by Non Conventional Water Resources

Country	Irrigated areas (ha)	Area irrigated by non conventional water resources / Total irrigated area (%)
Cyprus	38200	0.5
Jordan	10820.8	No data available
Lebanon	104160	No data available
Morocco	1350000	0.5
Palestine	24418	No data available
Turkey	1471000	No data available*

**Particularly in the inner parts of Turkey urban wastewater treatment plants discharge their effluent to rivers and irrigation channels, however, the amount of discharged effluent is not exactly known (therefore: no data available) and at the same time this water amount is relatively low compared to conventional irrigation sources (irrigation water). In Turkey, non-conventional water sources are currently not used for irrigation (with only few exceptions).*

Cyprus is the largest island in the Eastern Mediterranean with an area of 9 251 km^2. The area of the country currently under governmental control, to which this country profile and the accompanying information refer, is about 5807 km^2. The total population is 689 565 (Census 2001) with an annual growth of 1.45 %. The share of agriculture for accounts around 3.7 % of the GDP for 2001 and varies according to the weather conditions, ie. rainfall. For the area under control of the government with a tourist inflow of around 2.4 millions a year and population around 700 000 the domestic, industrial and commercial consumption of water is estimated at 67 MCM per year, where the irrigation water is around 175 MCM per year. The first large sewage treatment plant, in the Government controlled areas, started its operation in Lemesos in the summer of 1995. Sewage treatment plants of total capacity of about 20 MCM/year are currently operating. The Water Development Department is responsible for implementing the water policy of the Ministry of Agricultural, Natural Resources and Environment with primary objective to develop the national management scheme for the water resources of Cyprus. As treated wastewater is part of the water resources, the Government appointed the Water Development Department as the responsible body for the tertiary wastewater treatment as well as the allocation and distribution of the treated wastewater to agriculture. The Department of Agriculture, which also belongs to Ministry of Agriculture, Natural Resources and Environment, is responsible for the education of farmers in all matters related to agricultural production, including the use of treated wastewater. The selection of crop and the irrigation system to be used as well as the preparation of irrigation schedules are amongst the responsibilities of the Department. The follow up of the guidelines and the code of practice is also responsibility of the Department of Agriculture. The sewerage boards are public sector organizations, which have the responsibility of the concentration, operation and maintenance of the main sewers system including the pipes, the pumping stations and the treatment plants. Its main target is to produce treated effluent, which can be used for irrigation purposes. The sewerage boards treat the wastewater up to secondary level and the tertiary treatment is undertaken by the Government. The boards are under the control of the ministry of Interior and their president is the mayor of the city. The Ministry of the Interior and the Water Boards are responsible for the administration at the consumers' level and the distribution of domestic water. At present there are plans by the Government to reorganize the institutional set-ups of the water sector through the establishment of a water entity to undertake full responsibility of the management of all water resources responsible for all the water cycle.

Jordan with a total area of approximately 89 210 km^2, lies to the east of the Jordan River. The total population is around 5 million of which 29% is rural. The population growth is estimated at 3.45%. Over 90% of the country receives less than 200 mm of rainfall per year, [6]. Agriculture fluctuates around 2 % of Jordan's GDP. The level of Dead Sea falls each year by 85 centimeters due to extensive water use in the Jordan basin. Irrigated soils along the Jordan valley show signs of salinization since natural floods are no longer available to flush the irrigated land and leach salts. One of the water resources, which need to be made available for irrigation purposes, is recycled water from municipal wastewater treatment plants. The total quantity of reused treated wastewater was around 50 million m^3 in the 90s, 73 million m^3 in 2000 and is expected to grow up to 237 million m^3 in 2020. Treated wastewater will be a main water supply resource to agricultural sector in coming years in Jordan. Jordan already uses some quantities of the wastewater generated in the country for agricultural purposes, but there are plans to further expand it, since demand for fresh water in cities is increasing in relation with the growing urban sector. Improper treatment of wastewater not only prevents efficient use in agriculture, but actually endangers the health of people. Therefore the need for efficient control and monitoring of wastewater treatment and reuse is of vital importance. Wastewater collection, transportation, treatment, disposal and reuse receive the greatest concern by the health authorities in the Ministry of Health (MOH). The MOH realizes that the protection and promotion of human health of the public cannot be guaranteed and safeguarded without monitoring wastewater treatment and controlling its use. Other responsible bodies are the Water Authority of Jordan, the Ministry of Environment, The Ministry of Agriculture and the National Center of Agricultural Research and Technology Transfer, the Ministry of Industry, and the Jordan Institution of Standards and Metrology.

Lebanon with a total area of 10 422 km^2, is situated east of the Mediterranean Sea. The total population is 3.6 million of which 13% is rural. The annual demographic growth rate is estimated at 1.65 %. Agriculture accounts for around 12 % of GDP. Lebanon has a relatively favorable position as far as its rainfall and water resources are concerned, but constraints for development exist due to the limited water availability during the seven dry summer months. The Ministry of Energy and Water, formerly known as the Ministry of Hydraulic and Electrical Resources, implements projects through its General Directorate for Hydraulic and Electrical Resources and it exercises its authority upon the Water Offices and Committees through its General Directorate for Operation. Autonomous Water Offices (drinking and irrigation offices), making a total of 21 offices, operate projects and distribute domestic and irrigation water to users, apart from the Litani River Authority, which organizes, prepares and implements its own integrated and multi-dimensional projects, according to its own terms of reference for hydro-agricultural and hydro-electric development of silt and water resources of basins of South Lebanon and Central as well as South Bekaa, including its mandate to run the national hydrometric network, and 209 local water management committees; all of which operate under the authority of the MEW. Other bodies involved are the Ministry of Interior and Municipalities and the various municipalities responsible for wastewater, the Council for Development and Reconstruction, that finances and implements infrastructure and rehabilitation, modernization and extension projects, the Ministry of Agriculture, the Ministry of Health, for the quality control of drinking water, the Ministry of Environment, the Ministry of Public Works, the National Meteorological Department of the General Directorate of Civil Aviation and the Investment Development Organization. Municipal wastewater management in Lebanon has been absent particularly during the many years of civil unrest a period in which existing treatment plants were destroyed and/or put out of operation. In other urban as well as rural areas, untreated wastewater is directly dumped into rivers, irrigation channels, valleys, and ravines as well as septic systems. This situation is now changing as the government has put forth an ambitious program for the construction of treatment plants, some of which are being constructed and are expected to go into operation soon.

Morocco is located in the north-west of the African continent with a total area of 450 000 km^2 (exc. W. Sahara) and 710 850 km^2 in total. The total population is 28.7 million of which 52% is rural. Agriculture accounts for around 10% of GDP. Over 50% of the precipitation is concentrated on only 15% of the country's area, [6]. At institutional level, water management is a shared responsibilty between the Ministry of Equipment (for resources mobilization, management and planning), the Ministry of Agriculture (which is the principal consummer and manager of the wetlands) and the Department of the Environment (which is responsible for the development of laws and standards with regards to discharges). On the administrative level, the General Directorate of Hydraulics, a department of the Ministry of Public Works, is in charge of the water resources management. The recent common practice for wastewater disposal is the direct reuse of the wastewater for irrigation. Most of the treatment plants are not operating adequately making wastewater unsuitable for unrestricted irrigation. A high percentage of citizens in urban areas are connected to the water network. However, in rural areas, this percentage was much lower (14% in 1990), but it constantly increases (40%) due to specific programs adopted by the national authorities, such as the "Program for the Supply of Drinking Water to the Rural Populations" (PAGER).

Palestine is located in the transitional zone between the arid desert climate of the Sinai Peninsula and the temperate and the semi humid Mediterranean climate and occupies an area of 6 020 km^2. The broad population characteristics of Palestine are strongly influenced by political developments, which have played a significant role in the growth and distribution of population in the Governorates. Until recently, the available demographic statistics about the Palestinian Territory have been characterized by the multiplicity and variation of its sources. After succeeding in executing the first Palestinian Census, highly accurate demographic data about the Palestinian Territory became available. According to the Palestinian Central Bureau of Statistics (PCBS) 2002, Palestine had a total population of 3 549 524 living in the two geographical areas, 64% in the West Bank including Jerusalem and 36% in Gaza Strip. This level is expected to reach 4,938,264 by the year 2010 assuming an average growth rate of (4.83-3.5) percent for the years (2000-2010), which is high above the world average of 1.5 percent. The growing population strains natural resources and the assimilative capacity of the environment. The situation of the sewerage system is extremely critical. Both the West Bank and Gaza are facing a series of wastewater and sanitation related problems. These are: large scale discharge of untreated wastewater, leaking of collected wastewater from sewer systems and cesspits, water treatment plants that are badly functioning and uncontrolled reuse of untreated wastewater by the irrigation sector. The total annual wastewater production in the area is estimated to be about 30 MCM. There is a strong need for appropriate management, for establishing sanitation infrastructures in rural communities and effective wastewater treatment plants and for promotion of sustainable practices for the protection of environment and public health. The institutes/organizations that are active in the field under examination are The Palestinian Water Authority, the Ministry of Planning, the Environmental Quality Authority, the Ministry of Agriculture, the Ministry of Local Government, the The Municipalities and the Village Councils, the Ministry of Health and the Coastal Municipal Water Utility.

Turkey with an area of 780 576 km^2, lies between Europe and Asia. The total population is about 68 million of which 34% is rural. The annual demographic growth is estimated at approximately 1.83%. Rainfall shows great differences from one region to another. In Turkey about 8.5 million ha of agricultural land is considered to be economically feasible to be irrigated, currently about half of this area is indeed being irrigated. In the southeast of the country, approximately 1.7 million hectares will be irrigated within the framework of GAP (The Project of Southeast Anatolia), involving some 13 major schemes/projects, [6]. Irrigation technique practices and excessive water consumption in irrigation leads to some serious problems such as erosion, water-logging, salinity and alkalinity problems etc. and reduces the success of irrigation coverage. These issues have also social, health and environmental aspects regarding the inhabitants in the region. The increasing need for irrigation systems encourages the specialists to focus on the topic and today, it is more evident that reclamation and reuse become an attractive option for conversing and extending available water resources in some cases. A number of governmental and non-governmental organizations have direct and indirect interest in the development and conservation of water resources in Turkey. The institutional framework has three levels; namely, decision making, executive and users level. In decision-making level, prime ministry, state planning organization and ministries take place. Governmental organizations under the ministries are at the executive level. There are both governmental and non-governmental organizations at the water users level for the operation and maintenance of the projects. The major ministries related with water, wastewater and agricultural irrigation and their responsibilities could be summarized as follows: The Ministry of Health has the responsibility of performing analysis related to water quality. The Ministry of Public Works and Settlement is in charge of financing water and wastewater infrastructures and giving technical support. The Ministry of Energy and Natural Resources is in charge of investigating, planning and managing of water resources for irrigation, community water supply and energy production. The Ministry of Environment and Forestry sets relevant standards for environmental pollution control, carries out inspection of pollution sources and routinely monitors the quality of water resources. The Ministry of Agriculture and Rural Affairs has the responsibility of determining and implementing plans and policies on agriculture and agricultural irrigation. The Ministry of Internal Affairs is responsible for the administrative management. The State Planning Organization prepares national development plans and programmes, and coordinates financial support for investments.

☙ Plans and Policies for the Future

In **Cyprus** the water shortage problem was identified and dealt in time. The slogan, *Not a Drop of Water to the Sea*, determines the water policy of the Government. In Cyprus, demand for water is expected to increase in the forthcoming years, while at the same time the capabilities for developing new water resources will be lessened. Therefore, in order to satisfy the increasing water demand and to eliminate the dependency of the towns and tourist centers on rainfall the Government has decided to proceed with the construction of seawater desalination plants. At the same time the Government has turned its attention to other non-conventional sources such as the use of recycled water for irrigation, recharge and amenity purposes, the desalting of brackish water, the changing of the cropping pattern to less water demanding crops, the introduction of new effective management procedures through the establishment of a Water Entity, the efficient use of available water including the better use of pricing and water conservation measures and the preservation of the water quality. But the implementation of short or long term projects will not solve the water shortage problem of Cyprus, unless everybody realises that water is a scarce resource and that all people have the responsibility and obligation to manage it correctly and to make every possible effort for its correct use and conservation. Undoubtedly water scarcity is the biggest and most difficult problem Cyprus is facing besides the political problem. There is no recipe for a permanent solution of the water problem of Cyprus. However, the long-term rational policy that has been followed has alleviated the problem and created all the necessary conditions for facing any future periods of drought. This project falls within the overall approach of the Ministry of Agriculture, Natural Resources and Environment for the protection of water resources, the control and monitoring of treatment plants and the utilization of the treated effluent in irrigation. Various projects are now under development which concern the improvement of agricultural practices, research on the potential use of treated sewage in agriculture and establishment of criteria on water requirements in agriculture.

It is apparent, by a simple comparison of the supply and demand, that the current water situation is not sustainable. The recent droughts of 1989/91 and 1995/2000 demonstrate quite convincingly how critical the water situation may become. A new water policy is warranted that will bring about sustainability. The new water policy should include the following specific measures, which should be holistically applied.

- Secure additional sources of supply
- Ensure efficient use of available water
- Modify the current irrigation water allocation matrix
- Built up strategic water reserves
- Maintain and enhance the quality of the water
- Introduce new effective/efficient management procedures through the establishment of a Water Entity

In **Jordan** treated wastewater from urban areas will play a key role in supplying the agricultural sector with water. This is one of the main research activities of the Water and Environment Research and Study Centre of Jordan. The urban sector is growing gradually and more wastewater is being generated. Numerous projects are undertaken concerning the construction and operation of wastewater treatment plants and sewer systems by the Ministry of Planning in various areas such Zarqa, Qwaismeh, Yajooz/Jubaih wastewater project, the Yajooz/Alrashid wastewater project, Baqa, Irbid, Wadi Mussa, Wadi Hassan, etc. The tools and methodologies that will be developed in this project will help the authorities to have continuous control and monitoring of all these treatment plants. In order to increase the use of treated wastewater in Jordan, decentralised wastewater treatment plants are also needed. It is the aim of the country to intensify agriculture in the vicinity of the treatment plants. Nevertheless, no matter how the reclaimed water is allocated the interrelated actions needed to support the use of reclaimed water can be listed in approximate order of priority according to the Ministry of Water and Irrigation:

- Support the farmers to improve on-farm water management, especially to deal with water quality issues. This needs a major integrated extension and applied research effort
- Enhance management of information, especially in terms of water quality, and make it available to farmers. Regular monitoring and reporting of soil and crop health needs to be introduced
- Control secondary faecal contamination sources in the basin
- Enhance the Jordanian standards and guidelines for water reuse and
- Control hazardous discharges to sewers and wadis more vigorously

An ongoing project that is currently taking place at national level is the evaluation of long term impacts of reclaimed effluent reuse for irrigation in the Jordan Valley. In addition to the aforementioned, at the Jordan University of Sciences and Technology, there is ongoing research on the impacts of the quality of wastewater reused for irrigation purposes on soil and the yield.

Lebanon is currently embarking on a massive program for wastewater treatment. More than eighty percent of the population will be served, generating approximately 640,000 m^3 of treated sewage daily, a highly considerable amount of effluent planned solely to be dumped into the sea. The amounts are so substantial that reusing even a percentage of it generates opportunities of tapping into a huge water resource that is basically being wasted. A water resource that may alleviate existing water imbalances and enable fresh water resources to be devoted to higher quality needs. The use of the treated water for the single largest water consumer in the country (namely irrigation) and in combating major problems resulting from seawater intrusion into fresh water aquifers along the Lebanese coast, are two applications that seem promising enough to justify an extensive study of the subject. The work basically encompasses a detailed planning and management study on water reuse in the country, and concludes with a layout of the usage options for the currently generated and projected wastewater treatment effluents. Optimal solutions as related to the reclamation and reuse or sea disposal of the water will be recommended based on economic, environmental, and social feasibility studies. Ongoing projects are:

- Wastewater treatment for the towns of Rabieh and Keyfoun, Lebanon
- Design of sewer network for Industrial Area at Baalbek, Lebanon
- Design of a Septic Tank System and Sea Outfall for a population of 30,000 at Nahr El Barid Camp, Lebanon
- Study of water and wastewater treatment for South Lebanon and the Bekaa regions under the Damage Assessment Studies, Emergency Recovery Program in Lebanon.
- Pre-feasibility study for wastewater management plan for Lebanon.
- Feasibility study for wastewater management for the City of Sidon and the surrounding area.
- Lebanon - National Environmental Strategy.
- Design of a Wastewater Treatment Plant for the Town of Laboue in the Bekkaa, Lebanon.

- Design of a Wastewater Treatment plant for the Town of Barouk in the Chouf, Lebanon.
- Construction of Zahle WWTP
- Tebbane Sewer and water supply networks
- Design of sewer network.& pumping station for 5 coastal treatment plants

The Moroccan Government's 1995 Environmental Strategy highlights water, air, solid waste and soil as its top environmental priorities in order. **Morocco** is forecast to enter water deficit by the year 2020, and water quality already is deteriorating due to the lack of industrial and domestic wastewater treatment. With only 5% of urban sewage being treated, Morocco needs treatment plants to serve the needs of millions of people. The targets of the government is to improve water resources management by strengthening policy, regulatory and institutional frameworks, promoting adoption of improved environmental technologies, and broadening public participation for environmental action, including urban housing and sanitation. Various projects helped towards increasing the efficiency of water use in irrigated agriculture by 20 percent in the Tadla irrigated region. In Morocco today 7000 ha are irrigated with untreated wastewater. A research project concerning wastewater reuse in El Jadida province was started recently at the Environment Faculty of Chouaib Doukkali University in cooperation with the Services des Experimentations, des Essais et Normalization of the Ministry of Agriculture. It is also worth mentioning that in Morocco, an agricultural-pastoral country, where water is scarce and half the population lives in rural areas, the interaction between humans and nature is particularly intense, for three reasons:

- For farming families, which make up 80 percent of the rural population, the place of residence is also the workplace, and the separation between life in the home and in the production site is not clearly marked, as it is in the city.
- Rural areas are directly exposed to constraints imposed by climatic variables and water supply, especially with respect to seasonal activities, income contingencies, and spatial mobility.
- The wide geographic dispersal of homes, encouraged by the customs of the country, with its inevitable negative consequences for basic infrastructure and various community installations, contributes to the socio-economic and cultural isolation of families, and is an obstacle to the overall development of the country. Families are forced to live under more traditional forms of life that is less open to modernity.

The objectives regarding wastewater are:

- Until 2005 and 2015, 90% and 95% respectively of the wastewater generated must enter the wastewater treatment network.
- The provision of all principal urban centres with wastewater treatment plants equipped with at least primary treatment before 2005
- Construction of complementary installations to perform secondary and tertiary wastewater treatment from 2005 to 2015.

Depletion of water resources and deterioration of water quality in both **West Bank and Gaza** are very important environmental themes that require direct and urgent measures. The lack of sufficient wastewater management is one of the largest causes of these problems. Groundwater resources are rapidly deteriorated by infiltration of untreated wastewater, influencing directly the quality and availability of this scarce and essential resource. Moreover lack of wastewater management has a direct impact on human health, marine pollution, and deterioration of nature and biodiversity as well as landscape and aesthetic distortion. The highest priority in the Environmental Strategy Plan is given to setting up an effective wastewater management system in both West Bank and Gaza. This includes:

- Maximization of collection of wastewater
- Upgrading the existing wastewater collection systems.
- Rehabilitation or upgrading of existing wastewater treatment plants or the construction of new treatment plants
- Establishment of proper standards for influent and effluent wastewater quality
- Establishment of a system in which the cost of investment and operation of the wastewater management systems are recovered.

Also, priority is given to the water resources management like for example reuse of treated wastewater for agricultural purposes, prevention of reuse of untreated wastewater, establishment of wastewater treatment standards in relation to allowed reuse by the irrigation sector. Ongoing projects concern the construction of sewer networks and wastewater treatment plants.

The Palestinian Water Authority (PWA) has considered the following three principal objectives for sustainable water resources management:

- Provide quantity and quality of water for domestic purposes in compliance with WHO standards.
- Supply adequate quality and sufficient quantity of water that is required for the planned agricultural production in Gaza Strip.
- Managing the aquifer at its safe yield and preventing further deterioration of the aquifer water quality.

Successful implementation of those issues will allow the maintenance of the water balance and the prevention of further deterioration of the aquifer. In parallel, clear and precise legislation and strict water sector implementation policies are mandatory for successful implementation.

In **Turkey** about 8.5 million hectares of agricultural land is considered to be economically feasible to be irrigated. Currently about half of this area is being irrigated. In the southeast of the country, close to 1.7 million hectares will be irrigated within the framework of GAP (The Project of Southeast Anatolia), involving some thirteen major schemes/projects. In Turkey, the national policies are designated according to the national development plans prepared by the SPO, (State Planning Organization). Each development plan is prepared for a period of 5 years and includes the principles, plans, and policies that will be applied within this time period for the sustainable development of the country. In the SPO's latest 5-year development plan, for the time period 2001-2005, the policies related to sewerage and wastewater treatment are stated as follows:

- The groundwater and surface water resources shall be protected against pollution, and the use of treated wastewater in agriculture and industry shall be encouraged.
- The society shall be informed about the effective use of water and also about the protection of the infrastructures and water resources; the press, both audio-visual and printed, shall be encouraged to run training programs on saving water.
- As regards to infrastructure facilities, suitable technology for settlement conditions shall be sought and used effectively, and the material and equipment requirements shall be met primarily from the domestic market

- The municipalities shall develop action plans for emergency supply of drinking water and waste disposal facilities in case the infrastructure is damaged due to a natural disaster.
- An effective control shall be carried out to prevent illegal use of water. The use of Supervisory Control and Data Acquisition systems by the metropolitan municipalities will be encouraged.
- In context with urbanization and to improve the quality of life, funds allocated for urban infrastructure shall be increased. Build-Operate or Build-Operate-Transfer models in new investments shall be encouraged with a view to ensure rational distribution of available resources. Facilities that are under construction will have a higher priority in resource allocation.
- Privatization of water and sewerage facilities shall be encouraged and the municipalities shall be restructured to act as supervisory bodies.

Available Funds for the Promotion of the Sustainable Treatment and Reuse of Urban Wastewater in the Med countries

The field of wastewater treatment and reuse of the effluent for agricultural purposes has received particular attention in the recent years and it is expected that the research activities for the development and application of innovative practices for the most efficient wastewater reuse will be further encouraged in the future. In this framework, many international opportunities for the acquisition of funding exist for the Mediterranean countries. More specifically, organizations such as the European Union (EU), the United Nations, the US Agency for International Development, the World Bank and the European Investment Bank promote and support financially research projects in several areas of interest including the environmental sector and particularly the wastewater treatment and reuse. This section seeks to briefly describe the most important instruments that could be utilized by the authorities, research institutions, universities and companies of the MEDA countries in funding their research and development activities.

- ✧ **The MEDA Program**

This program is the primary financial instrument currently in the European Union for the implementation of the Euro-Mediterranean Partnership, and it includes the provision of financial as well as technical support in the development of structures, and projects in the Mediterranean Countries, [7]. This program is under the responsibility of the Directorate General on External Relations of the EU. All countries under examination, namely Cyprus, Jordan, Lebanon, Morocco, Palestine and Turkey are eligible in acquiring financial support as well as collaborating with EU Member States in the development of various sectors of interest. The activities of the MEDA program have dual form, Regional and Bilateral. The regional co-operation seeks to address areas of common concern at a multilateral level, in the framework of the Barcelona Declaration as well as to develop closer and integrated collaboration between the EU Member States and the MEDA partners. Two main areas of activities are included in the context of the regional cooperation: 1) Economic dialogue, economic transition, industrial and private sector development programmes and 2) Environment and infrastructure support programmes. The latter are of particular concern for the purposes of wastewater treatament and reuse since it includes the Euro – Mediterranean Regional Program for Local water management. The main aim of this program is the achievement of the sustainable management of the water resources, with specific emphasis on the rational water planning and management and the generation of new water sources. Six main areas of action and four horizontal themes have been identified:

Areas of Action:

- Integrated management of local drinking water supply, sanitation and sewage
- Local water resources and water demand management (quantity and quality) within catchment areas and islands
- Prevention and mitigation of the negative effects of drought and equitable management of water scarcity
- Irrigation water management
- Use of non-conventional water resources
- Preparation of national and local scenarios for the period until 2025 that enable precise objectives to be set and actions to be taken for sustainable water management.

Horizontal Themes:

- Strengthening institutional capacities and training
- Exchange of information and know-how
- Transfer of know-how and technology;
- Awareness raising, mobilisation and promotion of commitment of the population.

✧ **The Short and Medium-term Priority Environmental Action Program (SMAP)**

This program is another EU instrument, also in the framework of the implementation of the Euro-Mediterranean Partnership, and concerns the protection of the Mediterranean environment, [8]. The main priority fields of action identified for this program include:

- Integrated water management
- Waste management
- Hot Spots (covering both polluted areas and threatened biodiversity elements)
- Integrated Coastal Zone Management
- Combatting Desertification.

With respect to the integrated water management, the actions that have been identified as extremely significant are:

- Evaluation and monitoring of water quality and quantity; assessment of potential (available and new) resources especially in critical areas (i.e. highly populated or with big seasonal increases of population, often due to tourism).
- Establishment and implementation of programs for the provision of safe drinking water, including the assessment of the micro-biological quality of drinking water supplies, and for waste water treatment systems in the Mediterranean, encouraging transfer of appropriate technology and know-how to this regard.
- Establishment and implementation of water conservation plans, including as mentioned in the Marseilles Water Conference, water sluicing techniques, 'upstream' soil saving and silt dredging.
- Protection of water reservoirs and wetlands and where appropriate establishment of river basin and catchment area management plans.

- Identification and use of measures and techniques for: (1) improved collection, treatment, disposal and re-use of municipal and industrial waste water, sludge and stormwater run-off , including the setting up of infrastructures for the treatment of urban sewage;(2) prevention of salinisation and treatment of brackish water.
- Establishment and implementation of programs to tackle water losses including rehabilitation of existing networks, leak detection, preventive maintenance, mapping and training and development of techniques to reduce irrigation inputs.
- Encouragement of decentralised authorities (e.g. river basin committees as appropriate, local bodies for water management etc) bringing together users and local communities on the basis of shared responsibilities, using appropriate measures to alter unsustainable water production and use patterns, with the aim of promoting the integrated local management of water.
- Re-organisation of the management of water resources leading, where appropriate, to the establishment of financially autonomous enterprises and other similar bodies with fully transparent management and cost-recovery mechanisms.

✧ The 6th Framework Program

This program is the EU framework program for research, technological development and demonstration, for which funding opportunities exist for various areas of concern including among others: Life sciences, genomics and biotechnology for health, Information society technology, Food quality and safety and Sustainable development, global change and ecosystems, [9].

Regarding wastewater treatment and reuse, particular interest is on the area of Sustainable development, global change and ecosystems, in which the aim is to strengthen the capacities and infrastructure to reach sustainable development. One of the funding instruments used to develop these as well as other areas of concern is international cooperation activities, in which among other, the Med countries can participate (Cyprus and Turkey may participate in the majority of the FP6 since they are associated one way or another to the EU). In the framework of the international cooperation activities for the Mediterranean countries the aim is to extend the research activities beyond the borders of the European Union. The fields of concern under the Mediterranean cooperation activities include: Environment: Integrated management of limited water resources, Protection and conservation of cultural heritage and Health.

The primary interest for water and wastewater issues is on the management of limited water resources, which is a key limiting condition for sustainable development, increased quality of life and peace. The focus is put on four key areas:

- Comprehensive policy for integrated water planning:
  - Improved water planning and management to enhance water supplies, with consideration for local physical and cultural conditions
  - Comprehensive planning of the interface between urban, industrial and agricultural water supplies
  - Developing comprehensive Decision Support Systems (DSS) through the use of area wide Geographical Information Systems (GIS) combined with remote sensing capabilities in support of analysis and enforcement as appropriate.
  - Understanding of transboundary water flows and quality problems and the promotion of co-operative policy initiatives
  - Study of alternatives for dispute resolution and for the management of conflicts involving a variety of stakeholders and a combination of diversity of uses.
- Improving the water consumption by users and uses and plant breeding for efficient water and nutrient use
  - Research on sustainable irrigation, including advanced modelling on irrigation and drainage scheduling (including supplemental and deficit irrigation), fertilisation and plant nutrition, as well as the utilisation of non-conventional water resources.
  - Management practices for more sustainable rain-fed agricultural systems
  - Development of improved plant crop germplasm more adapted to drought through multidisciplinary approaches, combining physiology, breeding and biotechnology expertise
  - Emphasis will be given to crops with strategic importance for the region.
- Advanced water treatment, re-use and energy implications
  - Efficient use of treated water and multiple use of water resources for a variety of uses

- Encouragement, support and promotion of institutional and legal mechanisms for water purification and reuse
- Establishment of public health standards for specific purification requirements with special reference to the corresponding economic and financial implications
- Technological innovations for alternative water supplies, including municipal and industrial wastes, drainage and saline waters
- Consideration of renewable energy resources (e.g. wind and solar energy) for increased water supplies, desalination and purification is highly relevant for all these activities
- Improvement of all types of energy related equipment for water purification, treatment and distribution systems
- Integrated approaches for appropriate waste water treatment through the use of renewable energy.

✧ **The Life Program**

This program is of concern for various Med countries like for example Cyprus, Turkey, Lebanon, Jordan, Gaza Strip and West Bank, Morocco, etc. It is another EU instrument to co-finance various environmental initiatives in the EU and certain third countries. Its priorities are the ones described in the 6th Action Program for the Environment of the EU, addressing the following main areas: Climate Change, Nature and Biodiversity, Environment and Health and quality of life, and Natural Resources and Waste, [10].

It is divided in three different domains, namely Life – Environment, Life 3rd Countries and Life – Nature. The specific objective of LIFE-Environment is to contribute to the development of innovative techniques and methods by co-financing demonstration projects. Five main areas are addressed via this instrument: land-use development and planning; water management; reduction of the environmental impact of economic activities; waste management; reduction of the environmental impact of products through an integrated product policy.

The objective of LIFE-3rd countries is to contribute to the establishment of capacities and administrative structures needed in the environmental sector and in the development of environmental policy and action programmes in third countries bordering on the Mediterranean and the Baltic Sea other than central and east European accession candidate countries. The priority areas include all aspects of sustainable development and all major environmental problems of the region.

- **The Global Environment Facility**

Global Environment Facility (GEF) was established, by the World Bank and the United Nations Development Program, as a joint international effort to help solve global environmental problems, [11]. It seeks to achieve high environmental goals such as:

- the protection of biological diversity
- the reduction of greenhouse gases
- the protection of international waters
- the protection of the ozone layer

The projects under the program International Waters enable countries to recognize and learn more about the water-related challenges they share, find ways to work together, and undertake important domestic changes needed to solve problems. The three categories of water projects are: water bodies; integrated land and water projects; and contaminants.

- **Other funding opportunities**

The World Bank as well as the European Investment Bank give opportunities for grants, loans and project funding in various sectors and areas of concern, [12, 13]. Other sources of international funding include the OECD and the United States Agency for International Development, [14, 15].

No specific instruments are devoted for the funding of environmental and other projects in these funding resources. However, via direct grants and procurement of services it is possible to propose and implement specific projects. Particularly the USAID publishes calls for proposal on several issues, in its website.

- **Specific information on various countries funding programs**

In *Cyprus,* by the year 2012 it is anticipated that an amount of 400 million Euro will be used on construction of Sewage Treatment Plants. At the moment research on sustainable treatment and reuse is in progress.

In *Morocco* various partnerships with economic operators, professional bodies and the Non-Governmental Organizations are being developed. In regards to international co-operation, both multilateral and bilateral partneships are being developed like for example copperations with the United States Agency for International Development "USAID", the World Bank, the German Agency of Financial Co-operation (KfW), etc. In addition to these, there are available funds for industrial depollution (FODEP). FODEP is an incentment tool, set up by the Department of the Environment with the support of the German Agency of Financial Co-operation (KfW), for the implementation of voluntary agreements for depollution or preserving of the natural resources.

International cooperation carries enormous potential benefits for environmental protection in *Palestine* where common problems and shared resources are subject to intense human pressures. The donor community has played, and will continue to play, a pivotal role in the quest for peace and environmental security. International aid to the Palestine during the interim period (1993-2002) has been crucial to finance the various investment programs in the West Bank and Gaza Strip, especially in the areas of water, wastewater and infrastructure where the need was paramount. Funding for wastewater projects and reuse could be enhanced by further commitments from the donor agencies such as (Mediterranean Action Program- MAP, United Sates Development Program, Arab States League, EU countries and various UN organizations).

The implementation of water/wastewater projects is important to improve the environmental situation in Palestine. Significant efforts are being placed by various Palestinian stakeholders to improve their planning capacity and improving their institutional efficiency through a regular developmental planning cycle. These efforts require constant feedback and will continue to improve as the planning cycles continue in the years to come. Therefore, it is necessary to have good coordination with the international donor communities and encourage their willingness to work within the planning framework set by the Palestinian institutions

Further, in face of the growing emergency humanitarian needs, it is important that water/wastewater projects are not neglected, but rather integrated into emergency response measures. Furthermore, environmental degradation will aggravate the humanitarian situation. It will be technically more difficult and more costly to resolve more acute environmental problems.

In *Turkey*, according to the Budget Law, environment related investments can be financed from several funds. The important ones are the funds allocated for the municipalities, special provincial administrations, special environmental protections, development of tourism, and local administrations. Until recently, the environmental pollution prevention fund was also active. However, since the World Bank and the IMF both expressed concerns regarding the management of this fund, it was terminated as of December 2001, with the accumulated funds being transferred to the National Budget. Funds resulting from taxes and fees mentioned can also be used for water treatment and supply, sewerage and sewage treatment projects. Moreover, the Bank of Provinces, (BoP) gives loans and grants to municipalities, makes advance payments, and serves as guarantor for foreign loans. Aside from BoP, municipalities can also borrow from foreign sources by the guarantees of the central government for their larger projects.

Turkey can also secure resources from international and national organizations and institutions such as the World Bank, United Nations, European Community (i.e. European Social Fund, European Regional Development Fund, Agricultural Orientation and Guarantee Fund), European Investment Bank (EIB), the METAP Fund (supported by UNDP, EU, EIB, and the World Bank), Islamic Development Bank, and Kuwait Development Fund for its environmental investments.

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EUROPEAN COMMISSION

EURO-MEDITERRANEAN PARTNERSHIP

Development of Tools and Guidelines for the Promotion of the Sustainable Urban Wastewater Treatment and Reuse in the Agricultural Production in the Mediterranean Countries

(MEDAWARE)

Task 1: Determination of the Countries Profile

PART A: GEOGRAPHY AND POPULATION

1. Geography and Population

1. Geography and Population

1.1 CYPRUS

1.1.1 Introduction

Republic of Cyprus is located at the East Mediterranean basin, 75 km south of Turkey, 105 km west of Syria, 380 km north of Egypt, 380 km east of Rhodes (Greece). Cyprus is the third largest island in the Mediterranean and is situated at geographic latitude of 35 degrees north and longitude 33 degrees east. The maximum length of the island is 224 km from east to west and the maximum width is 96 km from north to south.

Cyprus became an independent Republic in 1960. The economic growth of the country was interrupted in July 1974 by the Turkish invasion, which resulted in the occupation of about 36% of the territory of the Republic, the displacement of one third of the population from their homes.

The Administrative Districts are the following:

- Lefkosia (partly occupied)
- Ammochostos (mainly occupied)
- Lemesos
- Pafos
- Larnaca
- Kyreneia (occupied)

The location of the districts is presented in the map below (Figure 1).

1.1.2 Total area of the country

The total area of Cyprus is 9,251 km2, of which approximately 18% is covered by forests. These include forests of conifers, such as Calabrian pine, Black pine, Cedar, Cypress and small scale plantations of Eucalyptus. Cultivated land represents approximately 67% of the total agricultural land, uncultivated land 30%, while the rest 3% is fallow land.

Figure 1: Map of Cyprus

1.1.3 Description of borders

Mediterranean Sea.

1.1.4 Description of landscape

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. The central Troodos massif, rising to 1951 m and, to a less extent, the long narrow Kyrenia mountain range, with peaks of about 1000m.

1.1.5 Total population[1]

Cyprus, which is not under the Turkish occupation consist of 5 Districts. These are Lefkosia District where the capital city is located, Limassol, Larnaka, Pafos and Ammochostos. The location of the districts is presented in the map above (Figure 1). It is worth noting that half of the area of Nicosia District is under the Turkish occupation as well as the 2/3 of Ammochostos District. The analysis of the population by district follows.

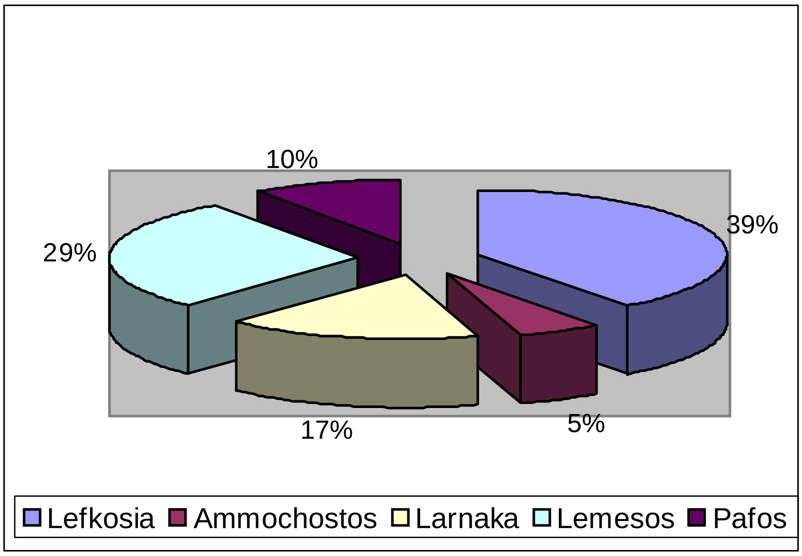

Figure 2: Population by District

The data presented in the Table 1 and 2 below are collected from the Statistical Service of Cyprus. The latest data refer to the census of population 2001.

Table 1: Census of population 2001 (compared to Census of 1992)

Population by district	Census 1992	Census 2001	% change
Lefkosia	244.779	273.642	11,8
Ammochostos	30.798	37.738	22,5
Larnaka	100.242	115.268	15,0
Lemesos	173.634	196.553	13,2
Pafos	52.572	66.364	26,2
TOTAL	**602.025**	**689.565**	**14,5**

Source: Census of population 2001, Statistical Service.

[1] Note: Population does not include more than 115,000 Turkish settlers illegally residing in the Turkish-occupied part of Cyprus

The total population enumerated in the government-controlled area was 689.565, showing an increase of 14,5% since 1992. Based on a post enumeration survey that took place after the census, it was estimated that about 1,98% of the population was not enumerated (they were absent, not recorded, did not respond, etc), thus raising the population figure to 703.500 on October 1st, 2001, compared to 615.000 in 1992.

Only a marginal increase in the drift of the population to the cities was recorded over the last few years, since the percentage of the population in urban areas reached 68,8% from 67,7% in 1992 and 63% in 1982; in other words, it has been observed that, in general, the population in rural areas was maintained, even though in mountainous villages a decrease in the number of residents continued to take place.

The density of the population in Cyprus is 114 people per square Kilometer (ranges from 47 to 154 in Pafos and Ammohostos district respectively). In Urban areas the density of the population is 894 per square Kilometer (ranges from 1286 in Nicosia to 437 in Pafos). In rural areas the density of the population is 39 per square Kilometer (ranges from 154 in Ammochostos to 15 in Pafos).

Table 2: Population by District and Density (1st October, 2001)

District	District	Population	Density (per sq km)
TOTAL	Lefkosia	273.642	141
	Ammochostos	37.738	154
	Larnaka	115.268	111
	Lemesos	196.553	139
	Pafos	66.364	47
	TOTAL	**689.565**	**114**
URBAN	Lefkosia	200.686	1.286
	Ammochostos	n/a	n/a
	Larnaka	70.502	570
	Lemesos	156.939	1081
	Pafos	46.323	437
	TOTAL	**474450**	**894**
RURAL	Lefkosia	72.956	41
	Ammochostos	37.738	154
	Larnaka	44.766	49
	Lemesos	39.614	31
	Pafos	20.041	15
	TOTAL	**215.115**	**39**

Source: Census of population 2001, Statistical Service

1.2 JORDAN

1.2.1 Introduction

The expanding population and the climatic and topographical conditions of the country have exerted enormous pressure on the limited water resources and created a severe water supply-demand imbalance where the renewable water resources are among the lowest in the world, and is declining with time. Resources are already seriously limited and are far below under the water poverty line of 1000 m^3 per capita per year. On a per capita basis, available water from existing renewable sources is projected to fall from 160 m3 /capita/year in 2002 to 90m^3/capita/year by the year 2025. The supply-demand imbalance has influenced the quality of water resources where over abstraction from groundwater aquifers exploited the aquifers at more than double their sustainable yield in the average.

Water resources consist primarily of surface and ground water resources, with treated wastewater being used on an increasing scale for irrigation, mostly in the Jordan Valley. Renewable water resources are estimated at about 780 MCM per year .

Treated wastewater generated at nineteen existing wastewater treatment plants is an important component of Jordan's water resources. About 73 MCM per year (2002) of treated wastewater are effectively discharged into the watercourses or used for irrigation, about 76% is generated from the biggest wastewater stabilization pond Al-Samra treatment plant. By the year 2020, when the population is projected to be about 9.9 million, about 240 MCM per year of wastewater are expected to be generated.

The Ministry of Water and Irrigation strategy is to fully use the wastewater effluent for restricted irrigated agriculture. Implementing this strategy necessitates that the qualities of the wastewater effluents meet the Jordanian reclaimed domestic wastewater standards (893/2002) and WHO guidelines for irrigation water quality. The Ministry has adopted a new overall water strategy and new policy statements in four water sub-sectors: utilities, irrigated agriculture, wastewater management, and ground water management. Taken together these five documents strongly suggest that the government is committed to:

- Maximize the integrated socio-economic returns to water,
- Sustain irrigated agriculture in the Jordan Valley,
- Increase wastewater services and manage wastewater so that it can be available for irrigated agriculture,
- Protect the quality of ground water and,
- Limit the abstraction of ground water to sustainable yield.

In this regard the highest priorities are given for upgrading the existing treatment plants and the monitoring facilities to fully comply with the effluent water quality standards.

1.2.2 Total area of the country

Jordan, with a total area of about 89 210 km², lies to the east of the Jordan river and is divided into eightgovernorates: Amman, Zarqa, Irbid, Mafraq, Balqa, Karak, Tafileh and Ma'an.

1.2.3 Description of borders

It is bordered in the north by Syria, in the north-east by Iraq, in the south-east and south by Saudi Arabia, in the far south-west by the Gulf of Aqaba (northern shores of the Red Sea) and in the west by Israel.

Figure 3: Map of Jordan

1.2.4 Description of landscape

The country can be divided into four physiographic regions:

- the Ghors (lowlands) in the western part of the country, which consist of 3 zones: the Jordan valley which starts at Lake Tiberias in the north (220 m below sea level), the lowlands along the Dead Sea (405 m below sea level) and the Wadi Araba which extends in a southerly direction to the northern shores of the Red Sea (total area: 5 000 km²);
- the highlands, which run from north to south at an altitude of between 600 and 1 600 m above sea level (total area: 5 510 km²);
- the plains, which extend from north to south along the western borders of the desert (Badiah) (total area: 10 000 km²);
- the desert region (Badiah) in the east, which is an extension of the Arabian desert (total area: 68 700 km²).

1.2.5 Total population

The total population is 5329000. Table 3 gives information on the estimated population by governorate and sex for 2002.

Table 3: Population by Governorate and Sex, 2002

Governorate	Male	Female	Total	%
Amman	1,061,890	965,795	**2,027,685**	38.05
Balqa	183,880	165,700	**349,580**	6.56
Zarqa	436,900	401,350	**838,250**	15.73
Madaba	70,815	65,075	**135,890**	2.55
Irbid	492,270	458,425	**950,695**	17.84
Mafraq	128,685	116,980	**245,665**	4.61
Jarash	81,550	75,125	**156,675**	2.94
Ajloun	60,300	85,005	**118,305**	2.22
Karak	111,995	102,230	**214,225**	4,02
Tafielah	42,160	38,840	**81,000**	1.52
Ma'an	56,350	47,565	**103,915**	1.95
Aqaba	60,320	46,795	**107,115**	2.01

1.3 LEBANON

1.3.1 Introduction

The republic of Lebanon is located on the eastern coast of the Mediterranean Sea in Southwest Asia and it is situated at geographic latitude of 33 50 N, 35 50 E. Lebanon's coastal location, high mountain backbone, and climate have greatly influenced the country’s history, people, and economy. Lebanon is a relatively small country of only 10,422 km^2 (*water:* 170 km^2 *land:* 10,252 km^2). From north to south it extends 220 km and from east to west it spans 80 km at its widest point. The country is bounded by Syria on both the north and east and by Israel on the south. During World War II (1943), Lebanon became an independent republic and for three decades prospered under a free-market economy. Domestic and regional tensions, intensified by foreign influences, erupted into the devastating Lebanese Civil War that extended from 1975 to 1990.

The fifteen-year civil war seriously damaged Lebanon's economic infrastructure; however, Lebanon's economy made impressive gains since the launch, in 1993, of "Horizon 2000", the government's $20 billion reconstruction program which among other projects included the reconstruction of the water and wastewater sectors. Lebanon’s GDP has reached $18.8 billion in the year 2001, of which agriculture covered around 12 %. Domestic wastewater management is one of the greatest problems that face the Lebanese municipalities and concerned ministries (Ministry of Energy and Water, CDR). Lebanon generates an estimated 249 million m^3 of wastewater per year, with a total BOD load of 99,960 tonnes. Industries generate an extra load estimated at 43 million m^3 of wastewater per year.

1.3.2 Total area of the country

The total area of Lebanon is 10,422 km^2 (about 4,000 square miles/1,040,000 ha).

1.3.3 Description of borders

The country overlooks the eastern coast of the Mediterranean Sea, and falls between Israel from the south and Syria from the north and east.

1.3.4 Description of landscape

In general, it is a mountainous state consisting of the following physiographic units: the Coastal Plain, the Western Mountains (Lebanon Range), the Eastern Mountains (Anti-Lebanon Range), and the Bekaa Plain. The Coastal Plain runs for 220 km and has a width of 2 to 3 km. The Western Mountains run parallel to the coast. They have an elevation peak at 3088 m above sea level called El-Qurnat El-Sawda, and they loose elevation in the south to reach only 600 m near Marjayoun. The Eastern Mountains run parallel to the Western Mountain Range. Their elevation reaches 633 m at Tala’t Moussa and 2814 m at Mount Hermon at the end of the range in the south. As for the Bekaa Plain, it is a collapsed depression between the Eastern and Western Mountain Ranges. Its width in the south does not exceed several kilometers, but it gets wider in the north to reach 20 km near Lake Homs.

The elevation of this plain ranges between 900 and 1100 m above sea level (ACASD, UNESCO-ROSTAS, IHEE, 1988).

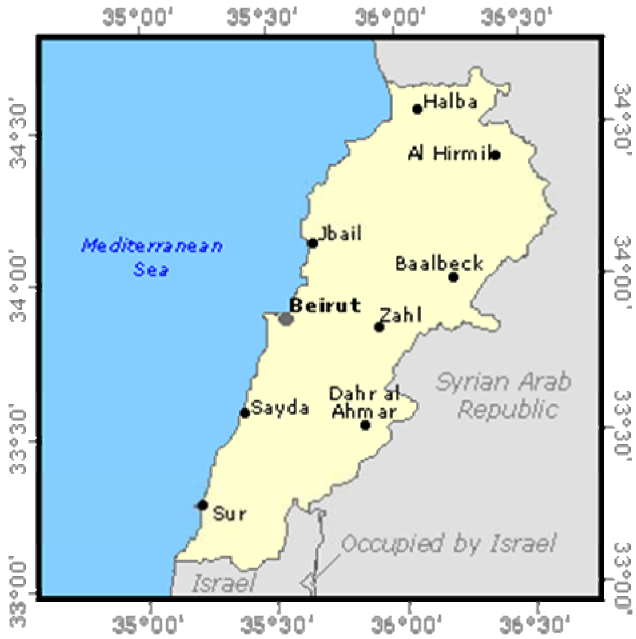

Figure 4: Map of Lebanon

1.3.5 Total Population

The total population of Lebanon was estimated to be 3,614,000 people in 2002, composed of 1,770,000 males (49.0 %) and 1,843,000 females (51.0 %) (ESCWA, 2002). Population size is increasing at the rate of 1.65 % yearly, implying about 66,000 net births in 1999. Average life expectancy is 71.3 years; it is lower in the North (68.5 years) and higher in Beirut (74.5 year) (MOE, 2001).

The total population of Lebanon increased by almost a million people between 1980 and 2000 and is projected to reach 4,581,000 by 2025. The proportion of males is slightly less than the proportion of females; this may be explained by the excessive immigration of young males and the 17 years of civil war, which resulted in many casualties, mostly of the male population.

Table 4: Population Estimates for the Years 1996, 1997, and 2001

Mohafaza/Caza	*MOSA Survey Estimates [1/]*		*CAS Population Estimates (1997) Percent Distribution [2/]*		*SOER Population Estimates (2001) [3/]*	
	Population Estimates (1996)	*Average Household Size (1996)*	*Population*	*Percent*	*Population*	*Percent*

Beirut	**407,403**	**4.1**	**403,337**	**10.20%**	**429,777**	**10.10%**
Mount Lebanon	**670,610**	**4.4**	**1,507,559**	**37.60%**	**1,606,383**	**37.60%**
Jbeil	62,407	4.7				
Kesrouan	123,600	4				
Metn	367,150	4.2				
Baabda	371,882	4.7				
Aaley	99,947	4.4				
Chouf	120,473	4.6				
North	**670,610**	**5.3**	**807,204**	**20.20%**	**860,118**	**20.10%**
Akkar	198,174	6				
Tripoli	227,857	5.2				
Minieh-Dinnieh	96,417	5.7				
Zgharta	48,974	4.6				
Bcharre	16,831	4.7				
Koura	47,540	4.4				
Batroun	34,817	4.6				
Bekaa	**399,891**	**5**	**530,448**	**13.20%**	**574,810**	**13.50%**
Hormel	38,975	5.8				
Baalbeck	157,049	5.3				
Zahle	124,336	4.6				
West Bekaa	55,692	5				
Rachaiya	23,839	5				
South	**283,057**	**4.9**	**472,105**	**12%**	**503,053**	**11.80%**
Jezzine	14,626	3.5				
Saida	138,348	4.9				
Sour	130,083	5.1				
Nabatiyeh	**205,412**	**4.6**	**275,372**	**6.80%**	**293,423**	**6.90%**
Hasbaya	19,460	4.3				
Bint Jbeil	52,710	4.8				
Marjayoun	40,879	4.5				
Nabatiyeh	92,363	4.7				
Total	**3,111,832**	**4.7**	**4,005,025**	**100%**	**4,267,564**	**100%**

* Modified table adopted from '*State of the Environment*' report, MOE (2001)

1/ MOSA/UNDP, 1996

2/ NO.9, 1998

3/ Population estimates for 2001 (unofficial records)

This ratio varies slightly according to the age group. Moreover, the population by age groups between 1970 and 1997 reveals that the population is becoming older. In 1997, more than half of the population was in the 20-59 years age (MOE). Population size in Lebanon as varied by age group and gender, along with other demographic profiles, are found in Appendix A.

About one third of the total population of Lebanon resides in Beirut and its suburbs (Table 1). After the expansion of the Beirut suburbs, Beirut proper accounts now for only 10% (1997 statistics). Within the Beirut suburbs, the highest proportion of the population resides in Chiah, Furn El Chubak, Sin el Fil and Bourj Hammoud, defined as the Northern and Southern Beirut Suburbs.

Other population characteristics are given below:

Table 5: Population Size in Lebanon (by Sex)

Year	*Males %*	*Females %*	*Total (Thousand)*
1980	49.15699	50.88048	2,669
1985	48.31334	51.64918	2,668
1990	48.54405	51.45595	2,713
1995	48.75355	51.24645	3,169
2000	48.94165	51.08696	3,496
2005	49.08706	50.91294	3,779
2010	49.19094	50.78417	4,017
2015	49.32448	50.67552	4,219
2020	49.42164	50.57836	4,409
2025	49.50884	50.49116	4,581

* Modified table adopted from ESCWA, 2002

Table 6: Population by Age Group and Gender (1997)

Age Group	*Total (1997)*	*Male*	*Female*
0-19	1,558,083	51.5	48.5
20-39	1,342,447	49.5	50.5
40-59	703,997	48.6	51.4
Above 60	391,232	51	49
NID	9,286	35.5	64.5
Total	**4,005,025**	**50.2**	**49.8**

* Taken as is from CAS study, No.9/1998

Table 7: Demographic profiles 2000-2020

Indicator	*2000-2005*	*2005-2010*	*2010-2015*	*2015-2020*
Population change per year (Thousands)	57	48	41	38
Births/year, both sexes (Thousands)	69	69	68	66
Death/year, both sexes (Thousands)	20	21	23	25

Population growth rate (%)	1.56	1.24	1.01	0.87
Crude birth rate (per 1,000 population)	19.1	17.8	16.6	15.4
Total fertility rate (children/women)	2.18	2.08	2	1.92
Life expectancy, males (Years)	71.9	72.7	73.2	73.7
Life expectancy, females (Years)	75.1	75.9	76.7	77.5

***** Taken as is from UNPD World population Prospects: the 2002 Revision Population database

1.4 MOROCCO

1.4.1 Introduction

Morocco is located in the north-western corner of the African continent. It enjoys a privileged position with two maritime frontages opening on the Mediterranean in the north and in the Atlantic Ocean in the west.

1.4.2 Total area of the country

The total surface of the Kingdom of Morocco reaches 710.850km^2.

Figure 5: Map of Morocco

1.4.3 Description of borders

Morocco is located at the north-west corner of the African continent, between the 36th and the 21st parallel. Morocco is delimited in the north by the Straits of Gibraltar and the Mediterranean, in the east by Algeria, in the west by the Atlantic Ocean and in the south by Mauritania. The maritime frontage of Morocco extends on around 3.416km of which:

- 512km on the Mediterranean coast in the north, from Saidia to Cape Spartel
- 2.934km on the Atlantic Ocean coast in the west, from Cape Spartel to Lagouira.

1.4.4 Description of landscape

A major part of the surface of Morocco is covered by mountains. The Moyen-, the Haut- and the Anti- Atlas, major mountain ranges, reach 2.000 to 4.000m. The highest peak, the Toubkal, located in the Haut Atlas, reaches 4.165m. The Anti-Atlas, in the south, constitutes a lower mountainous border. In the Middle, the mountains ranges of Rif are the prolongation of the Betique cordillera of south Spain.

In the north, the mountains of Rif, separated from the Atlas by the gorge of Taza, extend to the Mediterranean.

In the edge of the Atlas, western Morocco consists of vast plates (Rharb, Chaouïa, Haouz and Souss). In the east, a plate of 1300m altitude separates Morocco from Algeria. The Sahara desert begins in the south of the country. Morocco includes a vast Saharan and pre-Saharan zone beyond the Atlas mountain chains. This zone connects Morocco to the Black Africa, the Mauritania.

Thanks to the snowing up of its mountains, the Kingdom is drained by long well-alimented rivers. The Moulouya is discharged in the Mediterranean, while the Sbou, the Bou-Regreb, the Oum er-R' bia, the Tennsift and the Souss in the Atlantic Ocean. The Saharan rivers, like Draa or Dadès, are intermittent in their lower flows.

1.4.5 Total population

Morocco is a composite society. One third of the population speaks berber, language which is distinguished in three sub-groups: the *tarifit* (RIF), the *tamazight* (Moyen Atlas) and the *tachelihit* (Haut Atlas, Anti-Atlas, Souss). The Arabic-speaking people, who constitute two thirds of the population, are in their great majority Berbers who have been arabized. The Jewish population from various origins has substantially been reduced after the massive emigration to Israel, France and Canada. Europeans, approximately 500.000 before the independence, do not exceed today 100.000. Approximately 1.8 millions Morrocans (7,6% of the working population) live abroad, the majority of them in France. In 1997, the total population was estimated at 28,2 millions. The Moroccan rural population is estimated at 48% of the total, (1994).

Table 8: Data on the population of Morocco (Ministry of Communication)

	Year 2000
Surface	710 850 Km^2
Total population (thousands)	28 705
Population density ($/km^2$)	40,4
Urban population (%)	55,2
Female population (%)	50,2
Age distribution of the population (%)	
- less than 15 years old	32,3
- less than 25 years old	53.6

- 25-59 years old	39.1
- 60 years old and more	7,3
Households (thousands)	5 211
Average size of households	5,5
Rate of natality (p. thousand)	21,9
Rate of mortality (p. thousand)	5,9

The particularly fragile, vulnerable and very coveted marine zone, is under an increasing pressure due to the population concentration, socio-economic activities and the existing infrastructures situated along the coastal zone. Thus, the extension of an unhealthy environment, the deficiency of liquid and solid treatment and the absence of treatment plants generate large quantities of liquid waste which are the source of the pollution problems and the degradation of the coastal environment.

In addition, the geographical distribution of the industrial activities of Morocco is characterized by a strong concentration in the Atlantic zone and mainly on the axis Kenitra-Casablanca. The principal industrial sectors which are located there are: the agro alimentary, the textile, the chemical, para-chemical, mechanical and electrical industry.
The Moroccan coastal Atlantic zone concentrates:
61% of the total urban population of the large cities
80% of the permanent labor of the industries
53% of the touristic capacity
92% of the sea traffic

In the Mediterranean coastal zone, the industries are concentrated in the west coast in the urban agglomerations of Tangier and Tetouan. The western Mediterranean, which is the most urbanized one, the conflict between tourism, agriculture and industry is ever intensifying.

1.5 PALESTINE

1.5.1 Introduction

The Palestinian territories consist of two physically separated areas, of Gaza Strip and the West Bank including east Jerusalem. A lot can be written about the extreme variety of the Palestinian geography. The Palestinian land includes mountains over 1000 meter high above sea level on one hand, and desert at 401 meters below sea level on the other hand. Palestine has a narrow, but very nice shoreline on the Mediterranean. This shoreline called Gaza Strip, which considered one of the most high populated areas worlds wide.

1.5.2 Total area of the country

It is necessary to recognize that to give an accurate number which could illustrate the precise area of Palestine is too difficult, because of the non stable political situation and the non finished peace process negotiations. However the Palestinian Central Bureau of Statistics made a solid report (land use statistics in the Palestinian Territory, 1999 – 2000) which clarified that, Palestine occupies an area of 6020 km^2.

Table 9: Area of land by type of the use, 2000

Region /Governorate	Total (km^2)	Other land* (km^2)	Built up land in Israeli Settlements (km^2)	Palestinian Built up Land (km^2)	Forest and Wooded Land (km^2)	Agricultural Land (km^2)
Palestinian Territory	6020.0	3682.7	146.0	585.7	90.8	1514.8
West Bank	5655.0	3519.0	128.3	531.9	87.6	1388.2
Gaza Strip	365.0	163.7	17.7	53.8	3.2	126.6

* It includes heath, pastures, meadows, fallow land and others.

Source: (PCBS, April, 2002).

1.5.3 Description of borders

Palestine is located to the Eastern Shore of the Mediterranean, between 29.30 – 33.15 North and 34.15 – 35.40 East. The Palestinian Territories are made up of two geographical regions, Gaza Strip and the West Bank, which are separated by Israel.

Palestine is bordered by Israel on the north, Egypt on the south, Jordan on the east, and the Mediterranean Sea on the west. (Figure 6).

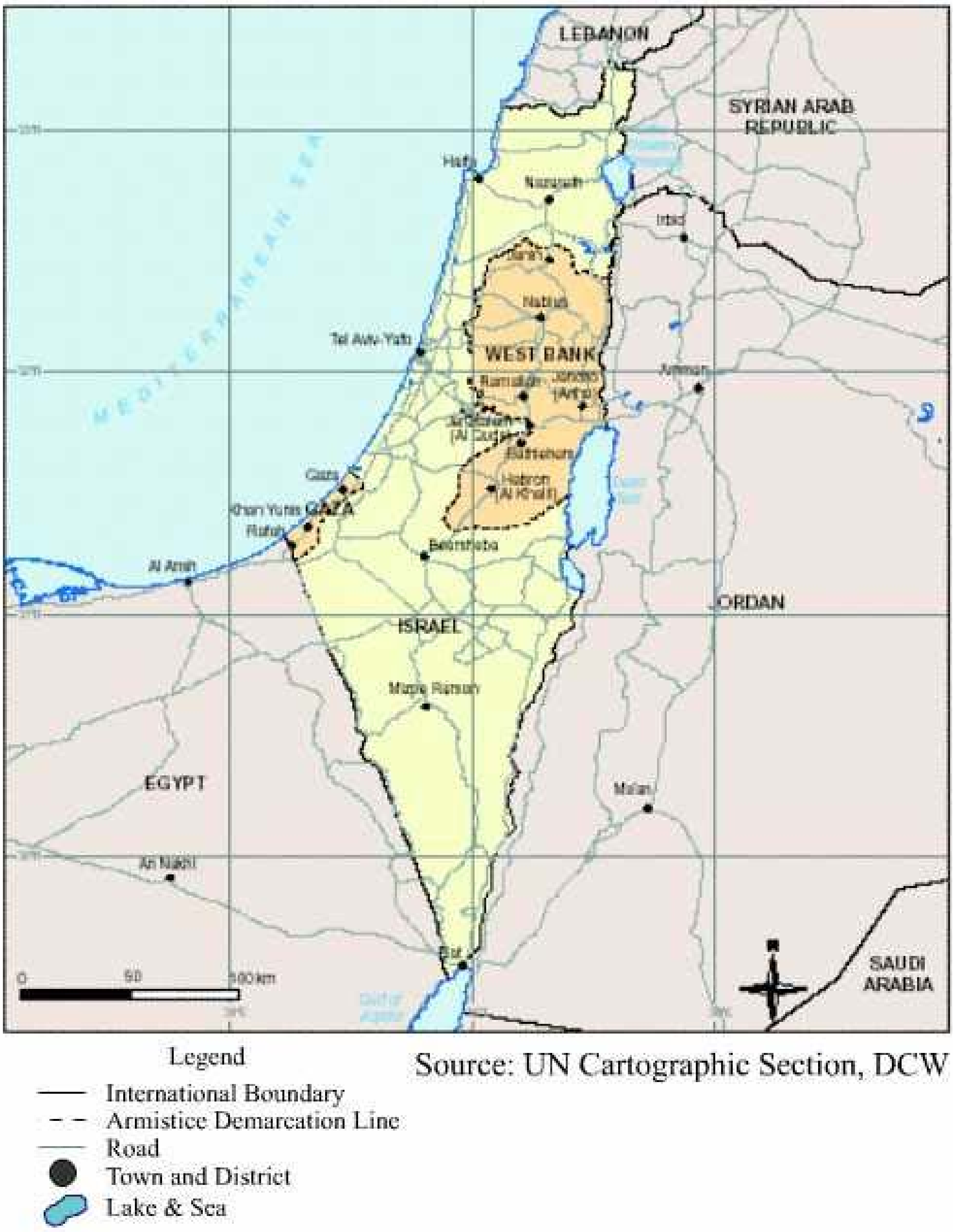

Figure 6: Map of Palestine

1.5.4 Description of landscape

Palestine is a land of extreme diversity. The terrain ranges from the jungles of Jenin and Nablus in the north, to the dry desert near the Dead Sea and Gaza's sand dunes in the south. The West Bank is mostly composed of limestone hills that are between 700 to 900 meters high. The highest point is called "Tall Asur" at 1,022 meters above sea level, while, the oasis of Jericho which at 401 meters below sea level is the lowest place on Earth. The central highlands of the West Bank consist of semi-arid rocky slopes, an arid Jordan rift valley and rich plains in the north and west. Brown lithosols and loessial arid brown soils cover the eastern slopes and grassland, with pockets of cultivation spreading over the steep slopes.

Figure 7: Landscape of Hebron, (West Bank)

Fertile soils are found in the Palestinian plains. Gaza is a narrow (6-12 km wide), low-lying stretch of sand dunes along the eastern Mediterranean Sea. It forms a foreshore plain that slopes gently up to an elevation of 90 meters.

1.5.5 Total population

The broad population characteristics of Palestine are strongly influenced by political developments, which have played a significant role in the growth and distribution of population in the Governorates. According to (PCBS, 2000) Palestine has a total population of 3,224,504 living in the two geographical areas, 64% in the West Bank including Jerusalem and 36% in Gaza Strip, it is important to mention that population of Gaza Strip are considered as a costal zone residents. Today Palestine has a very young population in comparison with other countries, 47% of the population is 14 years or younger. As much as 18% of the Palestinian citizens are 4 years or younger. In addition, Palestine has an average of nearly 6.4 persons per household.

The estimated population growth in Palestine has declined from 5.2% in 1995 to 3.1% in 2000. The total number of population is expected to reach 4,938,264 by the year 2010 assuming an average growth rate of 4.83-3.5 percent for the years 2000-2010.

Table 10: Projected Population in the Palestinian Territories in the End Year by Region, 1997-2003

Year	Palestinian Territory	Region	
		West Bank	Gaza Strip
1997	2,840,269	1,822,717	1,017,552
1998	2,958,579	1,895,255	1,063,324
1999	3.084,881	1,972,284	1,112,597
2000	3,224,504	2,057,145	1,167,359
2001	3,381752	2,152,501	1,229,251
2002	3,549,524	2,253,734	1,295,790
2003	3,721,544	2,356,811	1,364,733

Source: Statistical Abstract of Palestine NO.(3), November,2002

In addition, according to (PSBC, 2000), there are 708 localities in the Palestinian territories. 605 of them are rural in which 805,360 households' people live. According to (PCBS, 2002) estimations, Palestine has a total population of 948,232 living in the rural areas. These people form about 31% of population. In Gaza Strip, 63.6% of the population lives in urban areas, 5.3% in rural areas while 31.1% do live in refugee camps.

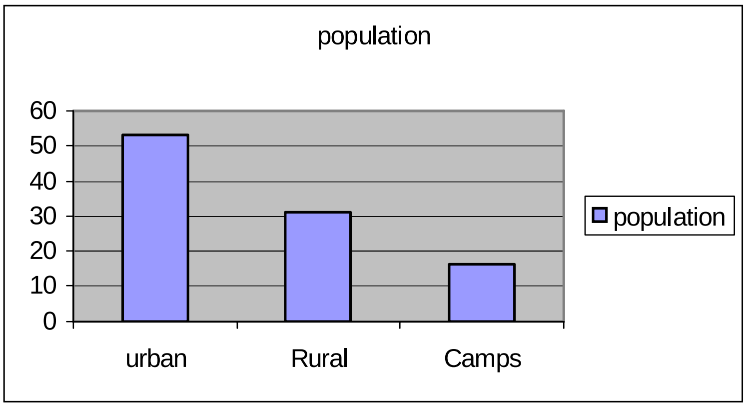

Figure 8: Percentage Distribution of Population by Type of locality-2000.

Source: (PCBS) Population Housing and Establishment Census 1997, January 2000.

*Camps: Refugees Camps.

Population density in the Gaza Strip is very high compared with that in the West Bank and the neighboring countries.

Table 11: Area and Population Density in the Palestinian Territory, 2000

Governorate	Area (km^2)	Number of Population	Population Density (Person/km^2)
Palestinian Territory	6,020	3,224,504	535.6
West Bank (including East Jerusalem)	5,655	2,057,145	363.8
Gaza Strip	365	1,167,359	3,198.2

Source: PCBS, 2000.

1.6 TURKEY

1.6.1 Total area and description of borders

Turkey occupies a unique geographical and cultural position at the cross-roads between Europe and Asia. Geographically, the country is located in the northern half of the hemisphere at a longitude of 36º N to 42º N, and a latitude of 26º E to 45º E. Turkey is roughly rectangular in shape and is 1660 km long, and 550 km wide. Turkey has a total land area of 780 576 km^2, of which 23 271 km^2 (3% of total area) is located in Europe and called Thrace and 756 855 km^2 (97% of total area) is located in Asia and known as Anatolia. Country's population is concentrated in the west and along the coastal areas. Although Ankara is the capital city, Istanbul has the largest population (www.turkey.org/countryprofile).

Turkey has long borders due to its geographical location and topography. The borders are 8 522 km in total; 2 573 km of which constitute the land borders, and 5 769 km constitute coastlines. The country shares land boundaries with Greece and Bulgaria in the northwest, Georgia, Armenia and Azerbaijan in the northeast, Iran in the east and Iraq and Syria in the southeast (www.mfa.gov.tr/grupc/ca/caa/a11.htm).

Figure 9: Map of Turkey

Turkey is surrounded by the Black Sea in the north, the Mediterranean in the south, and the Aegean Sea in the west. In the northwest there is also an internal sea, the Sea of Marmara, between the straits of the Dardanelles and the Bosphorus, important waterways that connect the Black Sea with the Aegean Sea.

1.6.2 Description of landscape

Anatolia is a high plateau region, rising progressively towards the east and broken by the valleys of some 15 rivers, including the Tigris and the Euphrates. It is fringed in the north by the Koroglu Mountains and in the south by the Taurus Mountains. There are numerous lakes including Tuz, Beysehir and Lake Van.

The elevation rises from west towards east and stabilizes at around 800 m above sea level in the Central Anatolian Plateau. Further east, the elevation increases and reaches 2000-2200 m on the average in Eastern Anatolia, while it drops to 700-500 in Southeast Anatolia. Despite the existence of broad plains and plateaus, the topography is largely hilly and mountainous across Turkey as a whole.

Nearly 63% of the land has slopes steeper than 15% in average, even in the coastal areas. Average altitude is 1132 m and only 10% of the country is less than 250 m above sea level. High mountains are concentrated in central and eastern Anatolia.

The high plains of Eastern Anatolia are generally large areas for animal husbandry, but there are lower, warmer and more fertile plains such as the Igdir plain. The rivers that originate in this region, like Euphrates and Tigris, flow south as the elevation decreases rapidly. They are born in the South Eastern Anatolia region and, forming Upper Mesopotamia, and leave Turkey. The highest mountain of Turkey is the Mount Ararat in the east (5 166 m), and it is not far from the lake Van, the biggest lake of the country.
In the Black Sea region, Northern Anatolia Mountains run parallel to the coastline in an east-west direction. Therefore the coasts are fairly smooth; not too many indentations or projections exist. Only several (Carsamba, Bafra, etc.) fertile plains were formed.

In the south, the Taurus Mountains lay parallel to the Mediterranean Sea with average elevations around 2 500 m, sometimes reaching 4 000 m above sea level.

In the Aegean coastline, although it is a continuation of the Mediterranean coast, the mountain ranges lie from east to west, perpendicular to the Aegean Sea creating fertile valleys and fields washed by the rivers, and thus coastline is quite irregular.

The region around the Marmara Sea, both in Anatolia and in Thrace has very few changes in elevation, and is comprised of large, flat, fertile lands.

1.6.3 Total population

The population of Turkey in 2000 is 67 803 927 and the annual population growth rate in 1990-2000 period is 18.3‰. Among 81 provinces, the most populated three provinces are Istanbul, Ankara and Izmir respectively.

The number of capita per square kilometers is 88. When the population size is examined by regions, it is seen that the Marmara Region, population of which is 17 365 027, has the highest population among other regions and it constitutes approximately 26% of Turkey’s population. Eastern Anatolian Region with a population of 6 137 414 has the smallest population and it constitutes 9% of Turkey's population.

In 2000, while city population (population in the province and district centers) is 44 006 274 and annual growth rate of city population is 26.8‰ village population is 23 797 653 and the annual growth rate of village population is 4.2 %.

Total employed population in the agriculture sector is 12 576 827 persons. According to 2000 Population Census, the unemployment rate in Turkey is 8.9%. The unemployment rate of males is higher than that of females. In 2000, 9.9% of males and 7.2% of females have been unemployed. (State Institute of Statistics, 2000a).

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ME8/AIDCO/2001/0515/59341-P033

EUROPEAN COMMISSION
EURO-MEDITERRANEAN PARTNERSHIP

Development of Tools and Guidelines for the Promotion of the Sustainable Urban Wastewater Treatment and Reuse in the Agricultural Production in the Mediterranean Countries

(MEDAWARE)

Task 1: Determination of the Countries Profile
PART B: CLIMATE AND WATER RESOURCES

MEDAWARE- Part B

INDEX

2. Climate and Water Resources

2.1 CYPRUS

2.1.1 Description of climate

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

The predominant clear skies and high sunshine amounts give large seasonal and daily differences between temperatures of the sea and the interior of the island, which also cause considerable local effects especially near the coasts. Cyprus receives the solar radiation on a horizontal surface under relatively small angles of incidence. The maximum possible values of sunshine duration for Cyprus lie between the extremes of 9.8 hours in winter and 14.5 hours in summer.

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

In winter Cyprus is near the track of fairly frequent small depression which crosses the Mediterranean Sea from west to east between the continental anticyclone of Eurasia and the generally low pressure belt of North Africa. These depressions give periods of disturbed weather usually lasting from one to three days and produce most of the annual precipitation, the average fall from December to February being about 60% of the annual total.

Rainfall

The average annual total precipitation increases up the south-western windward slopes from less than 450 mm to nearly 1100 mm at the top of the central massif. On the leeward slopes amounts decrease steadily northwards and eastwards to between 300 and 350 mm in the central plain and the flat south-eastern parts of the island. Figure 1 shows the average annual precipitation map of Cyprus for the year 1961-1990.

The narrow ridge of the Kyrenia range, stretching 100 miles from west to east along the extreme north of the island, produces a relatively small increase of rainfall to nearly 600 mm along its ridge at about 1 000 m.

Rainfall in the warmer months contributes little or nothing to water resources and agriculture. The small amounts which fall are rapidly absorbed by the very dry soil and soon evaporated in high temperatures and low humidity.

Autumn and winter rainfall, on which agriculture and water supply generally depend, is somewhat variable. The average rainfall for the year as a whole is about 465 millimeters but it was as low as 182 millimeters in 1972/73 and as high as 759 millimeters in 1968/69. (The average rainfall refers to the island as a whole and covers the period 1961-1990). Statistical analysis of rainfall in Cyprus reveals a decreasing trend of rainfall amounts in the last 30 year.

Snow occurs rarely in the lowlands and on the Kyrenia range but falls frequently every winter on ground above 1,000 meters usually occurring by the first week in December and ending by the middle of April. Although snow cover is not continuous during the coldest months it may lie to considerable depths for several weeks especially on the northern slopes of high Troodos.

Figure 2 shows the distribution of average precipitation over the months (1961-1990) for selected Meteorological Stations.

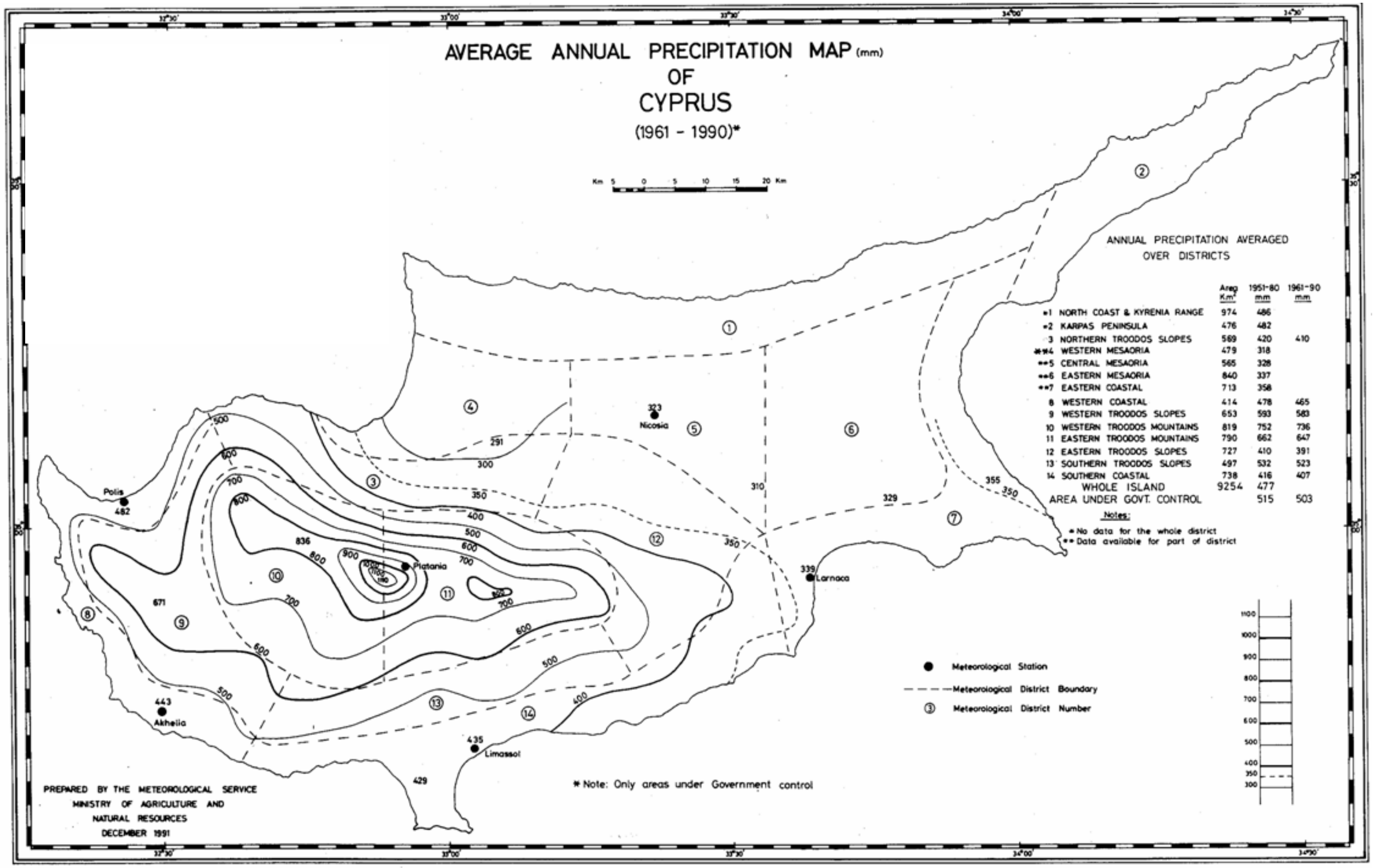
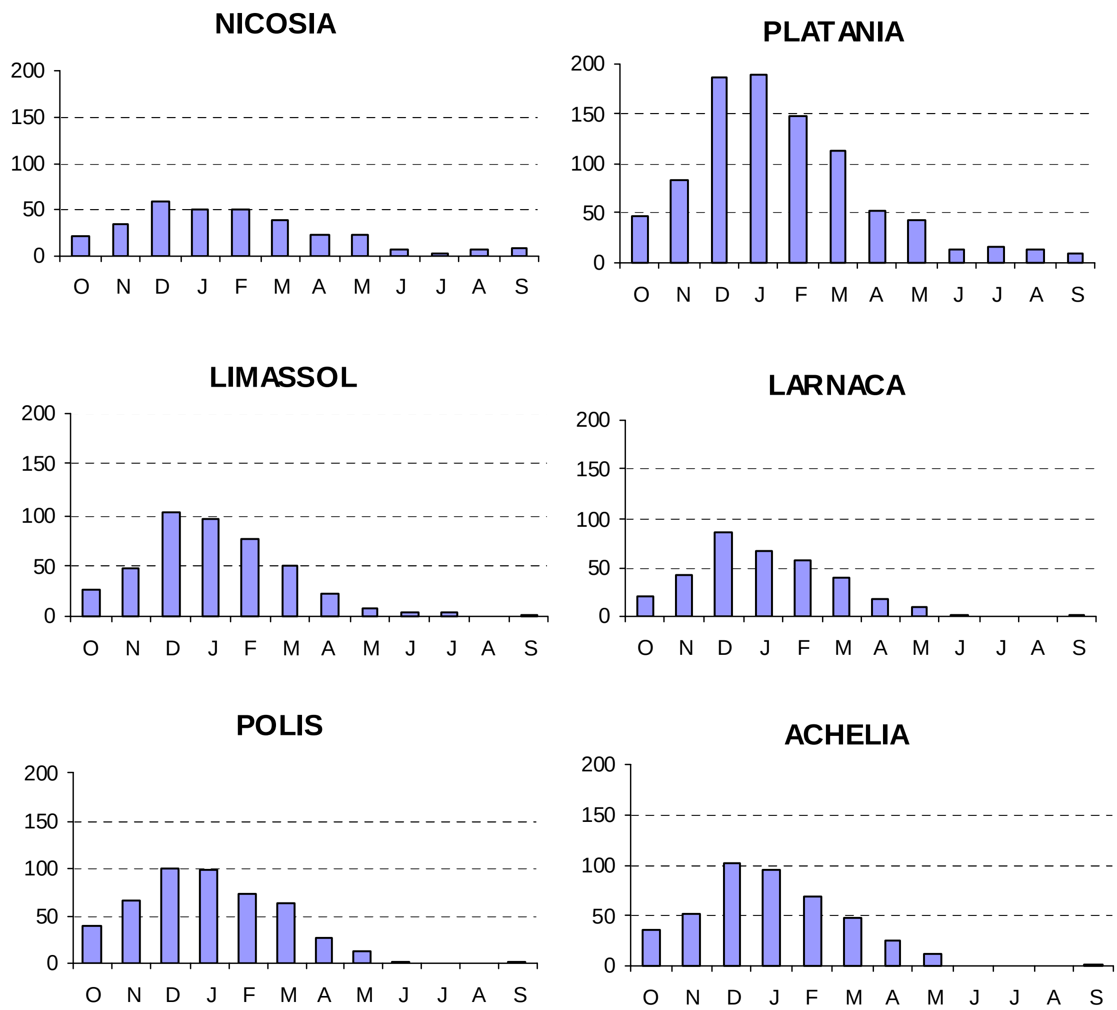


Figure 1: Average Annual Precipitation Map

Figure 2: Distribution of average precipitation (mm) over the months (1961-1990)



MEDAWARE- Part B

Air Temperatures

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

The seasonal difference between mid-summer and mid-winter temperatures is quite large at 18ºC inland and about 14ºC on the coasts.

Differences between day maximum and night minimum temperatures are also quite large especially inland in summer. These differences are in winter 8 to 10ºC in the low-lying areas and 5 to 6ºC on the mountains increasing in summer to 16ºC on the central plain and 9 to 12ºC elsewhere.

In July and August the mean daily temperature ranges between 29 ºC on the central plain and 22 ºC on the Troodos mountains, while the average maximum temperature for these months ranges between 36 ºC and 27 ºC respectively. In January the mean daily temperature is 10 ºC on the central plain and 3 ºC on the higher parts of Troodos mountains with an average minimum temperature of 5 ºC and 0 ºC respectively. Some representative temperatures are given in Table 1 below.

Table 1: Representative temperatures in ºC

	January			July		
	Lowest Min. Recorded	**Mean Min.**	**Mean Max.**	**Mean Min.**	**Mean Max**	**Highest Max. Recorded**
Nicosia 160m MSL	-3	5	15	21	37	43
Famagusta 20m MSL	-6	6	16	22	34	41
Paphos 10m MSL	-1	10	17	22	30	37
Prodhromos 1380m MSL	-11	1	6	18	26	32

Frosts are rarely severe but are frequent in winter and spring inland and in some years handicap the economically important production of early vegetable crops and main citrus crops.

Sunshine

All parts of Cyprus enjoy a very sunny climate compared with most countries. In the central plain and eastern lowlands the average number of hours of bright sunshine for the whole year is 75% of the time that the sun is above the horizon. Over the whole summer, for six months, there is an average of 11.5 hours of bright sunshine per day whilst in winter this is reduced only to 5.5 hours in the cloudiest months, December and January.

Even on the high mountains the cloudiest winter months have an average of nearly 4 hours bright sunshine per day and in June and July the figure reaches 11 hours.

2.1.2 Volume of surface water, groundwater

The total annual water crop is estimated around 900 million m^3 (MCM) out of which 600 MCM is surface water and the remaining around 300 MCM is groundwater. However the water than can be used now is only 300 MCM per year. Out of the 300 MCM, 75 MCM are used for domestic, industrial and commercial use which corresponds to around 100m3/cap/year. The remaining is used for irrigation. For the area under control of the government with a tourist inflow of around 2.4 Million a year and population around 700,000 the domestic, industrial and commercial consumption of water is estimated at 67 MCM per year, where the irrigation water is around 175 MCM per year.

2.1.3 Water demand

The Total Annual Water Demand all over Cyprus for the year 2000 is estimated to be 265.9 million m3 (MCM). Agriculture, Domestic use, Industry and Environment are the four main economic sectors of water demand. Table 2 lists the water demand for these sectors as well as the percent contribution of each sector to the total annual water demand.

Table 2: Annual Demand by Sector for the Year 2000

DEMAND SECTOR	MCM	%
AGRICULTURE	182,4	69
DOMESTIC	67,5	25
INDUSTRY	3,5	1
ENVIRONMENT	12,5	5
TOTAL	**265,9**	**100**

It is estimated that the water demand in the Government controlled areas will increase from 266 MCM in 2000 to 315 MCM in 2020. It is noted that conveyance, distribution and other losses are included in the above numbers.

2.1.4 Agricultural water demand

The amount of water withdrawal for agricultural purposes is 182,4 MCM of water per year or 69%. Animal Husbandry accounts for only 8 MCM or 4%, while the remaining 174,4 MCM are used for irrigation purposes, covering mainly from Government Irrigation Schemes. Irrigation efficiency especially in the Government schemes is high. The total annual Agricultural water demand is represented in Table 3, below.

Table 3: Distribution of the Agricultural Water Demand

SECTOR & SOURCE OF WATER		MCM	%
IRRIGATED AGRICULTURE	Government Irrigation Schemes	100,1	55
	Non-Government Irrigation Schemes	74,3	41
	Total for Irrigation	**174,4**	**96**
ANIMAL HUSBANDRY		**8**	**4**
TOTAL		**182,4**	**100**

2.1.5 Industrial water demand

Industry in Cyprus is limited both in type and in capacity. As a result its demand for water is small and accounts for only 4 MCM or 1%. The main source of water supply to the industrial sector is groundwater.

Environmental demand includes the landscape irrigation demand and the water demand for ecological areas, and accounts for13 MCM or 5%. The sources of water supply are municipal domestic water (for ecological areas), groundwater and reclaimed water (for landscape irrigation).

2.1.6 Domestic water demand

The domestic demand sector comprises two sub-sectors i.e., the residential and tourism. These sub-sectors are interwoven, as their conveyance network is common.

Table 4: Annual Demand by Sector for the Year 2000

DOMESTIC DEMAND	MCM	%
Residents	53,4	20
Tourism	14,1	5
Total	67,5	25

The sources satisfying the current demand are desalination (43%), surface water (25%) and groundwater (32%). All these sources are from Government water works. Water is sold in bulk to Water Boards, Municipalities and Community Councils.

It has been estimated that the present per capita daily water consumption, including losses in the distribution system, for the urban, rural and tourism sub-sectors is 215 (180 net), 180 (150 net) and 465 liters, respectively.

2.1.7 Water supply coverage: urban and rural

Almost all population today is served by good quality pressurized (piped) water. It is noted that 74% of the population lives in the main cities and suburbs requiring 78% of the total domestic supply and the remaining 26 percent in the villages requiring 22% of the total domestic supply. The losses in the distribution system (unaccounted water) range from 12 - 15 percent in the urban centers to 35 - 40 percent in the rural areas.

2.1.8 Origin of irrigation water

57% of the annual amount of water for irrigation purposes is provided mainly from Government Irrigation Schemes. In the Government schemes the sources of water used are surface water, groundwater and reclaimed water. As a rule the water demand in the non- Government schemes is satisfied by groundwater.

Surface Water: Although the capacity of all the main dams is 273.6 MCM, the average annual amount of water available for use is estimated to be about 101.5 MCM. During the dry year of 2000 the contribution to irrigation of all dams was only 28.5 million m3. Out of the 101.5 MCM, 82 MCM are used within Government Projects, 14.5 MCM for domestic use (after treatment) and 5 MCM for ecological areas.

Groundwater extraction is estimated to be about 127.4 MCM on an annual basis. Such figure does not mean the safe yield of the aquifers, which is much lower. From this amount, 100.4 MCM are used for agriculture (26 MCM are within the Government Irrigation Schemes and 74.4 MCM are outside the Government Schemes).

Springs contribute very little, amounting to 3.5 MCM per year, for the domestic use of the mountainous villages.

Desalination units at present contribute up to 33.5 MCM per year.

MEDAWARE- Part B

Treated sewage effluent: Presently, only about 3 MCM is used, from which 2 MCM for agriculture and the rest for landscape irrigation.

2.2 JORDAN

2.2.1 Description of climate/agroclimate

Jordan covers an area of about 89.3 million dunums (8.93 million hectares), 5-9% of which can be defined as agricultural land. The total rain fall in Jordan is estimated at 8.5 billion cubic meters of which about 85% is lost to evaporation with the remainder flowing into wadis and partially infiltrating into deep aquifer. Low rainfall areas cover an area of approximately 81 million dunums, of which 9.1 million dunum receives between 100 to 200 mm rainfall, 12.8 million dunums receive 50 to 100 mm, and 58.7 million dunums receive less than 50 mm of rainfall annually. Rainfed lands constitute the largest cultivable area in Jordan, which is used mainly for cereals and fruits. The intensity of farming depends on the amount and timing of rainfall received in the period between October-March. Based on the annual rainfall, Jordan is divided into the following agroclimatic regions:

Table 5: Land area in Jordan according to agro-climatic regions

Region	Average Annual Rainfall (mm)	Area (Million dunum)	% Total Area
Semi Desert	< 200	80.8	90.5
Arid	200-350	5.1	5.7
Semi-Arid	350-500	1.9	2.1
Semi-Humid	> 500	1.0	1.1
Water Area	-	0.5	0.6
TOTAL	**-**	**89.3**	**100**

Source: Water Authority

The rainfed agriculture is an important component in Jordan's economy. On the average, it contributes about 12% of the gross domestic product. Water and nitrogen are the most limiting factors of crop production in the rainfed agriculture in Jordan. The use efficiency of both nitrogen and water are significantly influenced by various farming systems and agricultural practices associated with these systems. Crop rotation, tillage and crop residue management are key factors influencing water and nitrogen use efficiency in the rainfed agriculture.

Agroclimatology

Climatologically, the country is divided into three distinct regions. These are the Jordan Valley, the highlands and the steppe and steppe desert. The rainy season extends from October to March or April. Annual rainfall is very much related to topography, with the mountain region receiving the highest, and the steppe desert the lowest rainfall. Over 50% of the area of Jordan receives less than 100 mm of annual rainfall, while annual rainfall in the major dryland agricultural areas ranges from 250-600 mm. Rainfall is erratic, irregular and highly variable, with occasional high intensities, especially in the highlands.

Rainfall is the most variable and the most important limiting factor in the rainfed agricultural system in Jordan. The rainfed areas in Jordan have a Mediterranean semiarid climate with precipitation averaging between 200 and 500 mm annually. The rainfall is often distributed during a short rainy season in unpredictable amounts and frequently occurs as intense storms that can cause severe water erosion. Wind erosion is also a serious problem in many areas during the dry months.

The following is a brief description of the climatological elements in the country.

Temperature

There is a large variation in temperature form one region to another in Jordan. The Jordan Valley has a temperature regime similar to that of the subtropical climate; these are hot in summer and warm in winter. The climate of the highlands of Jordan is characterized by a mild summer and a cold winter. The steppe and steppe desert regions have a continental climate.

Evaporation

Annual total potential evapotranspiration (PET), calculated according to Penman (1948), is above 1300 mm in most parts of the country. Mean monthly values of PET during winter range from 20-30-, 45-60 and 35-45 mm in the highlands, the Jordan Valley, and steppe, respectively. Maximum monthly values were recorded during July. The range was 150-180, 200-240 and 210-230 mm for the highlands, the Jordan Valley and the steppe, respectively.

Rainfall

Most of the rain falls between November and March. Annual rainfall averages 30 -100 mm in the steppe desert and exceeds 800 mm in some areas in the highlands, with large variability between and within the regions. Physiography and latitude control, to a large extent determine the spatial distribution of rainfall in Jordan. Winter rainfall constitutes 75% of annual rainfall in the highlands, while it reaches 50% of annual rainfall in The steppe and steppe desert.

Agriculture in Jordan depends largely on rainfall, especially in the highlands and the steppe. Precise knowledge of the rainfall characteristics is essential for agricultural planning and decision-making under dryland conditions

2.2.2 Volume of surface water, groundwater

Surface water resources are unevenly distributed among 15 basins. The largest source of external surface water is the Yarmouk river, at the border with Syria. Originally, the annual flow of the Yarmouk river was estimated at about 400 million m (of which about 100 million m³ are withdrawn by Israel). Total flow is now much lower than 400 million m³ as a result of the upstream Syrian development works which have been done in the 1980's. The Yarmouk river accounts for 40% of the surface water resources of Jordan, including water contributed from the Syrian part of the Yarmouk basin. It is the main source of water for the King Abdullah canal and is thus considered to be the backbone of development in the Jordan valley. Other major basins include Zarqa, Jordan river side wadis, Mujib, the Dead Sea, Hasa and Wadi Araba. Internally generated surface water resources are estimated at 400 million m /year.

Jordan's groundwater is distributed among 12 major basins. Total internally produced renewable groundwater resources have been estimated at 500 million m³/year, of which 220 million m³ constitute the base flow of the rivers. Groundwater resources are concentrated mainly in the Yarmouk, Amman-Zarqa and Dead Sea basins.

The safe yield of renewable groundwater resources is estimated at 275 million m³/year. Most of it is at present exploited at maximum capacity, in some cases beyond safe yield. Of the 12 groundwater basins, 6 are being overextracted, 4 are balanced with respect to abstraction and 2 are under-exploited. Average groundwater depletion was estimated at 190 million m³/year in 1990. Over-extraction of groundwater resources has degraded water quality and reduced exploitable quantities, resulting in the abandonment of many municipal and irrigation water well fields, such as in the area of Dhuleil.

The main non-renewable aquifer presently exploited is the Disi aquifer (sandstone fossil), in southern Jordan with a safe yield estimated at 125 million m³/year for 50 years. Other nonrenewable water resources are found in the Jafer basin, for which the annual safe yield is 18 million m³. In total it is estimated by the Water Authority of Jordan that the safe yield of fossil groundwater is 143 million m³/year.

2.2.3 Water demand

Water withdrawal was 810 MCM per year (2002).

2.2.4 Agricultural water demand

The amount of water withdrawal for agricultural purposes is 63.8% of the total withdrawal water, (516.78 MCM). Also 0.8% is used for livestock (6.5 MCM).

2.2.5 Industrial water demand

Industrial activity in Jordan is limited. As a result its demand for water is small and accounts for only 4.6%, (37.26 MCM).

2.2.6 Domestic water demand

The domestic demand sector comprises 30.8 % of the total withdrawal, (249.5 MCM).

2.2.7 Water supply coverage: urban and rural

The Government undertook the complete development of water resources and the construction of water projects beginning from the source all the way to the destinations of consumption. The percent connections to municipal network in Jordan constituting urban and rural population covered almost 97% of the population in 2000. 3% constitutes the non-served people mostly in rural areas.

The Water Authority of Jordan (WAJ) supplied about 245.5MCM per year (2002). Hence, the average per capita per day share of drinking water was about 130 Liters.

Table 6: Amount of drinking water supplied per year (2002) in the 12 Governorates of the Kingdom

Governorates	Supply quantity MCM	L/C/D
Amman	94.091.543	123.6
Balqa	18.338.840	138
Zarqa	34.412.052	114
Madaba	6.051.075	118
Irbid	31.352.868	87
Al-mafrac	16.852.935	203
Jerash	4.148.732	69
Ajloun	3.485.172	76
Karak	11.172.589	136
Tafileh	3.005.388	101
Ma'an	7.970.928	206
Aqaba	14.685.630	379.5
Total	**245.567.732**	

2.2.8 Origin of irrigation water

Jordan water is derived from surface and underground sources. Renewable water resources are estimated at about 780 million m^3 per year, consisting of approximately 275 million m^3 per year from underground sources, 505 million m3 from surface sources. An additional 140 million m^3 per year are estimated to be available from fossil aquifers sustainable for between 40-50 years. Brackish aquifers are not yet fully explored but at least 50 MCM/year is expected to be accessible for urban uses after desalination and 73 MCM per year (2002) of treated wastewater.

2.3 LEBANON

2.3.1 Description of climate

The climate of Lebanon is typically Mediterranean, with a cool, humid winter season between late November and early April and a warm, dry summer. Total precipitation reaches about 8,600 million m^3/year as an average. The coastal plain is characterized by moderate temperatures and an annual rainfall averaging between 700 and 800 millimeters, mostly heavy rain in winter which is about 80 to 90 days of rainfall per year. About 90 % of all precipitation is received between November and April. The mountains are cooler, and receive between 1,200 and 2,000 millimeters of precipitation; much of it as snow that melts during spring and early summer. The Bekaa valley is the warmest and driest area; its annual rainfall ranges between 250 millimeters and 750 millimeters. Figure 3 shows the average rainfall measured at BIA during two time periods. Other recorded rainfall-related figures are found in Appendix C.

The above amounts are subject to variations from year to year. The average annual rates can decrease by 55% during dry periods. Concerning the snow covering the mountains, the equation governing snow thickness and water depth has not been established in Lebanon yet. However, it is generally acceptable to consider 1 mm of water depth as equivalent to 1 cm of snow. At +1800 m elevation, snow thickness can reach 7 m and thus have a major effect on groundwater recharge through infiltration. The snow pack also affects the river flows as it delays it by 2 to 3 months. In fact, the maximum flows occur in the spring due to the melting snow, i.e., a few months after the maximum rainfall.

Evapotranspiration rates are estimated by subtracting surface and water flows from precipitation rates. The figures obtained in Lebanon for evapotranspiration reached 50% of the precipitation; that is, 4500 million m^3/year, (Jaber, 1997).

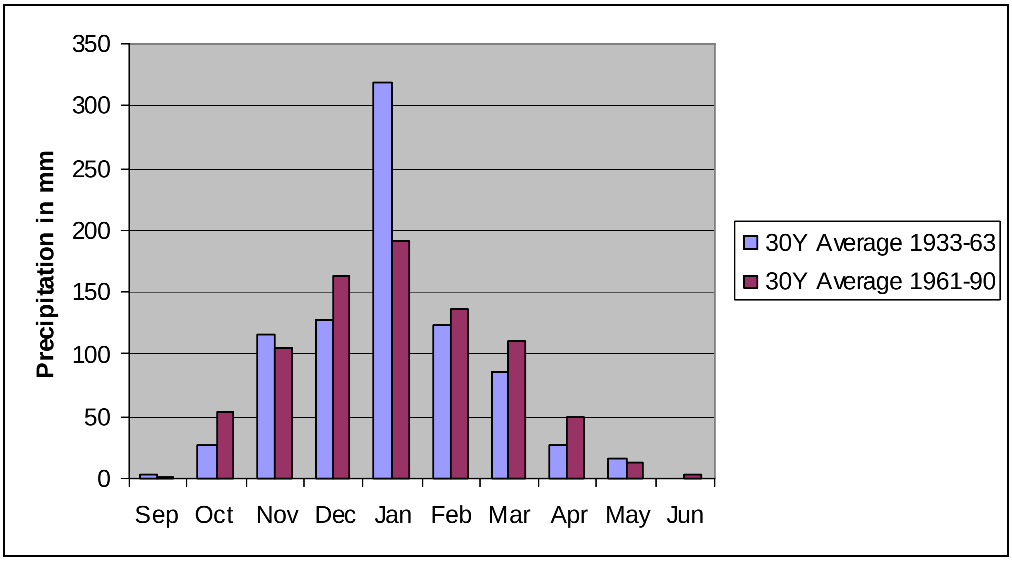


Figure 3: Average Rainfall Measured at BIA during Two Time Periods, (CAS Bulletin, No.1/2000)

The relative humidity in the coastal areas as well as on the western slopes of the Lebanon Mountain Chain facing the sea is quite high and shows uniform trends. The monthly averages vary between a low of around 64% in November and exceed 73% in August. However, in the inland regions, the monthly averages can reach a high of 76% in the winter and a low of 44% in the dry season. Sun shines about 3,225 hours per year which is relatively high. Evaporation, on the other hand, is highest in Bekaa reaching about 1,761 mm per year; it also reaches 1,341 mm per year in Beirut.

2.3.2 Volume of surface water, groundwater

Lebanon is a mountainous country with two parallel mountain ranges that run north to south, and between them lays the Bekaa Valley. These topographical features create an orographic effect. This results in heavy precipitation along the coastal plains and much less in the interior, and this rain shadow explains the notable difference in vegetative cover between the lush greenery of the coastal areas and the dry landscape of the interior. Lebanon's climate is generally Mediterranean, with abundant rainfall in the winter but dry summers (Amery, 2000).

The country has 17 perennial streams (Table 7) and about 23 seasonal ones. Their combined length is approximately 730 km and their total annual flow averages 3,900 million m^3. Most river flows peak during March and April; some may reach maximum flow later during the year, such as the Assi River which peaks in July. Minimum flows are typically recorded in the months of September and October. The Assi River exhibits the highest flow index.

Table 7: Flow Data for the Perennial Rivers of Lebanon

River Name	***Length***	***Monthly Flow in million m^3***				***Perennial Index***
		Annual	***Average***	***Max***	***Min***	
El Kabir	58	190	6.02	13.90	1.80	0.13
Ostuene	44	65	2.07	4.01	0.80	0.20
Aaraqa	27	59	2.06	6.27	0.80	0.13
El Bared	24	282	8.94	15.20	2.70	0.18
Abou Ali	45	262	15.17	37.30	1.60	0.04
El Jaouz	38	76	2.40	6.18	0.40	0.06
Ibrahim	30	508	16.10	27.60	1.90	0.07
El Kalb	38	254	8.04	18.10	2.40	0.13
Beirut	42	101	2.59	10.00	0.10	0.01
Damour	38	307	13.80	32.70	0.60	0.02
El Awali	48	299	9.71	26.20	3.90	0.15
Saitani	22	14	0.73	1.30	0.00	0.00
El Zahrani	25	38	1.59	3.40	0.30	0.09
Abou Assouad	15	11	0.35	NA	NA	NA
Litani	170	793	12.50	30.80	4.30	0.14
El Assi	46	480	16.40	20.90	11.50	0.55
Hasbani	21	151	4.80	11.30	1.60	0.14

* Adopted from SOER, 2001

Water resources of Lebanon are derived mainly from rainwater, snow, surface water, and precipitation. The country is made up of two principle hydrological regions: (1) the Mediterranean (or coastal) watershed, with an area of 5,500 km^2, which gives rise to 12 perennial rivers from the western slopes of the mountain ranges, flowing from the east to west into the sea, and (2) the interior watershed, with an area of 4,700 km^2, which is the source of the Litani, Assi (also know as Orontes), and Hasbani rivers.

Several studies were conducted to estimate the hydrological budget of Lebanon. One is the study presented by Fady Comair, president of the board of the Litani Water Authority at the end of the year 1997; other studies differ greatly from those that are "official". Table 8 shows the most optimistic figures (Mallat 1982, United Nations 1992).

The figure of 2,600 million m^3/year constitutes 2,400 million m^3/year of surface water and 200 million m^3/year of groundwater. The country can receive far more than 2,600 million m^3 of water in a rainy year. This figure can also drop by as much as 50% if a drought lasts for a few years (Al Nahar, 25 May 1996). Every 7 to 10 years, Lebanon experiences a drought, sometimes lasting for 3 or more years (Example: The 1988-91 drought reduced Lebanon's internally renewable water supply by 40%).

The United Nations report (1992) estimated amount of 2,557 million m^3 is received during the wet season, and a small proportion (818 million m^3) is received during the dry season making a total of 3, 375 million m^3 of available water. Potentially usable groundwater is estimated at 600 million m^3/year of which only 160 million m^3 is used. Mallat noted that a severe disparity occurs even between the seasons; a mere 125 million m^3/year of water is available during the month of August, just when irrigation is mostly needed. Table 9 illustrates significant spatial and seasonal differences in distribution of water throughout the country.

Table 8: Hydrological Budget of Lebanon (million m^3/year)

Factors	*Water Budget according to the Litani River Authority (Comair, 1998)*	*Water Budget according to Mallat (1982)*
Total precipitation	+8,600	+9,700
Evapotranspiration	-4,300	-5,070
Percolation to groundwater and flow into the sea	-880	-600
Flow into Israel Hasbani River	-160	-140
Groundwater flow to Huleh and Northern Israel	-150	
Flow into Syria Assi River	-415	-415
Flow into Syria Kabir River	-95	-95

Net Available Surface Water	**+2,600**	**+3,375**

* Source: Amery, 2000

Table 9: Geographical Pattern of Water Distribution by Season

Geographical area	*Wet season*	*Dry season*	*Total*
Western slopes	1,958	515	2,473
Bekaa			
Assi Basin	54	43	97
Upper Litani Basin	488	153	641
Hasbani River, springs, and other waters	68	96	164
Totals	**2,557**	**818**	**3,375**

*Source: Mallat, 1982

Table 10 indicates that the amount of water available is 3,922 million m^3/year. However, the figure given by Mallat is 3,375 million m^3/year, and the one provided by Lebanon's Litani Water Authority is significantly lower. This is due to the different methodologies used by different sources in gathering and analyzing information.

Table 10: Water Flow in the Major Hydrological Zones of Lebanon in Wet and Dry Seasons (million m^3/year)

Hydrological Zones	*Wet Season*	*Dry Season*	*Total*
Water flow in the western slopes of Mount Lebanon			
Kabir to Beirut rivers	1,426	395	1,821
Damour to Zahrani rivers	489	102	591
Lower Litani (Khardali into the sea)	104	26	130
Ra's Ain Spring (Tyre)	15	13	28
Subtotal	2,034	536	2,570
Water flow in the Bekaa Valley			
Northern Bekaa (including Assi and excluding Litani)	248	254	512 [1/]
Upper Litani (to Khardali)	488	153	641 [2/]

Hasbani basin	112	40	152 3/
Small Springs	35	12	47
Subtotal	883	469	1,352
Total	2,917	1,005	3,922

* Sources: Interviews with Lebanese officials, unpublished documents, and news reports
1/ A total of 410 million m^3/year of the Assi flows into Syria
2/ A total of 220 million m^3/year are stored in the Karaoun reservoir
3/ A total of 140 million m^3/year flows into Israel

Surface waters: streams, rivers and lakes

Lebanon has approximately 40 streams that flow into the Mediterranean Sea or in neighboring countries. However, only 17 streams are perennial. Most rivers in Lebanon have their sources originate from springs, which are often quite large. These springs emerge from the permeable limestone strata cropping out at elevations laying between 915 and 1,524 meter in Mount Lebanon.

In Mount Lebanon, few springs emerge in this manner. Other springs emerge from alluvial soil and later join to form rivers. Whatever their source, the rivers are fast moving, straight, and generally cascade down narrow mountain canyons to the sea.

The streams draining the mountain ranges are mostly seasonal torrents, conveying floodwaters following winter rainstorms and snowmelt in the spring. Only the streams that are fed by perpetual springs flow year-round. Most of these streams, whose length does not exceed 60 km, flow from east to west, with relatively steep gradients.

These streams are recharged by rainwater at elevations below 800 m and by snow at elevations above 800 m. This explains the occurrence of two flood periods, the first taking place around January-February during the rainy season, and the second around April-May when the snow melts. The two principal perennial rivers of Lebanon are the Litani and the Assi rivers.

The Litani river

The Litani River (160 km long) starts its course in the Bekaa Valley near Baalbeck and runs southward. Just six kilometers from Israel's northern tip, it changes direction as it makes an abrupt 90-degree turn westward (there it is called Al Qasmiyah river) through a gorge to discharge into the Mediterranean Sea, north of Tyre. The entire length of the Litani thus lies in Lebanese territory. The Litani River drops a total of 1,000 m from its source to the Karaoun Dam. The steepest descent is between Karaoun and Khardali, where the river drops 600 m within a short distance. In its final stretch, the river flows gently and drops 300 m over a distance of 50 km till it reaches the sea. The Karaoun reservoir is used for irrigation, supply of potable water, hydroelectric generation, recreation and tourism. Act 14522 (16 May 1970), allocates the water of the Litani to the southern Bekaa (30 million m^3) and the South (160 million m^3) for domestic consumption and irrigation through canals at an elevation of 800 m above sea level.

Precipitation in the Litani's entire watershed averages around 700 mm/year. The lowest recorded precipitation in this area is 450 mm. The average precipitation in the upper Litani is 800 mm/year within a watershed area of 1,600 km^2. A total of 1,280 million m^3/year of water is therefore received in this area, of which 60 % seeps through to replenish the groundwater or is lost to evapotranspiration. This leaves 500 million m^3/year of surface water, of which 80 million m^3/year is pumped out before reaching the Karaoun. Thus about 420 million m^3 reach the reservoir on an average year (Comair, 1998).

Although it is a perennial stream, the Litani's discharge fluctuates from season to season and from year to year. Its most copious flow (some 60 % of the annual discharge) occurs between January and April, during the winter rains and subsequent snowmelt. The annual discharge can vary from a low volume of less than 200 million m^3 to a high volume of more than 1,000. The long-term average is about 700 million m^3/year. The Litani's low salinity (20-40 ppm) makes it an especially attractive water source.

The Litani Development Authority, established in 1954, has planned the utilization of the river for hydropower and irrigation. The program called for three storage and power dams, one each on the upper, middle, and lower sections of the river. An important aspect of the program was the diversion of a portion of Litani's waters to the Awwali stream, mainly for hydropower generation.

The most important of these dams is the Karaoun Dam, completed in 1966, with a storage capacity of 200 million m^3/year. The dam is used for regulating the downstream discharge and in the generation of electrical power. It was designed to convey a total volume of about 520 million m^3/year, of which nearly 500 m^3 were to be diverted from the Litani river and the remainder collected from springs along the course of the diversion. The 190 megawatts of electricity generated by the system supplies power to the coastal cities of Beirut, Sidon, and Tyre, as well as to the smaller villages of southern Lebanon.

According to the most recent data (FAO, 1997), 54.3 % of all the land in Lebanon is irrigated from surface-water sources; and 45.7 % from groundwater sources, and the main sources of irrigation are the Litani–Awwali river system and subsurface water. Table 11 delineates the water flow in the Litani River:

Table 11: Water Flow in the Litani River by Hydrological Zone

(million m^3/year)

Hydrological Zone	*Winter*	*Summer*	*Total*
Upper Litani (Springs to Karaoun)	360	130	490
Mid-Litani (Karaoun to Khardali)	120	40	160
Lower Litani (Khardali to Qasmiyah)	105	25	130
Total	585	195	780

* Source: Amery, 2000

Most towns and villages in the Bekaa Valley have no sewer system leading to sewage discharge without treatment into nearby valleys and inveriably into the Litani River (Table 12). The problem becomes magnified during the summer, when the river's flow is reduced, while that of sewage flow is not. By the end of November, the end of the long dry season, when the Karaoun Lake is at its lowestlevel, more than 10% of its volume is wastewater discharged into the upper Litani or directly into the lake from surrounding villages (Comair 1998, Srour and Sleiman 1998).

Table 12: Wastewater Discharge into the Upper Litani, May-Nov (L/s)

Region	*Volume (L/s)*	*Location*
Baalbeck	50	Litani headwater
Zahle	300	Lower headwater
Western Bekaa	70	Upper Litani, near Karaoun
Total	**420**	**Up to Lake Karaoun**

* Source Comair, 1998; Srour and Sleiman, 1998

The Orontes river

Lebanon's other major perennial river is the Orontes, also known as the Assi. It rises near Baalbeck in the Bekaa, just a few kilometers north of the source of the Litani, and is similarly fed by runoff and seepage from rainfall and snowfall occurring over the Lebanon and Anti-Lebanon Mountain ranges. The two rivers – so alike and so close to the source – flow in opposite directions. The Orontes flows northward through the Bekaa Valley, staying within Lebanon for a distance of around 35 km before entering Syria and then Turkey where it discharges in the Mediterranean.

Within Lebanon, the mean annual flow rate of the Orontes is about 400 million m^3. Although the Orontes is an international river flowing in three countries (Lebanon, Syria, and Turkey), it has so far not been the cause of overt conflict. Lebanon does not utilize the Orontes to a significant degree. In August of 1994, the Lebanese and Syrian governments reached a water sharing agreement; according to which Lebanon receives 80 million m^3/year if the Assi River's flow is 400 million m^3 or more during that given year. If this figure falls to lower than 400 Mm^3, Lebanon's share is adjusted accordingly, relative to the reduction on flow. Existing wells in the basin are allowed to continue operation but no new wells are permitted.

Groundwater

Estimates for the groundwater quantity available for exploitation range from 400 to 1,000 million m^3/year, depending on the source of information. Snow cover is a principal cause of many fissures and fractures, which enhance snowmelt as well as rainwater to percolate and infiltrate deep into the ground and feed these aquifers. Ultimately, the water in these layers either: 1) remains stored in aquicludes, some may be exploited through wells while others remain in deep layers untapped; 2) reappears as surface waters, at lower elevations, in the form of springs that feed into rivers; 3) forms submarine springs discharging near the coastline; or 4) is lost to deep layers and may reappear in the groundwater of neighboring countries.

Characterization of groundwater resources in Lebanon is imperative to determine the extent, hydrologic associations, storage capacity, quality, and retention time in each aquifer. In this context, a number of studies have been conducted, the most comprehensive of which dates back to the 1970s. The general repartition of groundwater along the Lebanese territory is a direct outcome of the lithology and structure characterizing the country. Hence, the country has been divided into two major and distinct hydrogeological provinces: the *Interior Province* comprising the eastern flanks of the Lebanon range, the Bekaa valley, and the western flanks of Anti-Lebanon; and the *Mediterranean Province* comprising the western flanks of the Lebanon range down to the sea. The line of divide between these two basins has been delineated as a fictitious line passing through the mountain tops of Mount Lebanon, Jabal Barouk, Jabal Niha, and the Lebanese Galilee.

In both provinces several basins were identified and are classified according to the outcropping aquiferous ethologic formation: Kesrouan Limestone Formation aquifer (Jurassic age), Sannine-Maameltein Limestone Formation aquifer (two formations forming a single aquifer of Cenomanian and Turonian age respectively), the Eocene limestone aquifer (Eocene), the Neogene and Quaternary deposits of the Bekaa reserves, in addition to the following formations that are of importance only in the Mediterranean Province: the Jebel Terbol Limestone Formation aquifer (Miocene age), the Abeih and Mdeirej (Aptian and Albian age) groundwater reserves, the Chouf Sandstone groundwater reserves, and the recent deposits groundwater reserves. While the physical characteristics of these aquifers/basins are expected to remain the same since 1970, the hydraulic/hydrologic properties have changed due to uncontrolled groundwater tapping. (This section is largely based on a 1970 UNDP report of underground aquifers in Lebanon).

2.3.3 Water demand

There have been many attempts to estimate current and future water consumption in Lebanon. It is very difficult to determine the actual breakdown of water consumption as a large share of water in public distribution systems is lost through system leakages and most supplementary sources in the form private wells are unlicensed and therefore not monitored. Nevertheless, there is a general consensus that agriculture represents between 60 and 70 % of the total water consumption. This share is likely to decrease over the coming years as more water is diverted for domestic and industrial consumption.

In 1966, the domestic and industrial sectors consumed 94 million m^3 of water, and the agricultural sector consumed 400 million m^3. By the mid-1990s, Lebanon was estimated to consume at least 890 million m^3/year of water, close to 50 % of which was drawn from the aquifers. It is also widely reported that the current annual water consumption lies around 1,400 million m^3. However, demand forecasts are conflicting, ranging from 1,897 million m^3 (El-Fadel et al., 2000) to 3,300 million m^3 (Fawaz, 1992) for the year 2010. Table 13 indicates the total current and projected water consumption. Whatever the rate of increase, water consumption remains inferior to actual water demand. In other words, if more water were available, more water would be consumed. All forecasts, however, do point to the imminence of a water deficit in Lebanon within the next 10-15 years.

Table 13: Current and Projected Water Consumption (million m^3)

Year	*Domestic*	*Industrial*	*Irrigation*	*Total*
1966	94		400	**494**
1990 [2/]	310	130	740	**1,180**
1990 [1/]	271	65	875	**1,211**
1994 [1/]	205	130	950	**1,285**
1996	185-368	35-70	669-900	**889-1,338**
2000 [3/]	280	400	1,600	**2,280**
2015	900	240	1,700	**2,840**

* Sources: Jaber(1997); Comair (1998); Ad Deyar, 6 July 1995, 5 Dec 1996
1/ MOE-state report/ LEDO Indicator #25
2/ An Nahar, 25 Feb 1996
3/ Nasir Nasrallah, as quoted in An Nahar, 25 May 1996

2.3.4 Agricultural water demand

The agricultural sector is by far the largest consumer of available water resources in Lebanon. While the total land area under cultivation has remained fairly constant during the past decades, irrigated lands have more than doubled, from 40,775 hectares in 1961 to 104,009 hectares in 1999 (MOA/FAO, 2000). This reflects the intensification of agricultural practices (i.e., producing more per unit area). Moreover, the gradual substitution of traditional and wild cultivars with new crop varieties constitutes an added pressure on limited water resources. Compared to traditional crops, new imported varieties usually consume more water and are more droughts sensitive. Irrigation water is provided from both surface and groundwater. Figure 4 reveals that irrigation water is almost equally supplied from surface water and well water (48 and 52 %, respectively). The number of farms that have private water wells is believed to be increasing rapidly although there are no data on water wells to support this claim. Moreover, many farms have more than one well.

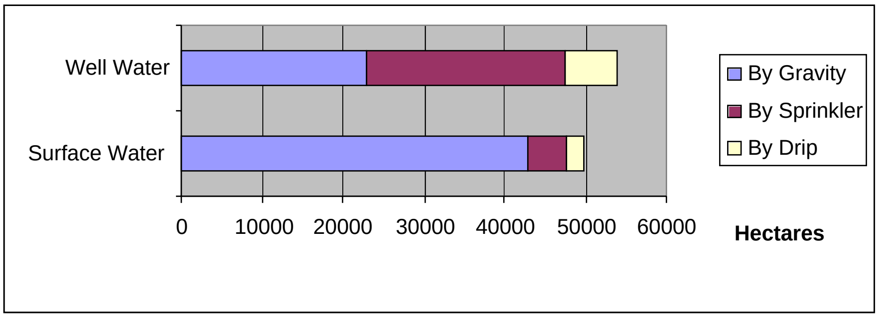


Figure 4: Distribution of Irrigated Lands by Water Source and Irrigation Method, (MOA/FAO, 2000)

The potential increase in irrigable land in the southern Bekaa Valley is from 23,000 to 25,000 ha (Table 14). Around 20 % of this land, especially that lying along riverbanks require drainage. In 1972, 10,000 ha in the southern Bekaa Valley were irrigated. Another 13,000 ha are scheduled for irrigation. The water required to irrigate these two areas is estimated at 140 million m^3/year, of which 30 million m^3/year will be drawn from Karaoun Lake, 74 million m^3/year from groundwater, and 36 million m^3/year from other surface-water sources (United Nations, 1992). To rehabilitate and irrigate lands in the southern Bekaa Valley (between Bar Elias and Jib Janeen), the national Litani Water Authority straightened and deepened the river's channel between 1970 and 1972. This project was later delayed as a result of the civil war. During the summer of 1998, the Authority completed building an irrigation canal that had been dug in the mid-1970s without ever going into operation. Also during the summer of 1998, the Authority started to extend the existing canal system beyond its then northern reach.

There are plans to irrigate 6,000 and 4,000 ha, respectively, in the Hermel and Akkar regions of the northern Bekaa. A total of 33,000 ha are slated for irrigation in southern Lebanon. This includes 1,200 ha near Saida and the currently irrigated area of 6,000 ha in the Qasmiyah region. In the coastal plain, 58,000 ha can be irrigated by coastal rivers and aquifers.

Table 14: Potentially Irrigable Areas within the Litani Water Basin

Location	***Area in hectares***	***Source of water***
Baalbeck	1,000	Ras Al Ain Spring
	250	Ain Hshbai
Zahle	2,100	Ain Al Berdaouni
	900	Wadi Yafoufah
Chtaura	400	Chtaura Spring
Chtaura-Ameek	5,000	Litani
Southern Bekaa	25,000	Karaoun Reservoir (30 million m^3)
		Groundwater (75 million m^3)
		Shamsin Springs (33 million m3)
Rehabilitated lands in South Lebanon	33,000	Karaoun and Khardali
	(From a total of 75,300)	Reservoirs
		Springs in mid-Litani watershed
Jezzine (experimental plan)	930	Karaoun reservoir (30 million m3)
	(From a total of 1,500)	Karaoun reservoir and springs
	6,100	South of Karaoun
Other areas	(Unknown)	Small springs, some Litani tributaries, coastal freshwater springs, and groundwater
Total	**74,680**	**Litani water basin**

* Source: Srour and Sleiman, 1998

2.3.5 Industrial water demand

Little is known of the quantity of water used by the industrial sector. In addition to receiving water through the public water distribution system, most industries are equipped with private (unmonitored) water wells and tap underground water at liberty (and for free). Anecdotal evidence suggests that deep wells are running dry more frequently than before in certain parts of the country. Taking such data limitations into consideration, the industrial sector was estimated to consume about 130 million m^3 in 1994. In 1996, an estimated 71.4 % of all industrial water used in the country was drawn from underground sources, and the remainder was drawn from surface sources. Water consumption is expected to reach 240 million m^3 in 2015. This corresponds to about 9-17 % of total water consumption in Lebanon, assuming a national consumption of 1,400 million m^3. Future water consumption trends are a function of water availability and industrial growth rate.

2.3.6 Domestic water demand

It is difficult to estimate current levels of domestic water supply. Several sources indicate that the target capacity is 160 liters per person per day. Actual delivery is presumably much lower, perhaps as low as 64 liters per day in some areas, due to high system and distribution losses (Jaber, 1999). Daily domestic water consumption was estimated at 165 L/capita in the mid-1990s. This figure is expected to reach 215 L by 2000 and 260 L by 2015 (Jaber, 1997). Beirut uses 80 million m^3/year of water, of which 30 million m^3 comes from aquifers in the Damour region and 50 million m^3 comes from the Jeita springs. According to the CAS Census of Buildings and Establishment (1996-97), 79 % of buildings were connected to water supply networks. The highest rates of connection were recorded in Beirut and Kesrouan (93 and 94 %, respectively), while the lowest were in Hermel and Akkar (41 and 49 %, respectively).

2.3.7 Water supply coverage: urban and rural

The total population of Lebanon was estimated at 3,614,000 people in 2002 (ESCWA, 2002). According to the Ministry of Social Affairs (MOSA), 88% of the population lives in urban areas. The estimated average total population growth rate is reported at 1.8 % (National Action Program, 2003). The growth rate for rural areas is below the country's average while that for urban areas is in excess of it.

According to the CAS Census of Building and Establishment (1996-1997), 79 percent of buildings are connected to water supply networks. The highest rates of connection are reported in urban areas such as Beirut and Kesrouan; 93 percent and 94 percent, respectively. The rates for water connection in rural areas are lower, for example in Hermel and Akkar the reported figures are estimated at 41 percent and 49 percent, respectively.

2.3.8 Origin of irrigation water

The agricultural sector is by far the largest consumer of available water resources in Lebanon. The agricultural water consumption was estimated to be around 669-900 million m^3 in 1996 (Ministry of Environment, 2001). Agricultural sector consumes between 60 and 70 percent of the total water consumption. This share is likely to decrease over the coming years as more water is diverted for domestic and industrial consumption.

Irrigation water is provided from both surface and groundwater almost equally. 48 percent of irrigation water is supplied through surface water and 52 percent through ground water. Around 50,000 hectares of cultivated lands are irrigated by surface water most of which uses gravity as an irrigation method. Around 54,000 hectares are irrigated from groundwater sources and the methods used vary between gravity, sprinkler and drip irrigation. The number of farms that have private water wells is believed to be increasing rapidly although there are no records on the numbers of water wells to support this claim. Moreover, many farms have more than one well.

2.4 MOROCCO

2.4.1 Description of climate

The climate of Morocco is differentiated among the various regions: Mediterranean in the north, Atlantic in the west and Saharan in the south. Only the littoral zones have moderate climate. The variations of the temperature during the day are sometimes considerable.

The climate of Morocco is differentiated among the various regions: mediterranean in the north, atlantic in the west and saharan in the south. Only the littoral zones have moderate climate. The variations of the temperature during the day are sometimes considerable.

Along the coasts, the influence of the ocean provides the cities with soft temperatures. Towards the interior of the country, the winters are characterized by lower temperatures and the summers are hotter. In high altitudes, temperatures lower than -18^{o}C are frequent and the peaks of the mountains are covered with snow in the bigger part of the year.

Rains, which fall mainly during the winter period, are heavier in the north-west and less important in the west and the south. Rainfall presents major spatial, temporal, seasonal and annual variations. Typical of the country is the alteration between years of strong rainfall and years of drought. Average rainfall is higher than 500mm in the north-western areas and exceeds 1500mm in certain high points along the Mediterranean. It decreases gradually while going towards the west and the south, while it does not exceed 200m in the east and 100m in the Saharan and pre-Saharan zones. Snowfall is observed in the highest peaks of mountains Atlas and Rif.

2.4.2 Volume of surface water, groundwater

- Rainfall: 150 000 000 000 m^3
- Evaporation: 120 000 000 000 m^3
- Water resources: 30 000 000 000 m^3

It is estimated that only 20% of total annual rainfall, namely 30 000 000 000 m^3, unequally distributed in the national territory, arrive in the water basins and the ground waters.
Water resources are estimated at 30km^3, 22,5km^3 of which consist of surface water and 7,5km^3 of groundwater. The resources used are estimated at 11km^3. 7.5km^3 derive from surface water and 3.5km^3 from groundwater. The use of surface water is regularized by small dams which allow an even distribution of water resources. Thus, water is available even in the driest periods.

2.4.3 Water demand

The water withdrawal is estimated at approximately 11km^3, 92,2% of which are used in agriculture (4,9% for domestic use and 2.9% for industrial). Of these 11km^3, 7.5km^3 come from surface water and 3.5km^3 from groundwater.

2.4.4 Agricultural water demand

92% of the usable water resources are used for the irrigation of 1.6millon ha, namely 21% of the U.A.S (U.A.S of the country: 7.5millions ha, thus 17% of the total surface).

2.4.5 Industrial water demand

3% of the used water resources are used to supply the following industrial sectors as follows, (Table 15).

Table 15: Industrial water demand per sector

	1998	1999	2000[£]
Transformation industry	117,9	120,7	124,9
Agro-alimentary industry	121,9	123,3	129,7
Textile and leather industries	119,1	117,2	118,0
Metallurgical, mechanical, electric and electronic industry	109,9	117,2	121,3
Other industries	118,3	123,0	127,7

[*] Index of the industrial production (base 100: 1992)

(Source : Site du Ministère de l'Industrie, du Commerce et de l'Artisanat)

2.4.6 Domestic water demand

5% of the total water resources are used for drinking water supply (domestic use)

2.4.7 Water supply coverage: urban and rural

The volume of the available water per capita varies from 450m^3 per year in the most arid areas to 1100m^3 in the most irrigated ones.

2.4.8 Origin of irrigation water

Until the end of the 60s, the water consumed originated exclusively from underground water. Due to increasing water demand on the one hand, the extension of the infrastructures of irrigation for the agricultural activities and the demographic growth on the other, the underground water resources were gradually dried up and reached a point where the construction of dams and water basins became necessary.

The last thirty years, several dams of various capacities were built. In Morocco, there are 96 big dams, 7 medium and 64 small ones. A program is currently in action which aims at the construction of 2 to 3 new dams per year, from now on until the year 2020. The biggest dam of Morocco is that of “Al Wahda”. Its capacity being 3.8 km^3, this dam is the second biggest dam of the African continent.

In the field of water management, the various regions also have at their disposal a water conveyance system. This means that areas with large water reserves can supply areas with fewer water supplies. In spite of all the efforts made so far in this field, it seems that until 2020-2025, if the projections come true, Morocco will face a serious water shortage problem.

2.5 PALESTINE

2.5.1 Description of climate

Typical of the Mediterranean, the climate in Palestine is mild: moist winters and hot, dry summers. The climate of the West Bank Governorates is a semi-arid Mediterranean, featuring a dry season and a rainy season. The rainy seasons extends from October to April, while in the summer between May and September no rain is expected.

Mean amounts of the annual rainfall on the West Bank Governorates is about 500 mm a year. The The highest distribution of the rainfall rate is in the mountainous areas around Bethlehem and in the Ramallah - Nablus areas where annual rainfall is about 700 mm. Rain tends to fall in intense storms. The northern Gaza Strip receives 400 mm annually, while the southern part receives 200 mm, and the Dead Sea receives less than 100mm.

The average annual temperature is 19^0C in the West Bank, 17^0C in the mountains and 25^0C in the Jordan Valley and Gaza. Usually the highest temperature is in July while the lowest one is in January. The highest temperature is 43^0 C, and the lowest recorded one is–3^0C.

The relative humidity range approximate 50-70 %, with minimum humidity in June and maximum in January. The humidity also varies between the north and the south, as well as between the west and the east. Evaporation is high in summer. Wind direction is usually from west and northwest, with a speed of 10-13 knots per hour and 10-12 knots per hour respectively. In the period of April to June, hot (Khamasin) winds come from the south carrying dust from the desert, causing a hazy atmosphere. The speed of this wind is 3-5 knots per hour.
(Source, UNEP Desk Study & EQA records).

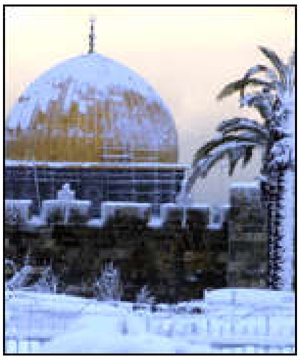


Figure 5: Snowcapped Jerusalem

2.5.2 Volume of surface water and groundwater and water withdrawal

Water is the most precious natural resource in the West Bank and Gaza Strip. Ample supplies of high quality water are essential for economic growth, life quality and sustainability.

Palestine suffers from water scarcity because of its arid and semi-arid climatic conditions and rainfall variability, and because of the abnormal political situation resulting from the long Israeli occupation, and Israel's complete control over all natural resources in Palestine.

The water resources in Palestine are divided into two main categories: surface and subsurface or groundwater resources.

2.5.3a Water resources of the West Bank

Surface Water

The only permanent river, which can be used as a source of surface water in the West Bank, is the Jordan River. The Jordan River is 260 Km long with a surface catchment area of about 18,300 Km^2 of which 2833 Km^2 lie upstream of the Lake Tiberias outlet.
Since the occupation in 1967, Palestinians have no access to the river water and are forbidden from using its water even though the Palestinian rights in the Jordan River are about 250 MCM.

Figure 6: Jordan River

Flood Water Flow

Surface flood runoff in the West Bank is mostly intermittent; it is estimated at about 64 MCM/yr.
Runoff has not been utilized or controlled on a large scale in the West Bank. Small-scale utilization of such surface water is practiced in some villages by constructing cisterns to fulfill their municipal needs, especially in villages that have no other water sources. Some farmers use small-scale open pools for irrigation.

Groundwater

Water resources of the West Bank are mainly the groundwater aquifer. The main aquifer system called the Mountain Aquifer, recharged from rainfall, the storage capacity of this aquifer is estimated to range from 600-650 MCM/yr and can be divided into three groundwater basins according to direction: the Western, Northeastern and Eastern.

The following table presents the yield of the aquifers and the Israeli and Palestinian abstraction:

Table 16: The Aquifer Yield and the Israeli and Palestinian Abstraction

Aquifer	**Yield (MCM/yr)**	**Israeli Abstraction (MCM/yr)**	**Palestinian Abstraction (MCM/yr)**	**Residual (MCM/yr)**
Eastern Aquifer	172	40	54	78
Western Aquifer	362	340	22	0
North Eastern Aquifer	145	103	42	0
Total	678	483	118	78

Source: PECDAR, Water Sector Strategic Planning, 2001

It is worthwhile mentioning that 80 percent of the storage area is located within the Israeli borders. Currently, this Aquifer is tapped by Israel through 300 deep wells to the west of what is so called "the green line".

The Palestinian water consumption is low due to restrictions imposed by Israel on water pumping. The main difficulty for Palestinian water supply is the unequal distribution of water between the Israelis and Palestinians, which arises from the Israeli control over water resources.

Also about 300 springs are distributed throughout the West Bank, from Jenin in the north to Yatta in the south, and from the western border of the West Bank to the Jordan Valley and the Dead Sea in the east. The total average annual yield of these springs is estimated to be around 60 million m^3, though as noted above a number of springs have wholly or partially dried up due to over-abstraction, (Desk Study, 2003).

2.5.3b Water resources of Gaza Strip

Surface Water

The surface Water System in Gaza Strip consists of wadis, which only flow during short period. Wadis are characterized by short duration flash floods, which occur after heavy rainfall, during most of the time the wadis are completely dry.

The major wadis are wadi Gaza that originates in the Negev desert. In addition, there are two small and insignificant wadis in Gaza Strip, wadi El-Salqa in the south, which flow to the sea and wadi Beit Hanons in the north, which flows into Israel.

The estimated average annual flow volume of Wadi Gaza is 20 to 30 MCM (Long term average). In 1994 the runoff was estimated at a bout 40 MCM, where the rainfall in Gaza Strip in that year was a bout 1000 mm.

Some recharge to the aquifer is available from the major surface flow (Wadi Gaza). But because of the extensive extraction from Wadi Gaza in Israel, this recharge is limited to, at its best 1.5-2 x 10^6

m^3 during the ten or 50 days that Wadi actually flows in a normal year.. (The Gaza Strip Aquifer-Palestine).

Flood Water Flow

The average annual rainfall varies from 400 mm/yr in the north to 200 mm/yr in the south. Rainfall is considered as the major source of renewable groundwater in the aquifer. The total rainfall recharge to the aquifer is estimated to be approximately $45m^3$/yr. The remaining rainwater evaporates or dissipates as run-off during the short periods of heavy rainstorms.

Groundwater

In the Gaza Strip, the groundwater exists in the Coastal Aquifer (shallow aquifer), which consists mainly of sandstone, sand and gravel. It is the extension of the Coastal Plain Aquifer in Israel. The maximum thickness of the different bearing horizons occurs in the northwest along the coast (150m) and decreasing gradually toward the east and southeast along the eastern border of Gaza Strip to less that 10m. Depth to water level of the coastal aquifer varies between few meters in the low land area along the shoreline and about 70m along the eastern border.

The aquifer is highly permeable with a transmissivity of about 1,000 m^2/day and an average porosity of 25%. The depth to water ranges between 70 meters in the highly elevated area in the east and 5 meters in the low land area. (PWA, 1999).

The coastal aquifer holds approximately $5x10^9m^3$ of groundwater of different quality. However, only 1.4 $x10^9m^3$ of this is “freshwater”, with chloride content of less than 500mg/l. That means that approximately 70% of the aquifer are brackish or saline water and only 30% are fresh water.

The Coastal Aquifer Management Program (CAMP, 2000a) established the 1998 water balance of Gaza Coastal Aquifer by estimating all water inputs and outputs. The total estimated inflow to Gaza aquifer of 123.2 million m^3 per year is composed of:

- recharge from precipitation 35 million m^3 per year
- return flows from leakages, wastewater and irrigation 51.6 million m^3 per year
- lateral inflow from Egypt and Israel 36.6 million m^3 per year.

The total estimated outflow of 154.1 million m^3 per year reflects:

- municipal abstraction 50.3 million m^3 per year
- agricultural abstraction 90.3 million m^3 per year
- agreed Mekorot abstraction 5 million m^3 per year
- natural discharge to the sea 8.5 million m^3 per year.

The above figures show a deficit of 30.9 million m^3 between total input and output to Gaza aquifer, implying the following adverse consequences: lowering of the groundwater table, reduction in availability of fresh groundwater, and increased seawater intrusion and potential intrusion of deep brines, (Desk Study, 2003).

2.5.4 Agricultural, industrial and domestic water demand

Agricultural irrigation is the largest reason for water consumption in Palestine (and globally), in comparison with domestic and industrial consumption, each only using less than a third as much water.

Table 17: Water Pumped for Agricultural in the Palestinian Territory

District	Quantity of pumped water (1000 m^3)
Total Palestinian Territory	116,670
West Bank	32,670
Gaza Strip	84,000

Source: Palestinian Central Bureau of Statistics, Agricultural Statistics Various Data 2001

The following figure shows the percentage of water withdrawal for agricultural, industrial and domestic purposes.

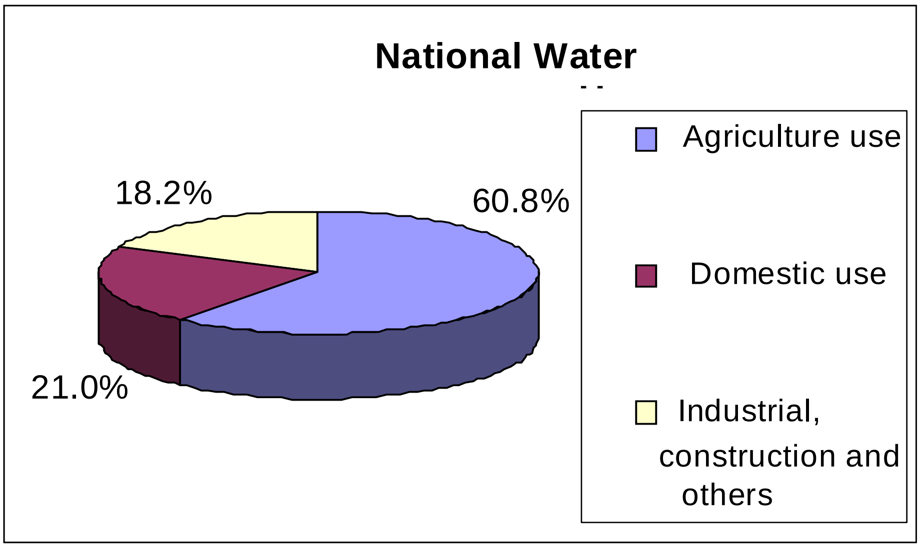


Figure 7: National Water Use in Palestine, Source: ARIJ, April 2001, Current Status of water in Palestine.

It should also be noted that a change in consumption patterns would be necessary, since the most exhaustive study to date estimates that the problem of water shortage will be more serious for the next coming years. The following tables clarify this point.

Table 18: Projected* Sectoral Demand for Palestine

Year	Domestic	Agricultural	Industrial	Total
1990	78	140	7	225
2000	263	217	18	497
2010	484	305	37	826
2020	787	415	61	1263

Source: ARIJ, Issac, 1995

**Projections are based upon the population projections, and are premised upon Israeli supply restrictions being eliminated.*

Table 19: Water Resources Gap in the West Bank and Gaza Strip

Year	Gap in the West Bank (MCM/yr)			Gap in the Gaza Strip (MCM/yr)		
	Demand	Resource	Gap	Demand	Resource	Gap
2000	202	155	**-47**	152	140	**-12**
2005	342	225	**-117**	176	151	**-25**
2010	421	314	**-107**	199	159	**-40**
2020	584	547	**-37**	162	155	**-107**

Source: WSSPS, 2001.

2.5.5 Water supply coverage: urban and rural

Table 20: Distribution of Householders According to Water Resources

Distribution ratio for families regarding to drinking water sources	*Urban* %	Rural %	Camps %
Houses connected to the networks	91.9	63.3	89.4
Houses not connected to the networks	2.0	0.9	7.0
Collection wells with supply networks	3.5	21.9	1.0
Collection wells without supply networks	0.9	5.3	0.6
Tanks	1.4	6.0	1.1
Spring	0.0	2.5	0.2
Other sources	0.3	0.1	0.7

Save drinking water sources	98.3	91.4	98.0

Source: PCBS, Health Survey, November 2001

2.5.6 Origin of irrigation water

About 90% of irrigation water -for irrigated crops- in Palestine can be considered ground water (including springs); the rest contributes between drainage and wastewater. In the West Bank about one hundred major springs, with an average annual flow discharge of 52 MCM/yr, are being used for irrigation.

The efficiency of these springs is low where large amounts of water are lost through seepage into the ground and through evaporation.

The consumption of irrigation water is about 60.8% of the total water consumption; it also good to mention that wastewater reuse in irrigation does not exceed 0.3 MCM/yr, while the potential wastewater reuse increases 50.0 MCM/yr.

2.6 TURKEY

2.6.1 Description of climate

Although Turkey is situated in a large Mediterranean geographical location where climatic conditions are quite temperate, the diverse nature of landscape and in particular the existence of the mountains that run parallel to the coasts result in drastic regional differences in climatic conditions. While the coastal areas bear relatively mild climates, the inland Anatolian plateau experiences extremes of hot, dry summers and long lasting, cold winters with limited rainfall. Figure 8 presents the average long term monthly precipitation and temperature variations in Turkey. It can be clearly seen that there exists an inverse relationship between these two variables.

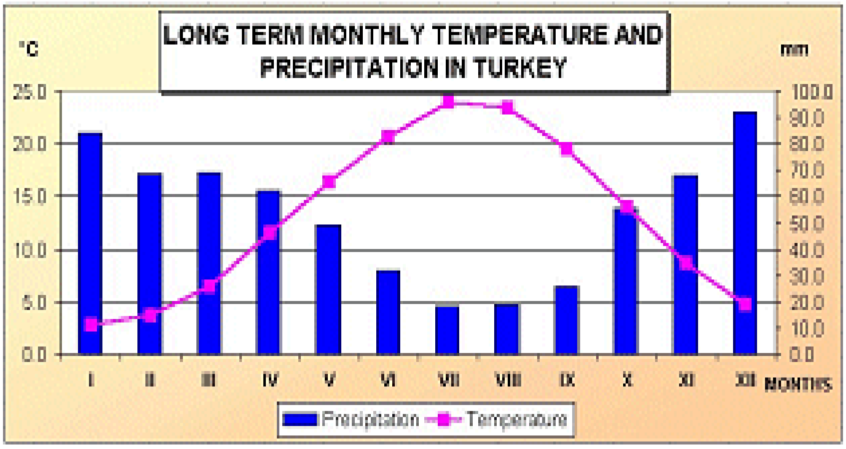


Figure 8: Long term (30 year) monthly precipitation and temperature variations in Turkey (*www.meteor.gov.tr/2003eng/general/climate/climateofturkey*)

The average annual precipitation for the country is 642.6 mm. The Aegean and Mediterranean coasts have cool, rainy winters and hot, moderately dry summers. Annual precipitation in these areas varies from 580 to 1 300 mm, depending on location. The Black Sea coast receives the highest amount of rainfall. The eastern part of the Black Sea region receives us much as 2 200 mm rainfall annually and is the only region of Turkey that receives rainfall throughout the whole year.

Turkey's regions have different climates mainly because of their rather irregular topography. Taurus Mountains are close to the coast and rain clouds cannot penetrate to the interior of Central Anatolian part of the country. Hence rain clouds leave most of their water on the coastal zones. In the Eastern region of Anatolia, the elevation of mountains exceeds 2 500–3 000 m. For instance, Erzurum (population = 389700, 2003; www.world-gazetteer.com) is the city being located on the highest mountain plateau of the world. Northern Black Sea Mountains and the Caucasian Mountain hold the rain clouds, and consequently the area is affected by the continental climate with long and very cold winter periods. Minimum temperatures of -30°C to -38°C are observed in the mountainous areas in the east, and snow may lie on the ground 120 days of the year. Winters are bitterly cold with frequent, heavy snowfall. Villages in the region remain isolated for several days during winter storms. Summers, on the other hand, are typically hot and dry, with average temperatures above 30°C. Spring and autumn are generally mild, but during both seasons sudden hot and cold spells frequently occur in the Eastern region. Annual precipitation averages about 500-800 mm with actual amounts determined by elevation. Figure 9a and 9b presents long term average precipitation and temperature variations in Turkey, respectively.

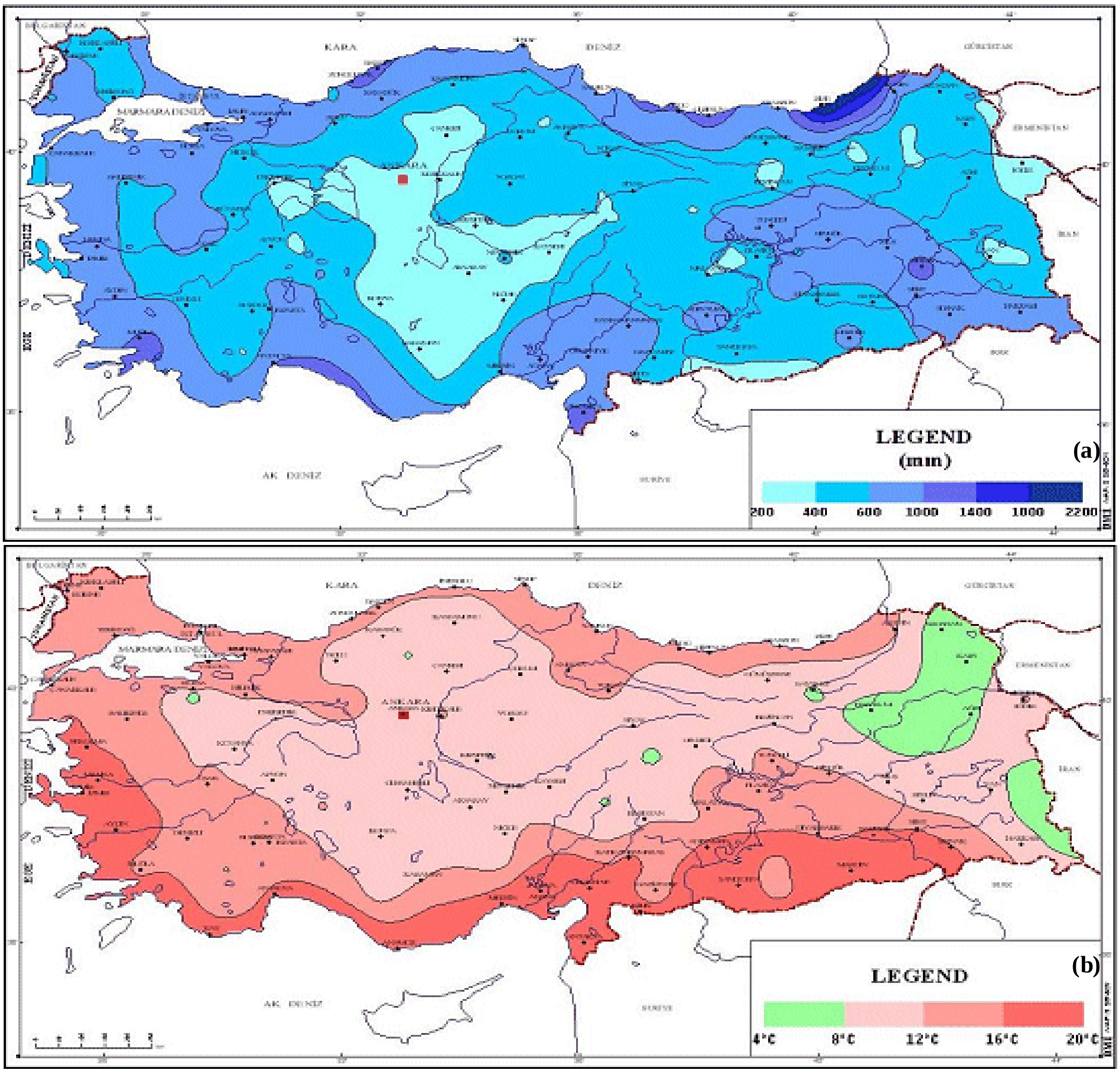


Figure 9: Long term average precipitation (a) and temperature (b) variations in Turkey (*www.meteor.gov.tr/2003eng/general/climate/climateofturkey*)

In Istanbul and around the Marmara Sea, the climate is moderate (average winter 4°C and summer 27°C). In the inner parts of the Marmara Region, however, winter temperatures can drop below zero. In Western Anatolia, there is a mild Mediterranean climate with average temperatures of 9°C in winter and 29°C in summer. On the southern coast of Anatolia similar climatic conditions are observed. The climate of the Central Anatolian Plateau is a steppe climate and much more subject to extremes than are the coastal areas. There is a significant temperature difference between day and night. Rainfall is low usually in the form of snow. The average temperature is 23°C in summer and -2°C in winter. The climate in the Black Sea region is wet, humid (average summer temperatures “23°C, winter 7°C”) and the annual rainfall is highest in this region. The Eastern Black Sea region receives rainfall throughout the whole year. In Eastern Anatolia and South-Eastern Anatolia there is a long winter, and snow remains on the ground from November until the end of April (the average temperature in winter is -13°C and in summer 17°C). The driest regions are Karaman, Igdir and Sanliurfa, where annual rainfall frequently is less than 300 mm. Summers are usually very hot and dry, with temperatures above 30°C.

There are several reasons of the rainfall variability in Turkey. During winter, pressure patterns over the Mediterranean and the surrounding land masses are known to be controlled by the movement and intensity of both the Icelandic low and low pressure zones near the Equator (Baum and Smith, 1953). Under the controlling influences, the lowest pressure centered over the central Mediterranean in winter is displaced to the east. Barry and Chorley (1992) indicated a strong tendency for low pressure centers to move northeast over the Balkans and the Black Sea. The heavy rain conditions in winter season at the Aegean and Mediterranean coastal areas Turkey are associated with frontal cyclones depending on the south westerly air flows (Turkes, 1996; Karaca et al., 2000). Furthermore, recent studies are focusing on the El Nino southern Oscillation (ENSO) influence on the southern Europe and Mediterranean Middle East region rainfall. Mariotti et al.,(2002) showed that a significant influence of ENSO on rainfall in region of the Euro-Mediterranean sector with seasonally changing characteristics. Besides, there are attempts to find a relationship between the North Atlantic Oscillation and rainfall in Turkey (Komuscu, 2001; Turkes and Erlat, 2002). Komuscu analyzed the drought conditions related to changes in the weather patterns in Atlantic region. Turkes and Erlat (2002) found a negative correlation between inter annual variability of the North Atlantic Oscillation (NAO) indices and precipitation in Turkey. Following to spring months, the highs over the Balkans, southern Russia, Ukraine and Anatolia weaken; the low pressure centers over the Mediterranean are less pronounced. Over the Mediterranean, pressure is slightly higher than over the heated land masses of Anatolia. This result leads to formation of the summer precipitation patterns in Turkey.

2.6.2 Volume of surface water, groundwater

In general, Turkey cannot be evaluated as a water-rich country. The country has a total land area of 779 452 km^2 (78 million ha), out of which 765 152 km^2 is land and the remaining 14 300 km^2 is surface water. Rainfall accounts for an average of 501 billion m^3 of water annually. It is estimated that 274 billion m^3 of this amount returns to the atmosphere through evaporation and transpiration from soil and water surfaces and plants; 41 billion m^3 feeds underground reservoirs through leakage and deep percolation forming surface water and 186 billion m^3 runs off into seas or lakes as surface water. Around 7 billion m^3 of water is added to the country's water potential through rivers of neighboring countries. Thus the gross amount of renewable fresh (surface) water potential of Turkey is about 234 billion m^3 depending on climatic fluctuations.

The total safe yield of groundwater resources is estimated to be 12 billion m^3. The total, technically and economically usable surface and ground water potential of Turkey is only around 110 billion m^3, with 95 billion m^3 (86%) coming from rivers located within Turkish borders, 3 billion m^3 (3%) from external rivers originating outside the country borders and 12 billion m^3 (11%) from groundwater resources (The General Directorate of State Hydraulic Works, 1999).

Turkey possesses 177 714 km of river, 203 599 ha of natural lakes and 179 920 ha of lakes created by dams and artificial lakes, the latter area being continuously increasing all the time. To handle matters concerning drainage areas water resources more precisely, Turkey has been divided into 26 river basins (i.e. water collection regions). The country's geographical and climatic variety reveals that its water supplies are often not to be found in the right place and at the right time to meet the ever increasing demand. As has been indicated previously, the average annual precipitation is 642.6 mm, but this figure conceals wide variations from region to region. In order to control and regulate all potential surface water sources in the country, the construction of 662 more dams is required. It is obvious that the above mentioned facts require huge investments and a long period of construction. According to the National 8th Five Years Development Plan, the water supplies from these dams would be regulated to achieve the following: Irrigation of 6 609 382 ha; drainage of 135 801 ha; flood control of 636 794 ha; conveyance of 7726 hm^3 of water to urban areas and generation of 121 884 MkWh of electric power via hydroelectric plants with a total capacity of 34484 MW of generated electricity (The General Directorate of Rural Services, 2001).

The General Directorate of State Hydraulic Works established in 1954 under the Ministry of Public Works and Settlements is responsible for major irrigation projects at flow capacities over 500 L/s, flood control, swamp reclamation, hydropower development, and water supply to cities with population over 100,000. In recent years, it has been responsible for extending irrigation to an average of nearly 50,000 ha. per year. The General Directorate of Rural Services (GDRS) is administered under the Prime Ministry and is in charge of cities with population below 100,000 and manages river water sources for agricultural and domestic purposes at flow capacities below 500 L/s. GDRS is also responsible for the education of farmers and cooperative investments, the construction of rural roads, communal buildings in rural areas, small reservoirs and small-scale irrigation schemes and for supplying drinking water to rural communities.

2.6.3 Water demand

Turkey can be classified as a country facing potential water stress, considering the fact that there might be serious water scarcity where the expandable annual drinking water reserves are around 1000 m^3 per capita. The available amount of water per capita is 1735 m^3, the overall potential around 3690 m^3 per capita. The total annual water withdrawal is 42.0 billion m^3 for the whole country by 2000 (The General Directorate of Rural Services, 2001).

The estimated distribution of annual water requirements and water consumption of Turkey are given Tables 21 and 22, respectively. It is understood by comparison of the two tables that: 30.6/43.3 x 100 = 71% of total water resources development was realized in 1990, 79% in 1995 and 80% in the year 2000. The total development of water resources by state institutions in several sectors reached 32 billion m^3 in 1994. This means that only 14 % of the gross water potential

(=32/234), or 29% of the technically and economically usable potential (= 32/110) has been developed. 75% (29.2 billion m^3) of this water is used as irrigation water and for agricultural

Table 21: Water Requirements of Turkey (Year 2000)

Year	Total (10^6 m^3)	Sectoral Requirement		
		Domestic (10^6 m^3)	Irrigation (10^6 m^3)	Industrial (10^6 m^3)
1990	43.300	5.900	32.300	5.100
1995	50.600	7.400	37.000	6.200
2000	58.100	9.000	41.800	7.300

Table 22: Water Consumption in Turkey (Year 2000)

Year	Total Consumption (10^6 m^3)	Development (%)	Sectoral Consumption		
			Domestic (10^6 m^3)	Irrigation (10^6 m^3)	Industrial (10^6 m^3)
1990	30.600	28	5.141	22.016	3.443
1992	31.600	29	5.195	22.939	3.466
1995	33.500	30	5.300	24.700	3.500
2000	42.000	38	6.400	31.500	4.100
2002	38.900	36	5.700	29.200	4.000

purposes, 15% (5.7 million m^3) for domestic and 10% (4.0 million m^3) for industrial purposes (adopted from General Directorate of Rural Services, 2001).

River Basin – Based Evaluation of Water Potential

A river basin rather than regional water management provides a more integrated water management approach. With the purpose to evaluate large – scale problems related with the development and use of water sources efficiently, SHW categorizes Turkey into her river basins according to their respective drainage areas. Hence, the country is divided into 26 main hydrological basins and basin-wide master plans have been prepared. Table 23 presents Turkey's water and agricultural land potential on the basis of this classification. Mostly leading a demand-oriented approach, water-related projects are rather developed for hydropower generation, irrigation, municipal water supply and flood protection.

From Table 23, it can be inferred that the average annual rainfall of the country corresponds to a water potential of 501 km^3. It can also be concluded that from year 1999 on, the construction of 730 dams has been planned to regulate Turkey's water regime in order to use water and land resources more efficiently. In this way it will be possible to irrigate 7 254 454 ha, dry 130 326 ha, protect flood on 704 868 ha land area, as well as to supply 9 856.3 hm^3 drinking water to cities and suburbs. An additional benefit will be to gain 123040 GWh energy from 485 hydroelectric power plants working at a total power of 34 728.7 MW.

2.6.4 Agriculture water demand

River Basin-Based Operation of Irrigation Areas

SHW has constructed a total area of 2 296 350 ha for irrigation, of which 11 % is operated by SHW himself and 72% by other end-user organizations (irrigation associations, village authorities, municipalities etc.). SHW has recently reported that not all of the irrigation areas constructed and operated by SHW can be actually irrigated. 63 % of the SHW – operated irrigation schemes (125 889 ha) could not be irrigated due to many reasons which are; insufficient water resources (8%; corresponding to 9 617 ha), lack of irrigation facilities being physically in operation (4%, 5 054 ha), drainage problems including salinity (1%, 2 362 ha), inadequate topographic conditions (4%, 4 797 ha), insufficient rainfall (36%, 45 048 ha.), social and economic problems (21%, 26 404 ha), fallowing (16%, 19 676 ha), operation failures and insufficient maintenance (1%, 1 584 ha), making up a total of 125 889 ha. On the other hand, among the 1 583 543 ha that has been constructed by SHW and transferred thereafter to other organizations, 36% could also not be irrigated due to several reasons that can be cited as follows; inadequacy of water resources (13%), insufficient irrigation structures (6%), groundwater and salinity problems (4%), inadequate maintenance (1%), topographic conditions (3%), rain-fed cropping (23%), fallowing (12%), economic and social problems (21%), water pollution, marketing problems, agricultural areas being converted to industrial or settlement areas, graze land and pastures (18%) (The General Directorate of State Hydraulic Works, 1999).

In order to obtain the expected benefit from irrigation investments which have been carried out at high costs, non-irrigated land within the command area must be decreased. Considering the reasons for non-irrigation within the command area, it can be inferred that decreasing non-irrigation primarily depends on the two following factors (The General Directorate of State Hydraulic Works, 2002);

- Irrigation schemes providing irrigation water to users in an active and stable way, giving no harm to environment has to be established
- End users have to be properly organized and educated. Organizations in the agricultural area have to give pay attention this subject and should cooperate with each other.

Table 23: Turkey's water and agricultural land potential (adopted from The General Directorate of State Hydraulic Works, 1999)

River Basin				Average Water in Basin			Water Storage in Basin		Land Sources in Basin	
Nr.	Name	1997 Demography	Surface Area (km^2)	Average Annual Precipitation (mm)	Annual River Basin Yield ($l\ s^{-1}\ km^{-2}$)	Annual Total Flow (km^3)	Number of dams	Stored Water (hm^3)	Agricultural Area (ha)	Area Suitable for Irrigation (ha)
1	Meric Ergene	1056473	14560	604.0	2.9	1.33	21	1817.0	1095320	1077992
2	Marmara	11329437	24100	728.7	11.0	8.33	58	2894.5	865704	729957
3	Susurluk	2674579	22399	711.6	7.2	5.43	26	3848.0	850046	755934
4	Kuzey Ege	617011	10003	624.2	7.4	2.09	15	797.0	367479	316348
5	Gediz	2327897	18000	603.0	3.6	1.95	16	3565.9	667207	623403
6	K. Menderes	1972770	6907	727.4	5.3	1.19	17	1697.7	222437	194799
7	B. Menderes	1975402	24976	664.3	3.9	3.03	22	2739.9	1044296	907383
8	Batı Akdeniz	890441	20953	875.8	12.4	8.93	25	1830.0	437356	406601
9	Antalya	1558219	19577	100.4	24.2	11.06	14	2858.0	451224	448111
10	Burdur Goller	200200	6374	446.3	1.8	0.50	9	161.7	251403	249484
11	Akarcay	665447	7605	451.8	1.9	0.49	3	172.0	364411	359938
12	Sakarya	5703375	58160	524.7	3.6	6.40	45	6827.9	2814341	2681137
13	Bati Karadeniz	1892776	29598	811.0	10.6	9.93	28	2784.0	855008	640557
14	Yesilirmak	2290024	36114	496.5	5.1	5.80	44	6194.9	1617206	1401213
15	Kizilirmak	3963186	78180	446.1	2.6	6.48	78	23774.3	4049796	3761142
16	Konya Kapali	2430709	53850	416.8	2.5	4.52	25	2800.8	2182762	2134915
17	Dogu Akdeniz	2051695	22048	745.0	15.6	11.07	11	10173.5	438281	327790
18	Seyhan	1695572	20450	624.0	12.3	8.01	18	6124.5	764673	714014
19	Asi	1277313	7796	815.6	3.4	1.17	8	1086.5	376240	331719
20	Ceyhan	1418391	21982	731.6	10.7	7.18	27	8229.3	779792	713670
21	Firat	7199119	127304	540.1	8.3	31.61	89	112193.2	4293793	4111316
22	Dogu Karadeniz	2494663	24077	1198.2	19.5	14.90	41	1491.6	712575	350717
23	Coruh	467718	19872	629.4	10.1	6.30	21	7467.3	326220	303362
24	Aras	889157	27548	432.4	5.3	4.63	20	4085.2	642017	641137
25	Van Kapali	1005209	19405	474.3	5.0	2.39	7	608.7	436485	433319
26	Dicle	2818791	57614	807.2	13.1	21.33	42	30630.5	1148238	1137628
	Total	62865574	779452	642.6	186.05	186.05	730	246853.9	28054310	25753586

2.6.5 Industrial water demand

See paragraph 2.6.3.

2.6.6 Domestic water demand

Table 24 presents water withdrawal distribution in urban and rural areas. From Table 24 it can be concluded that most of the water is withdrawn for urban use and almost 40 % of this water is supplied from dams. Similarly, 67 % of the total rural water withdrawal is provided from groundwater wells. Water withdrawals have been sub-categorized in accordance with SHW data where urban population is defined for cities where the population exceeds 15 000. For the establishment of withdrawal rates with respect of demographic trends, population statistics from the year 2000 have been considered.

Table 24: Urban and Rural Water Withdrawal (State Institute of Statistics, 2001)

	Rural Withdrawal distribution (%) Total water amount: 164 x 10^6 m^3	Urban Withdrawal distribution (%) Total water amount: 6202 x 10^6 m^3
Spring water	24.3	22.1
Lake	0.53	10.3
River	1.54	2.21
Dam	4.90	39.6
Groundwater	67.4	24.1
Pond	0.37	1.57
Other	0.96	0.12

2.6.7 Water supply coverage

The overall situation of water supply within the country, according to 2000 data states that Turkey is divided into 3227 municipalities, of which 2359 have a drinking water network and only 143 of these municipalities have a drinking water treatment facility. Lacking infrastructure, insufficient number of treatment facilities, water leakage (32% of total supply) and illegal water consumption (37% of total supply) hinder the efficient use of municipal water facilities (The State Planning Organization, 2001). Besides, 36% (= 28 million ha) of the total land is devoted for agricultural purposes, revealing that more than one third of the country is used for agricultural activities which is a considerably high value. Hence the supply and management of water resources for agricultural activities play a vital role in food production and security, and many countries, of which Turkey is one, have therefore paid much attention to improving and expanding their current irrigation systems. In Turkey, a total of 75% of the funds allocated for agricultural investments is directed towards irrigation projects. However, the full completion of projects in this sector ranges between 15 and 20 years.

2.6.8 Origin of irrigation water

Table 25 lists the irrigation areas constructed by SHW with respect to water sources in the period 1987–2002 (The General Directorate of State Hydraulic Works, 2002).

Table 25: Irrigation areas constructed by SHW with respect to water sources (adopted from The General Directorate of State Hydraulic Works, 2002)

	Water Resources (ha)					
Years	Dam	Lake	Pond	River	Groundwater	Total (ha)
1987	801805	64645	22234	341706	277045	1507435
1988	833275	69045	22477	329898	281535	1536230
1989	863139	73345	25666	345168	289855	1597173
1990	878394	72975	32673	343608	298520	1626170
1991	891979	87011	36346	360453	312105	1687894
1992	911393	89833	38364	367853	315285	1722728
1993	934135	97208	41070	382436	336130	1790979
1994	958297	101070	43918	385361	343360	1832006
1995	1008629	106070	45836	381990	355325	1897850
1996	1049996	125697	48003	388510	367170	1979376
1997	1074164	134379	52990	402041	394574	2058148
1998	1135749	149110	59888	403937	406234	2154918
1999	1174439	151010	66762	389645	420706	2202562
2000	1201631	151935	69420	396780	432859	2251625
2001	1217834	161260	70738	403354	443164	2296350
Increase (%)	51.9	149.5	218.2	18.0	60.0	52.3

Table 25 indicates that specifically water supply for irrigation through lakes and ponds has been increased within the last 14 years.

- *Area Irrigated by Reused Wastewater or Other Non-Conventional Water Resources*

Agricultural irrigation applications realized with reused wastewater or other non-conventional water resources are not conducted offically. The common property of The General Directorate of Rural Services and General Directorate of State Hydraulic Works is the usage of groundwater and clean surface waters for irrigation.

Local application examples about irrigation of agricultural areas with non-conventional water resources can be mentioned. For example, wastewater reused for agricultural applications are wide spread in South East Anatolia. The wastewater is commonly used for the irrigation of vegetables in the area. In Siverek, located in South East Anatolia, domestic wastewaters discharged into stream have been reused for agricultural applications. Cotton, wheat and various vegetables are the agricultural products mainly irrigated with wastewater. In this area firstly eggplant, pepper and tomato have been planted. Also cabbage, carrot and spinach known as seconder products have been raised. Due to the fact that these products can be sold at a certain profit, farmers have selected the irrigation method realized with reused wastewater. Some of these areas have been irrigated with surface wastewater by gravity and the others through pumping from wastewater channels. In Siverek, the total area irrigated by wastewater is 165 ha. and the consumption of irrigation water was 1.9 million m^3 in 2001 (South-Eastern Anatolia Project – Regional Development Administration, 2002).

Because of insufficient sewarage facilities and lack of satisfactory treatment, an enourmous amount of domestic wastewater has been discharged into rivers. These water resources have also been used for irrigation. For example, in Trakya, located in North-West Anatolia, 1 560 620 m^3 of domestic wastewater has been discharged into the river Evros and 9 000 ha. of agricultural area has been irrigated by the polluted waters (www.tekirdag.gov.tr, www.dsi.gov.tr).

MEDAWARE

ME8/AIDCO/2001/0515/59341-P033

EUROPEAN COMMISSION

EURO-MEDITERRANEAN PARTNERSHIP

Development of Tools and Guidelines for the Promotion of the Sustainable Urban Wastewater Treatment and Reuse in the Agricultural Production in the Mediterranean Countries

(MEDAWARE)

Task 1: Determination of the Countries Profile

PART C: WASTEWATER AND THE USE OF NON CONVENTIONAL WATER RESOURCES

MEDAWARE- Part C

<u>INDEX</u>

3. Wastewater and the Use of Non Conventional Water Resources

3.1 CYPRUS

3.1.1 Wastewater Treatment Plants

The number of Sewage Treatment Plants currently (STPs) in operation is around 30.These STPs cover the four major greater urban areas and some large tourist centers (Lefkosia, Lemesos, Larnaka, Pafos and Agia Napa – Paralimni) and part of the rural areas. Centralized sewage networks now serve 12% of the rural population. There is also a large number of small STPs in the hotels. In addition there exists a programme for building such units in 28 large rural centers (having a population of more than 2000) and in sensitive mountain villages by the year 2012. This is in accord with the instructions/principles of the Urban Wastewater Directive 91/271/EEC of the European Union (EU). It is worth noting that all plants have provisions for tertiary treatment so that their effluent is safely used for irrigation.

3.1.2 Treated wastewater produced

The first large sewage treatment plant, in the Government controlled areas, started operation in Lemesos in the summer of 1995. Sewage treatment plants of total capacity of about 20 MCM/year are now in operation.

Table 1 presents the main treatment plants with their capacity all over Cyprus, stage of treatment and use.

Table 1: Sewage Effluent Treatment Plants

Name	W. Produced m3/Year	Treatment	Use
Lefkosia Sewage Board	3650000	Secondary	Diverted to Pedieos River
Anthoupolis-Lefcosia	127750-(max2.56 million)	Secondary	Stored in open Reserv. for evaporation
Larnaca Sewage Board	912500 maximum	Tertiary	Landscape Irrigation
Agia Napa – Paralimini	2500000 maximum	Tertiary	Landscape-Forest
Lemesos Sewage Board	3000000	Tertiary	Agriculture-Landscape of Hotels
Pafos Sewage Board	4895000	Tertiary	Agriculture
Bathia Gonia	803000	Tertiary	Agriculture
Dhali-Nisou	182500	Tertiary	Agriculture
Platres	73000	Tertiary	Not operating-Agriculture

Name	W. Produced m3/Year	Treatment	Use
Carlsberg	146000	Tertiary	Agriculture
Lefkosia New Hospital	182500	Tertiary	Not operating-Landscape
Lemesos Hospital	47450	Tertiary	Landscape
Alassa (new site village)	18250	Tertiary	Agriculture
Palechori	73000	Tertiary	Diverted to the River
Apostolos Loucas	25550	Secondary	Used by The Agr. Res. Instit.
Kofinou	65700	Secondary	Agriculture
Zenon-Kamares II	109500	Secondary	Landscape irrigation
Agglisides	365000	Secondary	Agriculture
Kornos	25550	Tertiary	Landscape Irrigation
Stavrovouni	25550	Tertiary	Landscape Irrigation
Agios Ioannis	17900	Tertiary	Landscape Irrigation
Malounda	7300	Tertiary	Landscape Irrigation
Klirou	26300	Tertiary	Landscape Irrigation
Kyperounda	109500	Tertiary	Agriculture
Troodos	8800		Landscape
TOTAL Maximum	**19829850**		

3.1.3 Wastewater reused

Recycled domestic water is presently used for the watering of football fields, parks, hotel gardens, road islands and for forestation (1,5 MCM/yr) and for the irrigation of permanent crops in particular (3,5 MCM/yr). It is estimated that by the year 2012 an amount of approx. 30 MCM of treated sewage effluent will be available for agriculture and landscape irrigation.

3.1.4 Desalinated water

Desalination of sea water was first introduced in Cyprus, on a large scale basis, on the 1st of April 1997 with the operation of the Dhekelia plant. Today there are two desalination plants in operation, the one at Dhekelia of 40000 m^3 per day capacity and the other at Larnaca of 51667 m^3 per day capacity. Both are reverse osmosis plants and produce 33 MCM of water a year. Desalination units were set up with the aim of eliminating the dependence on rainfall regarding potable water supplied to the large urban and tourist centers.

3.1.5 Applications of non-conventional water resources

The Government´s water policy is not restricted to desalination plants, but is also focused on the exploitation of other non-conventional water sources such as recycled water, which replaces equal quantities of good quality water. Recycled water, which results from the treatment of wastewater, is used for irrigation purposes and the enrichment of aquifers.

The combined production of the two desalination plants is at present more than sufficient to meet the winter daily domestic demand for water of the cities and suburbs of Nicosia and Larnaca as well as of the tourist centers of Ayia Napa and Paralimni.

Treated sewage effluent covers some of the needs in agriculture. Already some quantities are used for the following crops: Citrus, Olives, Vines, Fodders and Landscape. Table 2 presents the irrigated crops at Lemesos Sewage Treatment Plant, as an example of an application of treaded sewage effluent.

Table 2: Lemesos Sewage Treatment Plant – irrigated crops, 2000

Area	Crops	Area-Decars
Mari area	Citrus	33
	Olives	21
	Alfalfa	66
	Corn	53
	Sudax	26
	Potatoes	18
	Onions	5
	Turf (Vasillicos Cement)	10
	Total	**232**
Ag. Georgios Alamanon	Citrus	0
	Olives, Figs, Other trees	135
	Alfalfa	417
	Corn	0
	Sorghum	0
	Potatoes	0
	Onions	0
	Aromatic Plants	20
	Total	**572**
Parekklisia	Landscape	5
Pyrgos	Landscape	53
Lemessos Hotels	Landscape	502
Tychona Municipality	Landscape	300
Lemesos	Olives, Figs, Other trees	36
Yermasoyia Municipality	Landscape	6
	Total	**902**
GRAND TOTAL		**1706**

3.2 JORDAN

3.2.1 Wastewater Treatment Plants

Presently, there are 19 wastewater treatment plants serving most of the major cities and towns in the country. Table 3 shows the existing wastewater treatment plants. About 63% of the total population of Jordan has access to wastewater collection and treatment systems.

Table 3: Existing Wastewater Treatment Plants

NO	WWTP	Operation	Gov.	Type of Treatment
1	As Samra	1985	Zarqa	WSP
2	Abu Nuseir	1988	Amman	AS
3	Wadi Essir	1996	Amman	WSP+ Aeration
4	Wadi Arab	1999	Irbid	EA
5	Irbid	1987	Irbid	TF+AS
6	Ramtha	1988	Irbid	WSP
7	Salt	1981	Balqa	EA
8	Baqa'	1988	Balqa	TF
9	Fuhais	1996	Balqa	EA
10	Ma'an	1989	Ma'an	WSP
11	Wadi Mousa	2001	Ma'an	EA
12	Mafraq	1988	Mafraq	WSP
13	Jarash	1983	Jarash	EA
14	Kufranja	1989	Ajloun	TF
15	Madaba	1989	Madaba	AS
16	Karak	1988	Karak	TF
17	Tafila	1988	Tafila	TF
18	Aqaba	1987	Aqaba	WSP
19	Wadi Hassan	2000	Irbid	EA

3.2.2 Treated wastewater produced

The aforementioned wastewater treatment plants can treat up to 88.5 MCM per year (Influent). The quantity of treated wastewater is about 73 MCM per year (Effluent). The following table gives detailed information on the treated wastewater produced.

Table 4: Treated Wastewater (Influent& Effluent, MCM for the yr 2002):

NO	WWTP	Influent MCM	Effluent MCM
1	As Samra	65.245	53.301
2	Abu Nuseir	0.722	0.712
3	Wadi Essir	0.698	0.290
4	Wadi Arab	2.579	2.516
5	Irbid	2.6	2.551
6	Ramtha	0.839	0.691
7	Salt	1.425	1.299
8	Baqa'	4.296	3.992
9	Fuhais	0.556	0.381
10	Ma'an	0.790	0.557
11	Wadi Mousa	0.316	0.08
12	Mafraq	0.659	0.506
13	Jarash	1.062	0.983
14	Kufranja	0.811	0.585
15	Madaba	1.525	1.352
16	Karak	0.550	0.449
17	Tafila	0.270	0.271
18	Aqaba	3.406	2.655
19	Wadi Hassan	0.155	0.075
Total		**88.502**	**73.1**

3.2.3 Wastewater reused

Treated wastewater effluent is considered a valuable water resource for irrigation. This is deemed by the supply-demand imbalance of drinking water, the arid climatic conditions of the country and the deficit in the trade of food commodities. Therefore the Government of Jordan has imposed that all new wastewater treatment projects must include feasibility and design aspects for treated wastewater reuse. Jordanian Standards JS 893/2002 for Reclaimed Domestic wastewater is based on reuse categories. Untreated wastewater is prohibited to be discharged to the watercourses or to be used for irrigation by the Jordanian law.

3.2.4 Desalinated water

The amount of desalinated water in Jordan is relatively small but an future option in the policy of Ministry of Water of Irrigation. The amount available up to date is about 2 MCM from two small Pilot Plants.

3.2.5 Applications of non-conventional water resources

All treated wastewater is used for irrigation purposes.

3.3 LEBANON

3.3.1 Wastewater treatment plants

In Lebanon there are 15 wastewater treatment plants. Table 5 gives the location and monitoring authority of each plant.

Table 5: Wastewater Treatment Plants in Lebanon

Region	Water Board	Plant Location/ Name
Greater Beirut	Beirut	Dbaiye
	Ain El Delbe	Dachonieh
		Hazmieh
North	Tripoli	Haab
	Nabaa El Ghar	Kousba
	Batroun	Nabaa Delleh
Mount Lebanon	Metn	El Marj Lake
		Jeita
	Jbeil	Nahr Ibrahim
South	Saida	Nabaa Kfarwa
	Nabaa El-Tasse	Nabaa Azzibeh
	Sour	El Bass
		Ras El Ain
	Jabal Amel	Taybeh [3/]
Bekaa	Zahle	Berdawni
Total	**12 authorities**	**15 plants**

1/ Source: METAP/ERM, 1995
2/ Source: *Pers Comm* El Hassan Z, CDR/Water supply specialist

3.3.2 Treated wastewater produced

The following table summarizes the capacity of wastewater treatment plants in Lebanon.

Table 6: Distributions and Flow Capacity of Water Treatment Plants in Lebanon

Plant Location/ Name	*Capacity*	
	1995 [1/]	*2001* [2/]
Dbaiye	230,000	430,000
Dachonieh	50,000	50,000
Hazmieh	50,000	50,000
Haab	40,000	40,000
Kousba	5,000	16,000
Nabaa Delleh	3,500	12,000
El Marj Lake	3,500	3,500
Jeita	16,000	17,000
Nahr Ibrahim	4,000	16,000
Nabaa Kfarwa	8,500	8,500

Nabaa Azzibeh	4,000	4,000
El Bass	6,000	12,000
Ras El Ain	13,500	15,000
Taybeh [3/]	8,000	8,000
Berdawni	10,000	10,000
Total	**452,000**	**692,000**

1/ Source: METAP/ERM, 1995
2/ Source: *Pers Comm* El Hassan Z, CDR/Water supply specialist
3/ A new plant with a design capacity of 25,000 m^3/day is under preparation

3.3.3 Wastewater reused

None of the large-scale wastewater treatment plants that are planned by the government is currently operational, except for the Ghadir preliminary treatment plant. Therefore, the only source of treated wastewater is the small community-based treatment plants that are producing around 16,000 m^3/day.

However, with the achievement of the construction of the major large-scale treatment plants (coastal and inland), Lebanon will achieve around 80 % wastewater treatment by the year 2020. This is estimated to generate around 1 million m^3/day of treated wastewater.

3.3.4 Desalinated water

The presence of ample fresh water sources has limited the adoption of desalination of brackish and seawater to individual households and industrial institutions who needed supplementary sources of water for individual use. No figures are available as to the quantities of water that are produced through desalination as these are practiced on a private basis and not reported to the authorities. Desalinated water has never been used in Lebanon on a municipal scale and is not envisaged to be used as such in the near future.

3.3.5 Applications of non-conventional water resources

Raw wastewater is being reused for irrigation in several regions of Lebanon. Such is the case in the Bekaa region where some of the sewers are purposely blocked to allow sewage to be diverted for irrigation. In other regions, wastewater is being discharged in rivers or streams used for irrigation such as in Akkar and Bekaa (Ras El Ain, Zahleh).

The treated wastewater that is produced by the community-based treatment plants, and which is approximated at 16,000 m^3/day, is being reused mainly for irrigation. The completion of the government plan for inland large-scale treatment plants will increase considerably the amount of treated wastewater, an important fraction of which will be used for irrigation. As for the plants that are being constructed in the coastal region, their effluents which will form the bulk of the total treated wastewater (about 70%) will be discharged into the sea and, except for a small portion of that effluent, there are no plans set for reuse. The main reason for the absence of agricultural land in the neighborhood of the effluent sources. There is however a good possibility that a substantial portion of this effluent be used for ground water recharge in areas where seawater intrusion into the fresh water aquifer has been progressing over the years.

3.4 MOROCCO

3.4.1 Wastewater treatment plants

Although the construction of wastewater treatment plants began in the 50s, the treatment of wastewater has for long been delayed. According to the Higher Council of Water and Climate, out of the 69 WWTP which were recorded, only 29 remain in an operating state, representing 42% of the total (see the Table below).

Table 7: Wastewater treatment plants

WWTP type	Number	In operation	Out of service	Not connected	% in operation
Activated sludge	20	12	5	3	60
Bacterial beds	11	5	6	0	45,5
Decanters Digesters	17	2	13	2	11,8
Draining	3	0	3	0	0
Lagunage	13	7	5	1	53,8
Infiltration Percolation	2	2	0	0	100
Algae channel	3	1	1	1	33,3
Total	69	29	33	6	42

(Source: CSEC, 2001)

*3.4.2 **Treated** wastewater produced*

The annual volume of urban wastewater has increased from 48 million m^3 in 1960 to 500 million m^3 in 1999. It is estimated that this amount will reach 900 million m^3 in 2020. This significant increase is due to population growth, which is estimated at 5% per year. The contribution of industry in the total wastewater generation is estimated at 12%. Only 8% of the quantity produced is treated.

In Morocco, untreated wastewater is discharged in the water recipients. Approximately 60% is discharged in the sea. The rest is either discharged in the surface waters or reused for the irrigation of 7000ha.

3.4.3 Wastewater reused

Wastewater is considered to be an alternative resource of water and a source of nutrients. Thus it has for long been used for irrigation in some great continental agglomerations. A surface of approximately 7235ha is directly irrigated with untreated urban wastewater (CSEC, 1994), namely 70 million m^3 of wastewater is reused every year in agriculture without any precaution measures to be applied (for example the WHO standards). Various types of cultures are irrigated with wastewater such as fodder crops, horticulture, field crops and arboriculture.

3.4.4 Desalinated water

Morocco has established several units of desalination and demineralization in the provinces of the south and more particular in Tarfaya, Smara, Boujdour and Laâyoune. For the supply of urban areas with drinking water, the National Office of Drinking Water uses: 64,4% surface water, 35,3% underground water and 0,3% desalinated water.

3.4.5 Applications of reused non conventional water resources

In Morocco the exploited non conventional water resources are:

- Desalinated sea water. Desalination is the most used non conventional wayer resource in Morrocco in order to satisfy the demand of drinking water in the provinces of the south.

- Untreated wastewater is currently used for the irrigation of a surface of more than 7000 ha., with a total volume exceeding 70 million m^3 per year.

3.5 PALESTINE

The scarcity of water in the Mediterranean and Middle East countries requires endorsement of sustainable wastewater management. The wastewater related problems, which these countries are facing, are yearly increasing owing to the increasing discharge of wastewater as a result of the increasing demand of fresh water for industrial purposes, human consumption and agricultural productions.

In view of water resources shortage in Palestine, the Palestinian Environmental Strategy paved the way for maximizing the use of non-conventional water resources. These resources can be classified as the following:

- Storm water harvesting
- Brackish water desalination
- Sea water desalination
- Waste water reuse

3.5.1 Information on produced, treated, reused wastewater, desalination water and application of reuse – Gaza Strip

Three treatment plants are found in the Gaza Strip namely, Beit-Lahia, Gaza City and Rafah. The effluents of the treatment plants are mostly discharged to the Mediterranean Sea and to the ambient environment. The total annual wastewater production in the area is estimated to be about 40 MCM, from which 22 MCM are disposed into the sewers and 18 MCM into cesspits or pit latrines.

Wastewater reuse will provide a very good alternative to groundwater abstraction especially for the agricultural sector.

At the present, about 25% of the total wastewater produced daily from the Gaza Waste Water Treatment Plant (GWWTP) is used to replenish the groundwater by means of water infiltration (10,000 m^3 of 40,000 m^3 of treated wastewater produced). The infiltration basin is located at the east of the GWWTP in the sand dune areas and about 2-Km from the Mediterranean Sea.

Most of the treated wastewater (10,000 m^3/day) and the collected rainwater at the northern area are discharged at the sand dunes around the wastewater treatment plant in Beit Lahia City. (EQA, 2001, Land Based Pollution Sources).

The following table summarizes wastewater generation, treatment, reused and desalinated in the Gaza Strip.

Table 8: Wastewater Generation and Treatment in Gaza Strip

	Category	Unit	Quantity
1.	**Population connected to wastewater treatment**	%	**54**
2.	**TOTAL number of wastewater treatment plants**	number	**3**
3.	**Total wastewater generated**	1000 m^3/d	110
3.1	**Non-treated wastewater**	1000 m^3/d	42
3.2	**Treated in public treatment plants**	1000 m^3/d	68
3.3	***Reused wastewater (from the treated effluent)**	%	20
3.4	**Desalinated water**	m^3/yr	678800
4	**Discharge to Environment (raw and treated)**	%	60
5	**Discharge to the Sea (raw and treated)**	%	40

Source: PWA, 2001

**** includes treated effluent into infiltration basins***

Treated wastewater is mainly discharged into infiltration basins at Gaza central wastewater treatment plant and some local farmers adjacent to the treatment plant use part of the treated effluent to irrigate fodder crops without any awareness training on how to use the treated wastewater.

3.5.2 Information on produced, treated, reused wastewater, desalination water and application of reuse – West Bank

Groundwater is foreseen as the major source of water resources development in the West Bank over the next 20 years. This projection relies on maximizing sustainable abstraction from the West Bank mountain aquifers based on negotiations between Israelis and Palestinians.

Only 30-35 % of the population is connected to sewerage networks. The majority of the population uses individual or communal cesspits for temporary storage of wastewater. Cesspits are emptied by vacuum tankers, which usually dump their contents into open ground, into wadis, sewerage networks, irrigation channels, and solid waste disposal sites.

In spite of the low overall percentage of access to sewerage, approximately 70 % of houses in the main West Bank cities are connected. On the other hand, in refugee camps sewage flows through open drains originally constructed to convey rainwater. Most villages have no sewerage system and wastewater is discharged into soak-away (infiltration) pits. The existing wastewater treatment plants in the West Bank are inadequate to serve the volume of wastewater being discharged. (EQA, 2002).

MEDAWARE- Part C

There are 5 public plants in the West Bank (Jenin, Tulkarem, Ramallah, Al Bireh and Hebron.

The following table summarized wastewater generation, treatment, reused and desalinated in the West Bank.

Table 9: Wastewater Generation and Treatment in the West Bank

#	Category	Unit	Quantity
1.	**Population connected to wastewater treatment**	%	**35**
2.	**Total number of public wastewater treatment plants**	number	**5**
3.	**Total wastewater generated**	1000 m^3/d	85
3.1	**Non-treated wastewater**	1000 m^3/d	59
3.2	**Treated in public treatment plants**	1000 m^3/d	13
3.3	**Reused wastewater (from the treated effluent)**	%	10
4	**Discharge to Environment (raw)**	%	75
5	**Discharge to the treatment plants (partially treated) and then into wadis**	%	25

Source: PWA, 2001

Keeping in mind that ground water is the only source of fresh water in Palestine, this will cause tension in the future development of the country, as there is intense competition for the resource with neighbors.

3.6 TURKEY

3.6.1 Wastewater Treatment Plants

The responsibility of constructing, operating and monitoring the sewage collection and treatment systems has been given to the municipalities since 1930 through the Municipalities the Law no:1580 and General Sanitary Law no:1593. The State Planning Organization (SPO) has decided to distribute clean drinking water to everybody, and collect and treat domestic wastewater everywhere in the country within the framework of 'International Drinking Water and Sanitation-Studies for the Next Decade-' that has been initiated in 1980. The Law dated 1981 on Municipalities Income has brought the concept of constructing sewage treatment plants being financially supported by land and costruction owners, which has been further revised in 1985 through the Law of Public Works. The major items of environmental health and pollution prevention has been referred and stated in the Environment Law dated 1983. The National Water Pollution Control Regulation dated 1988 dictates the receiving water standards of wastewater that are collected through sewage systems and that are treated either by means of dilution or through satisfactory treatment (www.yerelnet.org).

Till late 1990's, the National Bank of Provinces has been in charge of realizing wastewater treatment plants within the framework of annual investment programmes according to instructions of the related municipalities. Those constructed plants were then transferred to the municipalities for operation. However, nowadays many associations like Greater Metropolitan Municipalities- Water and Sewerage Administrations-, The Ministry of Tourism, Southeast Anatolian Project (SAP) Administration, The General Directorate of Special Protection Areas, and General Directorate of Massive Housing deal with the investment of wastewater treatment plants. The Greater Metropolitan Municipalities especially those with high urban populations prefer to solve their wastewater treatment problems by utilizing foreign credits and by managing the investment period.

Between the years 1970-1980, 11 wastewater treatments plants have been installed and operated by the Bank of Provinces (BoP). This number has increased in following years accordingly; 60 plants in the period 1980-1990, 82 plants till the end of 1998, and 118 plants till the end of 2001.

In year 2001, a total number of 118 wastewater treatment plants have been in operation in Turkey with a total annual capacity of 2548 million m^3. Even though the total capacity has been stated as 2548 million m^3, the calculated amount of treated sewage was 1245 million m^3 which accounts to 49% of the total treatment capacity. 38% (468 million m^3) of the total treated amount subjected to physical treatment, whereas 50% (618 million m^3) to biological treatment and the rest 12% (159 milllion m^3) to advanced treatment.

3.6.2 Treated wastewater produced

According to a recent detailed survey conducted by the municipalities, 4523.3 million m^3 of water has been supplied to the residential sites of 2991 municipalities in the year 2001. The total amount of annual wastewater originating from the whole country has been registered as 2737 million m^3. Almost 93% (2 532 million m^3) of this amount discharged to the corresponding to sewage system arises from urbanized districts having a population over 15 000, whereas the remaining 7% (205 million m^3) originate from rural areas with population less than 15 000 (State Institute of Statistics, 2001).

3.6.3 Wastewater reused

For the time being, Turkey does not face a severe water scarcity problem due to its climate and geographical structure. Turkey has many lakes as well as national and transboundary rivers from which water is supplied to industries, domestic uses and to arable land for irrigational purposes. Thus, water reuse has not been practiced noticeably. However, the signs of water quality deterioration point out the fact that it will be one of the priority issues in the near future. Effluent wastewater reuse in irrigation will be the major recommended and applicable system in rural areas with comparatively larger agricultural land, whereas reuse in certain industries with higher water consuming processes through in-plant control techniques will be preferred in industrialized regions mostly situated in the vicinity of urban cities (Orhon et al., 2003).

Tourist villages and compounds especially those along the Aegean and the Mediterranean coasts of the country are building their own treatment facilities as they are far away from municipal service boundaries. Shortage of water resources and increased water demand in summer months forced these tourist complexes to reuse their effluents. The major form of reuse is irrigation of gardens and parks. The most common wastewater treatment type is the extended aeration of activated sludge system. Package units are installed whenever population is somewhat like 1000 capita. Secondary effluents are usually disinfected by the addition of chlorine. Reliability of the effluent quality is very questionable due to many reasons like the health effects of wastewater reuse in the coastal settlements.

3.6.4 Desalinated water

There are no records of desalinated water in Turkey so far.

3.6.5 Applications of non-conventional water resources

Industrial wastewater reuse mainly depends on the specific water quality requirements of the industrial sectors. These applications necessitate individual studies. Such examples of detailed surveys are conducted especially in textile industry where water consumption is high. The results of an example study performed on a wool finishing textile plant indicate that a 34% reduction in water consumption is possible and 23% of the generated wastewater can be reused after treatment (Dulkadiroglu et al., 2002; Dogruel et al., 2002). Similar attempts have been accelerated within the last few years.

Another detailed study has been conducted on the potential reuse of centrally treated effluent for reuse in the Istanbul Metropolitan Area (Tanik et al., 1996). The final evaluation based on the current program of construction and commisssioning of treatment facilities confirms that large-scale reuse applications in Istanbul will not be a major consideration in the near future.

An investigation of irrigational reuse option of wastewater for Konya City, another Metropolitan City located in the Central Anatolia, known as the grain silo of Turkey, housing the highest agricultural land in the country, has also been conducted (Sarikaya et al., 1998). The outcome of this study indicates that effluent of the city meets the irrigational reuse standards after secondary treatment and that it can be used for irrigation of especially grain and sugar beet crops. This option, opposite to Istanbul's option, puts forth the reality that such an application may be considered as an economical and an ecological solution to the wastewater disposal problem of Konya City. Grain and sugar beet are the most important crops in the city. Irrigation water demand of these crops was calculated considering the monthly temperature, lightening ratio, water demand of the two crops, precipitation and evaporation ratios.

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EUROPEAN COMMISSION

EURO-MEDITERRANEAN PARTNERSHIP

Development of Tools and Guidelines for the Promotion of the Sustainable Urban Wastewater Treatment and Reuse in the Agricultural Production in the Mediterranean Countries

(MEDAWARE)

Task 1: Determination of the Countries Profile

PART D: AGRICULTURE AND IRRIGATION PRACTICES

MEDAWARE- Part D

<u>INDEX</u>

4. Agriculture and Irrigation Practices

4.1 CYPRUS

4.1.1 Cultivable areas

The total Agricultural land covers an area of about 200.000 hectares(Agricultural Statistics 2001). From these 92.300 hectares represent temporary crops (46,5%) and 41.300 hectares permanent crops (20,8%). The remaining 55.400 hectares represent fallow, uncultivated, grazing, forest and scrub or deserted land with 5%, 24%, 1% and 3% respectively, (Table 1).

From 1985 to 2001, the Agricultural land decreased by 6% mainly due to urban development.

Table 1: Agricultural Land, 2001

LAND USE	Irrigable Area (*1000 hectares)	Total Area (*1000 hectares)
CROP AREA	**35,2**	**133,6**
Temporary crops	***19,2***	***92,3***
Cereals	4	56
Legumes	0,5	0,8
Industrial Crops	0,5	0,5
Fodder crops	4,5	25,3
Vegetables and melons	9,7	9,7
Permanent Crops	***16***	***41,3***
Vines	2,5	18,2
Citrus	5,4	5,4
Fresh fruit	3,6	3,6
Nuts	1,2	3,9
Olives and Carobs	3,3	10,2
FALLOW LAND	**1,5**	**9,5**
GRAZING LAND	**0**	**1**
UNCULTIVATED LAND	**1,5**	**47,8**
SCRUB AND DESERTED LAND	**0**	**6,6**
TOTAL	**38,2**	**198,5**

Source: Agricultural Statistics, Series II, Report No 33, Statistical Service.

4.1.2 Contribution of agriculture to GDP

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 million contributes around 20% to the GDP. The contribution of agriculture to GDP amounted 3,7% for 2001.

4.1.3 Percentage of the labor force employed in agriculture

Employment in the Agricultural sector is 23.400. The share of employment in agriculture in relation to the total labor force was 7,1% in 2001.During the past few years a marginal decrease has been recorded, mainly due to the decrease in demand for labor for agricultural activities

4.1.4 Types of crops cultivated

The main temporary crops are cereals with 61% of the total area under temporary crops, followed by fodder crops with 27,4% and vegetables with 10,5%. The main permanent crops are grapes with 44,1% of the total area under permanent crops, followed by olives and carobs with 24,5%, citrus with 13,1%, nuts with 9,4% and fruits with 8,7%.

4.1.5 Area of irrigated regions

Irrigated land accounts 38.200 hectares or 19,2% of the total area enumerated. Of this 51% was irrigated from water pumped from boreholes, 39,2% from dams, 6,3% from rivers and 3,5% from springs.

4.1.6 Types of crops irrigated

From 35.200 hectares of irrigated crops, 19.200 refer to temporary crops, while 16.000 refer to permanent crops. The main irrigated temporary crops were vegetable and melons with 27,6%, followed by fodder crops with 12,8% and cereals with 11,4%. The main irrigated permanent crops were citrus with 15,3% followed by fresh fruits with 10,2%, olives and carobs with 9,4% and Vines with 7,1%.

The percentage of water demand for permanent and annual grop is 59% and 41%, respectively (Figure 1). This accounts 95, 8 MCM/year and 65, 5 MCM/year.

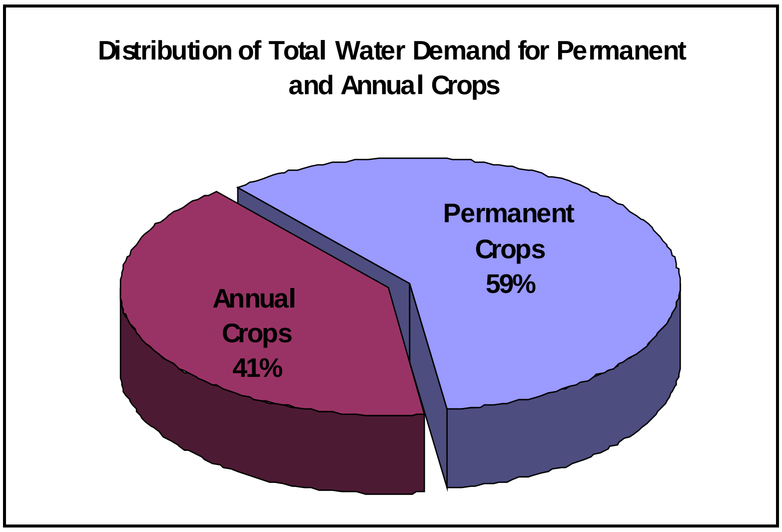

Figure 1: Distribution of water demand for permanent and annual crops

4.1.7 Types of irrigation

Modern irrigation systems have been used in Cyprus agriculture for the last 30 years. Due to the relatively high installation cost the drip method was initially used for irrigation of high value crops, such as greenhouse vegetables and flowers. At a later stage the installation cost was reduced, and the use of drippers, minisprinklers and low capacity sprinklers was expanded for irrigating trees and field vegetables. Proper hydraulic design of the irrigation systems, offered free of charge by the Ministry, coupled by a subsidy of the installation cost, resulted in a rapid expansion of the new irrigation systems. It is estimated that currently over 95% of the total irrigated land of the country is being served by modern irrigation methods.

4.1.8 Area of the region irrigated by non-conventional water resources

At the moment the only non-conventional water resources used for irrigation is treated wastewater. The only available data is for Limassol Treatment Plant where the area irrigated by treated water represents only the 0,5% of the total irrigable area. We have to take under consideration that large amounts of treated wastewater are used for landscaping (e.g. larnaca, Ayia Napa and Paralimni). Especially at hotels the effluent is used for the irrigation of their gardens.

4.2 JORDAN

4.2.1 Cultivable areas

All areas are given in dunum which corresponds to 0.1 ha.

Table 2: Total, irrigated, and rainfed areas planted with fruit tress, field crops, and vegetables in Jordan in general and in the mountain height and Jordan valley in particular (area in 000 Dunum) in 2002.

	IRRIGATED AND RAINFED AREA IN 000 DONUM								
	MOUNTAIN HEIGHT REGION			**JORDAN VALLEY REGION**			**GRAND TOTAL AREA**		
CROP	**TOTAL**	**IRRIG.**	**RAINFED**	**TOTAL**	**IRRIG.**	**RAINFED**	**TOTAL**	**IRRIG.**	**RAINFED**
FRUIT TRESS	766.3	240.9	525.4	116.8	115.2	1.6	**883**	**356.1**	**526.9**
FIELD CROPS	1320	41.5	1278	33.7	32.8	0.9	**1380.2**	**74.3**	**1305**
VEGETABLES	187.0	164.1	22.9	155.6	154.8	0.9	**342.7**	**318.9**	**23.7**
TOTAL	**2273.3**	**446.6**	**1827.1**	**306.1**	**302.7**	**3.4**	**2605.9**	**749.3**	**1856.6**

4.2.2 Contribution of agriculture to GDP

Table 3: The contribution of agriculture to GDP

YEAR	AGRICULTURE CONTRIBUTION TO GDP
1997	3.55 %
1998	3.36 %
1999	2.62 %
2000	2.52 %
2001	2.38 %
2002	2.48 %

4.2.3 Percentage of the labor force employed in agriculture

According to some estimations based on the available statistics the percentage of the labor force in agriculture is about 7.6%.

4.2.4 Types of crops cultivated

Table 4: Area, and production of different field crops grown in Jordan in general and in the mountain height and Jordan valley in particular (area in 000 Dunum and production in M ton).

	AREA (000 DUNUM), PRODUCTION (M TON)								
	MOUNTAIN HEIGHT REGION			**JORDAN VALLEY REGION**			GRAND TOTAL AREA		
CROP	**PLANTED AREA**	**HARVESTED AREA**	**PROD.**	**PLANTED AREA**	**HARVESTED AREA**	**PROD.**	**PLANTED AREA**	**HARVESTED AREA**	PROD.
WHEAT	407.6	308	41.9	19.5	19.5	1.9	**427**	**327.5**	43.8
BARLEY	844.4	546.6	55.8	7.1	7.1	1	**851.5**	**553.8**	56.8
LENTILS	13.2	11.9	1.7	0	0	0	**13.2**	**11.9**	1.7
VETCH	7.8	7.8	0.7	0	0	0	**7.8**	**7.8**	0.7
CHICKPEA	16.4	16.3	3	0.2	0.2	0.1	**1.6**	**16.5**	3.1
MAIZE	0.3	0.3	1.9	4.5	4.5	11.9	**4.8**	**4.8**	13.8
TOBACCO	3.5	3.5	0.6	0	0	0	**3.5**	**3.5**	0.6
GARLIC	0.6	0.6	2	0	0	0	**0.6**	**0.6**	2
COMMON VETCH	5.7	5.7	1	0	0	0	**5.7**	**5.7**	1
SESAME	0.3	0.3	0.1	0	0	0	**0.3**	**0.3**	0.1
CLOVER	19.5	19.5	210.1	2.4	2.4	20.5	**21.9**	**21.9**	230.6
OTHERS	1.1	1.1	0.3	0	0	0	**1.1**	**1.1**	0.3
TOTAL	**1320.4**	**921.7**		**33.7**	**33.7**		**1380.2**	**981.5**	

Table 5: Area, number, and production of different fruit tress grown in Jordan in general and in the mountain height and Jordan valley in particular (area in 000 Dunum, number of trees in 000 tree, and production in M ton).

	AREA (000 DUNUM), NUMBER OF TREES (000 TREE), AND PRODUCTION (M TON)								
	MOUNTIN HEIGHT REGION			JORDAN VALLEY REGION			GRAND TOTAL AREA		
CROP	area	Trees#	production	area	Trees#	production	area	Trees#	production
CITRUS	2.2	69	2.0	75.4	2213	122.2	**77.6**	**2282**	124.2
OLIVES	637.8	8414	176.4	7.0	156	4.5	**644.8**	**8570**	180.9
GRAPES	35.0	1926	31.5	4.1	340	3.2	**39.0**	**2266**	34.8
FIGS	5.4	158	3.7	0.3	23	0.5	**5.7**	**181**	4.2
ALMONDS	4.8	176	2.5	0	0	0	**4.8**	**176**	2.5
PEACHES	15.8	664	13.5	0.4	17	0.6	**16.1**	**681**	14.0
PLUMS	6.5	271	7.7	0	0	0	**6.5**	**271**	7.7
APRICOTS	7.7	335	6.2	0.1	5	0.2	**7.8**	**340**	6.4
APPLES	38.5	2696	36.3	1.2	66	3.0	**39.7**	**2762**	39.2
POMEGRANATES	2.6	98	2.7	1.3	65	2.5	**4.0**	**163**	5.2
PEARS	2.7	124	2.0	0	0	0	**2.7**	**124**	2.0
GUAVA	0.5	21	0.7	1.3	58	1.3	**1.8**	**79**	2.0
DATES	1.2	16	0.8	2.3	47	1.3	**3.5**	**63**	2.1
BANANAS	0.2	19	0.3	22.6	2408	47.1	**22.8**	**2427**	47.4
NECTARINES	1.3	56	1.1	0	0	0	**1.3**	**56**	1.1
CHERRY	1.9	81	4.7	0	0	0	**1.9**	**81**	4.7
OTHERS	2.2	128	2.9	0.9	21	1.1	**3.1**	**150**	4.0
TOTAL	**766.3**	**15253**		**116.8**	**5421**		**883.0**	**20673**	

Table 6: Area and production of different vegetables grown in Jordan in general and in the mountain height and Jordan valley in particular (area in 000 Dunum and production in M ton).

	AREA (000 DUNUM) AND PRODUCTION (M TON)					
	MOUNTIN HEIGHT REGION		**JORDAN VALLEY REGION**		**GRAND TOTAL AREA**	
CROP	**AREA**	**PRODUCTION**	**AREA**	**PRODUCTION**	**AREA**	**PRODUCTION**
TOMATO	39.9	154.1	36.7	205.7	76.6	359.8
SQUASH	12	17	12.3	30.7	24.3	59.4
EGGPLANTS	1.7	4.7	18	54.7	19.7	59.4
CUCUMBER	4.7	24.7	5.7	92.8	10.4	116.9
POTATO	17.6	52.9	17.4	52.5	35	105.3
CABBAGE	6.6	15.9	3.7	13.2	10.3	29.1
CAULIFLOWER	31	51.3	2.4	7.8	33.4	59.1
HOT PEPERS	0.4	0.5	3.5	13.2	3.9	13.7
SWEET PEPERS	1.6	3.5	3.3	16	4.9	19.5
BROAD BEAN	5.7	11.1	4.1	7.2	9.8	18.2
STRING BEAN	3.4	3.2	6.2	15.2	9.6	18.4
PEA	2.7	1.58	0.1	0.2	2.8	1.7
COW-PEA	0.4	0.2	0.6	1.2	1	1.4
JEW'S MELLOW	0.5	0.8	14.9	54.3	15.3	55.1
OKRA	5.7	8.5	2.5	7	8.2	15.5
LETTUCE	6.7	12.9	3.1	6.8	9.8	19.7
SWEET MELON	4.5	12.2	5.5	24.3	10.1	36.5
WATERMELON	10.6	42	5.8	29.8	16.4	71.8
SPINACH	2	5.2	0.6	2	2.6	7.2
ONION GREEN	9.2	29.7	2.5	14.7	11.6	44.4
ONION DRY	10.5	28.5	1.3	5.2	11.7	33.7
SNAKE CUCUMBER	1.5	2.3	0.3	1	1.8	3.4
TURNIP	0.1	0.2	0.1	0.2	0.2	0.5
CARROTS	2	5.8	1	2.3	2.9	8.1
PARSLEY	2.8	6	1.6	4.8	4.4	10.8
RADISH	0.2	0.4	0.5	1.6	0.7	2
OTHERS	3.2	4.9	1.9	6.4	5.2	11.3
TOTAL	**187**		**155.6**		**342.7**	

4.2.5 Area of irrigated regions and crops

Table 7: Irrigated and Non-Irrigated Areas under Tree Crops, Field Crops and Vegetables (1994-2002)

year	Crops	Total Area (Dunum)	Irrigated Area (Dunum)	Non-Irrigated Area (Dunum)
2002	Fruit Trees	**883,033.1**	356,085.7	526,947.4
	Field Crops	**1,354,130.2**	74,310.9	1,279,819.3
	Vegetables	**342,679.3**	318,937.8	23,741.5
2001	Fruit Trees	**873,551.2**	348,974.7	524,576.5
	Field Crops	**1,381,038.1**	106,057.0	1,274,981.0
	Vegetables	**305,620.9**	301,295.2	4,325.7
2000	Fruit Trees	**869,450.7**	348,189.6	521,261.1
	Field Crops	**1,155,785.5**	110,308.3	1,045,477.2
	Vegetables	**328,817.4**	310,618.3	18,199.1
1999	Fruit Trees	**857,275.7**	339,691.0	517,584.7
	Field Crops	**1,839,854.2**	109,737.2	1,730,117.0
	Vegetables	**357,413.7**	338,121.2	19,292.4
1998	Fruit Trees	**846,466.3**	336,805.5	509,660.8
	Field Crops	**1,719,024.9**	117,167.0	1,601,857.9
	Vegetables	**337,993.5**	317,640.6	20,353.0
1997	Fruit Trees	**831,437.1**	330,067.7	501,369.4
	Field Crops	**1,608,070.2**	131,679.0	1,476,391.2
	Vegetables	**302,823.8**	277,690.7	25,133.1
1996	Fruit Trees	**718,802.8**	235,991.2	482,811.6
	Field Crops	**1,211,970.5**	106,110.2	1,105,860.3
	Vegetables	**271,482.4**	258,525.8	12,956.7
1995	Fruit Trees	**707,088.4**	228,433.0	478,655.5
	Field Crops	**1,499,647.9**	111,791.4	1,387,856.5
	Vegetables	**429,308.9**	392,412.0	36,897.0
1994	Fruit Trees	**695,923.7**	695,923.7	0.0
	Field Crops	**1,177,201.3**	139,268.9	1,037,932.4
	Vegetables	**313,242.6**	302,664.6	10,578.0

4.2.6 Types of irrigation

Treated wastewater is discharged to open Wadis where it flows either to the reuse sites or to dams, where it is mixed with rain water or base flows. Table 8 indicates the reservoirs and the amount of treated wastewater impounded in each one. Different irrigation methods are used depending on the effluent quality, crops irrigated and the availability of mixing water. Furrow, flooding and drip irrigation methods are used, while sprinkler irrigation is not used in compliance with the Jordanian Standards for reuse from a health point of view.

Table 8: Treated Wastewater Storage

Reservoir	Effluent source	Effluent stored (MCM)
King Talal Reservoir	• As-Samra WWTP • Baqa'a , Jerash & Abu-Nsair WWTPs	53.95 3.8
Wadi Shueib Reservoir	• Salt WWTP	1.0
Kafrein Resrvoir	• Wadi Essir WWTP	0.05
Total		**58.8**

4.2.7 Area of the region irrigated with reused or other non-conventional water resources

More the ¾ of the treated wastewater are actually stored and mixed with the fresh water of the largest water reservoir (King Talal Dam) which irrigate the main irrigated area of Jordan Valley. Therefore, it is more reliable to estimate the % of area from the fraction of treated wastewater to total irrigation water which is about 13%

4.3 LEBANON

4.3.1 Cultivable areas

In 1999, 248,000 hectares of lands were cultivated (24 % of the Lebanese territory), of which 42 % were irrigated and 2 % were under greenhouse production (MOA/FAO, 2000). An additional 53,137 ha were fallow lands abandoned for more than five years. Almost 42 % of the exploitable agricultural land is located in the Bekaa, which also accounts for 52 % of the total irrigated land (Figure 2).

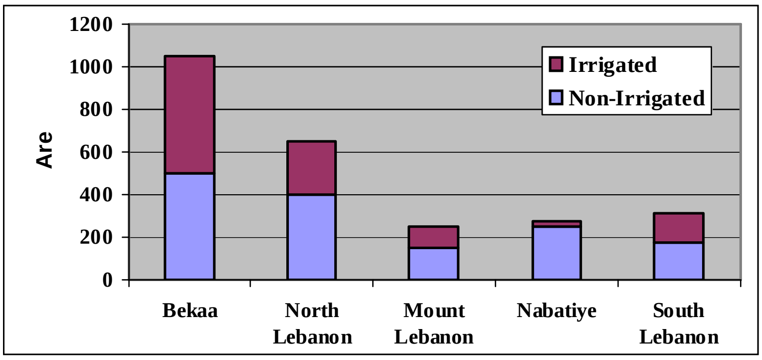

Figure 2: Irrigated and Non-Irrigated Lands by Mohafaza/Caza (MOA/FAO, 2000)

4.3.2 Contribution of agriculture to GDP

Lebanon's economic infrastructure was seriously damaged during the 1975-1991 civil war, but peace enabled the central government to restore control in Beirut. A financially sound banking system and resilient small- and medium-scale manufacturers helped in economic recovery. Family remittances, banking services, manufactured and farm exports, and international aid provided the main sources of foreign exchange. Real GDP grew 8 % in 1994, 7 % in 1995, 4 % in 1996 and in 1997 but slowed to 2 % in 1998, -1 % in 1999, and -0.5 % in 2000. Growth recovered slightly in 2001 to 1 %. During the 1990s, annual inflation fell to almost 0 % from more than 100 %. The planned privatization of state-owned enterprises had not occurred by the end of 2002, and the government had successfully avoided a currency devaluation and debt default in 2002. Some of the most prominent economic indicators are provided in Table 9.

Table 9: Economic Indicators Status

Economic Indicator	***Status***
GDP: purchasing power parity	$ 18.8 billion (2001 est.)
GDP-real growth rate	1 % (2001 est.)
GDP-per capita: purchasing power parity	$ 5,200 (2001 est.)
GDP-composition per sector	Agriculture: 12 % Industry: 21 % Services: 67 % (2000)
Population below poverty line	28 % (1999 est.)
Inflation rate (consumer prices)	0.5 % (2001 est.)
Labor force	1.5 million In addition, there are as many as 1 million foreign workers (1999 est.) (2001 est.)

* CIA, 2002

4.3.3 Percentage of labor force employed in agriculture

The percentage of the labor force employed in agriculture is about 28 % of a total of 2.5 million labor force (1.5 million local and 1.0 million foreign). It is estimated that the number of permanent labor that work in agriculture is in the range of 195,000 and the temporary (seasonal) labor is about 505,000. These figures include people working in the para-agricultural field, such as selling fertilizers, pesticides, agricultural equipment, etc.

4.3.4 Types of crops cultivated

Lebanon produces crops in five major categories: cereals, fruits (not including olives), olives, industrial crops (e.g., sugar beet, tobacco), and vegetables. Fruit and olive trees occupy 45 % of the total cultivated area, and have increased by about 230,000 dunums (1 dunum = 1,000 m^2) in the past 10 years (Table 10). The area covered by greenhouse production has also significantly increased over the past years, from 6,700 dunums in the late 1980s to almost 50,000 dunums in 1999.

Agricultural production is concentrated in the Bekaa, which accounts for 42 % of total cultivated land. The Bekaa hosts 62 % of the total area used for industrial crops (including sugar beet, tobacco, and vineyards) and 57 % of the total area used for cereal production (Table 11). The North (Akkar and Koura regions) host 40 % of the area used for olive production in the country. Fruit trees cover 24 % of the total cultivated area. More recent and detailed tables containing agricultural land size and production rate for all types of crops cultivated in Lebanon for the years 2000 and 2001 are found in Appendices D & E.

Crop production relies heavily on agro-chemicals, including several pesticide derivatives and fertilizers. Agriculture in Lebanon is also increasingly shifting to irrigated production, thereby putting added pressure on dwindling water resources. Increased irrigation implies more groundwater pumping, leading to salinity buildup in the soil matrix.

Table 10: Area Cultivated by Major Crop Type

Crop Type	*Area cultivated (1000m²)*			*Percent change*
	Period 1980-1995 [1/]		*1999* [2/]	
Cereals	(1989)	1,020,000	518,420	-49%
Fruit trees	(1989)	560,000	595,147	+6%
Olives	350,000		524,213	+50%
Industrial crops	n/a		247,265	n/a
Vegetables	(1988)	230,000	452,320	+97%
Other	n/a		142,000	n/a
Total	**(1980)**	**2,850,000**	**2,479,365**	**-13%**
	(1986)	**2,740,000**		**-9.50%**

1/ METAP/ERM, 1995 (reported values cover different years)
2/ MOA/FAO, 2000

Table 11: Land Used for Major Types of Crops by Mohafaza (Dunums)

Mohafaza/Caza	*Cereals*	*Fruit Trees*	*Olives*	*Industrial Crops*	*Vegetables*
Mount Lebanon	3,140	97,820	77,678	1,613	31,100
North	120,380	135,685	209,628	37,769	128,584
Bekaa	297,737	217,570	31,443	153,232	259,743
South	37,638	123,304	89,340	14,625	20,753
Nabatiyeh	59,525	20,768	116,124	40,026	12,141
Lebanon	518,420	595,147	524,213	247,265	452,321

* Source: MOA/FAO, 2000

Following more information of the agriculture production is provided in table format.

Table 12: Description of the agricultural production for the years 2000, 2001

Type of Production	*2000*		*2001*	
	Area in hectares	*Production (thousands tons)*	*Area in hectares*	*Production (thousand tons)*
Cereals				
Wheat	40,045	108.1	43,606	139.5
Corn	876	3.5	879	3.8
Hay	8,689	9.4	7,040	8.1
Others	648	29.1	529	20.6
Total	**50,258**	**150.1**	**52,054**	**172**

Groves				
Dry Beans	63	0.1	60	0.1
Dry Broad Beans	139	1.5	138	1
Lentils	685	0.8	450	0.5
Chickpeas	2,573	2.2	1,950	1.9
Green Peas	338	4.4	310	4.4
Green Beans	2,759	45.9	2,468	41.6
Green Broad Beans	1,068	9	1,190	10.6
Others	89	1.1	89	1.2
Total	**7,714**	**65**	**6,655**	**61.3**
Vegetables with leaves				
Artichoke	80	0.8	80	0.8
Cornflower	442	11.5	394	13.2
Cabbage	662	18.4	686	20.9
Lettuce	1,358	47.5	1,093	35.1
Vegetables for Salad	1,638	41.8	1,584	40.6
Spinach	98	3.3	105	3.5
Others	309	3.4	273	2.7
Total	**4,587**	**126.7**	**4,215**	**116.8**
Legumes				
Melon	699	21.6	465	14.9
Capsicum	395	6.9	280	5.9
Cucumber	3,663	149.4	4,106	161
Eggplant	988	27.9	752	21.6
Zuchini	1,128	24.2	697	16.6
Bamia	335	1.1	293	1.3
Tomatoes	4,660	235	4,350	247
Watermelon	2,050	57	2127	61
Total	**13,918**	**523.1**	**13,070**	**529.3**
Root plants				
Potatoes	12,913	275	11,943	257
Onion	4,564	157.6	4,120	144.2
Garlic	550	11	490	11
Carrots	358	8.2	439	10.8
Others	305	6.1	280	5.8
Total	**18,690**	**457.9**	**17,272**	**428.8**
Industrial Plants				
Beetroot	7,027	341.7	270	15.2
Tobacco	8,726	10.8	9,110	12.8
Others	1,367	2.8	1,488	2.9
Total	**17,120**	**355.3**	**10,868**	**30.9**
Fruits				
Orange	8,820	152.4	8,900	155.8
Mandarine	2,200	49.8	2,250	46.1
Lemon	3,629	103.7	3,607	103.1

Grapefruit	556	11.8	535	11.5
Apple	9,302	126.7	9,460	112
Pear	3,063	36.6	3,058	30.8
Apricot	5,475	20	5,781	19.6
Cherry	7,596	45.4	7,589	42.3
Peach	2,848	29.7	2,848	27.6
Plum	2,384	25.7	2,400	34.2
Grapes for industry	2,709	24.4	2,800	27.2
Grapes for tables	11,376	88.2	11,022	89
Strawberry	968	27.3	1,020	29.7
Avocado	290	3	286	4.4
Banana	2,748	65.6	2,748	66.7
Figs	2,970	17.8	2,930	16.5
Pomegranate	1,138	8.7	1,196	7.6
Persimmon Kaki	628	6.4	700	5.9
Others	2,714	27.5	2,713	28.7
Total	**71,414**	**870.7**	**71,843**	**858.7**
Olives	55,646	189.5	56,834	85.8
Other Trees				
Almond	6,478	24.7	6,561	23.9
Pine	6,100	1	5,980	1.9
Others	730	0.7	780	0.9
Total Other Trees	14,025	28.8	14,106	29.9
Seeds, Flowers, Bulbs, Ornamental Plants	1,950	-	1,950	-
Feedstock	4,518	19.5	3,884	16.6
Total	**259,840**	**2,786.60**	**252,751**	**2,330.10**

* MOA, 2001

Table 13: Import and Export of Cereals and Groves

Cereals	***Import (million L.L)***			***Export (million L.L)***		
	1999	***2000***	***2001***	***1999***	***2000***	***2001***
Wheat	80,698	82,436	79,013	32	12	24
Corn	44,984	45,480	48,201	46	8	15
Hay	14,733	9,728	10,979	141	0	1
Rice	36,579	29,815	23,273	1,158	1,160	299
Others	729	2,211	1,597	6	6	17
Total	**177,723**	**169,670**	**163,063**	**1,383**	**1,186**	**356**

* MOA, 2001

Groves	*Import (million L.L)*			*Export (million L.L)*		
	1999	*2000*	*2001*	*1999*	*2000*	*2001*
Dry Beans	6,215	6,808	4,319	144	116	135
Dry Broad Bean	3,928	4,035	3,995	75	168	116
Lentils	5,126	5,589	6,170	478	555	438
Chickpeas	8,083	11,735	13,651	99	169	502
Peas	1,937	1,747	3,841	47	73	77
Green Beans	2,995	4,714	5,038	41	32	30
Green Broad Beans	0	682	3,273	6	7	5
Others	5,757	2,357	2,343	281	152	369
Total	**34,041**	**37,667**	**42,630**	**1,171**	**1,272**	**1,672**

* MOA, 2001

4.3.5 Area of irrigated regions

In 1999, 248,000 hectares of lands were cultivated (24 % of the Lebanese territory), of which 42 % were irrigated and two percent were under greenhouse production (MOA/FAO, 2000). An additional 53,137 hectares were fallow lands abandoned for more than five years. Almost 42 % of the exploitable agricultural land is located in the Bekaa, which also accounts for 52 % of the total irrigated land (see the Figure 2).

4.3.6 Types of crops irrigated

During the period 1992-94, the total cultivated area was estimated at 189,206 ha, of which 104,120 ha consisted of annual crops and 85,086 ha consisted of permanent crops, mainly fruit trees and olives (FAO, 2003).

As for the type of irrigated crops, Lebanon produces crops in five major categories: cereals, fruits (not including olives), olives, industrial crops (e.g., sugar beet, tobacco), and vegetables. Fruit and olive trees occupy 45 percent of the total cultivated area, and have increased by about 230,000 dunums (1dunum=1,000 m^2) in the past 10 years (Tables 10, 11).

4.3.7 Types of irrigation

There is a high dependence on gravity irrigation which accounts for 64 percent of the total irrigated land and is the predominant method of irrigation with surface water. Compared to sprinkler and drip irrigation, gravity irrigation inherently carries high water losses, due to low system efficiencies and high evaporation losses. While efficiency of gravity irrigation could be significantly improved using optimal water and crop management schemes, the majority of farmers in Lebanon lack basic agricultural training.

The following figure shows the distribution of irrigated lands by water source and irrigation method (Ministry of Environment, 2001).

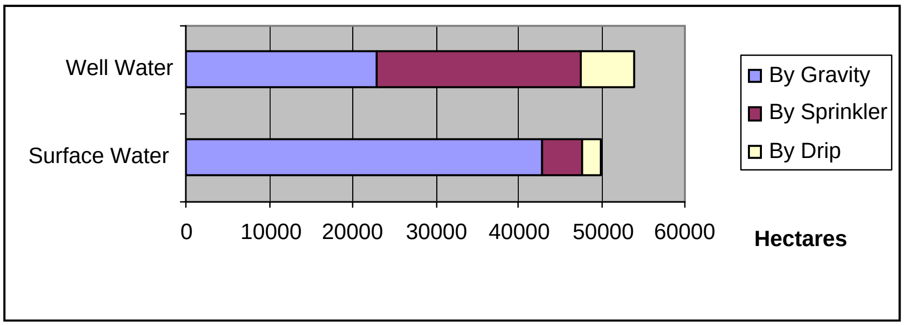

Figure 3: Distributions of Irrigated Lands By Water Source and Irrigation Method (MOA/FAO, 2000)

4.3.8 Area of the region irrigated by non conventional water resources

Although it is common knowledge that a number of areas are irrigated with raw sewage, a mixture of raw sewage and river water and treated wastewater, however, the actual areas in the regions that practice such irrigation procedures have not been defined.

4.4 MOROCCO

4.4.1 Cultivable areas

The useful agricultural surface increases with a rate of 8,7 millions of hectares, from 303ha for 1000 inhabitants in the year 2000 to 220ha per capita in the year 2020.

The useful agricultural surface (U.A.S) of the country is estimated at 7.5 millions of hectares, namely the 17% of the total surface of the country.

For the year 1993 the U.A.S. was estimated to 7,23 millions of hectares, 6,25 of which were occupied by annual agriculture and 0,66 by permanent agriculture.

4.4.2 Contribution of agriculture to GDP

Agriculture remains on of the dominant sectors of the economic activity of Morocco. It represented approximately 17% of the G.D.P. in 1994, decreased to 13% in 1999 and reached 10% in 2002. However, the agricultural production remains very related to the climatic conditions.

4.4.3 Percentage of the labour force employed in agriculture

The agricultural sector, principal employer of the country, occupies a dominant place in the Moroccan economy. 40% of the working population depends on the agricultural sector (years: 1999-2000), which accounts for 78% of the rural employment.

4.4.4 Types of crops cultivated

Two types of agriculture are practiced in Morocco: a traditional, using the swing plough or the hoe for satisfying the basic needs, and a modern mechanized one whose products are destined to be exported. The principal production are cereals: wheat (30 % of the cultivated grounds), barley (27 %) and to a lesser extent corn; leguminous plants (broad beans, peas, lenses, beans), horticulture, citrus fruits and sugar plants (18%). Fruit-bearing arboriculture and the olive-trees provide a considerable complement (18.5%).

4.4.5 Area of irrigated regions

The irrigation uses 92% of the resources which are distributed primarily on six large basins serving the nine perimeters of great irrigation (453.300 ha) and the perimeters of small and average hydraulics (120.300 ha). The remaining resources (8%) are used for drinking water supplies and industrial uses.

The irrigable potential is currently approximately 1,35 million hectares, 843.000 of which are served by great hydraulics and 510.000ha by small and average hydraulics. Moreover, one should add approximately 300.000 ha, which are seasonaly or flood irrigated. This potential remains relatively limited with regards to to the needs of country. Consequently, it would be advisable to be better developed/valorised by the national authorities.

4.4.6 Types of crops irrigated

Table 14: Types of crops irrigated

Type of culture	**Production (thousand quintals)***		
	1997-98	**1998-99**	**1999-2000**
Principal Cereals	**65 490**	**37 639**	**19 425**
Durum wheat	15 444	7 995	4 274
Common wheat	28 341	13 540	9 533
Barleycorn	19 700	14 740	4 668
Corn	2 005	1 364	950
Leguminous plants	**2 448**	**1 293**	**799**
Oleaginous Cultures	**1 067**	**849**	**574**
Industrial Crops	**41 078**	**46 064**	**42 023**
Horticulture	**46 185**	**46 031**	**42 611**
Citrus fruits (thousand tons)	**1 591**	**1 303**	**1 400**

http://www.mincom.gov.ma/french/generalites/agricu/evaluation/sommaire.htm

4.4.7 Types of irrigation

The irrigation technique practiced is surface irrigation. The irrigation by spraying is not practiced, apart from some installations in the great hydraulics. The principal cultures irrigated are the cereals.

4.4.8 Area of the region irrigated by non-conventional sources

The total annual volume of urban wastewater generated was estimated at 370 million m^3 in 1990. According to estimations, this amount will reach 500 and 700 million in 2000 and 2020 respectively. This important increase is due to urban population growth, which is estimated at 5% per year.

60 millions m^3 of wastewater currently irrigate a surface of more than 7000 ha, which includes arboriculture, fodder crops, cereals and horticulture. However, wastewater is reused in agriculture either without being in any way treated or mixed with water from streams in which it is discharged.

Table 15: Principal zones of reutilization of wastewater in Morocco*

Province	Surface (ha)	Speculations
Marrakech	2000	Cereals, horticulture, arboriculture
Meknès	1400	Cereals, horticulture, arboriculture
Oujda	1175	Horticulture, cereals, arboriculture
Fès	800	Arboriculture, horticulture
El Jadida	800	Horticulture, fodder crops
Khouribga	360	Cereals, horticulture
Agadir	310	Arboriculture, horticulture, soya, floriculture
Béni-Mellal	225	Cereals, horticulture, cotton, beetroots
Ben guérir	95	Horticulture, fodder crops, arboriculture
Tétouan	70	Horticulture, fodder crops
Total	7235	

(* : Source : CSEC, 1994)

4.5 PALESTINE

4.5.1 Cultivable areas

The occupied Palestinian Territories can be divided into five main ecological sub-regions: the Mediterranean shoreline costal plain, the upper costal plain, the central highlands, the semi-arid eastern slope steppes and the arid semi-tropical Jordan valley.

Data reveal that 1,816 thousand dunums of Palestinian farmland were cultivated in the Palestinian Territory between 2000 and 2001 of which 89.9% in the West Bank and 10.1% in Gaza Strip.

According to 2000-2001 results, plant production including fruit trees constituted 64.7% of the cultivated area of Palestinian Territory. Vegetables and crops produce comprised 9.6% and 25.7 of the cultivated Palestinian areas respectively (Figure 5). 67.5% of Gaza strip's cultivated areas rely on irrigation compared with only 7.3% of the West Banks cultivated area that relies on the same source of irrigation.

4.5.2 Contribution of agriculture to GDP

Agriculture is still the most important economic sector, but its contribution to GDP has decreased from 37% at the end of the 1970s, to 22% in the end of 1980s, then it has declined to 10% at the last ten years.

Table 16: Percentage Contribution to GDP by Economic Activity in the West Bank and Gaza Strip, 1997-2000

Economic Activity	**Year**			
	1997	**1998**	**1999**	**2000**
Agriculture and Fishing	11	10	8	11

Source: Statistical Abstract of Palestine NO. (3), November 2002

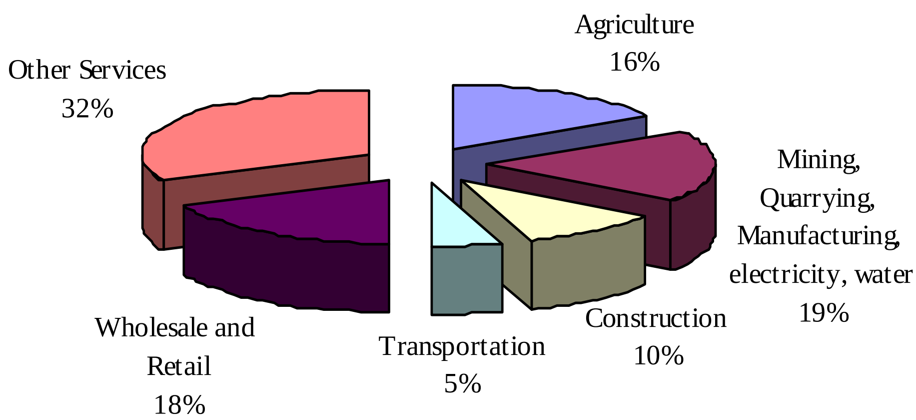

Figure 4: Contribution *to the GDP by Sector*, Source: World Bank, 2002

4.5.3 Percentage of the labor force employed in agriculture

The survey results conducted in the year 2001 indicated that, the employed persons were distributed according to place of work. About 61.4 percent working in the West Bank while 24.9 percent working in Gaza Strip and 13.7 percent working in Israel and Israeli colonies.

Results revealed that 34.5 percent of employed persons are working in services, while 19.4 percent are working in commerce, hotels and restaurants and 12 percent working in agriculture, hunting and fishing. (Labor Force Survey).

4.5.4 Types of crops cultivated

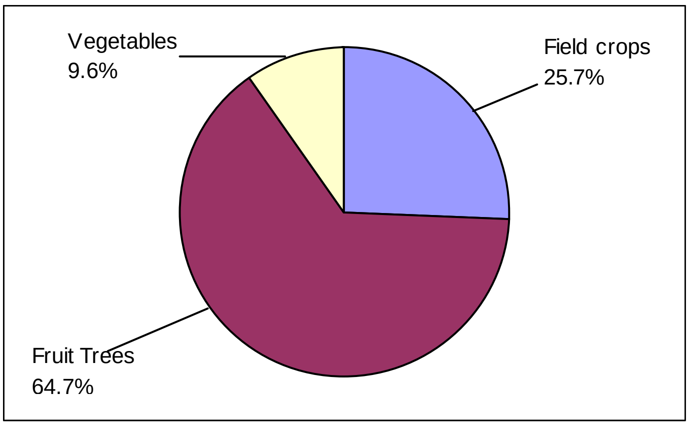

Figure 5: Percentage of Cultivated Area of Fruit trees, Vegetables and Field Crops in the Palestinian Territory, 2000/200, Source, (PCBS, April, Agricultural Statistics 2000/2001).

Fruit trees: About 1,174 thousand dunums of land are used for fruit trees' production, including 1,099 thousand dunums in West Bank and 75 thousand dunums in Gaza Strip. About 80.6% of the area cultivated with fruit in Gaza Strip is irrigated, whereas 98.1% of the total cultivated fruit trees are of the West Bank is irrigated by rain. Most of fruit production in Gaza Strip is citrus production. Olive production forms most of fruit production in the West Bank, making up to 78.5% of fruit trees area in Palestine Territory, followed by 6.1 of grape and 5.6% of almond production

Vegetables: Results show that 174 thousand dunums of land are used for vegetable production in the Palestinian Territory of which 70.0% in the West Bank and 30.0% in Gaza Strip. About 73.2% of the vegetable area of the West Bank is irrigated while the rest is rainfed. The area of protected vegetables constitutes 40.7 thousand dunums or 23.4% of the vegetable area of the Palestinian Territory. The open irrigated area comprises 53.7% and 22.9% of the area is rainfed (see Figure 6).

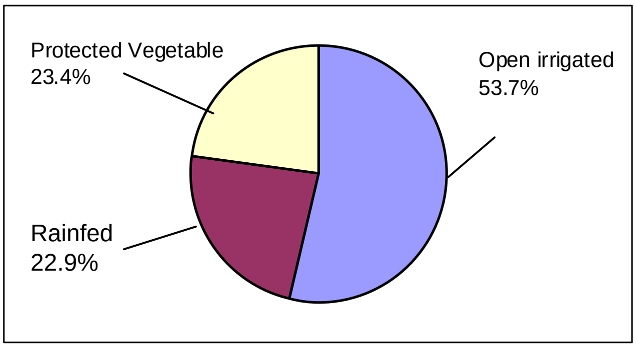

Figure 6: Percentage of Vegetables Area in the Palestinian Territories by Agriculture Pattern, 2000/2001, Source: (PCBS,, Agricultural Statistics,, April 2000/2001).

Field Crops: About 467 thousand dunums of land are used for cereal production. 94.3% of which is rainfed, the rest 5.7% is irrigated. Wheat production comprised 44.1% of the total field crops area.

4.5.5 Area of irrigated regions and types of irrigated crops

Table 17: Area of Fruit Trees in the Palestinian Territories by Type, 2000/2001

Area: Dunums

Crop	Bearing		Unbearing		Total Area
	Rainfed	Irrigated	Rainfed area	Irrigated Area	
Valencia Orange	-	20536	-	7	20543
Sammoty Orange	-	8879	-	19	8898
Lemon	-	6583	1	563	7147
Clement	-	3934	-	35	3969
Navel Orange	-	1700	-	17	1717
Grapefruit	-	1039	-	-	1039
Mandarin	-	623	-	-	623
Poppy	-	456	-	26	482
Francawy orange	-	364	-	23	387
Balady Orange	-	150	-	-	150
Bomaly	-	67	-	-	67
Other citrus	-	73	-	45	118
Olive	863322	21426	33383	3342	921473
Grape	65554	1927	4532	18	72031
Almond(hard)	53019	15	423	-	53457
Plum	25765	26	1526	-	27317
Fig	13143	87	531	60	13821
Almond(soft)	9800	7	2408	-	12215
Aloe	6656	-	24	-	6680
Apricot	4560	100	969	-	5629
Guava	-	3593	-	250	3843
Date	2133	1123	-	528	3784
Peach	1398	439	251	205	2293
Apple	1528	324	198	15	2065
Banana	-	1481	-	550	2031

Pomegranate	540	150	35	10	735
Akadenia	174	217	25	5	421
Pears	303	11	12	-	326
Sumac	279	-	-	-	279
Mango	-	203	-	16	219
Cherry	100	-	50	-	150
Quince	134	-	11	-	145
Avocado	-	71	-	3	74
Pican	-	57	-	-	57
Custard apple	-	30	-	3	33
Nectarine	-	10	-	18	28
Others	41	134	7	30	221
Total	75835	1048449	44386	5788	1174458

Source: Agriculture Statistics, 2000/2001, PCBS, October 2002.

Table 18: Area of Vegetables in the Palestinian Territories by Type, 2000/2001. Area: Dunums

Crop	Rainfed	Irrigated	Plastic House	French Tunnel	Surface Tunnel	Total Area
Cucumber	13	13466	12503	237	1947	28166
Squash	6208	13107	19	-	5925	25259
Tomato	4200	9488	8286	-	764	22738
Eggplant	-	8511	143	253	749	9656
Okra	7832	670	15	-	745	9262
Cauliflower	593	8165	-	-	-	8758
Maize	-	6673	-	-	1470	8143
Snake cucumber	6067	714	-	-	-	7681
Peas	3335	2134	-	-	-	5469
Kidney bean	20	3103	515	145	1067	4850
White cabbage	-	4811	-	-	-	4811
Broad bean	1167	3419	-	-	-	4586

Jew's mallow	-	3006	1383	27	-	4416
Hot pepper	-	3670	519	82	109	4380
Chick-peas	3308	545	-	-	-	3853
Water melon	2566	357	-	-	805	3728
Onion(green)	318	2660	-	-	-	2978
Muskmelon	1405	409	157	-	205	2176
Spinach	675	1484	-	-	-	2159
Strawberry	-	-	4	-	1736	1740
Cowpea	803	831	38	1	15	1688
Radish	-	1150	-	-	-	1150
Pumpkin	731	301	-	-	-	1032
Paprika	-	695	166	18	48	972
Lettuce	-	884	-	-	-	884
Turnip	-	698	-	-	-	698
Parsley	-	669	-	-	-	669
Cut flower	-	-	550	-	-	550
Chard	-	460	-	-	-	460
Kidney bean	-	434	-	-	-	434
Gourd	274	39	-	-	-	313
Carrot	-	313	-	-	-	313
Fennen	-	230	-	-	-	230
Taro	-	100	-	-	-	100
Warak lesan	-	66	-	-	2	68
Garlic (green)	7	74	-	-	-	81
Red cabbage	-	51	-	-	-	51
Red beet	-	23	-	-	-	23
Other	245	91	51	-	-	387
Total	39767	93501	24349	763	15587	173967

Source: Agriculture Statistics, 2000/2001, PCBS, October 2002.

Table 19: Area of Field Crops in the Palestinian Territories by Type, 2000/2001.

Area: Dunums

Crop	Rainfed	Irrigated	Total Area
Wheat	205214	880	206094
Barley	102680	320	103000
Sern	21635	-	21635
Clover	19645	920	20565
Lentil	20314	-	20314
Chick-peas	18436	-	18436
Vetch	18414	-	18414
Potato	205	16341	16546
Dry onion	11050	4321	15371
Sesame	4815	-	4815
Tobacco	3826	-	3826
Sweet potato	-	2570	2570
Broad bean	2246	8	2254
Sorghum	1930	150	2080
Alfalfa	1655	-	1655
Broom Corn	1622	-	1622
Anise	1575	1	1576
Black cumin	837	-	837
Thyme	252	416	668
Dry Garlic	587	80	667
Cumin	495	-	495
Onion-Tuber	40	373	413
Dry Cowpea	125	60	185
Fenugreek	172	6	178
Seed Onion	100	60	160
Safflower	122	-	122
Meramieh	37	40	77
Sun flower	71	5	76
Ment	-	71	71
Chamomile	1	50	51

Tombak	12	-	12
Others	2257	80	2337
Total	440370	26752	467122

Source: Agriculture Statistics, 2000/2001, PCBS, October 2002.

Table 20: Cultivated Area of Fruit Trees, Vegetables and Field Crops in the Palestinian Territory, 2000/2001

Area: Dunums

Region	Field Crops			Vegetable				Fruit Trees					Grand Total
								Unbearing		Bearing			
	Rainfed	Irrigated	Total	Rainfed	Open Irrigated	Protected	Total	Irrigated	Rainfed	Irrigated	Rainfed	Total	
Palestinian Territory	440370	26752	467122	39767	93501	40699	173967	5788	44386	75835	1048449	1174458	1815547
West Bank	402481	8966	411447	32671	66439	22669	121779	847	44154	20055	1034095	1099151	1632377
Gaza Strip	37889	17786	55675	7096	27062	18030	52188	4941	232	55780	14354	75307	183170

Source: Palestinian Central Bureau of Statistics, PCBS, October, 2002.

4.5.6 Types of Irrigation

Surface irrigation is the oldest method of irrigation used in the West Bank and Gaza Strip. Furrows and basins are the most common methods in the region. Basin irrigation is used mostly for irrigating trees, mainly citrus, while furrows methods are used to irrigate vegetables. There is a certain difficulty involved in the management of water distribution in these installations.

Pressurized irrigation techniques (drip and sprinkler systems) which are common used in the West Bank and Gaza Strip can reduce these water losses. Usually, potatoes, onions, carrots, radishes and spinach are irrigated using permanent sprinkler systems; whereas most vegetables crops under plastic houses or in open fields are irrigated using drip irrigation. The main disadvantage of the drip irrigation system is the susceptibility to clogging by salt precipitation of calcium carbonate, iron oxide, algae and microbial limes. To minimize this problem, water is usually treated by adding acids to dissolve the sediments of calcium carbonate in the emitters. Screen filters are also used to separate suspended solids.

4.5.7 Area of the region irrigated by reused wastewater or other non-conventional water resources

Unfortunately there is no accurate data regarding waste water reuse and non-conventional water in agricultural sector. Studies and reports show that about 5-10% of wastewater is reused in irrigation in the West Bank. In Gaza Strip some wastewater reuse practices are implemented and few are planned to be applied in the irrigation sector.

4.6 TURKEY

4.6.1 Cultivable areas

Turkey, with its geographical structure and ecological conditions, has a big potential in terms of quantity in agricultural production and diversity in products. According to 1991 agricultural statistics, the total agricultural land is 23 451 087 ha. By the year 2000, while total area of land used for agricultural applications remained approximately the same, 1 8207 000 ha of this land were cultivated, and 4 826 000 ha was reserved for fallow purposes. Vegetable gardens was 793 000 ha, vineyards 535 000 ha, fruit gardens 1 418 000 ha, and olive gardens was 600 000 ha. Forest area of Turkey is 20 703 000 ha. Land use in Turkey is given in Figure 7.

4.6.2 Contribution of agriculture to GNP

Comprising 45% of employment and about 15% of national income, agricultural sector has social sector as well as economic sector characteristics. Besides production of essential consumables, in the supply of raw material to other sectors, its share on consumption costs and its significance in export makes the agricultural sector socio-economically important. The share of agricultural sector in Gross National Product was about 40% in the first years of newly founded Turkish Republic. However, with constant costs, it showed decreasing trend that was 36% in 1970's, 16% in 1990 and 13.5% in 2000.

Agricultural sector prices, which have a 22.2% share in the wholesales price index figure, increased by 30% in 1999 and by 39.8% in 2000. Especially in December 2001, due to the bad weather conditions, agricultural prices increased by 13.2% in a month, which was the highest after 6 years. In spite of the decline in the output, agricultural sector price increase is realized as 65.5% in 2001. In 2002, agricultural sector continued its volatile trend in the inflation data. In the last quarter, food price inflation accelerated as a result of Ramadan, but the year end increase was the lowest figure since the last 15 years.

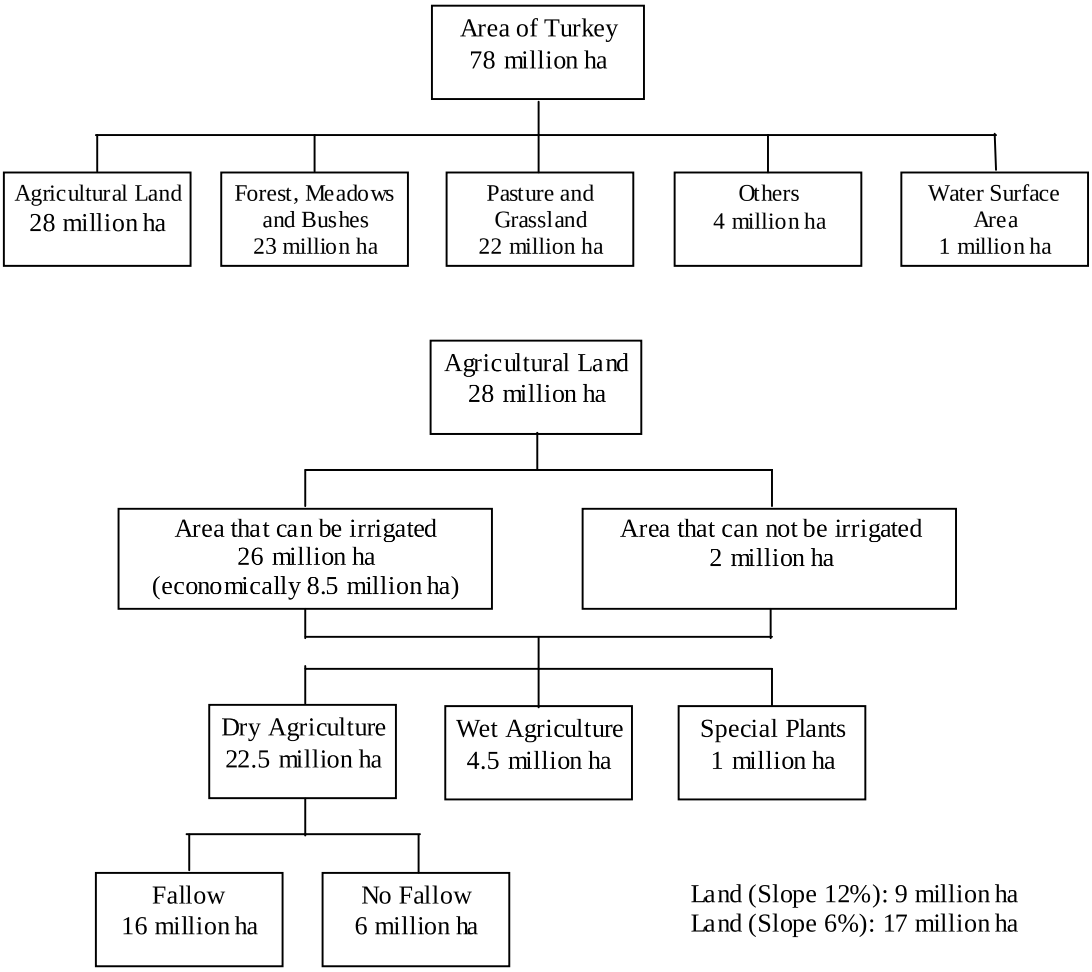

Figure 7: Land use in Turkey (adopted by *www.dsi.gov.tr*)

4.6.3 Percentage of labor force employed in agriculture

In 1980-2000, the number of employed people in Turkey has been continuously increasing. However, the share of manpower employed in the agriculture sector which has the biggest share in the total employment decreased continuously within this period. While the proportion of people employed in this sector was 60% in 1980, it decreased to 48.4% in 2000. 75.6% of employed females worked in agriculture sector and 42.8% of employed males worked in the services sector intensely in 2000 (State Institute of Statistics, 2000a).

4.6.4 Types of crops cultivated

Turkey is an agricultural country. It has a rich cropland, and there are a lot of crops that has been cultivated. The basic types of crops cultivated in Turkey are, field crops, fruits, vegetables and a sub-categorization is provided below:

Field Crops : Cereals, Pulses Industrial Crops, Oil Seeds, Tuber Crops
Fruits : Pome Fruits, Stone Fruits, Citrus, Nuts, Grape-Like Fruits, Green Tea
Vegetables : Leafy or Stem Edible Vegetables, Leguminous Vegetables, Fruit Bearing Vegetables, Root Bulb and Tuberous Vegetables, Other Vegetables

According to 2000's data, distribution of land use as agricultural land, forest area, field crops, vegetable production and fruit production are given in Table 21 and Table 22.

Table 21: Distribution of Agricultural Land and Forest area (adopted from State Institute of Statistics, 2000b)

Land Use	Distribution (%)
Forest	45.1
Area Sown	39.6
Fallow Land	10.5
Fruit	3.1
Vegetable	1.7

Table 22: Percentages of Field crops, Vegetable production and Fruit production (adopted from State Institute of Statistics, 2000b)

Crops	**Per cent of Production (%)**
Field crops (63 433 032 tons)	
Cereals	50.6
Pulses	2.1
Industrial crops	31.5
Oil seeds	3.5
Tuber crops	12.3
Vegetable production (22 357 612 tons)	
Leguminous	2.3
Fruit bearing	68.5
Leafy or stem	5.9
Melons-Watermelons	20.6

Root, bulb and tuberous	2.4
Other	0.3
Fruit production (14 179 138 tons)	
Grape-like fruits	31.2
Citrus	16.6
Pome fruits	21.6
Stone fruits	25.0
Nuts fruits	5.6

A high percentage of production belongs to cereals and fruit bearing in the country.

4.6.5 Area of irrigated regions

According to The General Directorate of State Hydraulic Works feasibility studies, the total area that can be irrigated is 26 million ha of which only 8.5 million ha can be currently irrigated both technically and economically (see Figure 7). Total irrigation areas that have been managed by SHW and constructed by SHW, other state and private sector between the years 1980–2001 are given in Table 23. Table 24 shows irrigation areas by river basins for 2000, managed by SHW. The operation of most irrigation areas developed by SHW in different provinces of Turkey, are transferred to farmers and private sector (The General Directorate of State Hydraulic Works, 2002).

Table 23: Irrigation area constructed by SHW or others and managed by SHW (adopted from *www.dsi.gov.tr*)

Years	Area (ha)	Irrigated Area (ha)	Irrigation Ratio (%)
1980	1 000 574	652 928	65.3
1981	1 051 356	764 300	72.7
1982	1 117 040	831 500	74.4
1983	1 181 985	837 300	70.8
1984	1 265 065	927 000	73.3
1985	1 370 870	1 027 500	75.0
1986	1 457 635	1 087 300	74.6
1987	1 507 435	1 050 700	69.7
1988	1 536 230	1 043 100	67.9
1989	1 597 173	1 213 530	76.0
1990	1 626 170	1 114 436	68.5
1991	1 687 894	1 076 024	63.7
1992	1 722 728	1 205 092	70.0

1993	1 790 979	1 196 162	66.8
1994	1 832 006	1 066 749	58.2
1995	1 897 850	1 240 275	65.4
1996	1 979 376	1 319 273	66.7
1997	2 058 148	1 378 173	67.0
1998	2 154 918	1 405 553	65.2
1999	2 202 562	1 438 273	65.3
2000	2 251 625	1 467 291	65.2
2001	2 292 451	1 377 810	60.0
2002	2 340 197	1 471 984	62.9

Table 24: Irrigation Areas by Basins (2000) managed by SHW (adopted from www.dsi.gov.tr)

Number	Name	Irrigation Area (ha)
1	Meric Ergene	50 669
2	Marmara	19 694
3	Susurluk	79 562
4	Kuzey Ege	12 728
5	Gediz	110 869
6	Kucuk Menderes	1 545
7	Buyuk Menderes	151 031
8	Batı Akdeniz	44 234
9	Antalya	85 645
10	Burdur Goller	23 145
11	Akarcay	21 271
12	Sakarya	97 567
13	Batı Karadeniz	26 520
14	Yesilirmak	79 077
15	Kizilirmak	103 019
16	Konya Kapali	162 593
17	Dogu Karadeniz	40 049
18	Seyhan	130 966
19	Asi	20 150
20	Ceyhan	155 524
21	Firat	311 433
22	Dogu Karadeniz	-
23	Coruh	11 455

24	Aras	77 900
25	Van Kapali	48 400
26	Dicle	25 804
Total		1 890 850

4.6.6 Types of crops irrigated

There exist no a statistical information available on amounts, varieties and yields for irrigated crops of permanent and annual plants. There is no explanatory information about the given values that belong to irrigated or dried agricultural crops. The main groups of permanent crops in Turkey are nuts, fruits, pome fruits, stone fruits (olives included), grape and grape like fruits, citrus, tea plantation. The main groups of annual crops in Turkey are cereals, pulses, industrial crops, oil seeds, tuber crops, fodder crops, leafy or edible stem vegetables, fruit bearing vegetables, leguminous vegetables, and other vegetables.

The total agricultural area of Turkey is 28 million ha and 26 million ha of this area has an irrigation potential but economically only 8 million ha can be irrigated. 4.5 million ha was irrigated in agricultural areas in 2002. Irrigable agricultural areas cover 15.5% (4 354 000 ha) of the total agricultural areas of Turkey (www.dsi.gov.tr). Irrigated and non-irrigated agricultural crop groups in Turkey are nuts fruits, pome fruits, stone fruits (olives included), grape and grape like fruits, citrus, tea plantation, cereals, pulses, industrial crops, oil seeds, tuber crops, fodder crops, leafy or edible stem vegetables, fruit bearing vegetables, leguminous vegetables, and other vegetables. Each group includes a lot of vegetables or fruits. Some crops of each group with the production amount in 2000 are given in Table 25 (State of Institute of Statistics, 2002).

Table 25: Production Amounts of Crops (adopted from State Institute of Statistics, 2002)

Main Product Group	Product Type	Production (ton)
Nuts Fruits	Pistachios	75 000
	Almonds	47 000
	Walnuts	116 000
	Hazelnuts	470 000
	Chestnuts	50 000
Pome Fruits	Pears	380 000
	Quinces	105 000
	Apples	2 400 000
	Medlar	4 600
	Loquats	11 500
Stone Fruits	Comel	12 000
	Plums	195 000
	Apricots	530 000
	Cherries	230 000

	Peaches		430 000
	Sour Cherries		106 000
	Wild Apricots		49 000
	Olives	For table use	490 000
		For pressing	1 310 000
	Jujube		5 300
Grape and Grape Like Fruits	Grapes		3 600 000
	Strawberries		130 000
	Bananas		64 000
	Mulberry		60 000
	Figs		240 000
	Persimmons		12 000
	Pomegranates		59 000
	Carobs		14 000
	Kiwi		1 400
	Oranges		1 070 000
Citrus Fruits	Sour Oranges		2 200
	Grapefruits		130 000
	Lemons		460 000
	Mandarins		560 000
Tea Plantation	Green Leaves		758 038
	Dry Tea Obtained from Green Tea Leaf		138 770
Cereals	Wheat		21 000 000
	Barley		8 000 000
	Rye		260 000
	Oats		314 000
	Spelt		8 600
	Maize		2 300 000
	Millet		5 300
	Rice		210 000
	Canary Grass		234
	Mixed Grain		10 560

Table 26: Production Amounts of Crops (continued)

Main Product Group	Product Type	Production (ton)
Pulses Broad	Beans	37 000
	Peas	3 100
	Chickpeas	548 000
	Dry Beans	230 000
	Green Lentil	73 000
	Red Lentil	280 000
	Kidney Beans	2 600

	Cow Vetches		134 000
	Wild Vetches		3 600
	Fenugreek		670
	Everlasting Pea		3 480
	Grass Pea		1 037
Industrial Crops	Tobacco		200 280
	Sugar Beets		18 821 033
	Hemp Fiber		1 244
	Poppy Capsule		11 564
	Aniseed		20 000
	Cotton Lint		879 940
	Flax Fiber		7
	Dry Pepper		21 340
	Cumin		6 900
	Lupine Hop		355 740
Oil Seeds	Cotton Seed		1 295 066
	Sunflower		800 000
	Sesame		23 800
	Poppy Seed		11 564
	Flax Seed		173
	Hemp Seed		140
	Groundnuts		78 000
	Soybeans		44 500
	Safflower		18
	Rapeseed		187
Fodder Crops	Silage Maize		700 000
	Cow Vetches	Green	395 000
		Dried	261 000
	Wild Vetches	Green	360
		Dried	800
	Alfalfa	Grain	1 900
		Green	1 807 000
		Dried	1 540 000
	Sainfoin	Grain	1 938
		Green	200 000
		Dried	330 000

Table 27: Production Amounts of Crops (continued)

Main Product Group	Product Type	Production (ton)
Leafy or Edible Stem Vegetables	Cabbages	622 000
	Black Cabbages	103 000
	Artichokes	24 500
	Celery	16 500

	Leaf Lettuce	118 000
	Head Lettuce	215 000
	Spinach	205 000
	Leek	308 000
	Garden Orache	7 300
	Purslane	2 250
	Dill	1 700
	Parsley	40 000
	Mint	5 000
	Rocket	1 150
	Cress	1 250
Tuber Crops	Dry Garlic	81 000
	Dry Onions	2 200 000
	Potatoes	5 370 000
	Beets for Fodder	140 000
Fruit Bearing Vegetables	Melons-Water Melons	5 805 000
	Pumpkins	72 000
	Squash	260 000
	Cucumbers	1 825 000
	Eggplants	924 000
	Okra	27 500
	Tomatoes	8 890 000
	Stuffing Pepper	390 000
	Green Pepper	1 090 000
Leguminous Vegetables	Green Beans	514 000
	Green Peas	48 000
	Green Broad Beans	45 000
	Calavence	41 000
	Cow Pea	12 000
Root, Bulb and Tuberous Vegetables	Green Garlic	21 000
	Green Onions	228 000
	Carrots	235 000
	Horse Radish	22 500
	Red Radish	145 000
	Jerusalem Artichokes	450
	Turnip	1 500
Other Vegetables	Cauliflower	90 000
	Asparagus	12

4.6.7 Types of irrigation

Types of irrigation methods applied in Turkey are mainly 95.03 % surface irrigation (2 173 402 ha), 4.71% sprinkler irrigation (107 969 ha) and 0.16% drip irrigation (3 762 ha) (State of Institute of

Statistics, 2002). Micro-irrigation methods have not been applied in Turkey yet. Irrigation potential of total water consumption in 1997 was stated as 75%. This portion has been aimed to be decreased to 65% through applying new irrigation techniques and modernization methods by the year 2030. To reach this target, The General Directorate of State Hydraulic Works (SHW) has established new irrigation systems in several agricultural areas in Turkey. A total of 114 479 ha and 8 268 ha agricultural land have been irrigated by using sprinkler irrigation method and drip irrigation method in 2000, respectively. The drip irrigation method has been mostly applied in Adana province with 67% of total micro-irrigation method (State of Institute of Statistics, 2002). Total investment of sprinkler and drip irrigation systems covered 8% of total irrigation budget of Turkey in 2002. The surface irrigation yield with the existing irrigation systems (channels) is approximately 60%. This yield percentage can be increased to 85-90% by applying sprinkler and drip irrigation methods (http://www.tbmm.gov.tr).

4.6.8 Area of the region irrigated by reused wastewater or other non-conventional water resources

Agricultural irrigation applications realized with reused wastewater or other non-conventional water resources are not conducted officially. The common property of The General Directorate of Rural Services and General Directorate of State Hydraulic Works is the usage of groundwater and clean surface waters for irrigation.

Local application examples about irrigation of agricultural areas with non-conventional water resources can be mentioned. For example, wastewater reused for agricultural applications are wide spread in South East Anatolia. The wastewater is commonly used for the irrigation of vegetables in the area. In Siverek, located in South East Anatolia, domestic wastewaters discharged into stream have been reused for agricultural applications. Cotton, wheat and various vegetables are the agricultural products mainly irrigated with wastewater. In this area firstly eggplant, pepper and tomato have been planted. Also cabbage, carrot and spinach known as seconder products have been raised. Due to the fact that these products can be sold at a certain profit, farmers have selected the irrigation method realized with reused wastewater. Some of these areas have been irrigated with surface wastewater by gravity and the others through pumping from wastewater channels. In Siverek, the total area irrigated by wastewater is 165 ha. and the consumption of irrigation water was 1.9 million m^3 in 2001 (South-Eastern Anatolia Project – Regional Development Administration, 2002).

Because of insufficient sewarage facilities and lack of satisfactory treatment, an enourmous amount of domestic wastewater has been discharged into rivers. These water resources have also been used for irrigation. For example, in Trakya, located in North-West Anatolia, 1 560 620 m^3 of domestic wastewater has been discharged into the river Evros and 9 000 ha. of agricultural area has been irrigated by the polluted waters (www.tekirdag.gov.tr, www.dsi.gov.tr).

Types of Irrigated Crops

There exist no a statistical information available on amounts, varieties and yields for irrigated crops of permanent and annual plants. There is no explanatory information about the given values that belong to irrigated or dried agricultural crops. The main groups of permanent crops in Turkey are nuts, fruits, pome fruits, stone fruits (olives included), grape and grape like fruits, citrus, tea plantation. The main groups of annual crops in Turkey are cereals, pulses, industrial crops, oil seeds, tuber crops, fodder crops, leafy or edible stem vegetables, fruit bearing vegetables, leguminous vegetables, and other vegetables.

The total agricultural area of Turkey is 28 million ha and 26 million ha of this area has an irrigation potential but economically only 8 million ha can be irrigated. 4.5 million ha was irrigated in agricultural areas in 2002. Irrigable agricultural areas cover 15.5% (4 354 000 ha) of the total agricultural areas of Turkey (www.dsi.gov.tr). Irrigated and non-irrigated agricultural crop groups in Turkey are nuts fruits, pome fruits, stone fruits (olives included), grape and grape like fruits, citrus, tea plantation, cereals, pulses, industrial crops, oil seeds, tuber crops, fodder crops, leafy or edible stem vegetables, fruit bearing vegetables, leguminous vegetables, and other vegetables. Each group includes a lot of vegetables or fruits. Some crops of each group with the production amount in 2000 are given in Table 28 (State of Institute of Statistics, 2002).

Table 28: Production Amounts of Crops (adopted from State Institute of Statistics, 2002)

Main Product Group	Product Type		Production (ton)
Nuts Fruits	Pistachios		75 000
	Almonds		47 000
	Walnuts		116 000
	Hazelnuts		470 000
	Chestnuts		50 000
Pome Fruits	Pears		380 000
	Quinces		105 000
	Apples		2 400 000
	Medlar		4 600
	Loquats		11 500
Stone Fruits	Comel		12 000
	Plums		195 000
	Apricots		530 000
	Cherries		230 000
	Peaches		430 000
	Sour Cherries		106 000
	Wild Apricots		49 000
	Olives	For table use	490 000
		For pressing	1 310 000
	Jujube		5 300
Grape and Grape Like Fruits	Grapes		3 600 000
	Strawberries		130 000
	Bananas		64 000
	Mulberry		60 000
	Figs		240 000
	Persimmons		12 000

	Pomegranates	59 000
	Carobs	14 000
	Kiwi	1 400
Citrus Fruits	Oranges	1 070 000
	Sour Oranges	2 200
	Grapefruits	130 000
	Lemons	460 000
	Mandarins	560 000
Tea Plantation	Green Leaves	758 038
	Dry Tea Obtained from Green Tea Leaf	138 770
Cereals	Wheat	21 000 000
	Barley	8 000 000
	Rye	260 000
	Oats	314 000
	Spelt	8 600
	Maize	2 300 000
	Millet	5 300
	Rice	210 000
	Canary Grass	234
	Mixed Grain	10 560

Table 29: Production Amounts of Crops (continued)

Main Product Group	Product Type	Production (ton)
Pulses Broad	Beans	37 000
	Peas	3 100
	Chickpeas	548 000
	Dry Beans	230 000
	Green Lentil	73 000
	Red Lentil	280 000
	Kidney Beans	2 600
	Cow Vetches	134 000
	Wild Vetches	3 600
	Fenugreek	670
	Everlasting Pea	3 480
	Grass Pea	1 037
Industrial Crops	Tobacco	200 280
	Sugar Beets	18 821 033
	Hemp Fiber	1 244
	Poppy Capsule	11 564
	Aniseed	20 000
	Cotton Lint	879 940
	Flax Fiber	7
	Dry Pepper	21 340
	Cumin	6 900
	Lupine	355

	Hop		740
Oil Seeds	Cotton Seed		1 295 066
	Sunflower		800 000
	Sesame		23 800
	Poppy Seed		11 564
	Flax Seed		173
	Hemp Seed		140
	Groundnuts		78 000
	Soybeans		44 500
	Safflower		18
	Rapeseed		187
Fodder Crops	Silage Maize		700 000
	Cow Vetches	Green	395 000
		Dried	261 000
	Wild Vetches	Green Dried	360 800
	Alfalfa	Grain	1 900
		Green	1 807 000
		Dried	1 540 000
	Sainfoin	Grain	1 938
		Green	200 000
		Dried	330 000

Table 30: Production Amounts of Crops (continued)

Main Product Group	Product Type	Production (ton)
Leafy or Edible Stem Vegetables	Cabbages	622 000
	Black Cabbages	103 000
	Artichokes	24 500
	Celery	16 500
	Leaf Lettuce	118 000
	Head Lettuce	215 000
	Spinach	205 000
	Leek	308 000
	Garden Orache	7 300
	Purslane	2 250
	Dill	1 700
	Parsley Mint	40 000 5 000
	Rocket	1 150
	Cress	1 250
Tuber Crops	Dry Garlic	81 000
	Dry Onions	2 200 000
	Potatoes	5 370 000
	Beets for Fodder	140 000

MEDAWARE- Part D

Fruit Bearing Vegetables	Melons-Water Melons	5 805 000
	Pumpkins	72 000
	Squash	260 000
	Cucumbers	1 825 000
	Eggplants	924 000
	Okra	27 500
	Tomatoes	8 890 000
	Stuffing Pepper	390 000
	Green Pepper	1 090 000
Leguminous Vegetables	Green Beans	514 000
	Green Peas	48 000
	Green Broad Beans	45 000
	Calavence	41 000
	Cow Pea	12 000
Root, Bulb and Tuberous Vegetables	Green Garlic Green Onions	21 000 228 000
	Carrots	235 000
	Horse Radish	22 500
	Red Radish	145 000
	Jerusalem Artichokes	450
	Turnip	1 500
Other Vegetables	Cauliflower	90 000
	Asparagus	12

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Development of Tools and Guidelines for the Promotion of the Sustainable Urban Wastewater Treatment and Reuse in the Agricultural Production in the Mediterranean Countries

(MEDAWARE)

Task 1: Determination of the Countries Profile

PART E: WATER RELATED PROBLEMS ASSOCIATED WITH HEALTH AND ENVIRONMENT

INDEX

5. Water Related Problems Associated with Health and Environment

5.1 CYPRUS

5.1.1 Area salinized by irrigation

Saline soils in Cyprus are limited. However secondary salinization due to the use of semisaline water for irrigation is common particularly under greenhouse production. To overcome the problem leaching is practiced during the growing season and more substantial leaching before planting.

5.1.2 Population affected by water-related diseases

Cyprus is free of water related diseases.

5.2 JORDAN

5.2.1 Area salinized by irrigation

In general, there are no problems of salinization of soil when fresh water is used for irrigation. However, there are indications for increasing soil salinity in area irrigated with treated wastewater which is 10820.8 ha.

5.2.2 Population affected by water-related diseases

No statistics is available yet. However, the Ministry of Health is very concerned with this aspect and through this project collaboration between the Ministry and JUST is to be established with the aim to collect this information.

5.3 LEBANON

5.3.1 Area salinized by irrigation

Because of an overuse of fertilizers and mismanagement of irrigation in the semi-arid area and in the greenhouses of the coastal area, secondary salinization has been observed (Darwish, 2002). Studies showed significant nutrient buildup and salinity problems under greenhouse conditions (Atallah *et al*., 1999; Darwish, 2000). On the other hand, the monitoring of the electrical conductivity of the saturated-paste extract of 75 samples in Northern Bekaa, Qaa region, by Darwish *et al*. in 2000 indicated the increasing proportion of salt-affected soils in comparison with a previous field sampling undertaken in 1997 for the same area by El-Khatib *et al*. The following table shows the results of this comparison.

Table 1: Evolution of soil salinity in a semi-arid Lebanese region between 1997, (El-Khatib *et al*., 1998) and 2000 (Darwish *et al*., 2002)

Level of salinity dS m^{-1}	***Normal <2***		***Very slightly saline 2-4***		***Slightly saline 4-8***		***Saline 8-16***		***Number of samples***
Year of observation	1997	2000	1997	2000	1997	2000	1997	2000	75
Proportion %	35.3	15.9	23.5	30.1	31.4	39.3	9.8	14.7	

These soils have an exchangeable sodium less than 0.5% and a pH<8.5. Consequently, the soils are salt-affected. As a result of this secondary salinization, after several years of exploitation, the productivity of some soils in Qaa has decreased.

No further investigative studies or surveys on soil salinization are known to have been conducted in Lebanon, however, it is suspected that some areas similar to the Qaa region are experiencing problems of salinization.

5.3.2 Population affected by water-related diseases

Domestic wastewater in Lebanon is being discharged into the Mediterranean Sea, as well as into the river system, with no treatment prior to disposal. Consequently, bacterial contamination of coastal waters, rivers and drinking water sources were well documented, indicating a great harm to the environment, and posing potential public health related hazards.

Although archival evidence linking groundwater pollution to drinking water quality and community health in Lebanon is sparse, reports of special studies demonstrate a clear connection and trend. The National Wastewater Management Plan 1982 (NWMP82) report cited Central Public Health Laboratory analyses of drinking water samples collected in 1980-81, which showed that "…for locations outside Beirut, 30% of the samples had coliform bacteria present, with no significant seasonal variation. Beirut water followed a seasonal variation, with coliforms detected in only 5% of winter samples, but up to 20% of the samples in October and November. Of all the samples from wells and springs, 40% had coliforms present" (Khatib & Alami, 1994).

By comparison, tests conducted by the National Central Laboratory on 720 samples of drinking water, collected nationwide in 1994, showed 440 (67%) had coliform bacteria. Extensive field and laboratory tests conducted in the American University of Beirut (AUB) had shown the incidence of pollution in wells and springs to be higher in 1994 than they had been in 1990, but lower in storage tanks and distribution networks, a clear sign of deterioration at critical locations in the intervening years, partially offset by improving water treatment practices (Sarginson *et al*., 1998).

Regarding the linkage between polluted drinking water and public health, NWMP82 report commented on the dearth of information on reportable diseases, but quoted a 1980 AUB survey as tracing records of 1,510 cases of typhoid, 387 of viral hepatitis, and 204 of shigellosis occurring during 1979. One informed, though unofficial report suggested that the incidence of gastroenteritis and amoebic dysentery among the general population might be as high as 80%. Although the circumstances attending individual cases of these maladies vary, they are all associated either directly with consumption of polluted water, or indirectly through lack of cleanliness or consumption of fruits and vegetables irrigated or washed in polluted water (Khatib & Alami, 1994).

In 1995, the Epidemiological Surveillance Unit (ESU) of the Ministry of Public Health issued its first newsletter (EpiNews) on reportable disease statistics for Lebanon. Its March 1996 issue indicated that, by the end of 1995, only 54 of the country's 148 public and private hospitals were submitting reports. Health care centers and laboratories had started to report. Although the number of cases summarized in Table 2 is obviously not complete, the monitoring routine appears to be gaining strength (Khatib & Alami, 1994; Sarginson *et al*., 1998).

Table 2: Reported Incidence of Diseases Attributable to Pollution of Drinking Water, 1995-1997

Reportable Disease	***Jan-June 1995***	***July-Dec 1995***	***1995 Full Year***	***Jan-June 1996***	***July-Dec 1996***	***1996 full Year***	***Jan-June 1997***	***July-Dec 1997***	***1997 Full year***
Brucellosis	53	188	241	129	170	299	155	161	316
Dysentery	92	532	624	487	610	1097	286	340	626
Hepatitis (all types)	78	323	401	267	312	579	374	312	686
Typhoid/Paratyphoid	565	714	1279	335	536	871	539	314	853

No basis appears to be available for determining the number of cases that did not involve professional intervention, or the number of persons who carried and spread the infections without being seriously incapacitated. These may be numerous.

Water quality bacteriological analyses conducted on samples taken from various springs and wells in the Kesrouan area are shown in tables 3 and 4. These sources are used for drinking water purposes without any treatment, and as shown from the results, contain coliform concentrations that surpass established permissible drinking water concentrations (which are set at 0 Coliform/100 ml by USEPA and WHO).

Jaber (1997) reported an accident of contamination of Racheine Spring which was the principal water resource to supply Zghorta and the whole Tripoli city in North Lebanon. The spring water was contaminated in autumn 1997 and Zghorta and Tripoli area were contaminated by typhoid, and analysis showed high quantity of Coliforms. After several site visits, specialists found that there was, 8 km to the South of Racheine Spring, a village named Deir Nbouh and that some habitations discharged their wastewater in a valley between Racheine and the village. Geological fault passes through the said valley with some karstic holes one of them is about 4 m diameter and 5 m depth with a sink in the bottom. When heavy rains fall, torrential streams carry all wastes and pollutants stored in the valley, which will in turn infiltrate through the karstic formations of the underground aquifer located at a depth of less than 50 m. Disinfecting pills were distributed to the population to dissolve them in water. Racheine Source and the reservoirs were equipped with chlorinators. Then the MOEW proceeded to execute works to deviate wastewater from the above-mentioned valley to Biader Racheine, an area under the source emplacement (Jaber, 1997; Chammas, 2003).

Table 3: Bacteriological Analyses of some springs

Spring or Source of Water	***Aquifer Geology***	***Faecal Coliforms in 100 ml water***	***Total Coliforms in 100 ml water***		***Faecal Streptococcus in 100 ml water***
			Dbayeh Lab	***Ghorra Lab***	***Ghorra Lab***
Nabaa El Maghara (Hrajel)	Limestones of J6	>80	>80	260	100
Nabaa El Assal	Limestones and Dolomites of C4	0	9	2	0
Nabaa El Laban		0	42	5	0
Jiita Cavern	Limestones J4	17	>80	35	10

* Source: Chammas, 2003; CDR, MHER: "Water and Wastewater Feasibility Studies in Saida Drainage Zone", Beirut, January 1995

Table 4: Bacteriological Seasonal Analyses of Jiita Waters, and other Water Locations (laboratory of Dbayeh Station)

Spring or Well	*Date of Sample Extraction*	*Total Coliforms in 100 ml of water*	*Faecal Coliform in 100 ml of water*
Cavern Source	28/07/92	>80	0
	12/10/92	17	0
	27/10/92	20	2
	13/01/93	0	0
	14/04/93	25	0
	3/8/93	>80	17
Nabaa Kachkouch	28/07/92	>80	>80
	3/8/93	>80	5
Upstream of Jiita	12/10/93	>80	0
Nabaa El Assal	27/01/93	4	0
	5/4/93	6	0
	29/07/93	9	0
	4/8/93	4	0
Well of Dar Ali (Faraya)	12/10/92	>80	0
	25/01/93	>80	0
	22/07/93	>80	2
Well of Coin Vert (Faraya)	12/10/92	35	0
	25/01/93	524	0

* Source: Chammas, 2003; CDR, MHER: "Water and Wastewater Feasibility Studies in Saida Drainage Zone", Beirut, January 1995

5.4 MOROCCO

5.4.1 Area salinized by irrigation

In Morocco, phenomena of salinisation in an irrigated surface of approximately 40.000 ha are observed.

5.4.2 Population affected by water-related diseases

Outbreaks of cholera, which prevailed in Morocco until 1994, were observed during summers in regions which were irrigated by untreated wastewater.

Small scale outbreak of fluorosis in phosphate zones in rural areas due to consumption of underground water contaminated by fluorides (Garmes, Doctorat d'Etat, Faculté des Sciences El Jadida, 2000).

Isolated cases of typhoid due to consumption of untreated underground water.

However, there no more cases of outbreak of diseases mainly due to the quality of the water currently distributed by ONEP.

5.5 PALESTINE

5.5.1 Area salinized by irrigation

There are no statistics regarding the area salinized by irrigation, but the realistic changes in the lands of "plastic houses" show that, soil under plastic cover becoming saline. This may be explained as follows: In Jericho and Gaza Strip, the ground water is characterized by high level of salinity, above 1000 mg/l of Total Dissolved Solids (TDS). This water is used for irrigation of the crops in plastic houses. The plastic houses are covered all the time, and no flushing by rainwater could be happened, hence salts are accumulating in the soil.

The total area of plastic houses in Gaza Strip is approximately13253 dunums, while in Jericho are about 601 dunums.

5.5.2 Population affected by water-related diseases

Related data from the Ministry of Health is not documented to point out the statistics of affected population by water-related diseases, but some of the available reports and studies show the following:

In 1990, a survey conducted by Chrissmith in Gaza Strip showed that 50% of children under age 10 years old infected by Ascaris.

In 1989, Ali Shrayeh and others collected information for 6 years, they took 22970 samples from Nablus to Jordan River, and the result showed the following:

- The infected persons by Ascaris is 177 per 1000
- The infected persons by Trichuris is 13 per 1000

5.6 TURKEY

5.6.1 Area salinized by irrigation

In Turkey, observation of the agricultural areas salinized by irrigation and management of observation studies of water table is done by DSI. Water table raised by rain, groundwater and irrigation water is very harmful to the roots of plants because of accumulation. The water table measurements are carried out with analysis of samples taken from observation wells of about 4 meter depth. To investigate the area salinized by irrigation, a salinity diagram system taken from USA is being used. The results of water table studies according to years is given in Table 5.

Water table records at the period of heavy irrigation are conducted in order to investigate agricultural areas salinized by irrigation. These studies have been carried out in almost 60% of the irrigated areas to measure salinity and drainage problems of agricultural soils. If salinity values are exceeding 5000 µmhos/cm, these areas will be drained related to the critical salinity levels. According to the results of water table studies prepared within the past years, salinity values more than 5000 µmhos/cm were detected in 221 823 ha of irrigated land that accounts to 7% of the irrigated areas have been salinized in Turkey.

5.6.2 Population affected by water-related diseases

In Turkey, there are serious environmental and sanitary issues arising due to water related diseases mentioned in The World Health Report in 2002. The data gathered from the country indicate six illnesses caused by poor guality waters. These illnesses are typhoid fever, bacillary dysentery and amoebiasis, enteritis and other diarrheal diseases, meningococcal infections, typhus and other rickettsioses, and parasitic diseases. Typhoid fever and bacillary dysentery infect the plants irrigated with sewage which in turn affect humans. These bacteria, always found in soil, can damage the epital parts of intestine at infected people. Amoebiasis, spread on raw vegetables and fruits that are not washed properly is a gastro-stomach infectious illness. Typhus known as one of the important illness of rickettsioses, enteritis known as one of the intestine inflammation and meningococcal infections can exist due to poor guality drinking water and sewage facilities. Population affected by water-related diseases is given in Table 6.

According to State of Institute of Statistics(SIS) analysis, the values and rate of death were 4639 and 2.66%, respectively. On the other hand the records of state hospitals have shown that the number of illnesses treated and recovered are very high. For example, only at a city, Van, the state hospitals registered a great number of positive laboratory results, specifically; 11 984 cases of enteritis and other diarrheal diseases, 333 cases of Brusella, 36 cases of typhoid fever, 22 cases of bacillary dysentery and 11 cases of hepatitis (The Turkish Association of Medical Doctors, 2002).

Table 5: The results of Water Table Observation Studies according to years (The General Directorate of State Hydraulic Works, 2002)

Years	1998		1999		2000		2001		2002	
Salinity Levels	Area (ha)	Rate (%)	Area (ha)	Rate (%)	Area (ha)	Rate (%)	Area (ha)	Rate (%)	Area (ha)	Rate (%)
0-2500	1022421	89	1043780	88	1059672	89	1127769	90	863035	86
2500-5000	81299	7	81994	7	87420	7	91411	7	114399	11
5000-7500	21402	2	21667	2	27607	2	23322	2	20551	2
7500-10000	12824	1	17766	2	12856	1	10166	1	5992	1
10000<	15085	1	14464	1	6798	1	6109	0	5214	1
Total	1153031	100	1179671	100	1194353	100	1258777	100	1009191	100
The ratio of observation area to total irrigation area (%)	64		64		64		68		53	

Table 6: Deaths by Water-Related Diseases in 2000

The cause of death	Cholera	Typhoid fever	Bacillary dysentery and amoebiasis	Enterits and other diarrheal diseases	Typhus and other rickettsioses	Meningococcal infections	Other infectious and parasitic diseases	Total
Total	-	7	6	512	2	3464	648	4639
The rate of diseases (%)	-	0.15	0.13	11	0.04	75	14	2.66

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(MEDAWARE)

Task 1: Determination of the Countries Profile

PART F: WATER POLICY AND INSTITUTIONAL ENVIRONMENT

MEDAWARE - Part F

INDEX

6. Water Policy and Institutional Environment

6.1 CYPRUS

6.1.1 Institutional framework

Mainly two Ministries, the Ministry of Agriculture Natural Resources and Environment and the Ministry of the Interior carry out the Management of the Water Resources of the Cyprus. Other institutions are involved directly or indirectly with Management of the Water Resources, as presented in Table 1.

Table 1: Institutions involved with Water Resources Management

INSTITUTIONS		
A. Independent Organizations		
Directly Related to Water		
Indirectly Related to Water	1	House of Representatives
	2	Audit Office
	3	Law Office of the Republic
	4	Planning Bureau
B. Government Organizations		
Directly Related to Water	1	Water Development Department (MANRE)
	2	Geological Survey Department (MANRE)
	3	Department of Agriculture (MANRE)
	4	Agricultural Resource Institute (MANRE)
	5	District Administration Nicosia (MOI)
	6	District Administration Limassol (MOI)
	7	District Administration Larnaka (MOI)
	8	District Administration Famagusta (MOI)
	9	District Administration Pafos (MOI)
	10	Medical Services & Public Health Services (MOH)
	11	General Laboratory (MOH)
Indirectly Related to Water	1	Statistics Service (MOF)
	2	Treasury Department (MOF)
	3	Environmental Service (MANRE)
	4	Meteorogical Service (MANRE)
	5	Land Consolidation Department (MANRE)
	6	Fisheries Department (MANRE)
	7	Department of Secondary Education (MOEC)
	8	Department of Technical & Vocational Education (MOEC)
	9	Department of Primary Education (MOEC)

C. Semi-Government Organizations		
Directly Related to Water	1	Water Board of Nicosia
	2	Water Board of Larnaca
	3	Water Board of Limassol
	4	Sewage Board of Nicosia
	5 6	Sewage Board of Larnaka Sewage Board of Limassol
	7	Sewage Board of Pafos
	8	Sewage Board of Paralimni and Ayia Napa
	9	Sewage Board of Agros
	10	Pafos Municipality
	11	Lakatamia Municipality
	12	Ayia Napa Municipality
	13	Paralimni Municipality
	14	Aradhipou Municipality
	15	Yermasogia Municipality
	16	Deryneia Municipality
	17	Dali Municipality
	18	Lefkara Municipality
	19	Village Boards
Indirectly Related to Water	1	The University of Cyprus
	2	Cyprus Tourism Organization
MANRE: Ministry of Agriculture Natural Resources and Environment MOI: Ministry of the Interior MOH: Ministry of Health MOF: Ministry of Finance MOEC: Ministry of Education and Culture		

The Water Development Department is responsible for implementing the water policy of the Ministry of Agricultural, Natural Resources and Environment with objective the national development and management of the water resources of Cyprus. As treated wastewater is part of the water resources the Government appointed the Water Development Department as the responsible body for the tertiary treatment as well as the allocation and distribution of this water to farm level.

The Department of Agriculture, which also belongs to Ministry of Agriculture, Natural Resources and Environment, is responsible for the education of farmers in all matters related to agricultural production with the use of treated wastewater. The selection of crop and the irrigation system to be used as well as preparation of irrigation schedules are amongst the responsibilities of the Department. Also the follow up of the guidelines and the code of practice is also responsibility of the Department of Agriculture.

The sewerage boards is a public sector organization and has the responsibility of the concentration, operation and maintenance of the main sewers system which includes the pipes, the pumping stations and the treatment plants. Its main target is to produce treated effluent, which can be used for irrigation purposes. Sewerage boards treat the wastewater up to secondary level and the tertiary treatment is undertaken by the Government. The board is under the control of the ministry of Interior and its president is the mayor of the city.

The Ministry of the Interior and the Water Boards are responsible for the administration at the consumers' level and the distribution of domestic water.

At present there are plans by the Government to reorganize the institutional set-ups of the water sector through the establishment of a water entity to undertake responsibility for the management of all water resources responsible for all the water cycle.

6.1.2 Policies and Legislative Framework

The Government's policy towards agriculture is very generous and this has contributed to the selection of non-efficient cropping patterns and even to the wastage of water. It should be noted that in the last six years the water tariff for the domestic sector does not reflect the full cost as is formed with the recent introduction of the comparatively expensive desalinated water. The subsidy is as high as 34 percent. The present price of the water to agriculture and domestic sector is 6.5 c/m3 and 33,5 c/m3 respectively.

It is apparent, by a simple comparison of the supply and demand, that the current water situation is not sustainable. The recent droughts of 1989/91 and 1995/2000 demonstrate quite convincingly how critical the water situation may become. A new water policy is warranted that will bring about sustainability. The new water policy should include the following specific measures, which should be holistically applied.

- Secure additional sources of supply
- Ensure efficient use of available water
- Modify the current irrigation water allocation matrix
- Built up strategic water reserves
- Maintain and enhance the quality of the water
- Introduce new effective/efficient management procedures through the establishment of a Water Entity

Treated wastewater and reuse is a reliable source of water even in drought years. However, its use is associated with environmental and health risks. The guidelines for domestic treated effluents use for irrigation are presented in Table 2.

Table 2: Cyprus guidelines for domestic treated effluents use for irrigation

Irrigation of	BOD mg/L	SS mg/L	Faecal coli-forms/100ml	Infestinal worms/L	Treatment required
All crops (a)	(A) 10*	10*	5* 15**	Nil	Secondary and Tertiary and disinfection
Amenity areas of unlimited access and vegetables eaten cooked (b)	(A) 10* 15**	10* 15**	50* 100**	Nil	Secondary and Tertiary and disinfection
Crops for human consumption. Amenity areas of limited access.	(A) 20* 30*	30* 45**	200* 1000*	Nil	Secondary and storage >7 days and disinfection, or Tertiary and disinfection.
	(B)		200* 1000*	Nil	Stabilization-maturation ponds total retention time >30 days or Secondary and storage > 30 days
Fodder crops	(A) 20* 30**	30* 45**	1000* 5000**	Nil	Secondary and storage >7 days or Tertiary and disinfection.
	(B)		5000*	Nil	Stabilization-maturation ponds total retention time >30 days or Secondary and storage > 30 days
Industrial crops	(A) 50* 70**		3000* 10000**	Nil	Secondary and Disinfection
	(B)		3000* 10000**		Stabilization-maturation ponds total retention time >30 days or Secondary and storage > 30 days

A Mechanised methods of treatment (activated sludge e.t.c.)
B Stabilization ponds

* These values must not be exceeded in 80% of samples per month (Min. number of samples = 5).
** Maximum value allowed

(a) Irrigation of leafy vegetables, bulbs and corms eaten uncooked is not allowed
(b) Potatoes, beetroots, colocasia.

<u>*Note:*</u> No substances accumulating in the edible parts of crops and proved to be toxic to humans or animals are allowed in effluent.

The legal framework in Cyprus has been enacted during the colonial era and still remains in force by virtue of the provisions of Article 188 of the Constitution. Additions and modifications were made to the legislation since then to take account of changes, new developments and trends, but these were very limited. The existing Laws totaling around sixteen have the following provisions:

- All ground water and all surface water and wastewater resources are vested to the state.
- The Government has the power to construct waterworks and sell water at a price fixed by the Government and the Parliament.
- The water rights are protected and riparian rights are given to those who can prove that they own such rights.
- The Laws give the right to private individuals to sink or construct wells or drill boreholes, for ground water abstraction, after getting a permit from the District Officer.
- The Laws give the right to individuals to form Irrigation Divisions or Associations to construct irrigation works.
- The Laws give the right to villages and towns to form their own Commissions for constructing their own waterworks for domestic supply.
- The Laws give the right to town or villages to form their own sewage and drainage Boards for the collection, treatment and disposal of sewage effluents.
- The Laws, except in the cases of Irrigation Divisions, Association, Commission and Sewage Boards, do not mention the administrative authority which keeps the water resources inventory, or evaluates, or allocates and controls the use of water. This is a basic setback of the water legislation.

Concerning environmental issues on water the Law no 69/91-"Water pollution control" and the "Water and Soil pollution monitoring law no 106(I)/2002", provides for the reduction, control and abolition of water pollution for the best protection of the natural water resources and the health and well being of the population.

6.2 JORDAN

6.2.1 Institutional framework

Wastewater collection, transportation, treatment, disposal and reuse receive the greatest concern by the health authorities in the Ministry of Health (MOH). The MOH realizes that protection and promotion of human health of the public can't be guaranteed and safeguarded without monitoring wastewater and controlling its use. Therefore, all possible and applicable measures are enforced to prevent any illegal use of wastewater or any use of treated effluents in a manner that may endanger the public health. The Public Health Law No. 54 for the year 2002 is the legislative tool through which the Ministry undertakes all actions to safeguard the health of the people.

Other agencies and organization however, participate in the monitoring programs at varying levels. Of these agencies, Water Authority of Jordan is a major body. Others include the Ministry of Environment. Details of each monitoring program are following:-

- Ministry of Health (MOH)

The Ministry of Health has the most intensive and comprehensive monitoring program among other agencies. This program consists of:

1- periodic and regular health inspection of the treatment plants to make sure that no adverse health effects are resulting from any plant regardless of the owner of the plant, public or private sectors.
2- Medical health examination of the workers in the plants is conducted on regular basis to discover any symptoms or ill effects of the exposed people. Treatment of sick people is administered if deemed necessary.
3- Health education of the workers in the treatment plants as well as to the farmers and the public.
4- Sampling and testing of both raw sewage and treated effluents, with emphasis on the latter. Laboratory analysis includes the following parameters:

    - Microbiological content of the water, TCC and Thermo-tolerant Coliforms. Pathogenic enteric bacteria, Cholera, Salmonella, and Shigella. Intestinal parasites including nematodes and protozoa. Screening is conducted to discover the presence of any pathogens. Emphasis is made on Ascaris, Enclystoma, Giardia and Entamoeba.

    - Chemical analysis. The major items, which are tested regularly, include BOD, COD, TSS, PH, TDS, Heavy metals are monitored irregularly.

The results of testing are compared for compliance with the Jordanian standard No. 893/2002 for the use of treated wastewater in irrigation. Field visits to the farms where the treated effluent is expected to be used for irrigation. According to the Jordanian standard, it is not allowed to:

- Discharge any raw sewage into the environment.
- Irrigate crops, which are eaten raw with treated effluent regardless of its quality.
- Irrigate crops that are eaten cooked unless the faucal coliforms are less than 1000 /100 ml and the nematode eggs count is less than 1/liter.

All violations to these standards are dealt with very strictly and on time. Irrigated crops are destroyed under the supervision of the health and police authorities. Moreover, the violating farmer is used in the court where he is charged a penalty fee for his act.

Due to the strict measures applied by the MOH, the number of violators is continuously decreasing. In 1998, only 4 donums of vegetables where destroyed compared to 192 donums in 1997 and 2121 donums in 1996.

At present, the irrigated crops are limited to animal feed and trees including fruit trees. Treated water after mixing surface waters are used for unrestricted irrigation. Presently, there are no regulations as to the quality of irrigation water except for the effluents from wastewater treatment plants.

- Water Authority of Jordan (WAJ)

(WAJ) owns and operates 19 treatment plants. The monitoring program, which is run by the water authority, covers these plants only. The goal of their program is to ensure that the plants are functioning well and that the treated waters meet the requirements set in the Jordanian standard for different uses. The components of their program are similar to those of MOH with respect to laboratory analysis only.

Recently (WAJ) has established the Water Reuse & Environment Unit as the permitting, monitoring and standard setting Authority in Jordan for both municipal and industrial reuse program, the unit also plays strong role in the water reuse projects and in the Environmental Impact Assessment and in the environment issues and water resources protection .

National Water Reuse Coordination Committee has been formed and has been holding regular meetings to coordinate all water reuse activities in Jordan. The committee is composed of representative of Ministries of Agriculture, The Environment, Health, Water and Irrigation and professors from the Jordanian Universities and research institutions and experts from the private sector.

- Ministry of Environment (MOE)

The monitoring program is run by the Royal Scientific Society (RSS) for the order of MOE. The reports are received by MOE and disseminated to concerned agencies for necessary action. The scope of the program and the small number of samples, which are tested, do not allow for proper assessment of the quality of wastewater. In addition, no crops are monitored.

- National Supporting Facilities / Institutional Arrangements

Several public agencies are vested with primary responsibility for the water sector in Jordan such as the Ministry of Water and Irrigation, The Water Authority of Jordan and The Jordan Valley Authority.

The Ministry of Water and Irrigation, having been empowered by a by-law No. 54 of 1992, is responsible for the formulation and implementation of water and wastewater development programs. Its main function, according to its mandate, are to formulate policy and strategy, plan water resources development, carry out research and development, conduct socio-economic and environmental studies, procure financial resources, monitor water and wastewater projects, implement human resources development and public awareness programs, and establish information systems.

The Water Authority, which was created by the law 18/1988 as a national government agency, has two principal functions: The provision of water and sewerage services, and water resources management . Jordan Valley development is governed by law 19/1988, as an extension of the temporary law No. 18/1977 that created the JVA as a responsible organization for the Jordan Valley development. Under its mandate, it is responsible for the development of water resources (irrigation, domestic, industrial and municipal), design and construction of roads water supply, sanitation, and electricity in addition to other infrastructure facilities.

The Ministry of Health, under the Public Health law No. 54/2002 , is empowered to monitor the operation of the wastewater treatment plants and sewerage systems. It also has the authority to ensure the safety of drinking water and treated effluents discharged or reused for irrigation or recharge.

The Ministry of Environment formed by the law no. 1/2003 is responsible for setting general policy, preparation of national strategy for environmental protection, preparing general standards and regulations, by-laws development, conducting water monitoring programs, licensing and developing environmental requirements for any development projects.

Other governmental, non-and semi-governmental institutions are involved in research studies, monitoring programs and standard setting, these are:

1- The Ministry of Agriculture and The National Center of Agricultural Research and Technology Transfer (NCARTT) being responsible for the irrigation water quality works closely with the MWI on standard settings, it also conducts many research projects related to wastewater reuse and its effect on crops.
2- The Ministry of Industry carries out industrial pollution prevention program and co-operates with MWI and MOH in setting industrial discharge standards and regulations.
3- Jordan Institution of Standards and Metrology is responsible for standard settings and amendments in cooperation with the concerned parties.
4- The RSS provides technical and advisory services. One of its main contributions is the monthly monitoring programs for the effluent discharged from As-Samra plant, the aim of the study being the assessment of the treatment efficiency and the suitability of treated wastewater for irrigation and the purification efficiency throughout the river, in addition to

the assessment of its effect on the groundwater quality in the area. Under a separate contract, the RSS. Monitors the water quality in King Talal Reservoir and the water released for the dam before and after mixing it with surface water.

5- The Water and Environment Research Center at the Universities of Jordan, Science and Technology , Hashmia, Al Albait …etc. are carrying research projects in co-operation with WAJ.

6- The Royal Society for the Conservation of Nature (RSCN) and the Jordanian Environmental Society (JES) provide training, advisory services and carry out awareness programs.

6.2.2 Policies and Legislative Framework

Ministry of Water and Irrigation, Ministry of Agriculture, Ministry of Environment, Ministry of Health are all responsible for policies and legislative framework for wastewater reuse. These policies comply with most recent standards for wastewater reuse issued in 2002 under the number : 893/2002

6.3 LEBANON

6.3.1 Institutional framework

Domestic wastewater management is one of the greatest problem areas facing the Lebanese municipalities and concerned ministries (Energy and Water, Interior and CDR). Due to the limited number of industries existing in Lebanon, domestic and commercial flows form the bulk of the wastewater flows that have to be accounted for in the design of wastewater collection, treatment and disposal facilities. Thus, Lebanon generates an estimated 250 million m^3 of wastewater per year, with a total BOD load of about 100,000 t. In addition, industries generate an estimated 43 million m^3 of wastewater per year. It has been estimated that the total BOD load of industrial wastewater is about 5,000 t per year (Ecodit, 2001).

Numerous governmental, semi-autonomous and autonomous agencies are involved in the water, sewage and storm water sectors. Their responsibilities are interrelated in such a way that it is extremely difficult to discern a clear authoritative system linking decrees to appropriate agencies to implement them, and to verify that the agency assigned has the resources and capabilities to implement the decree. The sector is not financially viable, since it depends on government support for capital investments and, to a lesser extent, for operation and maintenance.

The main institutions that are more or less related to the water sector in Lebanon are the following, in order of extent of involvement:

1. The Ministry of Energy and Water (MEW), formerly known as the Ministry of Hydraulic and Electrical Resources (MHER), implements projects through its General Directorate for Hydraulic and Electrical Resources and it exercises its authority upon the Water Offices and Committees through its General Directorate for Operation (Article 1 of Decree No. 5469 of 1966).
2. Autonomous Water Offices (drinking and irrigation offices), making a total of 21 offices operate projects and distribute domestic and irrigation water to users, apart from the Litani River Authority (LRA), which programs, prepares and implements its own integrated and multi-dimensional projects, according to its own terms of reference for hydro-agricultural and hydro-electric development of silt and water resources of basins of South Lebanon and Central as well as South Bekaa, including its mandate to run the national hydrometric network, and 209 local water management committees; all of which operate under the authority of the MEW.
3. The Ministry of Interior and Municipalities (MIM) and the various municipalities responsible for wastewater.
4. The Council for Development and Reconstruction (CDR), for financing and implementation of infrastructure and rehabilitation, modernization and extension projects.
5. The Ministry of Agriculture (MOA) and the following institutions under its authority:
   a. The Agronomical Research Institute of Tell-Amara (ARIL).
   b. The Green Plan (GP).
6. The Ministry of Health, for the quality control of drinking water.

7. The Ministry of Environment (MOE).
8. The Ministry of Public Works, the National Meteorological Department of the General Directorate of Civil Aviation.
9. The Investment Development Organization (IDO), by its recent plan to assist and promote exports of agricultural products (EXPORT PLUS).

The MEW has been set up by Law No.20 of 1966 and its amendments; its responsibilities have been defined in Article 1 of this Law as follows:

1. Extend and generalize water and electricity projects on a national level and implement them or supervise their implementation or operation.
2. Apply the rules and regulations related to the protection of public water and its use.
3. Exercise administrative authority on autonomous offices and other sectors involved in the water field.
4. Exercise control over water and electricity concessions.

The General Directorate for Operation, within the MEW, is responsible for the control of concessions in the field of water in the following aspects:

1. Study of applications for water permits and concessions; control of hydraulic plants.
2. Study of disputes and steps to settle violations; study of tariffs; control and audit of concessions accounts.

In general, MEW is responsible for technical, administrative and financial control of hydraulic concessions and ensures the application of specifications and contracts related to the utilization of water.

The present shortcomings of the institutional situation of the water sector are reflected by the following shortcomings and deficiencies:

1. Excessive centralization, which requires a time-consuming chain of approvals from the ministry for even minor decisions; this has generated excessive dependence on central authorities for financial and technical assistance. A common instance is the appeal of autonomous water authorities and municipalities to higher levels of government for technical and financial support.
2. Dilution of tasks and responsibilities, between several ministries, municipalities, 4 water authorities and many water committees without an adequate coordination mechanism.
3. Lack of financial resources resulting from a lack of a cost recovery tariff policy, thus preventing appropriate spending on maintenance and new investments.
4. Mismanagement, lack of maintenance, and obsolete equipment resulting in poor efficiency and wastage of water.
5. Poor protection of water resources and pollution of distributed water (discharge of waste water directly into water bodies without any treatment).
6. Inadequacy of staff (advanced age of staff; average is 50), equipment and poorly adapted rules for the monitoring and control of thousands of private informal boreholes scattered throughout Lebanon which resulted in anarchic utilization of the ground resource (contamination and increase in salinity of groundwater);

6.3.2 Policies and Legislative Framework

- ***Current policies regarding the water sector***

In 1995, a Damage Assessment Report was prepared to formulate a policy framework for the wastewater sector (Khatib and Alami, 1994). Implemented over three phases, the resulting National Emergency Response Program (NERP) launched two major programs:

- Coastal Pollution Control Program (CPCP); and
- Water Resources Protection Program (WRPP).

Another framework for Mediterranean Sea protection is the Barcelona Convention, elaborated in 1975 by all nations bordering the Sea (except Albania, Algeria and Syria), and consisting of six legal protocols, which, if ratified and implemented, would give the Mediterranean Sea the protection it drastically needs (Greenpeace, September 2000). The six protocols of this convention are respectively: Land-Based Sources (LBS) Protocol, The Dumping Protocol, Protocol Concerning Specially Protected Areas, Offshore Protocol, Hazardous Wastes Protocol, and the Emergency Protocol.

Moreover, despite the cancellation in the late nineties of the World Bank loan to fund wastewater management works in Saida, Sour, and Kesrouan, CPCP is proceeding with alternative funding from various sources. Works under the WRPP include the rehabilitation of water treatment plants and water sources (springs and wells), as well as the rehabilitation and construction of transmission networks (Ecodit, 2001).

- ***National emergency rehabilitation project***

Achievements under the National Emergency Rehabilitation Program (NERP) include the rehabilitation of two wastewater-pumping stations in El-Mina (Tripoli) and Jounieh, and the rehabilitation and construction of 820 km of sewer networks in different areas of Lebanon. The construction and equipping of the first phase of a large-scale wastewater treatment (preliminary treatment) plant in Lebanon was completed in Ghadir, South of Beirut, as well as the rehabilitation of the associated sea outfall. This plant was brought into service in November 1997. NERP also implemented the installation and/or rehabilitation of sewer networks to serve the North Beirut area as well as the northern suburbs of the capital, up to the coastal agglomeration of Dbayeh.

In 2001, the MOE took the lead in setting up a national follow-up committee to look into and facilitate wastewater management works across the country. Hosted by the MOE, this committee is composed of representatives from the CDR, the MOEW, and the MOIM, and holds regular meetings to check on progress and bottlenecks (Ecodit, 2001).

- ***Lebanese legal texts***

Three relevant legal texts regarding wastewater are Decree No. 2761 which dates back to 19 September 1933, and comprises the rules regarding the evacuation of wastewater, Law No. 502 of 6 June 1996 which is concerned with the rehabilitation of wastewater networks and treatment plants, and Law No.221 which integrates the previously 22 Water Authorities into 4 regional Water Authorities and enables the transfer of the responsibility for wastewater collection and disposal from the municipalities to the MOEW. Law No.221 was amended later by Law No.241 of August 2000 and Law No.377 of December 2001. Details of these laws are found in Appendix G.

Decree No.2761 (1933)

Following are its different articles:

Article 1: Wastewater is to be discharged in channels made from impervious materials that are resistant to corrosion.

Article 2: Wastewater from buildings is to be collected in storage reservoirs before being emptied in public sewer lines.

Article 3: The outlets of waste hole effluent should be completely separate from the outlets of household wastewater effluent, though it is possible for both these sources to discharge into a common wastewater way, with the exception of kitchen wastewater discharge.

Article 4: Channels and pipes conveying wastewater from toilets are to be designed in a way that prevents the accumulation of residues, and they are to be aerated continuously and covered to prevent the breeding of flies and mosquitoes.

Article 5: Collecting wastewater or discharging it directly or indirectly into wells, natural or artificial caves, underground zones, near drinking water domains, before taking the appropriate measures to prevent groundwater contamination and health problems are completely forbidden.

Article 6: It is forbidden to discharge directly or indirectly into water channels, rivers, or seawater any substance that may contaminate water used for domestic, agricultural and industrial purposes, or for animal beverage and fish raising.

Article 7: Buildings should have their own sewers that are connected to the public lateral sewers.

Article 8: Individuals or public enterprises should not install their own wastewater channels before getting an approval from the Directorate of Health.

Article 9: When installing new wastewater channels, the following should be taken into account:

1. Different sewers are used: public lateral and sub-lateral sewers as well as building and house sewers that connect residences to public sewers.
2. Sludge treatment equipment is used.
3. A strategy for treated wastewater discharge is adopted.

Article 10: Building owners are responsible for the fees that are necessary for connecting their wastewater pipes to the public sewer while respecting the local laws related to this issue.

Article 11: Industrial wastewater shouldn't be discharged in sewer lines without the permission of the Directorate of Health, and after it is adequately treated.

Article 12: Treated wastewater shouldn't be discharged in water streams, lakes or rivers or used for irrigation purposes unless permitted by the Directorate of Health and Agriculture.

Article 13: Sewer network installation and maintenance, and revenues from this activity can become a source of public or private benefits. However, all steps in privatization are to respect the legal aspect.

Septic Tanks

Article 14: Septic tanks and other similar equipment used for biological treatment of wastewater and sludge digestion are not to be installed or operated if they do not treat adequately wastewater and result in a clear stable and odorless effluent.

Article 15: Septic tanks or any other similar treatment strategy shouldn't be used without the approval of the Directorate of Health.

Article 16: Anyone that would like to install this kind of equipment should get the approval of the Directorate of Health after presenting a complete written and illustrated description of the intended installation, and the size of the population it is going to serve.

Article 17: After examining a proposed project, a pilot plant has to be installed to demonstrate the effectiveness of the strategy that won't be certified before testing the safety of its effluent. The number of people that are served by the plant shouldn't exceed the number defined in the permit. A 'certificate of examination' is given to pilot plants that perform satisfactory treatment.

Article 18: After getting the approval of the Directorate of Health, and before using any treatment equipment, the owners or installers have to present again a copy of the certificate of examination, the plant description map as well as the number of people that will benefit from the plant, and the fate of their treated effluent.

Article 19: The BOD of the treated effluent should not exceed 0.2 g/l of wastewater.

Article 20: The size of a septic tank has to be at least 1 m^2 per 10 persons.

Article 21: Septic tanks and associated equipment outlets should meet the following requirements:

1) They should not cause odors that annoy the residents living in the building or their neighbors.
2) The treated effluent should not contain more than 4 cm of unstable organic matter per liter of wastewater.

Article 22: Building owners are allowed to install common septic tanks serving an entire block.

Article 23: The expenses of the installation of septic tanks and sedimentation tanks are to be controlled by the Directorate of Health.

Article 24: If health inspectors find that equipment has to be fixed, the Directorate of Health gives a one-month delay to the owner to fix the problem.

Ponds

Article 25: These should be installed underground. The covering layer should be formed by at least 40 cm of impervious material. Moreover, these ponds should be well aerated.

Article 26: When the ponds are constructed in rocks, the thickness of the impervious walls should not be less than 45 cm; in the case of cement walls, only 15 cm thick walls are enough. Walls and ceilings are to be lined adequately to prevent leakages.

Article 27: The pond shouldn’t be divided into compartments. Building foundations shouldn’t pass through these ponds.

Article 28: The size of the pond has to be designed following specific criteria.

Article 29: The height of the pond is not less than 2 m, and the opening of the pond from which water is extracted should have a length of 1 m and a width of 65 cm, and it should have a tight cover.

Article 30: Any pond that is leaking from the bottom or from the walls has to be fixed.

Article 31: Ponds have to be emptied once a year during winter; and collected sludge has to be disposed of according to local laws. The pond owner himself finances this operation.

Article 32: The pond technique has to be applied in all regions that do not have any treatment plants or septic tanks.

Article 33: Any pond that does not respect the previously defined properties has to be covered with at least 40 cm of impervious material.

Article 34: Ponds are to be removed or forbidden in drinking water regions, or if there is proof of the occurrence of groundwater contamination.

Article 35: Any violation of this decree is punished according to the legislative decree No. 118 of 21/9/1933.

Article 36: Enactment of the present law will become effective immediately after its publication in the Official Gazette.

Law No.221 (2000)

In May 2000, the parliament approved on a new law: Law No. 221 "Organization of the Water Sector" (corrected by Law No. 241 in August 2000, and later by Law No. 377 in December 2001). Article 2 of Law No. 221 describes the competencies and missions of the Ministry of Water and Energy (new name of the MHER). Article 3 dictates the creation of 5 Water Exploitation Public Establishments, the duties and competences of which are defined in Article 4.

Article 2: Ministry of Water and Energy

1. To collect, control, meter, establish statistics and study water resources and evaluate water demand by each sector.
2. To control surface water and ground water quality and identify standards to be met.
3. To establish the General Planning Project for hydraulic resources allocation, to prepare the National Water and Wastewater general master plan and update it continuously, and submit it through the Minister to the Council of Ministers to be approved.
4. To design, study, and implement the large water installations and works such as dams, artificial lakes, water networks…and to operate them.
5. To implement, when needed, artificial recharge of underground water reservoirs and to control underground water extraction.
6. To protect water resources from losses and pollution by elaborating legal texts and taking necessary measures and dispositions to avoid water pollution, as well as to bring these water resources back to their former natural quality.
7. To give licenses and permits for public water usage and temporary occupation of public properties, and to finalize all the necessary formalities according to the laws and by-laws in force.
8. To implement studies, and hydraulic, geological and hydrological researches, to collect technical data relevant to hydraulic matters, to establish technical maps concerning these studies, and to update them regularly.

9. To carry out control and tutelage over Public Establishments and other bodies operating in the water field, according to the present law dispositions, texts and stipulations relevant to each of the aforementioned establishments and institutions.
10. To ameliorate performances of the Water Exploitation Public Establishments (WEPEs) and to evaluate their performances on the basis of indicators mentioned in the action plans, which have been approved according to the legal procedures.
11. To establish standards to be adopted in the studies conducted by WEPEs as well as in their works implementation. To establish conditions and regulations for surface and underground water extraction and use, and their quality standards and control.
12. To prepare and carry out expropriation formalities relevant to the MHER and WEPEs submitted to its tutelage according to the laws and regulations in force.
13. To express a technical opinion on the licenses and permits for quarries and mines concerning their impacts on water resources.
14. To provide and strengthen public relations with the population and to inform the people of all necessary information concerning the water matters and to provide adequate orientation toward rational usage.

<u>Article 3</u>: Water Exploitation Public Establishments (WEPEs)

WEPEs will be created and named:

1. Beirut-Mount Lebanon water establishment – main office: Beirut;
2. North Lebanon water establishment – main office: Tripoli;
3. South Bekaa water establishment – main office: Zahle;
4. North Bekaa water establishment – main office: Baalbeck;
5. South Lebanon water establishment – main office: Saida.

These mentioned Establishments will have the status of moral person and operate in as administrative and financial autonomy; their operating perimeter is fixed in the map attached to the present Law.

This article was corrected later by Law No.241.

<u>Article 4:</u>

1) Duties and competences of each water establishment within its exploitation perimeter are:
   a) To carry out studies, implementation, operation, maintenance and renewing of projects for drinking and irrigation water distribution within the frame of General Water Master Plan or according to Ministry’s permit to use public water resource;
   b) To propose drinking and irrigation water services tariffs taking into consideration general socio-economic conditions of the country.
   c) To control drinking and irrigation distributed water quality

2) Water Establishment will operate under their own regulations. An independent auditor shall be appointed to control the accounts.

The above mentioned establishments will hire the services of an audit company responsible for the preparation of a report on the financial status and closing accounts as well as on the internal regulatory system applied in the establishment.

Article 8:

Actual water autonomous authorities and committees will continue to manage drinking and irrigation water, to accomplish their functioning works until their merging to form WEPEs.

Mount Lebanon and North Lebanon water establishments are responsible for drinking water, wastewater and irrigation, while Bekaa and South Lebanon water establishments are responsible for only drinking water and wastewater; irrigation will be left under the jurisdiction of the Litani River Authority in Central and South Bekaa and South Lebanon.

Law No. 241(August 2000)

Article 3 of the Law No. 221, dated on May 29th, 2000 (Organization of the Water Sector) is corrected and its text will be read as following:

Article 3: Water Exploitation Public Establishments (WEPEs)

WEPEs will be created and their names and main offices will be as following:

1. Beirut-Mount Lebanon Water Establishment – main office: Beirut;
2. North-Lebanon Water Establishment – main office: Tripoli;
3. Bekaa Water Establishment – main office: Zahle;
4. South-Lebanon Water Establishment – main office: Saida.

These mentioned Establishments will have the status of moral person and operate in as administrative and financial autonomy; their operating perimeter is fixed in the map attached to the present Law.

Law No. 377 (December 2001)

This law corrected articles 2, 4, 5 of law No. 221 and the attached map that describes the operating perimeter of WEPEs. Following are the corrections brought to articles 2 and 4.

Article 1: Are canceled paragraphs 3 and 11 of the Article 2 of the Law 221 dated on May 29th, 2000 corrected by the Law No. 241 dated on August 7th, 2000 concerning the Organization of the Water Sector. They will be replaced by the following text:

Paragraph 3 (New): to establish the General Planning Project for hydraulic resources allocation, reparation among drinking and irrigation water usage on the national level as well as to prepare the National Water and Wastewater General Master Plan and update it continuously, and submit it through the Minister to the Council of Ministers to be approved.
Paragraph 11(New): to establish standards to be adopted in the studies conducted by Water Exploitation Public Establishments as well as in their implementation; to establish conditions and regulations for extraction and use of surface water and management of wastewater, and their quality standards and control.
Article 2: Are canceled subparagraphs a, b, and c of the first paragraph of Article 4 of the Law No. 221 dated on May 29th, 2000 corrected by the Law 241 dated on August 7th, 2000 concerning Water Sector Organization. They will be replaced by the following new texts:

a) To carry out studies implementation, operation, maintenance and renewing of projects for drinking and irrigation water distribution as well as wastewater collect and treatment within the frame of General Water and Wastewater Master Plan or according to Ministry's permit to public water resources or to the Ministry's choice of the emplacements of wastewater treatment plants or new outlets for wastewater effluents evacuation.
b) To propose drinking, irrigation water and wastewater services tariffs taking into consideration general socio-economic conditions of the country.
c) To control drinking and irrigation distributed water quality as well as wastewater and wastewater treatment plants outlet.

<u>Law No. 502 (1996)</u>

Following are its different articles:

Article 1: The permission for the government to make a contract to rehabilitate drinking water networks and sewer networks - 2nd phase.

Article 2: This law becomes active the minute it is published in the Official Newspapers.

The Environmental Limit Values (ELV) for wastewater discharged into surface water, where surface water is defined as inland water permanently or temporarily flowing in beds or flowing quickly from springs are provided in Table 3. A minimum flow of 0.1 m^3/s needs to be guaranteed when discharging. Column 1 (Appendix I) shows the regulated pollution parameters, column 2 gives the emission limit values for existing facilities and column 3 for new facilities. Emission limit values of column 2 will automatically expire when the Barcelona Convention Protocol is ratified by the Republic of Lebanon. In this case the emission limit values of column 3 will become automatically valid for all kind of facilities.

Table 3: Environmental Limit Values for Wastewater Discharged into Surface Water

1	2	3
Parameter	***ELV for existing facilities***	***ELV for new facilities***
pH	5-9	6-9
Temperature	30ºC	30ºC
BOD5 mg/l	100	25
COD mg/l	250	125
Total Phosphorus mg/l	16	10
Total Nitrogen mg/l	40	30
Suspended Solids mg/l	200	60
AOX	5	5
Detergents mg/l	3	3
Coliform Bacteria/100ml	2,000	2,000
Salmonellae	Absence	Absence
Hydrocarbons mg/l	20	20
Phenol index mg/l	0.3	0.3
Oil and Grease mg/l	30	30
Total Organic Carbon mg/l	75	75
Ammonia mg/l	10	10
Ag mg/l	0.1	0.1
Al mg/l	10	10
As mg/l	0.1	0.1
Ba mg/l	2	2
Cd mg/l	0.2	0.2
Co mg/l	0.5	0.5
Total Cr mg/l	2	2
Hexavalent Cr mg/l	0.5	0.2
Cu mg/l	1.5	0.5
Fe mg/l	5	5
Hg mg/l	0.05	0.05
Mn mg/l	1	1
Ni mg/l	2	0.5
Pb mg/l	0.5	0.5
Sb mg/l	0.3	0.3
Sn mg/l	2	2
Zn mg/l	5	5
Active Cl_2 mg/l	1	1
Cyanides mg/l	0.1	0.1
Fluoride mg/l	25	25
Nitrate mg/l	90	90
Phosphate mg/l	5	5
Sulphate mg/l	1,000	1,000
Sulphide mg/l	1	1

* Source: Taken as is from MOE, SPASI, 2001

6.4 MOROCCO

6.4.1 Institutional framework

At institutional level, water management is a shared responsibilty between the Ministry of Equipment (for resources mobilization, management and planning), the Ministry of Agriculture (which is the principal consummer and manager of the wetlands) and the Department of the Environment (which is responsible for the development of laws and standards with regards to discharges). The institutional framework consists of the foloowing bodies:

Advisory authorities
- Higher Council of Water and Climate
- National Council of the Environment
- Prefectorial and Provincial Commissions of water

Administrative authorities
- Ministry of Health
- Ministry of Equipment
  - National Office of Drinking Water
  - Basin Agencies
  - Directorate of Meteorology
  - Directorate General of Hydraulics
- Ministry of Interior
  - Directorate General of Local Communities
  - Directorate of Control and Conceded Services
  - Water Services
- Ministry of Agriculture and Rural Development
  - Administration of Rural Engineering
  - Directorate of Waters and Forests
  - Regional Offices of Agricultural Development
- Ministry of Energy and Mines
  - National Office of Electricity
- Secretariat of State of the Environment
- Ministry of regional planning, the water and the environment

Actors in local level
- Local Communities
- Consummers Associations

On the administrative level, the General Directorate of Hydraulics (DGH), a department of the Ministry of Public Works, is in charge of the water resources management.

In fact, the policy elaborated by DGH is implemented by the Regional Directorates of Hydraulics (DRH). The production of drinking water, up to 80% of the total, is the responsibility of the National Office for Drinking Water (ONEP), a public institution which is financially independent and under the supervision of the Ministry of Equipment.

The remaining 20% is the responsibility of the "*Régies autonomes de Distribution*", which are also in charge of the distribution of water in the whole country.

Various communities and companies are also involved in water distribution. This is particularly the case in Casablanca (Lydec), Rabat (Redal), Tangier and Tétouan (Vivendi).

A high percentage of citizens in urban areas are connected to the water network. However, in rural areas, this percentage was much lower (14% in 1990), but it constantly increases (40%) thanks to specific programs adopted by the national authorities, such as the "Program for the Supply of Drinking Water to the Rural Populations" (PAGER).

Everything that is related to the irrigation policy is the responsibility of the Administration of the Agricultural Engineering under the supervision of the Ministry of Agriculture and Rural Development.

The importance of agriculture for the Moroccan economy and the irregularity of the precipitation in Morocco make irrigation an essential component of the agricultural policy.

The Regional Offices of Agricultural Development (ORMVA) and the Provincial Directorates of Agriculture are in charge of the implementation of the water policy in the agricultural sector.

- Institutional Aspect of the Administration of Water Purification in Morocco

The Ministry of the Environment (ME)
This institution is responsible for the protection of the environment in general and particularly the protection of the natural resources. This Ministry provides technical assistance in aid of the local communities for which water treatment is a principal component.

The Local Communities (CL)
The Communal Charter of September 30, 1976 assigns to Local Communities the management of public services including liquid treatment.

Ministry of the Interior
While administratively supervising the local communities, this department plays an important role regarding wastewater management through the General Directorate of the Local Communities (DGCL) and the General Directorate of Urbanism, Architecture and Regional Planning (DGUAAT).

Ministry of Public Health

It contributes to the protection of public health by preserving the hygiene of the habitat and the public health.

Ministry of Agriculture and Rural Development

With a long experience in the protection of the rural environment, particularly before the decentralization policy, is in charge of wastewater treatment and agricultural reuses through the ORMVA.

Ministry of Equipment (ME)

Being in charge by the State to manage the hydraulic sector, this department deals with questions of water treatment due to the research activities it performs in the field of water protection and management.

Basin Agencies

Decentralized organs for water management, these agencies have obvious interactions with regards wastewater management.

National Office of Drinking Water (ONEP)

Responsible for drinking water conveyance, distribution management within the communities and monitoring of wastewater that is likely to be used for human consumption. At this moment, ONEP is also in charge of the cleaning up of certain rural centers.

Other administrative authorities

* National Council of the Environment (CNE): Created in 1980, is an independent consultative authority in matters of environmental protection. It was re-energized by the creation of the Ministry of the Environment. It currently has departments at regional and local level

* The Higher Council of Water Climate (CSEC): Created in 1981 by royal decision, it was institutionalised recently by a Decree and reassembles all authorities concerned with water management and the climate.

Role of the Ministry of regional planning, the water and the environment

This institution, which is in charge for the constant monitoring of the state of the environment so as to ensure sustainable development, has initiated a medium (2005) and long (2020) term policy, based on the quality objectives, with the setting up of four priorities:

- Water
- Solid waste
- Air pollution
- Soil

In addition, the Ministry of the Environment is in charge of determining the quality standards for wastewater. The standards are elaborated through the Committee "Norms and standards" of the National Council of the Environment.

This department is also in charge of the institutionalization of the Environmental Impact Assessment through another Committee descending from the CNE. Concerning wastewater management, this department implemented, in collaboration with the ONEP, the study of the environmental impacts of the 2nd project of treatment.

6.4.2 Policies and Legislative Framework

- **Organisation of the water policy**

In 1995, Law No10/95 which came into force established the legal framework of the national water policy for the next decades. This law includes a series of legal instruments aiming at dealing with the problems of the deficiency of water resources, the increasing water demand, the rise of the water price and the degradation of the environment and the water recipients.

The major principles of this law are in brief the following: (a) water is a state-owned property; (b) water has an economic value and (c) the necessity to accomplish solidarity at all levels (national, regional and local) regarding water management after national dialogue.
This dialogue was materialized by the creation of three organizations, namely the Higher Council of Water and Climate (CSEC), the Basin Agencies (AdB) and the Prefectorial and Provincial Commissions of Water.

The CSEC is a discussion forum where the national water policy is analyzed and the basic outlines of the future policy are determined.

The AdB, probably the most innovative feature of the Water Law, supplements the administrative organization of the water sector in Morocco. While playing an important role in the decentralization of the water management, they are the link between all actors playing a role in the decision making.

- Description of socioeconomic instruments applied aiming at the sustainable wastewater treatment, disposal and reuse

The Communal Charter of 1976 assigns the communities the responsibility of water management and treatment.
According to Law No 10-95, the CSEC is in charge of establishing the general directions of the national water policy.
The objectives regarding wastewater are:

– Until 2005 and 2015, 90% and 95 respectively of the wastewater generated must enter the wastewater treatment network.
– The provision of all principal urban centres with wastewater treatment plants equipped with at least primary treatment before 2005
– Construction of complementary installations to perform secondary and tertiary wastewater treatment from 2005 to 2015.

- **Description of the legislative framework**

Quality Standards for water to be used for irrigation: **Joint Decision of the Ministry of Equipment and the Ministry of Urban and Regional Planning, the Habitat and the Environment No 1276-01 of October 17, 2002 which establishes the quality standards of water that is to be used for irrigation**

Art.2
Any water that is going to be used for irrigation must comply with the quality standards found in the table joined in the present Decree.

However, the Basin Agencies can, if the available water resources are insufficient, permit the use in irrigation of water which does not comply with the limit values of the aforementioned table in terms of salinity, toxic ions and various parameters (see table).

Art.4
For the provision of authorization for the use of wastewater in accordance with the Decree No 2-97-875 of February 4, 1999, the Basin Agencies must conform to the following criteria:

Table 4: Use of wastewater criteria

CATEGORY	CONDITION FOR REALISATION	EXPOSED GROUPS	INTESTINAL NEMATODES i[*] [arithmetic mean (average) of the number of eggs per liter]	FECAL COLIFORMES [geometric mean of the number per 100 ml] ii[+]	TREATMENT PROCESS FOR WASTEWATER Capable of ensuring the required microbiological quality
A	Irrigation of cultures to be consumed raw, sport fields, parks iii[+].	Farmers Public Consumers	Absence	≤ 1000 (d)	A series of stabilization tanks designed to obtain the desired microbiological quality or any other equivalent treatment.
B	Irrigation of cereals, industrial crops, fodder crops, pastures and tree plantations iv[§].	Farmers	Absence	No standards is recommended	Retention in the stabilization basin for 8-10 days or any other process which allows an equivalent elimination of the helminths and the fecal coliformes.
C	Local irrigation of cultures of category B if the farmers and	None	Without object	Without object	Preliminary treatment according to the irrigation

	public consumers are not exposed to it				technique, but at least primary decantation

i[*]Ascaris, Trichuris (whipworm) and Ankylostoma
ii[+] During the irrigation period
iii[+] A strict directive (<200 fecal coliformes per 100ml) is justified for lawn with which the public can have a direct contat
iv[§] In the case of fruits trees, the irrigation must be stopped two weeks before harvest and no fruit that has fall down must be collected. Irrigation by spraying is prohibited.

Table 5: Quality standards of water in order to be used for irrigation

	Parameters	**Limit values**
	BACTERIOLOGIC PARAMETERS	
1	Fecal coliforms	1000/100 ml*
2	Salmonella	Absence in 51
3	Bacterium of cholera	Absence in 450 ml
	PARASITOLOGIC PARAMETERS	
4	Pathogenic parasites	Absence
5	Eggs, Cysts of parasites	Absence
6	Larvae of Ankylostomides	Absence
7	Fluococercaires of *Schistosoma haemotobium*	Absence
	TOXIC PARAMETERS (1)	
8	Mercury (Hg) in mg/l	0,001
9	Cadmium (Cd) in mg/l	0,01
10	Arsenic (As) in mg/l	0,1
11	Total Chrome (Cr) in mg/l	0,1
12	Lead (Pb) in mg/b	5
13	Copper (Cu) in mg/l	0,2
14	Zinc (Zn) in mg/l	2
15	Selenium (Se) in mg/l	0,02
16	Fluorine (F) in mg/l	1
17	Cyanide (Cn) in mg/l	1
18	Phenols in mg/l	3
19	Aluminum (Al) in mg/l	5
20	Beryllium (Be) in mg/l	0,1
21	Cobalt (Co) in mg/l	0,05
22	Iron (Fe) in mg/l	5
23	Lithium (Li) in mg/l	2,5
24	Manganese (Mn) in mg/l	0,2
25	Molybdenum (Mo) in mg/l	0,01
26	Nickel (Ni) in mg/l	0,2
27	Vanadium (V) in mg/l	0,1

*1.000 CF/100 ml for cultures intended for raw consumption
Controls are to be performed only if the concerned water is likely to come in touch with wastewater

Parameters		Limit values
PHYSICO-CHEMICAL PARAMETERS		
28	Total salinity (STD) mg/l*	7680
	Electric Conductivity (CE) mS/cm à 25°C*	12
29	Infiltration Le SAR** = 0 - 3 et CE = 3 - 6 et CE = 6 - 12 et CE = 12 - 20 et CE = 20 - 40 et CE =	 <0,2 <0,3 <0,5 <1,3 <3
TOXIC IONS (affecting sensible cultures)		
30	Sodium (Na)	
	.Surface Irrigation (SAR*)	9
	.Irrigation by spraying (mg/l)	69
31	Chlorine (Cl)	
	.Irrigation de surface (mg/l)	350
	.Irrigation by spraying (mg/l)	105
32	Boron (B) (mg/l)	3
VARIOUS PARAMETERS (affecting sensible cultures)		
33	Temperature (°C)	35
34	pH	6,5-8,4
35	Suspended solids in mg/l Gravitational irrigation Local irrigation and irrigation by spraying	 2.000 100
36	**Nitrates** (N-NO_3) in mg/l	30
37	Bicarbonate (HCO_3) (Irrigation by spraying mg/l)	518
38	Sulfates ($\mathbf{SO^{2}}{}_{\cdot 4}$) en mg/l	250

* If electric conductivity exceeds 3mS/cm, severe restrictions are applied to water when it is to be used for irrigation, but the 50% of the potential yield can be irrigated with water of 8,7 mS/cm (in the case of barley).

* SAR = Sodium absorption ratio (coefficient of sodium absorption)

CE = Electric Conductivity.

- Description of the licensing procedure

Definitions:

Environment: All the natural and artificial elements, as well as the economic, social and cultural factors which are essential for the existence, transformation and development of the habitat, living organisms and human activities.

Environmental Impact Assessment: The document required in order to obtain administrative authorization to proceed with activities, works, industrial, agricultural or commercial facilities and plants. This document allows the evaluation of the direct and indirect effects of the aforementioned actions in the environment in short, medium and long term and facilitates the proposal of measures which shall eliminate, attenuate and compensate the negative impacts of them in the environment. The study of the environmental impacts aims also at informing the public for the impacts of the planned actions.

Article 2
Any activity, work, installation or plant which is to be implemented by any private or public person or entity and which can cause, due to its size or nature, damage to the environment must be the subject of an Environmental Impact Assessment.

Article
The procedure of an Environmental Impact Assessment includes their mandatory public announcement. However, the activities, works, facilities or installations which are included in Article 2 of the present Law and which are the object of a public investigation under other legislative texts are excluded from this article. The conditions for the application of such investigation are legislatively specified.

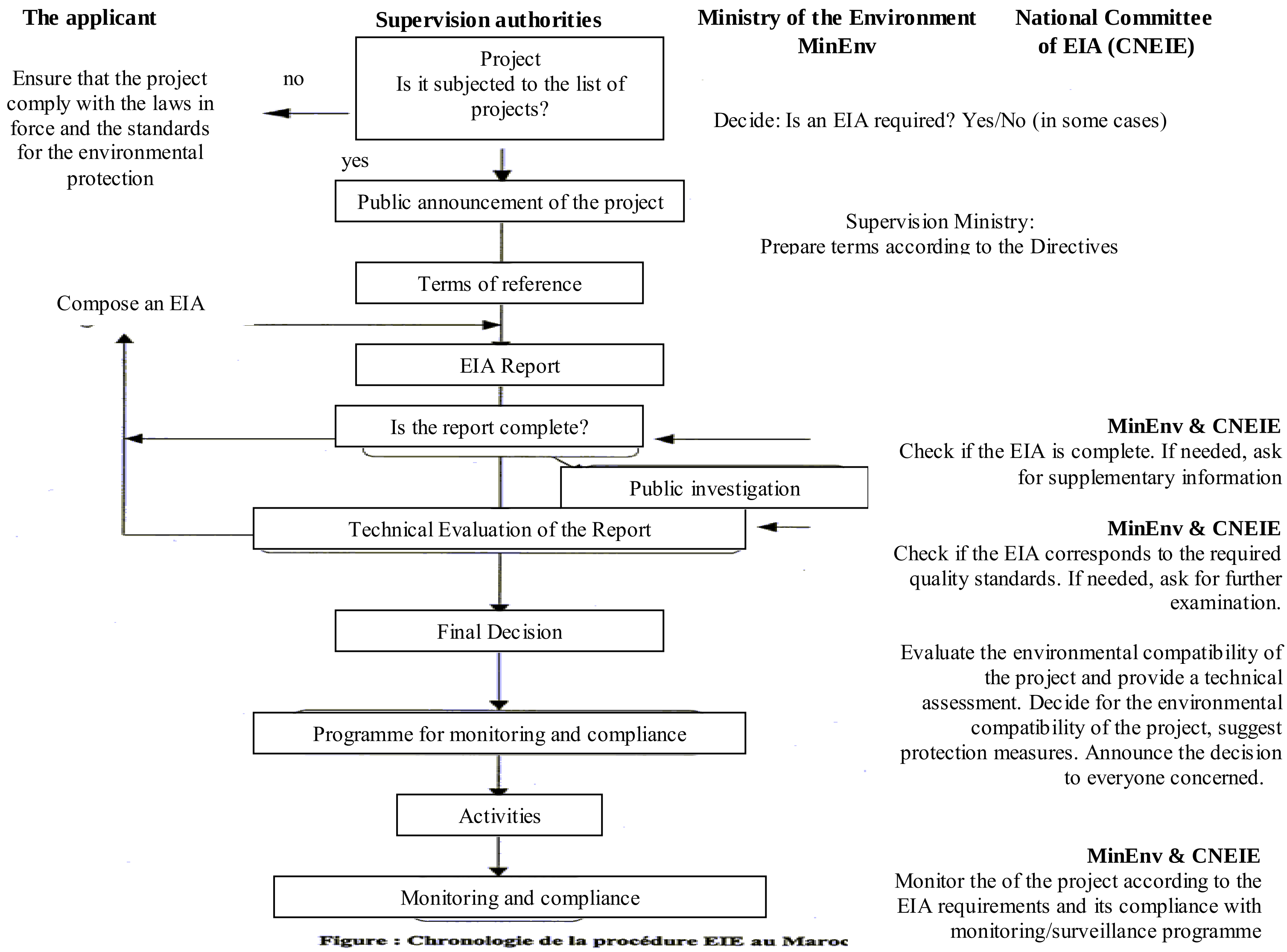

Figure 1: The procedure of EIA in Morocco

6.5 PALESTINE

6.5.1 Institutional framework

Several ministries and authorities are involved in water quality management including planning, development, source protection, monitoring, research and regulation. The following institutions are the main actors that either produce regulations or follow them regarding the water and its management and development. The main ministries and authorities are:

- The Palestinian Water Authority (PWA)
- The Ministry of Planning
- Environmental Quality Authority (EQA)
- Ministry of Agriculture
- Ministry of Local Government
- The Municipalities and the Village Councils
- Ministry of Health
- Coastal Municipal Water Utility

The Palestinian Water Authority (PWA) is responsible for strategic planning, licensing, monitoring … etc. The "water management contract" project, which started in Sept 1996 with PWA as the implementing agency aims at organizing the water supply and service delivery into a utility, which eventually may be established as an autonomous body. The utility will be formed from the municipalities and will be managed by a board of the mayors of municipalities, assisted by technical managers. The water facilities will be owned by the utility. The utility will deal with water production, water supply, water treatment and quality improvement.

The Ministry of Planning was established in 1994. The Ministry is concerned with the physical and strategic planning for rural and urban areas. It is involved in national development plans for medium and long term and with international cooperation and coordination. The development objective of the Ministry was to institutionalize the strategic planning process at the national level and support the participation of the ministries and agencies of the Palestinian National Authority in the preparation and implementation of the three and five years plans.

Environmental Quality Authority *(EQA)*, the prime responsibility of EQA is to promote sustainable development of the Palestinian society. Its main task is to protect the environment, including its water, soil, air, natural resources, nature and bio-diversity, and to prevent public health risks related to environmental issues. EQA does not bear the sole responsibility for the environment. Other authorities, ministries and municipalities, as well as the private sector share it. EQA is responsible for giving environmental approval for water projects. EQA is also responsible for following up the Environmental Impact Assessment or Initial Environmental Examinations of these projects. In addition, EQA, in cooperation with other concerned institutions, is responsible for setting water quality standards, increasing public awareness in the water sector, protection of water resources, and setting the required regulations.

Ministry of Agriculture (MoA) has a general directorate comprising five departments and one unit working with policies, planning and development. The other eight general directorates work with agricultural production research, publicity, forestry, fisheries, veterinary services, plant protection, irrigation and administration/finance. MoA has a well-developed water section including a wastewater engineer to follow up the activities related to wastewater. MoA has developed a number of project ideas for effluent reuse and are ready to develop these ideas further into detailed project proposals, based on the available funds. Also the ministry has a water laboratory for monitoring of the quality of irrigation water.

Ministry of Local Government (MoLG) is assigned responsibility for the local government system and has been actively engaged in defining the structure of local government, the institutional arrangements and the key organizations at the various levels and the role and functions at these levels. In November 1996, a new intermediate organization (governorate) was introduced to coordinate the central government with municipalities and villages. The ministry also supervises the works of the municipalities for all infrastructures works including water, sewage and drainage.

The Municipalities and the Village Councils are responsible for providing the public with water supply. In the areas where there is a collection system, the municipalities are also responsible for the wastewater services as well. The legal system is very complicated because of the different influence from the Ottoman Empire, the British mandate, the Egyptian Administration and the Israeli occupation. Individuals and municipalities could hold water rights. The institutional capacity for the municipalities is weak. The weakness is due to the following two reasons: the weak organizational structure and the weak human resources. In large municipalities, the structure gets more complicated to accommodate the need of the population, since all large municipalities are urban areas. The small villages have simple structures, since most of these villages are agricultural villages.

Ministry of Health (MoH): The development objective of Ministry of Health is to improve preventive and curative health care for the entire Palestinian population. It is responsible for domestic sources of pollution. MoH in collaboration with other ministries is responsible for increasing the awareness of the public towards the environment. Drinking water quality monitoring and its health impact is the major responsibility of the Ministry of Health.

Coastal Municipal Water Utility (CMWU)

The CMWU will be formed in Gaza Strip and will perform the following tasks:

1- Design, construction, operation and maintenance of water services including facilities for wastewater collection and treatment for recharge and irrigation.

2- The CMWU is local government owned, with community representation on the board. It will be administratively autonomous, although tariffs will be reviewed and water abstraction and discharge will be licensed and monitored by PWA.

Other Institutions:

- UNRWA (United Nations Relief and Work Agency) has by capacity and resources maintained a role in the sectors of water, wastewater and environmental protection in the Gaza Strip. In order to strengthen the agency’s approach to the problems of water supply, sewerage, surface water drainage and solid waste disposal, UNRWA established a Special Environmental Health Program (SEHP) to improve the overall health conditions in the refugee camps and their surroundings. The activities in SEHP have in the latest years turned from mainly feasibility studies to more design, planning and implementation. UNRWA is used by a number of donors for projects over the whole Gaza Strip, mostly within the refugee camps.

- NGOs: Many Non-Governmental Organizations are working in Palestine in the field of water projects and research. The NGOs may work directly with people to improve their water and wastewater services especially in rural areas. Large-scale projects are coordinated with the municipality or the relevant ministries. Some of the NGOs projects have to do with public awareness campaigns and sanitation.

6.5.2 Policies and Legislative Framework

EQA, PWA, other authorities, ministries and municipalities, the private sector, share responsibilities with respect to the water/wastewater quality management issues. A number of Ministries and Authorities were established with specific mandates. Several laws that touch on sustainable development of water resources issues are either passed the PLC and in the process of enactment or still debated in the PLC. The draft Water Law, which is being debated in the Palestinian Legislative Council for the third and the final reading, confirms and assures the optimal utilization of water resources. In December 1999, the Environmental Law was endorsed by the Palestinian Legislative Council and approved by his Excellency the President Yaser Arafat. The Environmental Law is clear in assigning tasks and responsibilities to EQA and other agencies, without creating duplication of tasks, or interfering with other activities. A number of principles and guidelines have been defined in the Environmental Law, which form the basis for environmental legislation, decisions, and structures of environmental institutions.

The main responsibilities of EQA are in the field of planning, developing standards, norms and guidelines, development of environmental legislation and environmental policy, Environmental Impact Assessment (EIA), monitoring, licensing and enforcement and public awareness and training. The prevention of pollution at source, the precautionary principle and the prior licensing of wastewater discharges by competent authorities have become key elements of successful policies for preventing, controlling and reducing inputs of hazardous substances, nutrients and other water pollutants from point sources into environment. In the previous two years, the Environmental Quality Authority in cooperation with the competent ministries working in water sector takes some actions to prevent and control the water pollution. Accordingly, the ministry has prepared draft regulations and standards for different themes with regard to water pollution control. Regulations and standards prepared pursuant to the environmental law and related to water pollution control include: Drinking water quality standards, wastewater reuse standers and its executive list, standards of wastewater discharge to the sea, discharge of industrial sewage into the sewage system.

One of the most important targets of EQA is to protect the quality of the water resources in order to be suitable for the desired or designated uses of water. Also one of the most important policies of PWA is the endurance of protection and pollution control of water resources. Water resources must be developed and managed efficiently in order to meet present and future water needs, in an environmentally sustainable manner. Wastewater reclamation and reuse, desalination and storm water recharge together with renewable aquifer capacity will provide quantity of water that would satisfy water demands for the next 20-years. However, comprehensive aquifer protection is necessary to maintain its sustainable capacity. Certain aspects of water demand management and water quality management should be considered to support management of the aquifer at its sustainable capacity. The Palestinian Water Authority (PWA) has considered the following three principal objectives for sustainable water resources management:

- Provide quantity and quality of water for domestic purpose in compliance with WHO standards.
- Supply adequate quality and sufficient quantity of water that is required for the planned agricultural production in Gaza Strip.
- Managing the aquifer at its safe yield and preventing further deterioration of the aquifer water quality.

Successful implementation of those issues will be able to maintain water balance and prevent further deterioration of the aquifer. In parallel, clear and precise legislation and strict water sector implementation policies are must for successful implementation.

- ***Socio-economic Instruments***

Palestine as a typical Mediterranean country consists of the West Bank and Gaza Strip, those two parts of the Historic Palestine, which were occupied by the Israeli army since 1967 and still parts of them under Israeli authority's control. Today, Palestine is inhabited by almost 3.5 million people living in an area of about 6020 km^2. About 60% of the population is living in small rural communities. The first priority of the Palestinian water policy is to improve the water and sanitation infrastructures in rural Palestine, where the poor rural communities are neglected and the development of water supply and sanitation services might come first by the year 2015. In urban Palestine, about 24 % of the total population is served by a central urban sewerage system, while only 5% of the collected municipal wastewater experienced partial treatment.

Lack of effective planning in water and sanitation infrastructures in rural communities has led to poor environmental health, ineffective wastewater treatment, exacerbated by under-funded national institutions and lack of skilled staff and appropriate management and coordination.

Though Palestine does have water policy and environmental law, however, these were developed in response to and under the pressure of donor and regional agreements. Most of newly erected water and sanitation facilities were donor initiated. Even those old and overloaded urban sewage treatment facilities, built in the past, were erected to serve the

Israeli environmental policy and not according to the needs of the Palestinian people, i.e. to preserve the natural resources and protect the aquatic environment.

If untreated wastewater is allowed to accumulate, the decomposition of the organic materials it contains can lead to the production of large quantities of malodorous gases. In addition, untreated wastewater usually contains numerous pathogenic, or disease-causing microorganisms that dwell in the human intestinal tract. Wastewater also contains nutrients, which can stimulate the growth of aquatic plants, and it may contain toxic compounds.

Huge amounts of wastewater are generated everyday; about 80-85% of the water used in houses is discharged in the form of wastewater. In Palestine, which is characterized as a semi-arid area with limited high quality water resources, the conservation and reuse of water has become essential. The major reason is that the demand for water has reached the limits of available water, along with an increased withdrawal of fresh water from natural resources. Therefore, the necessity arises to locate and examine alternative water sources. Reuse of treated wastewater, mainly for agricultural irrigation, is an attractive option for environmental and ecological considerations since it solves both pollution and water-shortage problems (Oron 1994). The main advantage of effluent application for agriculture is its high nutrient content, so that only minor quantities of additional fertilization are required, all of which can be used economically for agriculture (Asano 1988; Bouwer 1987; Asano et al.1992).

However, an obstacle that faces potable water reuse projects is public acceptance, making public education programs vital. On the other hand, non-potable reuse for urban, industrial, and agricultural purposes is widely accepted and engenders public enthusiasm as being environmentally appropriate (Okun 1991).

During the last few years after signing the peace agreement between Palestinians and Israelis in 1991, West Bank growth has accelerated due to the implementation of new development plans. This was demonstrated by a sudden increase in population number due to the Palestinian returnees, a steady growth in population of those who are living in Palestine, in addition to rapid expansion of commercial, industrial and agricultural activities. These continuous activities posed a significant strain and an increasing demand for basic facilities such as supply of clean water. Keeping in mind that ground water is the only source of fresh water in Palestine, this will cause tension in the future development of this country, as there is intense competition for the resource with Israel.

In Palestine, all research activities have been directed towards the health and environmental implications of reusing treated wastewater, but virtually no attention has been given to public opinion, awareness, and attitudes toward the use of reclaimed wastewater. Therefore, Palestinian Environmental Authority (PEnA) EQA now, conducted a survey to learn how well public at large accepts the use of treated wastewater.

- **Licensing Procedure**

PWA, as the agency responsible for improving water resources management, has a department for licensing water wells used for municipal, agricultural and industrial purposes. The client must apply an application for digging a well and the application is reviewed by a specialized committee consisted of hydrologist, agronomist water quality specialist where this committee has a certain criteria for giving the permit, this may include the number of people served, the area to be irrigated, etc.

For water reuse, currently no official licensing procedure is followed at PWA since the treated wastewater effluent from the treatment plants is not safe enough to be used. On the other hand, EQA has drafted a standard for treated wastewater to be used for agriculture, discharge to receiving water and wastewater discharged from industrial facilities.

- **Standard limits for wastewater reuse**

The newly issued Palestinian Environmental Law aiming at the improvement of aquatic environment imposes stringent penalties for polluters. However, regulations for effluent quality standards for sewage works, industrial discharges, and wastewater reuse have been drafted (EQA, 2001).

The overall objective of these standards is to encourage the safe use of wastewater and bio solids in agriculture and aqua-culture in a manner that protects the health of the workers involved and of the public at large.

These standards were drafted by an inter-ministerial technical committee taking into consideration the public health, economical reality and international standards. Microbiological, physical, chemical, heavy metals, pesticides, and radiation parameters were specified and given national maximum allowable limits for each standard.

Indeed, relative to its size and means, Palestine has devoted more effort to wastewater reuse. This has been reflected by the attention paid by various governmental and NGO's for wastewater effluents reused for agricultural irrigation.

The use of treated wastewater in agriculture can both serve the agricultural sector's demands for water and constitute a sustainable way of disposing wastewater to the environment. Pre-conditions for the success of the scheme are the proper treatment of wastewater according to its use and perfect management of its distribution, experts stressed. "It is very important to reuse wastewater after treatment for two reasons. The first one is environmental; the treatment of wastewater will minimize the impacts [improper disposal] on the environment. The other thing is to use it as a resource in agriculture.

1. Standards for the disposal of domestic effluents in the sea within National Waters (Disposal at 500m off the coast)

Discharging is the direct conveyance of wastewater into a water body, into the sewerage system or into the sea. This standard relates to the allowable limits being discharged to the sea (Table 6).

2. Wastewater reuse for restricted, unrestricted irrigation

Properly planned and managed wastewater use schemes can have a positive environmental impact, as well as increasing agricultural and aqua-cultural yields. Environmental improvement results from several factors, including:

- Avoidance of surface water pollution, which occurs if unused wastewater is discharged into rivers or lakes. Major pollution problems such as dissolved oxygen depletion, eutrophication, foaming and fish kills can be avoided.
- Conservation or more rational usage of freshwater resources, especially in arid and semi-arid areas: fresh water for urban demand, wastewater for agriculture.
- Reduced requirements for artificial fertilizers, with a concomitant reduction in energy expenditure and industrial pollution elsewhere.
- Soil conservation through humus build-up and prevention of land erosion.
- Desertification control and desert reclamation through irrigation and fertilization of tree belts.
- Improved urban amenity through irrigation and fertilization of green spaces for recreation and visual appeal.

3. Wastewater reuse for ground water recharge (by infiltration)

This standard relates to the allowable treated wastewater limits being used to the ground water recharge (by infiltration) Table 9.

4. Standard for Industrial wastewater Discharge to the sewerage System

This standard - Table 10 relates to the industrial wastewater discharge into municipal sewerage network, in other terms the pretreatment limits for industrial wastewater. This is to protect the sewer network infrastructure and the receiving natural environment.

5. Regional and International Co-operation

International cooperation carries enormous potential benefits for environmental protection in Palestine where common problems and shared resources are subject to intense human pressures. The donor community has played, and will continue to play, a pivotal role in the quest for peace and environmental security.

International aid to the PA during the interim period (1993-2002) has been crucial to finance the various investment programs in the West Bank and Gaza Strip, especially in the areas of water, wastewater and infrastructure where the need was paramount. Funding for wastewater projects and reuse could be enhanced by further commitments from the donor agencies such as (Mediterranean Action Program- MAP, United Sates Development Program, Arab States League, EU countries and various UN organizations)

The implementation of water/wastewater projects is important to improve the environmental situation in Palestine. Significant efforts are being placed by various Palestinian stakeholders to improve their planning capacity and improving their institutional efficiency through a regular developmental planning cycle. These efforts require constant feedback and will continue to improve as the planning cycles continue in the years to come. This requires coordination with the international donor community and their willingness to work within the planning framework set by the Palestinian institutions

Further, in face of the growing emergency humanitarian needs, it is important that water/wastewater projects are not neglected, but rather integrated into emergency response measures. Furthermore environmental degradation will aggravate the humanitarian situation. It will be technically more difficult and more costly to resolve more acute environmental problems.

Table 6: Standards for the Disposal of domestic Effluents in the Sea within National Waters (Disposal at 500m off the coast)

Parameter	Unit	Max. Value	Parameter	Unit	Max. Value
Temperature	ºC	35	Ammonium (NH_4)	mg/ L	5
pH	pH units	6 - 9	Mercury	mg/ L	0,001
Colour		Absence	Lead	mg/ L	0,5
BOD_5	mg O_2/ L	60	Cadmium	mg/ L	0,05
COD	mg/ L	200	Arsenic	mg/ L	0,05
Dissolved material	mg/ L	---	Total Chromium	mg/ L	1
Dry residues at 150ºC	mg/ L	1800	Copper	mg/ L	1,5
Suspended solids	mg/ L	60	Nickel	mg/ L	0,2
Turbidity	NTU	50	Iron	mg/ L	2.0
Sulphates	mg/ L	1	Manganese	mg/ L	0.5
Oil & grease	mg/ L	10	Zinc	mg/ L	5
Petroleum hydrocarbons	mg/ L	0,5	Silver	mg/ L	0,1
Phosphates (PO_4)	mg/ L	5	Barium	mg/ L	2
Nitrates (NO_3)	mg/ L	25	Cobalt	mg/ L	1
Phenols	mg/ L	1	Total pesticides	mg/ L	0,2
Fluorides	mg/ L	1,5	Cyanides	mg/ L	0,1
Aluminium	mg/ L	5	Total coliforms	colony/ 100 ml	5000

Source: Environmental Quality Authority (EQA, 2001)

Table 7: Standard for wastewater reuse for restricted irrigation

Parameter	Unit	Max. Value	Parameter	Unit	Max. Value
Temperature	ºC	25	Ammonium (NH_4)	mg/ L	---
pH	pH units	6 - 9	Mercury	mg/ L	0,001
Colour		Absence	Lead	mg/ L	1
BOD_5	mg O_2/ L	45	Cadmium	mg/ L	0,02
COD	mg/ L	150	Arsenic	mg/ L	0,02
Dissolved Oxygen	mg/ L	> 0.5	Total Chromium	mg/ L	0,5
Dry residues at 150ºC	mg/ L	1800	Copper	mg/ L	0.2
Suspended solids	mg/ L	40	Nickel	mg/ L	0,2
Turbidity	NTU	50	Iron	mg/ L	5.0
Sulphates	mg/ L	1	Manganese	mg/ L	0.2
Oil & grease	mg/ L	5	Zinc	mg/ L	2
Petroleum hydrocarbons	mg/ L	0,5	Silver	mg/ L	0,1
Phosphates (PO_4)	mg/ L	30	Barium	mg/ L	2
Nitrates (NO_3)	mg/ L	50	Cobalt	mg/ L	1
Phenols	mg/ L	0.002	Total pesticides	mg/ L	0,2
Fluorides	mg/ L	1,5	Cyanides	mg/ L	0,05
Boron	mg/L	0.7	Pathogens		Absent
Aluminium	mg/ L	5	Total coliforms	colony/ 100 ml	1000

Source: Environmental Quality Authority (EQA, 2001)

Table 8: Standard for wastewater reuse for unrestricted irrigation

Parameter	Unit	Max. Value
Temperature	ºC	25
pH	pH units	6 - 9
Colour		Absence
BOD_5	mg O_2/ L	60
COD	mg/ L	200
Dissolved Oxygen	mg/ L	> 0.5
Total dissolved Solids	mg/ L	1500
Total Suspended solids	mg/ L	50
Turbidity	NTU	50
Sulphates	mg/ L	500
Oil & grease	mg/ L	5
Artificial Detergents	mg/ L	15
Phosphates (PO_4)	mg/ L	30
Nitrates (NO_3)	mg/ L	50
Phenols	mg/ L	0.002
Fluorides	mg/ L	1,5
Boron	mg/L	0.7
Aluminium	mg/ L	5

Parameter	Unit	Max. Value
Ammonium (NH_4)	mg/ L	---
Mercury	mg/ L	0,001
Lead	mg/ L	1
Cadmium	mg/ L	0,02
Arsenic	mg/ L	0,02
Total Chromium	mg/ L	0,5
Copper	mg/ L	0.2
Nickel	mg/ L	0,2
Iron	mg/ L	5.0
Manganese	mg/ L	0.2
Zinc	mg/ L	2
Sodium	mg/ L	200
Barium	mg/ L	2
Cobalt	mg/ L	1
Total pesticides	mg/ L	0,2
Cyanides	mg/ L	0,05
Pathogens		Absent
Total coliforms	colony/ 100 ml	1000

Source: Environmental Quality Authority (EQA, 2001)

Table 9: Standard for wastewater reuse for ground water recharge(by infiltration)

Parameter	Unit	Max. Value	Parameter	Unit	Max. Value
Temperature	ºC	25	Ammonium (NH_4)	mg/ L	10
pH	pH units	6 - 9	Mercury	mg/ L	0,001
Colour		Absence	Lead	mg/ L	0.1
BOD_5	mg O_2/ L	60	Calcium	mg/ L	400
COD	mg/ L	200	Arsenic	mg/ L	0,02
Dissolved Oxygen	mg/ L	>1	Chloride	mg/ L	600
Total dissolved Solids	mg/ L	1500	Copper	mg/ L	0.2
Total Suspended solids	mg/ L	50	Nickel	mg/ L	0,2
Turbidity	NTU	50	Iron	mg/ L	2.0
Sulphates	mg/ L	1000	Manganese	mg/ L	0.2
Oil & grease	mg/ L	0	Zinc	mg/ L	5
Artificial Detergents	mg/ L	5	Sodium	mg/ L	230
Phosphates (PO_4)	mg/ L	15	Barium	mg/ L	2
Nitrates (NO_3)	mg/ L	15	Cobalt	mg/ L	1
Phenols	mg/ L	0.002	Total pesticides	mg/ L	0,2
Magnesium	Mg/L	150	Total Kjeldahl Nitrogen	Mg/L	10
Fluorides	mg/ L	1,5	Cyanides	mg/ L	0,1
Boron	mg/L	1	Pathogens		Absent
Aluminium	mg/ L	1	Total coliforms	colony / 100 ml	1000

Source: Environmental Quality Authority (EQA, 2001)

Table 10: Standard for industrial wastewater discharged to the sewerage system

Parameter	Unit	Max. Value	Parameter	Unit	Max. Value
Temperature	ºC	25	Ammonium (NH_4)	mg/ L	45
pH	pH units	6 - 9	Mercury	mg/ L	0,05
Colour	PCU	150	Lead	mg/ L	1
BOD_5	mg O_2/ L	500	Bryllium	mg/ L	0.5
COD	mg/ L	2000	Arsenic	mg/ L	0,25
NH_4	mg/ L	>1	Cadmium	mg/ L	0.5
Total dissolved Solids	mg/ L	2500	Copper	mg/ L	2
Total Suspended solids	mg/ L	500	Nickel	mg/ L	1
Turbidity	NTU	50	Iron	mg/ L	50
Sulphates	mg/ L	1000	Manganese	mg/ L	5
Oil & grease	mg/ L	100	Zinc	mg/ L	5
Artificial Detergents	mg/ L	25	Sodium	mg/ L	230
Phosphates (PO_4)	mg/ L	15	Barium	mg/ L	2
Nitrates (NO_3)	mg/ L	30	Cobalt	mg/ L	1
Phenols	mg/ L	3	Total pesticides	mg/ L	3
Magnesium	Mg/L	150	Total Kjeldahl Nitrogen	Mg/L	60
Fluorides	mg/ L	2	Cyanides	mg/ L	1
Boron	mg/L	3	Mineral oil	Mg/L	20
Aluminium	mg/ L	10	Residual Chlorine	Mg/L	3

Source: Environmental Quality Authority (EQA, 2001)

6.6 TURKEY

6.6.1 Institutional framework

The Turkish institutional framework for water, wastewater and agricultural irrigation is summarized in Figure 2. In this figure the ministries and organizations, their related, affiliated, and bounded institutions and units are given. Their relationships are indicated. The major aspects of the framework are explained below.

In Turkey, Prime Minister's Office (PMO) holds the top of the institutional framework tree. The framework consists of ministries, organizations, general directorates and special boards. The major ministries related with water, wastewater and agricultural irrigation and their responsibilities could be summarized as follows: The Ministry of Health (MoH) has the responsibility of performing analysis related to water quality. The Ministry of Public Works and Settlement (MoPWS) is in charge of financing water and wastewater infrastructures and giving technical support. The Ministry of Energy and Natural Resources (MoENR) is in charge of investigating, planning and management of water resources for irrigation, community water supply and energy production. The Ministry of Environment and Forestry (MoEF) sets relevant standards for environmental pollution control, carries out inspection of pollution sources and routinely monitors the quality of water resources. The Ministry of Agriculture and Rural Affairs (MoARA) has the responsibility of determining and implementing plans and policies on agriculture and agricultural irrigation. The Ministry of Internal Affairs (MoI) is responsible for the administrative management. The State Planning Organization (SPO) prepares national development plans and programmes, and coordinates financial support for investments.

The largest administrative structure in Turkey is the provinces. Provinces are governed by the governors, and are subdivided as administrative units into districts and districts into sub-districts. The governors, appointed by the MoI, have the utmost power for the administration of the provinces. Administrative services within a province are carried out by provincial directorates (e.g. province health directorate, province environment and forestry directorate, etc.) who are established under each governorship. Although these directorates report to the governor, at the same time they are the provincial branches of the related ministries. Therefore, they are affiliated to relevant ministries in terms of operation and are responsible for putting the plans and policies set by the ministries into practice upon authorization by the governors.

Municipalities, headed by mayors, are established at all levels of administrative units to undertake the public services (e.g. water supply, sewerage). Municipalities are administered by a mayor and the council of municipality elected by the public. If the central municipality in a province covers more than one district (which is the case for metropolitan cities), it is referred to as Greater Municipality. The Greater Municipalities have broader autonomy compared to the common municipalities. Municipality services related to water supply, sewerage, and sewage treatment and disposal are carried out by a 'Directorate of Water Works' established within the municipality. In Greater Municipalities, these duties are undertaken by the consolidated Water and Sewage Administrations. Bank of Provinces (BoP) gives financial and technical support to the municipalities for the required planning and construction works. For settlements having more than 100.000 inhabitants the General Directorate of State Hydraulic Works (SHW), instead of the municipalities, is responsible for water supply to the public. In rural settlements i.e. villages and hamlets, that fall outside of the district or sub-district administration boundaries, administration is undertaken by a chief (muhtar) and a Board of Seniors. Water, wastewater and irrigation infrastructure is provided by the General Directorate of Rural Services (GDRS) in such areas.

Several regions with unique conditions and requiring special treatment are administered by special administrative units. In context with water management, The Administration of Southeastern Anatolian Project for Regional Development (SAP-RDA) and The Authority for Protection of Special Areas (APSA) are the two examples for such special administrations.

Monthly routine water quality monitoring is carried out at defined sampling stations throughout the country by the SHW and Electrical Power Resources Survey and Development Administration (EPRSDA) general directorates of The MoENR. The main office and district offices of the MoH undertake control of water sanitation and quality in water supply systems. MoEF carries out water pollution analysis through its main office and the district offices as per required. Industry is obliged to collect numbers of samples in proportion with its discharge volume and get them analyzed in a ministry-approved laboratory and should document the results. In addition to water quality monitoring, SHW and EPRSDA both undertake countrywide routine monitoring of river flows and lake water levels at designated stations.

Agricultural irrigation facilities in Turkey are constructed by SHW and GDRS. Operations of large-scale facilities are also undertaken by these establishments while small-scale facilities are transferred to local administrators and other third parties. Farmer cooperatives, irrigation leagues, irrigation associations make the local administrations. The SHW and EPRSDA also undertake the responsibility of building dams for hydroelectricity.

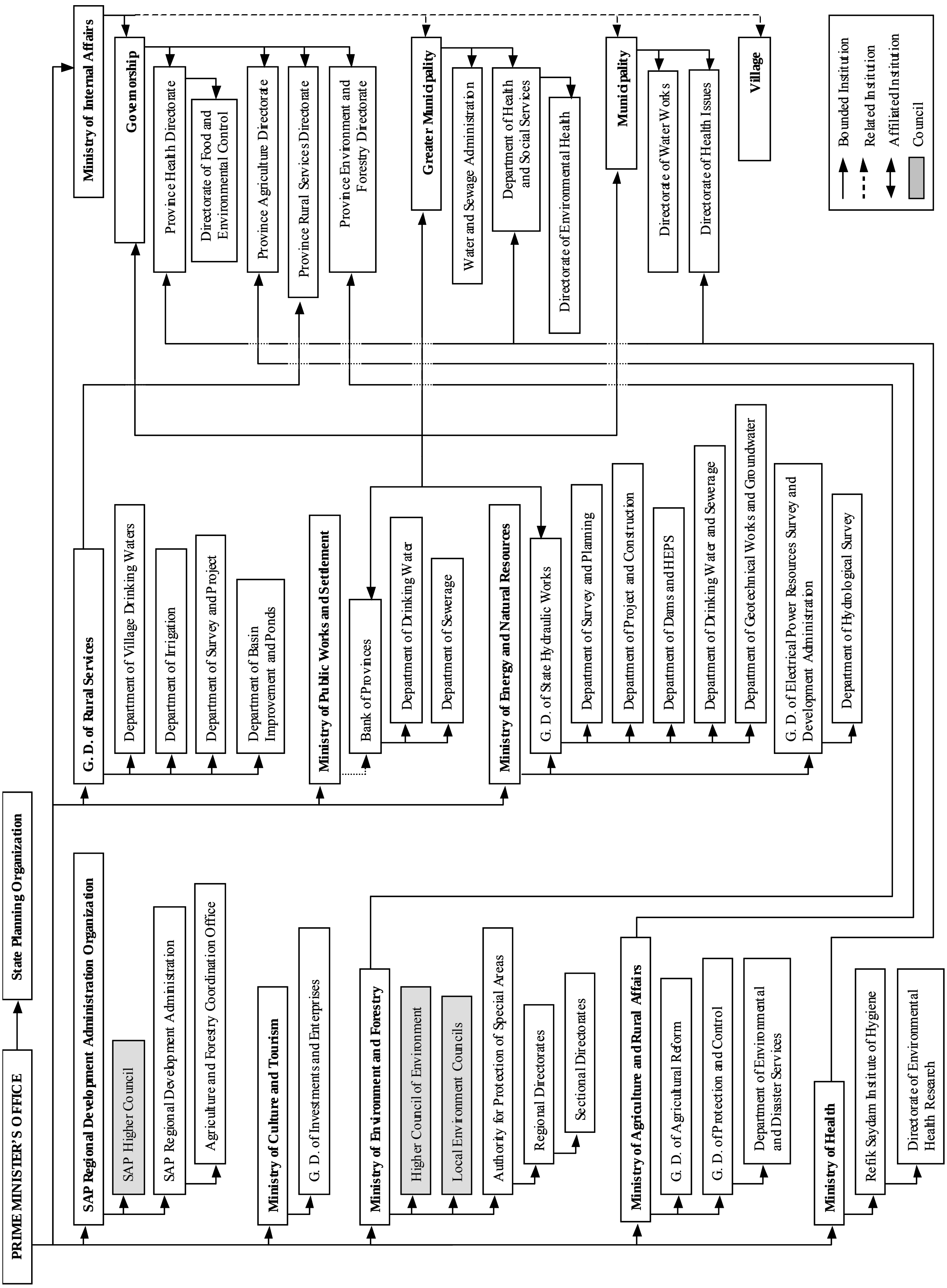

Figure 2: Turkish institutional framework for water, wastewater and agricultural irrigation

- **Responsibilities of Institutions**

State Planning Organization (SPO)

The SPO, organized under the PMO, develops economic, social and environmental plans in 5-year frames; and prepares annual investment programs. During preparation plans and programs, SPO forms specialized working commissions with the participants from relevant ministries, institutions, universities, NGOs, and the private sector for guidance and to reach a consensus. SPO approval is necessary for all the public investments whether it be financed through national or foreign funds.

Ministry of Environment and Forestry (MoEF)

The areas of responsibilities of the ministry, in relation to water and wastewater issues, cover the following areas: Programme and project development to determine principles of environmental protection; development of protection principles for proper urban and rural land-use; development of environmental pollution control standards; conduct, approve and facilitate implementation of environmental plans; establishment of laboratories for environmental analysis; monitoring and control of activities which may have negative impacts on the environment; initiate and foster continuous environmental education programs and build public awareness on environmental issues.

The MoEF establishes Local Environment Councils at each province to prepare and conduct local environmental management and protection plans and to inspect and monitor sources of pollution at the local-level. The local councils are formed by the representatives of the local administration, the related ministries, and the private sector. These councils are chaired by the governors. At the national-level, The Higher Council of Environment determines national environmental protection policies; to whom MoEF provides secretarial sevices.

Authority for Protection of Special Areas (APSA) is affiliated to the MoEF, and is responsible for the administration and protection of 13 designated special protection areas, which are natural reserves protected by law. The duties and responsibilities of APSA include land-use and investment planning for public works, carrying out environmental inspections within the jurisdiction areas. For administrative purposes APSA has organized in regional and sectional directorates.

Ministry of Health (MoH)

The MoH administers public health related practices. Inspections of water supplies, sewerage systems and wastewater treatment facilities, as related to public and environmental health, are conducted by MoH. For control purposes, MoH owns a central national laboratory, called Refik Saydam Institute of Hygiene, and other smaller local units within the governors’ offices and in municipalities.

Ministry of Public Works and Settlement (MoPWS)

The ministry has an important role in the development of municipal and regional land use plans. The major actor related to water and wastewater of MoPWS is the Bank of Provinces.

Bank of Provinces (BoP) is in charge of planning, construction and financing of drinking water and urban wastewater infrastructures for the requesting municipalities. The main responsibility of the bank is to manage and distribute allocated funds in the national budget to the local municipalities in the form of grants and loans. In addition, BoP provides technical support to the local governments for the infrastructure projects through its Drinking Water and Sewerage Department. Requests are taken and each municipality is served on a first come-first serve basis. This may sometimes take ten years or more and hence many greater municipalities seek their own sources of funding.

Ministry of Agriculture and Rural Affairs (MoARA)

This ministry is responsible for land use planning and water resources development in the rural section. In addition, development of agriculture and various socio-economic services, and the establishment of certain groundwater facilities within the rural area in accordance with the development plans are undertaken by the ministry. Protection of aquatic products is also undertaken by the MoARA. For this purpose, MoARA sets its own water quality standards where aquatic products are being produced. General Directorate of Protection and Control under MoARA is responsible for monitoring these water resources.

General Directorate of Agricultural Reform (AR) under MoARA is primarily responsible for agricultural reform, which aims to unite smaller farmlands into profitable establishments to achieve sustainable development and to increase agricultural productivity. Regulating water usage in these areas is within the duties of the AR Directorate.

General Directorate of Rural Services (GDRS)

The GDRS, affiliated to the PMO, is responsible for land use and water resources development (sewage and sanitation systems, irrigation) in rural areas. Its main duties related with water sector are: to provide services to the farmers for efficient use of soil and water resources and protection and development of these resources. Other duties of the general directorate include determining essential criteria for construction, maintenance and operation of water and sewerage services in the rural sector; to provide tap and drinking water to villages; and to construct and operate water distribution systems to meet water demands of up to 500 l/s. The relevant departments of the GDRS carry out these responsibilities.

Ministry of Energy and Natural Resources (MoENR)

Two General Directorates within this Ministry have duties related to water and wastewater management and irrigation:

General Directorate of State Hydraulic Works (SHW) is one of the primary managerial state water agencies. Its main objectives are to prepare feasibility studies, undertake designs for water-related projects; to construct hydraulic facilities and operate them. Specific duties of SHW are stream flow gauging, water quality monitoring, modeling hydraulic structures, carrying out surveys for river basin management, preparing master plans and feasibility reports and executing technically and economically feasible water resources projects; constructing dams and hydroelectric power plants; building irrigation and drainage systems; construction and operation of flood-control structures; performing ground water studies; developing and administering all the stages of water supply and treatment appurtenances for settlements over 100,000 population.

General Directorate of Electrical Power Resources Survey and Development Administration (EPRSDA) is responsible for monitoring of hydrological parameters at rivers and lakes for hydro-electrical power generation purposes. The measurements, including water quality measurements at some stations, are carried out under the responsibility of the Department of Hydrological Survey. The administration also plans and constructs hydroelectric power stations and dams.

Ministry of Culture and Tourism (MoCT)

The ministry has a duty to designate touristic areas and undertake important implementation measures in these areas regarding drinking water supply, urban wastewater treatment and solid waste disposal. It provides finance to municipality and infrastructure investments in identified project areas, either through its own budget or by acting as a liaison between foreign and other credit institutions. The General Directorate of Investments and Enterprises within the ministry undertakes these tasks.

Southeastern Anatolia Project Regional Development Administration (SAP-RDA)

Southeastern Anatolia Project (SAP) is a multi-sector (irrigation, hydraulic energy production, agriculture, urban and rural infrastructure, forestry, education and health) and integrated regional development project based on the concept of sustainable development. The project area covers 9 provinces in the Euphrates-Tigris basins and Upper Mesopotamia plains. The SAP-RDA overrides the municipalities, and is responsible for the administration of all water, wastewater treatment and irrigation activities in the region.

Non-Governmental Organizations (NGOs)

A number of NGOs are active in resolving environmental issues, however their impact on water and wastewater policy development so far have been limited.

Municipalities

The municipalities undertake public services in the urban sector. The major duties related to water and wastewater management are: to prepare investment plans and programmes; to coordinate co-financing and co-investment of large scale services; to provide drinking water, sewerage and sewage treatment and disposal to the public under jurisdiction; and to license operations of waste treatment and disposal plants. In greater municipalities, Water and

Sewage Administrations established within the municipalities are responsible for controlling discharges of industrial wastewaters; construction, operation and maintenance of water and wastewater treatment plants within their districts. These administrations also have the power to set their own discharge regulations in addition to the national regulations.

6.6.2 Policies and Legislative Framework

In Turkey, the national policies are designated according to the national development plans prepared by the SPO. Each development plan is prepared for a period of 5 years and includes the principles, plans, and policies that will be applied within the time period for the sustainable development of the country. In the SPO's latest 5-year development plan, for the time period of 2001-2005, following policies related to municipal water, sewerage and wastewater treatment are stated as follows:

- The groundwater and surface water resources shall be protected against pollution, and use of treated wastewater in agriculture and industry shall be encouraged.
- It is a necessity to construct the lacking water infrastructure for supply of sufficient and healthy drinking water to the public.
- The society shall be informed about effective use of water and about protection of the infrastructures and water resources; the press, both audio-visual and printed, shall be encouraged to run training programs on saving water.
- Continuous and adequate amount of municipal water will be provided to the consumer at a reasonable cost, and emphasis shall be given to the protection of consumers.
- Effective coordination shall exist among the institutions operating in utilities sector.
- As regards to infrastructure facilities, suitable technology for settlement conditions shall be sought and used effectively, and the material and equipment requirements shall be met primarily from the domestic market
- The municipalities shall develop action plans for emergency supply of drinking water and waste disposal facilities in case the infrastructure is damaged due to a natural disaster.
- An effective control shall be carried out to prevent illegal use of water. The use of Supervisory Control and Data Acquisition systems by the metropolitan municipalities will be encouraged.
- Implementation of a tariff system complying with contemporary management principles shall be ensured.
- In context with urbanization and to improve the quality of life, funds allocated for urban infrastructure shall be increased. Build-Operate or Build-Operate-Transfer models in new investments shall be encouraged with a view to ensure rational distribution of available resources. Facilities that are under construction will have a higher priority in resource allocation.
- Privatization of water and sewerage facilities shall be encouraged and the municipalities shall be restructured to act as supervisory bodies.

At the regional and local level, generally, no official specific policies exist however national policies are essentially applicable at this level too. The offices of governors are responsible for the implementation of the national policies and plans at all levels. Since Turkey do not have regional administration units, regional policies are not available, however policies developed by SAP-RDA and APSA can be considered as regional in essence.

- **Socioeconomic Instruments for Sustainable Wastewater Treatment, Disposal and Reuse**

The "Polluter Pays" principle is considered the essential instrument in Turkey for sustainable pollution control efforts with an understanding that polluter should pay for the restoration of any environmental damage done. This principle is normally implicated through instruments such as environmental-related taxes and fees.

A portion of taxes on goods and services (e.g. the gasoline consumption tax, electricity and coal consumption taxes) are indirectly diverted to environmental protection and clean-up services however this is decided on case-by-case bases by the government. Local governments collect fees, e.g. environmental cleansing fee, for providing certain environment services. Fees collected by the municipalities under the Municipal Revenues Act may also be used for the environment investments. Fees associated with wastewater are as follows:

- A "Pollution Prevention Fee" is collected from organizations that do not posses or operate a proper pre-treatment facility.
- A "Wastewater Collection Fee" is embedded in water consumption tariffs, collected from public connected to sewerage system.
- A special discount electricity tariff, which is 17% off the normal industrial rate, has been approved for waste treatment plant operation.

- **Legislative Framework**

The Turkish laws and regulations related with wastewater treatment, disposal and reuse are summarized in Table 11.

Table 11: Laws and Regulations Pertaining to Wastewater Treatment, Disposal and Reuse

Year	Establishment	4.1.1.1.1.1 Law/Regulation/Bulletin
1983	MoEF	Environment Law
1988	MoEF	Water Pollution Control Regulation (WPCR)
1989	MoEF	WPCR Administration Aspects Bulletin
1989	MoEF	WPCR Toxic and Hazardous Substances in Water Bulletin
1991	MoEF	WPCR Technical Aspects Bulletin
1995	MoARA	Aquatic Products Regulation
2001	MoEF	Environmental Inspection Regulation
2002	MoEF	Environmental Impact Assessment Regulation

The Environment Law, passed in 1983, lays down the fundamentals of environmental protection in Turkey. The law, which was constructed on the fundamental understanding of

"Polluter Pays" principle, stipulates the frameworks on rules to be obeyed by the public to protect the environment, the related fines, operation permits, inspections, stopping polluting activities and environmental impact assessment. Details on implementation are issued in the related regulations and bulletins.

Rules on wastewater treatment and water pollution control are stipulated by the Water Pollution Control Regulation (WPCR), issued by MoEF in 1988. According to this regulation surface waters are divided into four categories in terms of their inherent quality. Ambient quality standards are set for each category with reference to the quality and usage of a particular water body. Three protection bands around water resources to be used for drinking water abstraction have been stipulated. Activities to take effect at each band are described in this regulation. Moreover, standards on industrial and domestic wastewaters to be discharged into receiving waters and sewers have been set in the regulation. The item 28 is related to use of wastewaters for irrigation. In this item, it is mentioned that where water shortage is of concern and wastewaters pose an economic value; treated wastewaters are encouraged to be used for irrigation provided that they comply with the standards appearing in Technical Aspects Bulletin (WPCR-TAB). Suitability of the wastewater for use in irrigation is decided collectively by related offices of the SHW, BoP and MoARA.

The 1991 WPCR-TAB contains quality criteria to be used for categorizing agricultural irrigation waters and identifies important parameters and criteria to be followed in assessing wastewaters for their suitability in irrigation. The bulletin stipulates in table format, the maximum permissible heavy metal and toxic element concentrations and the maximum permissible levels for Boron; as well as suitability criteria for industrial effluents in irrigation. Moreover, the bulletin states the criteria for deciding whether domestic wastewaters may or may not be used for irrigation without disinfection in irrigation waters.

The WPCR Administration Aspects Bulletin stipulates the requirements for obtaining discharge permits and duration of the validity of permits. The WPCR Toxic and Hazardous Substances in Water Bulletin have been issued in 1989 to lay down the principles and criteria for protecting waters against pollution by toxic and hazardous substances.

The Aquatic Products Regulation (APR), issued in 1995, by the MoARA sets ambient water quality and discharge standards for the protection of water bodies used for developing aquatic products and identifies harmful substances that may not be dumped into such waters. Both ambient water quality standards and discharge standards are presented in a table format, in this regulation.

According to the Environmental Impact Assessment (EIA) Regulation issued in 2002 by the MoEF, for wastewater treatment plants serving a population of 20.000 or above inhabitants a Preliminary EIA study should be undertaken to decide whether a full EIA study is substantiated or not. The Environmental Inspection Regulation issued by MoEF in 2001 lays down fundamentals for auditing and inspection of industrial plants, as related to environmental pollution, and sets documentation principles in terms of quantity, quality, treatment and discharges of wastewaters produced in a given plant

Important tables and figures of WPCR, WPCR-TAB and APR, which include standards and constraints related with wastewater, are summarized in Tables 12 – 19 and Figure 3.

Table 12: Criteria for inland water quality classes

	Water Quality Class			
Water Quality Parameter	I	II	III	IV
A) Physical and inorganic-chemical parameters				
1. Temperature (°C)	25	25	30	> 30
2. pH	6.5-8.5	6.5-8.5	6.0-9.0	outside 6.0-9.0
3. Dissolved oxygen (mg O_2/l)[a]	8	6	3	< 3
4. Oxygen saturation (%)[a]	90	70	40	< 40
5. Chlorine ions (mg Cl^-/l)	25	200	400[b]	> 400
6. Sulfate ions (mg $SO_4^=$/l)	200	200	400	> 400
7. Ammonia nitrogen (mg NH_4^+-N/l)	0.2[c]	1[c]	2[c]	> 2
8. Nitrite nitrogen (mg NO_2^--N/l)	0.002	0.01	0.05	> 0.05
9. Nitrate nitrogen (mg NO_3^--N/l)	5	10	20	> 20
10. Total phosphorus (mg PO_4^{-3}-P/l)	0.02	0.16	0.65	> 0.65
11. Total dissolved matter (mg/l)	500	1500	5000	> 5000
12. Color (Pt-Co units)	5	50	300	> 300
13. Sodium (mg Na^+/l)	125	125	250	> 250
B) Organic parameters				
1. COD (mg/l)	25	50	70	> 70
2. BOD (mg/l)	4	8	20	> 20
3. Organic carbon (mg/l)	5	8	12	> 12
4. Total Kjeldahl-nitrogen (mg/l)	0.5	1.5	5	> 5
5. Emülsified oil and grease (mg/l)	0.02	0.3	0.5	> 0.5
6. Methylene blue active substances (MBAS) (mg/l)	0.05	0.2	1	> 1.5
7. Phenolic substances (volatile) (mg/l)	0.002	0.01	0.1	> 0.1
8. Mineral oils and derivatives (mg/l)	0.02	0.1	0.5	> 0.5
9. Total pesticides (mg/l)	0.001	0.01	0.1	> 0.1
C) Inorganic pollution parameters[d]				
1. Mercury (µg Hg/l)	0.1	0.5	2	> 2
2. Cadmium (µg Cd/l)	3	5	10	> 10
3. Lead (µg Pb/l)	10	20	50	> 50
4. Arsenic (µg As/l)	20	50	100	> 100
5. Copper (µg Cu/l)	20	50	200	> 200
6. Chromium (total) (µg Cr/l)	20	50	200	> 200
7. Chromium (µg Cr^{+6}/l)	indeterminable	20	50	> 50
8. Cobalt (µg Co/l)	10	20	200	> 200
9. Nickel (µg Ni/l)	20	50	200	> 200
10. Zinc (µg Zn/l)	200	500	2000	> 2000
11. Cyanide (total) (µg CN/l)	10	50	100	> 100
12. Florine (µg F^-/l)	1000	1500	2000	> 2000
13. Free chlorine (µg Cl_2/l)	10	10	50	> 50
14. Sulfur (µg $S^=$/l)	2	2	10	> 10
15. Iron (µg Fe/l)	300	1000	5000	> 5000
16. Manganese (µg Mn/l)	100	500	3000	> 3000
17. Boron (µg B/l)	1000[e]	1000[e]	1000[e]	> 1000
18. Selenium (µg Se/l)	10	10	20	> 20
19. Barium (µg Ba/l)	1000	2000	2000	> 2000
20. Aluminum (mg Al/l)	0.3	0.3	1	> 1
21. Radioactivity (pCi/l)				
alfa-activity	1	10	10	> 10
beta-activity	10	100	100	> 100
D) Bacteriological parameters				
1. Fecal coliform (MPN/100 ml)	10	200	2000	> 2000
2. Total coliform (MPN/100 ml)	100	20000	100000	> 100000

(a) It is sufficient to ensure concentration and percentage saturation of only one of the parameters
(b) It may be necessary to lower the limit of this concentration for irrigation of chlorine-sensitive plants
(c) The concentration of free ammonia may not exceed 0.02 mg NH_3-N/l depending on pH
(d) Criteria in this group give total concentrations of chemical derivatives constituting the parameters
(e) These criteria may have to be lowered to 300 µg/l for irrigation of boron-sensitive plants

Table 13: Discharge standards of domestic wastewaters to receiving bodies

Class 1 – Pollution load: 5-60 kg/day BOD, Population < 1000

Parameter	Unit	Composite sample (2 hrs)	Composite sample (24 hrs)
BOD_5	mg/l	50	45
COD	mg/l	180	120
SS	mg/l	70	45
pH		6-9	6-9

Class 2 – Pollution load: 60-600 kg/day BOD, Population: 1000-10000

Parameter	Unit	Composite sample (2 hrs)	Composite sample (24 hrs)
BOD_5	mg/l	50	45
COD	mg/l	160	110
SS	mg/l	60	30
pH		6-9	6-9

Class 3 – Pollution load > 600 kg/day BOD, Population > 10000

Parameter	Unit	Composite sample (2 hrs)	Composite sample (24 hrs)
BOD_5	mg/l	50	45
COD	mg/l	140	100
SS	mg/l	45	30
pH		6-9	6-9

Class 4 – For domestic wastewater treatment plants treating with stabilization ponds (independent of population)

Parameter	Unit	Composite sample (2 hrs)	Composite sample (24 hrs)
BOD_5	mg/l	75	50
COD	mg/l	150	100
SS	mg/l	200	150
pH		6-9	6-9

Table 14: Irrigation water quality parameters as basis to irrigation water classification

Quality Criteria	***Irrigation Water Class***				
	I. Class (very good)	II. Class (good)	III. Class (usable)	IV. Class (usable with caution)	V. Class (detrimental, unusable)
EC25 x 106	0 – 250	250 – 750	750–2000	2000-3000	> 3000
Variable Sodium Percentage (%Na)	< 20	20 – 40	40 – 60	60 – 80	> 80
Sodium Adsorption Ratio (SAR)	< 10	10 – 18	18 – 26	> 26	
Sodium Carbonate Residue (RSC), meq/l mg/l	> 1.25 < 66	1.25 – 2.5 66 – 133	> 2.5 > 133		
Chloride (Cl-), meq/l mg/l	0 – 4 0 – 142	4 – 7 142 – 249	7 – 12 249 – 426	12 – 20 426 – 710	> 20 > 710
Sulphate (SO4-), meq/l mg/l	0 – 4 0 – 192	4 – 7 192 – 336	7 – 12 336 – 575	12 – 20 575 – 960	> 20 > 960
Total salt concentration (mg/l)	0 – 175	175 – 525	525–1400	1400-2100	> 2100
Boron concentration (mg/l)	0 – 0.5	0.5 – 1.12	1.12 – 2	> 2	
Irrigation water class*	C_1S_1	C_1S_2, C_2S_2, C_2S_1	C_1S_3,C_2S_3, C_3S_3,C_3S_2, C_3S_1	C_1S_4,C_2S_4, C_3S_4,C_4S_4, C_4S_3,C_4S_2, C_4S_1	
NO3- or NH4+, mg/l	0 – 5	5 – 10	10 – 30	30 – 50	> 50
Fecal Coliforms** (per 100ml)	0 – 2	2 – 20	20 – 100	100 – 1000	> 1000
BOD5 (mg/l)	0 – 25	25 – 50	50 – 100	100 – 200	> 200
Suspended Solid Matter (mg/l)	20	30	45	60	> 100
pH	6.6 – 8.5	6.5 – 8.5	6.5 – 8.5	6.5 – 9	< 6 or >9
Temperature	30	30	35	40	> 40

Table 15: Permissible maximum heavy metal and toxic element concentration in irrigation water

Elements	Maximum total amounts per unit area, kg/ha	Permissible maximum concentrations	
		Limits for continuous irrigation under all soil conditions, mg/1	Limits for irrigation for less than 24 years on clayey soils with pH value 6.0-8.5, mg/1
Aluminium (Al)	4600	5.0	20.0
Arsenic (As)	90	0.1	2.0
Berlyllium (Be)	90	0.1	0.5
Boron (B)	680	-[3]	2.0
Cadmium (Cd)	9	0.01	0.05
Chrome (Cr)	90	0.1	1.0
Cobalt (Co)	45	0.05	5.0
Copper (Cu)	190	0.2	5.0
Fluorine (F)	920	1.0	15.0
Iron (Fe)	4600	5.0	20.0
Lead (Pb)	4600	5.0	10.0
Lithium (Li)[1]	-	2.5	2.5
Manganese (Mn)	920	0.2	10.0
Molybdenum (Mo)	9	0.01	0.05[2]
Nickel (Ni)	920	0.2	2.0
Selenium (Se)	16	0.02	0.02
Vanadium (V)	-	0.1	1.0
Zinc (Zn)	1840	2.0	10.0

[1] 0.075 mg/1 for citrus

[2] Concentration allowed only for acidic-clayey soils with high iron content

[3] Given on Table 19

Table 16: Principles and Technical Constraints for Reuse of Wastewater in Agriculture

Agricultural Production	Technical Constraints
Orchards and Vineyards	- Sprinkler irrigation is prohibited - Fruits falling from the trees should not be eaten - Number of fecal coliform 1000/100 ml
Fibrous Plants and Seed Crop Plants	- Surface or sprinkler irrigation is permitted - Biologically treated and chlorinated wastewater can be used in sprinkler irrigation - Number of fecal coliform 1000/100 ml
Forage crops, oil crops, after cooked eaten plants, floriculture	- Surface irrigation with mechanically treated wastewater

Table 17: Industrial Effluents Reusable in Irrigation

I	II	III
Effluent from the following can be used in irrigation of nearby lands	**Effluent from the following can be used in irrigation under certain conditions[x]**	**Effluent from the following is unsuitable for use in irrigation**
Beer, malt, wine, potato, vegetable, canning, marmalade, fruit canning, milk, potato starch processing plants and factories	Yeast, sugar, rice and cereal starch, bone glue factories, slaughterhouse, meat plants, tanneries, margarine factories, paper factories, textile industry (bleaching, mercerizing, dye house, print house, etc.), wool washing, fish flour, fish canning, mining facilities	Polish and paint factories, soap factories, inorganic heavy chemicals industry, pharmaceutical plants, metal processing plants, sulphide cellulose plants, viscous artificial silk factories, pyrolysis plants, gas plants, generator gas turbines, metallic oil industry, coal washing plants, dynamite industry, coking plants

[x] After treatment until values on Table 15 and Table 16 are achieved

Table 18: Whether the domestic treated wastewater can be reused without prior disinfection

reusable (+) not reuseable (-)	Crop Field		Pasture Meadow		Vegetable		Forage Crops		Orchards		Woodland and forests
	BY	BV	BY	BV	BY	BV	BY	BV	BY	BV	
Effluent from biological treatment plant, or from min. 2-hr clarification ponds (preliminary treatment)	+	+	+	+	-	-	+	-	-	-	+
Effluent from aerobic stabilization ponds or lagoons	+	-	+	-	-	-	+	-	-	-	+

Table 19: Irrigation water classification according to resistance of crops to boron

Irrigation water class	Boron concentration in irrigation water (mg/1) Sensitive crops [1] (mg/1)	Fairly sensitive crops [2] (mg/l)	Resistant crops [3] (mg/l)
I	less than 0.33	less than 0.67	less than 1.0
II	0.33-0.67	0.67-1.33	1.00-2.00
III	0.67-1.00	1.33-2.00	2.00-3.00
IV	1.00-1.25	2.00-2.50	3.00-3.75
V	more than 1.25	more than 2.50	more than 3.75

[1] : Example: walnut, lemon, fig, apple, grape and green beans
[2] : Example: wheat, barley, maize, oat, olive, cotton
[3] : Example: sugar beet, clover, broad beans, onion, cos lettuce, carrot

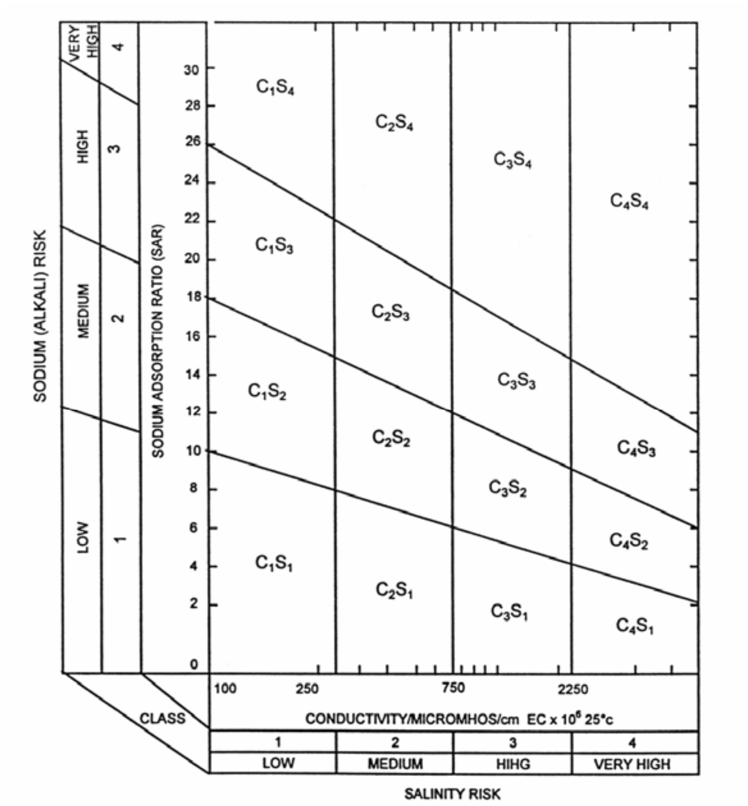

Figure 3: Irrigation water classification diagram

- Licensing Procedure

Discharge Permits

Direct discharge of domestic and industrial effluent into the natural environment is subject to permit. The municipalities in metropolitan cities and the local central government representatives elsewhere issue permits for effluent discharges into the natural environment in accord with the local environment council decisions and recommendations. In case the receiving environment is already highly polluted, then the General Directorate for the Environment issues the permit and decides on the location of the outfall and for the effluent quality restrictions applicable in that particular case. Duration of permit is generally three years. In case a risk is envisaged for the receiving environment, the authorities can refuse to renew the discharge permit or may set more stringent quality restrictions than those stipulated by the law. Permit holders are legally responsible for respecting the restrictions imposed and can either be taken to court for not doing so and/or have their permits withdrawn.

Connection Permits

The right and duty to be connected to a sewerage network is subject to a permit granted by the infrastructure manager, who stipulates the technical conditions for the implementation of the connection. It is forbidden to dispose of ground solid waste and/or substances likely to cause one of the following effects into the sewerage system: a depressive effect on sewage plant productivity, degradation of the sludge suitability for reuse, physical obstructions or other damage to facilities, or potential danger for operating staff. If the network manager considers that the discharge to be disposed of into the sewerage system is not fit for the system, the industry must pre-treat its effluent and pay a fee in proportion to its discharge strength. Full treatment is imposed when the discharge accounts for more than 10% of the total network load. The withdrawal of the water from the sewerage networks is subject to prior-written approval from the infrastructure manager.