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"Water Resource Management in a Semi-arid Area: A Case Study"

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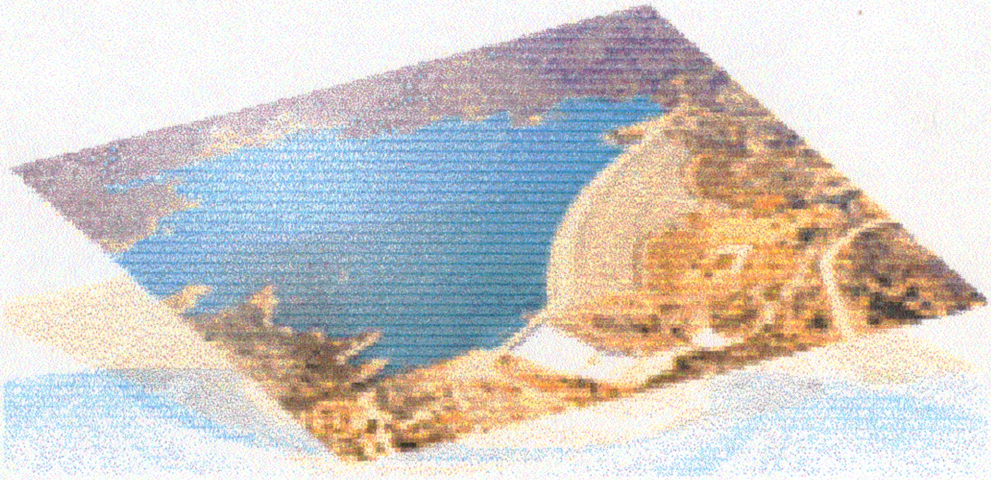

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WATER RESOURCE MANAGEMENT IN A SEMI-ARID AREA: CYPRUS- A CASE STUDY

by

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Finally I must thank my family in Cyprus for their forbearance and love.

Abstract:

The serious droughts of the recent years in a Semi-arid Island in Mediterranean Sea are presented in this MSc. Thesis. The Government' s Water Resource Policy and Scenarios applied to the Management of the resources are described briefly and commented upon extent.

They are set in a mathematical Linear Programming Model, which is presented after discussion and comparison, identifying the basic characteristics of a specific project called the Southern Conveyor Project. The optimization procedure is carried out on the demand allocations and costs to the economy.

Recommendations as to the future management of Cyprus Water Resources are then made on the basis of results of this optimization.

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INTRODUCTION:

The Hydrological Cycle and the natural motion of water in environment have challenged people and their actions for ages now. During the rise of civilization, major concerns of man were the water supply of his villages and the irrigation of his fields. Despite the fact that water is very valuable in use, it always had low exchange value. Hence it was excluded from the "market" and from the economic assumption.

Water is still one of the basic factors for the survival of humans and the ecology balance. The economic revolution of the recent decades reformulates the situation of the water resources uses. Day by day, higher water quantity and better water quality demand are occurring, due to the added needs that are borne from human life-style.

Throughout the world, the amount and the quality of water are the requirements which to prompt water resources planning. To meet the demands for the desired quality and quantity of water at particular locations and times, engineers have gained considerable experience in designing, constructing, removing and operating structures that will permit improved management of natural water supplies.

The incentive to plan for increased control of any water resource often follows a disaster, such as a flood, a drought or intolerable water quality conditions. Following these extreme situations, citizens review comities and plan boards to carry plans through to implementation. In most of the cases though, serious disagreements appear between different groups having different aims, viewpoints and interests for the benefits of the proposed projects (Grigg, 1990)

Water resources planning must take into account multiple users, multiple purposes and multiple objectives (Loucks, 1981). Planning for maximum net economic benefits is not sufficient because it matters who pays and who benefits. Other issues like the redistribution of national wealth, environmental quality, and equity are as important as economic efficiency. It is then clearly impossible to develop a single objective that satisfies all the political and social points of view.

The increased involvement of the public in water management has changed the way that engineers approach this task and now a bigger responsibility for making choices appears. Water resources' planning is not restricted to mathematical modelling but models can exemplify the approach. Models permit the evaluation of the economic and physical consequences of alternative engineering structures, of various allocating and operating policies and of the different assumptions. The results of any quantitative analysis of alternatives are often only a small part of the input to the overall planning and decision-making process. It is obvious that the results of most water resources management decisions have a direct impact on people and their relationships. Hence inputs of those having knowledge of law, regional planning and political science are also needed during the development and evaluation of the results of planning models.

Early water resource systems studies were often undertaken with a naïve view of the appropriate role and impact of models and modellers in the policymaking process. The success or failure of many past water resource studies is attributable to the communication efforts among systems planners, professional engineers responsible for system operation and design and public officials responsible for major decisions and setting general policies (Mays, 1992).

In the Present Project, the specific case of a Water Resource Management Project in a Semi-arid area in the Mediterranean is presented. The area of study is the Island of Cyprus, suffering from periodic water shortages leading to the inevitable question "what is the availability of water and how does it compare with the demand conditions?" A major part of the MSc Project consisted in the Collection and proceeding of the data, which required getting in touch with people in the Water Development Department, the sections of irrigation water use, of economic management of the Government's projects and with people from the section of the operation of the Southern Conveyor Project. Data was collected from other sources as well, like the Water Board of Limassol, and the Statistical Service of the Ministry of Finance.

The History of the Southern Conveyor Project development, the Project' s operation, and different scenarios applied during shortages or drought periods and a summation of these in a mathematical Linear Programming Model are presented after discussion and comparison to identify its basic characteristics. The target is to check the existing operational rules and combine them together to have a general view of the problem of managing limited water resources and optimizing them with respect to demand allocation.

Chapters One, Two and *Three* present the Area of study and the specific characteristics of the Southern Conveyor Project, which is under examination in the present thesis.

Chapter Four gives the Demands and the Allocation of water for both Domestic and Irrigation uses, whereas *Chapter Five* is a description of the existing management situation applied by the Water Development Department. In *Chapter Six* the different Costs of the Water units produced by the Desalination plants and the Reuse of water are compared to those from the Southern Conveyor System.

In *Chapter Seven* the Mathematical Model is set up for the optimization of water allocation. It uses Unit Benefit analysis to optimize the objective function and Sensitivity analysis to check how sensitive, the problem is to its main parameters. *Chapter Eight* discusses the future alternatives and recommendations for the Water resources of the Island in general.

CHAPTER ONE:
Area of Study

For a global view of the water resources of the island of Cyprus at a national level, a presentation of the existing characteristics of the area and the natural processes taking place is needed.

1.1. Natural features:

Cyprus is located in the northeast end of the Mediterranean Sea between the 33rd and 35th parallel and is the third largest island of this sea. Its total area is 9251 square kilometers of which 47% is agriculture area, forests cover 19% and the rest is urban area. Based on the latest research of the Department of Statistical and Research studies (1997), the total population of Cyprus is 746 100, which corresponds about to 80 people per square kilometer.

There are two main mountain ranges (Troodos and Pentadactylos) with elevations above mean sea level of 1952 m and 1085 m respectively. The coastline has a total length of 780 km. On the coasts and between the mountains valleys there are river alluvia causing fertile areas. All the rivers of the island are mountain torrents with very limited flows but turbulent ones during wintertime.

Cyprus has a temperate Mediterranean climate with mild winters, long hot summers and very limited autumn and spring seasons. The mean annual rainfall is between 300 mm to 500 mm in the central and southeast areas, 1100 mm at Troodos

Mountain and 550 mm at Pentadactylos Mountain. There is not only a topographic variation but also a seasonal and annual variation in the rainfall distribution, with frequent drought periods as Figure 1.3.2.(a) shows (Tsiourtis, 1995).

There is a high and intense sunshine during the year with a mean of 11.5 h sunshine during summer time and 5.5 h mean daily value during winter. High temperatures - of the order of 27°C on the mountains and 36°C in the valleys - during summers, in addition to the relative droughts and continual wind motion, result in high evapotranspiration values of 80% of the total rainfall.

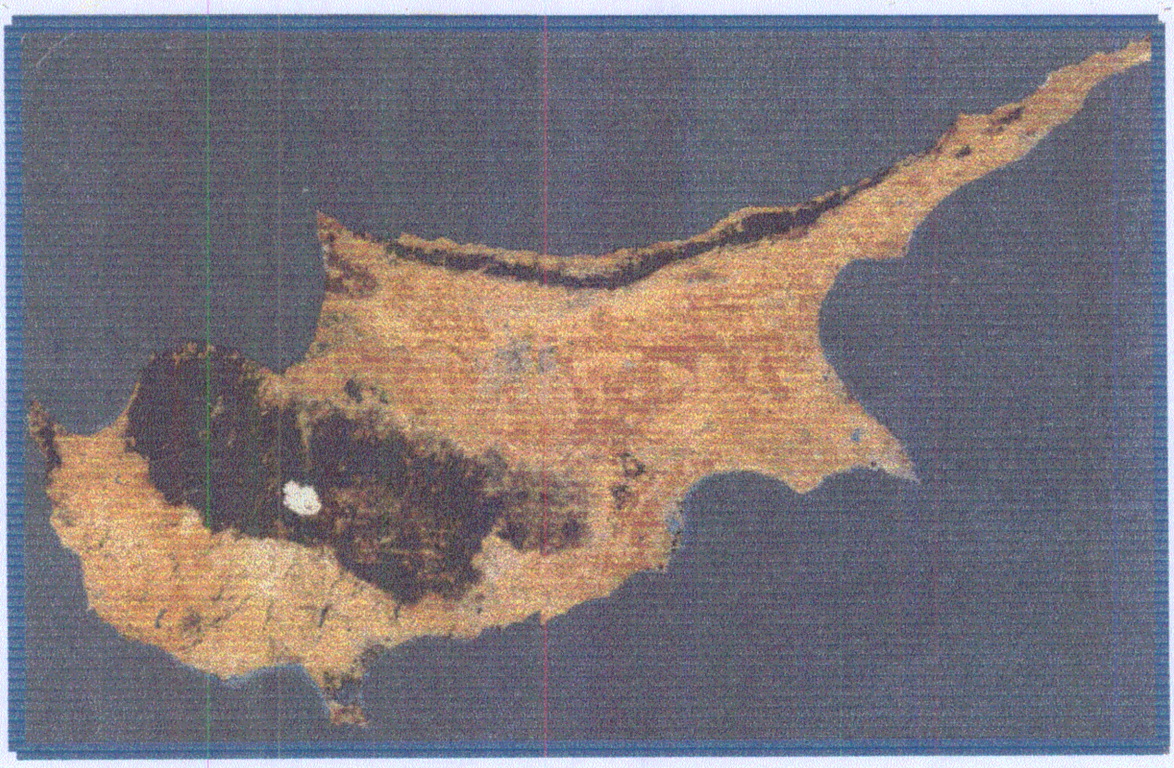

Figure 1.1.1: The Island of Cyprus

1.2. Water Resources:

The Issues in Hydrosystems Engineering are the optimal scale of development of the project as well as the optimal dimensions of the components of the systems focussing on its optimal operation. The Management of Water Resources is the coordinated action between the resource and its use today and in the future. The socioeconomic status of the resource and the methodology used is added to that process trying to harmonize the opposite sites. Figure 1.2.1 schematically shows various water uses and the general target of the management (Biswas, 1996)

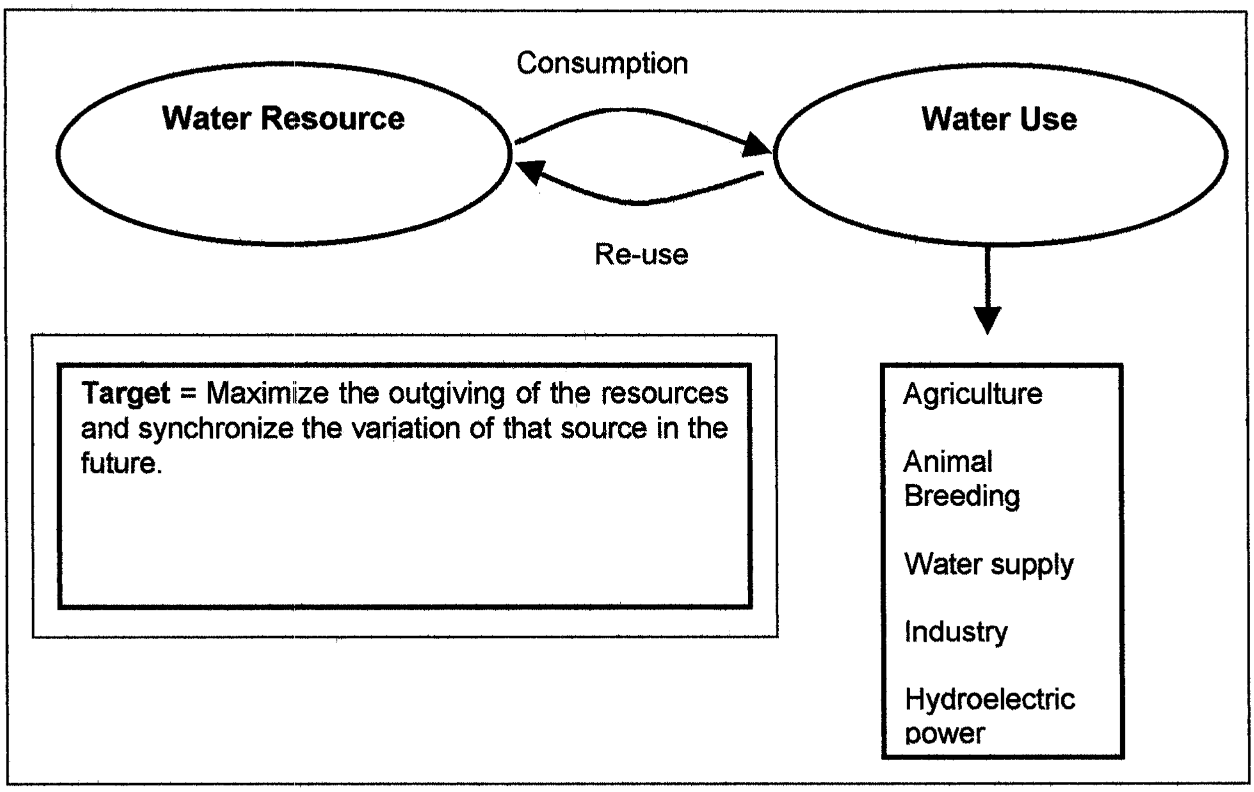

***Figure 1.2.1:** Water use representation*

All the Water Resources of Cyprus come from the rainfall and the little snowfall on the mountains during winter. Based on long-term observations, the mean rainfall intensity is 500 mm whilst over the last 30 years it has been dramatically reduced (Ministry of Agriculture and Natural Resources, Droughts). The total amount of water corresponding to the total area of the island is up to 4600 millions cubic meters (MCM) but only a percentage of 20% (900 MCM) are available for management since the remaining 80% is transferred to the atmosphere due to evapotranspiration processes. The mean annual distribution of the 900 MCM is about 2 : 1 in surface runoff and percolation to the ground water sources (600 MCM and 300 MCM respectively).

Despite the fact that across the coastal areas the rainfall intensity is very low, the main groundwater resources are spread there due to the sediment deposits and the alluvia transferred and deposited by the rivers. This specific composition of the ground has high permeability and permits the percolation and storage of the runoff water. So, from the 300 MCM that are stored in the ground layers, 270 MCM are pumped or over pumped from the boreholes, or come out as springs. It is estimated that about 70 MCM are lost to the sea, basically during winter months. From the surface runoff of 600 MCM, 150 MCM are diverted from the rivers during winter and spring for irrigation. The storage of the dams and lakes of the island is up to 303,8 MCM but the annual flow taken from them is 190 MCM. The rest of the surface waters, i.e. 260 MCM is lost to the sea.

1.3. Water Balance:

Refering to the above information, doing an annual balance of the water resources on the total inflow of 900 MCM per year, 67% is surface runoff, 33% is deep percolation 30% is pumping from boreholes or coming out of springs, 21% is mean annual flow from the dams and 17% is the diversion for irrigation. The sum of these flows represent a deficit of 5% which is the over pumping from the groundwater sources.

Total Area = 9251 km^2
Rainfall = 500 mm
Total Water Resources = 4600 Mm^3
80% Evapotranspiration = 3700 Mm^3

Net Water Resources = 900 Mm^3

Surface Sources
600 Mm^3
Diversions = 150
Dams = 190
Losses = 260

Groundwater Sources
300 Mm^3
Pumping + Springs = 270
Losses = 70
Over pumping = -40

***Figure 1.3.1.(a)**: Water balance representation*

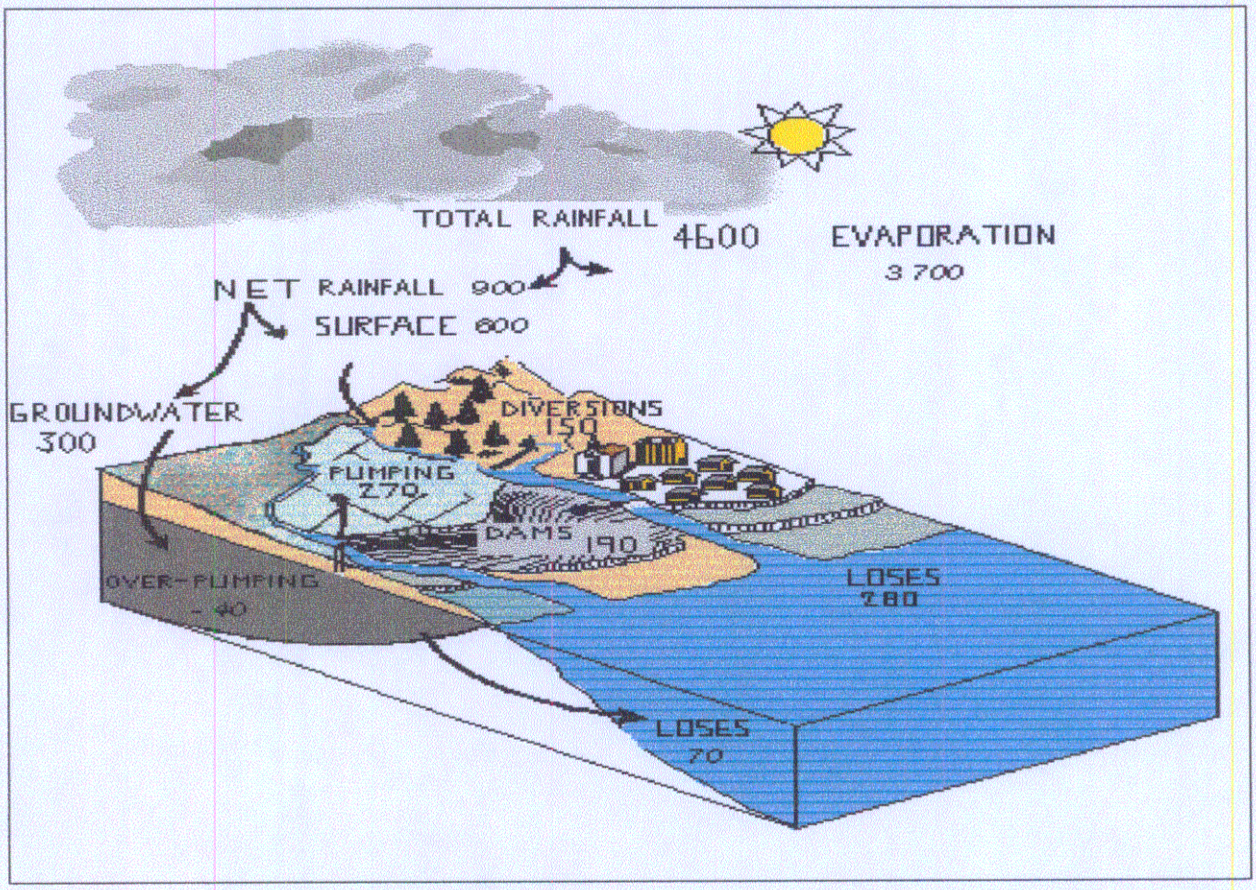

***Figure 1.3.1.(b)**: Water balance representation*

Related to the above water balance, the following bar charts show for the distribution of mean annual rainfall, the collection and storage of water in all the island reservoirs, since the year 1988.

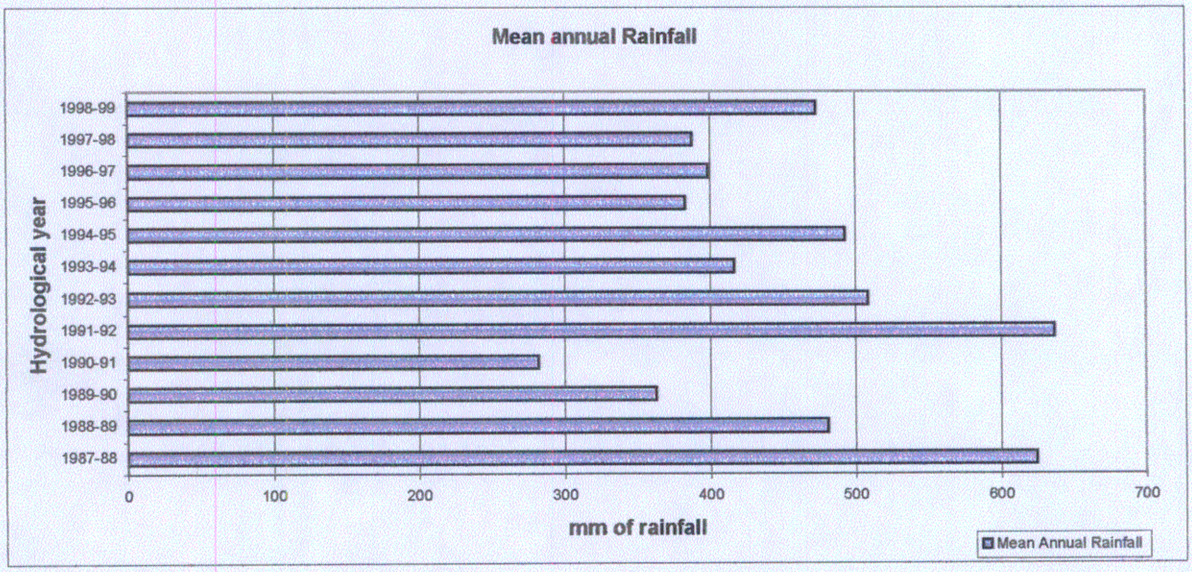

Figure 1.3.2.(a): Mean annual Rainfall on the Island of Cyprus

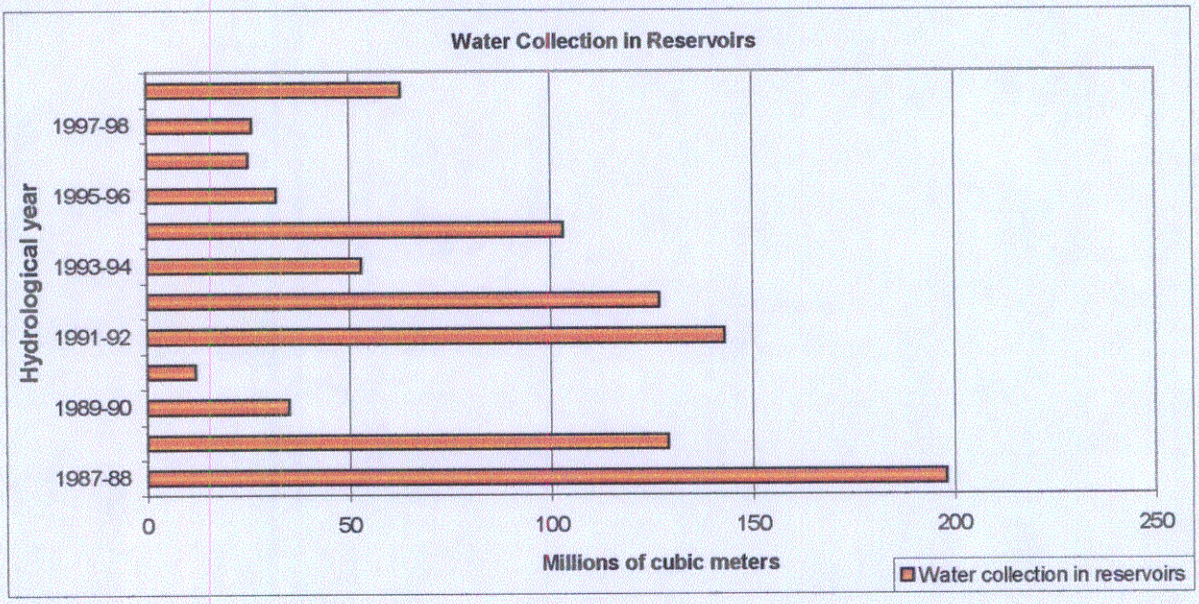

Figure 1.3.2.(b): Water Collection in Reservoirs of the Island of Cyprus

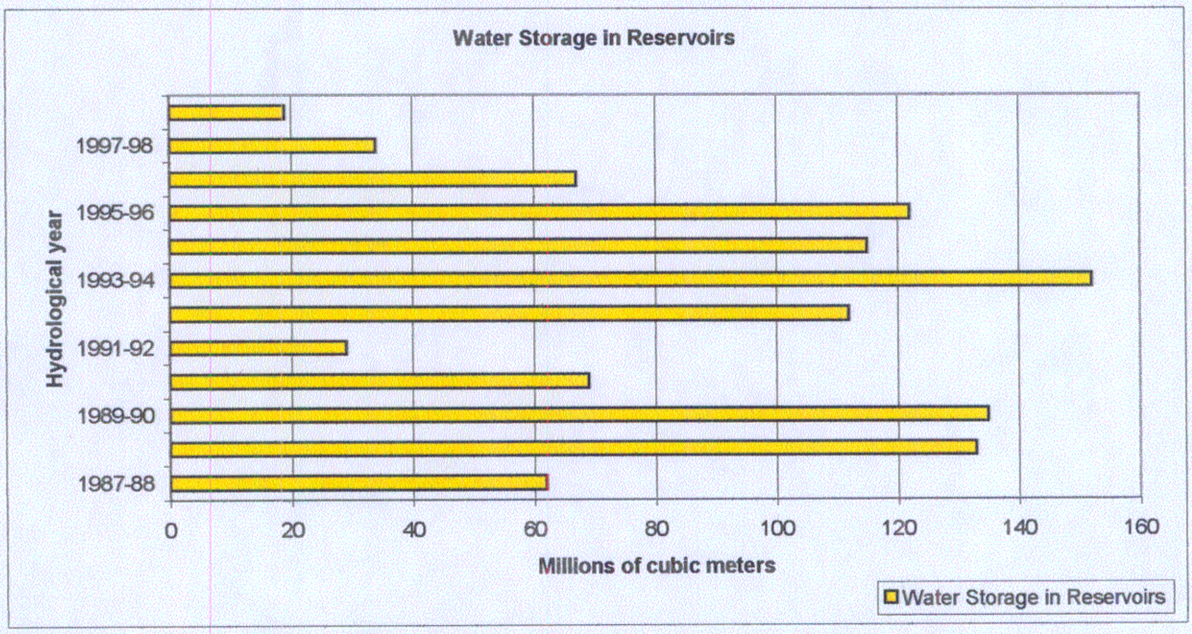

Figure 1.3.2.(c): Water storage in Reservoirs of the Island of Cyprus

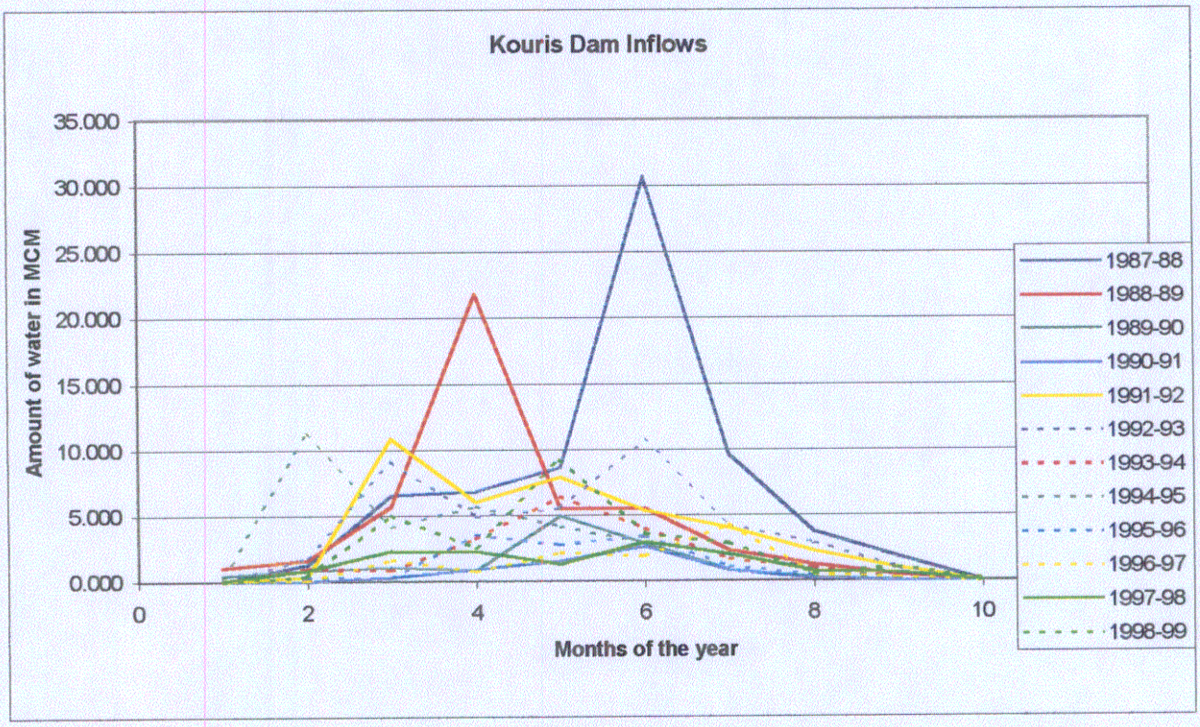

Figure 1.3.3: Kouris Dam Inflows

1.4. Government Framework:

The Government's planning of the water policy was well organized from the beginning of its existence, taking into account the possibilities of departments relative to the management of the water resources of the Island. The first Department dealing with water related issues was created in 1896 and named "Department of Municipal Works", having major responsibilities for the water supply and the irrigation (Socratous, 1981). Later on, it was renamed "Water Development Department" (WDD) and is under the authority of the Ministry of Agriculture, Natural Resources and Environment and reorganized in different sub departments for the satisfactory application of the government's water policy.

However, ideas for coordinated planning of the development of the southern Cyprus Rivers did not materialize until the independence of Cyprus and the creation of the Republic in 1960 (Charalambous, 1998). In 1961 the WDD first considered the possibility of developing groups of rivers. Aid and Development Agencies recommended the preparation of master water development plans for a series of inland rivers. By 1966 the ideas for utilization of the basins plus rivers to the east had developed to a larger extent.

The main objectives of WDD are the rationalization development and rational management of the Water Resources of Cyprus. Based on this framework, the aims of it are:

- Collection, sorting out and categorization of hydrological, hydro-geological and geotechnical data, necessary for the operation and safety of the Development Works.
- Study, Planning, Operation and conservation of the dams, lakes, irrigation networks, water supply networks, water treatment plans, desalination and recycling programs.
- Protection of the water resources and prevention of pollution.

The Department of Water Development is responsible for formulating national policy on water resources and for the planning, design and execution of government water policies. Water Development projects include domestic water supplies, irrigation and drainage projects, flood protection works, protection works against pollution of water resources, ground water recharge works and other relevant works.

Based on the fact that a huge growth of water resources planning, operation and management had occurred in all the Island areas, Water Boards in each city were created in order to incorporate within their areas both demand and distribution (local level). They are public utility organizations established and operating under the Water Supply (Municipal and Other Areas) Law. The Boards are semi-governmental; non-profit organizations; three of their members are appointed by the Council of Ministers and the local municipalities appoint the rest. The Boards have power to own and sell water. There is no Government subsidy to the Water Boards but the Boards set tariffs, approved by the Ministers and the Parliament.

The Boards' main objective is to provide sufficient and good quality water, at the lowest possible price to meet the domestic and industrial needs of its consumers (Charalambous, 1998).

The objectives of the Boards are accomplished by:

- Planning and execution of development projects,
- Operation and Maintenance of the water distribution network,
- The determination of water rates in order to finance the operating expenses and development projects of the Board, while remaining a non-profit making organization.

Distribution of water for domestic and industrial use, extension of pipelines, pipe installations, house connections to new plots of land maintenance, repairs of pipe networks are part of their remit operation.

The Government General Laboratory carries out the necessary chemical and bacteriological tests of water samples from all boreholes, reservoirs and from various points of consumption. These regular tests give a warning to the Board of possible pollution problems and are followed by the necessary corrective measures. Water supplied to consumers is safe to drink.

Given the conflicting actions of the numerous organizations dealing with and managing water, the lack of understanding and cooperation between them, there is no definitive classification and sorting of the objectives and actions (Mays, 1992). It is very important to have rationalisation for efficiency. So, a series of laws, borders and political frameworks mention the development and management of the Water Resources of the Country with very specific and analytical explanations of points of detail and references to the best way of protecting, developing and cooperating with them.

Their basic characteristics are:

- Propagation of the ideas and positions of the different actors involved
- Organized react ion to the different problems.
- The tuning and review of the field data collected.
- Protection of Environment.
- Water Resource Management.

All these measures seek to create and expand the water policy in order to have a development course maximizing the results of the productive operation and bringing uniformity to the different conflicting uses of water.

CHAPTER TWO:
Southern Conveyor Project

2.1. History:

The major concern of the Government's plans about the Irrigation areas of the island is the water resources, which are diminishing year-by-year and have no uniform distribution over the island of Cyprus. Both an increasing demand and a reduction in the supply of available water cause shortages of water for both agriculture and domestic consumption. Additional water supplies are therefore needed for reasons of social welfare, health and hygiene and there is little question that in agriculture water can be productively and economically used (Socratous, 1983). The resources of good land and skilled labour are available, as are crop markets and marketing systems, especially so in the case of the eastern part where the replacement of groundwater, is clearly the factor which will most limit continued agricultural production.

Over recent years, different ideas have risen and been implemented as large-scale projects in different areas of the island. These are responsible for the storage and delivery of water to the parts, which need it. Such programs involve reservoirs, local irrigation networks, management and abstractions from boreholes and recently some treatment plants (Konteatis, 1998). The construction of a huge project delivering water from the western part of the land to the eastern part where the main irrigation area is located and the biggest water problem exists, concerned the authorities since

1971. This project is called Southern Conveyor Project (SCP) and it is shown on the map of the Island in Figure 2.1.1.

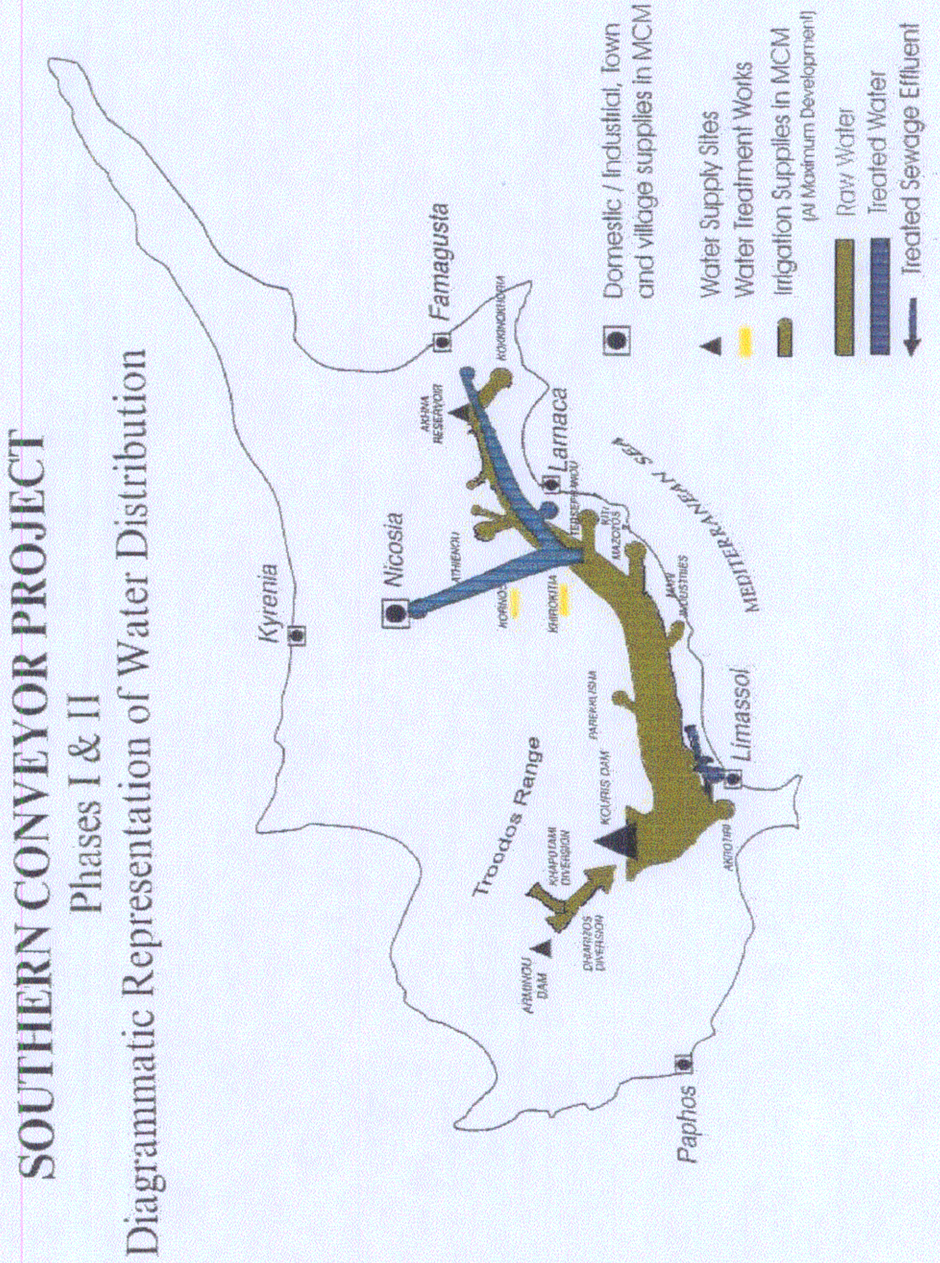

Figure 2.1.1: *Representation of the Southern Conveyor Project*

The Southern Conveyor Project is essentially concerned with the optimal development of the southern rivers and their associated alluvial aquifers, as well as other southeastern groundwater areas that depend on rainfall recharge. In terms of the Hydrometric Regions of the island (Figure 2.1.b.), as delineated in the early 1960's by the Water Development Department (WDD), the SCP primarily concerns the regions 1,7,8,9.

Precipitation is related to relief and potential supplies from Hydrometric Regions 1 and 9 (Figure 2.1.b) tend to dominate water resource development considerations. These two Regions receive more than 30% of the 4600 MCM of mean annual rainfall, although they only occupy 20% of the total area. The proportion of total Island-wide exploitable water resources is closer to 50%. The agricultural areas, which could benefit most from water resource development lay along low-lying coastal plains of Regions 1,8 and 9, plus much of the more arid Region 7 (Socratous, 1983).

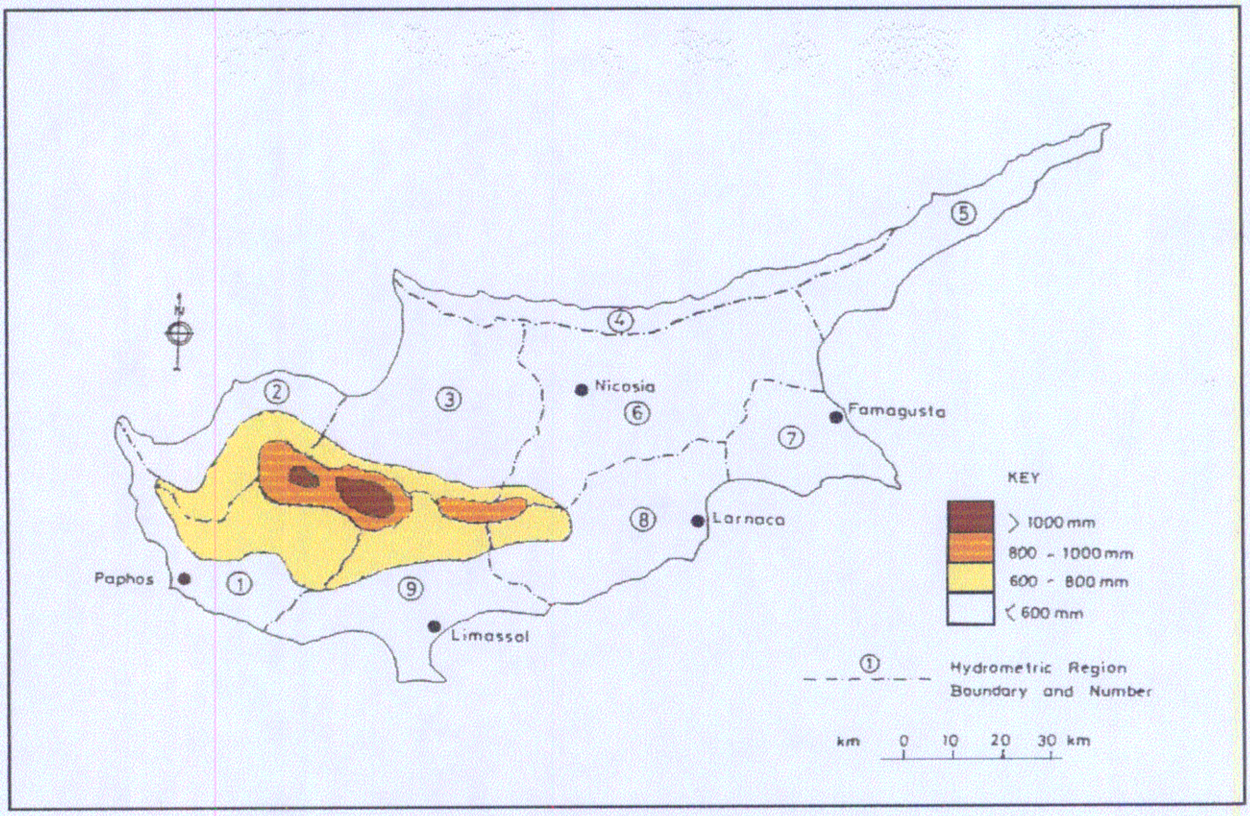

Figure 2.1.2: *The Hydrometric Regions of the Island*

The basic objective of the SCP is to collect and store surplus water which used to flow to the sea from the mountainous and relatively wetted part and convey it by means of a regional water carrier for use in areas where the water is most needed. In aiming to devise a socially and financially acceptable and economically viable scheme, the SCP promotes irrigated farming development in the south coastal region between Limassol and Famagusta that will benefit most from the Project. In addition the SCP will meet the future domestic and industrial water demands up to the year 2010 for the towns of Limassol, Larnaca, Famagusta and Nicosia and numerous village communities and also supply the needs of tourist development (Ministry of Agriculture and Natural Resources, 1983).

Following a pre-appraisal by a World Bank mission in Cyprus and because of the large size of the Project and its high financial cost, it was decided to implement the project in two phases. Phase 1 covered the irrigation requirements of Kokkinochoria and domestic water demands until 1993, whereas Phase 2 was expected to come into operation in 1998, which actually happened.

The build up in Project water supply and the demand is designed to serve for average year conditions. It is seen that the project as a whole supplies around 90 MCM/year at full development. During periods of shortage, occurring on average once every five years, a certain degree of rationing has to be imposed and tentative control rules used for the operation of Kouris Reservoir.

Further water was introduced to the SCP by raising the level of Yermasoyia Dam and increasing the reservoir storage by 10 MCM and also by building a new reservoir of 1 MCM at Pyrgos at Parekklisia Area. Both projects have been found to be technically feasible, as a result of investigations undertaken during the feasibility study.

2.2. Analytical Plan:

The initial ideas for the Southern Conveyor Project first a rose in the early 1970's and approaches were made to the ODA for technical assistance, which agreed to sponsor a study into the feasibility of a Southern Conveyor. A World Bank mission report suggested that such a study should be in two parts, with the initial stage to test the viability at a pre-feasibility study level. The Cyprus Government staff would be concerned with the overall master plan and with agriculture; consultants would be employed for the hydrological and engineering studies and the UK Water Research Association would develop and operate a systems economic model.

Negotiations continued into 1974 to enable terms of reference to be established for a combined study team, but the Turkish invasion in July 1974, postponed plans until further consideration. In late 1975 the situation was reviewed (Christodoulou, 1975). Missions from the World Bank offered assistance and eventually a further ODA mission in early 1977 produced detailed terms of reference for the study, which were soon accepted by the Government this enabling the project-study finally to be mounted in March 1978.

Water requirements in each area must be carefully considered and taken into account bearing in mind the optimum overall agricultural, industrial, domestic development of the southern part of Cyprus.

Intermediate objectives of this feasibility study were:

- To examine and advise on optimum irrigated farming development in the hydrological regions mentioned in Figure 2.1.2.

- To examine and advise on the feasibility and cost of supplying domestic, commercial and industrial water to Limassol, Larnaka, Famagusta and Nicosia, taking into account likely demand and irrigation areas.
- To examine and advise on the feasibility and economic viability of producing hydroelectric power at the proposed Dams at Arminou and Kouris.
- To prepare a report incorporating the results of the study in such a form as to be suitable for submission to an international financing organization with the object of securing finance for the recommended project.

In order to provide, as early as possible, information on the outline of a water and agriculture development strategy and to avoid detailed investigation of projects, which can soon be shown not to be economically viable, it was decided to carry out the Study in two stages. Stage 1 would concentrate on appraising the economic viability of the development options available, whilst Stage 2 would concentrate on developing the technical aspects and detailed costing for the recommended option.

During the Feasibility study in the form recommended, the Worlds Bank mission was primarily concerned with:

- Selection and evaluation of alternative development options, which were technically, socially and economically viable.
- Assessment of water resources in the four hydrological regions and the determination of any surplus water from transfer to the eastern regions.
- Survey of soils and land use within potential benefit areas of the study area, and identification of the most suitable irrigation areas in the light of potential crops and their water requirements.
- Compilation of domestic demands in the main cities of Limassol, Larnacca, Nicosia and the surrounding villages and tourist areas.

- Survey of sites and routes and outline engineering design with preliminary costing for the requisite hydraulic structures and irrigation networks.

- Development and use of a comprehensive system model.
- Financial and economic analyses as determined by hydrological, agricultural and engineering considerations.

After a comparison of four different alternatives in the feasibility study the chosen Proposal was to be implemented in two Phases.

***2.2.1. First Phase*:**

Phase 1 included the construction of the Kouris Dam, the main conveyor, the Akhna Dam and the Kokkinochoria Irrigation System. In 1992 just before the operation of the second Phase the project was expected to supply 33 MCM out of which 17 MCM was to be used for irrigation at Kokkinochoria and about 16 MCM would satisfy domestic demands. The construction of Phase 1 was expected to be completed in 5-6 years and cost around 95 million pounds.

Kouris Dam: This 115 MCM dam reservoir is the main water storage component and is designed to provide seasonal and inter-annual storage of the flows of the Kouris River and its tributaries. Such storage, by balancing the variable inflows, will permit a steady and reliable supply to the project benefit areas via the Southern Conveyor. The Kouris Dam, of zoned earth fill embankment construction is around 110m high. Its 5 km long reservoir has a surface area of 360 ha. Construction of the dam started in the later half of 1984 and was completed by the end of 1988. First impoundment was possible in November '87, when the outlet tunnel gates were closed. The contract for the construction of Kouris Dam was awarded to the joint venture Impregilo (Italy) with J&P (Cyprus) in July 1984 at a contract value of 19,954,512 pounds.

Figure 2.2.1.1: *Kouris Dam*

<u>Main Conveyor:</u> This is a 110km long pipeline of diameter ranging from 1440 mm down to 800 mm, which conveys the stored water to Akhna reservoir. A branch-off is allowed to recharge Yermasoyia Dam. A second branch-off supplements Vasilikos-Pentaskinos Project through a balancing reservoir. Two contracts were awarded to the joint venture of Cybarco (Cyprus) and Shand (UK) companies in October 1985 of a total contract value of 6,157,031 pounds. Installation of the main conveyor started late in 1985 and was substantially completed at the beginning of 1988. As from May 1988 water was supplied for irrigation to Kokkinochoria and other areas.

Figure 2.2.1.2: *Main Conveyor*

Akhna Reservoir: A 16 m high earth fill embankment dam retains 5.8 MCM of water, enabling the reservoir to provide balancing storage in the Kokkinochoria area. Water will be pumped to the nearby irrigation area at times of peak irrigation demand to supplement flows in the main conveyor and thus reduce the size of pipeline otherwise required. Work on the construction of Akhna Dam with a contract value of 1,312,980 pounds started in mid 1986 and was completed by the end of 1987.

Irrigation Network: An area of approximately 9000ha in the Kokkinochoria region will be irrigated through the 1st Phase of SCP. The works consist of:

- The laying of a 30 km long main conveyor by direct labor of the Water Development Department at an estimated cost of 897,000 pounds was completed in June '87.
- The construction of four irrigation-balancing reservoirs was awarded in April 1987 for a contract value of 1,416,964 pounds and was substantially completed within the first quarter of 1989.
- The construction of 15 central distribution points (CDP) reservoirs was awarded in April 1987 for a contract value of 1 416 964 cyp.pounds and was substantially completed within the first quarter of 1989.
- The construction of 15 CDP pumping stations and 4 other main pumping stations was awarded in March '87 for a contract value of 1 649 000 cyp.pounds and ended by the end of 1989.
- The construction of the secondary distribution system of a total length of 300km has been undertaken directly by the WDD. The estimate of this work was 4,500,000 pounds. The work commenced in January 1987 and was completed in 1990.
- A tertiary system was approved and consisted of a network reaching all farm parcels. Construction for this work started in mid 1989 and was completed by the end of 1990.

Farmers of the Kokkinochoria Area receive an "on-rotation" supply to supplement their existing groundwater supplies, which are protected from further decline. Recovery of water levels is possible by means of artificial recharge of the aquifer using the main conveyor supply from Kouris Reservoir.

Yermasoyia Reservoir: The mode of operation of this existing 14 MCM capacity reservoir changed with the advent of the SCP to allow water stored at its modest elevation to be more economically deployed in supplying Limassol for domestic water purposes. The shortfall in the domestic supply will be made good from Kouris Reservoir.

2.2.2. Second Phase:

Phase 2 included the construction of the Dhiarizos-Kouris Diversion, Irrigation Distribution System, Limassol Sewage Tertiary Treatment and Domestic Water Supply. The Phase 2 of the construction was competed by 1998 and cost around 75 million pounds. Table 2.2.2.1. shows the activities of the two Phases, while the Tables 2.2.2.2. (a,b) the time taken for each one to be completed.

Dhiarizos-Kouris Diversion: After several years of Project operation the inflow to Kouris Reservoir would be supplemented by flows from the upper Dhiarizos and Khapotami Rivers (21 MCM/year) diverted by gravity through a pipeline and 16 km of tunnel bored through chalky rocks.

Limassol Sewage Tertiary Treatment: A sewage treatment works for Limassol is scheduled for operation in the early 1990's. The SCP will treat the effluent with a further process to enable pumped supplies to be blended with conveyor water and thus permit unrestricted irrigation use in the Akrotiri Area.

Irrigation Distribution Networks: SCP supplies an area of 4300 ha. The Akrotiri (1755 ha), Pareklisia (320 ha), Mazotos (660 ha) and Kiti (1600 ha) areas plus a small area of the Vassilikos-Pentaskinos Project are directly supplied via branches from the main conveyor. An irrigation area at Avdimou receives indirect supplies by means of non-Project transfers from the Kouris River tributary upstream of Kouris Reservoir. The first four irrigation areas have been designed as "on-demand" systems with buried pipelines delivering water to farm outlets at sufficient pressure to enable full use of modern irrigation equipment. Balancing the peak daily demands will be achieved by night storage reservoirs. This component includes all connecting and distribution pipes and regulating tanks between the SCP main conveyor and hydrants at farm level. About 2 300ha of the total area were consolidated and new farm roads have been constructed.

Domestic Water Supply: Three treatment works treat raw water from Kouris and Yermasoyia Reservoirs for delivery to the towns of Limassol, Larnaka and Nicosia, the coastal tourist development of Limassol, Larnaka and Famagusta Districts and some 56 villages within reasonable distribution range of the conveyor and its supply branches. Nearly 200 km of treated water pipeline is required.

- For Limassol: Untreated water main from the Southern Conveyor to the treatment plant, water treatment works and conveyors from treatment plant to service reservoirs. The raw water flows to the plant by gravity through the system. It is treated by coagulation, flocculation, clarification, and filtration and dosing of chlorine and lime. The WDD directs the plant.
- For Nicosia and Larnaca: Untreated water main from Southern Conveyor to site of treatment plant, water treatment works (Tersephanou Plant) and main conveyor from Tersephanou to Nicosia service reservoir at Lakatamia (about 35 km away) including pumping stations and balancing reservoirs. For Larnaca there is a storage tank including the necessary pipeline connections. The WDD direct these plants.

PHASE I	PHASE II
1. Kouris Dam	1. Dhiarizos Diversion
2. Main Conveyor and VPP Connection	2. Akrotiri Irrigation System
3. Akhna Dam	3. Kiti Irrigation System
4. Kokkinochoria Irrigation System	4. Parekklisia Irrigation System
5. Athienou Irrigation System	5. Mazotos Irrigation System
6. Troulli-Avdelero Irrigation System	6. Aradhippou Irrigation System
7. Domestic Water Supply Dev.	7. Land Consolidation
8. Central Control System (Telemetry)	8. Limassol Water Treatment Works
9. Land Consolidation	9. Tersephanou Water Treatment Works
10. Farm Roads Outside Land Consolidation Area at Kokkinochoria	10. Tersephanou- Nicosia Conveyor
	11. Regional Water Supply Scheme (Villages West of Limassol)

Table 2.2.2.1: Phases I, &II List of Activities.

PHASE I	ORDER TO COMMENCE	COMPLETION DATE
1. Kouris Dam	1984	1988
2. Main Conveyor and VPP Connection	1985	1988
3. Akhna Dam	1986	1987
4. Kokkinochoria Irrigation System	1987	1989
5. Athienou Irrigation System	1991	1994
6. Troulli-Avdelero Irrigation System	1991	1994
7. Domestic Water Supply Deviation	1985	1989
8. Central Control System (Telemetry)	1992	1994
9. Land Consolidation	1988	1995

Table 2.2.2.2.a: Phase I time schedule

PHASE II	ORDER TO COMMENCE	COMPLETION DATE
1. Dhiarizos Diversion	1990	1994
2. Akrotiri Irrigation System	1988	1989
3. Kiti Irrigation System	1993	1998
4. Parekklisia Irrigation System	1993	1997
5. Mazotos Irrigation System	1998	1999
6. Aradhippou Irrigation System	1995	1999
7. Land Consolidation	1989	1995
8. Limassol Water Treatment Works	1989	1994
9. Tersephanou Water Treatment Works	1995	1997
10. Tersephanou- Nicosia Conveyor	1996	1998
11. Regional Water Supply Scheme (Villages West of Limassol)	1992	1994

Table 2.2.2.2.b: Phase II time schedule

2.2.3. System Representation-Operation:

The Schematic representation of the system of SCP as it operates nowadays is shown in the following Figure 2.2.3.1. The different incoming and outgoing points are clearly marked and discussed later on giving a more spherical idea of the operation of the whole system.

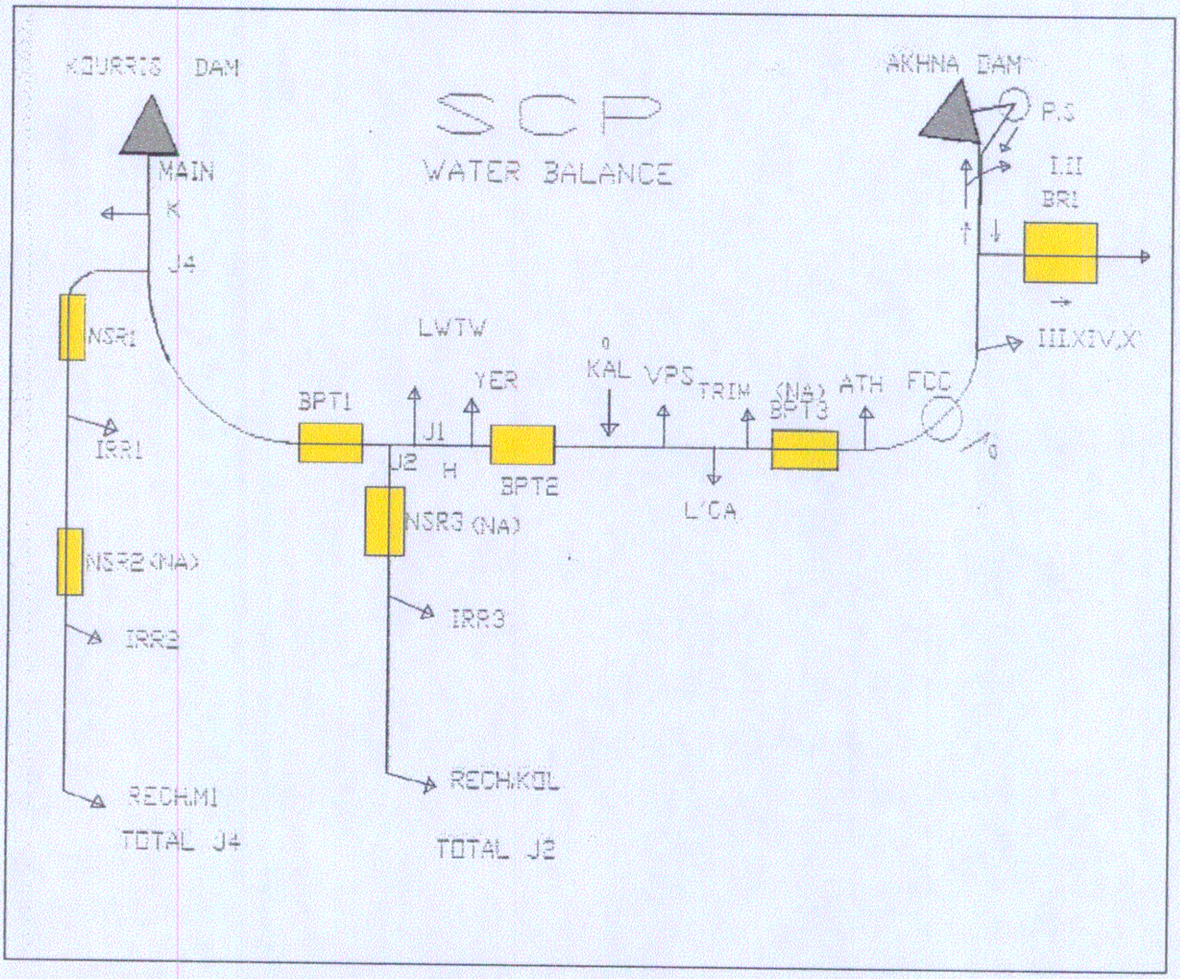

***Figure 2.2.3.1:** System Representation and Operation*

Kouris Dam: The starting point of the System having the major part of the operational decisions and rules of the main pipeline.

Akhna Dam: The final destination of the water flow in the main pipeline.

_K, J4, J2:_ Branches of the main Pipeline to provide water for irrigation in the area of Limassol.

YER: Water provided to the Yermasoyia Aquifer for recharging purposes

LWTW: Exit of the system for domestic supply of the area of Limassol, (Limassol Water Treatment Works)

BPT1-3: Pressure Break Points along the main pipeline in order to avoid the damage of the pipes due to high pressure conditions

KAL-VPS: Connection of the system with the projects Vasilicos Pentaschinos and Kalavassos Dam

TRIM, ATH: Irrigated water for the area of Larnaca

_I-XV:_ Different exits of the main branch for irrigation of the Famagusta area.

2.3. Technical Description:

Different Contractors constructed the parts of the Southern Conveyor Project on the basis of the European legislations and construction codes (Socratous, 1983). The characteristics of these activities are presented on the Tables 2.3.1. and 2.3.2 point out their most important technical features.

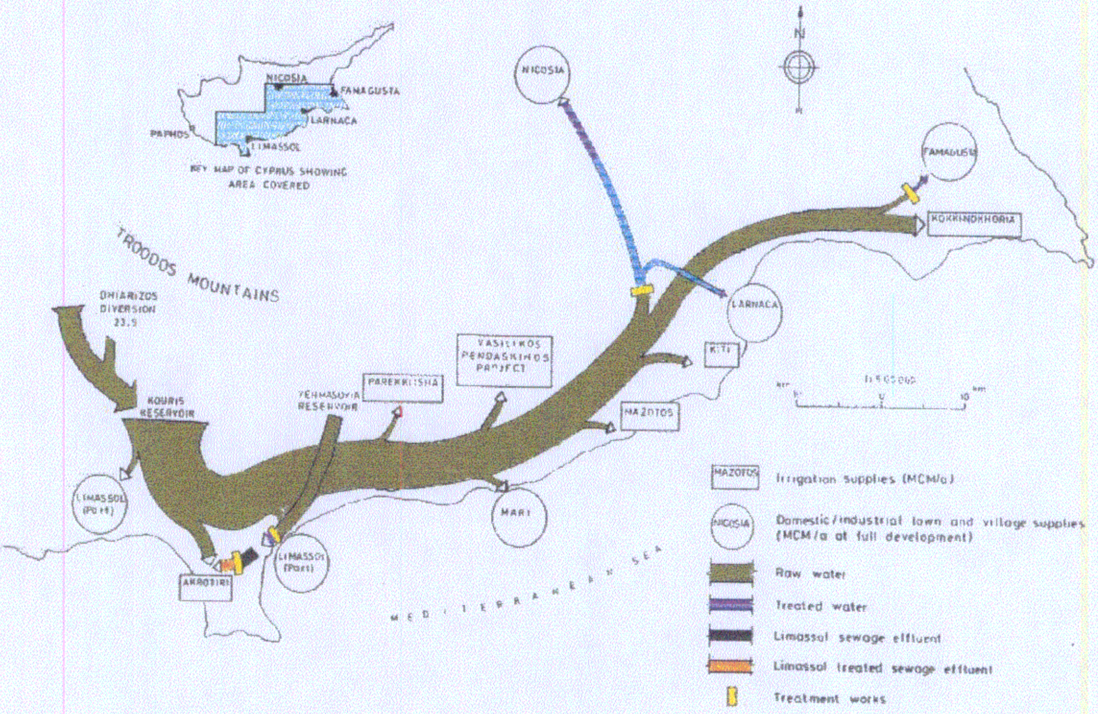

Figure 2.3.1: *The Southern Conveyor System*

PHASE I	TECHNICAL FEATURES
1. Kouris Dam	Earth fill, with central clay core Storage capacity: 115.0 MCM Embankment Height: 113.0m Maximum Spillway discharge: 1925 m^3/s Length/Area of reservoir lake: 5 km/360 ha Catchment area: 308 km^2
2. Main Conveyor and VPP Connection	Length: 109.81 km Type/Diameter of pipes: Ductile iron/1400-600 mm Break pressure tanks: 3 Overvelocity valves: 10 Offtakes: 29
3. Akhna Dam	Earth fill, with central clay core Storage capacity: 6.8 MCM Maximum spillway discharge: 32 m^3/s Area of reservoir lake: 116 ha
4. Kokkinochoria Irrigation System	Number of reservoirs: 4 Storage capacities: 52 592 cm Number of central distribution points: 15 Number of pumping stations: 19 Outstation control buildings: 3 Total length: 29.4 km Type of pipes/Pipe diameters: Ductile iron-cement/300-1000 mm
5. Athienou Irrigation System	Conveyor length: 12 km Type/Pipe diameter: Ductile iron/450 mm Number of reservoirs: 2 Number of pumping stations: 1 Irrigated area: 451 ha
6. Troulli-Avdelero	Length: 3.88 km

Irrigation System	Type/Pipe diameter: Cement/400 mm
7. Domestic Water Supply Deviation	No data
8. Central Control System (Telemetry)	No data
9. Land Consolidation	Total length of roads: 170 km Total Land consolidation area: 849.7 ha

Table 2.3.1: Technical Description of the Activities of Phase I

PHASE II	TECHNICAL FEATURES
1. Dhiarizos Diversion	Tunnel Length: 14.5 km Diameter of tunnel: Variable 2.4-2.5-2.6 m Length of diversion pipe: 1.59 km Diameter of diversion pipeline: 1.6 m Flow/Velocity: 6.5 m^3/s /1.3 m/s Average annual flow: 21 MCM Period of diversion: November to April
2. Akrotiri Irrigation System	Total length: 14.2 km Diameters /Type: 200-1000 mm/ Ductile iron-Cement
3. Kiti Irrigation System	No data
4. Parekklisia Irrigation System	Total length: 9.4 km Pipe diameters: 200-400 mm Type of pipes: Ductile iron- Cement
5. Mazotos Irrigation System	No data

6. Aradhippou Irrigation System	Pipe diameters: 100-450 mm Type of pipes: Ductile iron- Cement Total length: 6 km
7. Land Consolidation	Total length of roads: 164.4 km Total Land consolidation area: 2221 ha
8. Limassol Water Treatment Works	Present capacity: 40 000 m^3/day Ultimate capacity: 80 000 m^3/day Type/No filters: Gravity sand filters/ 6 Chemicals: Chlorine, lime, aluminium sulphate, Polyelectrolide Progress: Coagulation, flocculation, clarification, filtration dosing of chlorine and lime. Use of activated carbon and Ozonation are options, if needed
9. Tersephanou Water Treatment Works	Present capacity: 60 000 m^3/day Ultimate capacity: 90 000 m^3/day Type/No filters: Gravity sand filters/ 8 Chemicals: Chlorine, lime, aluminium sulphate, Polyelectrolide Progress: Coagulation, flocculation, clarification, filtration dosing of chlorine and lime. Use of activated carbon and Ozonation are options, if needed
10. Tersephanou- Nicosia Conveyor	Length: 36.5 km
11. Regional Water Supply Scheme (Villages West of Limassol)	Length: 27.19 km Type of pipes: Ductile iron- cement Diameter of pipes: 700-150 mm

Table 2.3.2: Technical Description of the Activities of Phase II

CHAPTER THREE:
Alternative approaches to water management

3.1. Large-scale Government Efforts:

The drought period, which has characterized the last five years, has contributed to the widening of the gap between supply and demand. To meet this growing gap over the long-term, the Cypriot Government, viewing the Water Resources Management of the island decided to introduce to the whole Water System different ways of saving water. They moved into the next stage of policy by establishing water treatment-units for sewage water for agriculture and to the commission of desalination units as the main source for water supply for domestic purposes.

3.1.1. Desalination Plants:

There is already one Desalination Plant in Dekelia area producing water sold to the Water Boards of Nicosia and Larnaka for Domestic Supply. This Plant was constructed during 1997 generating up to 13.10 MCM of water per year (40 000 m^3 per day). By the end of year 2000 another Desalination Plant will operate near the city of Larnaka covering more of the water supply needs of the town.

The Desalination units must obviously be on the coast so that the very large quantities of seawater are readily available (Konteatis, 1998). Further to minimize the pumping costs of the seawater, the station must also be as near sea level as is practicable. The quality of the available seawater becomes of major significance since, for optimum performance, "pure" seawater of consistent quality is required. Water users are in general more sensitive to changes in the concentration of normal water constituents than they are to their absolute level. This is particularly true in relation to the taste and odor of water. Water for public supply should fulfill 3 requirements

- It should be free from toxic and harmful constituents
- It should be pleasant in appearance and taste
- It should not interact unfavorably with materials of construction in the distribution system

This process yields water that is considerably softer and lower in dissolved solids than many conventional domestic supply waters. Distilled water invariably contains much lower concentrations of dissolved atmospheric gasses than natural water. It also tends to have higher temperature than the water used so far from treatment plants.

It is known that the product water from a distillation plant is not particularly palatable and there are two ways of remedying this, either by adding hardness forming salts to the desalted water or by blending it with at least an equal quantity of water from an alternative source (Buras, 1972). The processes may be necessary to prevent corrosion of, or removal of deposits in existing mains. This immediately restricts the number of suitable sites for a large scale combined plant because there are few places in the country where an equal quantity of blending water is also available at some point convenient to the projected plant site.

There was a massive argument about the location of the second Desalination Plant because no one wanted the Plant to be in his area. That caused major problems to the water production and hence to the management of the existing resources of the island. Nevertheless, the Government's plans are concentrated on the future installation of 3 more desalination plants. From the amenity viewpoint, if the selected site is one of considerable natural beauty, objections are lodged by some sectors of the community and the site should have to have compelling technical advantages for these objections not to be upheld. However people should realize the extent of the water problem and cooperate with the authorities in the effort of saving as much water as possible (Staudenmann, 1996).

Desalination water still has high costs and hence it is considered inappropriate for widespread use in agriculture. However, studies are under way for establishing whether it is economically feasible to use it for cash crops such as flowers.

3.1.2. Water Recycling:

By the end of the construction of Limassol Wastewater Treatment Plant, it was decided to have some wastewater treated for irrigation purposes in the whole region of the city area. At the present time, there is an amount of 12 000 m^3/ day produced by the treatment plant and it is expected to rise up to 44 500m^3/day by the end of year 2010 (total annual production 10.60 MCM). The major target of this operation is the substitution of the water from the dams with recycled water, wherever this is possible for agriculture and industrial use, in order to save the largest possible amount of water for domestic use.

In addition to this, water is stored in the ground sources by applying recycled water to the ground in order to percolate and reach the lower layers of groundwater sources and hence pumped it and use it. This kind of recycling of water has been applied for the last three years sufficiently for the:

- Development of new water resources

- Prevention of salination of the groundwater sources, especially on the coastal areas from the reverse movement of seawater in the ground layers.
- Development of a water resource policy

Around the world, governments exhort sewage treatment works to use the best available techniques not entailing excessive cost. Internal and external re-use are both attribute to the dual supply uses. In some cases, most significantly in the industrial sector, consumers that do not exhaust all the water supplied to them are able to re-use that supply for themselves, over and over again, although water treatment may be required as part of this loop. The advantage to the consumer and to the environment is that such internal re-use necessitates less primary abstraction to meet consumption requirements (Merret, 1997). Use of waste water for irrigation is a low-cost source of water, an economical way to dispose of wastewater to prevent pollution and sanitary problems, an effective use of plant nutrients contained in wastewater and providing additional treatment before being recharged to the groundwater reservoir.

With external re-use, a consumer, whether household, farmer or industrialist, uses its water supply, and then the wastewater is supplied to another institution. With both internal and external re-use, the wastewater often requires treatment. Re-use can be seen as a supply-side innovation (Pearson, 1983). At the same time, it brings about a lower aggregate consumption of water by the community as a whole than would happen in the absence of re-use, and, in that sense, re-use can also be regarded as a form of demand management.

The domestic wastes are treated with respect to the substances they contain and to the purposes for which they are planed to be used. It should be mentioned that the nutritients existing in the organic mater of the wastes give them an additional advantage for use in agriculture (Konteatis, 1998). The process of deep percolation into the ground, gives an additional natural treatment to the recycled water. The Limassol Wastewater Treatment Plant has three stages of treatment:

- Anaerobic Ponds, which allow to the anaerobic bacteria to act on the wastes and produce gases escape and sedimentation of the different solids.
- Facultative Ponds, which give the removal of the organic matter up to 90%-95%
- Maturation Ponds, where the removal of nitrogen and phosphorus take place as well as the filtration of the treated wastes. Chlorination takes place.

Treated sewage has high transportation costs due to the misalignment of the areas where sewage is collected and those areas where it is to be used. Hence it is anticipated that in addition to agriculture it will be used for various amenities, such as hotel gardens, parks and football fields.

3.2. Small-scale Government Efforts:

The WDD is trying to make citizens realize the dramatic water problem the island of Cyprus, has actively involved them in the water economy procedure and policy of not spending water regardless, it thus gives a symbolic amount (100 pounds) for the drilling of new boreholes in house yards. The water pumped out from them would be used for the irrigation of gardens and houseplants of the houses. The houses allowed to have such boreholes are those that are connected with local Water Boards taking their water from the Government's Water Works, part of them being the Southern Conveyor Project.

Another Government policy plan is financial assistance to connect the drilled boreholes mentioned above with the WC's of the houses. Such a connection saves up to 28% of water used for WC's so far. The amount given varies depending on the number of different connected appliances and on the kind of the building they supply. (Houses, Hospital, Offices, Hotels.)

The government also gives money for the installation and operation in homes of recycling greywater systems which re-use water for WC's, garden irrigation. With such a system a percentage of 33% of drinking domestic water is saved. Compared to ordinary wastewater, greywater contains less organic matter and only small amounts of plant nutrients. Hence local discharge after simple treatment is possible. Greywater composition is subject to wide fluctuations, which have to be taken into consideration during the sampling procedure. The concentration of a single greywater source could vary widely.

Treated greywater can be used for purposes that do not require potable water, like irrigation and toilet flushing (Staudenmann, 1995). Greywater can be treated in a simple way, close to home, then reused or disposed to a local stream or soil. For safe reuse of treated greywater, it is important to know what to remove during treatment, or what to avoid putting into the sink. For houses, 200 cyp.pounds are given and for the rest of the building types 20% of the cost of installation of the system.

People fill up the special forms and submit them together with the paper confirming the installation of all the previous appliances to their houses, to the local offices of WDD, in order to collect their money.

Based on a typical sample of Households having drilled boreholes, a tremendous reduction in water consumption and money saving is shown especially during the summer months, as shown by the comparison between the consumption before and after the borehole drilling (Statistical and Research Department). A mean reduction in consumption of 76% during summer months and a total mean consumption reduction of 54% were found. Concerning now the savings on the bills paid, a reduction of about 85% during the summer period and a 67% reduction on an annual basis are observed. These calculations show roughly that the policy of the Government to encourage users to follow all these alternative ways of limiting the consumption of domestic water is successful as well as popular with the citizens.

Given overall population trends, economic developments, rising incomes and new activities, compared to the potential for additional water supplies, the conclusion that can be drawn is that the conventional sources will not be able to match the increasing demand for water from households, industry, tourism and irrigated agriculture. Hence, the emphasis on the construction of desalination treatment units is in order to ensure that water is provided on a continuous basis to households.

CHAPTER FOUR:
Demand and Supply

The consumption of fresh water is most conveniently analyzed from the point of view of two large headings: domestic and agriculture. Domestic water is the water provided to households for their needs. Consumption by humans and from the variety of house appliances is included in this category. In the specific case studied in this project, water consumed for industrial purposes is included as well in the domestic consumption for the Island of Cyprus. In industry, water fulfils a multiplicity of functions, including cleaning, cooling and power generation. The agriculture water is a raw material required for the production process (Merrett, 1997). In farming, water is a biological necessity for the growth of plants and the raising of livestock.

Merrett (1997) distinguishes the concepts of water use in three different categories. The first one is the *need for water*, which has already been described above. The second water-use concept is that of *consumption or demand*, which refers to the quantity of water used by a single consumer in any given time period. The third water-use concept is specifically that of economist and is *effective demand*. This is the relationship, at a given time and within a defined market, between price per unit of a product or service and the quantity in each time period that consumers are estimated to be willing to purchase at each price. It is a price-relation function.

With component forecasts, the different categories of water consumption are identified and their rates of growth into the future are estimated using demographic and economic projections relevant to each category (Eavis, 1981).

The basis of the effective demand is the willingness and ability of households, farmers and industry to purchase water in defined amounts. When the conditions of demand are stable, the price-quantity relationship can be derived; that is, the proportionate change in quantity purchased divided by the proportionate change in price. An extended explanation of the effective demand is met in Chapter Six of this Study. This Chapter represents the Water needs and Consumption for both Domestic and Agriculture purposes.

4.1 Domestic Needs and Consumption:

Based on the needs of the Feasibility Study, done for the construction and operation of the SCP Project, demographic data were collected from the department of Statistics and Research of the Ministry of Finance. The population size in all the areas included in the Project, was written and mathematically projected in the future, until the year 2010. Then the calculation of the needs of those numbers, give the domestic demand of these areas. (Socratous, 1981)

During the operation of the system and some years after the previous demographic data collection, the actual values of water demands appeared. Having this new data as a basis, the Water Development Department did a correction of the correspondence values given in the Feasibility Study and re-estimated the future demand expected from the same areas up to year 2005 (Socratous, 1995). This latest version of demands for the areas involved in the SCP is presented in the Table 4.1.1 below.

However, both the SCP and the non-SCP sources should satisfy this Domestic water demand. Non-SCP sources are the local aquifers with drilled boreholes to the areas included in the project, which provide the Water Treatment Plants of the Towns with Domestic water. These groundwater sources were examined and their availability was estimated. Hence, the amount of water taken from these was known, and could also give a future estimation for their existence. The Desalination Plants described later on Chapter Five are included in this category as well. So, the deficit of the demand minus the water from the non-SCP sources gives the water that is, or should be provided by the Southern Conveyor Project. The following Table 4.1.1 gives this classification of the demands and the water supplied, or suppliable during the operation of the Project and in its future management.

It should be mentioned that this table only has the four major areas included in the project but each one has the values for the villages, the town and the tourism consumption. In the special case of the Larnaca Area, the domestic supply needs include the industrial purposes of the Mari Area. The population projections and the per capita consumption assumptions are very reasonable, taking into account the long-term use of the assumptions for capacity design purposes (Feasibility Study, 1981).

The treatment and conveyance losses are estimated to be 5.5%. All the demands for treated water are therefore increased by 5.5% to derive the gross demand figures on SCP system. The demand of Industrial Areas is taken as untreated demand, and hence no extra amount for treatment is added on water used for Industrial purposes.

DOMESTIC WATER DEMANDS (MCM)								
	DOMESTIC DEMANDS				*NON SCP SOURCES*			
Year	**Limassol**	**Larnaca**	**Nicosia**	**Famag.**	**Limassol**	**Larnaca**	**Nicosia**	**Famag.**
1988	13.50	5.00	13.40	5.10	14.70	1.00	15.80	4.60
1989	13.90	5.10	14.20	5.30	14.70	1.00	15.60	3.80
1990	14.30	5.10	14.50	5.80	14.70	1.00	15.60	3.00
1991	15.00	5.10	14.80	6.00	14.70	1.00	15.60	2.70
1992	15.70	5.20	15.00	6.10	14.70	1.00	15.60	2.50
1993	16.40	5.30	15.30	6.30	9.00	1.00	15.00	1.70
1994	17.10	5.70	15.40	6.40	9.00	1.00	15.00	1.70
1995	17.90	7.20	15.80	6.50	9.00	1.00	15.00	1.70
1996	18.60	7.60	16.00	6.60	9.00	1.00	15.00	1.70
1997	19.20	7.80	16.30	6.70	9.00	7.80	21.30	1.70
1998	19.90	8.00	16.50	7.00	9.00	14.10	21.10	1.70
1999	20.60	8.20	17.00	7.40	9.00	14.10	20.90	1.70
2000	21.30	8.40	17.40	7.70	9.00	27.10	20.70	1.70
2001	21.80	8.60	17.80	7.80	9.00	27.10	20.50	1.70
2002	22.20	8.70	18.10	8.00	9.00	27.10	20.40	1.70
2003	22.60	8.90	18.40	8.10	9.00	27.10	20.20	1.70
2004	23.10	9.00	18.80	8.30	9.00	27.10	20.10	1.70
2005	23.60	9.20	19.10	8.40	9.00	27.10	19.90	1.70

Table 4.1.1: *Domestic Water Needs and Consumption*

4.2 Irrigation Needs and Consumption:

The total irrigable land available in each project area has been determined, based on information in Volume 4 of the Feasibility Study Report. In most areas the total irrigable land, i.e. the area that is suitable for irrigation is much greater than the local sources available to irrigate these areas. As regards the existing irrigation, the area that is presently irrigated and the quantities of water used in this area have been determined using the information available in the "Groundwater Sources", volume 3 of the Feasibility study. As Government Policy described in Chapter Five, is very strict, there are not going to be any additional Irrigated Areas in the whole of the Island due to the occurrence of drought years (See Chapter Five).

The deficits have been estimated on the assumption that the present use of irrigation water on a per hectare basis is required to irrigate the rain fed irrigable land. The irrigation water use per hectare may vary from area to area mainly because of different cropping patterns (Nicolaou, 2000). However, these variations are small.

In the same way as for Domestic use, another table is produced for the irrigation needs of the agriculture areas of the project. An extension until year 2005 is made based on statistical estimators extract from the present values compared to the previous estimations the WDD made. The following Table 4.2.1 gives the Water Demands for Irrigation in the same areas as the previous one. Nicosia does not have Irrigable areas and hence it does not appear on this table. The table also gives the different sources of water needed i.e. Non-SCP and SCP sources.

IRRIGATION WATER DEMANDS (MCM)						
	IRRIGATION DEMANDS			*NON SCP SOURCES*		
Year	**Limassol**	**Larnaka**	**Famag.**	**Limassol**	**Larnaka**	**Famag.**
1988	32.10	29.00	49.40	20.10	2.90	8.00
1989	32.10	29.00	49.40	20.10	2.90	8.00
1990	32.10	29.00	49.40	20.10	2.90	8.00
1991	32.10	29.00	49.40	20.10	2.90	8.00
1992	32.10	29.00	49.40	20.10	2.90	8.00
1993	32.10	29.00	49.40	20.10	2.90	8.00
1994	32.10	29.00	49.40	20.10	3.50	8.00
1995	32.10	29.00	49.40	20.10	3.50	8.00
1996	32.10	29.00	49.40	20.10	3.50	8.00
1997	32.10	29.00	49.40	20.10	3.50	8.00
1998	32.10	29.00	49.40	30.70	3.50	8.00
1999	32.10	29.00	49.40	30.70	3.50	8.00
2000	32.10	29.00	49.40	30.70	3.50	8.00
2001	32.10	29.00	49.40	30.70	3.50	8.00
2002	32.10	29.00	49.40	30.70	3.50	8.00
2003	32.10	29.00	49.40	30.70	3.50	8.00
2004	32.10	29.00	49.40	30.70	3.50	8.00
2005	32.10	29.00	49.40	30.70	3.50	8.00

Table 4.2.1: *Irrigation Needs and Consumption*

4.3 Total Needs and Consumption:

The following table summarizes the data presented in the two previous ones.

	DOMESTIC DEMANDS (MCM)				IRRIGATION DEMANDS (MCM)			TOTAL NON SCP SOURCES (MCM)			
Year	Lim.	Larn.	Nic.	Fam.	Limas.	Larn.	Fam.	Lim.	Larn	Nic.	Fam.
1988	14.70	1.00	15.80	4.60	20.10	2.90	8.00	34.80	3.90	15.80	12.60
1989	14.70	1.00	15.60	3.80	20.10	2.90	8.00	34.80	3.90	15.60	11.80
1990	14.70	1.00	15.60	3.00	20.10	2.90	8.00	34.80	3.90	15.60	11.00
1991	14.70	1.00	15.60	2.70	20.10	2.90	8.00	34.80	3.90	15.60	10.70
1992	14.70	1.00	15.60	2.50	20.10	2.90	8.00	34.80	3.90	15.60	10.50
1993	9.00	1.00	15.00	1.70	20.10	2.90	8.00	29.10	3.90	15.00	9.70
1994	9.00	1.00	15.00	1.70	20.10	3.50	8.00	29.10	4.50	15.00	9.70
1995	9.00	1.00	15.00	1.70	20.10	3.50	8.00	29.10	4.50	15.00	9.70
1996	9.00	1.00	15.00	1.70	20.10	3.50	8.00	29.10	4.50	15.00	9.70
1997	9.00	7.80	21.30	1.70	20.10	3.50	8.00	29.10	11.30	21.30	9.70
1998	9.00	14.10	21.10	1.70	30.70	3.50	8.00	39.70	17.60	21.10	9.70
1999	9.00	14.10	20.90	1.70	30.70	3.50	8.00	39.70	17.60	20.90	9.70
2000	9.00	27.10	20.70	1.70	30.70	3.50	8.00	39.70	30.60	20.70	9.70
2001	9.00	27.10	20.50	1.70	30.70	3.50	8.00	39.70	30.60	20.50	9.70
2002	9.00	27.10	20.40	1.70	30.70	3.50	8.00	39.70	30.60	20.40	9.70
2003	9.00	27.10	20.20	1.70	30.70	3.50	8.00	39.70	30.60	20.20	9.70
2004	9.00	27.10	20.10	1.70	30.70	3.50	8.00	39.70	30.60	20.10	9.70
2005	9.00	27.10	19.90	1.70	30.70	3.50	8.00	39.70	30.60	19.90	9.70

Table 4.3.1: *Total Water Needs and Consumption*

CHAPTER FIVE:

Existing Management Situation

5.1. Drought Period:

The management of reservoir systems to increase their total economic value under different crisis situations is difficult to accomplish in practice (Turgeon, 1998). Floods, droughts, increased demand and other unpredictable situations cause major problems to the modellers studying and operating existing reservoir systems, so that they have to build models for the "new" phenomena. Drought is one of the most pervasive and worrisome problems faced by water resources managers. It is the most complex of hydrological phenomena and embodies issues related to climate, land use and water use norms as well as management issues such as preparedness. It is very easy to ignore them until is too late, because they do not have a recognizable start and end points (Grigg, 1990).

Droughts are usually caused by serious changes in the hydrological cycle, climate change and temperature rise, all of them occurring unexpectedly and with important consequences on the systems if not controlled early. Failures in water supply can have serious consequences for cities, industries and other water users such as irrigation, hydropower, recreation and wildlife.

Drought conditions in recent years in Cyprus have severely depleted the Main Reservoir storage (Kouris). The unpredictable nature of drought, over the last five years complicates the estimation of water allowances since it is extremely difficult to evaluate or quantify the drought depending on the criteria used in analyzing it. Integration of reservoir operation for irrigation with farm water allocation under hydrologic uncertainty is an important modelling problem, addressed by the government since 1995.

The major characteristics of a drought apart from the fact there is less rainfall compared to previous years or existing time series measurements, are the depletion of the water table as well as the minimization of the springs appearing at the ground surface. Most of the aquifers of the island are dry and the existing over-pumping has in some cases caused salination of the ground water sources making them useless for the water supply. The problem gets bigger and bigger when comparing a drought with another extreme event – an already existing one. This implies that having continuous drought periods for consecutive years makes the situation even more dramatic and inflexible to operate and manage.

Although in meteorological terms a drought is caused by an extended period of dryness, economic drought means not having sufficient water to meet demands due to hydrologic shortfalls below expected levels of supply. The WDD, gives the term "Drought" to the appearance of a rainfall 10% lower than the mean expected one, "Serious Drought" to a 15% less and "Very Serious Drought" to the 20% less than the mean expected rainfall. The expected level of supply is a socioeconomic part of the definition of the drought. The Standard Demand becomes larger than the Total Available Quantity of water, forcing the authorities to limit the amounts of water given to the users, based on different scenarios of consumption and needs for each occasion. The productive value of the reservoir release is obtained by solving an allocation problem to minimize the sum of evapotranspiration deficits across the crops over a period of time (Mujumdar, 1997). So, different kinds of objectives are tried out to find the water policy that is to be applied for irrigation and domestic supply given the limitations for the crops survival and the water needs per capita.

Actions therefore appeared as the most appropriate measures to be taken and the cost of drought consequences is born to the whole community not necessary directly involved in the precarious situation concerning the particular water resource taken into consideration (ReVelle, 1999). However, as for the water resource management, the complexity of droughts causes political conflict because drought is an intergovernmental problem with vertical and horizontal dimensions, concerning the in-departmental sections of the Water Development Department as well as the Ministries involved in the Water Management situations (Ministry of Agriculture, Finance).

The Water Development Department has reviewed the Drought Periods of 1995 and 1996 and on the basis of these, has produced scenarios of operation of the Southern Conveyor System assuming some standard demands that should be met. For the years 1997, 1998, and 1999 there are two reports, one prior to the beginning of the hydrological year giving framework policies that should be followed during the coming year and the second one as an overview of the situation, the extent of the Drought and the scenario's application.

5.2. Policy Scenarios:

The scenarios applied by the Water Development Department over these three years, have similar forms, giving the amounts of water demand in comparison with the existing water resources. Since the demand was higher than expected, a policy for the amount of water allocated depending on the user was enforced. In order to check the real demand the following procedure is applied (Droughts, 1997-99)

- All the consumers fill up a form at the local branches of Water Development Department, mentioning the use for which they need water (agriculture, farming, industry), the amount they need and to the kind of the irrigated plants they will have in their fields.

- Each form is examined by the WDD based on the criteria applied for each scenario, the water situation of each consumer and the previous year's consumption of water by the specific user.
- An answer about the amount of water allocated to each user is sent by the WDD. This gives the Department the opportunity to check its ability and the way of water use resulting in a sufficient water amount for the whole hydrological year.
- If a user during the year overuses water exceeding the agreed amount, then he receives an invoice from the WDD. If he keeps using an excess of water then the Department stops providing him with water.
- In these cases a cost of overuse is applied. It was applied only during the years 1998,1999.

The Water Development Department for the different kinds of uses predetermines the amount of water each user can have. This is a general policy for all the Government water works but in the special case of the SCP the policy is even more straightforward to apply because SCP suffers more from the Long Drought Period, which appeared on the island during recent years. During the years 1998, 1999 and 2000 the restrictions to the water supply were much more drastic than those applied during the 1997 because of the dramatic sequence of consecutive drought years. Especially for the irrigation, the reduction on the water amount offered for this use can be seen from the table (Table 5.2.1.). This table shows only the applied scenario for the SCP during the years 1997-1999.

The percentage given is of the water needs for the kind of plants based on the data provided by the Ministry of Agriculture for the yield of plant survival. Actual Farmers are those families, which are mainly economically dependent on agriculture, ie. 60% or more of their income is from their fields. For the cases of industry and animal breeding, the given percentage is of the amount given in 1996. Other uses are uses such as the upkeep of the grass of stadiums or irrigating plants in the Highways of the island.

PLANTS	*1997*	*1998*	*1999*
Domestic Supply	82%	72%-80%	72%-80%
Citrus Trees, Bananas, Avocado,	40%-50%	40%-68%	Water only for the absolute necessary needs of plants
Olives	25%	25%	25%
Grapes	100%	100%	100%
Greenhouses	Only to the "actual farmers" for both planting periods	Water only for the first planting period	Water for both planting periods
Seasonal Farming	Only to the "actual farmers"	No water given	No water given
Cereals	25%	25%	25%
Potatoes/ Carrots	70%	70%	70%
Food for animals	30%	30%	30%
Flowers	100%	100%	100%
Animal Breeding	100% of the supply for 1996	72% of the needs	72% of the needs
Industry	100%	72% of the needs	72% of the needs
Other uses	50%	No water given	No water given

Table 5.2.1: Policy Scenarios during droughts

such as the upkeep of the grass of stadiums or irrigating plants in the Highways of the island.

PLANTS	*1997*	*1998*	*1999*
Domestic Supply	82%	72%-80%	72%-80%
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Industry	100%	72% of the needs	72% of the needs
Other uses	50%	No water given	No water given

Table 5.2.1: Policy Scenarios during droughts

For the Irrigated Areas referred in the SCP system a weighted percentage coefficient is estimated based on the range of plantations and on their kind. This is presented here:

- **Limassol Area:** *5100 ha*

Citrus: 900 ha	50%
Olives: 3200 ha	25%
Grapes: 700 ha	100%
Greenhouses: 200 ha	100%
Flowers: 100 ha	100%

Weighted coef. C_{LIM}=(900*0.5+3200*0.25+700+200+100)/5100=0.44

$\boldsymbol{C_{LIM}=0.44}$

- **Larnaca Area:** *7250 ha*

Citrus: 2400 ha	50%
Greenhouses: 750 ha	100%
Food for animals: 4100 ha	30%

Weighted coef. C_{LAR}=(2400*0.50+750+4100*0.3)/7250=0.44

$\boldsymbol{C_{LAR}=0.44}$

- **Famagusta Area:** *12600 ha*

Potatoes, Carrots: 4100 ha	70%
Cereals: 5100 ha	25%
Greenhouses: 2000 ha	100%
Flowers: 1400 ha	100%

Weighted coef. C_{FAM}=(4100*0.7+5100*0.25+2000+1400)/12600=0.60

$\boldsymbol{C_{FAM}=0.60}$

It should be mentioned that some additional water supply was offered during these years to the users after they insisted they need more water. However, most of the users' requirements weren't satisfied because of the lack of water resources. This Additional water comes up to maximum of 0.7% of the predetermined amount of water given from the Southern Conveyor. It was observed that a larger reduction than 20% of the domestic supply is not easily accepted.

For the year 2000, two Scenarios have been examined with different assumptions for the water availability and water delivery to the consumers. Both assume that the water supplied from ground water sources will be an amount up to 19.10 MCM, the amount from the desalination plant up to 13.1 MCMC and the recycling water for irrigation in the Limassol area 3.0 MCM. However, the first option assumes that the incoming flow to the reservoirs of the S.C.P. will be equal to 12,2 MCM which was the lowest ever collected during the operation of the Project (1990-91). The second Scenario gives a higher incoming flow up to 19.58 MCM, which is the second lowest flow in the reservoirs (1997-98).

The following restrictions are to be implemented to save water whichever scenario is applied:

- No water given for any new irrigating areas
- No water given to new consumers for Seasonal Plantation
- Application of the over consumption tax
- Checking and keeping the amounts given to each farmer at the predetermined levels
- No water given to the agricultural areas having their own boreholes
- Checking the consumption from these private boreholes
- Understudy the water costs for irrigation

The Table 5.2.2 below shows the water resources for the two, and the final deficit coming from these scenarios.

WATER RESOURCES	SCENARIO 1 90/91 (MCM)	SCENARIO 2 97/98 (MCM)
Reservoirs		
Expect inflow	9.20	16.58
Dhiarizos Diversion	3.00	3.00
Storage from Previous year	5.70	5.70
Losses (evaporation/leakage) and dead volume	3.00	3.70
Available	14.90	21.58
Ground water sources	19.10	19.10
Desalination Plant	13.10	13.10
Recycling Water	3.0	3.0
Expected Total Amount	**50.10**	**56.78**
Water Needs		
Water supply	52.00	52.00
Irrigation	50.00	50.00
Total	102.00	102.00
Reduced Water Needs		
Water supply	41.10	41.10
Irrigation	21.30	21.30
Total	62.40	62.40
DEFICIT	**-12.30**	**-5.62**

Table 5.2.2. Comparison of the two proposed Scenarios for the year 2000

In order to check the policy scenarios described above, on the consumption basis, the WDD introduces four kinds of data for different consumptions. It should be remembered that year 1996 is used as a basis for the drought years.

The kind of consumptions that are compared are:

a. Actual monthly consumption 1996: *C96*

b. Expected monthly consumption of year (i) relative to the actual consumption of 1996: $(EC)_i$

   $(EC)_i = [C96/\text{sum monthly } (C96)]*(AC)_i$

   where: $(AC)_i$ is the approved consumption for the (ith) year based on its scenario

c. Expected monthly consumption of year (i) relative to the data provided by the Ministry of Agriculture for the irrigated plants, plus the water given for industrial purposes and animal breeding: $(EC)_i$

   $(EC)_i = sum_1^n\ (sum_1^{12}\ (area*water\ needs\ per\ month)*R\%) + animal\ breeding + industrial\ use$

   where: n is the number of irrigated kinds

   R% is taken from the Table 5.2.1.

d. Actual consumption of the ith year taken from the Government's works on the different areas per month: $(AC)_i$

The control and check of the consumption is obvious by comparing the numbers taken from (b) and (c) with the actual consumption given on (d). This should be done on an ordinary basis in order to be able to take the proper actions for those consuming more than they are aloud to.

5.3. COMPARISON OF THE DROUGHT YEARS:

The last Years 1996,1997, 1998, 1999, are years of continuous drought with a series of socioeconomic effects. The long drought period showed its effects in 1999, with each year less and less water available and the groundwater from the aquifers being no longer manageable. A characteristic indication of the situation is that for the Government Works as a whole the water resources for year 1996 were 141.4 MCM, for 1997 were 101.6 MCM, for 1998 only 79 MCM and for 1999 a higher amount of 109.00 MCM. During the 1998 there was the installation and operation of the Recycling water system in Limassol and the Desalination Plant in the Dekelia area.

For the Year **1996** the mean annual rainfall was 383 mm for 1995-96 and 399 mm for 1996-97. The four previous years the mean annual rainfall was varying between 488 mm and 637 mm. The storage of water for 1996 was high enough to permit the normal use of it for the different purposes. There were only few limitations and restrictions and only during the last months of the hydrological year 1996. Generally this year can be characterized as normal with respect to the water allocation and is used as a comparison for the consumption of water for the following ones. During this year the total amount of water allocated from all the Government's Water Projects was 44,309 MCM.

The results of the drought became more obvious the following year, **1997**, and the lack of water was the object of a series of arguments, discussions and negotiations between all the related departments involved in implementing the options of the different Scenarios described above. During the hydrological years 1996-97 and 1997-98, the mean annual rainfall had reached only 399 mm and 388 mm respectively in addition to the small amount of water storage left from the last year, 1996. An amount of just 26.662 MCM was supplied during 1997 from all the Government's Water Projects.

Even more tough and dramatic was the situation during **1998**, where the most of the reservoirs of the island were almost empty. The mean annual rainfall for this year was 388 mm for 1997-98 and 472 mm during 1998-99. The summer raining during this year was welcome by the agricultural community, since it saved the plants from the total disaster. Additionally the application of the above-described scenario with no additional reductions in the water supply could thus be implemented. An even smaller amount of allocated water was given for year 1998, just 23.929 MCM including also the amount from recycling water.

HYDROLOGICAL YEAR	**1996**	**1997**	**1998**
Mean Annual Rainfall (mm)	399	388	472
Mean annual Collection of water to the reservoirs (MCM)	24 874	26 453	62 633
Available amount of water from all the Government Works (MCM)	141.4	101.6	79
Water given for agriculture animal breeding and industry (MCM)	44.3	26.7	23.9
Water given for domestic consumption (MCM)	50.0	45.3	43.0

Table 5.3.1: Comparison between the recent drought years

CHAPTER SIX:
Costs, Benefits, and Minimal Water Requirements

6.1. Cost Benefit Analysis:

The Cyprus government has some overview on how water resources are developing over time. The provision of government finance for the country's river basins, water supply and sanitation activities always faces a budget constraint. It follows that, in choosing one set of initiatives demanding government resources, others inevitably have to be rejected or at least postponed (Merrett, 1993).

Engineering economic analysis is an evaluation process that can be used to compare various water resource project alternatives and the selection of the most economical one. The definition of the feasible alternatives followed by the application of a discounting technique to select the best alternative is required for this process. Money at different times cannot be directly combined or compared but must be first made equivalent through the use of discounting factors (convert a monetary value at one date to an equivalent value at another date) (Mays, 1997).

Cost Benefit Analysis is used to help governments decide whether to go ahead with various projects. The analysis seeks to establish whether the benefits to society from the project outweigh the costs, in which case the project should go ahead; or whether the costs outweigh the benefits, in which case it should not.

In its preparation and analysis phase, the project cycle includes an appraisal of the impact of an investment proposal on specific factors, such as the inhabitants of an area to be flooded for dam construction purposes, the civil engineering industry, regional government, farmers and manufacturing firms.

However, the method for the evaluation of capital projects concerns itself primarily with the costs and benefits of the activity from the point of view of the nation as a whole. For this reason, project costs and returns are considered in terms of the real economy, that is, the flow of real resources used up (water resources) in order to produce flows of real outputs or services (water uses). The general objectives of evaluation in economic terms are to test whether the returns on projects exceed their costs, to rank projects with respect to their economic efficiency and to help policy-makers choose a set of projects, within the financial constraints facing them, which contribute most effectively to the country's economic development in a manner consistent with its social, political and environmental values. This is anticipated behavior response.

Water projects extended over time incur costs throughout the duration of the project, and yields benefits. Typically, costs are large during the initial construction and startup period, followed by operation and maintenance costs only. In order to carry out cost benefit analysis, rules for economic optimization of the project design and procedures for ranking projects are needed. Preliminary investigation of alternatives can help to rule out projects because of technical infeasibility or on the basis of costs.

The cost-policy for the Southern Conveyor Project, followed by the Cyprus government, is operated by the Water Development Department whereas the local authorities and Water Boards control their own sections management. The characteristics of the project are that it has a well-defined geographical location; it is an activity with a specific starting point at which time investment costs are incurred;

and during the period of the project's life a series of outputs are produced which are available for identification, measurement and valuation in money terms.

The objective of the operation is to follow a set of target states, deviations from which are penalized. The channel routing is performed using a linear routing procedure. The real-time reservoir operation problem of Southern Conveyor Project is solved by making decisions on reservoir releases as information becomes available at relatively shortness times (Mays, 1992).

6.2. Cost Price of Water

Given the great development of the traditional water resources (groundwater and surface water), in addition to the non-easily acceptance of the desalination plants, as mentioned on Chapter 5, the management of demands is one of the last steps for recovery of the water problem on the island of Cyprus. The best water management is characterized by the proper cost price policy based on the fact that the price of water should be relevant to its real cost. The rational cost price of water is the basic factor of its effective use. One of the best water demand management tools is the price of water. Unfortunately this has not been used as extensively or as effectively as recommended of both because practical difficulties and opposition by the political power of the agriculture lobby. Thus, the message people receive is that, despite its shortage, water is still cheap!

In Cyprus this unfortunate effect was compounded by the policy of subsidizing the products of agricultural activity in the market, reinforcing the view that water could be used wastefully. This state of affairs was not helped by the absence of an effective policing system regarding the drilling of boreholes and the control of the annual quantities of water extracted by the farmers or other users from these boreholes.

The major water uses on the island of Cyprus are agriculture and domestic supply. Based on the study of the National Bank (IBRD) in 1994, appears that 75% of the total water consumption is used for farming and the remaining 25% for domestic supply which includes industrial and tourist water consumption which have the same cost per cubic meter of consumption. The industrial and tourist consumption represent 6% and 11% of the total domestic water consumption respectively.

Domestic water is of higher priority than that of irrigation water and therefore the domestic water sector should bear the major cost of the basic works of the system. On this basis an attempt has been made to estimate the capacity and cost of the system required for domestic water supply alone, and to allocate only the marginal cost of the overall Project to the irrigation sector.

6.2.1 Water rates and the Law:

According to the Government Waterworks Law, Cap 341, par. 24, the Council of Ministers may make Regulations, which may include provisions for:

a) Fixing the maximum fees, rates and any other money consideration, which may be levied or collected on or from any person. By virtue of the Law, such fees, rates or other consideration being liable to be fixed either per unit area of land, or according to the kind of crop or to the volume or time of water supplied or used, or according to the benefit accruing or liable to accrue to any person or any property by the water of any water works. Provided that in fixing such maximum rates regard shall be had to:

- Interest on capital expended
- Adequate provision for sinking fund and insurance of the works
- Cost of repair, maintenance and administration of the works

b) Establishing a fund wherein shall be deposited all fees, rates and other money and monetary penalties in respect of any waterworks and manner of disposal of such sums and generally the manner of operation and control of such fund. The rates of fees shall not be more than 40% of the weighted average unit cost of the water (per cubic meter). In some special cases, considered to prevail in the project area, the rate may be increased up to 65% of the weighted average unit cost of the water.

The Water Development Department has two ways of calculating the costs both for the Irrigation supply and for the Domestic one. The Irrigation water cost is calculated with the "Present Worth Value" method while the "Balanced Budget" method gives the Domestic water cost. In addition to that the domestic supply water has the whole value of cost compared to the irrigated one which is estimated only to the 22,3% of the mean level of the per unit cost of all the works (projects) (Nicolaou, 2000). The following formulas describe the two processes.

- ***Cost of Irrigation Water- "Present Worth Value":***

$$C_t = TOE_t / Q_t + [\sum_{b=1}^{40} (CI_t * (1+i)^{(t-b)})] / [\sum_{b=1}^{40} Q_t * (1+i)^{(t-b)}] \tag{6.2.1}$$

- ***Cost of Domestic Water Supply-"Balanced Budget":***

$$C_t = TOE_t + \max(DebtService-or-Depreciatin) + (WC_t - WC_{t-1}) / Q_t \tag{6.2.2}$$

$$WC_t = (CA_t + AR_t + I_t) - (AP_t + S_t) \tag{6.2.3}$$

where:

C_t= Unit cost of domestic water in cyp.pounds/m^3 in year t

TOE_t= Operation and maintenance costs in cyp.pounds in year t

WC_t=Working capital requirements in cyp.pounds in year t

Q_t= Quantity of domestic water in m^3 in year t

AR_t= Accounts Receivable in cyp.pounds in year t

I_t= Inventories in cyp.pounds in year t

AP_t= Accounts Payable in cyp.pounds in year t

S_t= Amounts due to suppliers in cyp.pounds in year t

CI_t= Capital cost in cyp.pounds including the costs for replacements

The term "Debt. Service" in Equation 6.2.2 stands for the aggregate amount of amortization and interest on debt in year t with respect to the domestic water supply schemes and includes foreign loans and government advances. Government advances were amortized at equal installments over the 40 years after an initial period of five years at a simple interest rate of 8.5% and 9% per annum for the periods 1984-1994 and 1995-2005 respectively.

The unit cost of water refers to the whole bulk of the domestic water quantities and not to that of an individual component or scheme. The total expenses in Equation 6.2.2 are derived by summing up the individual expenses of every component of the D.W.P.A. sector. In case a component is common to both the Domestic water and Irrigation Sectors, (eg. Dam or conveyor) the allocation of the costs between the two economic sectors is proportional to the quantity of water allocated to each sector. In mathematical terms for any year:

$$R_D = \frac{Q_D}{Q_D + Q_t} \quad \text{and} \quad R_I = \frac{Q_I}{Q_D + Q_t} \qquad (6.2.4)$$

The unit total cost of irrigation water is made up of the capital cost component and the annual cost component as follows:

- The capital cost component is calculated using the present worth method by processing the actual or anticipated capital costs and water quantities for sale at an interest rate of 8% over a period of 40 years.
- The annual cost component is made up from the operation, maintenance, power and administration costs. The annual unit cost for each project is calculated using the actual or anticipated annual cost divided by the quantity of water sold or for sale each year.

The unit total cost of water for each project is the sum of the unit capital and the unit annual costs, whereas the weighted average unit cost of all projects is calculated by dividing the sum of the total cost by the total quantity of water sold or for sale.

It should be mentioned that all the equations described above are applied for all the Water Projects of the island, not only for the water allocated from the Southern Conveyor Project. The economical life of these projects is estimated to be 40 years with the exception of the SCP, which has an extra time of 5 years (repayment of investments).

The two methods for allocated water require the same costs for all the projects. In other words the domestic supply cost should be the same in all the towns and the cost for irrigated water should be the same for all the agriculture projects. Since 1992 the cost of agriculture water is 6.31 cents/m^3 (Socratous 1997). However, it is suggested that by year 2003 it would rise to 11.64 cents/m^3, reaching the 38% of the mean level of the per unit cost. In the special case of SCP, this would become 12.50 cents/m^3. By then the funds would be 13 million pounds, which supports the idea of a greater reduction of sponsored fund, and increase in the cost of water sold by the

WDD. While this increase seems to be big just comparing the figures, it is not impossible taking into account the long time period during which it is applied (over 10 years from the decision made).

The Balanced Budget method secures the delivery of the necessary incomes for the coverage of the present capitalized needs for the payment of the debts of WDD. Despite the fact that this method is much more complicated than the previous one, it gives more accurate results. In addition it gives higher values of dues in comparison with the Present Worth Value technique. This is due to the fact that the part of the capital investment that is sponsored by foreign organizations is paid back in 10-15 years, which is much less than the 40 years mentioned as the economic life of the project. That may cause problems for the distribution of the capital investments during time periods. The cost for domestic supply water is up to 33,5 cents/m^3 and by the end of the current year would be 44 cents/m^3.

Regarding the alternative water resources described in Chapter 5, the Government decided that the price of the recycled water would be the same for the whole of the Island. The specific amount depending on the kind of use is proposed and is to be examined by the Council of the Ministers. These proposed values of the recycled water are: 5 cents/m^3 for irrigated areas, 6 cents/m^3 for private gardens, 15 cents/m^3 for football fields, 20 cents/m^3 for industrial use.

The current price of water produced by the desalination plant of Dekelia is 54 cents/m^3, which is expensive enough but it is estimated that with the operation of more Desalination Plants the price will fall, especially if the same consultants operate the plants (they will have fewer expenses for operation and maintenance since they will operate at the same time more than one plant).

FROM SCP	**TILL 2000**	**AFTER 2000**			
Domestic Use	*33.5 cents/m³*	*44 cents/m³*			
Agriculture Use	*6.31cents/m³*	*12.5 cents/m³*			
Other Sources	**Irrigation**	**Private Gardens**	**Football Fields**	**Industrial Use**	**Domestic Use**
Desalted Water					*54 cents/m³*

Table 6.2.1.1: *Summarization of the different prices of the sources and uses*

6.2.2 Cost of water in European Union:

The European Union based on its guidance Com (97) supports the application of present values of complete given back the costs. The water cost consists of the following parts:

i. Cost of operation, maintenance and management
ii. Cost of amortization
iii. Environmental cost
iv. Cost of overuse of resources

As mentioned above, the target of the European Union is the recovery of the cost of water use, which is meant to be the start of a healthy and successful water resources management. Given that, it is expected to have a serious effect on the economic policy applied today by the Cyprus Government, in view of the likelihood of becoming a European Union Member. So, by the year 2010, the value of the mean unit cost should have risen up to 100% compared to 22.3% applied till today.

As a general conclusion it should be mentioned that the price of water for each use should be estimated in such a way that would give the real value of a water unit, depending on its natural and economic worth. Water in Cyprus is valuable because it doesn't exist plentifully. That is why it must be managed as an economic good as most of the countries all over the world do. Giving the real value to water unit, the consumers are able to estimate its worth and save it.

CHAPTER SEVEN:

Mathematical Representation of Water Resources Management. Linear Programming

7.1 Problem Identification:

The Water Resources of Cyprus as well as the alternative approaches to their management were examined extensively in the previous chapters of this Dissertation Project. A global view of all the data collected during the study of the Southern Conveyor System was presented the optimal water allocation of the system is set. The objective is to examine the optimal allocation of water given that there are constraints to the operation of the problem, which consist in a set of target states, deviations from which are penalized.

The problem is one of real-time reservoir operation involving various hydrologic, hydraulic, operational, technical and institutional considerations. As Mays (1997) suggests, the real-time reservoir operation problem involves the operation of a reservoir system by making decisions on reservoir releases as information becomes available. For its efficient operation, a monitoring system is essential that provides the reservoir operator with the water allocations at various points of the SCP system and inflows including the losses due to evaporation and leakage during operation of the pipes.

A flow routing procedure is needed to predict the impacts of observed and/or predicted inflow hydrographs on the downstream parts of the river system. However, there is only short-term data available for the inflows to Kouris Dam, because the Dam was set in operation during the last ten years and hence the predicted inflows to the system dam are sampled randomly from the observed series.

The Problem is to find the Optimal Allocation of the amount of water available from both the system and the different local sources. This water is given either for Domestic Supply or for Irrigation Supply under the restrictions applied to the Demands by the WDD (Chapter 4,5). Data for demands, needs, inflows and losses are available up to the current year. For the next five years, the Statistical Service of the Government does a prediction of the future demands, while losses of the system and inflows to it are estimated based on the observed ones.

Before setting up a mathematical model to optimize the allocations from water of the system, the following steps suggested by Buras, (1997) are used to approach, analyze and finally solve the required problem:

- Definition and analysis of the variables and the specific characteristics of interest chosen from the available data.
- Determination of the criterion for optimization. Specification of the objective function in terms of the above variables together with coefficients.
- Development via mathematical expressions of a valid processor equipment model that relates the input-output variables of the process and associated coefficients. (Includes both equality and inequality constraints). Use of well-known physical principles (i.e. hydrological balance) and empirical relationships.
- Application of a suitable optimization technique to the mathematical statement of the problem.

- Examination of the sensitivity of the result to changes in the coefficients in the problem and the assumptions.

7.2 Problem Formulation:

Programming problems are concerned with the efficient use or allocation of limited resources to meet desired objectives. They seek to maximize or minimize a numerical function of a number of variables, with the variables subject to certain constraints. The large number of solutions that satisfy their constraints characterizes these problems. The selection of a particular solution as the best solution to a problem depends on some aim or overall objective that is implied in the statement of the problem.

Examining all the data collected and presented in previous chapters as well as the system operation, a mathematical problem of Linear Programming model is used for the solution of the Optimal Allocation of water. This kind of Problem optimization Programming is concerned with solving a special type of problem: that in which all relations among the variables are linear, both in the constraints and in the function to be optimized. The linear combination of the variables (objective function) must be optimized by the selected solution (nonnegative one) with a corresponding finite value of the objective function (Gass, 1992).

The general problem may be described as:

Given a set of n linear inequalities or equations in r variables, nonnegative values of these variables must be determined, which satisfy the constraints and maximize some linear function of the variables.

This is expressed mathematically in the form:

$Z=c_1X_1+c_2X_2+\ldots+c_nX_n$

Subject to the constraints:

$a_{i1}X_1+a_{i2}X_2+\ldots+a_{in}X_n \leq,=,\geq bi$

for I=1…r

For each constraint one and only one of the signs holds, but the sign may vary from one constraint to another. Values of the variables X_i are sought to satisfy the conditions for $X_i>=0$

In order to investigate the adequacy of a water resource system design, the operation of the system can be produced, or simulated, numerically. Here, the analysis can be done studying only a short length of inflow record, which includes a critical drought period. The optimization model has to allow the study all the years examined at the same time. It contains both the two poles of management, demand and releases, taking into account the water resources available and the need for aquifer recharge. The years examined are 1997 to 2005, years during which droughts appear and have to be managed.

7.2.1 Objective Function:

The amounts of water allocated, X_i 's are optimized by the problem and refer to the total amount of water given to the users (I=1…n). This amount is the sum of the water released from Kouris Dam plus the amount of water given from boreholes, desalination plants and recycled water. (Chapter 5)

The optimization problem for the operation of the SCP system is hence stated as:

Maximize $z=f(X_i)$ for i=1…n

X_i is the allocated amount of water, both from Kouris Dam and some of local sources in the different areas included in the SCP project.

The exact unit benefits for each use of water are very difficult to estimate, so values are chosen based on the following:

- The priority in the allocation should be given to the domestic supply of the areas examined taking into account the tourist consumption as well, and secondly the irrigation supply for them.
- In addition to these, the area of Famagusta is generally characterized as farming area and hence the unit benefit for it should be higher than the other agriculture unit benefits.
- In the case of aquifer recharge and the storage left in the system, this unit benefit has no meaning and hence is set equal to zero.

The variables are:

X_1: water given for domestic supply of Limassol area
X_2: water given for domestic supply of Larnaca area
X_3: water given for domestic supply of Nicosia area
X_4: water given for domestic supply of Famagusta area
X_5: water given for irrigation supply of Limassol area
X_6: water given for irrigation supply of Larnaca area
X_7: water given for domestic supply of Famagusta area
X_8: water given for aquifer recharge
X_9: water stored in the system

7.2.2 Constrains:

The constraints of the problem are basically divided into two groups: the hydraulic constraints and the operational constraints. The hydraulic constraints are equality constraints consisting of the equations of the water Balance of Kouris Dam.

The operational constraints are usually greater- than or less-than type constraints that define variable boundaries, such as maximum and minimum quantities of water requirements (demands), and of operational targets such as the non-negativity of the difference of water taken from local sources minus the water available from them (otherwise water would bel allocated without existing!).

The lower limits on demand are used are based on policy scenarios requirements presented in Chapter 5. The upper bounds on demand are the actual demand plus 5.5% due to any accepted losses during the operation of the system (Feasibility Study). Non-negativity constraints on discharges (allocation) are used. These constraints are given below:

$X_i \leq$ Demand (7.2.2.1)

$X_i \geq$ min required quantities (7.2.2.2)

Water Balance of Kouris = 0 (7.2.2.3)

$$S_{n+1} = S_n + I_n - U_n - L_n \quad (7.2.2.3.1)$$

Where:

S_n: Storage at the beginning of month n

I_n: Inflow for the month n

U_n: Release for month n

L_n: Losses (evaporation, leakage) of month n

Inflows for a series of months are obtained from records of the WDD and fed into computer. Draft U is also taken from the record of the operation of the dam. Specifying an initial storage the water balance is applied to the available record month by month (Table, in Appendix). Water demand is given for a particular time horizon and historic flows routed through the system. For the rest five years (2000-2005) a random resampling with replacement of the inflows from record is carried out.

$$\sum_{i=1}^{n} \text{(Releases from local sources – available water from local sources)} \geq 0 \qquad 7.2.2.4$$

$$X_i >= 0 \qquad 7.2.2.5$$

The Linear Programming Model to Optimize the Allocation of Water is run in "Excel" using the "Solver" tool. The Appendix at the end of the Project shows the Program run.

7.3 Solving the Problem - Different Scenarios:

As the population increases and industry grows, a greater demand on the water resources for domestic supply appears. At the same time as a decrease in farming together with the application of limitations and restrictions are observed during the policy scenarios of the Government, a decrease in water demand appears for agriculture.

The losses, as it is mentioned above, include the evaporation from the dam and the leakage from the system operation as a whole. Since the leakages are applied as a percentage of the demand (5.5% increase) the only factor included in the losses is evaporation. Evaporation is a function of the elevation of water in the dam at each time period. The elevation of water is given as a function of the available storage in it. Hence, using the following formulas the evaporation from the dam is estimated:

Elevation - Storage:

$$h = 183,446 + 1.062\frac{S}{10^6} - 0.00687(\frac{S}{10^6})^2 + 0.0000212(\frac{S}{10^6})^3 \qquad (7.3.2)$$

Area – Elevation:

$$A = -4552010 + 77862.43h - 528.064h^2 + 1.3857h^3 \qquad (7.3.3)$$

Evaporation From the Dam:

$$Evap. = (meanh * days * area)coef \qquad (7.3.4)$$

Where:

Elevation h in m

Storage s in MCM

Area in m^2

coef. For different months: J,F,N,D = 0.6/M,A,S,O=0.7/M,J,J,A =0.8

In the table in the Appendix, this water balance is presented and the annual inflows are used in the optimization problem.

The recharge and storage are taken as water allocations from the system although they are not physical. The Local Water sources (other than the SCP) are those taken from table 4.3 Chapter 4. The storage of the dam is taken as the active storage (i.e. that above dead storage where dead storage is inaccessible due to the level of the off-take or is allowed for silt accumulation.) and is estimated as a 90% of the capacity of the Dam. The required Storage is taken as constant throughout the time period and equal to 2.3 MCM, which is the mean value of the recharge quantities already given.

The Problem is solved for 20 different inflows scenarios presented in the table below. In the Appendix there are the solutions of the problem for all the scenarios are given.

	PREDICTED INFLOWS FOR THE SCENARIOS									
Years	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
2001	40.419	6.222	69.070	12.000	12.138	45.237	25.619	45.237	25.619	13.021
2002	69.070	13.021	45.237	11.742	40.419	11.724	11.724	13.021	31.561	45.237
2003	31.561	18.473	12.138	18.473	13.021	31.561	18.473	25.619	6.222	37.869
2004	37.896	11.724	6.222	34.869	25.619	40.419	34.869	31.561	12.000	40.419
2005	34.869	6.222	34.869	40.419	18.473	12.000	12.138	40.419	11.724	12.000
sum	**213.815**	**55.662**	**167.536**	**117.503**	**109.670**	**140.941**	**102.823**	**155.857**	**87.126**	**148.546**
Years	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
2001	11.724	45.237	18.473	11.742	40.419	37.869	13.021	40.419	34.869	31.561
2002	69.070	34.869	34.869	25.619	18.473	12.000	6.222	6.222	12.138	12.000
2003	12.138	40.419	12.000	45.237	31.561	45.237	18.473	45.237	45.237	40.419
2004	12.000	11.743	37.869	69.070	12.000	18.473	69.070	12.138	12.000	13.021
2005	11.724	25.619	69.070	31.561	11.724	31.561	12.138	13.021	37.869	40.419
sum	**116.656**	**157.887**	**172.281**	**183.229**	**114.177**	**145.140**	**118.924**	**117.037**	**142.113**	**137.420**

Table 7.3.1: *Different inflow scenarios*

The next two pages give the presentation of the form of the Excel spreadsheets that are available in the Appendix.

LINEAR PROGRAMM TO FIND THE OPTIMAL ALLOCATION OF THE WATER OF THE SCP SYSTEM

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr	Other water requirements: Recharge	Storage to next year
Unit benefit	1.3	1.1	1.2	1	0.6	0.8	0.9	1.5	0
Demands									
1997	19.2	7.8	16.3	6.7	32.1	29	49.4	2.3	100
1998	19.9	8	16.5	7	32.1	29	49.4	2.3	100
1999	20.6	8.2	17	7.4	32.1	29	49.4	2.3	100
2000	21.3	8.4	17.4	7.7	32.1	29	49.4	2.3	100
2001	21.8	8.6	17.8	7.8	32.1	29	49.4	2.3	100
2002	22.2	8.7	18.1	8	32.1	29	49.4	2.3	100
2003	22.6	8.9	18.4	8.1	32.1	29	49.4	2.3	100
2004	23.1	9	18.8	8.3	32.1	29	49.4	2.3	100
2005	23.6	9.2	19.1	8.4	32.1	29	49.4	2.3	100
Fractions of minimum required quantities to demands									
1997	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
1998	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
1999	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2000	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2001	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2002	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2003	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2004	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2005	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
Minimum required quantities									
1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0	0
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	0	0
1999	14.832	5.904	12.24	5.328	14.124	12.76	29.64	0	0
2000	15.336	6.048	12.528	5.544	14.124	12.76	29.64	0	0
2001	15.696	6.192	12.816	5.616	14.124	12.76	29.64	0	0
2002	15.984	6.264	13.032	5.76	14.124	12.76	29.64	0	0
2003	16.272	6.408	13.248	5.832	14.124	12.76	29.64	0	0
2004	16.632	6.48	13.536	5.976	14.124	12.76	29.64	0	0
2005	16.992	6.624	13.752	6.048	14.124	12.76	29.64	0	0
Releases from Kouris									
									10
1997	0	0	0	0	0	0	21.124	0.6	0
1998	0	0	0	0	0	0	10.721	2.3	0
1999	0	0	0	0	0	0	23.319	2.3	0
2000	0	0	0	0	0	0	30.384	2.3	5.185
2001	0	8.6	0	0	14.124	0	20.58	2.3	0
2002	0	0	0	0	0	0	49.124	2.3	17.646
2003	0	0	0	0	0	0	43.004	2.3	3.903
2004	0	9	0	8.3	14.124	0	3.98	2.3	4.115
2005	0	0	0	0	0	0	36.684	2.3	0

Year	Inflows: Kouris	Local resources: Limassol	Larnaca	Nicosia	Famagous	Total
1997	11.724	29.1	11.3	21.3	9.7	83.124
1998	13.021	39.7	17.6	21.1	9.7	101.121
1999	25.619	39.7	17.6	20.9	9.7	113.519
2000	37.869	39.7	30.6	20.7	9.7	138.569
2001	40.419	39.7	30.6	20.5	9.7	140.919
2002	69.07	39.7	30.6	20.4	9.7	169.47
2003	31.561	39.7	30.6	20.2	9.7	131.761
2004	37.893	39.7	30.6	20.1	9.7	137.996
2005	34.859	39.7	30.6	19.9	9.7	134.769

Year	Total	Water balance of Kouris
1997	21.724	0.00
1998	13.021	0.00
1999	25.619	0.00
2000	37.869	0.00
2001	45.604	0.00
2002	69.07	0.00
2003	49.207	0.00
2004	41.799	0.00
2005	38.984	0.00
	Totals	**Surpluses**

Releases from local sources

1997	13.824	5.616	11.736	4.824	14.124	12.76	8.516
1998	19.617	5.76	11.88	5.04	14.124	12.76	18.919
1999	20.6	8.2	17	7.4	14.124	12.76	7.816
2000	21.3	8.4	17.4	7.7	14.124	12.76	19.016
2001	21.8	0	17.8	7.8	0	24.28	28.82
2002	22.2	8.7	18.1	8	14.124	29	0.276
2003	22.6	8.9	18.4	8.1	14.124	21.68	6.396
2004	23.1	0	18.8	0	0	12.76	45.44
2005	23.6	9.2	19.1	8.4	14.124	12.76	12.716

	Limassol	Larnaca	Nicosia	Famagousta
1997	27.948	18.376	11.736	13.34
1998	33.741	18.52	11.88	23.959
1999	34.724	20.96	17	15.216
2000	35.424	21.16	17.4	26.716
2001	21.8	24.28	17.8	36.62
2002	36.324	37.7	18.1	8.276
2003	36.724	30.58	18.4	14.496
2004	23.1	12.76	18.8	45.44
2005	37.724	21.96	19.1	21.116

	Limassol	Larnaca	Nicosia	Famagous	Totals
1997	1.15	-7.08	9.56	-3.64	0.00
1998	5.96	-0.92	9.22	-14.26	0.00
1999	4.98	-3.36	3.90	-5.52	0.00
2000	4.28	9.44	3.30	-17.02	0.00
2001	17.90	6.32	2.70	-26.92	0.00
2002	3.38	-7.10	2.30	1.42	0.00
2003	2.98	0.02	1.80	-4.80	0.00
2004	16.60	17.84	1.30	-35.74	0.00
2005	1.98	8.64	0.80	-11.42	0.00

Total releases

1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0.6	0
1998	19.617	5.76	11.88	5.04	14.124	12.76	29.64	2.3	0
1999	20.6	8.2	17	7.4	14.124	12.76	31.135	2.3	0
2000	21.3	8.4	17.4	7.7	14.124	12.76	49.4	2.3	5.185
2001	21.8	8.6	17.8	7.8	14.124	24.28	49.4	2.3	0
2002	22.2	8.7	18.1	8	14.124	29	49.4	2.3	17.646
2003	22.6	8.9	18.4	8.1	14.124	21.68	49.4	2.3	3.903
2004	23.1	9	18.8	8.3	14.124	12.76	49.4	2.3	4.115
2005	23.6	9.2	19.1	8.4	14.124	12.76	49.4	2.3	0

Benefits

1997	17.9712	6.1776	14.0832	4.824	8.4744	10.208	26.676	0.9	0	89.3144
1998	25.5021	6.336	14.256	5.04	8.4744	10.208	26.676	3.45	0	99.9425
1999	26.78	9.02	20.4	7.4	8.4744	10.208	28.0215	3.45	0	113.7539
2000	27.69	9.24	20.88	7.7	8.4744	10.208	44.46	3.45	0	132.1024
2001	28.34	9.46	21.36	7.8	8.4744	19.424	44.46	3.45	0	142.7684
2002	28.86	9.57	21.72	8	8.4744	23.2	44.46	3.45	0	147.7344
2003	29.38	9.79	22.08	8.1	8.4744	17.344	44.46	3.45	0	143.0784
2004	30.03	9.9	22.56	8.3	8.4744	10.208	44.46	3.45	0	137.3824
2005	30.68	10.12	22.92	8.4	8.4744	10.208	44.46	3.45	0	138.7124

Objective function **1144.789**

7.4 Conclusions:

The chosen values for the unit benefits of the allocation of water for the several uses are: For The Domestic Supplies 1.3 for Limassol, 1.1 for Larnaca, 1 for Famagusta and 1.2 for Nicosia area. In the case of Agriculture supplies 0.6, 0.8 and 0.9 respectively excluding the Nicosia area, which has non farming fields. These values are lower than 1 meaning that priority is given to Domestic supply having U.B's greater than 1.

The following Figure 7.4.1 shows the distribution of the values taken by the objective function of the problem for all the different scenarios of inflows. The objective function varies between the values 857.58 and 1144.79 financial units/MCM, which appear to be the first two values of the graph. Checking the Table 7.3.1, the values of the sum of the inflows for these two o.f. are 55.662 and 213.815 respectively. An increase of inflows by 74% leads to an increase in the value of objective function by 25.1%, a smaller difference for such a big increase in inflows.

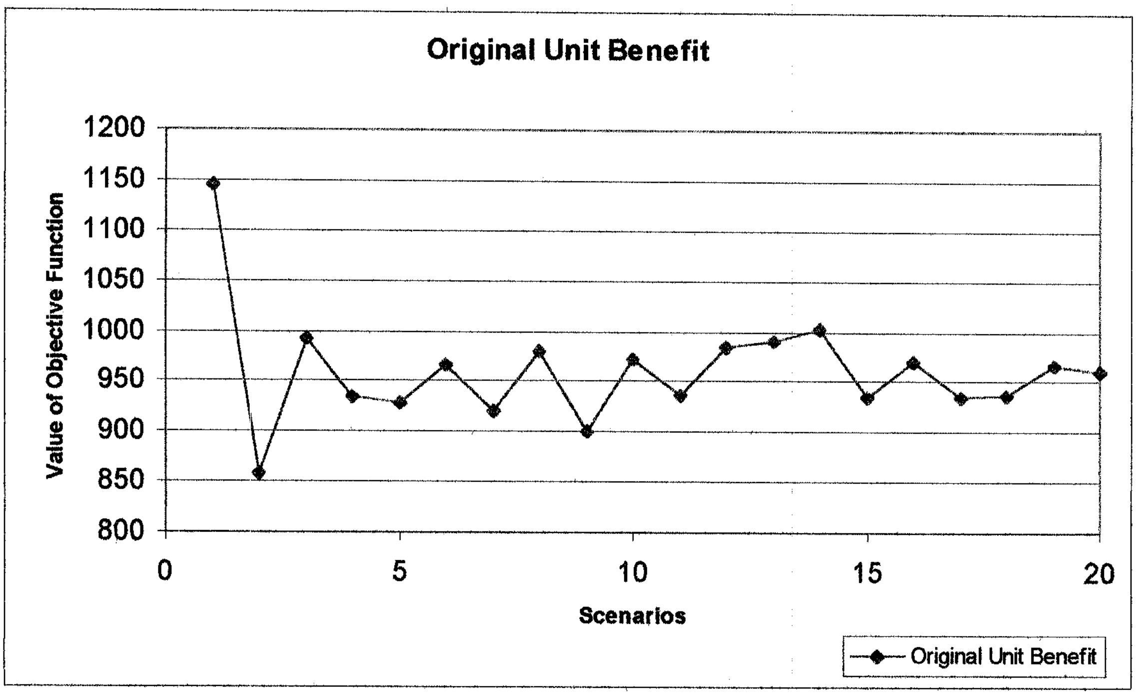

***Figure 7.4.1:** Values of Objective Function for the applied Scenarios*

Although the inflows were randomly picked from the series of existing ones, it can be seen that the value of the objective function depends on the sum of the inflows to the system for the years 1997-2005. However, the inflows for the first 4 years of this series are known exactly and they are the same for all the scenarios applied. Hence, the Objective Function is related to the future, predicted values of the SCP system inflows. It was expected that the objective function would depend on them because actually it is a function of the water allocated to the different uses.

From the Tables, in the Appendix it can be seen that for all the 20 scenarios, the Larnaca and Famagusta areas have serious problems of depletion their local sources and take water from other areas local water resources in order to keep the annual balance of surpluses positive or at least equal to zero. The desalination plants have already been included in the local resources of these areas, but they still seem to have a deficit of water for their needs. These areas must be the first Governments priorities for future alternative water resources.

Until the year 2000, the releases and inflows are the same while afterwards releases seem to be higher. Although this seem to be strange, the term "releases" for the specific problem, as it was set up, includes the amount left in the system as storage. The following bar charts give a distribution of the inflows and releases from the SCP system from 1997-2005.

Observing again the Excel spreadsheets and the table in the Appendix, giving the total inflows and releases from the system for all the scenarios, it is seen that a greater amount is left in the system as storage whereas water is allocated to the different uses and areas from the local sources. It should be noted that when dry years appear in the future, the inflow seems to be less than the "release" meaning that water is stored in the reservoir-proof of its operational use. This shows the dependency of the objective function on the future inflows and hence the necessity of this forecast in order to know what amount of water should be stored. However, no easy conclusion can be drawn as to what the policy should be for dry and less dry years.

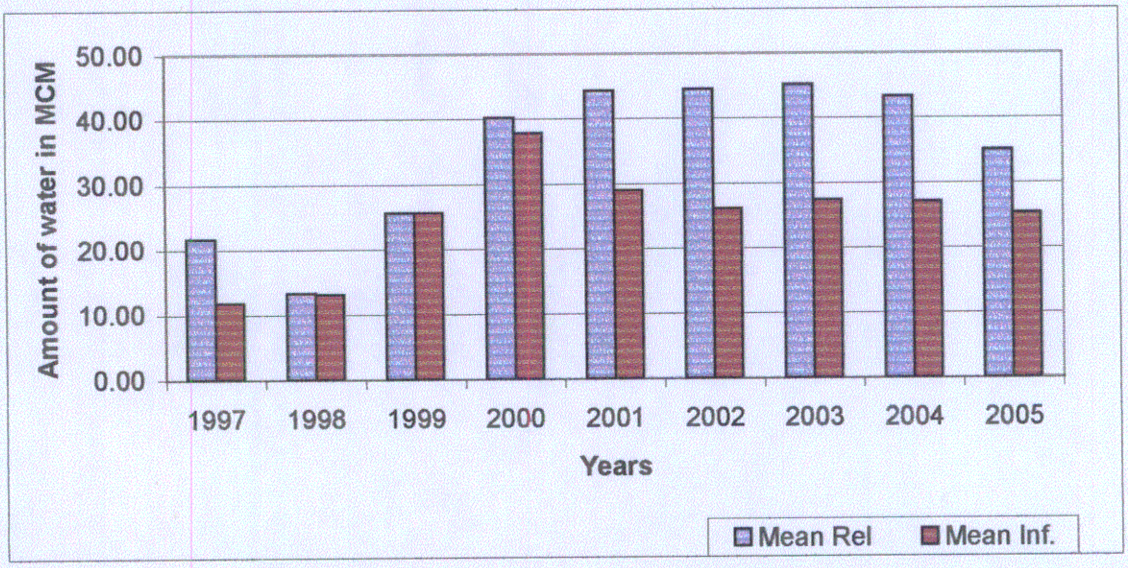

Figure 7.4.2: *Mean inflows and releases from the SCP system*

7.5 Sensitivity Analysis:

As stated in section 7.1, is worth doing a Sensitivity Analysis of the results taken from the optimization model. Thus, small differences in the assumptions and coefficients of the Objective Function would help to see the sensitivity of the model to them.

The Optimization Problem is solved again after increasing or decreasing the unit benefits of the model by 1.0% and 2.5%. The Graphs in the Appendix give the results taken from these various solutions to the problem. Firstly, all the unit benefits (for the 7 uses, 4 domestic areas and 3 agricultural ones) are increased or decreased together and give the following graph which is actually a proportional movement of the original one up or down by the chosen percentage.

The following Figure is shown simply for the purpose of confirming the original results and the operation of the Linear Programming Model set. It obviously gives a parallel movement to the original variation for all the four cases, either upwards or downwards depending on increase or decrease ob the Unit Benefits.

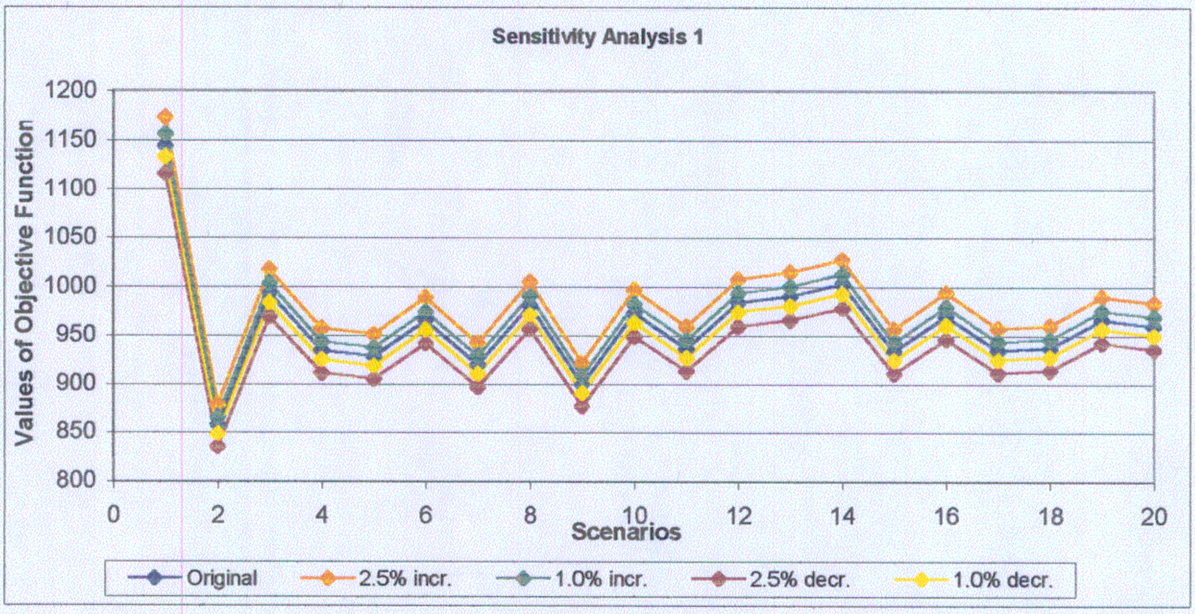

***Figure 7.5.1.(a):** Variation of the objective function under variation of the Unit Benefits*

The same percentages for the variation of the Unit Benefits are applied to the Program again but not for all the uses simultaneously. The Problem is solved for an increase or decrease in domestic unit benefit coefficients of 1.0% and 2.5% respectively keeping the agriculture ones constant at 0.6, 0.8 and 0.9 for Limassol, Larnaca and Famagusta respectively. The same procedure is followed for the agriculture unit benefit values. The results for all the variations on U.B's are given in Figure 7.4.5. For all the remaining combinations of the applied percentages on the U.B's, graphs of the variations of the objective function are given in the Appendix.

Independently of the inflows (i.e., the different scenarios) the objective function is not sensitive to small changes of the unit benefits either in the domestic or agriculture supply. The variation of the values of the objective function has the same shape for all the different percentages applied, with higher values for the changes of the unit benefits of the agriculture. This is obvious since the U.B's for agriculture have been set lower than 1 and hence by increasing them, higher values of the objective function are taken. The Objective Function in this case is found to have increased compared to the original ones by 1.013% whereas for the correspondence increase in domestic U.B's this is 1.01%. Both values are close enough to the original ones.

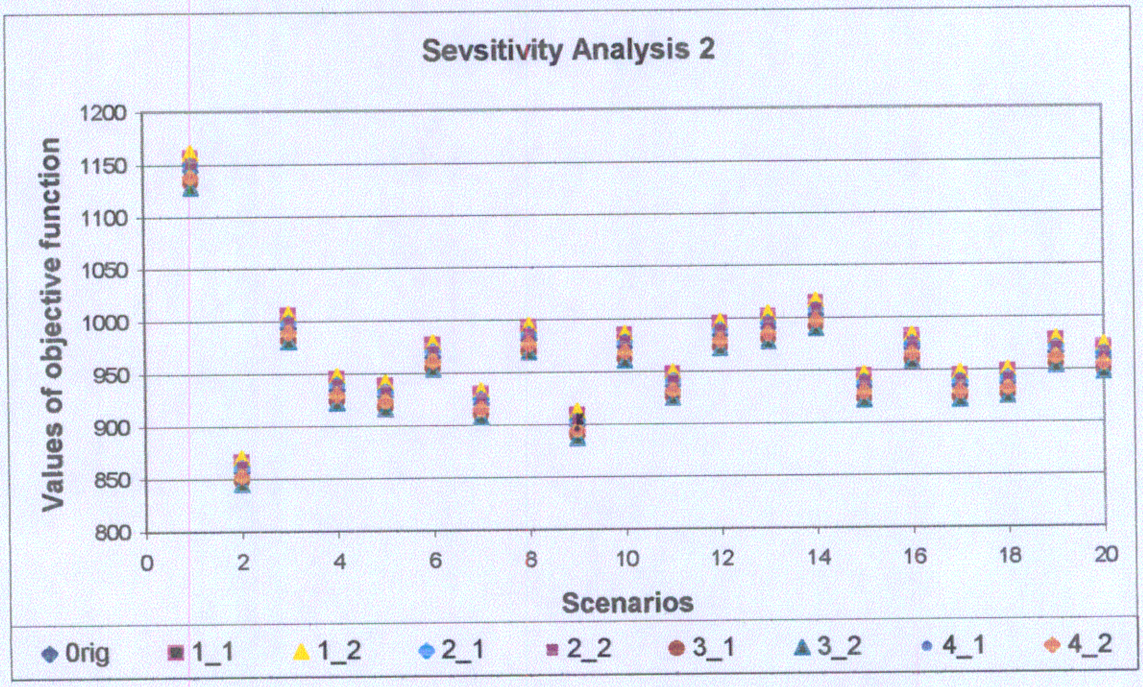

***Figure 7.5.1.(b):** Variation of the objective function under variation of the Unit Benefits*

where:

1_1: Increase in domestic U.B's by 2.5% 1_2: Increase in irrigation U.B's by 2.5%

2_1: Increase in domestic U.B's by 1.0% 2_2: Increase in irrigation U.B's by 1.0%

3_1: Decrease in domestic U.B's by 2.5% 3_2: Decrease in irrigation U.B's by 2.5%

4_1: Decrease in domestic U.B's by 1.0% 4_2: Decrease in irrigation U.B's by 1.0%

CHAPTER EIGHT:

Recommendations

The future demands for water would increase continually while the opportunities for development of new water sources will decrease dramatically in the years ahead. The WDD estimates that by the year 2010 the demand would be up to 415 MCM from which 320 MCM should be provided for agriculture purposes and only the 95 MCM would be for domestic supply.

That is why the Government sets as basic targets the rational management of the natural water sources including ground and surface water, as well as the new alternative ways to water sources (treated waste and desalted water). The Government's plants include the construction of new reservoirs, new domestic water treatment plants, wastewater treatment plants and desalination units. Setting as a target the year 2010 they believe that the biggest part of the water problem will be limited. It is estimated that by the end of all the future Government works the water balance of the island of Cyprus would be richer by 75-80 MCM.

In view of the targets and on the basis of the examination of collected data the following recommendations can be made:

1) Checking and management of the groundwater sources, the unauthorized boreholes and of the over pumping of all the private boreholes.
2) Total development and improvement of the surface waters
3) Recycling and reuse of the treated wastes of all the cities
4) Updating the government frameworks and the laws related to the water and natural resources.
5) Reduce of the losses and leakage from all the Government Operating Projects.
6) Choose and recommend irrigated plants with low water needs
7) Use of the actual price of water
8) Reduction of the evaporation from the dams
9) Observation of the development and improvement of the Desalination Plants.

In particular, the following suggestions as to ways of facing the lack of water can be formulated, both for the domestic water supply and irrigation:

1) Domestic Supply
    - Limitations
    - Proper pricing of water unit
    - Immediate fixing and repair of the damages to the distribution systems
    - Low percentage of leakages
    - Making overuse illegal
    - Use of appliances that save water (water friendly)
    - More information of the consumers
2) Irrigation
    - Limitations on the amount allocated
    - Improvement of the irrigation systems
    - Limitation to the seasonal plantations

In View of these targets a Mathematical Model was set up and solved by Linear programming giving a series of conclusions. The objective function of the optimization problem is related to the **future inflows** and the operation of the system is depending on them. It is noted that for the appearance of dry years the storage is higher than the cases of less dry ones.

For all the different scenarios applied for forecasted inflows the areas of **Larnaca** and **Famagusta** seem to have serious problems of lack of local water resources and hence they should be in the priority of the Governments' future plants.

The sensitivity analysis showed that the objective function is not sensitive to the unit benefits changes either in the domestic or the irrigation supplies.

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- www.pio.gov.cy/wdd/
- www.wbl.cy/
- www.pio.gov.cy/dsr

APPENDIX I:

Releases and Storage from Kouris Dam (in MCM)

YEAR	OCT stor	NOV stor	DEC stor	JAN stor	FEB stor	MAR stor	APR stor	MAY stor	JUNE stor	JULY stor	AUG stor	SEPT stor
1987-88	0,000	0,000	1,300	7,955	14,228	22,488	51,455	51,958	52,443	51,360	48,746	44,996
1988-89	44,854	44,503	45,812	50,240	68,840	71,264	72,944	70,496	67,520	61,224	57,003	53,314
1989-90	53,054	50,060	49,034	47,590	45,668	48,008	47,702	46,046	42,123	32,380	28,028	23,757
1990-91	23,611	19,640	17,250	15,605	14,966	15,191	15,974	14,867	12,959	10,587	9,219	7,722
1991-92	7,664	6,224	5,215	15,038	20,627	28,340	33,440	35,785	36,265	34,870	32,936	30,394
1992-93	30,316	28,483	28,899	37,775	42,480	47,846	57,953	61,014	62,694	59,678	56,490	53,184
1993-94	53,184	50,078	49,862	47,900	49,538	55,217	57,041	56,129	54,628	49,322	45,416	41,868
1994-95	41,750	39,060	48,458	51,968	57,155	60,657	60,993	60,410	57,592	50,474	46,064	41,673
1995-96	41,673	37,420	35,650	34,285	37,150	38,660	39,396	37,945	34,825	29,380	26,459	23,238
1996-97	23,238	20,326	17,972	17,655	16,481	17,061	17,274	19,963	18,788	15,528	13,226	10,363
1997-98	10,363	7,990	6,981	7,655	8,246	8,073	9,463	10,244	9,496	6,541	4,942	3,554
1998-99	3,554	1,858	1,591	5,984	7,906	16,575	19,318	20,925	19,182	18,172	15,719	13,014

YEAR	OCT rel	NOV rel	DEC rel	JAN rel	FEB rel	MAR rel	APR rel	MAY rel	JUNE rel	JULY rel	AUG rel	SEPT rel
1987-88	0,000	0,000	0,000	0,000	0,237	3,404	6,485	2,154	0,638	0,943	2,045	3,430
1988-89	1,228	0,207	1,168	1,363	2,140	2,782	3,978	3,108	2,833	2,505	3,681	3,300
1989-90	3,205	1,730	2,375	2,635	2,523	2,908	2,296	3,677	3,450	4,075	4,165	3,442
1990-91	3,359	1,924	1,897	1,466	1,226	1,717	1,751	1,745	0,964	0,811	1,062	1,092
1991-92	1,468	1,355	1,026	0,406	0,148	0,104	1,493	1,255	1,271	0,974	1,712	2,327
1992-93	1,685	1,253	0,170	0,081	0,068	0,419	0,902	0,806	1,150	2,039	2,967	2,956
1993-94	2,863	1,096	2,609	1,388	0,568	1,937	2,245	2,171	2,307	2,309	3,363	3,579
1994-95	2,789	1,872	0,337	0,355	0,512	2,847	2,370	3,064	3,056	3,531	4,103	4,155
1995-96	3,866	2,330	1,794	0,687	1,274	2,692	2,789	3,449	2,678	2,365	2,678	2,865
1996-97	2,359	2,462	2,210	1,893	1,526	1,791	1,717	1,654	1,655	1,456	2,050	2,689
1997-98	2,166	1,749	1,650	1,569	1,396	1,479	1,141	1,359	1,298	1,719	1,503	1,256
1998-99	1,594	0,643	0,660	0,618	0,512	0,746	1,166	2,111	1,879	2,495	2,591	2,542

Inflows and Losses from Kouris Dam (in MCM)

YEAR	OCT infl	NOV infl	DEC infl	JAN infl	FEB infl	MAR infl	APR infl	MAY infl	JUNE infl	JULY infl	AUG infl	SEPT infl
1987-88	0,000	1,300	6,500	6,800	8,650	30,700	9,600	3,690	1,830	0,000	0,000	0,000
1988-89	1,071	1,630	5,700	21,855	5,514	5,504	2,308	1,227	0,428	0,000	0,000	0,000
1989-90	0,440	0,850	1,100	0,836	4,930	2,860	0,863	0,230	0,029	0,000	0,000	0,000
1990-91	0,000	0,000	0,300	0,887	1,511	2,588	0,786	0,150	0,000	0,000	0,000	0,000
1991-92	0,000	0,386	10,891	6,038	7,917	5,346	4,016	2,289	0,986	0,000	0,000	0,000
1992-93	0,000	1,826	9,114	4,917	5,547	10,771	4,298	2,941	1,005	0,000	0,000	0,000
1993-94	0,000	1,004	0,846	3,265	6,424	4,008	1,672	1,069	0,185	0,000	0,000	0,000
1994-95	0,344	11,229	4,152	5,700	4,161	2,922	1,985	0,837	0,231	0,000	0,000	0,000
1995-96	0,000	0,313	0,281	3,542	2,770	3,407	1,119	0,497	0,071	0,000	0,000	0,000
1996-97	0,089	0,098	1,655	0,758	2,141	1,932	4,274	0,476	0,301	0,000	0,000	0,000
1997-98	0,032	0,861	2,328	2,246	1,279	2,922	2,016	0,737	0,600	0,000	0,000	0,000
1998-99	0,000	0,403	5,051	2,584	9,233	3,586	2,913	0,568	1,079	0,202	0,000	0,000

YEAR	OCT losses	NOV losses	DEC losses	JAN losses	FEB losses	MAR losses	APR losses	MAY losses	JUNE losses	JULY losses	AUG losses	SEPT losses
1987-88	0,022	0,034	0,118	0,162	0,289	0,344	0,397	0,374	0,245	0,150	0,074	0,058
1988-89	0,072	0,104	0,162	0,275	0,426	0,436	0,477	0,379	0,273	0,167	0,093	0,064
1989-90	0,073	0,770	0,208	0,276	0,300	0,304	0,333	0,395	0,208	0,168	0,085	0,056
1990-91	0,049	0,510	0,840	0,131	0,160	0,179	0,169	0,145	0,110	0,080	0,030	0,040
1991-92	0,044	0,570	0,100	0,187	0,261	0,309	0,351	0,359	0,265	0,177	0,108	0,059
1992-93	0,072	0,790	0,186	0,247	0,347	0,528	0,565	0,524	0,370	0,366	0,150	0,112
1993-94	0,107	0,124	0,156	0,258	0,399	0,438	0,436	0,402	0,284	0,225	0,122	0,071
1994-95	0,820	0,108	0,163	0,206	0,404	0,459	0,470	0,428	0,269	0,224	0,062	0,061
1995-96	0,610	0,770	0,113	0,165	0,283	0,351	0,334	0,261	0,189	0,172	0,093	0,043
1996-97	0,610	0,520	0,076	0,105	0,170	0,200	0,225	0,162	0,124	0,074	0,038	0,027
1997-98	0,270	0,360	0,046	0,086	0,119	0,150	0,144	0,123	0,071	0,047	0,017	0,022
1998-99	0,260	0,410	0,102	0,137	0,216	0,231	0,231	0,184	0,135	0,089	0,049	0,036

Water Balance of the Kouris Dam (in MCM)

YEAR	OCT balance	NOV balance	DEC balance	JAN balance	FEB balance	MAR balance	APR balance	MAY balance	JUNE balance	JULY balance	AUG balance	SEPT balance
1987-88		1,266	5,082	-0,017	1,851	18,692	-26,249	0,659	0,462	-0,010	0,495	0,262
1988-89	-0,087	1,670	3,061	15,789	-15,652	-0,138	-3,827	0,188	0,298	3,624	0,447	0,325
1989-90	-2,578	1,344	-0,457	-0,631	4,029	-2,692	-1,460	-2,186	0,294	5,500	0,102	0,773
1990-91	-3,262	1,537	-0,047	0,935	0,764	0,467	-1,917	-0,633	0,834	1,481	0,276	0,365
1991-92	-1,454	-0,099	10,774	-4,378	1,919	-2,780	-2,928	-1,670	-1,030	0,244	0,114	0,156
1992-93	-1,679	1,616	8,342	-4,287	0,427	4,458	-7,276	-1,450	-2,195	0,611	0,071	0,238
1993-94	-2,970	2,890	-1,703	3,581	3,819	-4,046	-2,833	-0,592	-0,905	2,772	0,421	-0,102
1994-95	-3,147	11,939	-5,746	1,629	-1,942	-3,886	-1,191	-2,072	-0,276	3,363	0,245	0,175
1995-96	-4,476	1,466	0,144	4,055	-1,652	-1,146	-2,740	-1,762	0,324	2,908	0,150	0,313
1996-97	-2,880	0,028	1,723	-0,923	1,619	-0,639	2,119	-4,029	-0,303	1,730	0,214	0,147
1997-98	-2,404	1,125	1,641	-0,083	-0,827	1,466	-0,659	-1,526	-0,021	1,189	0,079	0,110
1998-99	-1,854	1,046	4,556	-2,564	6,583	-6,060	-1,227	-3,334	0,808	-1,372	-0,187	0,127

The water balance for each month is given by:

Storage of previous month - storage of the month - losses - releases + inflows

The values in this table should be around to zero

INFLOWS TO KOURIS DAM										
Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Total

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Total
1987-88	0	1,3	6,5	6,8	8,65	30,7	9,6	3,69	1,83	0	69,07
1988-89	1,071	1,63	5,7	21,855	5,514	5,504	2,308	1,227	0,428	0	45,237
1989-90	0,44	0,85	1,1	0,836	4,93	2,86	0,863	0,23	0,029	0	12,138
1990-91	0	0	0,3	0,887	1,511	2,588	0,786	0,15	0	0	6,222
1991-92	0	0,386	10,891	6,038	7,917	5,346	4,016	2,289	0,986	0	37,869
1992-93	0	1,826	9,114	4,917	5,547	10,771	4,298	2,941	1,005	0	40,419
1993-94	0	1,004	0,846	3,265	6,424	4,008	1,672	1,069	0,185	0	18,473
1994-95	0,344	11,229	4,152	5,7	4,161	2,922	1,985	0,837	0,231	0	31,561
1995-96	0	0,313	0,281	3,542	2,77	3,407	1,119	0,497	0,071	0	12
1996-97	0,089	0,098	1,655	0,758	2,141	1,932	4,274	0,476	0,301	0	11,724
1997-98	0,032	0,861	2,328	2,246	1,279	2,922	2,016	0,737	0,6	0	13,021
1998-99	0	0,403	5,051	2,584	9,233	3,586	2,913	0,568	1,079	0,202	25,619

INFLOWS TO KOURIS DAM

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
1988	6,8	8,65	30,7	9,6	3,69	1,83	0	0	0	1,071	1,63	6,5	70,471
1989	21,855	5,514	5,504	2,308	1,227	0,428	0	0	0	0,44	0,85	1,1	39,226
1990	0,836	4,93	2,86	0,863	0,23	0,029	0	0	0	0	0	0,3	10,048
1991	0,887	1,511	2,588	0,786	0,15	0	0	0	0	0	0,386	10,891	17,199
1992	6,038	7,917	5,346	4,016	2,289	0,986	0	0	0	0	1,826	9,114	37,532
1993	4,917	5,547	10,771	4,298	2,941	1,005	0	0	0	0	1,004	0,846	31,329
1994	3,265	6,424	4,008	1,672	1,069	0,185	0	0	0	0,344	11,229	4,152	32,348
1995	5,7	4,161	2,922	1,985	0,837	0,231	0	0	0	0	0,313	0,281	16,43
1996	3,542	2,77	3,407	1,119	0,497	0,071	0	0	0	0,089	0,098	1,655	13,248
1997	0,758	2,141	1,932	4,274	0,476	0,301	0	0	0	0,032	0,861	2,328	13,103
1998	2,246	1,279	2,922	2,016	0,737	0,6	0	0	0	0	0,403	5,051	15,254
1999	2,584	9,233	3,586	2,913	0,568	1,079	0,202						20,165

APPENDIX II:

LINEAR PROGRAMM TO FIND THE OPTIMAL ALLOCATION OF THE WATER OF THE SCP SYSTEM

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Other water requirements: Recharge	Storage to next year	Inflows: Kouris	Local resources: Limassol	Larnaca	Nicosia	Famagous	Total
Unit benefit	1.3	1.1	1.2	1	0.6	0.8	0.9	1.5	0						
Demands															
1997	19.2	7.8	16.3	6.7	32.1	29	49.4	2.3	100	11.724	29.1	11.3	21.3	9.7	83.124
1998	19.9	8	16.5	7	32.1	29	49.4	2.3	100	13.021	39.7	17.6	21.1	9.7	101.121
1999	20.6	8.2	17	7.4	32.1	29	49.4	2.3	100	25.619	39.7	17.6	20.9	9.7	113.519
2000	21.3	8.4	17.4	7.7	32.1	29	49.4	2.3	100	37.869	39.7	30.6	20.7	9.7	138.569
2001	21.8	8.6	17.8	7.8	32.1	29	49.4	2.3	100	40.419	39.7	30.6	20.5	9.7	140.919
2002	22.2	8.7	18.1	8	32.1	29	49.4	2.3	100	69.07	39.7	30.6	20.4	9.7	169.47
2003	22.6	8.9	18.4	8.1	32.1	29	49.4	2.3	100	31.561	39.7	30.6	20.2	9.7	131.761
2004	23.1	9	18.8	8.3	32.1	29	49.4	2.3	100	37.896	39.7	30.6	20.1	9.7	137.996
2005	23.6	9.2	19.1	8.4	32.1	29	49.4	2.3	100	34.869	39.7	30.6	19.9	9.7	134.769

Fractions of minimum required quantities to demands

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Recharge	Storage to next year
1997	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
1998	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
1999	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2000	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2001	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2002	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2003	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2004	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2005	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0

Minimum required quantities

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Recharge	Storage to next year
1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0	0
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	0	0
1999	14.832	5.904	12.24	5.328	14.124	12.76	29.64	0	0
2000	15.336	6.048	12.528	5.544	14.124	12.76	29.64	0	0
2001	15.696	6.192	12.816	5.616	14.124	12.76	29.64	0	0
2002	15.984	6.264	13.032	5.76	14.124	12.76	29.64	0	0
2003	16.272	6.408	13.248	5.832	14.124	12.76	29.64	0	0
2004	16.632	6.48	13.536	5.976	14.124	12.76	29.64	0	0
2005	16.992	6.624	13.752	6.048	14.124	12.76	29.64	0	0

Releases from Kouris

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Recharge	Storage to next year	Total	Water balance of Kouris
									10		
1997	0	0	0	0	0	0	21.124	0.6	0	21.724	0.00
1998	0	0	0	0	0	0	10.721	2.3	0	13.021	0.00
1999	0	0	0	0	0	0	23.319	2.3	0	25.619	0.00
2000	0	0	0	0	0	0	30.384	2.3	5.185	37.869	0.00
2001	0	8.6	0	0	14.124	0	20.58	2.3	0	45.604	0.00
2002	0	0	0	0	0	0	49.124	2.3	17.646	69.07	0.00
2003	0	0	0	0	0	0	43.004	2.3	3.903	49.207	0.00
2004	0	9	0	8.3	14.124	0	3.96	2.3	4.115	41.799	0.00
2005	0	0	0	0	0	0	36.684	2.3	0	38.984	0.00

Totals **Surpluses**

Releases from local sources

									Limassol	Larnaca	Nicosia	Famagousta		Limassol	Larnaca	Nicosia	Famagous	Totals
1997	13.824	5.616	11.736	4.824	14.124	12.76	8.516		27.948	18.376	11.736	13.34		1.15	-7.08	9.56	-3.64	0.00
1998	19.617	5.76	11.88	5.04	14.124	12.76	18.919		33.741	18.52	11.88	23.959		5.96	-0.92	9.22	-14.26	0.00
1999	20.6	8.2	17	7.4	14.124	12.76	7.816		34.724	20.96	17	15.216		4.98	-3.36	3.90	-5.52	0.00
2000	21.3	8.4	17.4	7.7	14.124	12.76	19.016		35.424	21.16	17.4	26.716		4.28	9.44	3.30	-17.02	0.00
2001	21.8	0	17.8	7.8	0	24.28	28.82		21.8	24.28	17.8	36.62		17.90	6.32	2.70	-26.92	0.00
2002	22.2	8.7	18.1	8	14.124	29	0.276		36.324	37.7	18.1	8.276		3.38	-7.10	2.30	1.42	0.00
2003	22.6	8.9	18.4	8.1	14.124	21.68	6.396		36.724	30.58	18.4	14.496		2.98	0.02	1.80	-4.80	0.00
2004	23.1	0	18.8	0	0	12.76	45.44		23.1	12.76	18.8	45.44		16.60	17.84	1.30	-35.74	0.00
2005	23.6	9.2	19.1	8.4	14.124	12.76	12.716		37.724	21.96	19.1	21.116		1.98	8.64	0.80	-11.42	0.00

Total releases

1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0.6	0
1998	19.617	5.76	11.88	5.04	14.124	12.76	29.64	2.3	0
1999	20.6	8.2	17	7.4	14.124	12.76	31.135	2.3	0
2000	21.3	8.4	17.4	7.7	14.124	12.76	49.4	2.3	5.185
2001	21.8	8.6	17.8	7.8	14.124	24.28	49.4	2.3	0
2002	22.2	8.7	18.1	8	14.124	29	49.4	2.3	17.646
2003	22.6	8.9	18.4	8.1	14.124	21.68	49.4	2.3	3.903
2004	23.1	9	18.8	8.3	14.124	12.76	49.4	2.3	4.115
2005	23.6	9.2	19.1	8.4	14.124	12.76	49.4	2.3	0

Benefits

1997	17.9712	6.1776	14.0832	4.824	8.4744	10.208	26.676	0.9	0	89.3144
1998	25.5021	6.336	14.256	5.04	8.4744	10.208	26.676	3.45	0	99.9425
1999	26.78	9.02	20.4	7.4	8.4744	10.208	28.0215	3.45	0	113.7539
2000	27.69	9.24	20.88	7.7	8.4744	10.208	44.46	3.45	0	132.1024
2001	28.34	9.46	21.36	7.8	8.4744	19.424	44.46	3.45	0	142.7684
2002	28.86	9.57	21.72	8	8.4744	23.2	44.46	3.45	0	147.7344
2003	29.38	9.79	22.08	8.1	8.4744	17.344	44.46	3.45	0	143.0784
2004	30.03	9.9	22.56	8.3	8.4744	10.208	44.46	3.45	0	137.3824
2005	30.68	10.12	22.92	8.4	8.4744	10.208	44.46	3.45	0	138.7124

Objective function **1144.789**

LINEAR PROGRAMM TO FIND THE OPTIMAL ALLOCATION OF THE WATER OF THE SCP SYSTEM

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.			Inflows Kouris	Local resources Limassol	Larnaca	Nicosia	Famagous	Total	
	Unit benefit							**Other water requirements**								
	1.3	1.1	1.2	1	0.6	0.8	0.9	1.5	0							
	Demands							**Recharge**	**Storage to next year**							
1997	19.2	7.8	16.3	6.7	32.1	29	49.4	2.3	100	11.724	29.1	11.3	21.3	9.7	83.124	
1998	19.9	8	16.5	7	32.1	29	49.4	2.3	100	13.021	39.7	11.5	21.1	9.7	95.021	
1999	20.6	8.2	17	7.4	32.1	29	49.4	2.3	100	25.619	39.7	11.7	20.9	9.7	107.619	
2000	21.3	8.4	17.4	7.7	32.1	29	49.4	2.3	100	37.869	39.7	11.9	20.7	9.7	119.869	
2001	21.8	8.6	17.8	7.8	32.1	29	49.4	2.3	100	6.222	39.7	12.1	20.5	9.7	88.222	
2002	22.2	8.7	18.1	8	32.1	29	49.4	2.3	100	13.021	39.7	12.2	20.4	9.7	95.021	
2003	22.6	8.9	18.4	8.1	32.1	29	49.4	2.3	100	18.473	39.7	12.4	20.2	9.7	100.473	
2004	23.1	9	18.8	8.3	32.1	29	49.4	2.3	100	11.724	39.7	12.5	20.1	9.7	93.724	
2005	23.6	9.2	19.1	8.4	32.1	29	49.4	2.3	100	6.222	39.7	12.7	19.9	9.7	88.222	
	Fractions of minimum required quantities to demands															
1997	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
1998	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
1999	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2000	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2001	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2002	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2003	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2004	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2005	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
	Minimum required quantities															
1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0	0							
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	0	0							
1999	14.832	5.904	12.24	5.328	14.124	12.76	29.64	0	0							
2000	15.336	6.048	12.528	5.544	14.124	12.76	29.64	0	0							
2001	15.696	6.192	12.816	5.616	14.124	12.76	29.64	0	0							
2002	15.984	6.264	13.032	5.76	14.124	12.76	29.64	0	0							
2003	16.272	6.408	13.248	5.832	14.124	12.76	29.64	0	0							
2004	16.632	6.48	13.536	5.976	14.124	12.76	29.64	0	0							
2005	16.992	6.624	13.752	6.048	14.124	12.76	29.64	0	0							
	Releases from Kouris								10	**Total**						**Water balance of Kouris**
1997	13.824	5.616	0	0	0	0	1.684	0	0.6	21.724						0.00
1998	0	0	0	5.04	0	6.492	0	2.089	0	13.621						0.00
1999	0	5.904	0	0	0	0	6.924	2.3	10.491	25.619						0.00
2000	0	6.048	0	0	0	0	7.932	1.362	33.018	48.36						0.00
2001	0	0	0	5.616	0	9.228	0	2.3	22.096	39.24						0.00
2002	0	0	0	0	0	0	15.564	2.3	17.253	35.117						0.00
2003	0	6.408	0	5.832	0	4.044	0	2.3	17.142	35.726						0.00
2004	16.632	0	0	0	0	0	0.516	0	11.718	28.866						0.00
2005	5.268	6.624	0	6.048	0	0	0	0	0	17.94						0.00

Releases from local sources

Year							
1997	0	0	11.736	4.824	14.124	12.76	27.956
1998	14.328	5.76	11.88	0	14.124	6.268	29.64
1999	14.832	0	12.24	5.328	14.124	12.76	22.716
2000	15.336	0	12.528	5.544	14.124	12.76	21.708
2001	15.696	6.192	12.816	0	14.124	3.532	29.64
2002	15.984	6.264	13.032	5.76	14.124	12.76	14.076
2003	16.272	0	13.248	0	14.124	8.716	29.64
2004	0	6.48	13.536	5.976	14.124	12.76	29.124
2005	11.724	0	13.752	0	14.124	12.76	29.64

Totals

Limassol	Larnaca	Nicosia	Famagousta
14.124	12.76	11.736	32.78
28.452	12.028	11.88	29.64
28.956	12.76	12.24	28.044
29.46	12.76	12.528	27.252
29.82	9.724	12.816	29.64
30.108	19.024	13.032	19.836
30.396	8.716	13.248	29.64
14.124	19.24	13.536	35.1
25.848	12.76	13.752	29.64

Surpluses

Limassol	Larnaca	Nicosia	Famagous	Totals
14.98	-1.46	9.56	-23.08	0.00
11.25	-0.53	9.22	-19.94	0.00
10.74	-1.06	8.66	-18.34	0.00
10.24	-0.86	8.17	-17.55	0.00
9.88	2.38	7.68	-19.94	0.00
9.59	-6.82	7.37	-10.14	0.00
9.30	3.68	6.95	-19.94	0.00
25.58	-6.74	6.56	-25.40	0.00
13.85	-0.06	6.15	-19.94	0.00

Total releases

Year									
1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0	0.6
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	2.089	0
1999	14.832	5.904	12.24	5.328	14.124	12.76	29.64	2.3	10.491
2000	15.336	6.048	12.528	5.544	14.124	12.76	29.64	1.362	33.018
2001	15.696	6.192	12.816	5.616	14.124	12.76	29.64	2.3	22.096
2002	15.984	6.264	13.032	5.76	14.124	12.76	29.64	2.3	17.253
2003	16.272	6.408	13.248	5.832	14.124	12.76	29.64	2.3	17.142
2004	16.632	6.48	13.536	5.976	14.124	12.76	29.64	0	11.718
2005	16.992	6.624	13.752	6.048	14.124	12.76	29.64	0	0

Benefits

Year										
1997	17.9712	6.1776	14.0832	4.824	8.4744	10.208	26.676	0	0	88.4144
1998	18.6264	6.336	14.256	5.04	8.4744	10.208	26.676	3.1335	0	92.7503
1999	19.2816	6.4944	14.688	5.328	8.4744	10.208	26.676	3.45	0	94.6004
2000	19.9368	6.6528	15.0336	5.544	8.4744	10.208	26.676	2.043	0	94.5686
2001	20.4048	6.8112	15.3792	5.616	8.4744	10.208	26.676	3.45	0	97.0196
2002	20.7792	6.8904	15.6384	5.76	8.4744	10.208	26.676	3.45	0	97.8764
2003	21.1536	7.0488	15.8976	5.832	8.4744	10.208	26.676	3.45	0	98.7404
2004	21.6216	7.128	16.2432	5.976	8.4744	10.208	26.676	0	0	96.3272
2005	22.0896	7.2864	16.5024	6.048	8.4744	10.208	26.676	0	0	97.2848

Objective function 867.5821

LINEAR PROGRAMM TO FIND THE OPTIMAL ALLOCATION OF THE WATER OF THE SCP SYSTEM

Unit benefit

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Other water requirements: Recharge	Other water requirements: Storage to next year
	1.3	1.1	1.2	1	0.6	0.8	0.9	1.5	0

Demands

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Recharge	Storage to next year	Inflows Kouris	Local resources Limassol	Larnaca	Nicosia	Famagous	Total
1997	19.2	7.8	16.3	6.7	32.1	29	49.4	2.3	100	11.724	29.1	11.3	21.3	9.7	83.124
1998	19.9	8	16.5	7	32.1	29	49.4	2.3	100	13.021	39.7	11.5	21.1	9.7	95.021
1999	20.6	8.2	17	7.4	32.1	29	49.4	2.3	100	25.619	39.7	11.7	20.9	9.7	107.619
2000	21.3	8.4	17.4	7.7	32.1	29	49.4	2.3	100	37.869	39.7	11.9	20.7	9.7	119.869
2001	21.8	8.6	17.8	7.8	32.1	29	49.4	2.3	100	69.07	39.7	12.1	20.5	9.7	151.07
2002	22.2	8.7	18.1	8	32.1	29	49.4	2.3	100	45.237	39.7	12.2	20.4	9.7	127.237
2003	22.6	8.9	18.4	8.1	32.1	29	49.4	2.3	100	12.138	39.7	12.4	20.2	9.7	94.138
2004	23.1	9	18.8	8.3	32.1	29	49.4	2.3	100	6.222	39.7	12.5	20.1	9.7	88.222
2005	23.6	9.2	19.1	8.4	32.1	29	49.4	2.3	100	34.869	39.7	12.7	19.9	9.7	116.869

Fractions of minimum required quantities to demands

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Recharge	Storage to next year
1997	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
1998	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
1999	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2000	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2001	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2002	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2003	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2004	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2005	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0

Minimum required quantities

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Recharge	Storage to next year
1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0	0
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	0	0
1999	14.832	5.904	12.24	5.328	14.124	12.76	29.64	0	0
2000	15.336	6.048	12.528	5.544	14.124	12.76	29.64	0	0
2001	15.696	6.192	12.816	5.616	14.124	12.76	29.64	0	0
2002	15.984	6.264	13.032	5.76	14.124	12.76	29.64	0	0
2003	16.272	6.408	13.248	5.832	14.124	12.76	29.64	0	0
2004	16.632	6.48	13.536	5.976	14.124	12.76	29.64	0	0
2005	16.992	6.624	13.752	6.048	14.124	12.76	29.64	0	0

Releases from Kouris

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Recharge	Storage to next year	Total	Water balance of Kouris
									10		
1997	13.824	5.616	0	0	0	0	1.684	0	0.6	21.724	0.00
1998	0	0	0	5.04	0	6.492	0	2.089	0	13.621	0.00
1999	0	5.904	0	0	0	0	17.415	2.3	0	25.619	0.00
2000	0	0	17.4	0	0	11.924	0	2.3	6.245	37.869	0.00
2001	0	0	0	0	0	0.884	29.64	2.3	42.491	75.315	0.00
2002	0	0	0	8	0	0	23.524	2.3	53.904	87.728	0.00
2003	0	8.9	0	8.1	0	12.76	2.764	2.3	31.218	66.042	0.00
2004	23.1	0	0	0	0	0	9.785	2.3	2.255	37.44	0.00
2005	0	9.2	0	8.4	0	0	17.224	2.3	0	37.124	0.00

Releases from local sources

1997	0	0	11.736	4.824	14.124	12.76	27.956
1998	14.328	5.76	11.88	0	14.124	6.268	29.64
1999	20.6	0	16.963	5.328	14.124	12.76	12.225
2000	21.3	8.4	0	7.7	14.124	0.836	29.64
2001	21.8	8.6	17.8	7.8	14.124	11.876	0
2002	22.2	8.7	18.1	0	14.124	12.76	6.116
2003	22.6	0	18.4	0	14.124	0	26.876
2004	0	9	18.8	7.461	14.124	12.76	19.855
2005	23.6	0	19.1	0	14.124	12.76	12.416

Totals

	Limassol	Larnaca	Nicosia	Famagousta
1997	14.124	12.76	11.736	32.78
1998	28.452	12.028	11.88	29.64
1999	34.724	12.76	16.963	17.553
2000	35.424	9.236	0	37.34
2001	35.924	20.476	17.8	7.8
2002	36.324	21.46	18.1	6.116
2003	36.724	0	18.4	26.876
2004	14.124	21.76	18.8	27.316
2005	37.724	12.76	19.1	12.416

Surpluses

	Limassol	Larnaca	Nicosia	Famagous	Total
1997	14.98	-1.46	9.56	-23.08	0.00
1998	11.25	-0.53	9.22	-19.94	0.00
1999	4.98	-1.06	3.94	-7.85	0.00
2000	4.28	2.66	20.70	-27.64	0.00
2001	3.78	-8.38	2.70	1.90	0.00
2002	3.38	-9.26	2.30	3.58	0.00
2003	2.98	12.40	1.80	-17.18	0.00
2004	25.58	-9.26	1.30	-17.62	0.00
2005	1.98	-0.06	0.80	-2.72	0.00

Total releases

1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0	0.6
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	2.089	0
1999	20.6	5.904	16.963	5.328	14.124	12.76	29.64	2.3	0
2000	21.3	8.4	17.4	7.7	14.124	12.76	29.64	2.3	6.245
2001	21.8	8.6	17.8	7.8	14.124	12.76	29.64	2.3	42.491
2002	22.2	8.7	18.1	8	14.124	12.76	29.64	2.3	53.904
2003	22.6	8.9	18.4	8.1	14.124	12.76	29.64	2.3	31.218
2004	23.1	9	18.8	7.461	14.124	12.76	29.64	2.3	2.255
2005	23.6	9.2	19.1	8.4	14.124	12.76	29.64	2.3	0

Benefits

1997	17.9712	6.1776	14.0832	4.824	8.4744	10.208	26.676	0	0	88.4144
1998	18.6264	6.336	14.256	5.04	8.4744	10.208	26.676	3.1335	0	92.7503
1999	26.78	6.4944	20.3556	5.328	8.4744	10.208	26.676	3.45	0	107.7664
2000	27.69	9.24	20.88	7.7	8.4744	10.208	26.676	3.45	0	114.3184
2001	28.34	9.46	21.36	7.8	8.4744	10.208	26.676	3.45	0	115.7684
2002	28.86	9.57	21.72	8	8.4744	10.208	26.676	3.45	0	116.9584
2003	29.38	9.79	22.08	8.1	8.4744	10.208	26.676	3.45	0	118.1584
2004	30.03	9.9	22.56	7.461	8.4744	10.208	26.676	3.45	0	118.7594
2005	30.68	10.12	22.92	8.4	8.4744	10.208	26.676	3.45	0	120.9284

Objective function **993.8225**

LINEAR PROGRAMM TO FIND THE OPTIMAL ALLOCATION OF THE WATER OF THE SCP SYSTEM

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Other water requirements: Recharge	Storage to next year
Unit benefit									
	1.3	1.1	1.2	1	0.6	0.6	0.9	1.5	0
Demands									
1997	19.2	7.8	16.3	6.7	32.1	29	49.4	2.3	100
1998	19.9	8	16.5	7	32.1	29	49.4	2.3	100
1999	20.6	8.2	17	7.4	32.1	29	49.4	2.3	100
2000	21.3	8.4	17.4	7.7	32.1	29	49.4	2.3	100
2001	21.8	8.6	17.8	7.8	32.1	29	49.4	2.3	100
2002	22.2	8.7	18.1	8	32.1	29	49.4	2.3	100
2003	22.6	8.9	18.4	8.1	32.1	29	49.4	2.3	100
2004	23.1	9	18.8	8.3	32.1	29	49.4	2.3	100
2005	23.6	9.2	19.1	8.4	32.1	29	49.4	2.3	100
Fractions of minimum required quantities to demands									
1997	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
1998	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
1999	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2000	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2001	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2002	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2003	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2004	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2005	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
Minimum required quantities									
1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0	0
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	0	0
1999	14.832	5.904	12.24	5.328	14.124	12.76	29.64	0	0
2000	15.336	6.048	12.528	5.544	14.124	12.76	29.64	0	0
2001	15.696	6.192	12.816	5.616	14.124	12.76	29.64	0	0
2002	15.984	6.264	13.032	5.76	14.124	12.76	29.64	0	0
2003	16.272	6.408	13.248	5.832	14.124	12.76	29.64	0	0
2004	16.632	6.48	13.536	5.976	14.124	12.76	29.64	0	0
2005	16.992	6.624	13.752	6.048	14.124	12.76	29.64	0	0

Year	Inflows: Kouris	Local resources: Limassol	Larnaca	Nicosia	Famagous	Total
1997	11.724	29.1	11.3	21.3	9.7	83.124
1998	13.021	39.7	11.5	21.1	9.7	95.021
1999	25.619	39.7	11.7	20.9	9.7	107.619
2000	37.869	39.7	11.9	20.7	9.7	119.869
2001	12	39.7	12.1	20.5	9.7	94
2002	11.742	39.7	12.2	20.4	9.7	93.742
2003	18.473	39.7	12.4	20.2	9.7	100.473
2004	34.869	39.7	12.5	20.1	9.7	116.869
2005	40.419	39.7	12.7	19.9	9.7	122.419

Releases from Kouris	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Recharge	Storage to next year	Total	Water balance of Kouris
									10		
1997	13.824	0	0	0	0	0	7.3	0	0.6	21.724	0.00
1998	0	5.76	0	0	0	0	5.772	2.089	0	13.621	0.00
1999	0	0	0	0	0	0	18.596	2.3	4.723	25.619	0.00
2000	0	6.048	10.323	0	0	0	0	2.3	23.921	42.592	0.00
2001	3.036	6.192	0	5.616	0	0	0	2.3	18.777	35.921	0.00
2002	0	0	0	0	0	0	21.78	2.3	6.439	30.519	0.00
2003	0	6.408	0	5.832	0	0	10.372	2.3	0	24.912	0.00
2004	16.424	9	0	7.145	0	0	0	2.3	0	34.869	0.00
2005	0	0	0	8.4	14.124	12.76	2.835	2.3	0	40.419	0.00

Releases from local sources

1997	0	5.616	11.736	4.824	14.124	12.76	22.34
1998	14.328	0	11.88	5.04	14.124	12.76	23.868
1999	20.6	5.904	12.24	5.328	14.124	12.76	11.044
2000	17.727	0	2.205	5.544	14.124	12.76	29.64
2001	12.66	0	12.816	0	14.124	12.76	29.64
2002	22.2	6.264	13.032	5.76	14.124	12.76	7.86
2003	22.6	0	13.248	0	14.124	12.76	19.268
2004	6.676	0	18.8	0	14.124	12.76	29.64
2005	23.6	9.2	19.1	0	0	0	30.1

Totals

Limassol	Larnaca	Nicosia	Famagousta
14.124	18.376	11.736	27.164
28.452	12.76	11.88	28.908
34.724	18.664	12.24	16.372
31.851	12.76	2.205	35.184
26.784	12.76	12.816	29.64
36.324	19.024	13.032	13.62
36.724	12.76	13.248	19.268
20.8	12.76	18.8	29.64
23.6	9.2	19.1	30.1

Surpluses

Limassol	Larnaca	Nicosia	Famagous	Totals
14.98	-7.08	9.56	-17.46	0.00
11.25	-1.26	9.22	-19.21	0.00
4.98	-6.96	8.66	-6.67	0.00
7.85	-0.86	18.49	-25.48	0.00
12.92	-0.66	7.68	-19.94	0.00
3.38	-6.82	7.37	-3.92	0.00
2.98	-0.36	6.95	-9.57	0.00
18.90	-0.26	1.30	-19.94	0.00
16.10	3.50	0.80	-20.40	0.00

Total releases

1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0	0.6
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	2.089	0
1999	20.6	5.904	12.24	5.328	14.124	12.76	29.64	2.3	4.723
2000	17.727	6.048	12.528	5.544	14.124	12.76	29.64	2.3	23.921
2001	15.696	6.192	12.816	5.616	14.124	12.76	29.64	2.3	18.777
2002	22.2	6.264	13.032	5.76	14.124	12.76	29.64	2.3	6.439
2003	22.6	6.408	13.248	5.832	14.124	12.76	29.64	2.3	0
2004	23.1	9	18.8	7.145	14.124	12.76	29.64	2.3	0
2005	23.6	9.2	19.1	8.4	14.124	12.76	32.935	2.3	0

Benefits

1997	17.9712	6.1776	14.0832	4.824	8.4744	10.208	26.676	0	0	88.4144
1998	18.6264	6.336	14.256	5.04	8.4744	10.208	26.676	3.1335	0	92.7503
1999	26.78	6.4944	14.688	5.328	8.4744	10.208	26.676	3.45	0	102.0988
2000	23.0451	6.6528	15.0336	5.544	8.4744	10.208	26.676	3.45	0	99.0839
2001	20.4048	6.8112	15.3792	5.616	8.4744	10.208	26.676	3.45	0	97.0196
2002	28.86	6.8904	15.6384	5.76	8.4744	10.208	26.676	3.45	0	105.9572
2003	29.38	7.0488	15.8976	5.832	8.4744	10.208	26.676	3.45	0	106.9668
2004	30.03	9.9	22.56	7.145	8.4744	10.208	26.676	3.45	0	118.4434
2005	30.68	10.12	22.92	8.4	8.4744	10.208	29.6415	3.45	0	123.8939

Objective function **934.6283**

LINEAR PROGRAMM TO FIND THE OPTIMAL ALLOCATION OF THE WATER OF THE SCP SYSTEM

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Other water requirements		Inflows Kouris	Local resources Limassol	Larnaca	Nicosia	Famagous	Total
Unit benefit	1.3	1.1	1.2	1	0.6	0.8	0.9	1.5	0						
Demands								**Recharge**	**Storage to next year**						
1997	19.2	7.8	16.3	6.7	32.1	29	49.4	2.3	100	11.724	29.1	11.3	21.3	9.7	83.124
1998	19.9	8	16.5	7	32.1	29	49.4	2.3	100	13.021	39.7	11.5	21.1	9.7	95.021
1999	20.6	8.2	17	7.4	32.1	29	49.4	2.3	100	25.619	39.7	11.7	20.9	9.7	107.619
2000	21.3	8.4	17.4	7.7	32.1	29	49.4	2.3	100	37.869	39.7	11.9	20.7	9.7	119.869
2001	21.8	8.6	17.8	7.8	32.1	29	49.4	2.3	100	12.138	39.7	12.1	20.5	9.7	94.138
2002	22.2	8.7	18.1	8	32.1	29	49.4	2.3	100	40.419	39.7	12.2	20.4	9.7	122.419
2003	22.6	8.9	18.4	8.1	32.1	29	49.4	2.3	100	13.021	39.7	12.4	20.2	9.7	95.021
2004	23.1	9	18.8	8.3	32.1	29	49.4	2.3	100	25.619	39.7	12.5	20.1	9.7	107.619
2005	23.6	9.2	19.1	8.4	32.1	29	49.4	2.3	100	18.473	39.7	12.7	19.9	9.7	100.473

Fractions of minimum required quantities to demands

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Recharge	Storage to next year
1997	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
1998	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
1999	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2000	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2001	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2002	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2003	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2004	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2005	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0

Minimum required quantities

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Recharge	Storage to next year
1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0	0
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	0	0
1999	14.832	5.904	12.24	5.328	14.124	12.76	29.64	0	0
2000	15.336	6.048	12.528	5.544	14.124	12.76	29.64	0	0
2001	15.696	6.192	12.816	5.616	14.124	12.76	29.64	0	0
2002	15.984	6.264	13.032	5.76	14.124	12.76	29.64	0	0
2003	16.272	6.408	13.248	5.832	14.124	12.76	29.64	0	0
2004	16.632	6.48	13.536	5.976	14.124	12.76	29.64	0	0
2005	16.992	6.624	13.752	6.048	14.124	12.76	29.64	0	0

Releases from Kouris

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Recharge	Storage to next year	Total	Water balance of Kouris
									10		
1997	13.824	0	0	4.824	0	2.476	0	0.6	2.62E-12	21.724	0.00
1998	0	0	0	0	0	0	11.532	1.489	0	13.021	0.00
1999	0	0	0	0	0	0	18.596	2.3	4.723	25.619	0.00
2000	0	6.048	8.352	5.544	0	0	0	2.3	20.348	42.592	0.00
2001	20.316	0	0	5.616	0	0	0	2.3	4.254	32.486	0.00
2002	0	0	0	0	0	0	21.78	2.3	20.593	44.673	0.00
2003	16.78	0	0	5.832	0	0	0	2.3	8.702	33.614	0.00
2004	17.64	0	0	5.976	0	0	0	2.3	8.405	34.321	0.00
2005	5.194	6.624	0	0	0	12.76	0	2.3	0	26.878	0.00

Releases from local sources

1997	0	5.616	11.736	0	14.124	10.284	29.64
1998	14.328	5.76	11.88	5.04	14.124	12.76	18.108
1999	20.6	5.904	12.24	5.328	14.124	12.76	11.044
2000	21.3	0	4.176	0	14.124	12.76	29.64
2001	1.484	6.192	17.8	0	14.124	12.76	29.64
2002	22.2	6.264	13.032	5.76	14.124	12.76	7.86
2003	5.82	6.408	13.248	0	14.124	12.76	29.64
2004	5.46	6.48	13.536	0	14.124	12.76	29.64
2005	18.406	0	13.782	6.048	14.124	0	29.64

Totals

Limassol	Larnaca	Nicosia	Famagousta
14.124	15.9	11.736	29.64
28.452	18.52	11.88	23.148
34.724	18.664	12.24	16.372
35.424	12.76	4.176	29.64
15.608	18.952	17.8	29.64
36.324	19.024	13.032	13.62
19.944	19.168	13.248	29.64
19.584	19.24	13.536	29.64
32.53	0	13.782	35.688

Surpluses

Limassol	Larnaca	Nicosia	Famagous	Totals
14.98	-4.60	9.56	-19.94	0.00
11.25	-7.02	9.22	-13.45	0.00
4.98	-6.96	8.66	-6.67	0.00
4.28	-0.86	16.52	-19.94	0.00
24.09	-6.85	2.70	-19.94	0.00
3.38	-6.82	7.37	-3.92	0.00
19.76	-6.77	6.95	-19.94	0.00
20.12	-6.74	6.56	-19.94	0.00
7.17	12.70	6.12	-25.99	0.00

Total releases

1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0.6	2.62E-12
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	1.489	0
1999	20.6	5.904	12.24	5.328	14.124	12.76	29.64	2.3	4.723
2000	21.3	6.048	12.528	5.544	14.124	12.76	29.64	2.3	20.348
2001	21.8	6.192	17.8	5.616	14.124	12.76	29.64	2.3	4.254
2002	22.2	6.264	13.032	5.76	14.124	12.76	29.64	2.3	20.593
2003	22.6	6.408	13.248	5.832	14.124	12.76	29.64	2.3	8.702
2004	23.1	6.48	13.536	5.976	14.124	12.76	29.64	2.3	8.405
2005	23.6	6.624	13.782	6.048	14.124	12.76	29.64	2.3	0

Benefits

1997	17.9712	6.1776	14.0832	4.824	8.4744	10.208	26.676	0.9	0	89.3144
1998	18.6264	6.336	14.256	5.04	8.4744	10.208	26.676	2.2335	0	91.8503
1999	26.78	6.4944	14.688	5.328	8.4744	10.208	26.676	3.45	0	102.0988
2000	27.69	6.6528	15.0336	5.544	8.4744	10.208	26.676	3.45	0	103.7288
2001	28.34	6.8112	21.36	5.616	8.4744	10.208	26.676	3.45	0	110.9356
2002	28.86	6.8904	15.6384	5.76	8.4744	10.208	26.676	3.45	0	105.9572
2003	29.38	7.0488	15.8976	5.832	8.4744	10.208	26.676	3.45	0	106.9668
2004	30.03	7.128	16.2432	5.976	8.4744	10.208	26.676	3.45	0	108.1856
2005	30.68	7.2864	16.5384	6.048	8.4744	10.208	26.676	3.45	0	109.3612

Objective function **928.3987**

LINEAR PROGRAMM TO FIND THE OPTIMAL ALLOCATION OF THE WATER OF THE SCP SYSTEM

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Other water requirements: Recharge	Storage to next year	Inflows: Kouris	Local resources: Limassol	Larnaca	Nicosia	Famagous	Total	Water balance of Kouris
Unit benefit	1.3	1.1	1.2	1	0.6	0.8	0.9	1.5	0							
Demands																
1997	19.2	7.8	16.3	6.7	32.1	29	49.4	2.3	100	11.724	29.1	11.3	21.3	9.7	83.124	
1998	19.9	8	16.5	7	32.1	29	49.4	2.3	100	13.021	39.7	11.5	21.1	9.7	95.021	
1999	20.6	8.2	17	7.4	32.1	29	49.4	2.3	100	25.619	39.7	11.7	20.9	9.7	107.619	
2000	21.3	8.4	17.4	7.7	32.1	29	49.4	2.3	100	37.869	39.7	11.9	20.7	9.7	119.869	
2001	21.8	8.6	17.8	7.8	32.1	29	49.4	2.3	100	45.237	39.7	12.1	20.5	9.7	127.237	
2002	22.2	8.7	18.1	8	32.1	29	49.4	2.3	100	11.724	39.7	12.2	20.4	9.7	93.724	
2003	22.6	8.9	18.4	8.1	32.1	29	49.4	2.3	100	31.561	39.7	12.4	20.2	9.7	113.561	
2004	23.1	9	18.8	8.3	32.1	29	49.4	2.3	100	40.419	39.7	12.5	20.1	9.7	122.419	
2005	23.6	9.2	19.1	8.4	32.1	29	49.4	2.3	100	12	39.7	12.7	19.9	9.7	94	
Fractions of minimum required quantities to demands																
1997	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
1998	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
1999	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2000	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2001	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2002	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2003	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2004	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2005	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
Minimum required quantities																
1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0	0							
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	0	0							
1999	14.832	5.904	12.24	5.328	14.124	12.76	29.64	0	0							
2000	15.336	6.048	12.528	5.544	14.124	12.76	29.64	0	0							
2001	15.696	6.192	12.816	5.616	14.124	12.76	29.64	0	0							
2002	15.984	6.264	13.032	5.76	14.124	12.76	29.64	0	0							
2003	16.272	6.408	13.248	5.832	14.124	12.76	29.64	0	0							
2004	16.632	6.48	13.536	5.976	14.124	12.76	29.64	0	0							
2005	16.992	6.624	13.752	6.048	14.124	12.76	29.64	0	0							
Releases from Kouris									10	**Total**						**Water balance of Kouris**
1997	13.824	0	0	4.824	0	2.476	0	0.6	2.63E-12	21.724						0.00
1998	0	5.76	0	0	0	0	5.772	1.489	0	13.021						0.00
1999	0	0	0	0	0	0	23.319	2.3	0	25.619						0.00
2000	0	0	0	0	0	0	24.816	2.3	10.753	37.869						0.00
2001	21.8	0	0	5.006	0	0	0	2.3	26.884	55.99						0.00
2002	0	0	0	0	0	0	26.848	2.3	9.46	38.608						0.00
2003	0	0	0	5.832	0	0	21.932	2.3	10.957	41.021						0.00
2004	14.756	0	0	0	14.124	0	0	2.3	20.196	51.376						0.00
2005	0	6.624	19.1	0	0	0	4.172	2.3	0	32.196						0.00

Releases from local sources

1997	0	5.616	11.736	0	14.124	10.284	29.64		
1998	14.328	0	11.88	5.04	14.124	12.76	23.868		
1999	20.6	5.904	16.963	5.328	14.124	12.76	6.321		
2000	21.3	6.048	17.4	5.544	14.124	12.76	4.824		
2001	0	7.066	17.8	0.61	14.124	12.76	29.64		
2002	22.2	6.264	18.1	5.76	14.124	12.76	2.792		
2003	22.6	6.408	18.4	0	14.124	12.76	7.708		
2004	8.344	6.48	18.8	5.976	0	12.76	29.64		
2005	23.6	0	0	6.048	14.124	12.76	25.468		

Total releases

1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0.6	2.63E-12
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	1.489	0
1999	20.6	5.904	16.963	5.328	14.124	12.76	29.64	2.3	0
2000	21.3	6.048	17.4	5.544	14.124	12.76	29.64	2.3	10.753
2001	21.8	7.066	17.8	5.616	14.124	12.76	29.64	2.3	26.884
2002	22.2	6.264	18.1	5.76	14.124	12.76	29.64	2.3	9.46
2003	22.6	6.408	18.4	5.832	14.124	12.76	29.64	2.3	10.957
2004	23.1	6.48	18.8	5.976	14.124	12.76	29.64	2.3	20.196
2005	23.6	6.624	19.1	6.048	14.124	12.76	29.64	2.3	0

Benefits

1997	17.9712	6.1776	14.0832	4.824	8.4744	10.208	26.676	0.9	0	89.3144
1998	18.6264	6.336	14.256	5.04	8.4744	10.208	26.676	2.2335	0	91.8503
1999	26.78	6.4944	20.3556	5.328	8.4744	10.208	26.676	3.45	0	107.7664
2000	27.69	6.6528	20.88	5.544	8.4744	10.208	26.676	3.45	0	109.5752
2001	28.34	7.7726	21.36	5.616	8.4744	10.208	26.676	3.45	0	111.897
2002	28.86	6.8904	21.72	5.76	8.4744	10.208	26.676	3.45	0	112.0388
2003	29.38	7.0488	22.08	5.832	8.4744	10.208	26.676	3.45	0	113.1492
2004	30.03	7.128	22.56	5.976	8.4744	10.208	26.676	3.45	0	114.5024
2005	30.68	7.2864	22.92	6.048	8.4744	10.208	26.676	3.45	0	115.7428

Objective function **965.8365**

Totals

Limassol	Larnaca	Nicosia	Famagousta
14.124	15.9	11.736	29.64
28.452	12.76	11.88	28.908
34.724	18.664	16.963	11.649
35.424	18.808	17.4	10.368
14.124	19.826	17.8	30.25
36.324	19.024	18.1	8.552
36.724	19.168	18.4	7.708
8.344	19.24	18.8	35.616
37.724	12.76	0	31.516

Surpluses

Limassol	Larnaca	Nicosia	Famagous	Totals
14.98	-4.60	9.56	-19.94	0.00
11.25	-1.26	9.22	-19.21	0.00
4.98	-6.96	3.94	-1.95	0.00
4.28	-6.91	3.30	-0.67	0.00
25.58	-7.73	2.70	-20.55	0.00
3.38	-6.82	2.30	1.15	0.00
2.98	-6.77	1.80	1.99	0.00
31.36	-6.74	1.30	-25.92	0.00
1.98	-0.06	19.90	-21.82	0.00

LINEAR PROGRAMM TO FIND THE OPTIMAL ALLOCATION OF THE WATER OF THE SCP SYSTEM

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.			**Inflows** Kouris	**Local resources** Limassol	Larnaca	Nicosia	Famagous	Total	
Unit benefit								**Other water requirements**								
	1.3	1.1	1.2	1	0.6	0.8	0.9	1.5	0							
Demands								**Recharge**	**Storage to next year**							
1997	19.2	7.8	16.3	6.7	32.1	29	49.4	2.3	100	11.724	29.1	11.3	21.3	9.7	83.124	
1998	19.9	8	16.5	7	32.1	29	49.4	2.3	100	13.021	39.7	11.5	21.1	9.7	95.021	
1999	20.6	8.2	17	7.4	32.1	29	49.4	2.3	100	25.619	39.7	11.7	20.9	9.7	107.619	
2000	21.3	8.4	17.4	7.7	32.1	29	49.4	2.3	100	37.869	39.7	11.9	20.7	9.7	119.869	
2001	21.8	8.6	17.8	7.8	32.1	29	49.4	2.3	100	25.619	39.7	12.1	20.5	9.7	107.619	
2002	22.2	8.7	18.1	8	32.1	29	49.4	2.3	100	11.724	39.7	12.2	20.4	9.7	93.724	
2003	22.6	8.9	18.4	8.1	32.1	29	49.4	2.3	100	18.473	39.7	12.4	20.2	9.7	100.473	
2004	23.1	9	18.8	8.3	32.1	29	49.4	2.3	100	34.869	39.7	12.5	20.1	9.7	116.869	
2005	23.6	9.2	19.1	8.4	32.1	29	49.4	2.3	100	12.138	39.7	12.7	19.9	9.7	94.138	
Fractions of minimum required quantities to demands																
1997	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
1998	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
1999	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2000	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2001	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2002	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2003	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2004	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2005	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
Minimum required quantities																
1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0	0							
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	0	0							
1999	14.832	5.904	12.24	5.328	14.124	12.76	29.64	0	0							
2000	15.336	6.048	12.528	5.544	14.124	12.76	29.64	0	0							
2001	15.696	6.192	12.816	5.616	14.124	12.76	29.64	0	0							
2002	15.984	6.264	13.032	5.76	14.124	12.76	29.64	0	0							
2003	16.272	6.408	13.248	5.832	14.124	12.76	29.64	0	0							
2004	16.632	6.48	13.536	5.976	14.124	12.76	29.64	0	0							
2005	16.992	6.624	13.752	6.048	14.124	12.76	29.64	0	0							
Releases from Kouris									10	**Total**						**Water balance of Kouris**
1997	13.824	0	0	4.824	0	2.476	0	0.6	2.62E-12	21.724						0.00
1998	0	5.76	0	0	0	0	5.772	1.489	0	13.021						0.00
1999	0	0	0	5.328	0	0	13.268	2.3	4.723	25.619						0.00
2000	0	6.048	0	5.544	0	0	8.352	2.3	20.348	42.592						0.00
2001	0	0	0	5.616	0	0	13.499	2.3	24.552	45.967						0.00
2002	0	0	0	0	0	0	21.78	2.3	12.196	36.276						0.00
2003	0	0	0	0	0	0	22.612	2.3	5.757	30.669						0.00
2004	0	0	0	0	0	0	23.616	2.3	14.71	40.626						0.00
2005	0	0	0	0	0	0	24.548	2.3	0	26.848						0.00

Releases from local sources

1997	0	5.616	11.736	0	14.124	10.284	29.64
1998	14.328	0	11.88	5.04	14.124	12.76	23.868
1999	20.6	5.904	12.24	0	14.124	12.76	16.372
2000	21.3	0	12.528	0	14.124	12.76	21.288
2001	19.967	6.192	12.816	0	14.124	12.76	16.141
2002	22.2	6.264	13.032	5.76	14.124	12.76	7.86
2003	22.6	6.408	13.248	5.832	14.124	12.76	7.028
2004	23.1	6.48	13.536	5.976	14.124	12.76	6.024
2005	23.6	6.624	13.752	6.048	14.124	12.76	5.092

Totals

	Limassol	Larnaca	Nicosia	Famagousta
1997	14.124	15.9	11.736	29.64
1998	28.452	12.76	11.88	28.908
1999	34.724	18.664	12.24	16.372
2000	35.424	12.76	12.528	21.288
2001	34.091	18.952	12.816	16.141
2002	36.324	19.024	13.032	13.62
2003	36.724	19.168	13.248	12.86
2004	37.224	19.24	13.536	12
2005	37.724	19.384	13.752	11.14

Surpluses

	Limassol	Larnaca	Nicosia	Famagous	Totals
1997	14.98	-4.60	9.56	-19.94	0.00
1998	11.25	-1.26	9.22	-19.21	0.00
1999	4.98	-6.96	8.66	-6.67	0.00
2000	4.28	-0.86	8.17	-11.59	0.00
2001	5.61	-6.85	7.68	-6.44	0.00
2002	3.38	-6.82	7.37	-3.92	0.00
2003	2.98	-6.77	6.95	-3.16	0.00
2004	2.48	-6.74	6.56	-2.30	0.00
2005	1.98	-6.68	6.15	-1.44	0.00

Total releases

1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0.6	2.62E-12
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	1.489	0
1999	20.6	5.904	12.24	5.328	14.124	12.76	29.64	2.3	4.723
2000	21.3	6.048	12.528	5.544	14.124	12.76	29.64	2.3	20.348
2001	19.967	6.192	12.816	5.616	14.124	12.76	29.64	2.3	24.552
2002	22.2	6.264	13.032	5.76	14.124	12.76	29.64	2.3	12.196
2003	22.6	6.408	13.248	5.832	14.124	12.76	29.64	2.3	5.757
2004	23.1	6.48	13.536	5.976	14.124	12.76	29.64	2.3	14.71
2005	23.6	6.624	13.752	6.048	14.124	12.76	29.64	2.3	0

Benefits

1997	17.9712	6.1776	14.0832	4.824	8.4744	10.208	26.676	0.9	0	89.3144
1998	18.6264	6.336	14.256	5.04	8.4744	10.208	26.676	2.2335	0	91.8503
1999	26.78	6.4944	14.688	5.328	8.4744	10.208	26.676	3.45	0	102.0988
2000	27.69	6.6528	15.0336	5.544	8.4744	10.208	26.676	3.45	0	103.7288
2001	25.9571	6.8112	15.3792	5.616	8.4744	10.208	26.676	3.45	0	102.5719
2002	28.86	6.8904	15.6384	5.76	8.4744	10.208	26.676	3.45	0	105.9572
2003	29.38	7.0488	15.8976	5.832	8.4744	10.208	26.676	3.45	0	106.9668
2004	30.03	7.128	16.2432	5.976	8.4744	10.208	26.676	3.45	0	108.1856
2005	30.68	7.2864	16.5024	6.048	8.4744	10.208	26.676	3.45	0	109.3252

Objective function **919.999**

LINEAR PROGRAMM TO FIND THE OPTIMAL ALLOCATION OF THE WATER OF THE SCP SYSTEM

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Other water requirements: Recharge	Other water requirements: Storage to next year	Inflows: Kouris	Local resources: Limassol	Local resources: Larnaca	Local resources: Nicosia	Local resources: Famagous	Total
Unit benefit	1.3	1.1	1.2	1	0.6	0.8	0.9	1.5	0						
Demands															
1997	19.2	7.8	16.3	6.7	32.1	29	49.4	2.3	100	11.724	29.1	11.3	21.3	9.7	83.124
1998	19.9	8	16.5	7	32.1	29	49.4	2.3	100	13.021	39.7	11.5	21.1	9.7	95.021
1999	20.6	8.2	17	7.4	32.1	29	49.4	2.3	100	25.619	39.7	11.7	20.9	9.7	107.619
2000	21.3	8.4	17.4	7.7	32.1	29	49.4	2.3	100	37.869	39.7	11.9	20.7	9.7	119.869
2001	21.8	8.6	17.8	7.8	32.1	29	49.4	2.3	100	45.237	39.7	12.1	20.5	9.7	127.237
2002	22.2	8.7	18.1	8	32.1	29	49.4	2.3	100	13.021	39.7	12.2	20.4	9.7	95.021
2003	22.6	8.9	18.4	8.1	32.1	29	49.4	2.3	100	25.619	39.7	12.4	20.2	9.7	107.619
2004	23.1	9	18.8	8.3	32.1	29	49.4	2.3	100	31.561	39.7	12.5	20.1	9.7	113.561
2005	23.6	9.2	19.1	8.4	32.1	29	49.4	2.3	100	40.419	39.7	12.7	19.9	9.7	122.419
Fractions of minimum required quantities to demands															
1997	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
1998	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
1999	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
2000	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
2001	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
2002	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
2003	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
2004	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
2005	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
Minimum required quantities															
1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0	0						
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	0	0						
1999	14.832	5.904	12.24	5.328	14.124	12.76	29.64	0	0						
2000	15.336	6.048	12.528	5.544	14.124	12.76	29.64	0	0						
2001	15.696	6.192	12.816	5.616	14.124	12.76	29.64	0	0						
2002	15.984	6.264	13.032	5.76	14.124	12.76	29.64	0	0						
2003	16.272	6.408	13.248	5.832	14.124	12.76	29.64	0	0						
2004	16.632	6.48	13.536	5.976	14.124	12.76	29.64	0	0						
2005	16.992	6.624	13.752	6.048	14.124	12.76	29.64	0	0						

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Recharge	Storage to next year	Total	Water balance of Kouris
Releases from Kouris									10		
1997	13.824	0	0	4.824	2.476	0	0	4.61E-13	0.6	21.724	0.00
1998	0	0	0	0	0	0	11.532	2.089	0	13.621	0.00
1999	0	0	0	0	0	0	23.319	2.3	0	25.619	0.00
2000	21.3	0	3.516	0	0	0	0	2.3	10.753	37.869	0.00
2001	0	0	0	0	0	0	28.34	2.3	25.35	55.99	0.00
2002	22.2	0	0	0	0	0	7.084	2.3	6.787	38.371	0.00
2003	0	0	0	5.832	0	0	24.274	2.3	0	32.406	0.00
2004	0	6.861	2.3	5.976	14.124	0	0	2.3	0	31.561	0.00
2005	0	0	0	8.4	0	12.76	16.959	2.3	0	40.419	0.00

Releases from local sources

1997	0	5.616	11.736	0	11.648	12.76	29.64
1998	14.328	5.76	11.88	5.04	14.124	12.76	18.108
1999	20.6	5.904	16.963	5.328	14.124	12.76	6.321
2000	0	6.048	13.884	5.544	14.124	12.76	29.64
2001	21.8	8.6	17.8	5.616	14.124	12.76	1.3
2002	0	8.7	18.1	5.76	14.124	12.76	22.556
2003	22.6	8.75	18.4	0	14.124	12.76	5.366
2004	23.1	0	16.5	0	0	12.76	29.64
2005	23.6	9.2	19.1	0	14.124	0	15.976

Total releases

1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	4.61E-13	0.6
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	2.089	0
1999	20.6	5.904	16.963	5.328	14.124	12.76	29.64	2.3	0
2000	21.3	6.048	17.4	5.544	14.124	12.76	29.64	2.3	10.753
2001	21.8	8.6	17.8	5.616	14.124	12.76	29.64	2.3	25.35
2002	22.2	8.7	18.1	5.76	14.124	12.76	29.64	2.3	6.787
2003	22.6	8.75	18.4	5.832	14.124	12.76	29.64	2.3	0
2004	23.1	6.861	18.8	5.976	14.124	12.76	29.64	2.3	0
2005	23.6	9.2	19.1	8.4	14.124	12.76	32.935	2.3	0

Benefits

1997	17.9712	6.1776	14.0832	4.824	8.4744	10.208	26.676	6.91E-13	0	88.4144
1998	18.6264	6.336	14.256	5.04	8.4744	10.208	26.676	3.1335	0	92.7503
1999	26.78	6.4944	20.3556	5.328	8.4744	10.208	26.676	3.45	0	107.7664
2000	27.69	6.6528	20.88	5.544	8.4744	10.208	26.676	3.45	0	109.5752
2001	28.34	9.46	21.36	5.616	8.4744	10.208	26.676	3.45	0	113.5844
2002	28.86	9.57	21.72	5.76	8.4744	10.208	26.676	3.45	0	114.7184
2003	29.38	9.625	22.08	5.832	8.4744	10.208	26.676	3.45	0	115.7254
2004	30.03	7.5471	22.56	5.976	8.4744	10.208	26.676	3.45	0	114.9215
2005	30.68	10.12	22.92	8.4	8.4744	10.208	29.6415	3.45	0	123.8939

Objective function **981.3499**

Totals

Limassol	Larnaca	Nicosia	Famagousta
11.648	18.376	11.736	29.64
28.452	18.52	11.88	23.148
34.724	18.664	16.963	11.649
14.124	18.808	13.884	35.184
35.924	21.36	17.8	6.916
14.124	21.46	18.1	28.316
36.724	21.51	18.4	5.366
23.1	12.76	16.5	29.64
37.724	9.2	19.1	15.976

Surpluses

Limassol	Larnaca	Nicosia	Famagous	Totals
17.45	-7.08	9.56	-19.94	0.00
11.25	-7.02	9.22	-13.45	0.00
4.98	-6.96	3.94	-1.95	0.00
25.58	-6.91	6.82	-25.48	0.00
3.78	-9.26	2.70	2.78	0.00
25.58	-9.26	2.30	-18.62	0.00
2.98	-9.11	1.80	4.33	0.00
16.60	-0.26	3.60	-19.94	0.00
1.98	3.50	0.80	-6.28	0.00

LINEAR PROGRAMM TO FIND THE OPTIMAL ALLOCATION OF THE WATER OF THE SCP SYSTEM

Year	Lim. Dom	Lam. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Lam. Irr	Fam. Irr.	**Other water requirements**		**Inflows**	**Local resources**					
										Kouris	Limassol	Larnaca	Nicosia	Famagous	Total	
Unit benefit																
	1.3	1.1	1.2	1	0.6	0.8	0.9	1.5	0							
Demands								**Recharge**	**Storage to next year**							
1997	19.2	7.8	16.3	6.7	32.1	29	49.4	2.3	100	11.724	29.1	11.3	21.3	9.7	83.124	
1998	19.9	8	16.5	7	32.1	29	49.4	2.3	100	13.021	39.7	11.5	21.1	9.7	95.021	
1999	20.6	8.2	17	7.4	32.1	29	49.4	2.3	100	25.619	39.7	11.7	20.9	9.7	107.619	
2000	21.3	8.4	17.4	7.7	32.1	29	49.4	2.3	100	37.869	39.7	11.9	20.7	9.7	119.869	
2001	21.8	8.6	17.8	7.8	32.1	29	49.4	2.3	100	25.619	39.7	12.1	20.5	9.7	107.619	
2002	22.2	8.7	18.1	8	32.1	29	49.4	2.3	100	31.561	39.7	12.2	20.4	9.7	113.561	
2003	22.6	8.9	18.4	8.1	32.1	29	49.4	2.3	100	6.222	39.7	12.4	20.2	9.7	88.222	
2004	23.1	9	18.8	8.3	32.1	29	49.4	2.3	100	12	39.7	12.5	20.1	9.7	94	
2005	23.6	9.2	19.1	8.4	32.1	29	49.4	2.3	100	11.724	39.7	12.7	19.9	9.7	93.724	
Fractions of minimum required quantities to demands																
1997	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
1998	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
1999	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2000	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2001	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2002	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2003	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2004	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2005	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
Minimum required quantities																
1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0	0							
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	0	0							
1999	14.832	5.904	12.24	5.328	14.124	12.76	29.64	0	0							
2000	15.336	6.048	12.528	5.544	14.124	12.76	29.64	0	0							
2001	15.696	6.192	12.816	5.616	14.124	12.76	29.64	0	0							
2002	15.984	6.264	13.032	5.76	14.124	12.76	29.64	0	0							
2003	16.272	6.408	13.248	5.832	14.124	12.76	29.64	0	0							
2004	16.632	6.48	13.536	5.976	14.124	12.76	29.64	0	0							
2005	16.992	6.624	13.752	6.048	14.124	12.76	29.64	0	0							
Releases from Kouris									10	**Total**						**Water balance of Kouris**
1997	13.824	2.476	0	4.824	0	0	0	0	0.6	21.724						0.00
1998	0	5.76	0	0	0	0	5.772	2.089	0	13.621						0.00
1999	0	0	0	0	0	0	18.596	2.3	4.723	25.619						0.00
2000	0	6.048	0	5.544	0	0	8.352	2.3	20.348	42.592						0.00
2001	3.036	6.192	0	5.616	0	0	0	2.3	28.823	45.967						0.00
2002	0	6.264	0	0	0	0	15.516	2.3	36.304	60.384						0.00
2003	0	0	0	5.832	0	0	10.452	2.3	23.942	42.526						0.00
2004	0	0	0	0	0	0	18.518	2.3	15.124	35.942						0.00
2005	0	0	0	0	0	0	24.548	2.3	0	26.848						0.00

Releases from local sources

1997	0	3.14	11.736	0	14.124	12.76	29.64
1998	14.328	0	11.88	5.04	14.124	12.76	23.868
1999	20.6	5.904	12.24	5.328	14.124	12.76	11.044
2000	21.3	0	12.528	0	14.124	12.76	21.288
2001	12.66	0	12.816	0	14.124	12.76	29.64
2002	22.2	0	13.032	5.76	14.124	12.76	14.124
2003	16.272	6.408	13.248	0	14.124	12.76	19.188
2004	18.002	6.48	13.536	5.976	14.124	12.76	11.122
2005	23.6	6.624	13.752	6.048	14.124	12.76	5.092

Totals

Limassol	Larnaca	Nicosia	Famagousta
14.124	15.9	11.736	29.64
28.452	12.76	11.88	28.908
34.724	18.664	12.24	16.372
35.424	12.76	12.528	21.288
26.784	12.76	12.816	29.64
36.324	12.76	13.032	19.884
30.396	19.168	13.248	19.188
32.126	19.24	13.536	17.098
37.724	19.384	13.752	11.14

Surpluses

Limassol	Larnaca	Nicosia	Famagous	Totals
14.98	-4.60	9.56	-19.94	0.00
11.25	-1.26	9.22	-19.21	0.00
4.98	-6.96	8.66	-6.67	0.00
4.28	-0.86	8.17	-11.59	0.00
12.92	-0.66	7.68	-19.94	0.00
3.38	-0.56	7.37	-10.18	0.00
9.30	-6.77	6.95	-9.49	0.00
7.57	-6.74	6.56	-7.40	0.00
1.98	-6.68	6.15	-1.44	0.00

Total releases

1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0	0.6
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	2.089	0
1999	20.6	5.904	12.24	5.328	14.124	12.76	29.64	2.3	4.723
2000	21.3	6.048	12.528	5.544	14.124	12.76	29.64	2.3	20.348
2001	15.696	6.192	12.816	5.616	14.124	12.76	29.64	2.3	28.823
2002	22.2	6.264	13.032	5.76	14.124	12.76	29.64	2.3	36.304
2003	16.272	6.408	13.248	5.832	14.124	12.76	29.64	2.3	23.942
2004	18.002	6.48	13.536	5.976	14.124	12.76	29.64	2.3	15.124
2005	23.6	6.624	13.752	6.048	14.124	12.76	29.64	2.3	0

Benefits

1997	17.9712	6.1776	14.0832	4.824	8.4744	10.208	26.676	0	0	88.4144
1998	18.6264	6.336	14.256	5.04	8.4744	10.208	26.676	3.1335	0	92.7503
1999	26.78	6.4944	14.688	5.328	8.4744	10.208	26.676	3.45	0	102.0988
2000	27.69	6.6528	15.0336	5.544	8.4744	10.208	26.676	3.45	0	103.7288
2001	20.4048	6.8112	15.3792	5.616	8.4744	10.208	26.676	3.45	0	97.0196
2002	28.86	6.8904	15.6384	5.76	8.4744	10.208	26.676	3.45	0	105.9572
2003	21.1536	7.0488	15.8976	5.832	8.4744	10.208	26.676	3.45	0	98.7404
2004	23.4026	7.128	16.2432	5.976	8.4744	10.208	26.676	3.45	0	101.5582
2005	30.68	7.2864	16.5024	6.048	8.4744	10.208	26.676	3.45	0	109.3252

Objective function **899.5929**

LINEAR PROGRAMM TO FIND THE OPTIMAL ALLOCATION OF THE WATER OF THE SCP SYSTEM

Unit benefit

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Other water requirements: Recharge	Storage to next year
	1.3	1.1	1.2	1	0.6	0.8	0.9	1.5	0

Demands

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Recharge	Storage to next year	Inflows Kouris	Local resources Limassol	Larnaca	Nicosia	Famagous	Total
1997	19.2	7.8	16.3	6.7	32.1	29	49.4	2.3	100	11.724	29.1	11.3	21.3	9.7	83.124
1998	19.9	8	16.5	7	32.1	29	49.4	2.3	100	13.021	39.7	11.5	21.1	9.7	95.021
1999	20.6	8.2	17	7.4	32.1	29	49.4	2.3	100	25.619	39.7	11.7	20.9	9.7	107.619
2000	21.3	8.4	17.4	7.7	32.1	29	49.4	2.3	100	37.869	39.7	11.9	20.7	9.7	119.869
2001	21.8	8.6	17.8	7.8	32.1	29	49.4	2.3	100	13.021	39.7	12.1	20.5	9.7	95.021
2002	22.2	8.7	18.1	8	32.1	29	49.4	2.3	100	45.237	39.7	12.2	20.4	9.7	127.237
2003	22.6	8.9	18.4	8.1	32.1	29	49.4	2.3	100	37.869	39.7	12.4	20.2	9.7	119.869
2004	23.1	9	18.8	8.3	32.1	29	49.4	2.3	100	40.419	39.7	12.5	20.1	9.7	122.419
2005	23.6	9.2	19.1	8.4	32.1	29	49.4	2.3	100	12	39.7	12.7	19.9	9.7	94

Fractions of minimum required quantities to demands

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Recharge	Storage to next year
1997	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
1998	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
1999	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2000	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2001	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2002	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2003	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2004	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2005	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0

Minimum required quantities

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Recharge	Storage to next year
1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0	0
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	0	0
1999	14.832	5.904	12.24	5.328	14.124	12.76	29.64	0	0
2000	15.336	6.048	12.528	5.544	14.124	12.76	29.64	0	0
2001	15.696	6.192	12.816	5.616	14.124	12.76	29.64	0	0
2002	15.984	6.264	13.032	5.76	14.124	12.76	29.64	0	0
2003	16.272	6.408	13.248	5.832	14.124	12.76	29.64	0	0
2004	16.632	6.48	13.536	5.976	14.124	12.76	29.64	0	0
2005	16.992	6.624	13.752	6.048	14.124	12.76	29.64	0	0

Releases from Kouris

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Recharge	Storage to next year	Total	Water balance of Kouris
									10		
1997	13.824	0	0	4.824	0	2.476	0	0.6	2.62E-12	21.724	0.00
1998	0	0	0	0	0	0	11.532	1.489	0	13.021	0.00
1999	0	0	0	0	0	0	23.319	2.3	0	25.619	0.00
2000	0	6.048	8.766	5.544	0	0	0	2.3	15.211	37.869	0.00
2001	0	0	0	5.616	0	0	20.316	2.3	0	28.232	0.00
2002	0	0	0	0	0	0.205	29.64	2.3	13.092	45.237	0.00
2003	0	0	0	0	0.616	0	29.64	2.3	18.405	50.961	0.00
2004	0	0	0	5.976	0	0	25.424	2.3	25.124	58.824	0.00
2005	0	9.2	19.1	0	6.524	0	0	2.3	0	37.124	0.00

Releases from local sources

1997	0	5.616	11.736	0	14.124	10.284	29.64
1998	14.328	5.76	11.88	5.04	14.124	12.76	18.108
1999	20.6	5.904	16.963	5.328	14.124	12.76	6.321
2000	21.3	0	4.176	0	14.124	12.76	29.64
2001	21.8	6.192	17.8	0	14.124	12.76	9.324
2002	22.2	8.7	18.1	6.321	14.124	12.555	0
2003	22.6	8.9	18.4	5.832	13.508	12.76	0
2004	23.1	9	18.8	0	14.124	12.76	4.216
2005	23.6	0	0	8.4	7.6	12.76	29.64

Totals

Limassol	Larnaca	Nicosia	Famagousta
14.124	15.9	11.736	29.64
28.452	18.52	11.88	23.148
34.724	18.664	16.963	11.649
35.424	12.76	4.176	29.64
35.924	18.952	17.8	9.324
36.324	21.255	18.1	6.321
36.108	21.66	18.4	5.832
37.224	21.76	18.8	4.216
31.2	12.76	0	38.04

Surpluses

Limassol	Larnaca	Nicosia	Famagous	Totals
14.98	-4.60	9.56	-19.94	0.00
11.25	-7.02	9.22	-13.45	0.00
4.98	-6.96	3.94	-1.95	0.00
4.28	-0.86	16.52	-19.94	0.00
3.78	-6.85	2.70	0.38	0.00
3.38	-9.06	2.30	3.38	0.00
3.59	-9.26	1.80	3.87	0.00
2.48	-9.26	1.30	5.48	0.00
8.50	-0.06	19.90	-28.34	0.00

Total releases

1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0.6	2.62E-12
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	1.489	0
1999	20.6	5.904	16.963	5.328	14.124	12.76	29.64	2.3	0
2000	21.3	6.048	12.942	5.544	14.124	12.76	29.64	2.3	15.211
2001	21.8	6.192	17.8	5.616	14.124	12.76	29.64	2.3	0
2002	22.2	8.7	18.1	6.321	14.124	12.76	29.64	2.3	13.092
2003	22.6	8.9	18.4	5.832	14.124	12.76	29.64	2.3	18.405
2004	23.1	9	18.8	5.976	14.124	12.76	29.64	2.3	25.124
2005	23.6	9.2	19.1	8.4	14.124	12.76	29.64	2.3	0

Benefits

1997	17.9712	6.1776	14.0832	4.824	8.4744	10.208	26.676	0.9	0	89.3144
1998	18.6264	6.336	14.256	5.04	8.4744	10.208	26.676	2.2335	0	91.8503
1999	26.78	6.4944	20.3556	5.328	8.4744	10.208	26.676	3.45	0	107.7664
2000	27.69	6.6528	15.5304	5.544	8.4744	10.208	26.676	3.45	0	104.2256
2001	28.34	6.8112	21.36	5.616	8.4744	10.208	26.676	3.45	0	110.9356
2002	28.86	9.57	21.72	6.321	8.4744	10.208	26.676	3.45	0	115.2794
2003	29.38	9.79	22.08	5.832	8.4744	10.208	26.676	3.45	0	115.8904
2004	30.03	9.9	22.56	5.976	8.4744	10.208	26.676	3.45	0	117.2744
2005	30.68	10.12	22.92	8.4	8.4744	10.208	26.676	3.45	0	120.9284

Objective function **973.4649**

LINEAR PROGRAMM TO FIND THE OPTIMAL ALLOCATION OF THE WATER OF THE SCP SYSTEM

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.			Inflows	Local resources					
										Kouris	Limassol	Larnaca	Nicosia	Famagous	Total	
	Unit benefit							**Other water requirements**								
	1.3	1.1	1.2	1	0.6	0.8	0.9	1.5	0							
	Demands							**Recharge**	**Storage to next year**							
1997	19.2	7.8	16.3	6.7	32.1	29	49.4	2.3	100	11.724	29.1	11.3	21.3	9.7	83.124	
1998	19.9	8	16.5	7	32.1	29	49.4	2.3	100	13.021	39.7	11.5	21.1	9.7	95.021	
1999	20.6	8.2	17	7.4	32.1	29	49.4	2.3	100	25.619	39.7	11.7	20.9	9.7	107.619	
2000	21.3	8.4	17.4	7.7	32.1	29	49.4	2.3	100	37.869	39.7	11.9	20.7	9.7	119.869	
2001	21.8	8.6	17.8	7.8	32.1	29	49.4	2.3	100	11.724	39.7	12.1	20.5	9.7	93.724	
2002	22.2	8.7	18.1	8	32.1	29	49.4	2.3	100	69.07	39.7	12.2	20.4	9.7	151.07	
2003	22.6	8.9	18.4	8.1	32.1	29	49.4	2.3	100	12.138	39.7	12.4	20.2	9.7	94.138	
2004	23.1	9	18.8	8.3	32.1	29	49.4	2.3	100	12	39.7	12.5	20.1	9.7	94	
2005	23.6	9.2	19.1	8.4	32.1	29	49.4	2.3	100	11.724	39.7	12.7	19.9	9.7	93.724	
	Fractions of minimum required quantities to demands															
1997	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
1998	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
1999	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2000	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2001	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2002	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2003	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2004	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2005	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
	Minimum required quantities															
1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0	0							
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	0	0							
1999	14.832	5.904	12.24	5.328	14.124	12.76	29.64	0	0							
2000	15.336	6.048	12.528	5.544	14.124	12.76	29.64	0	0							
2001	15.696	6.192	12.816	5.616	14.124	12.76	29.64	0	0							
2002	15.984	6.264	13.032	5.76	14.124	12.76	29.64	0	0							
2003	16.272	6.408	13.248	5.832	14.124	12.76	29.64	0	0							
2004	16.632	6.48	13.536	5.976	14.124	12.76	29.64	0	0							
2005	16.992	6.624	13.752	6.048	14.124	12.76	29.64	0	0							
	Releases from Kouris								10	**Total**						**Water balance of Kouris**
1997	13.824	0	0	4.824	0	2.476	0	0.6	2.62E-12	21.724						0.00
1998	0	0	0	0	0	0	11.532	1.489	0	13.021						0.00
1999	0	0	0	0	0	0	23.319	2.3	0	25.619						0.00
2000	0	6.048	8.352	5.544	0	0	0	2.3	15.625	37.869						0.00
2001	15.332	0	0	5.616	0	0	0	2.3	4.101	27.349						0.00
2002	0	0	0	0	0	12.76	11.033	2.3	47.078	73.171						0.00
2003	0	0	13.248	5.832	3.532	0	0	2.3	34.304	59.216						0.00
2004	0	0	0	0	0	0	28.88	2.3	15.124	46.304						0.00
2005	4.172	6.624	13.752	0	0	0	0	2.3	0	26.848						0.00

Releases from local sources

1997	0	5.616	11.736	0	14.124	10.284	29.64
1998	14.328	5.76	11.88	5.04	14.124	12.76	18.108
1999	20.6	5.904	16.963	5.328	14.124	12.76	6.321
2000	21.3	0	4.176	0	14.124	12.76	29.64
2001	6.468	6.192	12.816	0	14.124	12.76	29.64
2002	22.2	6.264	15.045	5.76	14.124	0	18.607
2003	22.6	6.408	0	0	10.592	12.76	29.64
2004	23.1	6.48	18.8	5.976	14.124	12.76	0.76
2005	19.428	0	0	6.048	14.124	12.76	29.64

Totals

Limassol	Larnaca	Nicosia	Famagousta
14.124	15.9	11.736	29.64
28.452	18.52	11.88	23.148
34.724	18.664	16.963	11.649
35.424	12.76	4.176	29.64
20.592	18.952	12.816	29.64
36.324	6.264	15.045	24.367
33.192	19.168	0	29.64
37.224	19.24	18.8	6.736
33.552	12.76	0	35.688

Surpluses

Limassol	Larnaca	Nicosia	Famagous	Totals
14.98	-4.60	9.56	-19.94	0.00
11.25	-7.02	9.22	-13.45	0.00
4.98	-6.96	3.94	-1.95	0.00
4.28	-0.86	16.52	-19.94	0.00
19.11	-6.85	7.68	-19.94	0.00
3.38	5.94	5.36	-14.67	0.00
6.51	-6.77	20.20	-19.94	0.00
2.48	-6.74	1.30	2.96	0.00
6.15	-0.06	19.90	-25.99	0.00

Total releases

1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0.6	2.62E-12
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	1.489	0
1999	20.6	5.904	16.963	5.328	14.124	12.76	29.64	2.3	0
2000	21.3	6.048	12.528	5.544	14.124	12.76	29.64	2.3	15.625
2001	21.8	6.192	12.816	5.616	14.124	12.76	29.64	2.3	4.101
2002	22.2	6.264	15.045	5.76	14.124	12.76	29.64	2.3	47.078
2003	22.6	6.408	13.248	5.832	14.124	12.76	29.64	2.3	34.304
2004	23.1	6.48	18.8	5.976	14.124	12.76	29.64	2.3	15.124
2005	23.6	6.624	13.752	6.048	14.124	12.76	29.64	2.3	0

Benefits

1997	17.9712	6.1776	14.0832	4.824	8.4744	10.208	26.676	0.9	0	89.3144
1998	18.6264	6.336	14.256	5.04	8.4744	10.208	26.676	2.2335	0	91.8503
1999	26.78	6.4944	20.3556	5.328	8.4744	10.208	26.676	3.45	0	107.7664
2000	27.69	6.6528	15.0336	5.544	8.4744	10.208	26.676	3.45	0	103.7288
2001	28.34	6.8112	15.3792	5.616	8.4744	10.208	26.676	3.45	0	104.9548
2002	28.86	6.8904	18.054	5.76	8.4744	10.208	26.676	3.45	0	108.3728
2003	29.38	7.0488	15.8976	5.832	8.4744	10.208	26.676	3.45	0	106.9668
2004	30.03	7.128	22.56	5.976	8.4744	10.208	26.676	3.45	0	114.5024
2005	30.68	7.2864	16.5024	6.048	8.4744	10.208	26.676	3.45	0	109.3252

Objective function **936.7819**

LINEAR PROGRAMM TO FIND THE OPTIMAL ALLOCATION OF THE WATER OF THE SCP SYSTEM

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.			Inflows Kouris	Local resources Limassol	Larnaca	Nicosia	Famagous	Total	
Unit benefit								**Other water requirements**								
	1.3	1.1	1.2	1	0.6	0.8	0.9	1.5	0							
Demands								**Recharge**	**Storage to next year**							
1997	19.2	7.8	16.3	6.7	32.1	29	49.4	2.3	100	11.724	29.1	11.3	21.3	9.7	83.124	
1998	19.9	8	16.5	7	32.1	29	49.4	2.3	100	13.021	39.7	11.5	21.1	9.7	95.021	
1999	20.6	8.2	17	7.4	32.1	29	49.4	2.3	100	25.619	39.7	11.7	20.9	9.7	107.619	
2000	21.3	8.4	17.4	7.7	32.1	29	49.4	2.3	100	37.869	39.7	11.9	20.7	9.7	119.869	
2001	21.8	8.6	17.8	7.8	32.1	29	49.4	2.3	100	45.237	39.7	12.1	20.5	9.7	127.237	
2002	22.2	8.7	18.1	8	32.1	29	49.4	2.3	100	34.869	39.7	12.2	20.4	9.7	116.869	
2003	22.6	8.9	18.4	8.1	32.1	29	49.4	2.3	100	40.419	39.7	12.4	20.2	9.7	122.419	
2004	23.1	9	18.8	8.3	32.1	29	49.4	2.3	100	11.743	39.7	12.5	20.1	9.7	93.743	
2005	23.6	9.2	19.1	8.4	32.1	29	49.4	2.3	100	25.619	39.7	12.7	19.9	9.7	107.619	
Fractions of minimum required quantities to demands																
1997	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
1998	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
1999	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2000	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2001	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2002	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2003	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2004	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
2005	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0							
Minimum required quantities																
1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0	0							
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	0	0							
1999	14.832	5.904	12.24	5.328	14.124	12.76	29.64	0	0							
2000	15.336	6.048	12.528	5.544	14.124	12.76	29.64	0	0							
2001	15.696	6.192	12.816	5.616	14.124	12.76	29.64	0	0							
2002	15.984	6.264	13.032	5.76	14.124	12.76	29.64	0	0							
2003	16.272	6.408	13.248	5.832	14.124	12.76	29.64	0	0							
2004	16.632	6.48	13.536	5.976	14.124	12.76	29.64	0	0							
2005	16.992	6.624	13.752	6.048	14.124	12.76	29.64	0	0							
Releases from Kouris									10	**Total**						**Water balance of Kouris**
1997	13.824	0	0	4.824	0	2.476	0	0.6	2.62E-12	21.724						0.00
1998	0	0	0	0	0	0	11.532	1.489	0	13.021						0.00
1999	0	0	0	0	0	0	23.319	2.3	0	25.619						0.00
2000	0	0	0	0	0	0	27.524	2.3	8.045	37.869						0.00
2001	0	0	0	5.616	0	12.76	9.964	2.3	22.642	53.282						0.00
2002	0	0	0	0	0	0	29.64	2.3	25.571	57.511						0.00
2003	0	8.9	15.524	5.832	0	0	0	2.3	33.434	65.99						0.00
2004	0	0	0	8.3	0	12.76	12.664	2.3	9.153	45.177						0.00
2005	0	9.2	17.224	6.048	0	0	0	2.3	0	34.772						0.00

Releases from local sources

1997	0	5.616	11.736	0	14.124	10.284	29.64
1998	14.328	5.76	11.88	5.04	14.124	12.76	18.108
1999	20.6	5.904	16.963	5.328	14.124	12.76	6.321
2000	21.3	8.4	17.4	5.9	14.124	12.76	2.116
2001	21.8	8.6	17.8	0	14.124	0	19.676
2002	22.2	8.7	18.1	6.116	14.124	12.76	0
2003	22.6	0	2.876	0	14.124	12.76	29.64
2004	23.1	9	18.8	0	14.124	0	16.976
2005	23.6	0	1.876	0	14.124	12.76	29.64

Totals

Limassol	Larnaca	Nicosia	Famagousta
14.124	15.9	11.736	29.64
28.452	18.52	11.88	23.148
34.724	18.664	16.963	11.649
35.424	21.16	17.4	8.016
35.924	8.6	17.8	19.676
36.324	21.46	18.1	6.116
36.724	12.76	2.876	29.64
37.224	9	18.8	16.976
37.724	12.76	1.876	29.64

Surpluses

Limassol	Larnaca	Nicosia	Famagous	Total
14.98	-4.60	9.56	-19.94	0.00
11.25	-7.02	9.22	-13.45	0.00
4.98	-6.96	3.94	-1.95	0.00
4.28	-9.26	3.30	1.68	0.00
3.78	3.50	2.70	-9.98	0.00
3.38	-9.26	2.30	3.58	0.00
2.98	-0.36	17.32	-19.94	0.00
2.48	3.50	1.30	-7.28	0.00
1.98	-0.06	18.02	-19.94	0.00

Total releases

1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0.6	2.62E-12
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	1.489	0
1999	20.6	5.904	16.963	5.328	14.124	12.76	29.64	2.3	0
2000	21.3	8.4	17.4	5.9	14.124	12.76	29.64	2.3	8.045
2001	21.8	8.6	17.8	5.616	14.124	12.76	29.64	2.3	22.642
2002	22.2	8.7	18.1	6.116	14.124	12.76	29.64	2.3	25.571
2003	22.6	8.9	18.4	5.832	14.124	12.76	29.64	2.3	33.434
2004	23.1	9	18.8	8.3	14.124	12.76	29.64	2.3	9.153
2005	23.6	9.2	19.1	6.048	14.124	12.76	29.64	2.3	0

Benefits

1997	17.9712	6.1776	14.0832	4.824	8.4744	10.208	26.676	0.9	0	89.3144
1998	18.6264	6.336	14.256	5.04	8.4744	10.208	26.676	2.2335	0	91.8503
1999	26.78	6.4944	20.3556	5.328	8.4744	10.208	26.676	3.45	0	107.7664
2000	27.69	9.24	20.88	5.9	8.4744	10.208	26.676	3.45	0	112.5184
2001	28.34	9.46	21.36	5.616	8.4744	10.208	26.676	3.45	0	113.5844
2002	28.86	9.57	21.72	6.116	8.4744	10.208	26.676	3.45	0	115.0744
2003	29.38	9.79	22.08	5.832	8.4744	10.208	26.676	3.45	0	115.8904
2004	30.03	9.9	22.56	8.3	8.4744	10.208	26.676	3.45	0	119.5984
2005	30.68	10.12	22.92	6.048	8.4744	10.208	26.676	3.45	0	118.5764

Objective function **984.1735**

LINEAR PROGRAMM TO FIND THE OPTIMAL ALLOCATION OF THE WATER OF THE SCP SYSTEM

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr	Other water requirements: Recharge	Other water requirements: Storage to next year	Inflows: Kouris	Local resources: Limassol	Larnaca	Nicosia	Famagous	Total
Unit benefit	1.3	1.1	1.2	1	0.6	0.8	0.9	1.5	0						
Demands															
1997	19.2	7.8	16.3	6.7	32.1	29	49.4	2.3	100	11.724	29.1	11.3	21.3	9.7	83.124
1998	19.9	8	16.5	7	32.1	29	49.4	2.3	100	13.021	39.7	11.5	21.1	9.7	95.021
1999	20.6	8.2	17	7.4	32.1	29	49.4	2.3	100	25.619	39.7	11.7	20.9	9.7	107.619
2000	21.3	8.4	17.4	7.7	32.1	29	49.4	2.3	100	37.869	39.7	11.9	20.7	9.7	119.869
2001	21.8	8.6	17.8	7.8	32.1	29	49.4	2.3	100	18.473	39.7	12.1	20.5	9.7	100.473
2002	22.2	8.7	18.1	8	32.1	29	49.4	2.3	100	34.869	39.7	12.2	20.4	9.7	116.869
2003	22.6	8.9	18.4	8.1	32.1	29	49.4	2.3	100	12	39.7	12.4	20.2	9.7	94
2004	23.1	9	18.8	8.3	32.1	29	49.4	2.3	100	37.869	39.7	12.5	20.1	9.7	119.869
2005	23.6	9.2	19.1	8.4	32.1	29	49.4	2.3	100	69.07	39.7	12.7	19.9	9.7	151.07

Fractions of minimum required quantities to demands

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr	Recharge	Storage to next year
1997	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
1998	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
1999	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2000	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2001	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2002	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2003	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2004	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2005	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0

Minimum required quantities

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr	Recharge	Storage to next year
1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0	0
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	0	0
1999	14.832	5.904	12.24	5.328	14.124	12.76	29.64	0	0
2000	15.336	6.048	12.528	5.544	14.124	12.76	29.64	0	0
2001	15.696	6.192	12.816	5.616	14.124	12.76	29.64	0	0
2002	15.984	6.264	13.032	5.76	14.124	12.76	29.64	0	0
2003	16.272	6.408	13.248	5.832	14.124	12.76	29.64	0	0
2004	16.632	6.48	13.536	5.976	14.124	12.76	29.64	0	0
2005	16.992	6.624	13.752	6.048	14.124	12.76	29.64	0	0

Releases from Kouris

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr	Recharge	Storage to next year	Total	Water balance of Kouris
									10		
1997	13.824	0	0	4.824	0	2.476	0	0.6	2.62E-12	21.724	0.00
1998	0	0	0	0	0	0	11.532	1.489	0	13.021	0.00
1999	0	0	0	0	0	0	18.596	2.3	4.723	25.619	0.00
2000	0	6.048	0	5.544	0	0	11.666	2.3	17.034	42.592	0.00
2001	0	0	0	5.616	0	0	20.316	2.3	7.275	35.507	0.00
2002	0	0	0	0	0	0	21.78	2.3	18.064	42.144	0.00
2003	0	0	0	5.832	0	0	21.932	2.3	0	30.064	0.00
2004	0	0	0	8.3	0	0	27.269	2.3	0	37.869	0.00
2005	0	0	0	0	14.124	3.246	49.4	2.3	0	69.07	0.00

Releases from local sources

1997	0	5.616	11.736	0	14.124	10.284	29.64
1998	14.328	5.76	11.88	5.04	14.124	12.76	18.108
1999	20.6	5.904	12.24	5.328	14.124	12.76	11.044
2000	21.3	0	15.842	0	14.124	12.76	17.974
2001	21.8	6.192	17.8	0	14.124	12.76	9.324
2002	22.2	6.264	13.032	5.76	14.124	12.76	7.86
2003	22.6	6.408	18.4	0	14.124	12.76	7.708
2004	23.1	9	18.8	0	14.124	12.76	4.216
2005	23.6	9.2	19.1	8.4	0	21.7	0

Totals

Limassol	Larnaca	Nicosia	Famagousta
14.124	15.9	11.736	29.64
28.452	18.52	11.88	23.148
34.724	18.664	12.24	16.372
35.424	12.76	15.842	17.974
35.924	18.952	17.8	9.324
36.324	19.024	13.032	13.62
36.724	19.168	18.4	7.708
37.224	21.76	18.8	4.216
23.6	30.9	19.1	8.4

Surpluses

Limassol	Larnaca	Nicosia	Famagous	Totals
14.98	-4.60	9.56	-19.94	0.00
11.25	-7.02	9.22	-13.45	0.00
4.98	-6.96	8.66	-6.67	0.00
4.28	-0.86	4.86	-8.27	0.00
3.78	-6.85	2.70	0.38	0.00
3.38	-6.82	7.37	-3.92	0.00
2.98	-6.77	1.80	1.99	0.00
2.48	-9.26	1.30	5.48	0.00
16.10	-18.20	0.80	1.30	0.00

Total releases

1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0.6	2.62E-12
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	1.489	0
1999	20.6	5.904	12.24	5.328	14.124	12.76	29.64	2.3	4.723
2000	21.3	6.048	15.842	5.544	14.124	12.76	29.64	2.3	17.034
2001	21.8	6.192	17.8	5.616	14.124	12.76	29.64	2.3	7.275
2002	22.2	6.264	13.032	5.76	14.124	12.76	29.64	2.3	18.064
2003	22.6	6.408	18.4	5.832	14.124	12.76	29.64	2.3	0
2004	23.1	9	18.8	8.3	14.124	12.76	31.485	2.3	0
2005	23.6	9.2	19.1	8.4	14.124	24.946	49.4	2.3	0

Benefits

1997	17.9712	6.1776	14.0832	4.824	8.4744	10.208	26.676	0.9	0	89.3144
1998	18.6264	6.336	14.256	5.04	8.4744	10.208	26.676	2.2335	0	91.8503
1999	26.78	6.4944	14.688	5.328	8.4744	10.208	26.676	3.45	0	102.0988
2000	27.69	6.6528	19.0104	5.544	8.4744	10.208	26.676	3.45	0	107.7056
2001	28.34	6.8112	21.36	5.616	8.4744	10.208	26.676	3.45	0	110.9356
2002	28.86	6.8904	15.6384	5.76	8.4744	10.208	26.676	3.45	0	105.9572
2003	29.38	7.0488	22.08	5.832	8.4744	10.208	26.676	3.45	0	113.1492
2004	30.03	9.9	22.56	8.3	8.4744	10.208	28.3365	3.45	0	121.2589
2005	30.68	10.12	22.92	8.4	8.4744	19.9568	44.46	3.45	0	148.4612

Objective function **990.7312**

LINEAR PROGRAMM TO FIND THE OPTIMAL ALLOCATION OF THE WATER OF THE SCP SYSTEM

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Other water requirements: Recharge	Storage to next year	Inflows: Kouris	Local resources: Limassol	Larnaca	Nicosia	Famagous	Total
Unit benefit	1.3	1.1	1.2	1	0.6	0.8	0.9	1.5	0						
Demands															
1997	19.2	7.8	16.3	6.7	32.1	29	49.4	2.3	100	11.724	29.1	11.3	21.3	9.7	83.124
1998	19.9	8	16.5	7	32.1	29	49.4	2.3	100	13.021	39.7	11.5	21.1	9.7	95.021
1999	20.6	8.2	17	7.4	32.1	29	49.4	2.3	100	25.619	39.7	11.7	20.9	9.7	107.619
2000	21.3	8.4	17.4	7.7	32.1	29	49.4	2.3	100	37.869	39.7	11.9	20.7	9.7	119.869
2001	21.8	8.6	17.8	7.8	32.1	29	49.4	2.3	100	11.742	39.7	12.1	20.5	9.7	93.742
2002	22.2	8.7	18.1	8	32.1	29	49.4	2.3	100	25.619	39.7	12.2	20.4	9.7	107.619
2003	22.6	8.9	18.4	8.1	32.1	29	49.4	2.3	100	45.237	39.7	12.4	20.2	9.7	127.237
2004	23.1	9	18.8	8.3	32.1	29	49.4	2.3	100	69.07	39.7	12.5	20.1	9.7	151.07
2005	23.6	9.2	19.1	8.4	32.1	29	49.4	2.3	100	31.561	39.7	12.7	19.9	9.7	113.561

Fractions of minimum required quantities to demands

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Recharge	Storage to next year
1997	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
1998	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
1999	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2000	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2001	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2002	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2003	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2004	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2005	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0

Minimum required quantities

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Recharge	Storage to next year
1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0	0
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	0	0
1999	14.832	5.904	12.24	5.328	14.124	12.76	29.64	0	0
2000	15.336	6.048	12.528	5.544	14.124	12.76	29.64	0	0
2001	15.696	6.192	12.816	5.616	14.124	12.76	29.64	0	0
2002	15.984	6.264	13.032	5.76	14.124	12.76	29.64	0	0
2003	16.272	6.408	13.248	5.832	14.124	12.76	29.64	0	0
2004	16.632	6.48	13.536	5.976	14.124	12.76	29.64	0	0
2005	16.992	6.624	13.752	6.048	14.124	12.76	29.64	0	0

Releases from Kouris

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Recharge	Storage to next year	Total	Water balance of Kouris
									10		
1997	13.824	0	0	4.824	0	2.476	0	0.6	2.62E-12	21.724	0.00
1998	0	5.76	0	0	0	0	5.772	1.489	0	13.021	0.00
1999	0	0	0	5.328	0	0	17.991	2.3	2.87E-13	25.619	0.00
2000	0	6.048	0	5.544	0	0	12.471	2.3	11.506	37.869	0.00
2001	0	0	0	5.616	0	0	15.332	2.3	0	23.248	0.00
2002	0	6.264	0	0	0	0	17.055	2.3	0	25.619	0.00
2003	0	8.9	11.813	8.1	14.124	0	0	2.3	0	45.237	0.00
2004	0	6.263	0	8.3	14.124	12.76	0	2.3	25.323	69.07	0.00
2005	23.6	0	0	8.4	0	12.76	9.824	2.3	0	56.884	0.00

Releases from local sources

1997	0	5.616	11.736	0	14.124	10.284	29.64
1998	14.328	0	11.88	5.04	14.124	12.76	23.868
1999	20.6	5.904	16.963	0	14.124	12.76	11.649
2000	21.3	0	16.647	0	14.124	12.76	17.169
2001	21.8	6.192	12.816	0	14.124	12.76	14.308
2002	22.2	0	14.571	5.76	14.124	12.76	12.585
2003	22.6	0	6.587	0	0	12.76	40.053
2004	23.1	2.737	18.8	0	0	0	37.363
2005	0	9.2	19.1	0	14.124	0	39.576

Total releases

1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0.6	2.62E-12
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	1.489	0
1999	20.6	5.904	16.963	5.328	14.124	12.76	29.64	2.3	2.87E-13
2000	21.3	6.048	16.647	5.544	14.124	12.76	29.64	2.3	11.506
2001	21.8	6.192	12.816	5.616	14.124	12.76	29.64	2.3	0
2002	22.2	6.264	14.571	5.76	14.124	12.76	29.64	2.3	0
2003	22.6	8.9	18.4	8.1	14.124	12.76	40.053	2.3	0
2004	23.1	9	18.8	8.3	14.124	12.76	37.363	2.3	25.323
2005	23.6	9.2	19.1	8.4	14.124	12.76	49.4	2.3	0

Benefits

1997	17.9712	6.1776	14.0832	4.824	8.4744	10.208	26.676	0.9	0	89.3144
1998	18.6264	6.336	14.256	5.04	8.4744	10.208	26.676	2.2335	0	91.8503
1999	26.78	6.4944	20.3556	5.328	8.4744	10.208	26.676	3.45	0	107.7664
2000	27.69	6.6528	19.9764	5.544	8.4744	10.208	26.676	3.45	0	108.6716
2001	28.34	6.8112	15.3792	5.616	8.4744	10.208	26.676	3.45	0	104.9548
2002	28.86	6.8904	17.4852	5.76	8.4744	10.208	26.676	3.45	0	107.804
2003	29.38	9.79	22.08	8.1	8.4744	10.208	36.0477	3.45	0	127.5301
2004	30.03	9.9	22.56	8.3	8.4744	10.208	33.6267	3.45	0	126.5491
2005	30.68	10.12	22.92	8.4	8.4744	10.208	44.46	3.45	0	138.7124

Objective function **1003.153**

Totals

Limassol	Larnaca	Nicosia	Famagousta
14.124	15.9	11.736	29.64
28.452	12.76	11.88	28.908
34.724	18.664	16.963	11.649
35.424	12.76	16.647	17.169
35.924	18.952	12.816	14.308
36.324	12.76	14.571	18.345
22.6	12.76	6.587	40.053
23.1	2.737	18.8	37.363
14.124	9.2	19.1	39.576

Surpluses

Limassol	Larnaca	Nicosia	Famagous	Totals
14.98	-4.60	9.56	-19.94	0.00
11.25	-1.26	9.22	-19.21	0.00
4.98	-6.96	3.94	-1.95	0.00
4.28	-0.86	4.05	-7.47	0.00
3.78	-6.85	7.68	-4.61	0.00
3.38	-0.56	5.83	-8.64	0.00
17.10	-0.36	13.61	-30.35	0.00
16.60	9.76	1.30	-27.66	0.00
25.58	3.50	0.80	-29.88	0.00

LINEAR PROGRAMM TO FIND THE OPTIMAL ALLOCATION OF THE WATER OF THE SCP SYSTEM

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Other water requirements: Recharge	Storage to next year
Unit benefit	1.3	1.1	1.2	1	0.6	0.8	0.9	1.5	0
Demands									
1997	19.2	7.8	16.3	6.7	32.1	29	49.4	2.3	100
1998	19.9	8	16.5	7	32.1	29	49.4	2.3	100
1999	20.6	8.2	17	7.4	32.1	29	49.4	2.3	100
2000	21.3	8.4	17.4	7.7	32.1	29	49.4	2.3	100
2001	21.8	8.6	17.8	7.8	32.1	29	49.4	2.3	100
2002	22.2	8.7	18.1	8	32.1	29	49.4	2.3	100
2003	22.6	8.9	18.4	8.1	32.1	29	49.4	2.3	100
2004	23.1	9	18.8	8.3	32.1	29	49.4	2.3	100
2005	23.6	9.2	19.1	8.4	32.1	29	49.4	2.3	100

Year	Inflows Kouris	Local resources Limassol	Larnaca	Nicosia	Famagous	Total
1997	11.724	29.1	11.3	21.3	9.7	83.124
1998	13.021	39.7	11.5	21.1	9.7	95.021
1999	25.619	39.7	11.7	20.9	9.7	107.619
2000	37.869	39.7	11.9	20.7	9.7	119.869
2001	40.419	39.7	12.1	20.5	9.7	122.419
2002	18.473	39.7	12.2	20.4	9.7	100.473
2003	31.561	39.7	12.4	20.2	9.7	113.561
2004	12	39.7	12.5	20.1	9.7	94
2005	11.724	39.7	12.7	19.9	9.7	93.724

Fractions of minimum required quantities to demands

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Recharge	Storage to next year
1997	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
1998	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
1999	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2000	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2001	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2002	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2003	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2004	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2005	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0

Minimum required quantities

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Recharge	Storage to next year
1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0	0
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	0	0
1999	14.832	5.904	12.24	5.328	14.124	12.76	29.64	0	0
2000	15.336	6.048	12.528	5.544	14.124	12.76	29.64	0	0
2001	15.696	6.192	12.816	5.616	14.124	12.76	29.64	0	0
2002	15.984	6.264	13.032	5.76	14.124	12.76	29.64	0	0
2003	16.272	6.408	13.248	5.832	14.124	12.76	29.64	0	0
2004	16.632	6.48	13.536	5.976	14.124	12.76	29.64	0	0
2005	16.992	6.624	13.752	6.048	14.124	12.76	29.64	0	0

Releases from Kouris

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Recharge	Storage to next year	Total	Water balance of Kouris
									10		
1997	0	0	0	0	0	0	21.124	0.6	0	21.724	0.00
1998	0	0	0	0	0	0	11.532	1.489	0	13.021	0.00
1999	0	0	0	0	0	0	18.596	2.3	4.723	25.619	0.00
2000	0	0	0	0	0	0	24.816	2.3	15.476	42.592	0.00
2001	0	0	0	0	0	0	25.597	2.3	27.998	55.895	0.00
2002	0	0	0	0	0	0	21.78	2.3	22.391	46.471	0.00
2003	0	0	0	0	0	0	22.612	2.3	29.04	53.952	0.00
2004	0	0	3.516	5.976	14.124	0	0	2.3	15.124	41.04	0.00
2005	23.6	0.948	0	0	0	0	0	2.3	0	26.848	0.00

Releases from local sources

1997	13.824	5.616	11.736	4.824	14.124	12.76	8.516
1998	14.328	5.76	11.88	5.04	14.124	12.76	18.108
1999	20.6	5.904	12.24	5.328	14.124	12.76	11.044
2000	21.3	6.048	17.4	5.544	14.124	12.76	4.824
2001	21.8	6.192	17.465	5.616	14.124	12.76	4.043
2002	22.2	6.264	13.032	5.76	14.124	12.76	7.86
2003	22.6	6.408	13.248	5.832	14.124	12.76	7.028
2004	23.1	6.48	10.02	0	0	12.76	29.64
2005	0	5.676	13.752	6.048	14.124	12.76	29.64

Totals

Limassol	Larnaca	Nicosia	Famagousta
27.948	18.376	11.736	13.34
28.452	18.52	11.88	23.148
34.724	18.664	12.24	16.372
35.424	18.808	17.4	10.368
35.924	18.952	17.465	9.659
36.324	19.024	13.032	13.62
36.724	19.168	13.248	12.86
23.1	19.24	10.02	29.64
14.124	18.436	13.752	35.688

Surpluses

Limassol	Larnaca	Nicosia	Famagous	Totals
1.15	-7.08	9.56	-3.64	0.00
11.25	-7.02	9.22	-13.45	0.00
4.98	-6.96	8.66	-6.67	0.00
4.28	-6.91	3.30	-0.67	0.00
3.78	-6.85	3.04	0.04	0.00
3.38	-6.82	7.37	-3.92	0.00
2.98	-6.77	6.95	-3.16	0.00
16.60	-6.74	10.08	-19.94	0.00
25.58	-5.74	6.15	-25.99	0.00

Total releases

1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0.6	0
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	1.489	0
1999	20.6	5.904	12.24	5.328	14.124	12.76	29.64	2.3	4.723
2000	21.3	6.048	17.4	5.544	14.124	12.76	29.64	2.3	15.476
2001	21.8	6.192	17.465	5.616	14.124	12.76	29.64	2.3	27.998
2002	22.2	6.264	13.032	5.76	14.124	12.76	29.64	2.3	22.391
2003	22.6	6.408	13.248	5.832	14.124	12.76	29.64	2.3	29.04
2004	23.1	6.48	13.536	5.976	14.124	12.76	29.64	2.3	15.124
2005	23.6	6.624	13.752	6.048	14.124	12.76	29.64	2.3	0

Benefits

1997	17.9712	6.1776	14.0832	4.824	8.4744	10.208	26.676	0.9	0	89.3144
1998	18.6264	6.336	14.256	5.04	8.4744	10.208	26.676	2.2335	0	91.8503
1999	26.78	6.4944	14.688	5.328	8.4744	10.208	26.676	3.45	0	102.0988
2000	27.69	6.6528	20.88	5.544	8.4744	10.208	26.676	3.45	0	109.5752
2001	28.34	6.8112	20.958	5.616	8.4744	10.208	26.676	3.45	0	110.5336
2002	28.86	6.8904	15.6384	5.76	8.4744	10.208	26.676	3.45	0	105.9572
2003	29.38	7.0488	15.8976	5.832	8.4744	10.208	26.676	3.45	0	106.9668
2004	30.03	7.128	16.2432	5.976	8.4744	10.208	26.676	3.45	0	108.1856
2005	30.68	7.2864	16.5024	6.048	8.4744	10.208	26.676	3.45	0	109.3252

Objective function **933.8071**

LINEAR PROGRAMM TO FIND THE OPTIMAL ALLOCATION OF THE WATER OF THE SCP SYSTEM

Year	Lim. Dom	Lam. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Other water requirements		Inflows	Local resources				
										Kouris	Limassol	Larnaca	Nicosia	Famagous	Total
Unit benefit	1.3	1.1	1.2	1	0.6	0.8	0.9	1.5	0						
Demands								**Recharge**	**Storage to next year**						
1997	19.2	7.8	16.3	6.7	32.1	29	49.4	2.3	100	11.724	29.1	11.3	21.3	9.7	83.124
1998	19.9	8	16.5	7	32.1	29	49.4	2.3	100	13.021	39.7	11.5	21.1	9.7	95.021
1999	20.6	8.2	17	7.4	32.1	29	49.4	2.3	100	25.619	39.7	11.7	20.9	9.7	107.619
2000	21.3	8.4	17.4	7.7	32.1	29	49.4	2.3	100	37.869	39.7	11.9	20.7	9.7	119.869
2001	21.8	8.6	17.8	7.8	32.1	29	49.4	2.3	100	**37.869**	39.7	12.1	20.5	9.7	119.869
2002	22.2	8.7	18.1	8	32.1	29	49.4	2.3	100	**12**	39.7	12.2	20.4	9.7	94
2003	22.6	8.9	18.4	8.1	32.1	29	49.4	2.3	100	**46.237**	39.7	12.4	20.2	9.7	127.237
2004	23.1	9	18.8	8.3	32.1	29	49.4	2.3	100	**18.473**	39.7	12.5	20.1	9.7	100.473
2005	23.6	9.2	19.1	8.4	32.1	29	49.4	2.3	100	**31.561**	39.7	12.7	19.9	9.7	113.561
Fractions of minimum required quantities to demands															
1997	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
1998	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
1999	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
2000	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
2001	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
2002	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
2003	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
2004	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
2005	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
Minimum required quantities															
1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0	0						
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	0	0						
1999	14.832	5.904	12.24	5.328	14.124	12.76	29.64	0	0						
2000	15.336	6.048	12.528	5.544	14.124	12.76	29.64	0	0						
2001	15.696	6.192	12.816	5.616	14.124	12.76	29.64	0	0						
2002	15.984	6.264	13.032	5.76	14.124	12.76	29.64	0	0						
2003	16.272	6.408	13.248	5.832	14.124	12.76	29.64	0	0						
2004	16.632	6.48	13.536	5.976	14.124	12.76	29.64	0	0						
2005	16.992	6.624	13.752	6.048	14.124	12.76	29.64	0	0						
Releases from Kouris									10	**Total**				**Water balance of Kouris**	
1997	13.824	0	0	4.824	0	2.476	0	0.6	2.62E-12	21.724				0.00	
1998	0	5.76	0	0	0	0	5.772	1.489	0	13.021				0.00	
1999	0	0	0	5.328	0	0	17.991	2.3	2.89E-13	25.619				0.00	
2000	0	6.048	0	5.544	0	0	13.224	2.3	10.753	37.869				0.00	
2001	0	0	0	5.616	0	0	22.724	2.3	17.982	48.622				0.00	
2002	0	0	0	0	0	0	26.993	2.3	0.689	29.982				0.00	
2003	15.004	0	0	0	0	12.76	0	2.3	15.862	45.926				0.00	
2004	0	0	0	5.976	0	12.76	12.664	2.3	0.635	34.335				0.00	
2005	0	6.624	17.224	6.048	0	0	0	2.3	0	32.196				0.00	

Releases from local sources

1997	0	5.616	11.736	0	14.124	10.284	29.64
1998	14.328	0	11.88	5.04	14.124	12.76	23.868
1999	20.6	5.904	16.963	0	14.124	12.76	11.649
2000	21.3	0	17.4	0	14.124	12.76	16.416
2001	21.8	8.6	17.8	0	14.124	12.76	6.916
2002	22.2	6.409	18.1	5.76	14.124	12.76	2.647
2003	7.596	6.408	18.4	5.832	14.124	0	29.64
2004	23.1	9	18.8	0	14.124	0	16.976
2005	23.6	0	1.876	0	14.124	12.76	29.64

Totals

	Limassol	Larnaca	Nicosia	Famagousta
1997	14.124	15.9	11.736	29.64
1998	28.452	12.76	11.88	28.908
1999	34.724	18.664	16.963	11.649
2000	35.424	12.76	17.4	16.416
2001	35.924	21.36	17.8	6.916
2002	36.324	19.169	18.1	8.407
2003	21.72	6.408	18.4	35.472
2004	37.224	9	18.8	16.976
2005	37.724	12.76	1.876	29.64

Surpluses

	Limassol	Larnaca	Nicosia	Famagous	Totals
1997	14.98	-4.60	9.56	-19.94	0.00
1998	11.25	-1.26	9.22	-19.21	0.00
1999	4.98	-6.96	3.94	-1.95	0.00
2000	4.28	-0.86	3.30	-6.72	0.00
2001	3.78	-9.26	2.70	2.78	0.00
2002	3.38	-6.97	2.30	1.29	0.00
2003	17.98	5.99	1.80	-25.77	0.00
2004	2.48	3.50	1.30	-7.28	0.00
2005	1.98	-0.06	18.02	-19.94	0.00

Total releases

1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0.6	2.62E-12
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	1.489	0
1999	20.6	5.904	16.963	5.328	14.124	12.76	29.64	2.3	2.89E-13
2000	21.3	6.048	17.4	5.544	14.124	12.76	29.64	2.3	10.753
2001	21.8	8.6	17.8	5.616	14.124	12.76	29.64	2.3	17.982
2002	22.2	6.409	18.1	5.76	14.124	12.76	29.64	2.3	0.689
2003	22.6	6.408	18.4	5.832	14.124	12.76	29.64	2.3	15.862
2004	23.1	9	18.8	5.976	14.124	12.76	29.64	2.3	0.635
2005	23.6	6.624	19.1	6.048	14.124	12.76	29.64	2.3	0

Benefits

1997	17.9712	6.1776	14.0832	4.824	8.4744	10.208	26.676	0.9	0	89.3144
1998	18.6264	6.336	14.256	5.04	8.4744	10.208	26.676	2.2335	0	91.8503
1999	26.78	6.4944	20.3556	5.328	8.4744	10.208	26.676	3.45	0	107.7664
2000	27.69	6.6528	20.88	5.544	8.4744	10.208	26.676	3.45	0	109.5752
2001	28.34	9.46	21.36	5.616	8.4744	10.208	26.676	3.45	0	113.5844
2002	28.86	7.0499	21.72	5.76	8.4744	10.208	26.676	3.45	0	112.1983
2003	29.38	7.0488	22.08	5.832	8.4744	10.208	26.676	3.45	0	113.1492
2004	30.03	9.9	22.56	5.976	8.4744	10.208	26.676	3.45	0	117.2744
2005	30.68	7.2864	22.92	6.048	8.4744	10.208	26.676	3.45	0	115.7428

Objective function **970.4664**

LINEAR PROGRAMM TO FIND THE OPTIMAL ALLOCATION OF THE WATER OF THE SCP SYSTEM

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.			Inflows	Local resources				
										Kouris	Limassol	Larnaca	Nicosia	Famagous	Total
Unit benefit								**Other water requirements**							
	1.3	1.1	1.2	1	0.6	0.8	0.9	1.5	0						
Demands								**Recharge**	**Storage to next year**						
1997	19.2	7.8	16.3	6.7	32.1	29	49.4	2.3	100	11.724	29.1	11.3	21.3	9.7	83.124
1998	19.9	8	16.5	7	32.1	29	49.4	2.3	100	13.021	39.7	11.5	21.1	9.7	95.021
1999	20.6	8.2	17	7.4	32.1	29	49.4	2.3	100	25.619	39.7	11.7	20.9	9.7	107.619
2000	21.3	8.4	17.4	7.7	32.1	29	49.4	2.3	100	37.869	39.7	11.9	20.7	9.7	119.869
2001	21.8	8.6	17.8	7.8	32.1	29	49.4	2.3	100	**13.021**	39.7	12.1	20.5	9.7	95.021
2002	22.2	8.7	18.1	8	32.1	29	49.4	2.3	100	**6.222**	39.7	12.2	20.4	9.7	88.222
2003	22.6	8.9	18.4	8.1	32.1	29	49.4	2.3	100	**18.473**	39.7	12.4	20.2	9.7	100.473
2004	23.1	9	18.8	8.3	32.1	29	49.4	2.3	100	**69.07**	39.7	12.5	20.1	9.7	151.07
2005	23.6	9.2	19.1	8.4	32.1	29	49.4	2.3	100	**12.138**	39.7	12.7	19.9	9.7	94.138
Fractions of minimum required quantities to demands															
1997	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
1998	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
1999	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
2000	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
2001	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
2002	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
2003	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
2004	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
2005	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
Minimum required quantities															
1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0	0						
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	0	0						
1999	14.832	5.904	12.24	5.328	14.124	12.76	29.64	0	0						
2000	15.336	6.048	12.528	5.544	14.124	12.76	29.64	0	0						
2001	15.696	6.192	12.816	5.616	14.124	12.76	29.64	0	0						
2002	15.984	6.264	13.032	5.76	14.124	12.76	29.64	0	0						
2003	16.272	6.408	13.248	5.832	14.124	12.76	29.64	0	0						
2004	16.632	6.48	13.536	5.976	14.124	12.76	29.64	0	0						
2005	16.992	6.624	13.752	6.048	14.124	12.76	29.64	0	0						
Releases from Kouris									10	**Total**					**Water balance of Kouris**
1997	13.824	0	0	4.824	0	2.476	0	0.6	2.62E-12	21.724					0.00
1998	0	5.76	0	0	0	0	5.772	1.489	8.25E-43	13.021					0.00
1999	0	0	0	5.328	0	0	13.268	2.3	4.723	25.619					0.00
2000	0	0	0	5.544	0	0	12.544	2.3	22.204	42.592					0.00
2001	0	6.192	0	0	0	8.652	0	2.3	18.081	35.225					0.00
2002	0	6.264	0	0	0	0	9.3	2.3	6.439	24.303					0.00
2003	0	0	0	5.832	0	0	16.78	2.3	0	24.912					0.00
2004	23.1	9	0	8.3	1.384	0	0	2.3	24.986	69.07					0.00
2005	0	0	19.1	0	0	0	15.724	2.3	0	37.124					0.00

Releases from local sources

1997	0	5.616	11.736	0	14.124	10.284	29.64
1998	14.328	0	11.88	5.04	14.124	12.76	23.868
1999	20.6	5.904	12.24	0	14.124	12.76	16.372
2000	19.444	6.048	12.528	0	14.124	12.76	17.096
2001	15.696	0	12.816	5.616	14.124	4.108	29.64
2002	15.984	0	13.032	5.76	14.124	12.76	20.34
2003	22.6	6.408	13.248	0	14.124	12.76	12.86
2004	0	0	18.8	0	12.74	12.76	37.7
2005	23.6	9.2	0	8.4	14.124	12.76	13.916

Totals

Limassol	Larnaca	Nicosia	Famagousta
14.124	15.9	11.736	29.64
28.452	12.76	11.88	28.908
34.724	18.664	12.24	16.372
33.568	18.808	12.528	17.096
29.82	4.108	12.816	35.256
30.108	12.76	13.032	26.1
36.724	19.168	13.248	12.86
12.74	12.76	18.8	37.7
37.724	21.96	0	22.316

Surpluses

Limassol	Larnaca	Nicosia	Famagous	Totals
14.98	-4.60	9.56	-19.94	0.00
11.25	-1.26	9.22	-19.21	0.00
4.98	-6.96	8.66	-6.67	0.00
6.13	-6.91	8.17	-7.40	0.00
9.88	7.99	7.68	-25.56	0.00
9.59	-0.56	7.37	-16.40	0.00
2.98	-6.77	6.95	-3.16	0.00
26.96	-0.26	1.30	-28.00	0.00
1.98	-9.26	19.90	-12.62	0.00

Total releases

1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0.6	2.62E-12
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	1.489	8.25E-43
1999	20.6	5.904	12.24	5.328	14.124	12.76	29.64	2.3	4.723
2000	19.444	6.048	12.528	5.544	14.124	12.76	29.64	2.3	22.204
2001	15.696	6.192	12.816	5.616	14.124	12.76	29.64	2.3	18.081
2002	15.984	6.264	13.032	5.76	14.124	12.76	29.64	2.3	6.439
2003	22.6	6.408	13.248	5.832	14.124	12.76	29.64	2.3	0
2004	23.1	9	18.8	8.3	14.124	12.76	37.7	2.3	24.986
2005	23.6	9.2	19.1	8.4	14.124	12.76	29.64	2.3	0

Benefits

1997	17.9712	6.1776	14.0832	4.824	8.4744	10.208	26.676	0.9	0	89.3144
1998	18.6264	6.336	14.256	5.04	8.4744	10.208	26.676	2.2335	0	91.8503
1999	26.78	6.4944	14.688	5.328	8.4744	10.208	26.676	3.45	0	102.0988
2000	25.2772	6.6528	15.0336	5.544	8.4744	10.208	26.676	3.45	0	101.316
2001	20.4048	6.8112	15.3792	5.616	8.4744	10.208	26.676	3.45	0	97.0196
2002	20.7792	6.8904	15.6384	5.76	8.4744	10.208	26.676	3.45	0	97.8764
2003	29.38	7.0488	15.8976	5.832	8.4744	10.208	26.676	3.45	0	106.9668
2004	30.03	9.9	22.56	8.3	8.4744	10.208	33.93	3.45	0	126.8524
2005	30.68	10.12	22.92	8.4	8.4744	10.208	26.676	3.45	0	120.9284

Objective function **934.2231**

LINEAR PROGRAMM TO FIND THE OPTIMAL ALLOCATION OF THE WATER OF THE SCP SYSTEM

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.			**Inflows** Kouris	**Local resources** Limassol	Larnaca	Nicosia	Famagous	Total
Unit benefit								**Other water requirements**							
	1.3	1.1	1.2	1	0.6	0.8	0.9	1.5	0						
Demands								**Recharge**	**Storage to next year**						
1997	19.2	7.8	16.3	6.7	32.1	29	49.4	2.3	100	11.724	29.1	11.3	21.3	9.7	83.124
1998	19.9	8	16.5	7	32.1	29	49.4	2.3	100	13.021	39.7	11.5	21.1	9.7	95.021
1999	20.6	8.2	17	7.4	32.1	29	49.4	2.3	100	25.619	39.7	11.7	20.9	9.7	107.619
2000	21.3	8.4	17.4	7.7	32.1	29	49.4	2.3	100	37.869	39.7	11.9	20.7	9.7	119.869
2001	21.8	8.6	17.8	7.8	32.1	29	49.4	2.3	100	**40.419**	39.7	12.1	20.5	9.7	122.419
2002	22.2	8.7	18.1	8	32.1	29	49.4	2.3	100	**6.222**	39.7	12.2	20.4	9.7	88.222
2003	22.6	8.9	18.4	8.1	32.1	29	49.4	2.3	100	**45.237**	39.7	12.4	20.2	9.7	127.237
2004	23.1	9	18.8	8.3	32.1	29	49.4	2.3	100	**12.138**	39.7	12.5	20.1	9.7	94.138
2005	23.6	9.2	19.1	8.4	32.1	29	49.4	2.3	100	**13.021**	39.7	12.7	19.9	9.7	95.021
Fractions of minimum required quantities to demands															
1997	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
1998	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
1999	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
2000	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
2001	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
2002	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
2003	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
2004	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
2005	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0						
Minimum required quantities															
1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0	0						
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	0	0						
1999	14.832	5.904	12.24	5.328	14.124	12.76	29.64	0	0						
2000	15.336	6.048	12.528	5.544	14.124	12.76	29.64	0	0						
2001	15.696	6.192	12.816	5.616	14.124	12.76	29.64	0	0						
2002	15.984	6.264	13.032	5.76	14.124	12.76	29.64	0	0						
2003	16.272	6.408	13.248	5.832	14.124	12.76	29.64	0	0						
2004	16.632	6.48	13.536	5.976	14.124	12.76	29.64	0	0						
2005	16.992	6.624	13.752	6.048	14.124	12.76	29.64	0	0						
Releases from Kouris									10	**Total**					**Water balance of Kouris**
1997	13.824	0	0	4.824	0	2.476	0	0.6	2.62E-12	21.724					0.00
1998	0	5.76	0	0	0	0	5.772	1.489	0	13.021					0.00
1999	0	0	0	5.328	0	0	17.991	2.3	2.86E-13	25.619					0.00
2000	0	0	0	0	0	0	24.816	2.3	10.753	37.869					0.00
2001	0	0	0	5.616	0	0	18.118	2.3	25.138	51.172					0.00
2002	0	0	0	0	0	0	21.78	2.3	7.28	31.36					0.00
2003	0	0	0	5.832	14.124	2.656	0	2.3	27.605	52.517					0.00
2004	0	0	0	0	0	0	23.616	2.3	13.827	39.743					0.00
2005	0	6.624	13.752	0	0	0	4.172	2.3	0	26.848					0.00

Releases from local sources

1997	0	5.616	11.736	0	14.124	10.284	29.64
1998	14.328	0	11.88	5.04	14.124	12.76	23.868
1999	20.6	5.904	16.963	0	14.124	12.76	11.649
2000	21.3	6.048	17.4	5.544	14.124	12.76	4.824
2001	21.8	6.192	15.602	0	14.124	12.76	11.522
2002	22.2	6.264	13.032	5.76	14.124	12.76	7.86
2003	22.6	6.408	13.248	0	0	10.104	29.64
2004	23.1	6.48	13.536	5.976	14.124	12.76	6.024
2005	23.6	0	0	6.048	14.124	12.76	25.468

Totals

Limassol	Larnaca	Nicosia	Famagousta
14.124	15.9	11.736	29.64
28.452	12.76	11.88	28.908
34.724	18.664	16.963	11.649
35.424	18.808	17.4	10.368
35.924	18.952	15.602	11.522
36.324	19.024	13.032	13.62
22.6	16.512	13.248	29.64
37.224	19.24	13.536	12
37.724	12.76	0	31.516

Surpluses

Limassol	Larnaca	Nicosia	Famagous	Totals
14.98	-4.60	9.56	-19.94	0.00
11.25	-1.26	9.22	-19.21	0.00
4.98	-6.96	3.94	-1.95	0.00
4.28	-6.91	3.30	-0.67	0.00
3.78	-6.85	4.90	-1.82	0.00
3.38	-6.82	7.37	-3.92	0.00
17.10	-4.11	6.95	-19.94	0.00
2.48	-6.74	6.56	-2.30	0.00
1.98	-0.06	19.90	-21.82	0.00

Total releases

1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0.6	2.62E-12
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	1.489	0
1999	20.6	5.904	16.963	5.328	14.124	12.76	29.64	2.3	2.86E-13
2000	21.3	6.048	17.4	5.544	14.124	12.76	29.64	2.3	10.753
2001	21.8	6.192	15.602	5.616	14.124	12.76	29.64	2.3	25.138
2002	22.2	6.264	13.032	5.76	14.124	12.76	29.64	2.3	7.28
2003	22.6	6.408	13.248	5.832	14.124	12.76	29.64	2.3	27.605
2004	23.1	6.48	13.536	5.976	14.124	12.76	29.64	2.3	13.827
2005	23.6	6.624	13.752	6.048	14.124	12.76	29.64	2.3	0

Benefits

1997	17.9712	6.1776	14.0832	4.824	8.4744	10.208	26.676	0.9	0	89.3144
1998	18.6264	6.336	14.256	5.04	8.4744	10.208	26.676	2.2335	0	91.8503
1999	26.78	6.4944	20.3556	5.328	8.4744	10.208	26.676	3.45	0	107.7664
2000	27.69	6.6528	20.88	5.544	8.4744	10.208	26.676	3.45	0	109.5752
2001	28.34	6.8112	18.7224	5.616	8.4744	10.208	26.676	3.45	0	108.298
2002	28.86	6.8904	15.6384	5.76	8.4744	10.208	26.676	3.45	0	105.9572
2003	29.38	7.0488	15.8976	5.832	8.4744	10.208	26.676	3.45	0	106.9668
2004	30.03	7.128	16.2432	5.976	8.4744	10.208	26.676	3.45	0	108.1856
2005	30.68	7.2864	16.5024	6.048	8.4744	10.208	26.676	3.45	0	109.3252

Objective function **937.2391**

LINEAR PROGRAMM TO FIND THE OPTIMAL ALLOCATION OF THE WATER OF THE SCP SYSTEM

Year	Lim. Dom	Lam. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Lam. Irr	Fam. Irr.	Other water requirements		Inflows Kouris	Local resources Limassol	Larnaca	Nicosia	Famagous	Total
Unit benefit															
	1.3	1.1	1.2	1	0.6	0.8	0.9	1.5	0						
Demands								**Recharge**	**Storage to next year**						
1997	19.2	7.8	16.3	6.7	32.1	29	49.4	2.3	100	11.724	29.1	11.3	21.3	9.7	83.124
1998	19.9	8	16.5	7	32.1	29	49.4	2.3	100	13.021	39.7	11.5	21.1	9.7	95.021
1999	20.6	8.2	17	7.4	32.1	29	49.4	2.3	100	25.619	39.7	11.7	20.9	9.7	107.619
2000	21.3	8.4	17.4	7.7	32.1	29	49.4	2.3	100	37.869	39.7	11.9	20.7	9.7	119.869
2001	21.8	8.6	17.8	7.8	32.1	29	49.4	2.3	100	**34.869**	39.7	12.1	20.5	9.7	116.869
2002	22.2	8.7	18.1	8	32.1	29	49.4	2.3	100	**12.138**	39.7	12.2	20.4	9.7	94.138
2003	22.6	8.9	18.4	8.1	32.1	29	49.4	2.3	100	**45.237**	39.7	12.4	20.2	9.7	127.237
2004	23.1	9	18.8	8.3	32.1	29	49.4	2.3	100	**12**	39.7	12.5	20.1	9.7	94
2005	23.6	9.2	19.1	8.4	32.1	29	49.4	2.3	100	**37.869**	39.7	12.7	19.9	9.7	119.869

Fractions of minimum required quantities to demands

Year									
1997	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
1998	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
1999	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2000	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2001	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2002	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2003	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2004	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2005	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0

Minimum required quantities

Year									
1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0	0
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	0	0
1999	14.832	5.904	12.24	5.328	14.124	12.76	29.64	0	0
2000	15.336	6.048	12.528	5.544	14.124	12.76	29.64	0	0
2001	15.696	6.192	12.816	5.616	14.124	12.76	29.64	0	0
2002	15.984	6.264	13.032	5.76	14.124	12.76	29.64	0	0
2003	16.272	6.408	13.248	5.832	14.124	12.76	29.64	0	0
2004	16.632	6.48	13.536	5.976	14.124	12.76	29.64	0	0
2005	16.992	6.624	13.752	6.048	14.124	12.76	29.64	0	0

Releases from Kouris

Year									10	**Total**	**Water balance of Kouris**
1997	13.824	0	0	4.824	0	2.476	0	3.77E-13	0.6	21.724	0.00
1998	0	0	0	0	0	0	11.532	2.089	0	13.621	0.00
1999	0	0	0	5.328	0	0	17.991	2.3	0	25.619	0.00
2000	9.597	6.048	0	5.544	0	0	0	2.3	14.38	37.869	0.00
2001	14.124	6.192	0	5.616	0	0	0	2.3	21.017	49.249	0.00
2002	0	0	0	0	0	0	26.848	2.3	4.007	33.155	0.00
2003	0	0	7.808	5.832	14.124	0	0	2.3	19.18	49.244	0.00
2004	0	0	0	5.976	0	0	22.904	2.3	0	31.18	0.00
2005	0	9.2	0	8.4	0	12.76	5.209	2.3	0	37.869	0.00

Releases from local sources

1997	0	5.616	11.736	0	14.124	10.284	29.64
1998	14.328	5.76	11.88	5.04	14.124	12.76	18.108
1999	20.6	5.904	16.963	0	14.124	12.76	11.649
2000	11.703	0	13.773	0	14.124	12.76	29.64
2001	7.676	0	17.8	0	14.124	12.76	29.64
2002	22.2	6.264	18.1	5.76	14.124	12.76	2.792
2003	22.6	6.408	10.592	0	0	12.76	29.64
2004	23.1	6.48	18.8	0	14.124	12.76	6.736
2005	23.6	0	19.1	0	14.124	0	25.176

Totals

Limassol	Larnaca	Nicosia	Famagousta
14.124	15.9	11.736	29.64
28.452	18.52	11.88	23.148
34.724	18.664	16.963	11.649
25.827	12.76	13.773	29.64
21.8	12.76	17.8	29.64
36.324	19.024	18.1	8.552
22.6	19.168	10.592	29.64
37.224	19.24	18.8	6.736
37.724	0	19.1	25.176

Surpluses

Limassol	Larnaca	Nicosia	Famagous	Total
14.98	-4.60	9.56	-19.94	0.00
11.25	-7.02	9.22	-13.45	0.00
4.98	-6.96	3.94	-1.95	0.00
13.87	-0.86	6.93	-19.94	0.00
17.90	-0.66	2.70	-19.94	0.00
3.38	-6.82	2.30	1.15	0.00
17.10	-6.77	9.61	-19.94	0.00
2.48	-6.74	1.30	2.96	0.00
1.98	12.70	0.80	-15.48	0.00

Total releases

1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	3.77E-13	0.6
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	2.089	0
1999	20.6	5.904	16.963	5.328	14.124	12.76	29.64	2.3	0
2000	21.3	6.048	13.773	5.544	14.124	12.76	29.64	2.3	14.38
2001	21.8	6.192	17.8	5.616	14.124	12.76	29.64	2.3	21.017
2002	22.2	6.264	18.1	5.76	14.124	12.76	29.64	2.3	4.007
2003	22.6	6.408	18.4	5.832	14.124	12.76	29.64	2.3	19.18
2004	23.1	6.48	18.8	5.976	14.124	12.76	29.64	2.3	0
2005	23.6	9.2	19.1	8.4	14.124	12.76	30.385	2.3	0

Benefits

1997	17.9712	6.1776	14.0832	4.824	8.4744	10.208	26.676	5.66E-13	0	88.4144
1998	18.6264	6.336	14.256	5.04	8.4744	10.208	26.676	3.1335	0	92.7503
1999	26.78	6.4944	20.3556	5.328	8.4744	10.208	26.676	3.45	0	107.7664
2000	27.69	6.6528	16.5276	5.544	8.4744	10.208	26.676	3.45	0	105.2228
2001	28.34	6.8112	21.36	5.616	8.4744	10.208	26.676	3.45	0	110.9356
2002	28.86	6.8904	21.72	5.76	8.4744	10.208	26.676	3.45	0	112.0388
2003	29.38	7.0488	22.08	5.832	8.4744	10.208	26.676	3.45	0	113.1492
2004	30.03	7.128	22.56	5.976	8.4744	10.208	26.676	3.45	0	114.5024
2005	30.68	10.12	22.92	8.4	8.4744	10.208	27.3465	3.45	0	121.5989

Objective function **966.3788**

LINEAR PROGRAMM TO FIND THE OPTIMAL ALLOCATION OF THE WATER OF THE SCP SYSTEM

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Other water requirements: Recharge	Storage to next year	Inflows: Kouris	Local resources: Limassol	Larnaca	Nicosia	Famagous	Total
Unit benefit	1.3	1.1	1.2	1	0.6	0.8	0.9	1.5	0						
Demands															
1997	19.2	7.8	16.3	6.7	32.1	29	49.4	2.3	100	11.724	29.1	11.3	21.3	9.7	83.124
1998	19.9	8	16.5	7	32.1	29	49.4	2.3	100	13.021	39.7	11.5	21.1	9.7	95.021
1999	20.6	8.2	17	7.4	32.1	29	49.4	2.3	100	25.619	39.7	11.7	20.9	9.7	107.619
2000	21.3	8.4	17.4	7.7	32.1	29	49.4	2.3	100	37.869	39.7	11.9	20.7	9.7	119.869
2001	21.8	8.6	17.8	7.8	32.1	29	49.4	2.3	100	**31.661**	39.7	12.1	20.5	9.7	113.561
2002	22.2	8.7	18.1	8	32.1	29	49.4	2.3	100	**12**	39.7	12.2	20.4	9.7	94
2003	22.6	8.9	18.4	8.1	32.1	29	49.4	2.3	100	**40.419**	39.7	12.4	20.2	9.7	122.419
2004	23.1	9	18.8	8.3	32.1	29	49.4	2.3	100	**13.021**	39.7	12.5	20.1	9.7	95.021
2005	23.6	9.2	19.1	8.4	32.1	29	49.4	2.3	100	**40.419**	39.7	12.7	19.9	9.7	122.419

Fractions of minimum required quantities to demands

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Recharge	Storage to next year
1997	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
1998	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
1999	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2000	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2001	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2002	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2003	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2004	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0
2005	0.72	0.72	0.72	0.72	0.44	0.44	0.6	0	0

Minimum required quantities

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Recharge	Storage to next year
1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0	0
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	0	0
1999	14.832	5.904	12.24	5.328	14.124	12.76	29.64	0	0
2000	15.336	6.048	12.528	5.544	14.124	12.76	29.64	0	0
2001	15.696	6.192	12.816	5.616	14.124	12.76	29.64	0	0
2002	15.984	6.264	13.032	5.76	14.124	12.76	29.64	0	0
2003	16.272	6.408	13.248	5.832	14.124	12.76	29.64	0	0
2004	16.632	6.48	13.536	5.976	14.124	12.76	29.64	0	0
2005	16.992	6.624	13.752	6.048	14.124	12.76	29.64	0	0

Releases from Kouris

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.	Recharge	Storage to next year	Total	Water balance of Kouris
									10		
1997	13.824	0	0	4.824	0	0	2.476	0	0.6	21.724	0.00
1998	0	0	0	0	0	0	11.532	2.089	0	13.621	0.00
1999	13.268	0	0	5.328	0	0	0	2.3	4.723	25.619	0.00
2000	0	3.133	0	5.544	14.124	0	0	2.3	17.491	42.592	0.00
2001	21.8	0	0	0	0	0	0	2.3	24.952	49.052	0.00
2002	0	0	0	0	0	0	26.848	2.3	7.804	36.952	0.00
2003	22.6	0	0	0	0	5.164	0	2.3	18.159	48.223	0.00
2004	0	0	0	0	0	0	28.88	2.3	0	31.18	0.00
2005	0	9.2	0	0	14.124	0	14.795	2.3	0	40.419	0.00

Releases from local sources

Year	Lim. Dom	Larn. Dom	Nic. Dom	Fam. Dom	Lim. Irr	Larn. Irr	Fam. Irr.
1997	0	5.616	11.736	0	14.124	12.76	27.164
1998	14.328	5.76	11.88	5.04	14.124	12.76	18.108

Year	Totals: Limassol	Larnaca	Nicosia	Famagousta	Surpluses: Limassol	Larnaca	Nicosia	Famagous	Total
1997	14.124	18.376	11.736	27.164	14.98	-7.08	9.56	-17.46	0.00
1998	28.452	18.52	11.88	23.148	11.25	-7.02	9.22	-13.45	0.00

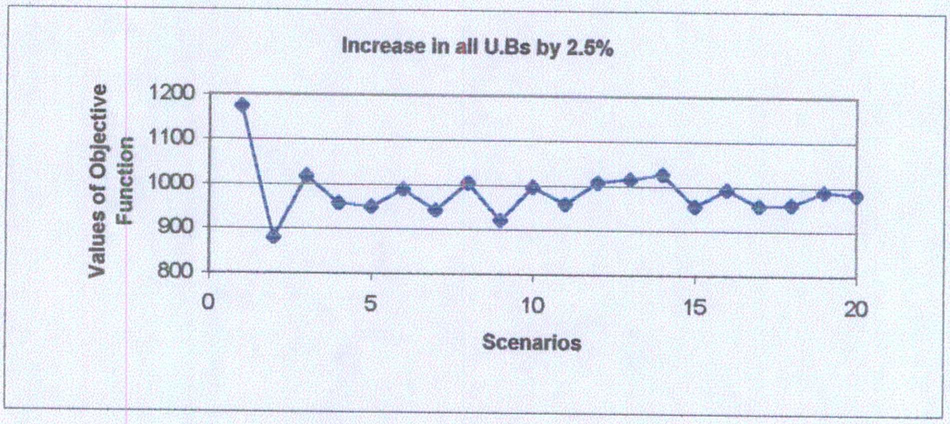
1999	7.332	5.904	12.24	0	14.124	12.76	29.64	21.456	18.664	12.24	29.64	18.24	-6.96	8.66	-19.94	0.00
2000	21.3	2.915	15.385	0	0	12.76	29.64	21.3	15.675	15.385	29.64	18.40	-3.78	5.32	-19.94	0.00
2001	0	6.192	13.668	5.616	14.124	12.76	29.64	14.124	18.952	13.668	35.256	25.58	-6.85	6.83	-25.56	0.00
2002	22.2	6.264	18.1	5.76	14.124	12.76	2.792	36.324	19.024	18.1	8.552	3.38	-6.82	2.30	1.15	0.00
2003	0	6.408	18.4	5.832	14.124	7.596	29.64	14.124	14.004	18.4	35.472	25.58	-1.60	1.80	-25.77	0.00
2004	23.1	6.48	18.8	5.976	14.124	12.76	0.76	37.224	19.24	18.8	6.736	2.48	-6.74	1.30	2.96	0.00
2005	23.6	0	19.1	8.4	0	12.76	18.14	23.6	12.76	19.1	26.54	16.10	-0.06	0.80	-16.84	0.00

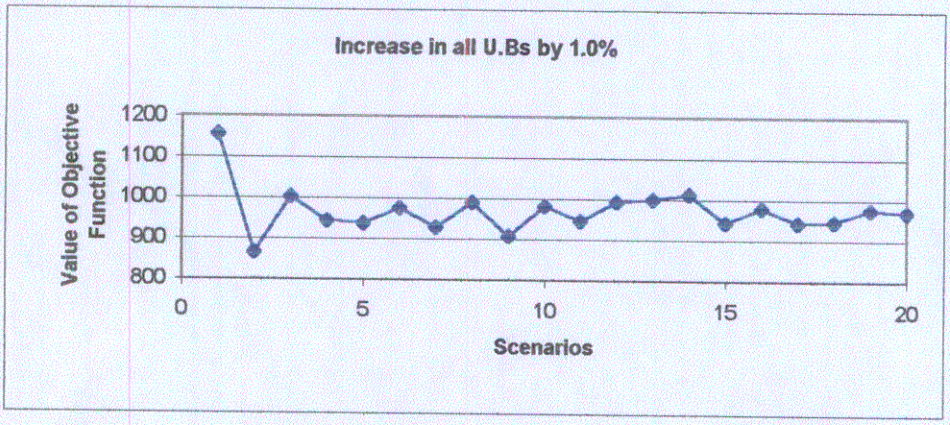
Total releases									
1997	13.824	5.616	11.736	4.824	14.124	12.76	29.64	0	0.6
1998	14.328	5.76	11.88	5.04	14.124	12.76	29.64	2.089	0
1999	20.6	5.904	12.24	5.328	14.124	12.76	29.64	2.3	4.723
2000	21.3	6.048	15.385	5.544	14.124	12.76	29.64	2.3	17.491
2001	21.8	6.192	13.668	5.616	14.124	12.76	29.64	2.3	24.952
2002	22.2	6.264	18.1	5.76	14.124	12.76	29.64	2.3	7.804
2003	22.6	6.408	18.4	5.832	14.124	12.76	29.64	2.3	18.159
2004	23.1	6.48	18.8	5.976	14.124	12.76	29.64	2.3	0
2005	23.6	9.2	19.1	8.4	14.124	12.76	32.935	2.3	0

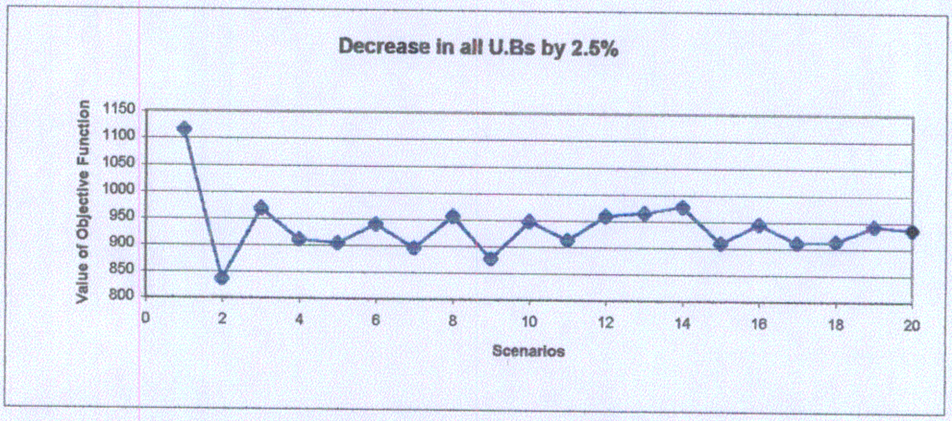
Benefits										
1997	17.9712	6.1776	14.0832	4.824	8.4744	10.208	26.676	0	0	88.4144
1998	18.6264	6.336	14.256	5.04	8.4744	10.208	26.676	3.1335	0	92.7503
1999	26.78	6.4944	14.688	5.328	8.4744	10.208	26.676	3.45	0	102.0988
2000	27.69	6.6528	18.462	5.544	8.4744	10.208	26.676	3.45	0	107.1572
2001	28.34	6.8112	16.4016	5.616	8.4744	10.208	26.676	3.45	0	105.9772
2002	28.86	6.8904	21.72	5.76	8.4744	10.208	26.676	3.45	0	112.0388
2003	29.38	7.0488	22.08	5.832	8.4744	10.208	26.676	3.45	0	113.1492
2004	30.03	7.128	22.56	5.976	8.4744	10.208	26.676	3.45	0	114.5024
2005	30.68	10.12	22.92	8.4	8.4744	10.208	29.6415	3.45	0	123.8939

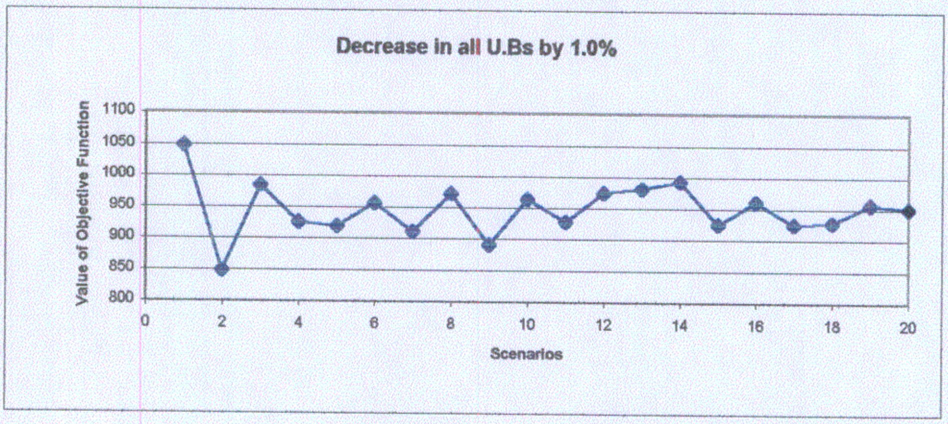
Objective function **969.9822**

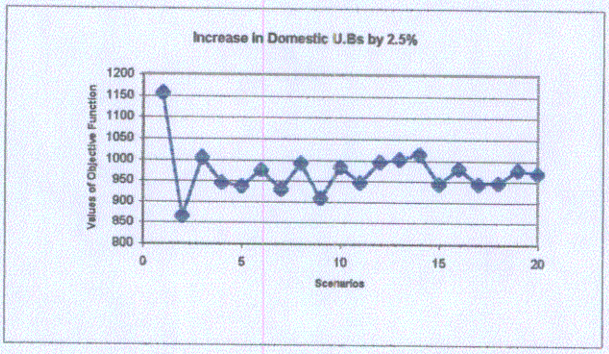
APPENDIX III:


Increase in all U.Bs by 2.5%
Values of Objective Function
1200
1100
1000
900
800
0
5
10
15
20
Scenarios


Increase in all U.Bs by 1.0%
Value of Objective Function
1200
1100
1000
900
800
0
5
10
15
20
Scenarios


Decrease in all U.Bs by 2.5%
Value of Objective Function
1150
1100
1050
1000
950
900
850
800
0
2
4
6
8
10
12
14
16
18
20
Scenarios


Decrease in all U.Bs by 1.0%
Value of Objective Function
1100
1050
1000
950
900
850
800
0
2
4
6
8
10
12
14
16
18
20
Scenarios


Increase in Domestic U.Bs by 2.5%
Values of Objective Function
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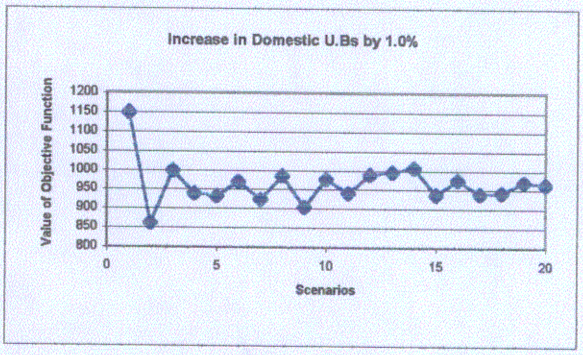
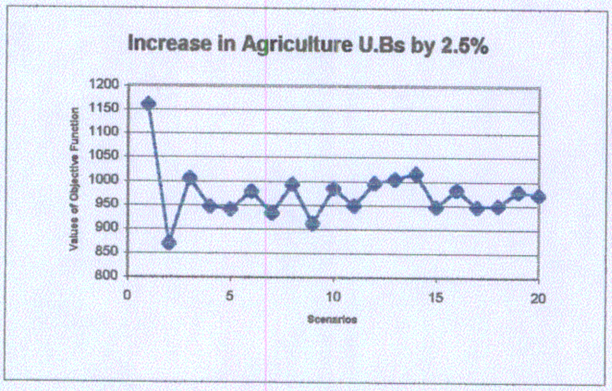
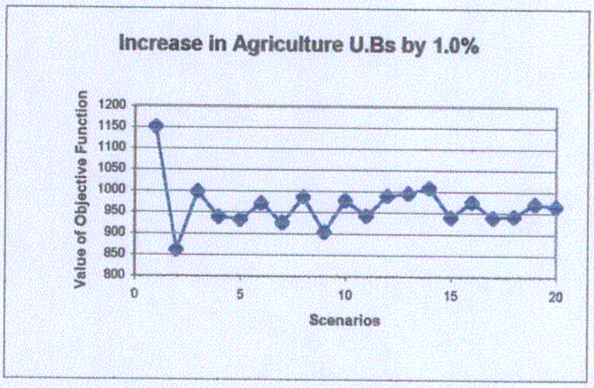
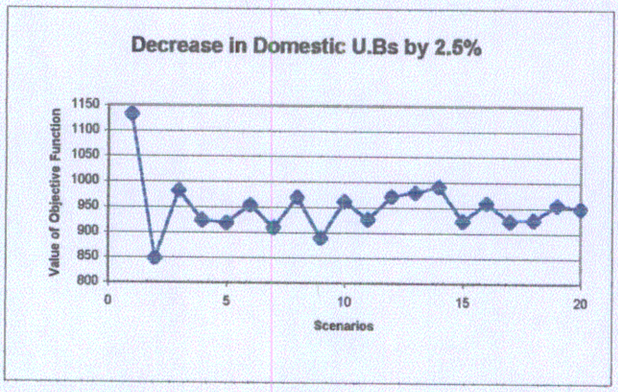
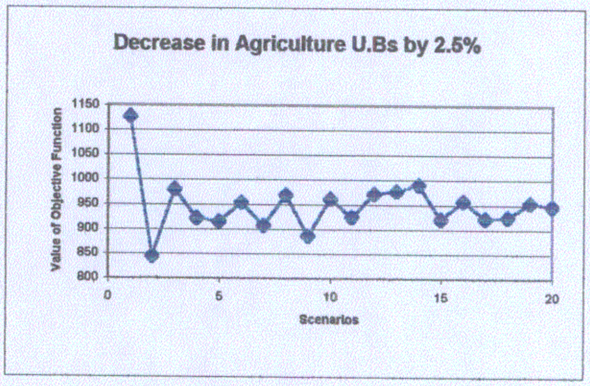
1100
1050
1000
950
900
850
800
0
5
10
15
20
Scenarios

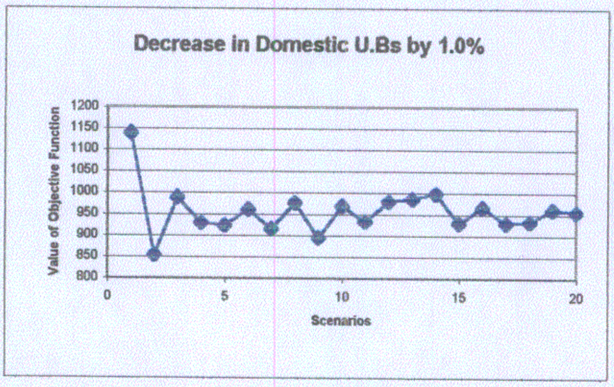

Increase in Domestic U.Bs by 1.0%
Value of Objective Function
1200
1150
1100
1050
1000
950
900
850
800
0
5
10
15
20
Scenarios

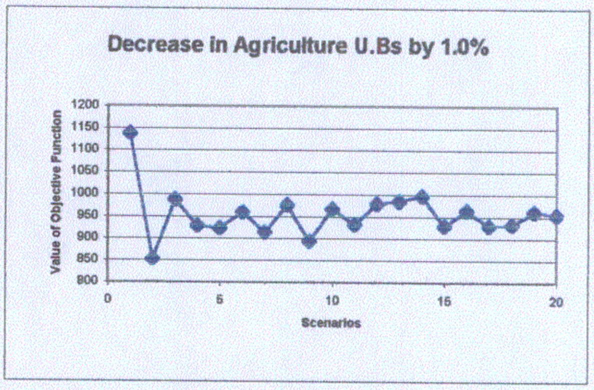

Increase in Agriculture U.Bs by 2.5%
Value of Objective Function
1200
1150
1100
1050
1000
950
900
850
800
0
5
10
15
20
Scenarios


Increase in Agriculture U.Bs by 1.0%
Value of Objective Function
1200
1150
1100
1050
1000
950
900
850
800
0
5
10
15
20
Scenarios


Decrease in Domestic U.Bs by 2.5%
Value of Objective Function
1150
1100
1050
1000
950
900
850
800
0
5
10
15
20
Scenarios

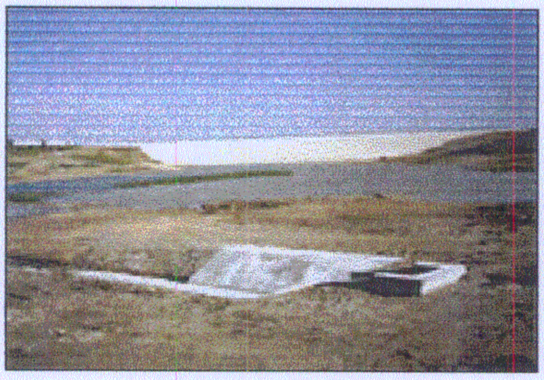

Decrease in Agriculture U.Bs by 2.5%
Value of Objective Function
1150
1100
1050
1000
950
900
850
800
0
5
10
15
20
Scenarios


Decrease in Domestic U.Bs by 1.0%
Value of Objective Function
1200
1150
1100
1050
1000
950
900
850
800
0
5
10
15
20
Scenarios


Decrease in Agriculture U.Bs by 1.0%
Value of Objective Function
1200
1150
1100
1050
1000
950
900
850
800
0
5
10
15
20
Scenarios

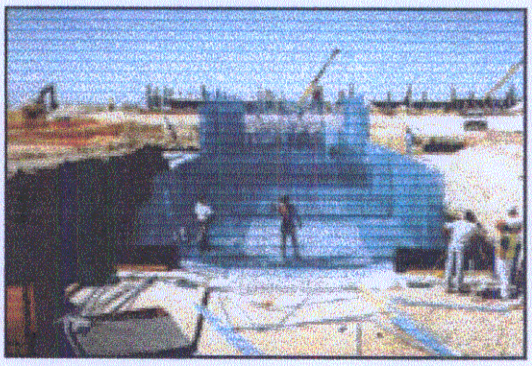
APPENDIX V:

Photographs:

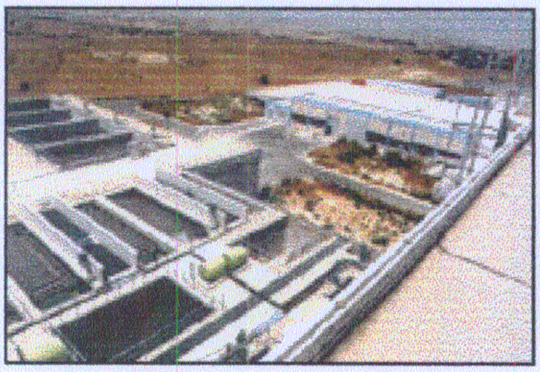


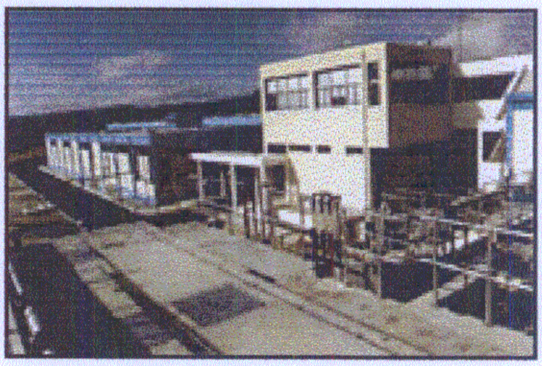
Akhna Dam

Pipes



Desalination Plant: Construction of the tank





Water Treatment Works in Limassol