

MANAGEMENT OF WATER IN CYPRUS*

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1. INTRODUCTION

The importance of water is definitely worldwide. In history many wars were fought and many conflicts were created because of the desire for sovereignty of water. On one particular occasion the king of Persia demanded from the Athenians “Την και Ύδωρ” i.e., “Land and Water”. The loss of these two resources, but especially of water, meant total capitulation. Today it is often said by many that water may well be the cause of a new war.

In Cyprus, water is the most important resource and a prerequisite for progress. Its scarcity has acted as a limiting constraint for the development of agriculture and for other economic activities such as tourism.

In this presentation an assessment of the water availability will be presented together with the phases through which water policy has passed over the years. The new water policy will be then presented.

2. WATER RESOURCES ASSESSMENT AND WATER POLICY REVIEW

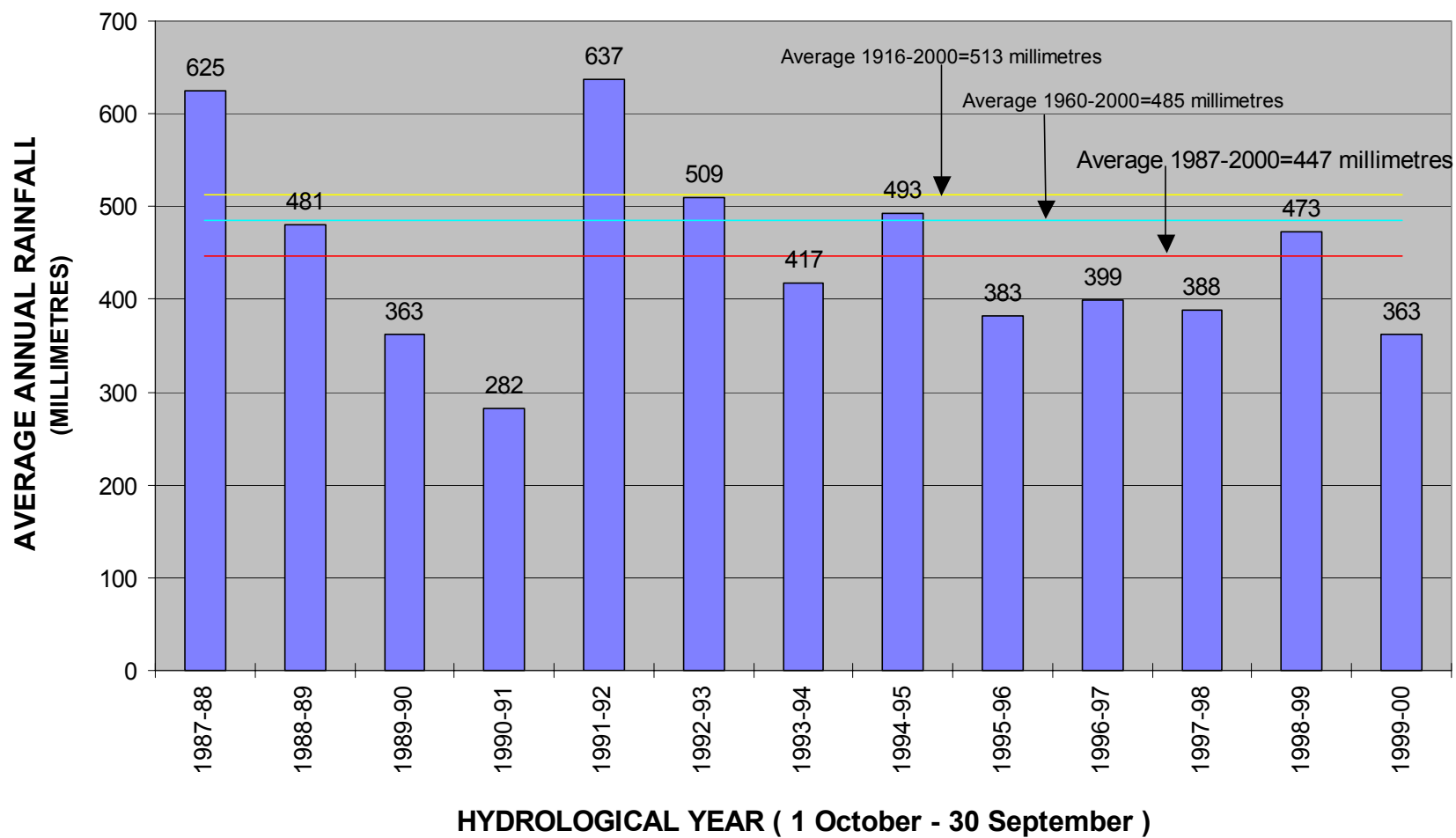
2.1 Water Supply

The maximum quantity of water, for calculating its availability for planning purposes, is the mean annual long term precipitation that is 513 mm (1916-2000, see Fig. 1) times the area that is 9250 Km². It corresponds for the whole island to approximately 4600 million cubic meters (MCM) of water per year. More than 80 percent of this returns to the atmosphere through evapotranspiration. Only the remaining 20 percent i.e., about 900 MCM can be considered as the actual water available for use. From this, 600 MCM is surface water and the rest i.e., 300 MCM, flows into the aquifers. The above are estimates of 1970 and refer to the whole island. They are based on rainfall-runoff and groundwater hydrology relationships of past years, see Fig. 2. Since then rainfall has decreased considerably, more than 13 percent, see Fig. 1. Consequently there is a marked decline of the surface and groundwater sources. It is estimated, that the reduction may be as high as 30 to 40 percent. A reassessment of both the surface and subsurface hydrology is urgently needed, for meaningful planning and management of the water resources of the island.

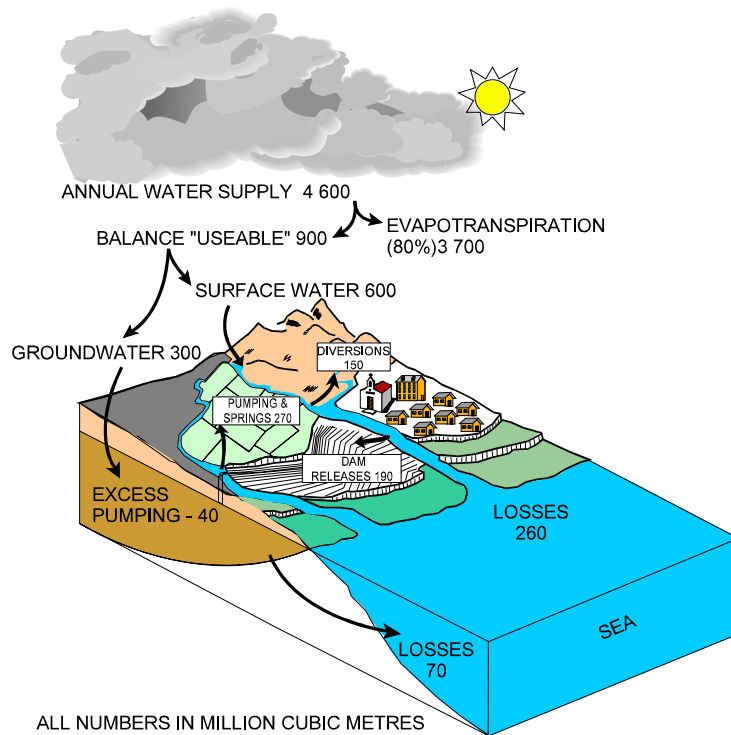
The drastic reduction of the water supply couple with the concurrent increase of the demand for water have brought about the full utilization and even overuse of the available traditional water sources, i.e. groundwater and surface water. Groundwater is reliable, clean and cheap when compared to other sources. The result is that all aquifers in Cyprus are today exploited beyond their safe yield which is estimated at

* Speech presented at the 1st Congress Balears 2015, “Water, perspectives for the future”

AVERAGE ANNUAL RAINFALL OF CYPRUS (AREA UNDER GOVERNMENT CONTROL) 1987 - 2000

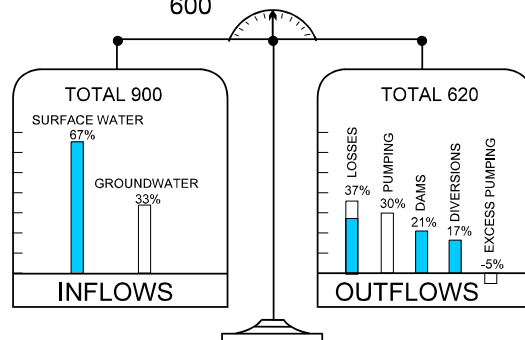


WATER BALANCE FOR CYPRUS



AREA OF CYPRUS = 9 251 km²
 AVERAGE ANNUAL RAINFALL = 500 mm
 TOTAL ANNUAL WATER SUPPLY = 4 600 Mm³
 85% EVAPOTRANSPIRATION = 3 700 Mm³

BALANCE "USEABLE" = 900 Mm ³	
SURFACE WATER 600	GROUNDWATER 300
River diversions = 150	Pumping } = 270
Diverted to dams = 190	Springs } = 270
(and used)	Losses to sea = 70
Losses to sea = 260	Excess pumping = - 40
600	300



230 MCM per year. The excess pumping over natural recharge is in the order of 40 MCM per year, see Fig. 2. The result is sea intrusion into most of the coastal aquifers. The Government of Cyprus embarked in 1960, the first year of its independence, into an ambitious program of tapping the surface waters that used to be lost into the sea. This program was in essence a comprehensive water resources program that was produced in 1967 to 1970 with the technical help of the United Nations Development Programme. Thanks to this program the storage capacity of surface reservoirs has reached 304,5 MCM from a mere 6,1 MCM in 1960. The yield of these reservoirs is about 130-150 MCM/year. This value is now seldomly reached because of the decline in rainfall and hence of runoff.

Now, as the conventional water sources are reaching saturation in their development the Government is planning the use of treated sewage as the additional main source for water supply for agriculture and the use of desalination water for domestic purposes.

The first large sewage treatment plant in the Government controlled areas started operation in Limassol in summer of 1995. Sewage treatment plants are now under design or construction in all the major cities and sensitive mountain villages of Cyprus. All municipal sewage treatment plants have provisions for tertiary treatment. Projections estimate that the volume of reclaimed sewage effluent will increase from 5 MCM of today to 13 MCM by the year 2005 rising to 25 MCM by the year 2020.

Desalination of sea water was first introduced in Cyprus on a large scale basis, on the 1st of April 1997, with the operation of the 20 000 m³/day reverse osmosis Dhekelia plant. Due to the drought prevailing at the time the plant was soon expanded to 40 000 m³/day. The plant operates on a Build, Own, Operate, Transfer (BOOT) basis and the desalinated water is presently sold to the Government, at source, at a varying unit price which is about £0,54/m³. A new sea water desalination plant, of 51 667 m³/day nominal capacity, has been constructed next to the Larnaca airport. It is scheduled to start normal operation by the end of February, 2001. This too, is a reverse osmosis BOOT type plant. The cost of the water from this plant will be only £0,43/m³. However, the present tragic situation demands the construction of another 30 000 to 40 000 m³/day sea water desalination plants. In this way the domestic water demand for water will not any more be dependent on the vagaries of the weather.

Other, tertiary or exotic sources of water supply, such as, importation of water from abroad, artificial rainfall, undersea fresh water tapping, underground deep drilling and evaporation suppression from water surfaces are not economically justifiable and/or risky and unreliable.

2.2 Water Demand

Domestic use and irrigation are the two main sectors of water demand. The total water consumption in the Government controlled areas in 1994, a year having no appreciable water supply restrictions was 235 MCM of which 55 MCM was for the domestic sector. The industrial and touristic demand were 6 and 11 percent respectively of the total domestic consumption. Gross and net consumption of water was 220 l.p.c.d. and 140 l.p.c.d. respectively. This compares well with consumption in most European countries. As the tourist industry seeks new forms of recreation e.g. golf facilities the water demand for recreation will be increasing. It is conservatively estimated that the domestic water demand will rise to 100 MCM in 2020.

Irrigation water use in 1994 in the Government controlled areas totalled to 180 MCM i.e., 77% of the total water demand. More than half of this amount was supplied from Government water works. The demand for irrigation water will increase to 225 MCM by 2015. Demand for irrigation water is expected to remain stable thereafter.

2.3 Water Management

In making the supply meet the demand the Government policy has encouraged and adopted such management measures as water rationing, increase of public awareness for water conservation measures and water pricing for improvements in the water use efficiencies.

Water rationing has been extensively applied in an attempt to curtail the demand in periods of drought. This has allowed the authorities in the last year to reduce the water by 20% of the normal demand for domestic purposes and by 67 percent for irrigation purposes. Water conservation measures include subsidies for use of inferior quality groundwater or the treatment of the gray water from households for the flushing of toilets and irrigation of house gardens in the cities. Furthermore the campaign for raising the “water awareness” of the public towards water conservation proved to be successful. Now, water pricing is an integral part of the Government policy on water. Water for municipal including industrial, commercial and tourist purposes is sold at full cost, while irrigation water is heavily subsidized by as much as 77 percent. The Government’s policy towards agriculture is very generous and this has contributed to the selection of non-efficient cropping patterns and even to the wastage of water. It should be noted that in the last six years the water tariff for the domestic sector does not reflect the full cost as is formed with the recent introduction of the comparatively expensive desalinated water. The subsidy is as high as 34 percent. The present price of the water to agriculture and domestic sector is 6.5 c/m³ and 33,5 c/m³ respectively.

3. NEW WATER POLICY

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

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

These measures should be holistically applied. Each measure compliments the other.

For the detailed and meaningful implementation of this policy a study is being conducted by WDD in cooperation with the Food and Agriculture Organisation (FAO) of the United Nations for the thorough reassessment of the island’s water resources. The study will be limited to the Government controlled area because our compatriots, the Turkish Cypriots, have not shown any interest in joining this study.

TABLE 1 - The New Water Policy and its Measures

No.	Main Measures of the New Water Policy	Details of the New Measures	Additional Yield in MCM/Yr	R e m a r k s
1	Additional sources of water supply	a: New surface sources	20	12 large dams of 85 MCM capacity. Some of the rivers to be tapped flow into the Turkish occupied area. Co-operation of the Turkish side is warranted.
		b: Desalination of sea and/or brackish water	50	<u>Domestic water needs:-</u> Four desalination plants (Dhekelia, Larnaca, Limassol, Paralimni) totaling 150 m ³ /day nominal capacity. Constant supply, no more rationing of water. <u>Irrigation needs</u> Only for high cash crops. Proposal is under study.
		c: Recycling of effluent water	10	Primary & secondary treatment are compulsory by law. Tertiary treatment cost is low, about 6,5 c/m ³ but transportation costs are high due to the long distances involved. Most of the recycled water, -60%- will be used for hotel gardens, parks, football and golf fields. Only 40% or 10 MCM for agriculture.
		d: Evaporation suppression from reservoirs	Almost nil	The chemical (fatty alcohol) may be toxic and unsafe to humans. Technique to be confined to those reservoirs allocated solely for irrigation.
		e: Tapping of undersea fresh water sources, Tapping of deep aquifers, Importation of water from abroad (Crete), Artificial rainfall (silver iodide).)) Nil))	Methods not yet proven to be reliable. Worthwhile investigating these methods further. In Israel they claim good results.

No.	Main Measures of the New Water Policy	Details of the New Measures	Additional Yield in MCM/Yr	R e m a r k s
2	“Water Demand” management	a: Water tariffs	4	<p><u>Irrigation water tariff</u> £0,065/m³, is only 23% of the total cost.</p> <p><u>Domestic Water Tariff</u> Rural areas : £0,335/m³ is only 66% of the total cost Urban areas : £0,27/m³ is only 53% of the total cost</p> <p><u>Policy</u> a: Gradual increase in the price to levels approaching the actual cost b: Progressive, seasonal & overconsumption tariffs</p> <p>Possible new policy: Introduction of “Water markets”</p>
		b: Water use efficiency	4	<p><u>Irrigated Agriculture</u> Increase of water use efficiency in hilly areas and in some non-government schemes. Subsidies for new advanced irrigation systems. New advanced agronomic practices, i.e., timing & quantity/irr. applic.</p> <p><u>Domestic Sector</u> “Unaccounted for water” to be reduced from 30%-40% down to 15%, especially in rural areas.</p>
		c: Water conservation measures and public awareness	2	<p>Strengthening the campaign for “water awareness” Subsidies for introduction of new water economizing technologies.</p>

No.	Main Measures of the New Water Policy	Details of the New Measures	Additional Yield in MCM/Yr	Remarks
3	Modification of the Irrigation water allocation matrix	a: Modification of the current cropping patterns		Substitute water intensive crops such as bananas, citrus, kolokasi summer vegetables with less water demanding crops such as flowers, aromatic plants winter crops. Agric. Research Institute to experiment with new profitable crops. Dept of Agric. to help farmers in the modification process.
		b: Limitation of irrigated agric. expansion		No further agricultural expansion, except for the on-going projects. New expansion, if any, after “water balance study” is completed. Subsidies not for water but to farmers or for crops.
4	Built strategic water reserves	Recharge of surface water in selected aquifers i.e., Stavrovouni area.		Water stored to be used in case of emergencies. Evaporation and subsurface leaks are limited. Monitoring pumping from the aquifers is warranted. Examples: Stavrovouni & Limassol forest areas.
5	Maintenance and enhancement of the water quality	“Groundwater Protection” Law of 1996 Code of Agr. Practise of 2000		Curtailment of overpumping of the aquifers Against overuse of pesticides/insecticides/fertilizers Public awareness and participation
6	Water Entity establishment	Expansion of Water Development Department into a “Water Entity”		Water resources planning, development, operation and management under one umbrella i.e., the “Water Entity”. Legislation for the “Water Entity” to be submitted very soon to the Parliament.

4. CONCLUSIONS

Water is by far the most precious resource in Cyprus. The quality of life and almost all economic activities depend upon the presence of an economic water supply. The present water situation is not sustainable in spite of the impressive development of the conventional surface water sources in the last four decades. Much has been done but still a lot remains to be done in the realm of water resources development and management. A new approach is presented that ensures sustainability of the water sector of the island.

The targets of this new plan are summarized below:

- a: the relief of the domestic sector from the vagaries of the weather
- b: the increase of water tariffs for all uses
- c: the use of recycled water for amenity purposes and irrigation
- d: the formation of underground strategic reserves
- e: the reduction of horizontal expansion of irrigation
- f: the changing of the cropping pattern to less water demanding crops
- g: the preservation and further enhancement of the water quality
- h: the formation of a Water Entity