



Second Technical Workshop on "Water Scarce Cities"

Beirut, Lebanon (July 10-11, 2017)

July 10-11, 2017

Cyprus water security experience

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Outline of Presentation



OVERVIEW OF WATER SCARCITY AND USE

WATER RESOURCES MANAGEMENT

WATER SAVING MEASURES

NON-CONVENTIONAL SOLUTIONS



OVERVIEW OF THE WATER SCARCITY PROBLEM AND USE OF WATER IN CYPRUS

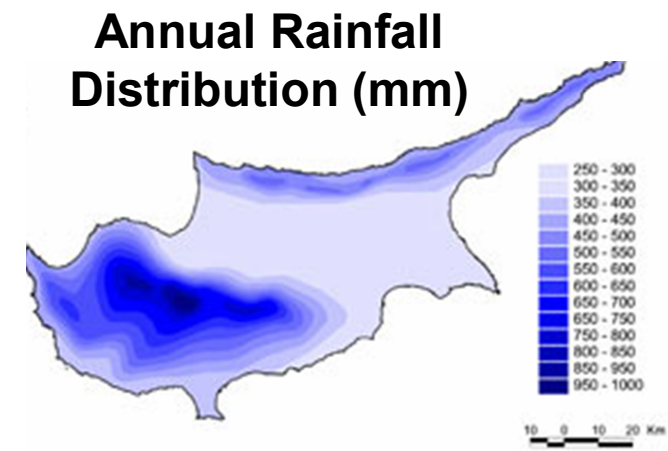




Water Situation in Cyprus

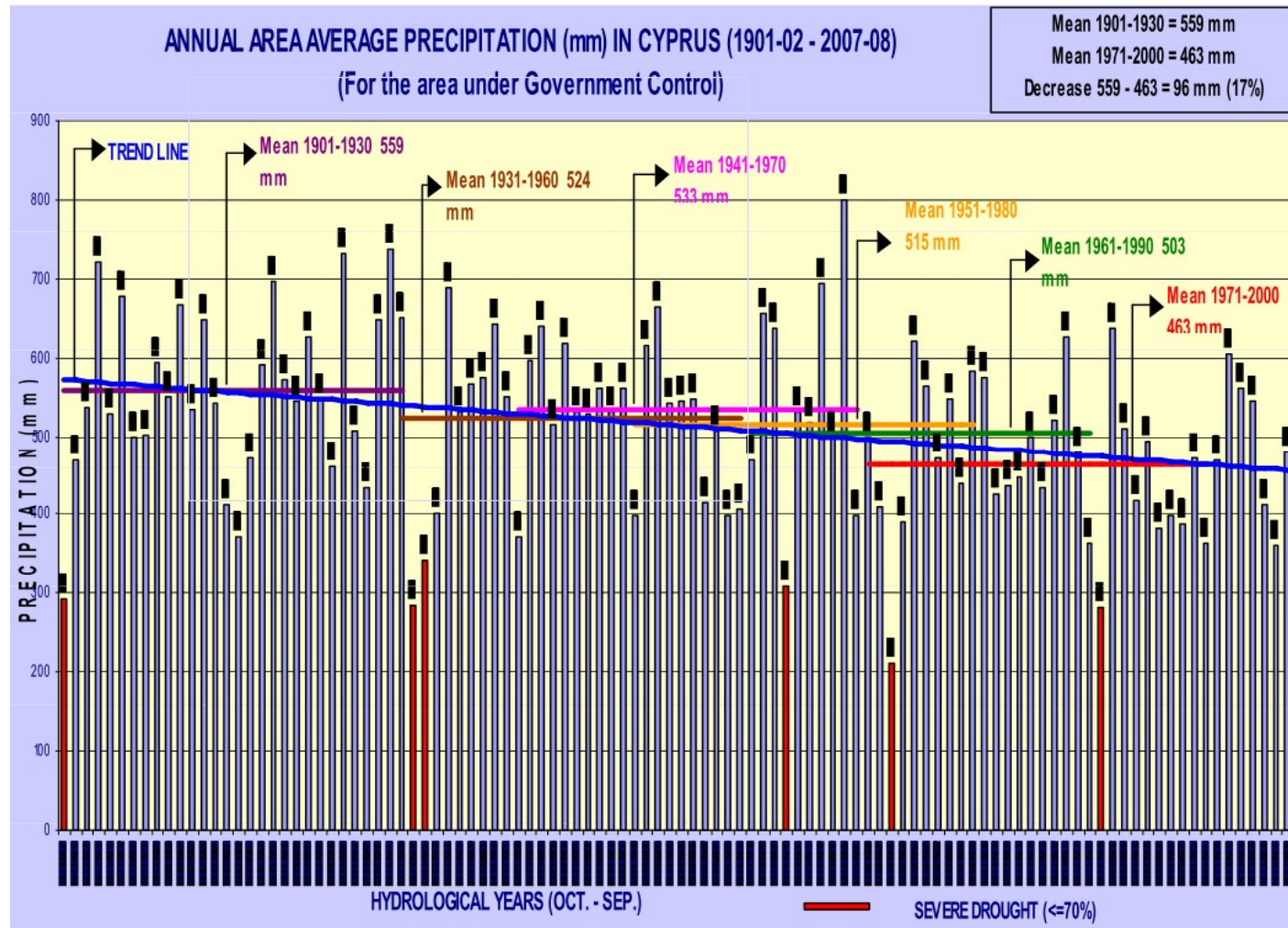


- Water scarcity has always been a very serious problem for Cyprus
 - Cyprus is one of the “water poor” countries of Europe
- Semi-arid climate
- Limited water resources
 - Depend mainly on rainfall
 - Scarce & expensive to exploit
- Unevenly distributed rainfall
- Frequent occurrence of droughts
- Many small catchments, but no perennial flow



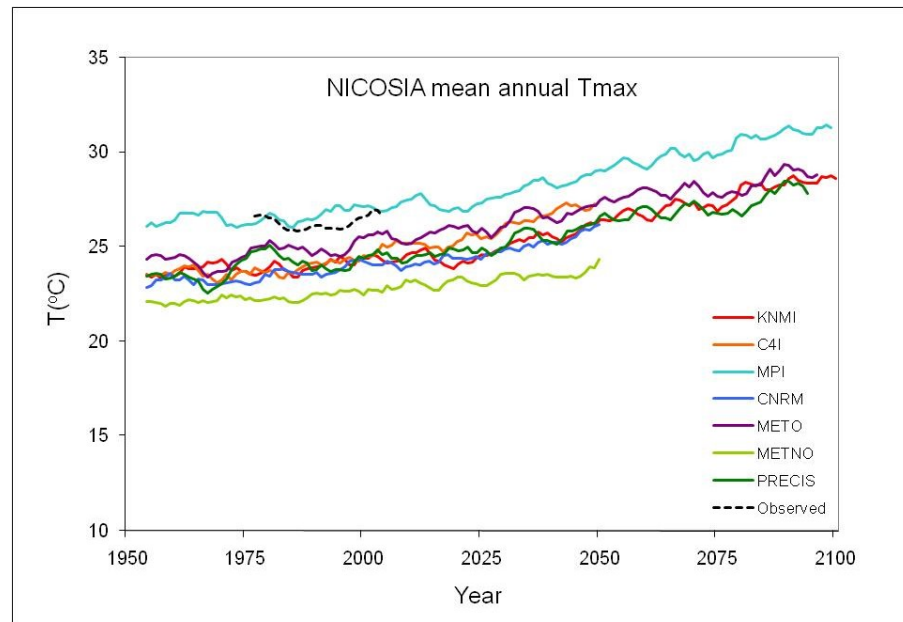
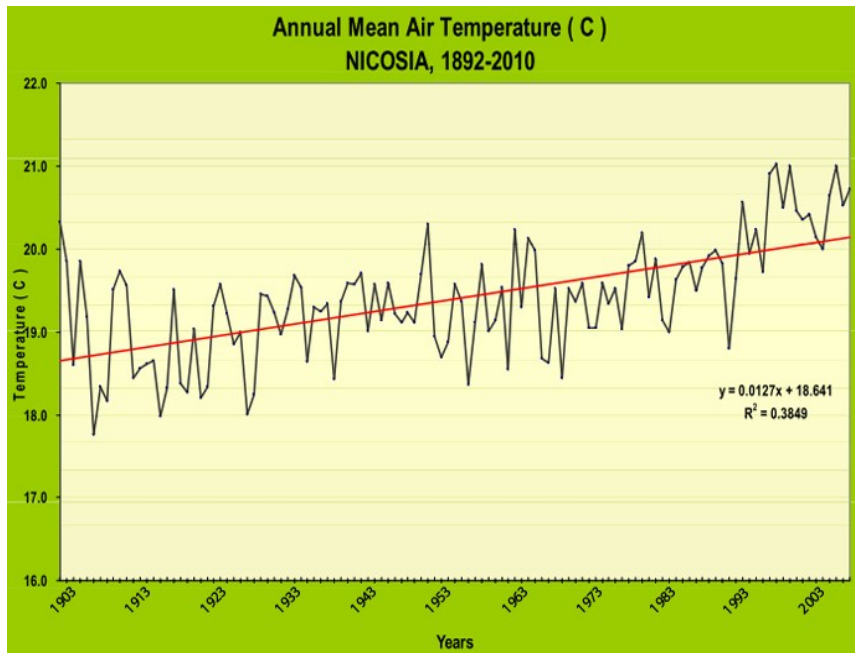


Declining Rainfall





Rising Temperature



- Climate models predict rise in temperature and increase in the intensity and frequency of extreme drought events
- These conditions, coupled with increased water demands are worsening the water scarcity problem in Cyprus

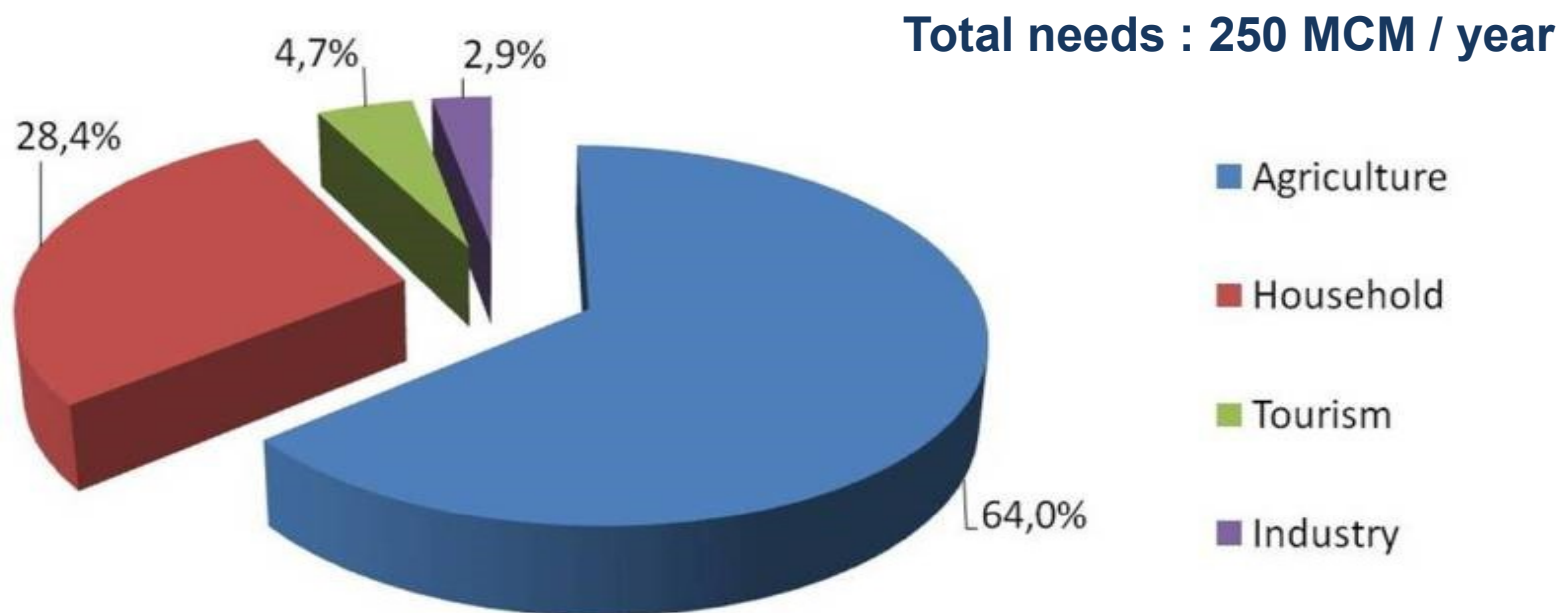


WATER RESOURCES MANAGEMENT





Uses of Water



- Above figures approximate water consumption per use
- Total water demand is higher than availability and needs particularly for irrigation are rarely satisfied
- Average consumption per capita is estimated to: 150 litres/capita/day
- Total population in the area under the control of Cyprus Government: 840.000



Water Resources Management



- Integrated & sustainable approach to water management
- Strategic planning
 - Long term actions to meet future demands under scarcity conditions
 - Short term actions to face a particular drought event within the existing framework

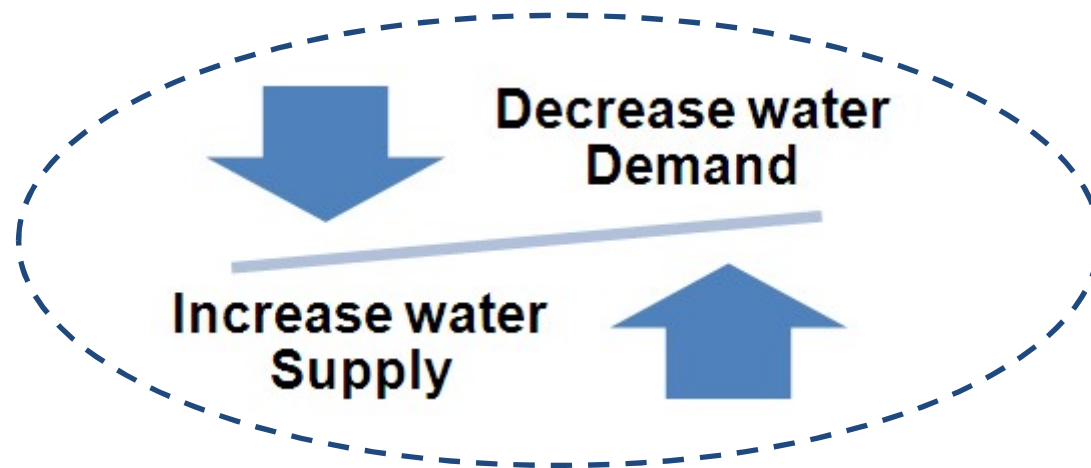




Water Management Master Plan

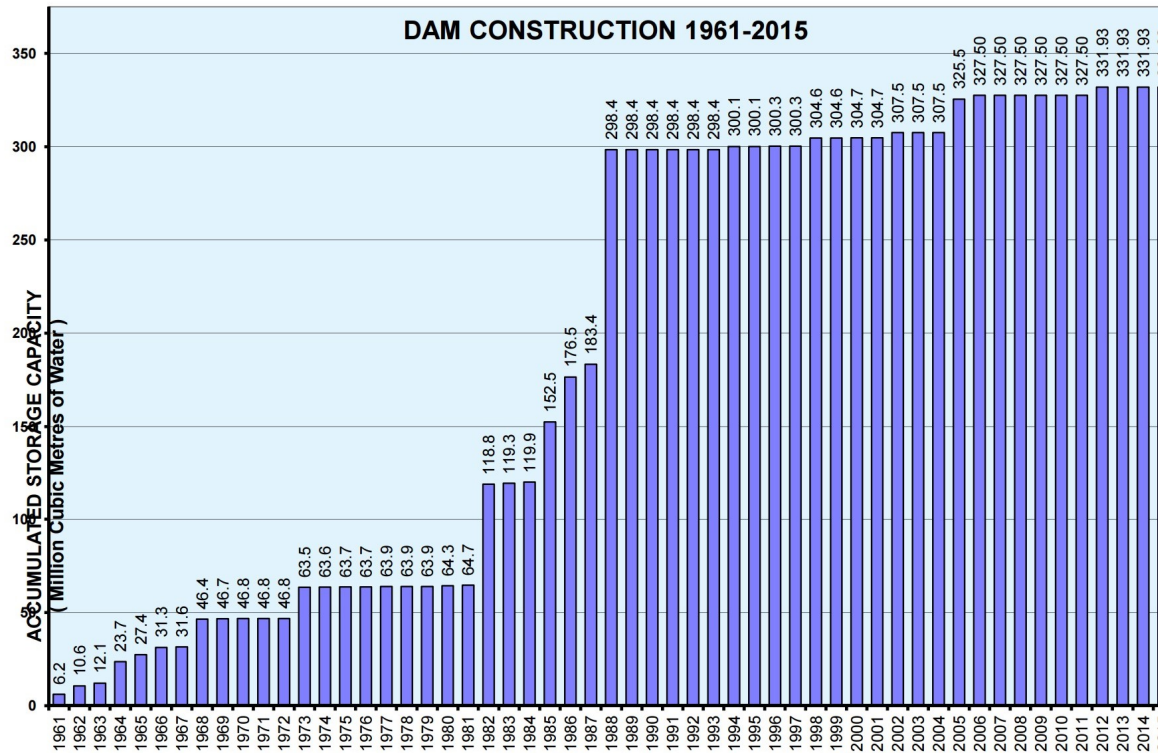


- Implementation embarked in the late 60s
- **Objective**: to satisfy in a sustainable way the different users of water and safeguard human & other life
- **Measures implemented**: to increase water availability and decrease water demand





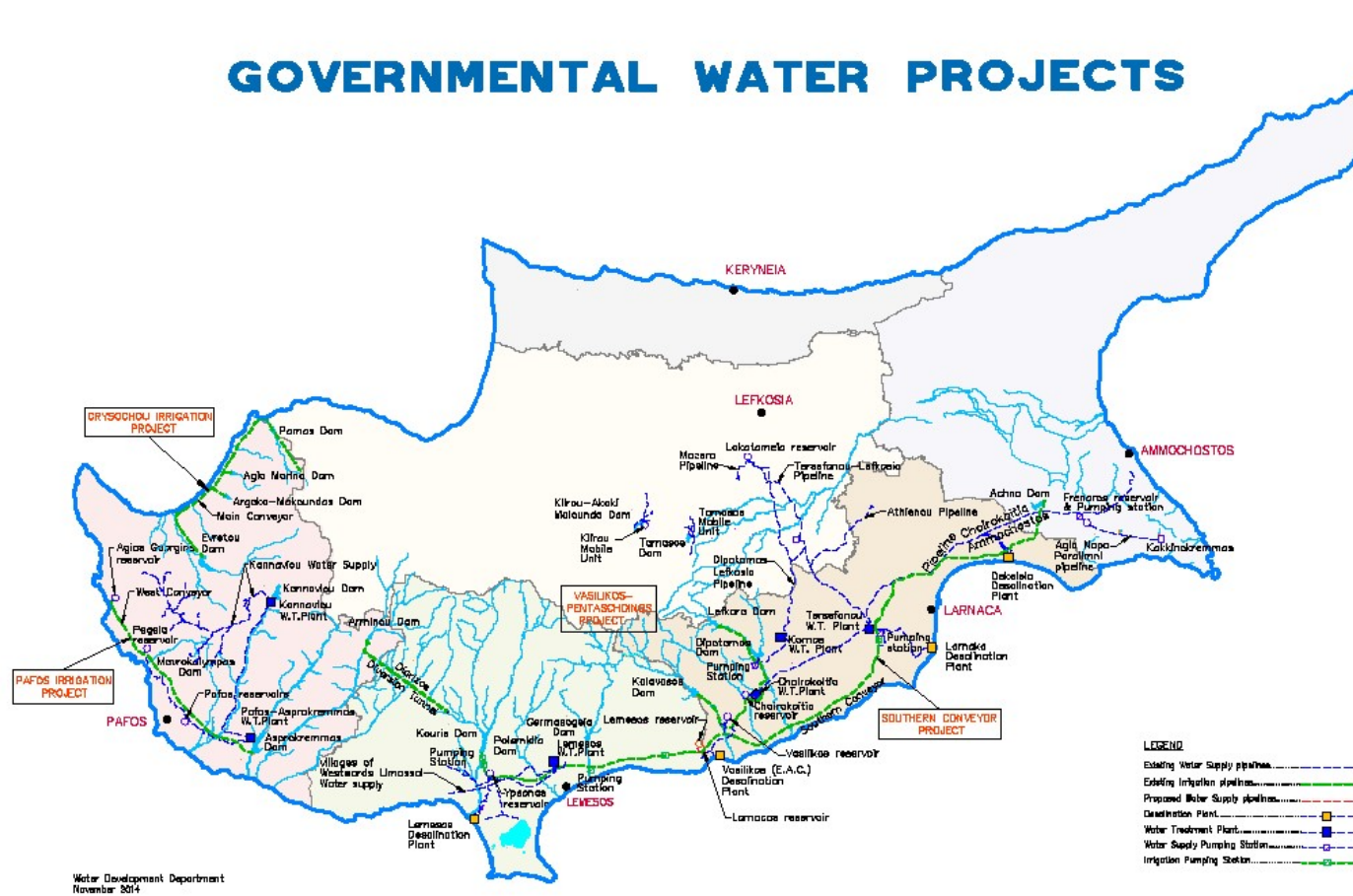
Supply Augmentation



- Increased storage capacity through dam construction
- Drilled boreholes for domestic and irrigation purposes
- Constructed several major water projects



GOVERNMENTAL WATER PROJECTS





KOURIS DAM





ASPROKREMMOS DAM





Water Balance



(mean values in Mm³ for period 2000-2011)

Rainfall:	476 mm
• Inflow into groundwater	201
• Outflow to the sea	62
Groundwater Balance [GW]	139
Inflow into surface storage [SW]	82
TOTAL Available (SW+ GW)	221
SW Releases	60
GW extraction (Pumping)	146
TOTAL Releases/ Extractions	206
DEMAND	250
DEFICIT	- 44 (+33*+8**)

*Desalinated **Reused



WATER SAVING MEASURES





Policy, legal and Institutional aspects



Legislative measures

- Water Saving Law adopted in 1991

Institutional changes

- For years water legislation evolved on an ad hoc basis – Numerous complex laws with fragmented responsibilities
- In 2010 an Integrated Water Management Law (Law N. 79(I)/2010) was established giving the responsibilities of water management to the Water Development Department (WDD)

Water Saving Law 1991

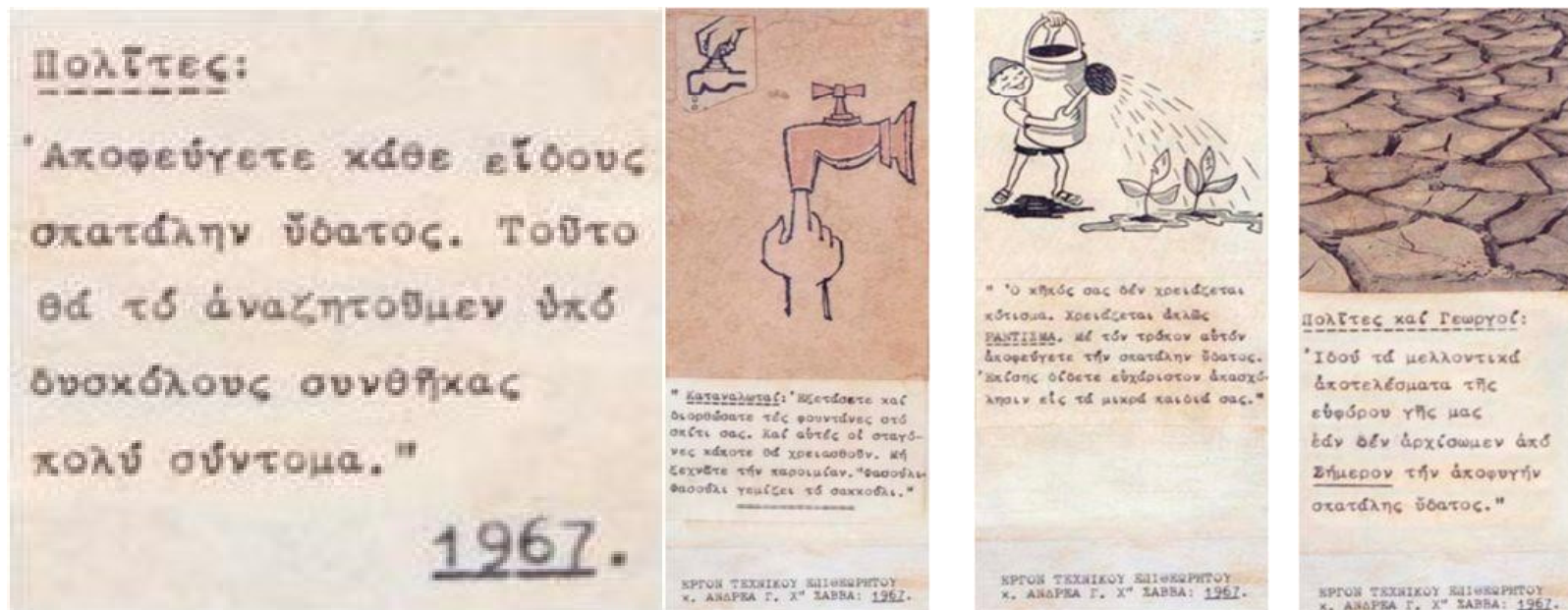
*Any person using a hose for the washing of pavements, or verandas, or roads or vehicles is guilty of criminal offence and could be **imprisoned for up to 3 months** OR be **fined up to €513**, or both (Extrajudicial fine is €51)*



Demand Management: Integral part of water policy



- Water saving is of particular importance for Cyprus
- Water saving measures have been a long time tradition of the water authorities





Education and Awareness Campaigns



- Public awareness campaigns
- Weekly television and radio programs for the farmers
- Establishment of Water Week
- School visits
- School drawing and essay competitions
- Distribution of information on water saving
- Daily updated web-site with information on water issues





Water Pricing and Metering



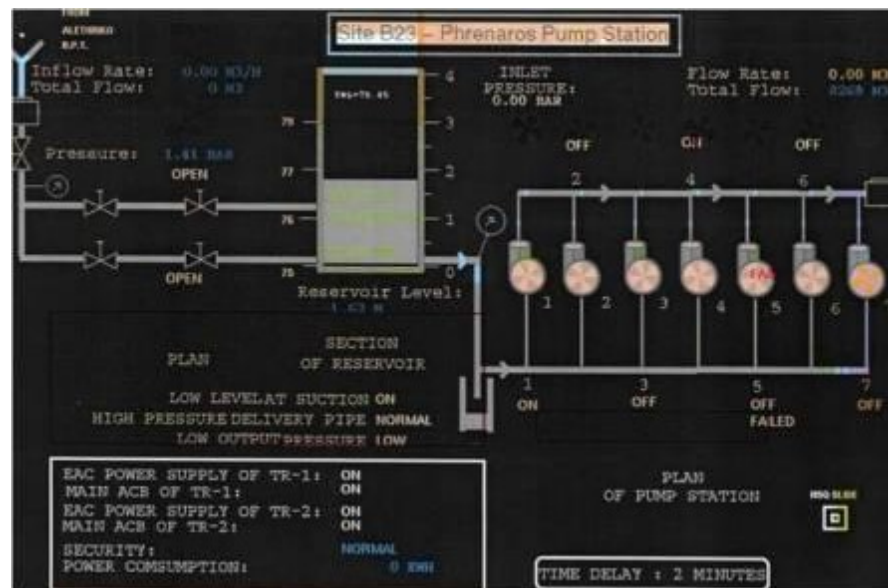
- Metering applied to all water uses
- Water billing is based on actual consumption metered at each individual water supply point
- Charges usually comprise a fixed and maintenance charge and a series of block charges (rising block tariffs)
- For irrigation water, charges are established on a volumetric basis and are uniform for all schemes



Leakage Reduction in Distribution Networks



- A systematic effort is made to reduce water losses
 - Efficient conveyance and distribution systems
 - Leakage detection methods
 - Real time tele-monitoring and tele-control on most important projects to optimise operation & maintenance
- The unaccounted water for the Water Boards is reduced the last two years to 12% - 20%
- In villages and small municipalities it is still high (up to 50%)





Economic incentives

- Drilling of private boreholes for garden irrigation with low grade water
- Connection of private boreholes to toilet tanks
- Installation of grey water recycling systems
- Installation of hot water circulating pumps for immediate hot water supply
- Installation of systems to collect rain water from greenhouses roofs

Subsidisation stopped temporarily in 2013 due to the economic crisis in Cyprus

SUBSIDIES ON LINE FORMS

HOT WATER RECIRCULATOR
€220

CONNECTION OF BOREHOLE WITH TOILET
€700

RECYCLING OF GREY WATER
€3000

BOREHOLES €700



Water saving devices

- Water saving measures are promoted through the National Green Public Procurement Action Plan
- Measures include use of tap and toilet water saving devices in public buildings





Cropping patterns

- Many irrigation projects were under study and implementation during 1970 – 1994
- At planning stage, a cropping pattern was selected and proposed to land owners to ensure efficient utilisation of water at farm level
 - Selection criteria: water supply reliability, project economics, land resources, climatic conditions
- Nevertheless certain crops were not profitable & were replaced with higher profit but more water consuming crops





Improvement of Irrigation Efficiency



- Water Use Improvement Project initiated in 1965 to provide farmers with technical & financial assistance
 - Installation of improved on farm irrigation systems
 - Application of proper irrigation schedules
- Improved irrigation systems currently cover 95% of total irrigated area (annual water savings are of the order of 75 MCM)
- Irrigation water in government schemes distributed through modern & highly efficient systems (closed pipes, drippers, sprinklers)
- Conveyance efficiencies: 90-95%, field application efficiencies: 80-90%





Quota control

- Water allocated to agriculture using a quota system and penalty charges for over-consumption
 - Allocation to farms depends on crop & area irrigated
 - Over-consumption fee is double of the usual tariff
 - The Water Development Department is entitled to interrupt water supply in cases of over-consumption
- Measure applied every year with the exception of some rare years of satisfactory rainfall-inflow

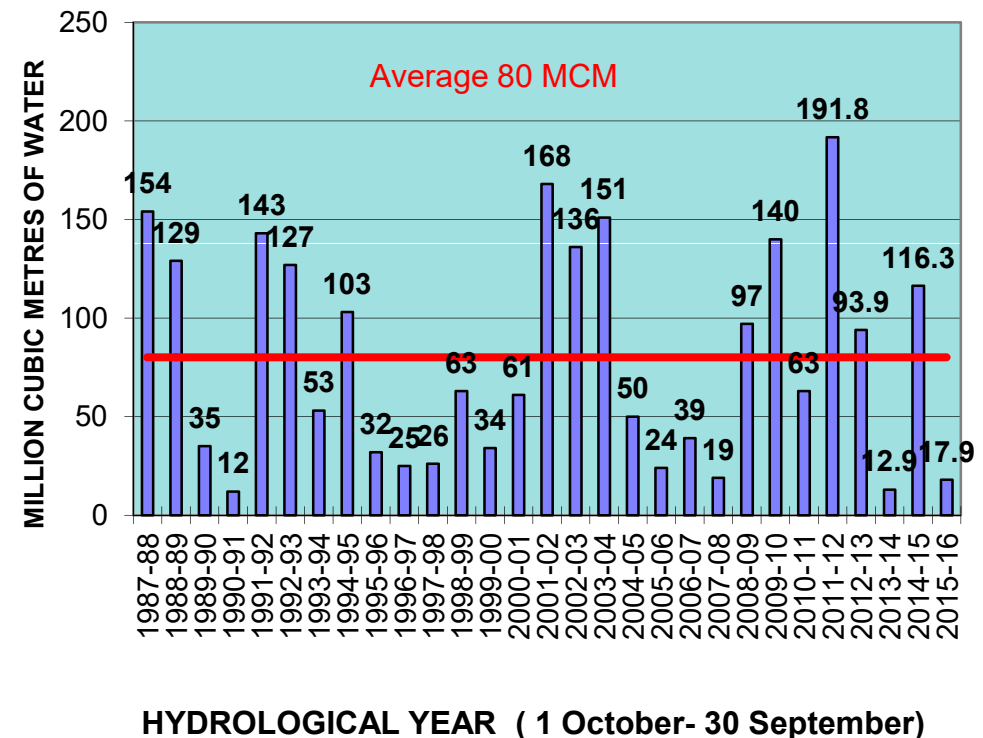


Despite the significant measures, available water was not enough



- Climate change caused a drop of 20% in precipitation resulting to a 40% reduction in surface runoff
- Experienced more frequent occurrence of extreme drought events
- Rapid increase in population and tourist arrivals

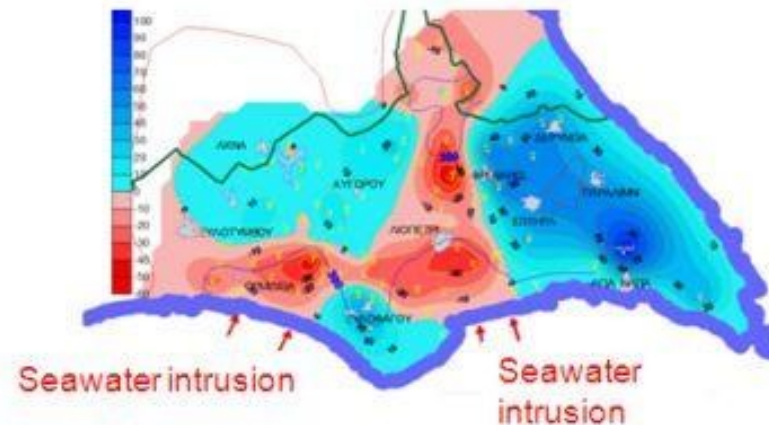
**Inflow of Water to the Dams
(MCM)**





....Groundwater Deteriorated...

- Groundwater resources have been the most obvious & easily accessible sources of water for many years
- In the attempt to meet the increasing water demand or to mitigate drought effects, they have been heavily over-pumped:
 - Led to seawater intrusion into coastal aquifers
 - Deteriorated both quality and quantity





Water rationing



- In 2008, Cyprus was faced with one of the most acute and prolonged droughts in the recent years
- A Drought Mitigation & Response Plan was applied in response
 - Almost 100% ban on water supply to agriculture
 - Strict restrictions on drinking water supply to households (36 hours/week)
- In 2009, situation improved and rainfall reached 105% of normal
 - Government was able to reduce household restrictions from 30% to 15% & provide some quantities of water to agriculture

Rationing measures implemented during periods of droughts with priority given to domestic sector



**Kouris Dam
Apr 2004**



**Kouris Dam
Sept 2008**



Facing water crisis in 2008

**Transportation of water
from Athens to
Limassol with tankers
in August 2008 :
35.000-50.000 m³/day**





NON-CONVENTIONAL SOLUTIONS





Non Conventional Water Supply Sources

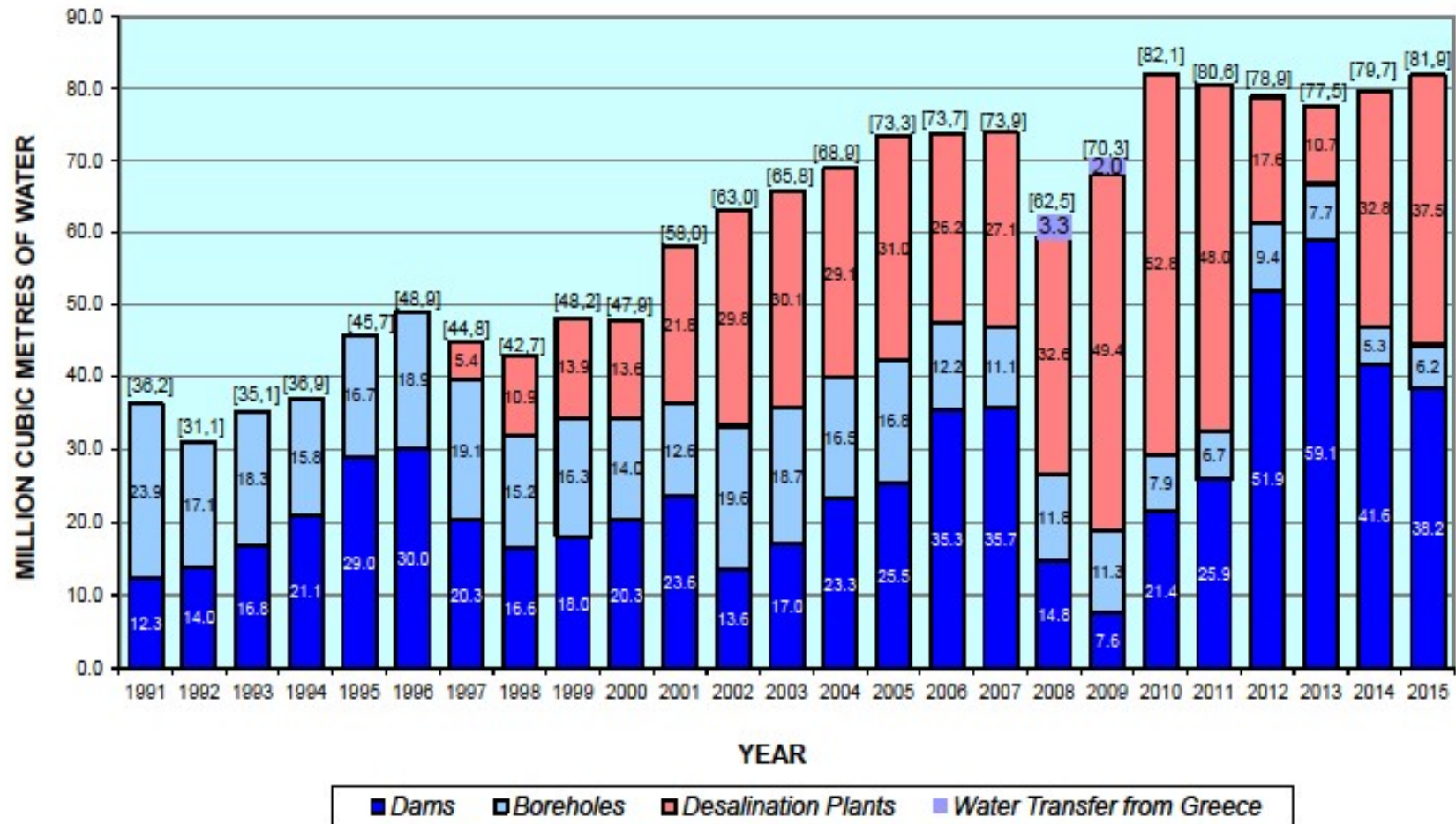
- About twenty years ago the Government in order to eliminate the dependency of the water supply on annual rainfall, decided:
- To proceed with the construction of sea water desalination plants to use for domestic water supply
- To replace part of the fresh water used in agriculture by treated effluent.



In 1997 Desalination was Introduced



GOVERNMENT WATER WORKS - DOMESTIC SUPPLY SOURCES (1991 - 2015)





Desalination Pros and Cons



Pros	Cons
<ul style="list-style-type: none">■ Coverage of drinking water needs of large urban and touristic areas<ul style="list-style-type: none">– Dependence on rainfall eliminated■ Availability of additional quantities of surface water for other uses<ul style="list-style-type: none">– Irrigation– Environmental Flows– Recharge of heavily over-pumped aquifers■ Economic and social benefits■ Safety and reliability of drinking water supply	<ul style="list-style-type: none">■ Energy-consuming process<ul style="list-style-type: none">– Emission of Greenhouse gasses■ Slight impact on the Marine Environment<ul style="list-style-type: none">– Increased salinity at the point of brine rejection■ High production cost



Water Reuse

ΤΜΗΜΑ ΑΝΑΠΤΥΞΕΩΣ ΥΔΑΤΩΝ
ΥΠΟΥΡΓΕΙΟ ΓΕΩΡΓΙΑΣ, ΦΥΣΙΚΩΝ ΠΟΡΩΝ ΚΑΙ ΠΕΡΙΒΑΛΛΟΝΤΟΣ

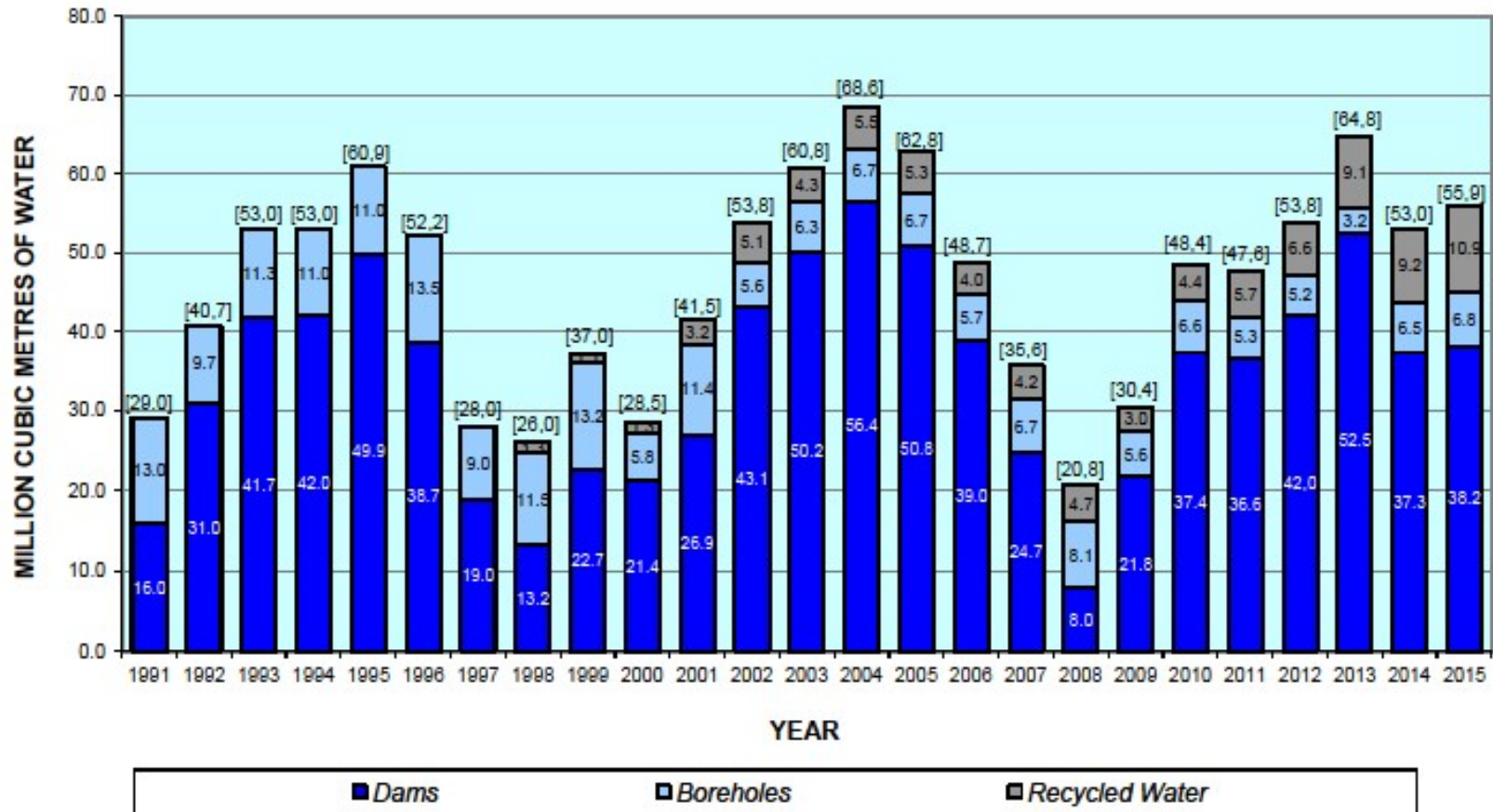




Reuse of Treated Effluent

- In Cyprus the treated effluent from the Urban Waste Water Treatment Plants is used for irrigation and recharge of aquifers
- Aquifers are used as storage reservoirs mainly in winter. The water from the aquifers is extracted and used for irrigation.
- Irrigation is done under the Code of Good Agricultural Practice
- During some winter months some quantities are discharged into the sea, as a temporary solution which will end after the implementation of the reuse projects

GOVERNMENT WATER WORKS - IRRIGATION SUPPLY SOURCES (1991 - 2015)



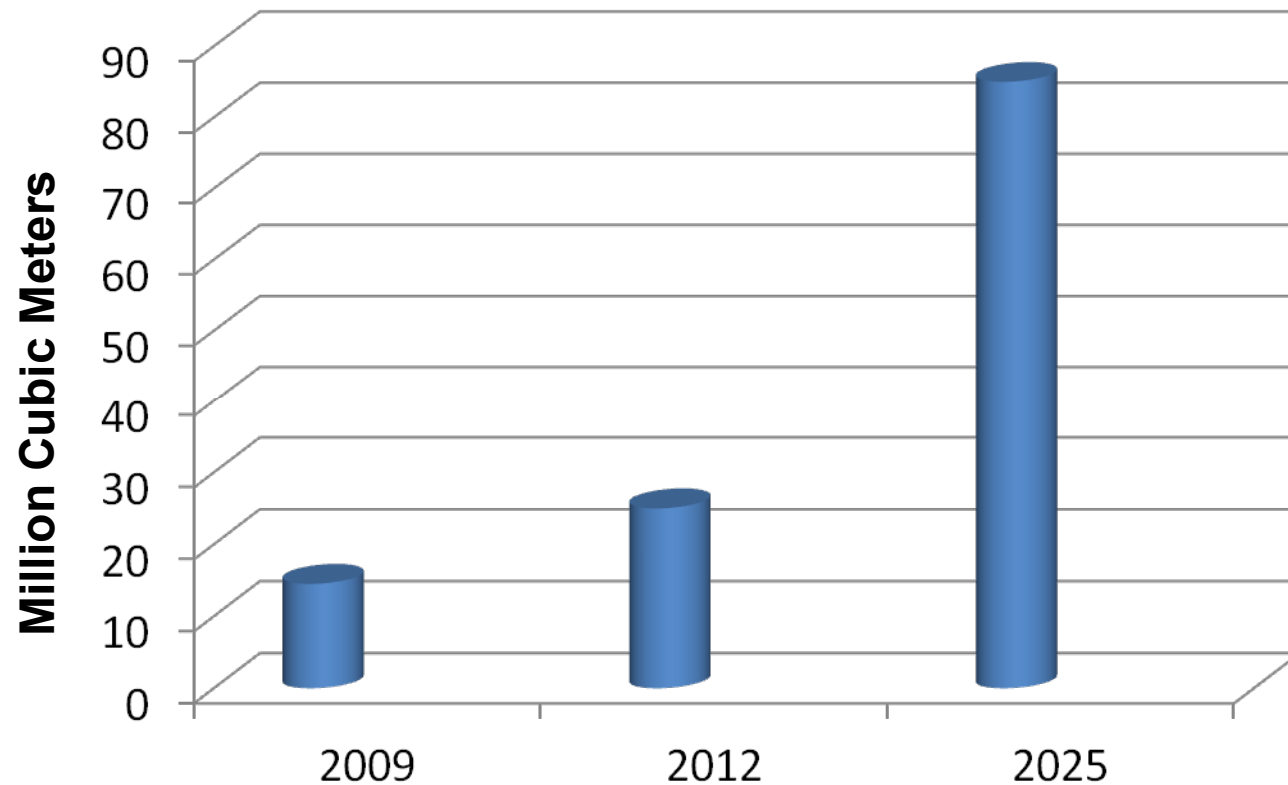


Treated Waste Water Reuse

Tertiary Treatment



Irrigation of agricultural crops and recreational areas either directly or through recharge of aquifers



Additional volumes of water for agricultural use



General Comments for the Reuse of Treated Effluent



- The treated effluent is another constant source of water
- The Government introduced the treated effluent in the Cyprus Water Balance
- The quality is under control and remains constant
- The treated effluent is suitable for the majority of the crops
- The farmers use less quantities of fertilisers because the treated effluent already contains nutrients such as Phosphorous and Nitrogen
- Almost all the Wastewater Treatment Plants in Cyprus are equipped with Tertiary Treatment, consisting of Sand Filtration and Chlorination in order to achieve higher quality characteristics and use the treated effluent for irrigation safely



Selling rates for treated effluent are much lower than the rates for fresh water



10. SELLING RATES OF TREATED EFFLUENT FROM TERTIARY TREATMENT PLANTS			
The rate of the treated effluent from the big wastewater treatment has been set by a ministerial decree as per the following table. These rates are charged by the government			
A/A	USE	Water Selling Rate	
		Existing Rate of Tertiary Treated Effluent	<i>Suggested Selling Rate of Fresh not filtered water from governmental</i>
		EURO Cent/ m3	<i>EURO Cent/ m3</i>
1	a) For Irrigation divisions for agricultural production	5	15
	b) For Persons for agricultural production	7	17
2	For sports	15	34
3	For irrigation of hotels green areas and gardens	15	34
4	For irrigation of Golf Courses	21	34
5	For pumping from an underground aquifer recharged by treated effluent	8	
6	For over consumption for items 1 to 5	increase by 50%	56
7	For municipal parks, green areas etc for rural communities where a plant has been built within its limits and the quantity does not exceed the approved quantity of more than 10 %		



Limassol (Moni) WWTP





CONCLUSIONS





Water scarcity and droughts increasing in intensity and extent



- Water scarcity and droughts is a major challenge
 - Climate change is expected to make matters worse
 - In Cyprus Desalination Plants cover the drinking water needs of large urban and touristic areas, eliminating dependence on rainfall and giving security and reliability of drinking water supply
 - The treated effluent is another constant source of water and it has been introduced in the Cyprus Water Balance for irrigation purposes
-



Taking on the challenge



- There is a need to intensify efforts to prepare for and manage water-related disasters
- Water saving & efficiency measures must be a priority
- Despite the many water saving & costly supply enhancement measures, the problem remains
- All necessary measures are being taken to ensure water security now and in the future through an **integrated multi-objective approach for water management**



Thank you



From the photographic competition of Water Board of Larnaca 2015 - first prize

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