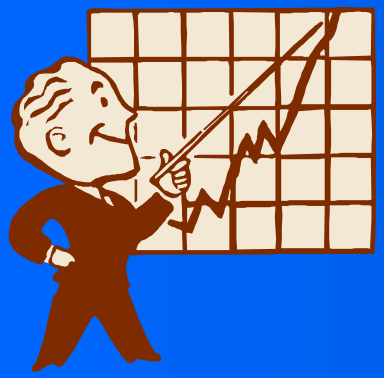
Desalination in Cyprus

The

CYPRUS EXPERIENCE



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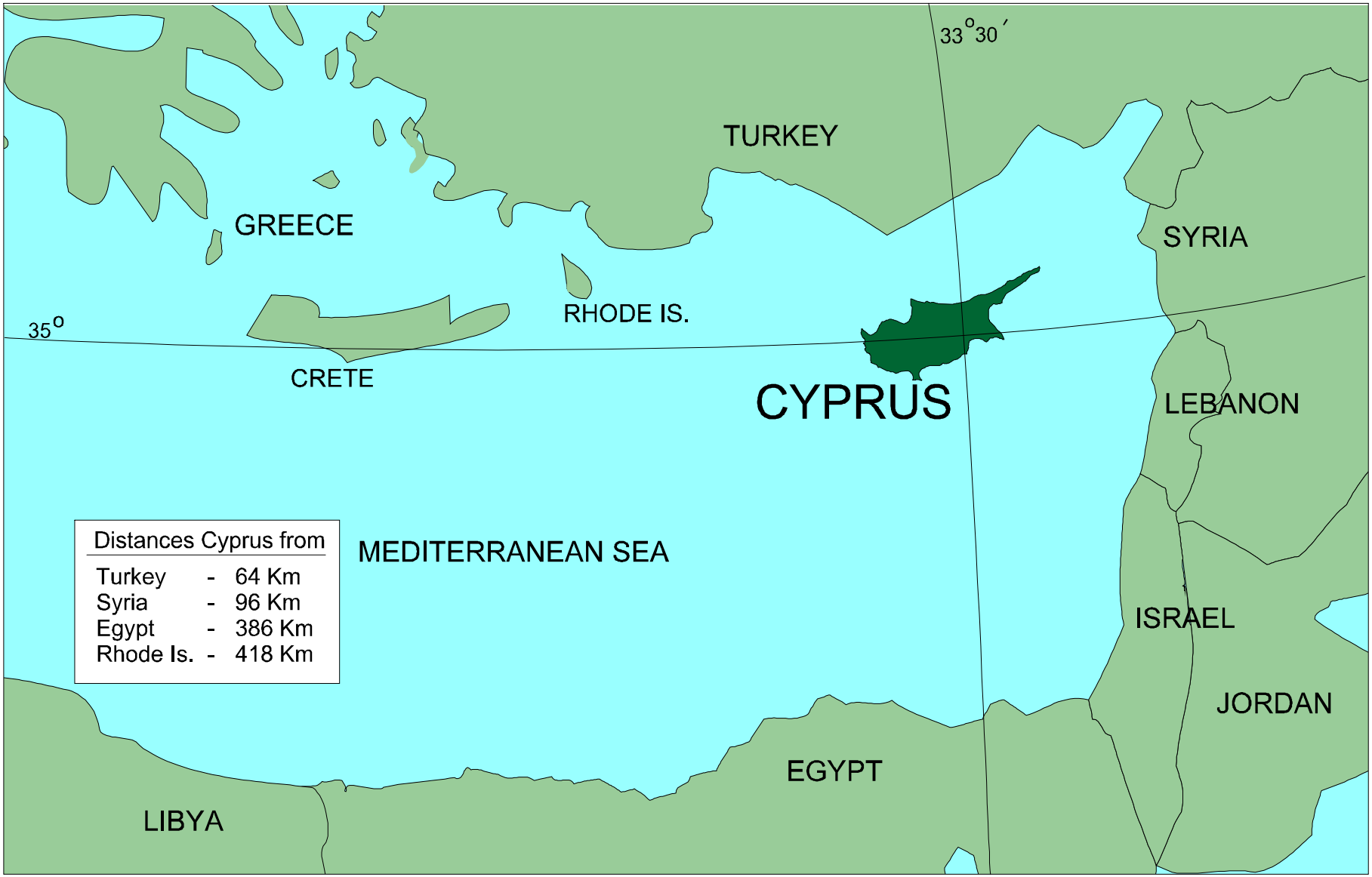
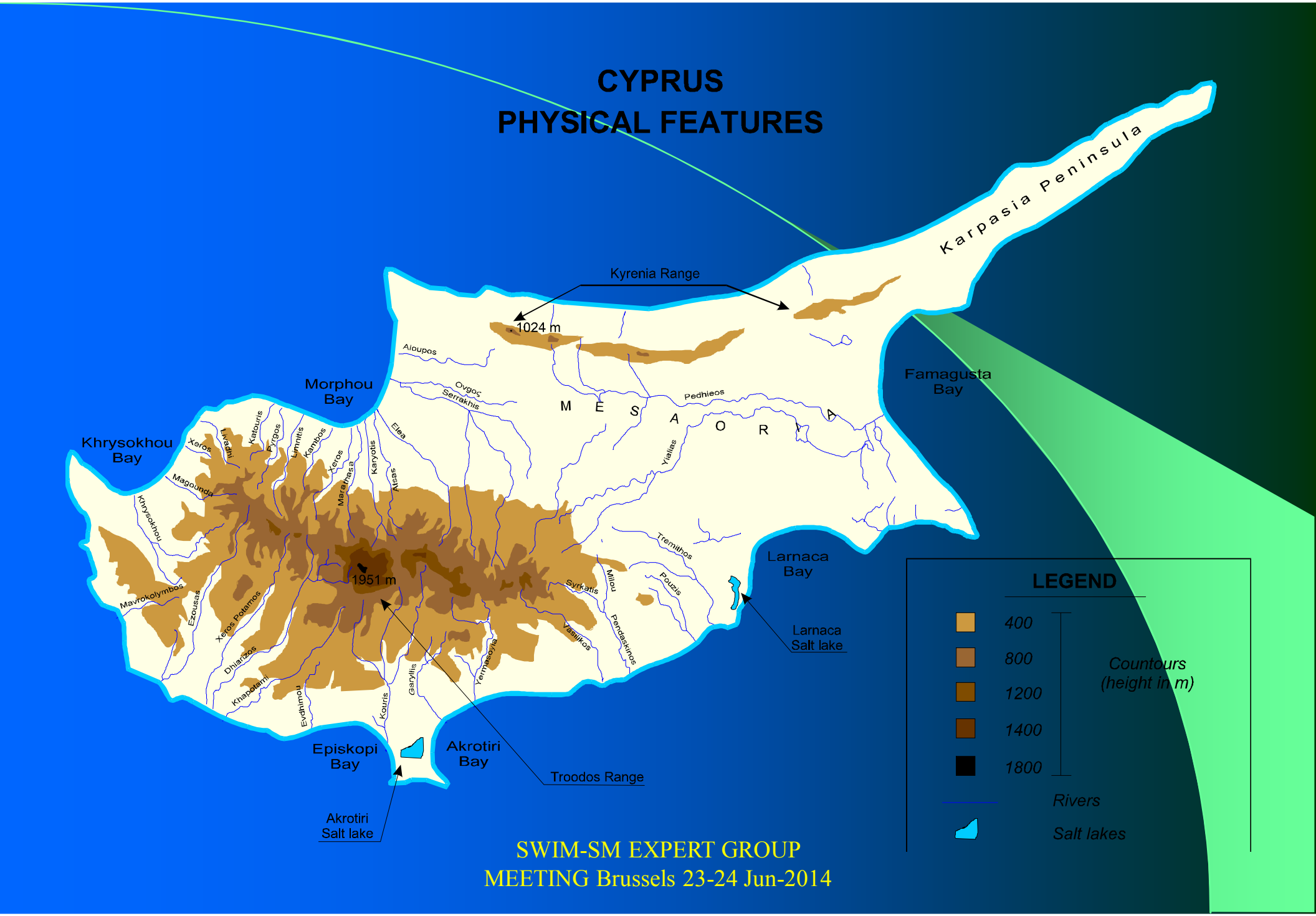
SWIM-SM EXPERT GROUP MEETING Brussels 23-24 Jun-2014

Content-Cyprus

- *1. Physiography, Climate, Resources,*
- *2- Current status of desalination ,*
- *3- Prospect of desalination until 2030*
- *4- National vision and policies adopted for desalination,*
  5-Environmental impacts of desalination
- *6.Policies and measures to mitigate impacts from desalination*
- *7.Capacity building and technical support needs,*
- *8 - Recommendations for the way forward*



LOCATION MAP


CYPRUS
PHYSICAL FEATURES
Karpasia Peninsula
Kyrenia Range
1024 m
Aloupos
Morphou Bay
Ovgos
Serrakhis
M E S A O R I A
Pedhieos
Famagusta Bay
Khrysokhou Bay
Xeros
Ezadhi
Katouris
Pyrgos
Limnitis
Kambos
Xeros
Marathasa
Karyotis
Elea
Atsas
Yialias
Magounda
Khrysokhou
1951 m
Tremithos
Larnaca Bay
Mavrokolymbos
Ezousas
Xeros Potamos
Dhiarizos
Khapotami
Evdhimou
Kouris
Garylis
Yermasoyia
Vasilikos
Syrkatis
Milou
Pendaskinos
Pouzis
Larnaca Salt lake
Episkopi Bay
Akrotiri Bay
Troodos Range
Akrotiri Salt lake
LEGEND
400
800
1200
1400
1800
Countours (height in m)
Rivers
Salt lakes
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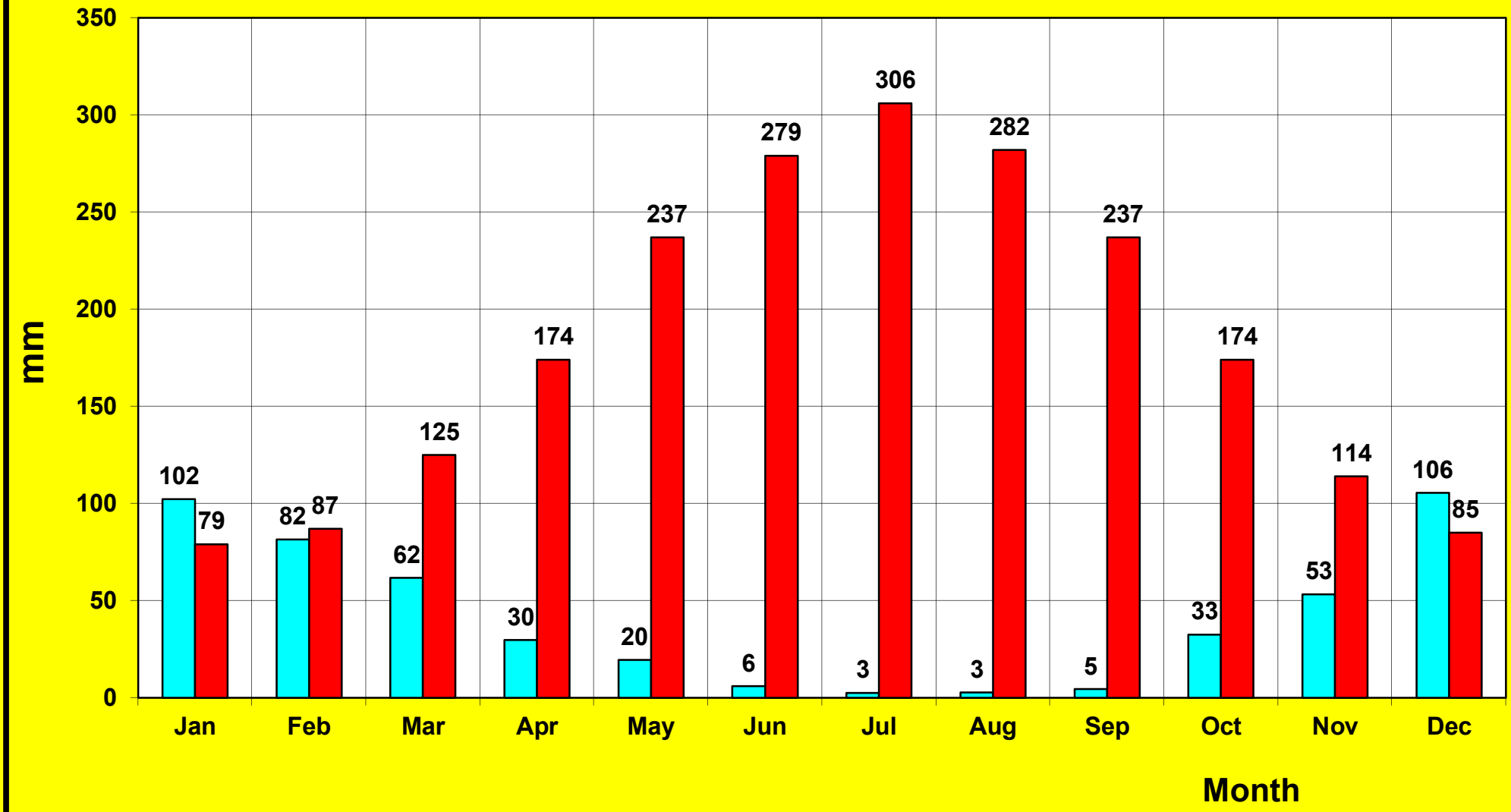
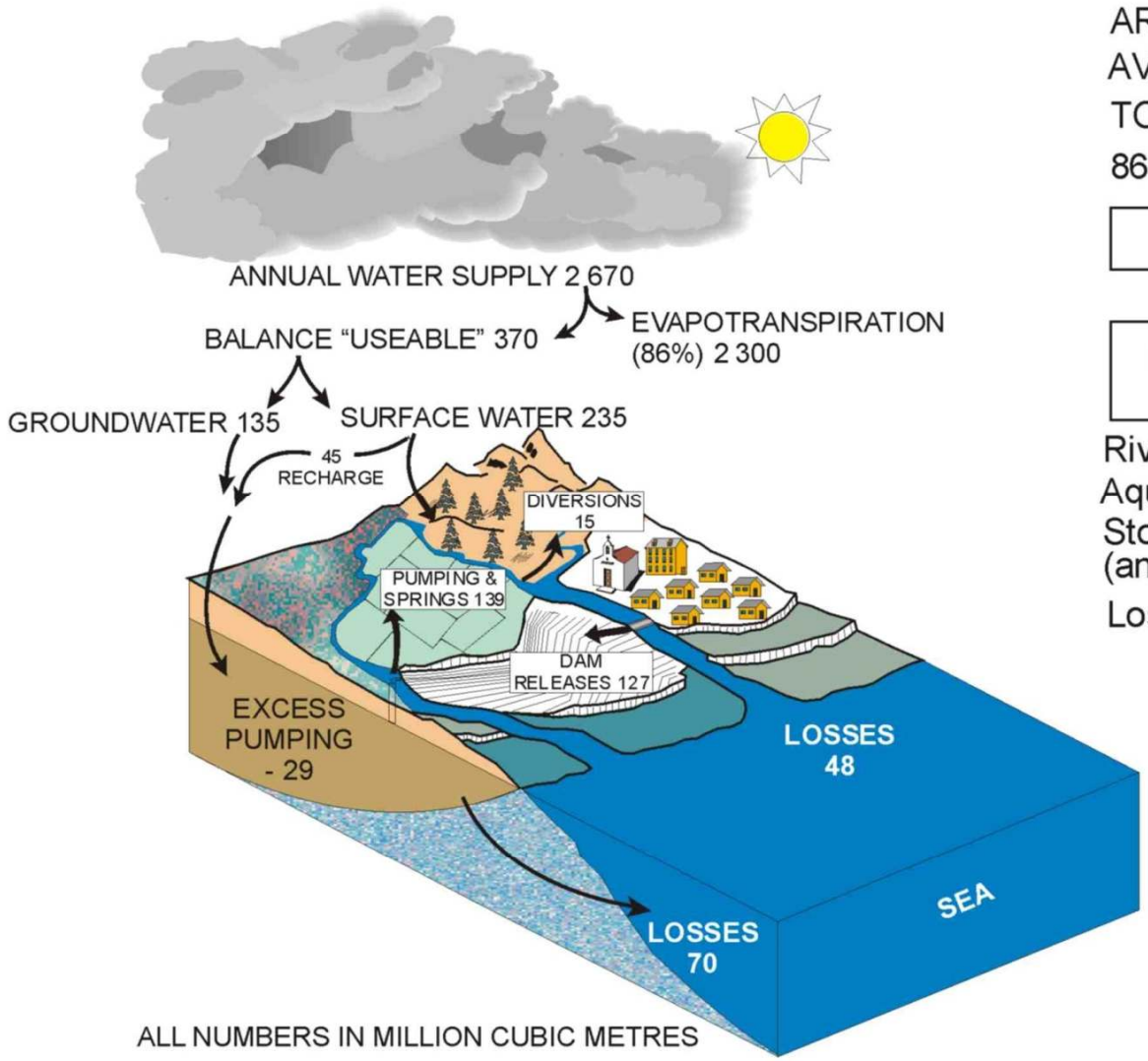
1. Climate Precipitation-Evaporation

- Climate: Semi Dry Mediterranean
- Rainfall 500 mm decreasing at a rate 1 mm/year mainly in winter months
- Temperature rising at a rate of 0,5 °C/100 years
- Potential Evaporation around 2000 mm/year

Average monthly precipitation and Evaporation



WATER BALANCE FOR CYPRUS (AREA UNDER GOVERNMENT CONTROL)



AREA = 5 800 Km^2

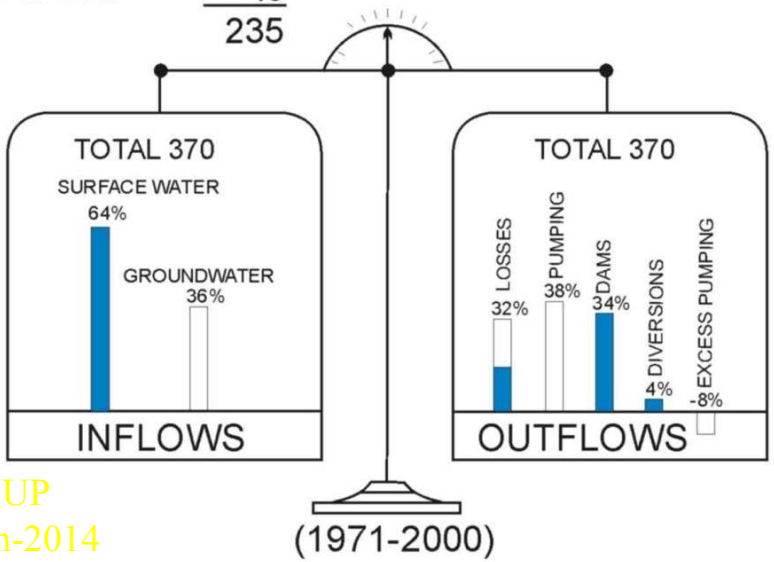
AVERAGE ANNUAL RAINFALL = 460 mm (1971-2000)

TOTAL ANNUAL WATER SUPPLY = 2 670 Mm^3

86% EVAPOTRANSPIRATION = 2 300 Mm^3

BALANCE "USEABLE" = 370 Mm^3

SURFACE WATER 235		GROUNDWATER 135	
Rivers diversions	= 15	Pumping Springs	= 139
Aquifer recharge	= 45	Losses to sea	= 70
Stored in dams (and used)	= 127	Excess pumping	= - 29
Losses to sea	= 48		180
	235		



(1971-2000)

1.A Water Development Projects

- Water Master plan was prepared in 1967-74.

a) Paphos Irrigation Project started operation in 1982

b) Khrysokhou Irrigation Project started operation in 1986

c) Vasilikos Pendaskinos Project started operation in 1985

d) Southern Conveyor Project 1987-2002

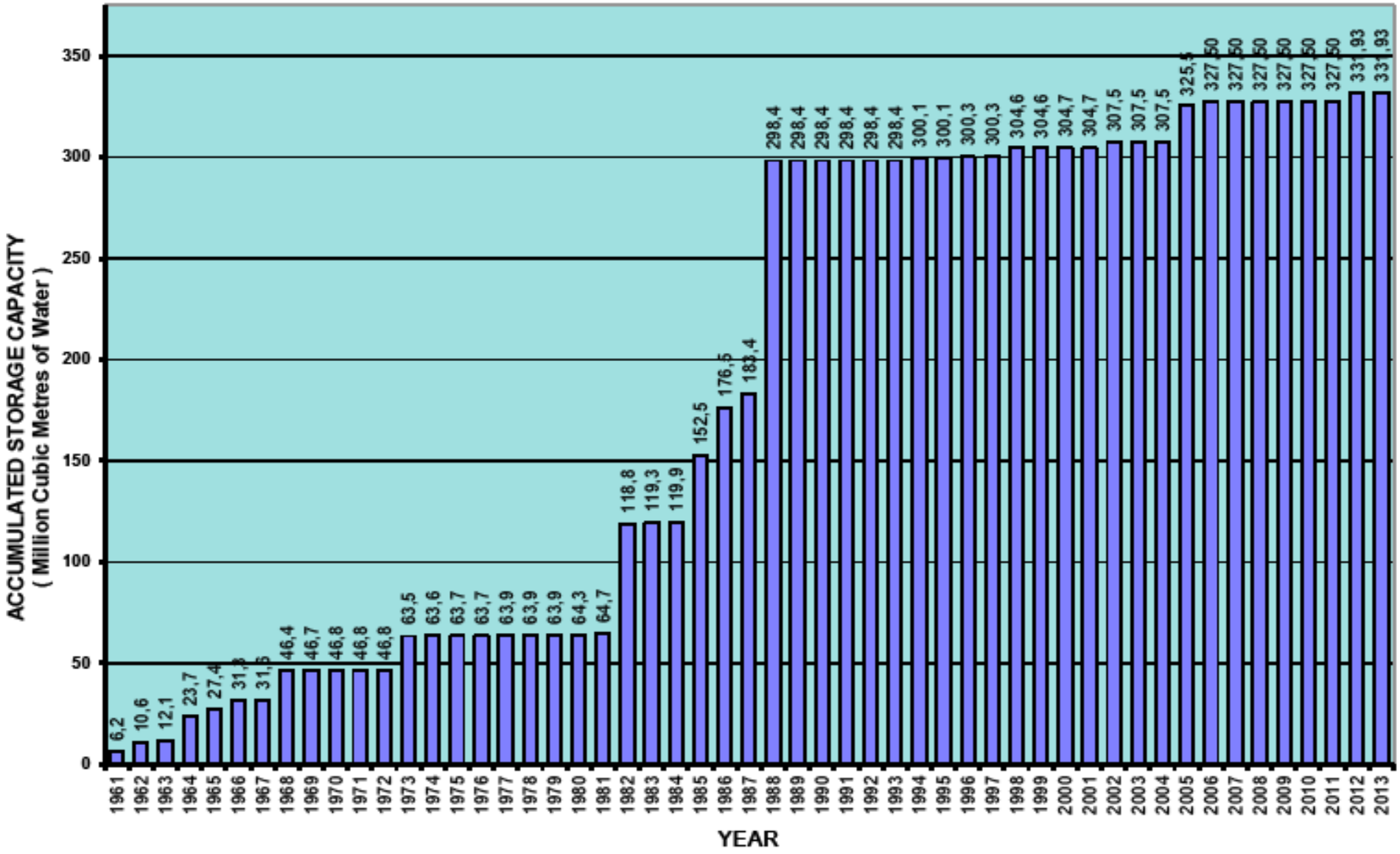
e) Morphou Tylliria Project (abandoned due to Turkish Invasion in 1974)

f) Pitsilia integrated Rural Development Project 1982

g) Other minor projects

MAJOR WATERWORKS

DAM CONSTRUCTION 1961-2013



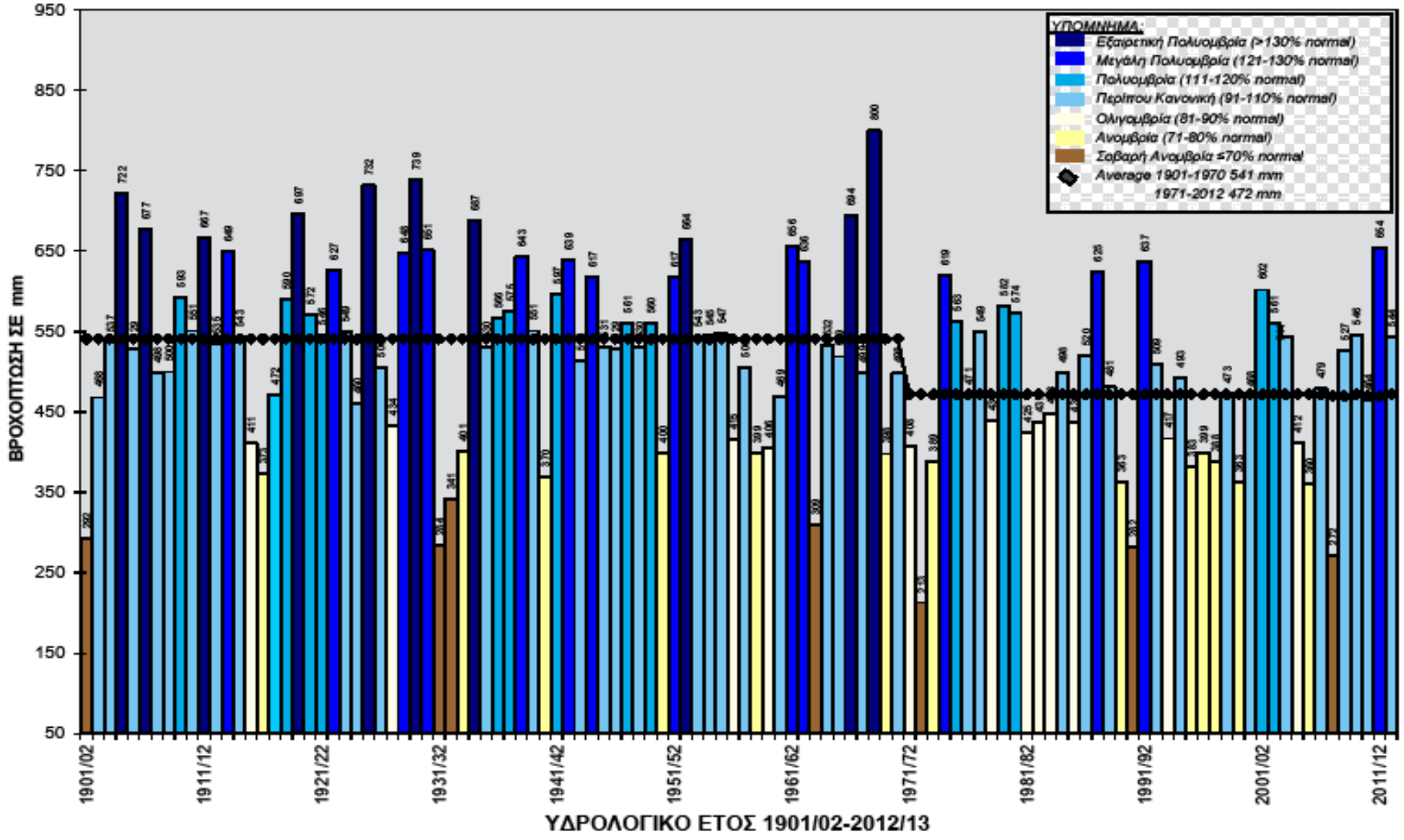
1.B Need for Desalination

- The Cyprus Master Plan provided for Desalination after the year 2005, in 1992 the need for desalination arose, BECAUSE.

- A) Most of the Conventional water resources were developed.

- B) Of Climate Change, with reduction of available water resources by 40%.

ΕΤΗΣΙΑ ΒΡΟΧΟΠΤΩΣΗ ΤΗΣ ΚΥΠΡΟΥ
(ΕΛΕΥΘΕΡΕΣ ΠΕΡΙΟΧΕΣ)



1.B Need for Desalination

- C) Of the Turkish invasion that caused increase on the island population in the non occupied area by 200,000 people increasing water demand.

- D) Of change of the development model (more tourists and better leaving conditions).

Introduction of Desalination

- Desalination was first introduced in 1997 with one Plant of original capacity 20,000 m3/day.
- Within a year its capacity was doubled
- By 2001 a second Desalination Plant was established with capacity 40,000 m3/day.

2. Current Status of Desalination

- Type of Financing: BOT model initially for 10 years concession period later 25 years.
- Type of Desalination: Seawater Reverse Osmosis.
- Water Quality: Originally Drinking quality later for Drinking and Reuse for Irrigation. (boron).
- Intake: Open Seawater intake, from deep water (10-15 meters with very low intake velocity<0.3 m/sec, with intake 4-6 m above sea bottom and at least 4 m below sea level.).

2. Current Status of Desalinat

- Discharge of Brine in deep water with diffusers or with Cooling water stream and without diffusers.
- Pre-treatment-conventional dual media filters and cartridge filters. Later with UF in Limassol.
- High Pressure pumps one for each PV train. Later introduced pressure centers.
- Energy Recovery originally Turbines low efficiency, now with isobaric with high efficiency.

2. Current Status of Desalination

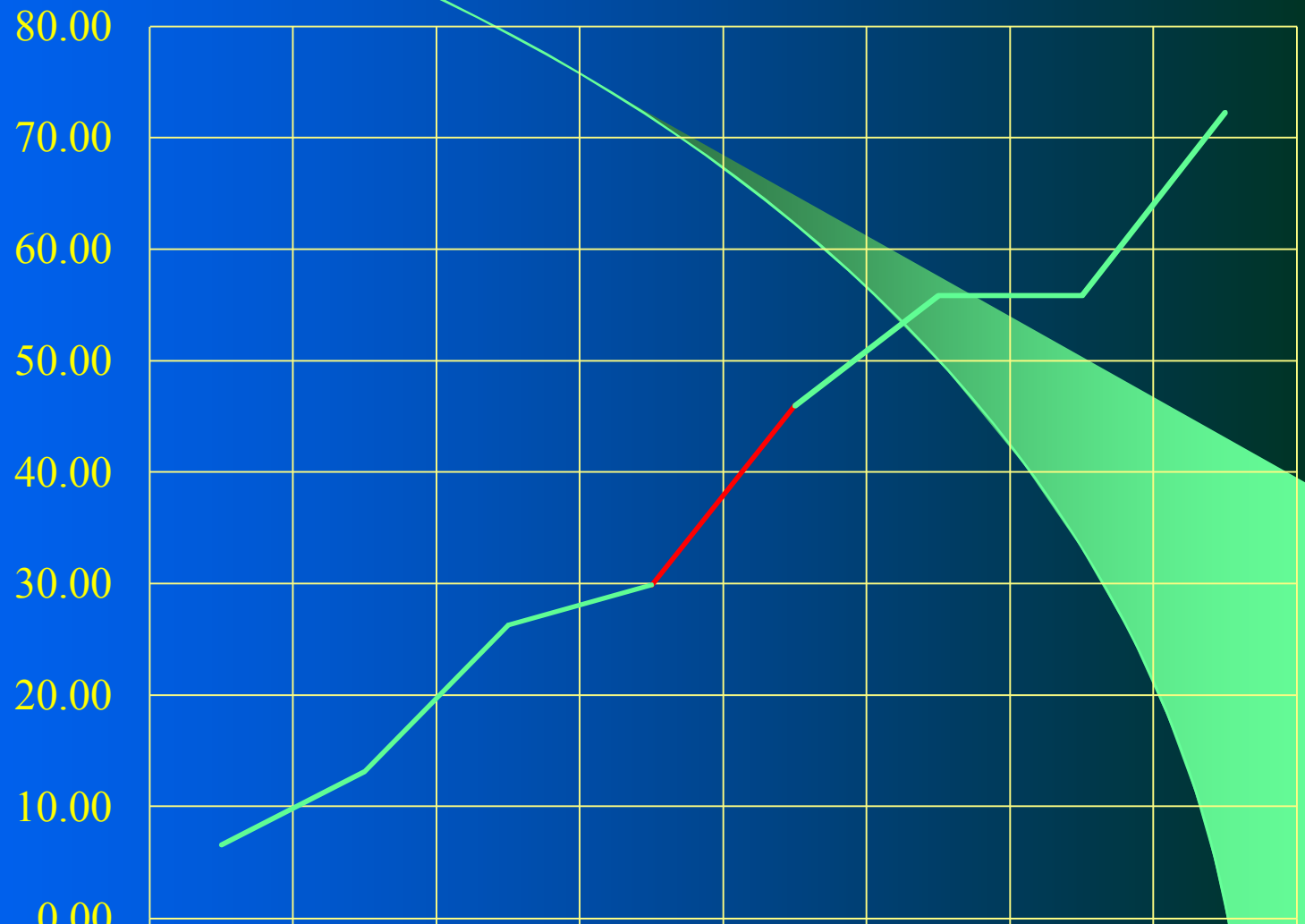
- Pre-treatment recovery 0.95%
- Membrane Stages: Originally one stage for Boron <1 ppm, later two stages for boron <0.5 ppm.
- Membranes Recovery for SWRO 40-45%.
- Post Treatment: Chemical Stabilization of permeate by increasing concentration of alkalinity and hardness and increase of pH , by injection of CO2 gas and then add caustic soda or lime. Finally water is chlorinated.

2. Current Status of Desalinat

- Energy Supply is from National Grid.
- Average annual Plant Availability >90%
- Product Water quality.
- Meeting EU standards for drinking water with --
  Chloride content 250 ppm
  Total Dissolve Solids <500 ppm
  Boron content <0.5 ppm
  Hardness >80 ppm
- Energy consumption 3-3.5 Kwh/m3.

Table 1 Desalination Plant by year of commissioning and capacity									
No	Year	1997	1968	2001	2002	2009	2010	2012	2014
1	Dhekelia	20,000	40,000	40,000	40,000	60,000	60,000	60,000	60,000
2	Larnaca	0	0	40,000	51,000	60,000	60,000	60,000	60,000
3	Moni (Tempo)	0	0	0	0	20,000	20,000	20,000	0
4	Paphos (Tempo)	0	0	0	0		30,000	30,000	0
5	VASILIKOS	0	0	0	0	0	0	0	60,000
6	LIMASSOL	0	0	0	0	0	0	0	40,000
7	Total Installed m3/day	20,000	40,000	80,000	91,000	140,000	170,000	170,000	220,000
8	Total Contractual MCM/yr	6.57	13.14	26.28	29.89	45.99	55.85	55.85	72.27

Cyprus- Total Contractual capacity of Desalination Plans in MCM/yr



	1997	1968	2001	2002	2009	2010	2012	2014
Total Contractual MCM/yr	6.57	13.14	26.28	29.89	45.99	55.85	55.85	72.27

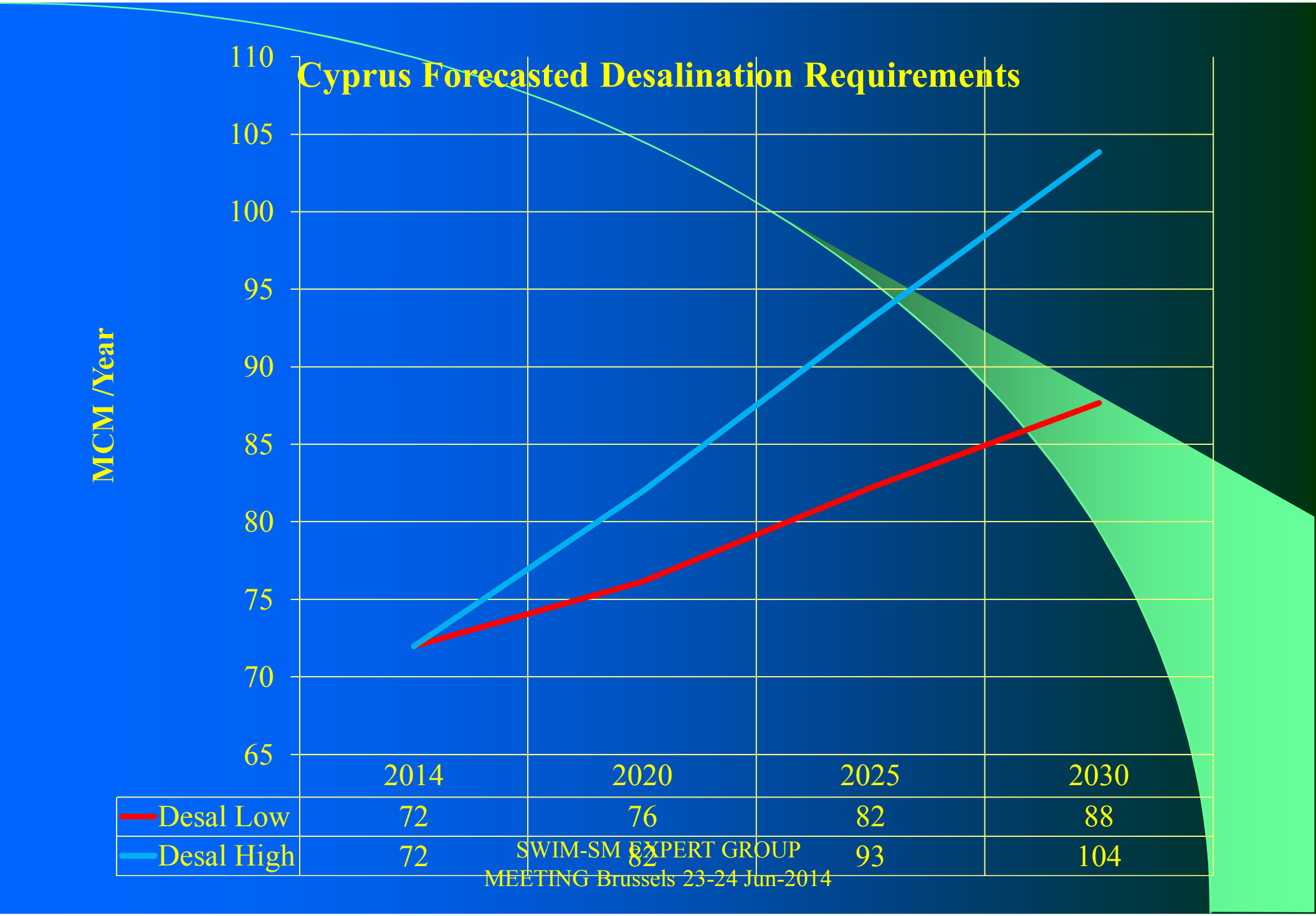
3. PROSPECT OF DESALINATION UNTIL 2030

- Taking into account that
- Cyprus is a divided country with 37% of its land occupied by the Turkish Army.
- The Climatic change with decreasing rainfall and increasing temperature,
- the Domestic Water demand increase yearly by 1.5-2.5%, Irrigation demand increasing by 1.%-1.5% and environmental demand by 2% to 2.5% annually.

3. PROSPECT OF DESALINATION UNTIL 2030

- the Recycling will represent in 2030 about 50% of the Domestic consumption.
- That Additional measures on Water demand will be implemented,
- Non accounted water will decrease
- And additional small quantities of conventional water resources will be developed
- The Desalination requirements by 2030 will be between 88 to 104 MCM per year as shown on the following graph or additional quantities between 16 to 32 MCM per year.

Cyprus Forecasted Desalination Requirements



	2014	2020	2025	2030
Desal Low	72	76	82	88
Desal High	72	82	93	104

4. NATIONAL VISION & POLICY

- Desalination is an alternative tool for satisfying the water demand.
- Desalination is a part of the water resoueces plan,
- Costs is a very important parameter in deciding on implementing desalination.
- At present desalination is used for Domestic uses exclusively.
- Environmental and social impacts from desalination plants are taken into account for site selection, and at the planning, construction and operation stages.

5. ENVIRONMENTAL IMPACTS

- For Each Plant Environmental Impact Assessment Studies were carried out all in accordance with the European Laws and Regulations.
- Marine Environment Monitoring programs were adopted and are carried out checking the seawater qualities changes on the coastal and marine environment areas (chemical, physical and biological parameters.

5. ENVIRONMENTAL IMPACTS

- During construction: Impact on the coastal areas during construction. Poseidonia uprooting, water pollution etc)
- During operation, disturbance of biotic life around intake heads and salt accumulation around the brine discharge diffusers (100 meters radius).
- During operation increase of CO 2 emissions to atmosphere.
- Pollution to sea from P-T chemicals and membranes treatment chemicals discharge to the sea. (The chemical quantities were reduced and no effect was noticed.
- Pollution of Agricultural lands in the event the desalinated water with high chlorides is either used for irrigation or recycled.

6. Policies and Measures for impacts Mitigation

- Use of high efficiency desalination systems (RO) to minimize emissions or use Renewable energy resources
- Abstract seawater from deep areas using very low intake velocities, to avoid impingement of living organisms.
- Discharge brine in deep water with diffusers to minimize salt concentration.
- During construction use efficient methods to avoid or destroy the biotic life along the pipelines.
- On land seawater or brine pipelines must be designed and constructed with high efficiency to avoid disturbance of lands and avoid leakages.
- Minimizing use of chemicals by adopting technologies with less or no need of chemicals.

7. Capacity building and Technical Support Needs

- Desalination Governance deal with planning, design, construction, o& and management and implementation of public policies.
- At present the Government of Cyprus is securing desalination technology though BOT Projects, where design, construction and O&M are carried out by international organizations.
- Capacity building is now confined within the Water Development Department, which is responsible for management of BOT Desalination Contracts.

7. Capacity building and Technical Support Needs

- For capacity building and Technical Supports the Government should establish an institution which should function within a legal framework and work with a working set including the Capacity Building and Technical Support.
- A quick capacity building will be the participatory development of desalination projects in which qualified staff will be involve in the design, construction and O&M.

8. Recommendations for the way forward

- Desalination is an essential tool for securing the necessary water resources that nature cannot provide because of population growth, climate change and increase in water demand.
- Desalination is high energy demanding and relatively expensive process, therefore before adopting it we must make sure that all other water resources and water saving and water demand management policies and technologies are applied successfully.
- For avoiding increase of emission of CO 2 to the atmosphere renewable energy resources must be used and more emphasis should be given for its development.
- For avoiding adverse impacts on the marine environment more emphasis should be given at the design and construction of the intake and brine discharge systems.

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Thank YOU

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