Dealing with water scarcity through PPPs for desalination and Non-Revenue Water reduction

Cyprus Experience with Desalination and Non-Revenue Water Reduction

Nicos Neocleous
Acting Chief Water Officer
Water Development Department
Ministry of Agriculture, Rural Development and Environment
Republic of Cyprus

Bambos Charalambous
NRW and Water Utility Specialist
World Bank Consultant

13 December 2016
Outline of Presentation

- WATER SITUATION IN CYPRUS
- EXPERIENCE WITH DESALINATION
- NON-REVENUE WATER REDUCTION
WATER SITUATION IN CYPRUS
Institutional and Administrative Structure of the Water Sector in Cyprus

Policy

Council of Ministers
(MARDE, Ministries of Interior, Finance, Commerce & Industry)

Executive Level

MARDE
Water Development Department

Ministry of Interior

End Users

Irrigation
Individual users

Irrigation Divisions-
Associations

Bulk Water Provider

Water Supply
Water Boards

Water Supply
Municipal Authorities

Water Supply
Community Boards

Sewage
Boards
Water scarcity has always been a very serious problem for Cyprus. Cyprus and Malta are 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
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 Management

- Increased storage capacity through dam construction
- Drilled boreholes for domestic and irrigation purposes
- Constructed water treatment plants & recharge works

Accumulated Storage Capacity (MCM of water)

- 6.2 MCM in 1991
- 327.5 MCM in 2008

WORLD BANK GROUP
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 Balance

*(mean values in Mm³ for period 2000-2011)*

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

*Desalinated **Reused
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
  - Since 1996, water demand for irrigated agriculture was satisfied only once, in 2004, when all dams were full

Total needs: 250 MCM / year
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
Legislative and Institutional Measures

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)
Improved Irrigation Efficiency

- Cropping patterns selected and proposed to farmers to ensure efficient utilisation of water at farm level based on water supply reliability, project economics, land resources, climatic conditions
- Water allocated to agriculture using a quota system and penalty charges for over-consumption
- Irrigation water in government schemes distributed through modern & highly efficient systems (closed pipes, drippers, sprinklers)
- Improved irrigation systems currently cover 95% of total irrigated area (annual water savings are of the order of 75 MCM)
- Conveyance efficiencies: 90-95%
- Field application efficiencies: 80-90%
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

Million Cubic Meters

<table>
<thead>
<tr>
<th>Year</th>
<th>2009</th>
<th>2012</th>
<th>2025</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>10</td>
<td>30</td>
<td>90</td>
</tr>
</tbody>
</table>

2009
2012
2025

Million Cubic Meters
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

- Domestic water supply networks in rural areas are gradually being replaced / improved
  - A €75 million budget has been allocated between 2001-2009
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)

INFLOW OF WATER TO THE DAMS
1987/88 - 2011/12
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
In 1997 Desalination was Introduced
EXPERIENCES WITH DESALINATION
Public-Private Partnerships (PPP)

- By developing partnerships with private-sector entities, the governments can use the private sectors’ knowledge, experience and financing capacity to improve the quantity and quality of basic public services.

- Such Public-Private Partnerships, if properly designed and implemented, can present a number of advantages.

- In Cyprus all desalination plants operate under Built, Own – Operate, Transfer (BOOT) Contracts, where private companies using their own funds, undertake the design, construction and operation of the Plants over a fixed period.

- The Government has the obligation to buy a minimum quantity of desalinated water each year over that fixed period.
Desalination Plant – Main Components

- Sub-sea conveyors for sea water collection (500m at Dhekelia and 1km at Larnaca) and sub-sea conveyors for brine rejection (500m at Dhekelia and 1.3km at Larnaca).
- Sea water pumping station.
- Ground conveyors to transfer sea water to the desalination plant and reject brine to the sea.
- Desalination Plant
  - Pre-treatment
  - Reverse osmosis
  - Post-treatment
- Treated / desalinated water reservoir
- Treated / desalinated water pumping station
Desalination Plant – Contractual Obligations

- The Contractor produces desalinated water of a specified quality and quantity and delivers it to the Water Development Department’s storage reservoirs.
- The water quality is checked every 2 hours. Additional quality tests are carried out on a daily and weekly basis.
- The Water Development Department is obliged to receive a specified minimum quantity every 3 months.
- Payments to the Contractor are made every 3 months.
- The Contractor submits 3-monthly reports on:
  - Quantities of water delivered.
  - Quantities over and above the minimum 3-monthly quantity.
  - Volume of water which did not comply to the specification.
  - Quantities which were not delivered by the Contractor for reasons beyond his direct control.
Pricing of Water Purchased

- **The Unit Price** is made up of four components:
  - C: Capital Expenditure
  - OM: Operation and Maintenance
  - E: Energy
  - SOM: Standby Operation and Maintenance

- **Different Unit Prices** are applied:
  - Unit Price for operation: C + OM + E
  - Unit Price for Stand-by: C + SOM
  - Unit Price for additional quantities: OM + E
Operational Conditions

- The Water Development Department has the option to purchase the desalination plant before the end of the Contract.
- The Contractor will indemnify the Water Development Department for quantities of water which he was not able to deliver.
- The Contractor has the option to produce and deliver the above quantities within the next 3-monthly periods.
- If he fails to do this a penalty is imposed.
- The penalty is equal to the current purchase price of desalinated water times the quantities of water which were not delivered.
- The penalty is applied once a year.
### DESALINATION PLANTS (1/3)

<table>
<thead>
<tr>
<th></th>
<th>DHEKELIA</th>
<th>LARNACA</th>
<th>DHEKELIA REFURBISHMENT</th>
<th>DHEKELIA EXTENTION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CONTRACT TYPE</strong></td>
<td>BOT</td>
<td>BOT</td>
<td>BOT</td>
<td>BOT</td>
</tr>
<tr>
<td><strong>START OF PRODUCTION</strong></td>
<td>1&lt;sup&gt;st&lt;/sup&gt; April 1997</td>
<td>12&lt;sup&gt;th&lt;/sup&gt; July 2001</td>
<td>20&lt;sup&gt;th&lt;/sup&gt; May 2007</td>
<td>18&lt;sup&gt;th&lt;/sup&gt; July 2008</td>
</tr>
<tr>
<td><strong>PERIOD</strong></td>
<td>10 Years</td>
<td>10 Years</td>
<td>20 Years</td>
<td></td>
</tr>
<tr>
<td><strong>CAPACITY</strong></td>
<td>40,000 m³/day</td>
<td>52,000 m³/day</td>
<td>40,000 m³/day</td>
<td>50,000 m³/day</td>
</tr>
<tr>
<td><strong>MINIMUM DAILY PRODUCTION (m³)</strong></td>
<td>-</td>
<td>46,500 m³</td>
<td>36,000 m³</td>
<td>45,000 m³</td>
</tr>
<tr>
<td><strong>MINIMUM YEARLY PRODUCTION (m³)</strong></td>
<td>-</td>
<td>16,972,500 m³</td>
<td>13,140,000 m³</td>
<td>16,425,000 m³</td>
</tr>
<tr>
<td><strong>CONTRACT PRICE</strong></td>
<td>€0.92/m³</td>
<td>€0.68/m³</td>
<td>€0.64/m³</td>
<td>€0.82/m³ *</td>
</tr>
<tr>
<td><strong>ADJUSTED PRICE (ELECTRICITY TARRIFF AND LABOR INDEX)</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>€1.31/m³</td>
</tr>
</tbody>
</table>

* For the extra 10,000 m³/day
## DESALINATION PLANTS (2/3)

<table>
<thead>
<tr>
<th>CONTRACT TYPE</th>
<th>MONI</th>
<th>GARYLLIS</th>
<th>PAFOS</th>
<th>LIMASSOL</th>
</tr>
</thead>
<tbody>
<tr>
<td>START OF PRODUCTION</td>
<td>22nd December 2008</td>
<td>2009</td>
<td>22nd November 2010</td>
<td>1st July 2012</td>
</tr>
<tr>
<td>PERIOD</td>
<td>3 Years</td>
<td>5 Years</td>
<td>3 Years</td>
<td>20 Years</td>
</tr>
<tr>
<td>CAPACITY</td>
<td>20,000 m³/day</td>
<td>13,000 m³/day</td>
<td>30,000 m³/day</td>
<td>40,000 m³/day</td>
</tr>
<tr>
<td>MINIMUM DAILY PRODUCTION (m³)</td>
<td>18,000 m³/day</td>
<td>11,700 m³</td>
<td>27,000 m³/day</td>
<td>36,000 m³</td>
</tr>
<tr>
<td>MINIMUM YEARLY PRODUCTION (m³)</td>
<td>6,570,000 m³</td>
<td>3,482,592 m³</td>
<td>9,855,000 m³</td>
<td>1,140,000 m³</td>
</tr>
<tr>
<td>CONTRACT PRICE</td>
<td>€1.39/m³</td>
<td>€0.29/m³</td>
<td>€1.219/m³</td>
<td>€0.8725/m³</td>
</tr>
<tr>
<td>ADJUSTED PRICE (ELECTRICITY TARIFF AND LABOR INDEX)</td>
<td>-</td>
<td>€0.35/m³</td>
<td>€1.70/m³</td>
<td>€1.27/m³</td>
</tr>
<tr>
<td></td>
<td>LARNACA REFURBISHMENT</td>
<td>VASSILIKOS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>------------------------</td>
<td>-----------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CONTRACT TYPE</strong></td>
<td>BOT</td>
<td>Purchase contract</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>START OF PRODUCTION</strong></td>
<td>Summer 2014</td>
<td>Summer 2013</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PERIOD</strong></td>
<td>25 Years</td>
<td>20 Years</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CAPACITY</strong></td>
<td>60,000 m³/day</td>
<td>60,000 m³/day</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MINIMUM DAILY PRODUCTION (m³)</strong>*</td>
<td>54,000 m³/day</td>
<td>54,000 m³/day</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MINIMUM YEARLY PRODUCTION (m³)</strong>*</td>
<td>19,710,000 m³</td>
<td>19,710,000 m³</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CONTRACT PRICE</strong></td>
<td>€0.59/m³</td>
<td>€0.813/m³</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ADJUSTED PRICE (ELECTRICITY TARIFF AND LABOR INDEX)</strong></td>
<td>€0.82/m³</td>
<td>€1.10/m³</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Desalination Plants at 2016

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>DHEKELIA EXTENSION</th>
<th>LARNACA REFURBISHMENT</th>
<th>LIMASSOL</th>
<th>VASSILIKOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTRACT TYPE</td>
<td>BOOT</td>
<td>BOOT</td>
<td>BOOT</td>
<td>Purchase Contract</td>
</tr>
<tr>
<td>START OF PRODUCTION</td>
<td>18 July 2008</td>
<td>Summer 2014</td>
<td>1 July 2012</td>
<td>Summer 2013</td>
</tr>
<tr>
<td>PERIOD</td>
<td>20 Years</td>
<td>25 Years</td>
<td>20 Years</td>
<td>20 Years</td>
</tr>
<tr>
<td>CAPACITY</td>
<td>60,000 m³/day</td>
<td>60,000 m³/day</td>
<td>40,000 m³/day</td>
<td>60,000 m³/day</td>
</tr>
<tr>
<td>MINIMUM DAILY PRODUCTION</td>
<td>54,000 m³</td>
<td>54,000 m³</td>
<td>36,000 m³</td>
<td>54,000 m³</td>
</tr>
<tr>
<td>MINIMUM YEARLY PRODUCTION</td>
<td>19,710,000 m³</td>
<td>19,710,000 m³</td>
<td>1,140,000 m³</td>
<td>19,710,000 m³</td>
</tr>
<tr>
<td>PURCHASE PRICE OF WATER</td>
<td>€0.69/m³</td>
<td>€0.59/m³</td>
<td>€0.87/m³</td>
<td>€0.81/m³</td>
</tr>
<tr>
<td>ADJUSTED PRICE FOR 2016</td>
<td>€0.83/m³</td>
<td>€0.47/m³</td>
<td>€0.92/m³</td>
<td>€0.77/m³</td>
</tr>
</tbody>
</table>

(€0.69/m³: Electricity Tariff and Labor Index)
Cost of Desalination

Cost based on two reverse osmosis plants

### DESALINATED WATER PRODUCTION

<table>
<thead>
<tr>
<th>DHEKELIA (1997-2007) (m³)</th>
<th>LARNACA (2001-2007) (m³)</th>
<th>TOTAL (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>122,985,322</td>
<td>112,083,355</td>
<td>234,798,677</td>
</tr>
</tbody>
</table>

### DESALINATED WATER COST

<table>
<thead>
<tr>
<th>DHEKELIA (1997-2007) (€)</th>
<th>LARNACA (2001-2007) (€)</th>
<th>TOTAL COST (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>137,812,166</td>
<td>80,196,431</td>
<td>218,008,597</td>
</tr>
</tbody>
</table>

**SUMMARY**

- **Power Consumption:**
  
  - 4.52 kWh / m³
  - OR
  - **135,000,000 kWh/year**
  
  Approximately for both desalination plants

- **Energy Cost:**
  
  - **€11,500,000 / year**
# Desalinated Water Production

<table>
<thead>
<tr>
<th>YEAR</th>
<th>TOTAL COST/YEAR (M €)</th>
<th>PRODUCED QUANTITY (M.C.M.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>65,28</td>
<td>32,6</td>
</tr>
<tr>
<td>2009</td>
<td>63,56</td>
<td>49,6</td>
</tr>
<tr>
<td>2010</td>
<td>62,36</td>
<td>52,8</td>
</tr>
<tr>
<td>2011</td>
<td>74,98</td>
<td>48,7</td>
</tr>
<tr>
<td>2012</td>
<td>49,98</td>
<td>17,6</td>
</tr>
<tr>
<td>2013</td>
<td>35,24</td>
<td>10,7</td>
</tr>
<tr>
<td>2014</td>
<td>36,92</td>
<td>32,8</td>
</tr>
<tr>
<td>2015</td>
<td>43,83</td>
<td>38,1</td>
</tr>
<tr>
<td>2016</td>
<td>39,27</td>
<td>62,6</td>
</tr>
<tr>
<td>TOTALS</td>
<td>471,4</td>
<td>345,5</td>
</tr>
</tbody>
</table>
# Desalination Pros and Cons

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>■ Coverage of drinking water needs of large urban and tourist areas</td>
<td>■ Energy-consuming process</td>
</tr>
<tr>
<td>▪ Dependence on rainfall eliminated</td>
<td>▪ Emission of Greenhouse gasses</td>
</tr>
<tr>
<td>■ Availability of additional quantities of surface water for other uses</td>
<td>■ Slight impact on the Marine Environment</td>
</tr>
<tr>
<td>▪ Irrigation</td>
<td>▪ Increased salinity at the point of brine rejection</td>
</tr>
<tr>
<td>▪ Environmental Flows</td>
<td>■ High production cost</td>
</tr>
<tr>
<td>▪ Recharge of heavily over-pumped aquifers</td>
<td></td>
</tr>
<tr>
<td>■ Economic and social benefits</td>
<td></td>
</tr>
<tr>
<td>■ Safety and reliability of drinking water supply</td>
<td></td>
</tr>
</tbody>
</table>
The inevitable choice to build Desalination Plants in Cyprus has proved particularly beneficial for the agriculture and salvation for the water supply of urban areas.

Nevertheless building Desalination Plants is not a panacea.

The environmental impact, mainly because of the emission of greenhouse gases, should not leave us indifferent at times where our planet struggles for survival.
Desalination Plants

- Furthermore the production cost, which is not recovered, at times where the oil price is unstable, should have us seriously concerned.
- It is therefore imperative to continuously seek of ways to increase the efficiency of the existing desalination technologies in such a way so as to reduce the energy consumption, and
- To seek for new methods to produce drinking water by utilizing renewable energy sources.
NON-REVENUE WATER REDUCTION
## Potable water volumes supplied – 2012

*Continuous 24x7x365 potable water supply – coverage is 100% in all areas*

<table>
<thead>
<tr>
<th>Service providers</th>
<th>Population served</th>
<th>Mm³</th>
<th>%</th>
<th>m³/capita/year</th>
<th>NRW (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Board of Nicosia</td>
<td>220 000</td>
<td>21.5</td>
<td>27</td>
<td>98</td>
<td>23</td>
</tr>
<tr>
<td>Water Board of Limassol</td>
<td>170 000</td>
<td>12.7</td>
<td>16</td>
<td>75</td>
<td>24</td>
</tr>
<tr>
<td>Water Board of Larnaca</td>
<td>70 000</td>
<td>5.6</td>
<td>7</td>
<td>80</td>
<td>28</td>
</tr>
<tr>
<td>Municipal Water Supply Departments</td>
<td>160 000</td>
<td>18.3</td>
<td>23</td>
<td>114</td>
<td>35</td>
</tr>
<tr>
<td>Community Boards</td>
<td>185 000</td>
<td>21.5</td>
<td>27</td>
<td>116</td>
<td>40</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>805 000</strong></td>
<td><strong>79.5</strong></td>
<td><strong>100</strong></td>
<td><strong>99</strong></td>
<td><strong>31</strong></td>
</tr>
</tbody>
</table>

Potable water volumes supplied – 2012

Continuous 24x7x365 potable water supply – coverage is 100% in all areas.
Network Management

DMA categories
Small : <1000 properties
Medium : 1000 – 3000 properties
Large : 3000 – 5000 properties

Factors considered in DMA design
- Minimum variation in ground level
- Single entry point into the DMA
- Well defined DMA boundaries
- Area meters correctly sized and located
- Apply pressure management
- Continuous monitoring

Source: WBL
Physical Losses

Reduction in:
- surges and excess pressures
- burst rates and background leakage
- flow rates of all leaks
- some components of consumption

Minimize “Leak Run Time”; Use quality materials & specification; Perform quality repairs & inspection

- High quality materials / Proper installation
- High standard of maintenance
- Pipeline replacement using a decision support system

Visual leaks
Unreported leaks
All customers are metered

Water theft
- Theft from hydrants
- Meter by-passes
- Tampering with meters

Meter under-registration
- Improve meter accuracy
- Volumetric meters
- Certified meter test bench

Meter reading errors
- Hand-held devices
- Change meter readers’ routes
- Check zero/low consumption

Accounting errors
- Billing software
- Threshold alarms

Source: Rizzo and Cilia, 2005
### Key Performance Indicators

#### Water Board of Nicosia

<table>
<thead>
<tr>
<th>YEAR</th>
<th>% of SIV</th>
<th>ILI</th>
<th>Lit/conn/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>19.5</td>
<td>2.9</td>
<td>137</td>
</tr>
<tr>
<td>2012</td>
<td>23.0</td>
<td>4.3</td>
<td>203</td>
</tr>
</tbody>
</table>

#### Water Board of Larnaca

<table>
<thead>
<tr>
<th>YEAR</th>
<th>% of SIV</th>
<th>ILI</th>
<th>Lit/conn/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>23.0</td>
<td>2.5</td>
<td>131</td>
</tr>
<tr>
<td>2012</td>
<td>28.0</td>
<td>3.3</td>
<td>168</td>
</tr>
</tbody>
</table>

#### Water Board of Lemesos

<table>
<thead>
<tr>
<th>YEAR</th>
<th>% of SIV</th>
<th>ILI</th>
<th>Lit/conn/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>16.7</td>
<td>1.8</td>
<td>91</td>
</tr>
<tr>
<td>2012</td>
<td>24.0</td>
<td>2.8</td>
<td>143</td>
</tr>
</tbody>
</table>
Water rationing

- In 2008, Cyprus was faced with one of the most acute and prolonged droughts in 20th century
- 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
Lifeline from Athens to Lemesos in August 2008:
8 months / 8.4 MCM
(Average 35,000 m³/day)
Cost: €56M
Increase in Leakage

Minimum Night Flow
Years 2007 and 2010 (All Reservoirs)

Source: Water Board Lemesos, Cyprus
## Increase in the Number of Breaks

### 20 DMAs: 373Km: 45% total

#### 2008 – 2009 Intermittent Water Supply (IWS)

<table>
<thead>
<tr>
<th>Description</th>
<th>Number of reported breaks</th>
<th>2007 (24x7x365)</th>
<th>2010 (24x7x365)</th>
<th>%increase</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mains</strong></td>
<td></td>
<td>Before IWS</td>
<td>After IWS</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>14 / 100km</td>
<td>42 / 100km</td>
<td>200</td>
</tr>
<tr>
<td><strong>Service</strong></td>
<td></td>
<td>connections</td>
<td>connections</td>
<td></td>
</tr>
<tr>
<td><strong>connections</strong></td>
<td></td>
<td>15 / 1000</td>
<td>30 / 1000</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Water Board Lemesos, Cyprus
## System Input vs Consumption

<table>
<thead>
<tr>
<th>Year</th>
<th>System Input Volume</th>
<th>Customer Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007 Before Intermittent Supply</td>
<td>0% (base line)</td>
<td>0% (base line)</td>
</tr>
<tr>
<td>2008 Intermittent Supply</td>
<td>-17,5%</td>
<td>-9,2%</td>
</tr>
<tr>
<td>2009 Intermittent Supply</td>
<td>-9,1%</td>
<td>-8,9%</td>
</tr>
<tr>
<td>2010 After Intermittent Supply</td>
<td>+12,8%</td>
<td>-1,2%</td>
</tr>
</tbody>
</table>

Source: Water Board Lemesos, Cyprus
Cost of Intermittent Supply

   - Loss of revenue:
     - Reduction in sales – cost of water saved: €300.000
   - Additional operational expenses:
     - Staff overtime for opening / closing valves: €365.000
     - Repairing additional reported breaks: €325.000
   TOTAL: €970.000

2. Additional estimated costs after Continuous Supply was established:
   - Additional leakage (2010 – 2012): €1,700,000
   - Estimated cost of locating leaks: €175,000
   - Estimated cost of repairing leaks: €125,000
   TOTAL: €2,000,000
Thank you

Nicos Neocleous
Acting Chief Water Officer
Water Development Department
Republic of Cyprus
Email: nicneocleous@gmail.com
Tel.: +357 99 687 608

Bambos Charalambous
NRW and Water Utility Specialist
World Bank Consultant
Email: bcharalambous@cytanet.com.cy
Tel.: +357 99 612 109