



# MEDITERRANEAN STRATEGY FOR SUSTAINABLE DEVELOPMENT

## WATER USE EFFICIENCY

## NATIONAL STUDY OF CYPRUS

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**Plan Bleu**

Regional Activity Centre

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**SUMMARY PAPER ON  
WATER USE EFFICIENCY IN CYPRUS**

Under the aegis of the Water Development Department and Plan Bleu

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1. Introduction.....	2
2. Priority actions.....	2
3. National efficiency improvement objectives.....	6
4. Policies and measures and projects implemented.....	7
5. Performance indicators used.....	14
6. Potential financial savings through water demand management.....	15
6.1. Case studies.....	16
6.2. Method used of economic assessment.....	19
7. Annexes.....	19

## **1. Introduction**

The report prepared on the invitation of Blue Plan, presents a national analysis of the basic data for Cyprus that could be used for calculating the water efficiency index, assessing the progress made in terms of water savings and identifying priority actions to be introduced in order to improve water use under national strategies for improving water efficiency. On the basis of these national studies the Blue Plan expects to produce a regional summary that would encourage the exchange of experience and sharing of good practices between countries.

This report is in accord to the first priority field of action of the framework strategy in improving integrated water resources and demand management as per the “Mediterranean Strategy for Sustainable Development” (MSSD) adopted in November 2005 and endorsed by the Barcelona Euro-Mediterranean Summit.

The assistance, discussion and provision of data by Agathi Hadjipanteli, Charis Omorphos and Yianna Nicolaou, Executive Engineers of the Water Development Department is greatly acknowledged.

## **2. Priority actions**

The management of scarce water resources is among the most significant challenges faced by the Cypriot government. Already one of the most water-poor countries among the E.U. member states, Cyprus has to confront an increasing water demand by tourism whilst the demand for agriculture still continues to be high. With most of the favourable water development schemes already implemented, Cyprus had to turn to non – conventional sources such as desalination and re-use of treated effluent. At the same time it has been realized that the key to a sustainable future lies in managing water demand and improve the water use efficiency.

Improved efficiency in drinking, irrigation and industrial water use is required. Given that the field irrigation efficiency is already generally high, attention needs to be paid to the conveyance efficiency to the irrigated plots. Furthermore, since the industrial water use is very limited, attention has to be paid to the domestic sector where unaccounted water is reported to be high mainly due to an aging water infrastructure, especially in the rural areas. The public awareness regarding the severity of the water problem is associated rather with a temporary on-going dry spell rather than with an endemic water shortage, a misconception that needs to be corrected.

In the text that follows emphasis is placed on priority actions that need to be introduced to improve the collection of basic data for the production of the efficiency index's various components, accompanied by a cost evaluation for such actions; this is deemed as the first step for taking corrective actions to ameliorate the situation and improve the water use efficiency. The priority actions are:

a) General actions

- Establish a focal point that would be responsible for promoting collection and processing of the basic data and the production of the water use efficiency index's various components. Such a unit could be set up within the Water Development Department (WDD) and could involve one Technical Assistant full time and a supervising Engineer working part-time (estimated cost €40000 per year).
- Acquire computing facilities (PC, printer, software) to maintain database for water use information, including development of such database (€2500 once).
- Telephone line, fax, Internet facilities (estimated €1000 once and €750 per year)
- Develop network of correspondents (For domestic supply: Treatment Plant managers, WDD District Offices monitoring borehole and spring supply of government domestic supply schemes, Water Boards, Municipality water managers, Village water authorities, large tourist developments and other major consumers outside regular supply networks. For Irrigation water efficiency: Major Government Water Works' managers including surface, groundwater and treated effluent, for each Irrigation Scheme, Irrigation Division treasurers and other major irrigators. For Industrial Water Efficiency: Major Industrial water consumers managers)
- Develop reporting templates for water volumes produced, distributed, invoiced and paid as well as methods for analysis and reporting.
- Connect with major existing databases (such as WDD's Water Invoicing System database, major Water Boards and Municipality databases)
- Focus on water audits as a tool to evaluate water use efficiency. As the name implies, a "Water Audit" can be defined as the process of conducting a complete inventory of all water fixtures from the supply source, to the distribution network, to the consumer and identifying leakage locations within it. The quantities of water produced and or purchased compared to the quantities invoiced and or paid by the consumers should provide a good approximation of the network efficiency.
- Organize training workshops for correspondents according to sector (domestic, irrigation, industry) for monitoring and reporting preferably at regional level (3 sectors x 3 regions x €3000 per event = € 27000 once).
- Printing and campaign material (€9000 once)

b) Drinking Water use efficiency:

- Identify major water treatment plants and maintain register on water produced and distributed. The same for groundwater quantities (borehole and spring) in major domestic supply schemes.
- Develop a Village Water Supply (VWS) register with particular information on water produced by well/borehole and or spring (including meter readings or information allowing assessment of water produced – yield per hour, hours per day of operation, service reservoir size etc.).
- Identify major clients receiving water in bulk from WDD and maintain register of water distributed to them.
- Obtain information from major water utility clients on the volumes of water distributed and invoiced.
- Work together with major water utilities and VWS authorities in identifying water wastage in water supply, known as unaccounted-for water.
- The problem of diminished reliability of water-meters on the occasion of water rationing (interrupted supply) caused by measuring air finding its way into the system should be investigated and researched together with the major water utility suppliers (Water Boards).
- Maintain register of Village Water Supply quantities of water invoiced and paid by consumers.
- Consider support in maintaining and or installing water-meters at VWS sources (estimated cost 30 water-meters x €1000 purchase & installation = €30000 once and €10000 per year for assistance in general water-meter maintenance)

c) Irrigation Water Use Efficiency

- Identify major Irrigation Schemes depending on Government Water Works and maintain register of quantities released for transport at the source by networks up to the agricultural plots and the quantities actually distributed to the plots. This should provide the losses and thus the efficiency of irrigation water transports upstream the agricultural plots.
- Survey major Irrigation Schemes and identify irrigation systems used and determine average plot irrigation efficiency (use agriculturists, existing irrigation demonstration experiments etc.) (Assuming 5 day survey by 2 persons in 6 major Irrigation Schemes = 60 man-days x €150 per day including expenses = € 9000 once).
- Identify main Irrigation Divisions outside Government Water Works and maintain register of water produced and actually used. Determine irrigation systems and efficiency used. Consider providing/installing water-meter at source (estimated cost for assumed 15 Irrigation Divisions at €1000 per water-meter = €15000 once).
- Identify major irrigators (large plantations) and maintain register of water produced and used.
- The same information as above should be maintained for the re-use of treated effluent for irrigation.
- Obtain information from major water utility clients on the volumes of water distributed and invoiced (WDD Water Invoicing System database and major Irrigation Divisions).

**c) Industrial water efficiency**

- Identify major Industries consuming water depending on Government Water Works (and or major water utilities) and maintain register of quantities recycled within the industry.
- Maintain register of water volumes consumed by the industrial process (volume provided to industry and volume recycled).
- Consider supporting the installation/maintenance of water-meter at selected industries/locations ((estimated cost for assumed 5 Industries at €1000 per water-meter = €5000 once).

**Table 1: The priority actions and costs to improve the collection of basic data and the production of the efficiency indices various components.**

Priority Action	Estimated cost in €	
	Once	Recurrent per year
<b>GENERAL ACTIONS</b>		
Focal Point for Efficiency monitoring		40000
Computing facilities - software	2500	
Telephone, fax, internet	1000	750
Develop correspondents network	-	-
Develop reporting templates	-	-
Connect to major databases	-	-
Focus on 'Water audits'	-	-
Training workshops for correspondents	27000	
Printing and campaign material	9000	
<b>Sub-total</b>	<b>39500</b>	<b>40750</b>
<b>DRINKING WATER EFFICIENCY</b>		
Register of water produced/distributed	-	-
VWS register of sources and yield	-	-
Register of major bulk water consumers and quantities	-	-
Info from utilities on volumes distributed and invoiced	-	-
Cooperate with utilities/VWS for unaccounted water	-	-
Research on air measured in water meters	10000	-
Register of VWS quantities invoiced/paid	-	-
Support maintenance/installation of water meters at VWS sources	30000	10000
<b>Sub-total</b>	<b>40000</b>	<b>10000</b>
<b>IRRIGATION WATER EFFICIENCY</b>		
Major Irr. Schemes based on GWW/ Register quantities released/transported	-	-
Survey Irrig. Schemes plot irrigation efficiency	9000	
Register use of Irr. Div. Outside GWW – Install water-meters	15000	
Register of water produced/used of large plantations	-	-
Same info as above for Reuse of effluent	-	-
Info from Irrig. Div. On volume produced/invoiced	-	-
<b>Sub-total</b>	<b>24000</b>	
<b>INDUSTRIAL WATER EFFICIENCY</b>		
Register of major industries and quantity recycled	-	-
Register water consumed	-	-
Support installation of water-meter at selected	5000	

industries		
<b>Sub-total</b>	<b>5000</b>	
<b>GRAND TOTAL</b>	<b>108500</b>	<b>50750</b>

### 3. National efficiency improvement objectives

Although there is no explicit National Strategy for improving water use efficiency (sectoral and total) and no deadlines for achieving them are provided, this objective preoccupies and is prominently presented in all policies and plans of the Country on water.

Among the six basic objectives of the present National Water Policies and Plans, the following water use efficiency objectives are highlighted:

- To apply irrigation water in line with the actual crops water requirements, and
- To reduce losses from the urban water distribution systems and to increase the efficiency of domestic water uses.

The latest completed Development Plan for 1999 to 2003 had the following basic objective and specific aim regarding water works:

- To improve the operation, maintenance and control of the water works to ensure optimal exploitation of existing works;

The Strategic Development Plan 2007-2013 (Planning Bureau<sup>1</sup>) under the Priority Axis “Basic infrastructures in the Environment sector and Energy”, emphasizes the need for the improvement of the efficiency of domestic networks. Under the indicative classes of works, it highlights the replacement of domestic water networks.

In the Strategic Development Plan of 2004-2006<sup>2</sup> the following were among the proposed actions included in the “Integrated management of water resources” aiming at the safeguarding of long-term quality and sufficiency of water resources:

- Upgrading of the distribution networks of drinking water.
- Creation of a correct water conscience and application of a policy and incentives scheme for saving water.

The efficient use of available water has a prominent place in the basic water policy of the Government as outlined in the annual reports of the Water Development Department of 2003 to 2006<sup>3</sup>.

At a recent meeting of the Council of the European Union<sup>4</sup> at which Cyprus participated with its Deputy Permanent Representative, the Council adopted

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<sup>1</sup> Planning Bureau at website:  
<http://www.planning.gov.cy/planning/planning.nsf/Main?OpenFrameSet>

<sup>2</sup> <http://www.eukn.org/binaries/cyprus/bulk/policy/2005/10/strategic-development.pdf>

<sup>3</sup> Water Development Department (Annual Report 2003 -04-05-06)  
[http://www.moa.gov.cy/moa/wdd/WDD.nsf/All/A77EA45E638713DDC22572BB002EEBA3/\\$file/AnnualReport2006\\_eng.pdf?OpenElement](http://www.moa.gov.cy/moa/wdd/WDD.nsf/All/A77EA45E638713DDC22572BB002EEBA3/$file/AnnualReport2006_eng.pdf?OpenElement)

<sup>4</sup> COUNCIL OF THE EUROPEAN UNION Press Release 2826th on the Environment (30 October 2007) <http://www.consilium.europa.eu/Newsroom>

conclusions which, taking into account of the seriousness and the international dimension of water scarcity and droughts point to the need for a review of the EU's strategy in this area. Among the conclusions adopted by the Council<sup>5</sup> the following refer explicitly to the objectives of enhancement of the water efficiency and provide a time-frame for their implementation:

*“12. HIGHLIGHTS that the ineffective management of water resources is a fundamental problem which influences water scarcity and can induce additional impacts when a drought occurs, even though it cannot generate a drought in itself, the latter being a natural phenomenon; CONSIDERS that the implementation of the demand-side approach, the enhancement of water efficiency (e.g. reduction of leakages) and further educational measures must be a clear priority, even though in some circumstances it might be necessary to consider further approaches on the supply side to address the impacts of WS&D;*

*20. INVITES the Commission to present a follow-up report in 2008, including deadlines for the implementation of the measures identified in the communication; NOTES that this implementation process should bring together Member States and the Commission to exchange information and best practice and that any legislative initiatives should be based on an in-depth impact assessment; CONSIDERS that the need for further measures, namely on drought risk management, should be assessed taking into account these conclusions, experience gained with the implementation of the WFD, and the results from research and technical activities on WS&D which are currently in progress; INVITES the Commission, on this basis, and taking into account the international dimension, to review and further develop the evolving EU strategy for WS&D by 2012.”*

The long-term water scarcity management in Cyprus on the demand side encourages<sup>6</sup> the installation of improved farm irrigation systems and promotes the construction of modern efficient conveyance and distribution systems with minor losses. Leakage detection methods are applied on water distribution systems to reduce water losses and real time telemonitoring and telecontrol are now used in the most important projects to optimize operation and maintenance.

## **4. Policies and measures and projects implemented**

### **Drinking Water use efficiency**

In Cyprus the proportion of the non invoiced quantity of water varies between 18 to 38% depending on the water utility company (Water board /Municipality /Community). The natural losses from distribution networks constitute the major part

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<sup>5</sup> COUNCIL OF THE EUROPEAN UNION “Water scarcity and droughts

- Draft Council conclusions” 13888/07, 15 October 2007

<http://register.consilium.europa.eu/pdf/en/07/st13/st13888.en07.pdf>

<sup>6</sup> MED Joint Process WFD /EUWI (June 2006) “Water Scarcity management in the context of the WFD - Policy Summary” Water Scarcity Drafting Group

Appendix “Coping with Drought – The Experience of Cyprus” by Charis Omorphos WDD

of this quantity. It is estimated that the loss of water from the domestic water networks is of the order of 8 million cubic meters annually.

There are three sources readily available for the estimation of the Non Revenue Water (NRW) loss of domestic water: i) the annual report of the Auditor General, ii) the Water Invoicing System of the Water Development Department, and iii) the Water Boards of the three main cities.

- **The Auditor General:**

The Auditor General of the Republic audits the accounts of the Municipalities, Community Boards and Town Water Boards annually. In this line the non-revenue water is very often identified and reported. Table 2 presents some of this information for a selected number of water utilities that shows the extent of the problem and its variation throughout the years.

**Table 2: NRW for selected Municipalities /Communities and the Water Boards as per the Auditor General's reports for 2001-2005**

Municipality	Average Consumption (mil. m <sup>3</sup> /y)	NRW in %					Ave. Eff. (%)	Est. Quant. Lost (mil.m <sup>3</sup> /y)
		2001	2002	2003	2004	2005		
Pafos	3.8 -4.5	29.4	29.5				29.4	1.2
Aradippou	1.4-1.5	49	41	33	41		41.0	0.6
Agia Napa	2.1-2.4	31.0	34.3	29.0	45.0		34.8	0.8
Dherynia	0.33-0.45	23.8	29.6	36.0	27.0		29.1	0.1
Germasogeia	1.7-1.8		32.3		30.0		31.1	0.5
Idalion	0.7-0.8		29	24	28	26	27.7	0.2
<b>Average</b>							<b>31.9</b>	<b>3.4</b>
<b>Community Board</b>								
Tseri	0.98-1.2			26.0	26.5	27.7	26.7	0.3
Geri	0.16-0.22		21.9	31.8	34.5	38.7	31.7	0.1
<b>Average</b>							<b>29.2</b>	<b>0.4</b>
<b>Water Boards</b>								
Nicosia	15.0-18.4	20.45	25.42	22.08	24.45	20.59	22.6	3.8
Limassol	11.4-13.7	18.6	16.4	14.8	17.4	19.0	17.2	2.1
Larnaca	5.6-5.7	36	31.5	30.5	28.0	28.0	30.8	1.7
<b>Average</b>							<b>23.5</b>	<b>7.6</b>

From the Table 2 above it appears that the NRW for the Municipalities and Communities is larger than that of the Water Boards. A gross estimate of the water lost is of the order of 8 million cubic meters for the selected water utilities.

The high losses are attributed to aging water supply networks, ongoing works on sewage systems and the old water meters. Efforts are under way for leakage tracing equipment and for instant corrective measures, replacement of old network and meters.

- **The Water Development Department:**

The Water Development Department maintains a “Water Invoicing System” for all the water that is sold from the Government Water Works, country-wide, either in bulk to local authorities for drinking or to individuals for irrigation. Table 3 presents the quantities consumed and invoiced compared to the quantities supplied at the source for the years 1996 – 1999 and 2004-2007.

**Table 3: Consumption (invoiced) water for domestic/irrigation from the Government Water Works and the respective total supply of water to the distribution network (all in million m<sup>3</sup>)  
(Source: WDD 2008)**

Year	BULK DOMESTIC WATER			IRRIGATION WATER		
	Supply to network	Consumption /invoiced	Non – invoiced (%)*	Supply to network	Consumption /invoiced	Non – invoiced (%)
1996	48.9	50.0	-2.25	52.2	44.311	15.11
1997	44.8	45.3	-1.12	28.0	26.662	4.78
1998	42.7	43.0	-0.7	26.0	23.867	8.20
1999	48.2	42.7	11.4	37.0	34.147	7.71
Data Gap						
2004	68.900	61.716	10.4	68.6	53.989	21.30
2005	73.300	66.790	8.88	62.8	54.080	13.88
2006	73.700	67.462	8.46	48.7	41.991	13.78
2007	73.900	69.730	4.17	35.6	24.672	30.70
<b>2004-7 average</b>			<b>7.98</b>			<b>19.91</b>

\*For the years 1996 – 1998 other sources contributed to the supply (springs, boreholes etc.) which were not recorded in the Supply to network.

According to the Table 3 above the main network losses for domestic water up to the point where the water utilities purchase the water in bulk, average to about 8% for the period of 2004 to 2007. This represents in effect the conveyance losses.

Most of the losses are attributed to faulty water-meter readings rather than pipeline losses<sup>7</sup>.

- **Water Boards:**

The Water Boards which are the main water distribution utilities of the three main cities in Cyprus (about 60% of the drinking water supply) maintain their own NRW statistics. These are shown in Table 4 for a sequence of years as early as 1985. The NRW quantity for Limassol appears to be reducing due to the serious efforts undertaken by this utility explained further as a case study in the following section of the report.

Overall it appears that the NRW for the Water Boards is in the range of 19.0 to 21.1 %.

A recent study (1999) for the Limassol Water Board, with completion horizon of 2010, has shown needs for upgrading the network to the value of €5.0 million not including replacement of asbestos-cement pipes. Since then €2.5 million has been spent for replacing central conveyors. The Limassol Water Board claims as a result of implementing a program for loss control, a reduction of the NRW from 27% in 1987 to 17% by 2006. Also the incidents of pipe failure have been reduced.

All the Water Boards attribute the losses to untimely detected leakage or damages on the network caused by third party (construction works etc.) and inaccurate water-

<sup>7</sup> WDD (personal communication)

meter readings. Also, a large part of the network set more than 40 years ago is past its useful network life and needs to be replaced.

**Table 4: Non revenue consumption or Loss (in %) as reported by the Water Boards of the main cities of the island (source: websites of Water Boards)**

Year	Nicosia	Limassol	Larnaca	Year	Nicosia	Limassol	Larnaca
1983			19.5	1996	15.80	13.5	21.0
1984			17.0	1997	11.30	13	15.0
1985	28.93	22	30.0	1998	10.50	13.5	13.5
1986	25.23	27	19.0	1999	16.40	8	14.5
1987	23.22	27	20.0	2000	12.80	14	36.0
1988	21.51	24.5	18.0	2001	20.45	18	32.0
1989	19.79	26.5	16.0	2002	25.22	17	31.0
1990	19.63	24	13.5	2003	22.69	15	30.5
1991	19.30	16.5	6.0	2004	24.38	17	28.0
1992	18.10	23	15.5	2005	20.59		28.0
1993	17.80	21.5	21.0	2006			
1994	17.50	19.5	17.0	2007			
1995	17.60	19.5	24.0	2008			
<b>Average non revenue consumption or loss</b>					<b>19.5</b>	<b>19.0</b>	<b>21.1</b>

The Water Development Department has an ongoing program for the replacement and improvement of the village water distribution networks. As an example, the 2007 budget for such works is shown on Table 5 where a total expenditure of about €3.4 million was earmarked for 28 villages. The same for 2008 for 26 villages amounted to €5.9 million.

Elsewhere in the budget, allowance is made for the promotion of measures for the reduction of unregistered leakages in the Municipalities and Communities that are Government Water Works consumers. For 2008 the sum of €512600 were earmarked within the article “Campaigns for water conservation” as part of other activities with the same target.

**Table 5: Budgeted Government expenditure (2007) for domestic supply network replacement and improvement**

District	No. of villages	Total expenditure (€)	Community contribution (€)
Nicosia	3	375900	25600
Limassol	4	758600	98250
Wine-villages development	4	214400	33150
S. Marathasa	2	333200	16700
Larnaca	3	299000	41300
Famagusta	1	111000	33300
Pafos	11	1293400	69800
<b>Total</b>	<b>28</b>	<b>3385500</b>	<b>318100</b>

#### **d) Irrigation Water Use Efficiency**

According to data kept by the Water Development Department<sup>8</sup> for all the water that is sold from the Government Water Works, country-wide, either in bulk or to individuals for irrigation, the derived Non Invoiced Water for the years of 2004 – 2007 averages to 19.91% (Table 3). This represents the losses of irrigation water use upstream of the agricultural plots.

Most of these losses are attributed to faulty water-meter readings rather than to leakages of the network.

In the text that follows the plot irrigation water use efficiency is dealt with in further detail.

### **The water use improvement project**

Under the “Water Use Improvement Project” which started in 1965 the Government provided the farmers with technical and financial assistance to convert to modern irrigation systems and to the application of irrigation schedules in compliance with the actual crop water needs, aiming at the conservation of water resources at the farm level. The project was originally planned for a five year period but it was extended successfully for more than three decades with remarkable results.

The financial assistance consisted of low interest loans and subsidies to install improved irrigation systems. Free technical assistance was offered in the form of planning and design of the irrigation system, the preparation of the irrigation schedule and the follow-up of the installation operation.

The drip method was initially used for irrigation of high value crops only but later with the reduction of the installation cost the use of drippers, mini-sprinklers and low capacity sprinklers was expanded for irrigating trees and field vegetables.

At present nearly 95% of the irrigated area in Cyprus is equipped with low-medium pressure improved irrigation systems, mostly micro irrigation, with higher than 80% average water use efficiency<sup>9</sup>. Table 6 shows the installation of improved irrigation systems in Cyprus through this project in the period of 1965 to 2000. It should be noted that systems for some additional 10000 ha were designed, the installation of which was undertaken directly by the farmers without participating in the project.

During the first decade of the project’s life (1965-1974) the gross benefits were estimated<sup>10</sup> at €23.1 million and the costs at €2.225 million for an area of approximately 5670 ha. The B/C ratio was 10.3:1 and the Net Present Value €20.8 million. Similar results were found for the subsequent periods.

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<sup>8</sup> Water Development Department (personal communication)

<sup>9</sup> Papadopoulos, C. Metochis and D. Chimonidou (2004) “IRRIGATION SYSTEMS PERFORMANCE: CASE STUDY OF CYPRUS”, Options méditerranéennes, Series B, n°52 Irrigation Systems Performance

<sup>10</sup> A. Phocaides (2002) IRRIGATION ADVISORY SERVICES IN CYPRUS  
Irrigation Advisory Services and Participatory Extension in Irrigation  
Management Workshop organised by FAO – ICID, Montreal, Canada

**Table 6: Installation of improved irrigation systems 1965-2000 through the Water Use Improvement Project (source: Phocaidis 2002)**

Period	No. of farmers	Area (ha)	Cost* (Euros)
1965-1974	2751	5670	1 844 056
1975-1984	7305	8415	10 717 669
1985-1994	6520	5490	12 059 018
1995-2000	1001	782	1 940 680
Total	17577	21992	€26 561 423

\*converted to euro on the basis of actual cost in Cyprus pounds at the time.

In Table 7 the progress of irrigated land and field irrigation efficiency in Cyprus in the period of 1960 to 2000 is shown.

**Table 7: Irrigated land at various irrigation systems (hax10<sup>3</sup>) and field irrigation efficiency (%) (source: Phocaidis 2002)**

Year	1960	1965	1970	1975	1980	1985	1990	1995	2000
Irrigated land	23.2	31.6	38.3	23.7	27.2	30.7	36.1	35.5	33.3
Gravity Irrigation	23.1	31.6	28.5	13.5	8.8	nil	nil	nil	nil
Piped Surf. irrigation	nil	nil	6.0	2.0	5.0	9.8	12.5	8.3	3.0
Improved Irrigation	nil	nil	3.75	8.22	13.4	20.9	23.6	27.1	>30
Ave. Efficiency	<45	50	56	64	71	80	80	82	84

It has been calculated<sup>11</sup> that the annual savings due to the micro irrigation techniques with high application efficiencies are of the order of 75 million cubic meters. Furthermore, there are savings in fuel from reduced pumping and mainly in manpower. The economic return per unit of water was increased. The increase in yield is estimated to be in the range of 15 and 76%.

There is still scope for further increase of water use efficiency in the hilly areas where land parcels are small and also in some non-government schemes.

A problem that needs attention<sup>12</sup> is the losses from the main irrigation networks since most farmers in Cyprus, being part-time farmers, tend to irrigate at the end of the day. This burst of consumption generates drops in the pipeline pressure which damages the fittings and develops leaks along the main pipelines. Similarly the network ends are not free from leakage, a problem that is difficult to monitor at the individual plot scale.

### **The Rural Development Plan (2007-2013)**

In the ongoing Rural Development Plan of 2007-2013 there is a Measure for the “Investment in agricultural and animal husbandry enterprises” aiming at the

<sup>11</sup> A. Phocaidis (2002) IRRIGATION ADVISORY SERVICES IN CYPRUS  
Irrigation Advisory Services and Participatory Extension in Irrigation  
Management Workshop organised by FAO – ICID, Montreal, Canada

<sup>12</sup> Association Agreau (2004) ENSA 2 Promotion 153 THE CYPRIOT AGRICULTURE FACING  
WATER MANAGEMENT PROBLEMS ATP 2003-2004 <http://agr.eau.free.fr>

improvement of competitiveness through enhancement of the natural potential and the modernization and restructuring of farming to sustain competitive pressures from similar produce from abroad. Under this Measure, modernization, new technology and the protection of water resources are included. More specifically, the installation of improved systems of irrigation are eligible for 40-50% grants for the cultivation of Olives, Citrus, deciduous trees, vegetables, flowers and aromatic plants. For new farmers an additional 10% of the expenditure is granted. The overall public spending on this measure is earmarked at €40 million.

The farmers in Cyprus have in the past 30 – 40 years been fully convinced about the effectiveness of improved irrigation systems through mainly the well planned and successfully executed improved irrigation Project. Today, the farmers themselves invest in improved irrigation systems due to the ease of operation that provides them, the lack of manpower, the limited water resources and, the increased yields that accrue. The initial effort and direct intervention by Government on this matter has been reduced in the last few years but the farmers themselves have taken up the matter.

#### e) **Industrial water use efficiency**

The industrial sector uses much lower quantities of water compared to the agriculture, domestic and tourism sectors. In the Environment Service database some 262 industries are listed. A large number of them are established within designated industrial areas and others are spread out all over the country. Some 41 industries are considered as being significant. The broader industrial sector mainly consists of light manufacturing, mining and electricity. The industrial sector uses the lowest volume of water, compared to the agriculture, domestic and tourism sectors. The industrial sector seems to follow a stabilising trend, both in terms of employment, as well as in terms of economic output. It has been estimated<sup>13</sup> that the total annual water demand of the Industry is of the order of 4.0 million (year 2005) and may increase to 5.0 million cubic meters by the year 2010.

There are no estimates for the efficiency index of industrial water use but these are expected to be of the same order as for the domestic supplies as indicated above since most of the Industries receive water from the Water Boards and it is difficult to ascertain the Industrial Water Efficiency separately.

By applying the same rates of current losses as for the domestic supply, the annual savings that could accrue if these losses are reduced to 15% would amount to 0.2 to 0.5 million cubic meters for current use to 0.3 to 1.0 million cubic meters by 2020.

Control of the industrial water use efficiency is done during the issuing of the permits by the Environment Service and subsequent monitoring for all industries especially those falling under the Integrated Pollution Prevention and Control (IPPC) Council Directive 96/61/EC and the corresponding Cyprus Law N56(I) / 2003.

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<sup>13</sup> WDD/FAO (2002) “ Re-evaluation of the Water Resources and Demand of the Island of Cyprus”, WDD, MANRE.

More specifically the use of water is controlled and where necessary measures for the prevention and recovery of waste generated by the installation are taken. The reuse of treated liquid wastes is encouraged and the water consumption must be recorded.

Due to the minute quantities of water used by the industry in Cyprus no specific policies and measures are adopted towards improving the industrial water efficiency other than those items specified under the IPPC Directive.

## **5. Performance indicators used**

There are no formal performance indicators to assess the above actions other than:

- The recorded Non Revenue Water (NRW) loss of domestic water. Information on this is available at the Water Boards and Municipalities and most of the Communities.
- The annual report of the Auditor General that audits the accounts of the Water Boards and Municipalities, and
- Ad hoc study of the Village Water Supply schemes regarding the water quantities at source and the volumes of water billed to their consumers.

For the main conveyance network efficiency the performance indicators used are the quantity produced and provided at source compared to the actual quantity of water invoiced (either bulk quantities or to individual consumers) as maintained by the Water Invoicing System of the Water Development Department which controls the supply for domestic purpose from all Government Water Works. The same applies for the water that is provided for irrigation purposes.

The performance indicators from year to year can not be considered as fully reliable since the effectiveness of the measures taken from year to year is masked on many occasions by the availability of water. High performance (translated in reduced losses) may be associated to reduced pressure in the network due to water supply cuts rather than effective control of leakages.

Another performance indicator might be the budgeted annual Government expenditure for domestic supply network replacement and improvement and the actual implementation of this measure.

In the Irrigation sector the performance indicator under the implementation of the “water use improvement project” is the annual number of applications received by farmers and the extent of land equipped with improved irrigation systems.

Similarly the progress of irrigated land and field irrigation efficiency in Cyprus is monitored annually by the Department of Agriculture through its Extension Offices and constitutes another performance indicator.

The number of farmers applying for grants for installing improved irrigation systems under the ongoing Rural Development Plan (2007-2013) will also be another performance indicator.

For the industrial water use efficiency the performance indicator will be the IPPC licensing and the clauses in regard to water use and the subsequent monitoring of the level of implementation by each industry.

## **6. Potential financial savings through water demand management**

The possible actions for water demand management have been identified and are, in an order of priority: control of leakages; increase of water prices; reduction of demand per capita through conservation education; reduction of the total area of irrigated crops; change of crop planting patterns to more efficient crops; further improvement of irrigation efficiency; limit of water uses; and, use of marginal water for certain uses.

The potential financial savings to be made through the implementation of water demand management measures are difficult to be assessed since no such programs are explicitly defined. Improved efficiency in the various sectors of activity using the water demand management policies have been dealt with in another report<sup>14</sup>. In that report the control of leakages and improvement of the irrigation efficiency were highlighted.

The efficiency index WAT\_PO1 for domestic water was determined<sup>14</sup> to average 76% for the cities and 64% for some major municipalities and the villages. Bringing this index to 85% is generally considered as economical. Further control of leakage may be uneconomic due to diminishing marginal benefits. The possible savings in water through this measure are expected to be of the order of 4 to 12 million cubic meters per year on the current demand of 67 million cubic meters per year increasing to 6 to 18 million cubic meters per year for the projected demand of 100 million cubic meters per year by 2020.

On the basis of the above and considering the average price paid per cubic meter of desalinated water in the island of €0.66 the immediate potential financial savings could amount between €2.64 and €7.92 million/yr on the current demand increasing to the range of €3.96 and €11.88 million/yr by 2020.

It should be noted that the “Drinking Water Efficiency” as shown on the WAT-PO1 spreadsheet template that accompanies this summary report, refers to conveyance losses for the bulk supplies implemented by the WDD only. To this efficiency the distribution efficiency by the Water Boards (which account for 60% of the supply) and of the other communities (40% of the supply) should be added. The estimated values averaged out for all distributors are: 76.7% (1996), 78.9 (1997), 79.3 (1998), 79 (1999), 74.2 (2004), 72.7 (2005), and 73.1% (2006). The reported values provided by the Water Boards refer to “non- revenue water” (or loss) per year thus the quantities produced and sold as required by the template can not be inserted (see note

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<sup>14</sup> Iacovos IACOVIDES (2007) National Report on « Monitoring progress and promotion of water demand management policies in Cyprus » Under the aegis of the Water Development Department and Plan Bleu

on template). Similarly, the irrigation efficiency refers to quantities provided for the supply from government waterworks. No data are available for irrigation outside government water works although plot irrigation efficiencies are similar.

For the irrigation water the water efficiency index is already quite high. Irrigation systems generally consist of closed systems with an overall conveyance efficiency averaging 85 - 90 % and the field application efficiency averages 82-84%. Thus, with the present technology no significant additional savings could be expected. Detailed information as to the surface equipped with modern irrigation systems is not readily available but it is estimated that currently the on farm irrigation systems comprise 90% micro-irrigation, 5% sprinkler irrigation and 5% surface irrigation.

Industrial water efficiency falls within the domestic supply efficiency and is already included there.

### 6.1. Case studies

A case study for the control of leakages in a domestic water distribution network is presented here below showing the methodology and approach followed and the results achieved:

#### **The Water Board of Lemesos Case-Study**<sup>15</sup>

The network of the Water Board of Lemesos, on the south coast of the island of Cyprus, is over 50 years of age and serves approximately 170,000 residents through approximately 64,000 consumer meters in an area of 70 km<sup>2</sup>. The annual volume of potable water distributed through the network of pipes, of approximate length 795km, is about 13.7x10<sup>6</sup> m<sup>3</sup> and of value €7.0 million.

The Water Board of Lemesos has maintained records of its operational activities since 1963, which include production of water from sources, distribution through district meters and consumption from consumer meters. A Supervisory Control and Data Acquisition (SCADA) telemetry system is connected to meter readings of water sources.

The Water Board established<sup>16</sup> a “water audit” system and has over the years developed its infrastructure in such a way so as to be able to account efficiently and accurately for all water produced or “lost” or “non-revenue water” (Figure 1). Reduction and control of water loss was achieved through the application of a holistic strategy integral part of which is the establishment of a strategy for pipe break incidents (“pipe breaks policy”).

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<sup>15</sup>S. Christodoulou, C. Charalambous, A. Adamou “ Managing the “Repair or Replace” dilemma on Water Leakages”

<sup>16</sup> B. Charalambous (2005) Experiences in DMA redesign at the Water Board of Lemesos, Cyprus

<http://www.findmoreleaks.com/downloads/Experiences%20in%20DMA%20redesign%20at%20the%20WBL.pdf>

A water audit for the year 2003 using the International Water Association (IWA) ‘best practice’ water balance and terminology is shown in Table 8 for the whole of the Water Board’s supply system.

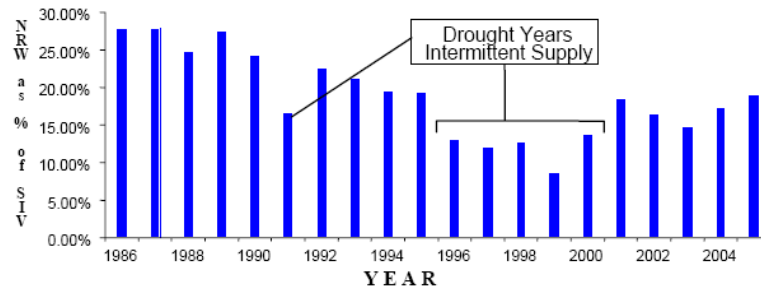


Figure 1. Non-revenue water.

In addition to the reported bursts, the Water Board of Lemesos through its strategy for active leakage control maintains records of unreported bursts located by means of acoustic leak localizers. Typical results<sup>17</sup> are shown in Table 9. Details of all such breaks are maintained and included in the analysis, together with the reported bursts.

In late 1980 the Water Board embarked on a detailed program of leakage management. The efforts made and importance placed by the Water Board for proper leakage management is reflected in the reduction of the non-revenue water over the years, from 25% of total water produced in 1987 to about 16% in 2002, as shown Table 10.

Table 8: Water Balance (m3) for the year 2003

<sup>17</sup> C. N. Charalambous (2003) EFFECTIVE WATER UTILITY MANAGEMENT (Conference on “Integrated Water Management, Policy Aspects 19-21 June 2003 ARI), Water Board of Lemesos

System Input Volume 11.985.560 100,00%		Billed Authorised Consumption 10.216.698 85,24%	Billed metered consumption (including water exported) 10.216.698 85,24%	Revenue water 10.216.698 85,24%
			Billed unmetered consumption Zero	
	Authorised Consumption 10.276.626 85,74%	Unbilled Authorised Consumption 59.928 0,50%	Unbilled metered consumption Zero	Non-revenue water 1.768.862 14,76%
			Unbilled unmetered consumption 59.928 0,50%	
	Water Losses 1.708.934 14,26%	Apparent Losses 299.639 2,50%	Unauthorised use 59.928 0,50%	
			Metering inaccuracies 239.711 2,00%	
		Real Losses 1.409.295 11,76%	Real losses on raw water mains and at the treatment works Zero	
			Leakage on transmission and/or distribution mains 80.458 0,67%	
			Leakage and overflows at transmission and/or distribution storage tanks 11.986 0,10%	
			Leakage on service connections up to the metering point 268.913 2,24%	
Detectable Losses 1.047.938 8,74%				

**Table 9: Unreported bursts – identified and repaired**

Type of pipe	Number of bursts		Percentage per type	
	1999	2002	1999	2002
20mm MDPE	7	7	39%	44%
32mm MDPE	9	8		
100mm AC mains	10	10		
150mm AC mains	12	9	61%	56%
200mm AC mains	3	0		
TOTAL	41	34	100%	100%
Estimated water saved	140,000 m <sup>3</sup>	110,000 m <sup>3</sup>		
Worth of water saved	US\$ 45,000	US\$ 35,000		

The Water Losses from the system are made up of Apparent Losses and Real Losses. These losses together with the Unbilled Authorised Consumption comprise the Non-Revenue Water (NRW).

The Apparent Losses, consist of two main components: (i) metering inaccuracies (2% of billed metered consumption), and (ii) Unauthorised Consumption (0.5% of billed metered consumption).

The Real Water Losses, or “physical losses”, is the annual volumes of water lost from the system through all types of leaks and overflows from reservoirs and from bursts in mains and service connections up to the point of customer metering, all within the District Metered Areas or DMAs.

The water meter management program, in which some 6000 meters are replaced annually, includes:

- Periodical checking and replacement if necessary of all source, storage and DMA meters,
- Use of high accuracy domestic meters.
- Meter reading and billing error minimization with the use of portable meter reader recorders.

The DMA redesign and the application of pressure reduction has produced favourable results with both background leakage and locatable losses being reduced by approximately 38%. Furthermore the frequency of reported leaks was reduced by approximately 41%. The overall pressure reduction for the fifteen DMAs was of the order of 32%.

The target of the Water Board of Lemesos is to reduce the Non Revenue Water to about 8% of the system input volume, which is considered to be the economic level of leakage. The Water Board demand forecasts indicate an increase of approximately 30% by the year 2020 and the leakage reduction will go some way towards offsetting this increase in demand as well as a provide considerable cost saving.

**Table 10: Non-revenue water expressed as a % of water production**

<b>YEAR</b>	<b>Water Losses (%)</b>	<b>YEAR</b>	<b>Water Losses (%)</b>	<b>YEAR</b>	<b>Water Losses (%)</b>
1985	22	1991	16	1997	12
1986	27	1992	23	1998	13
1987	27	1993	21	1999	8
1988	25	1994	19	2000	14
1989	27	1995	19	2001	18
1990	24	1996	13	2002	16

## 6.2. Method used of economic assessment

The method used for the economic assessment of the potential financial savings has been based on the feasible water savings that could be derived from the control of leakage in domestic supply at the cost of the average desalinated water price currently applicable in Cyprus.

## 7. Annexes

- I. The Water efficiency index (total and by sector)
- II. Comments on source, frequency and data availability, coverage, access, etc.