Evaluating Economic Policy Instruments for Sustainable Water Management in Europe

WP3 EX-POST Case studies Subsidies for Drinking Water Conservation in Cyprus

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Executive Summary

Definition of the analysed EPI and purpose

This study investigates the four subsidies for drinking water conservation initiated in Cyprus in 1997 by the Water Development Department (WDD). At the beginning, the subsidies encouraged the construction of domestic boreholes for garden irrigation and the connection of a borehole to toilet cisterns for flushing. These were followed in 1999 by additional subsidies to install domestic grey water recycling systems, and hot water recirculators. During the same period (1997) public water supply of desalinated water has been introduced as a source for domestic water to meet the deficit resulting from the growing demand. The rationale and underlining policy objective of the WDD on launching this EPI was to reduce demand for distributed drinking water in households (part of which was now coming from desalination) that is too expensive to be used for gardens and toilet flashing, especially during drought periods.

Introduction

The WDD was the single responsible entity involved in the design and implementation of the subsidies. The subsidies were granted following an application submission by the beneficiary and two inspections prior to the initiation (for approval) and after the finalization (for consistency check) of the associated works. In the case of drilling a borehole, a permit was first to be obtained by the local District Office. Regarding monitoring and enforcement, a cap of 250m^3 groundwater abstraction per year was imposed to the new boreholes, the meters though were not checked for compliance by the WDD, nor have any other safeguarding mechanisms after start-up been implemented by the WDD. The amount of the subsidy was formulated at 700€ for the boreholes drilling or connection to toilet cisterns, 220€ and 3,000€ for the installation of recirculators and grey water recycling systems respectively. These prices are applicable in 2009, yet the subsidies were initiated at much lower grants which gradually increased. In 2007-08 extreme drought influenced the beneficiaries into heavily applying for the subsidies which was probably driven from their will to secure water. Regarding the EPI's design, no detailed study prior to the launch of the subsidies has been identified that assesses their impact and effectiveness or identifies a logical basis on how the subsidy amount has been set, with the exception of a pilot study on grey water recycling in 7 establishments in Nicosia (5 households, 1 hotel, 1 stadium) hat was run for 1.5 years prior to the subsidy as experimental work and identified the water saving potential. Similarly, post-implementation evaluation was practically inexistent, apart for one identified follow-up study to assess the actual performance of boreholes for garden irrigation: in 2004, potable water consumption of 20-30 households was monitored in a suburb of Nicosia, 12 months before the installation of a borehole and 12 months after the installation of a borehole, and concluded a 27% saving.

Legislative setting and economic background

The most important economic sector of Cyprus is the tertiary sector, both in terms of economic output and employment, showing upward trends. The agricultural sector, on the contrary, has experienced downward trends. Nevertheless, when it comes to water use, out of a total of 254 mio m^3/year, about 62% is used for agricultural, 30% for domestic, 5% for tourism and 3% for industrial purposes.

In Cyprus water legislation was mostly developed during the colonial era (1928-1950). The most important laws around water management in Cyprus are the Government Waterworks Law (Cap. 341, 1959), the Wells Law (cap 351, 1959), the Water Supply (Municipal and Other Areas) Law (Cap 350), 25/1972, 31/1982, 172/1988, the Water (Domestic Purposes) Village Supplies Law (Cap 349), 66/1990, and after November 2010 the New Uniform Management of Water Resources Law which gives all the responsibilities of water management mostly to the WDD (including issuing of the borehole permits).

The relevant institutional setting is built in 3 levels: a policy level (cooperation among 4 Ministries, namely the Ministry of Agriculture, Natural Resources and Environment (MANR&E), the Ministry of the Interior, the Ministry of Finance and the Ministry of Commerce and Industry), an executive level (with responsible actors being the WDD of the MANR&E and the District Administration (DA) of the Ministry of Interior), and an end-user level (local organisations like the Municipal Water Boards, the Village Water Commissions, the Irrigation Divisions and Associations, the Sewerage Boards).

Regarding the domestic water supply, the WDD is currently responsible for the construction, operation, administration and management of all Government Water Works related to freshwater provision, and the bulk water supply provision for domestic use (collection and storage of water in reservoirs, treatment, distribution of potable water to the cities and villages - approximately 80%). At the users' level, the domestic water is supplied to the population by the Town Water Boards, the Municipality Boards and the Village/Community Boards, who obtain their bulk supplies from the WDD and partly from boreholes, subject to the prior approval of the Council of Ministers and the Parliament.

Brief description of results and impacts of the proposed EPI

From 1997-2010 a total of 13,172 subsidies have been granted (of which 59% for new boreholes, 34% for connection of boreholes to toilets, 6% for recirculators and 1% for grey water recycling systems installation). The vast majority (61%) of the subsidies were given in households of the Nicosia water district, 13% in Lemessos, 10% in Ammohostos, 9% in Larnaka and 9% in Pafos water districts. By looking at the temporal evolution of the number of subsidies as compared with the respective precipitation, it is observed that subsidies paid pick-up in periods of low precipitation/drought events, conveying a message that the motivation of the beneficiaries was securing uninterrupted water supply for their gardens, rather than conservation.

The cumulative drinking water savings (as estimated based on the number of subsidies and assumptions on potential savings) from all subsidies during the 14-year period 1998-2010 are about 12,420,240 m^3 (or 12.42 mio m^3) and represent 1.50% of the total 1998-2010 domestic water use and 3.37% of the total desalinated water provided by the public water supply system (PWSS) in 1998-2010. The above percentages vary from year to year. Although the EPI introduced savings in the drinking water supplied by the PWSS, its impact on the total domestic water use can not be clearly assessed, since the use of free groundwater may have led the beneficiaries to over-pump and irrationally use excess water. Although in the design of the subsidy meters were provisioned to be installed in the boreholes in order to measure the consumption, and a pumping cap of 250m^3/year has also been introduced, enforcement by the WDD was very loose (practically non-existent) and thus no regular monitoring of the boreholes' meters has been implemented in order to (a) check whether the cap has been respected, and (b) maintain a register of the total abstracted volumes. Furthermore, the borehole abstractions may have put additional pressure on the groundwater resources. WDD stated that the aquifers where subsidies were approved are marginal and of poor quality and thus practically not exploitable for many uses.

The water saved from the subsidies would probably have originated from desalination, thus it can also be translated to equivalent energy savings (due to the decrease in desalination production needs) and corresponding CO_2 emissions reduction. Each m^3 of water produced by desalination requires on average 4.5 KW, thus 3.43 KgCO2 are generated per m^3 of water produced. The subsidies granted from 1998-2010 resulted in a total 55,891,080 KWh of energy saving and 42,601 tones of CO_2 emissions saved for the entire period, or 3,277 tones/year on average.

The total amount of € paid in subsidies from 1997-2010 is about 5.5 million € (of which 59% for new boreholes, 34% for connection of boreholes to toilets, 3% for recirculators and 4% for grey water recycling systems installation). The overall average cost per m^3 saved from all the subsidies during the whole 1997-2010 period is 0.43€. To these costs though, transaction costs associated with the design and implementation of the EPI (e.g. expenses related to the inspections, labor expenses etc.) are not considered and thus should be added on top.

Conclusions and lessons learnt

At the beginning of the implementation, the EPI comes at a high cost, e.g. subsidies provided for connection of a borehole to toilet cisterns in 1997 and 1998 result in 2.83 and 1.52 € paid per m^3 water saved respectively. As the EPI implementation progresses and water saving is accumulating over the years, the unit cost is decreased as low as 0.10 €/m^3 (years 2001-2005). A time frame of about 3 years was thus required for the EPI to become cost-effective as compared to the selling prices of the Desalination Plants and water tariffs. From 2006 onwards the unit cost has highly and abruptly increased, reaching values higher than the desalinated water selling prices (maximum observed in 2007 was 2.5 €/m^3). This change is due to the fact that the payments were significantly increased, as well as the number of subsidies awarded (dramatic increase of 100-400% in some categories), supporting evidence that its cost-benefit clearly relates to the design parameters.

The overall performance of the EPI is subject to uncertainty. While drinking water conservation has likely been achieved, due to the fact that no monitoring was implemented all results are based on proxy calculations, and thus are subject to bias. The selection of boreholes as one of the subsidies creates ambiguity, regarding the adverse impacts on groundwater and the irrational use of a free water supply (thus resulting in an overall increase if domestic water use). Weaknesses in the design (no impact assessment prior to implementation, no research behind the selection and updates of the amounts paid, etc.) and enforcement of the EPI (no monitoring and follow-up) cause reservations regarding its effectiveness. In parallel to the subsidies, the WDD had launched a bundle of measures targeting water saving and demand reduction: awareness campaigns, water reuse, water pricing, water metering installation, leakage reduction. Thus, it is difficult to decouple the actual effect of the investigated EPI and the savings that are explicitly attributed to the subsidies.

While the EPI was aligned with the prevailing laws and policy setting and in terms of flexibility, it has the potential to be adjusted to local conditions, public participation, inclusion of stakeholders in the discussions and collective design were not pursued by the WDD, which, if incorporated, could have brought up issues of social equity, possible unsustainability of the measure as such, and useful suggestions for re-design and enhancement.

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1 EPI Background

1.1 Baseline

The EPI investigated in this study (subsidies for drinking water conservation in Cyprus) was initiated in 1997 by the Water Development Department (WDD), focused in the beginning on subsidies to construct a domestic boreholes for garden irrigation and connecting a borehole to toilet cisterns for flushing. These were followed in 1999 by additional subsidies to install domestic grey water recycling systems, and hot water rerirculators later on. During the same period (1997) public water supply of desalinated water has been introduced as a source for domestic water (Figure 1.1) with the purpose to encompass the deficit resulting from the growing demand. The rationale of the WDD on launching this EPI was to save valuable drinking water from the distribution network in households (part of which was now coming from desalination) that is too expensive to be used for gardens and toilet flashing, especially during drought periods. Prior to 1997 the water policy was much focused on increasing water supply and exploiting every drop of water (“not a drop to be lost in the sea”), thus lot was invested in dam infrastructure and increasing their capacity. This can be clearly observed in Figure 1.2 where the average 1980s’ storage capacity has doubled in the 1990s’. At the same time though, precipitation trends have been decreasing, thus the water policy in the early 2000 has been shifted towards alternative water supplies, efficient water use and conservation, sustainability has not though been paid much attention yet. The current EPI was run in parallel with a bundle of additional measures that included reduction of leakage through restoration of the networks, progressive block tariffs, meter installation, water saving campaigns etc., in an attempt of the WDD to tackle the increasing per capita consumption (Figure 1.3) and water scarcity problems, thus, the business as usual baseline has been going through a major transformation.

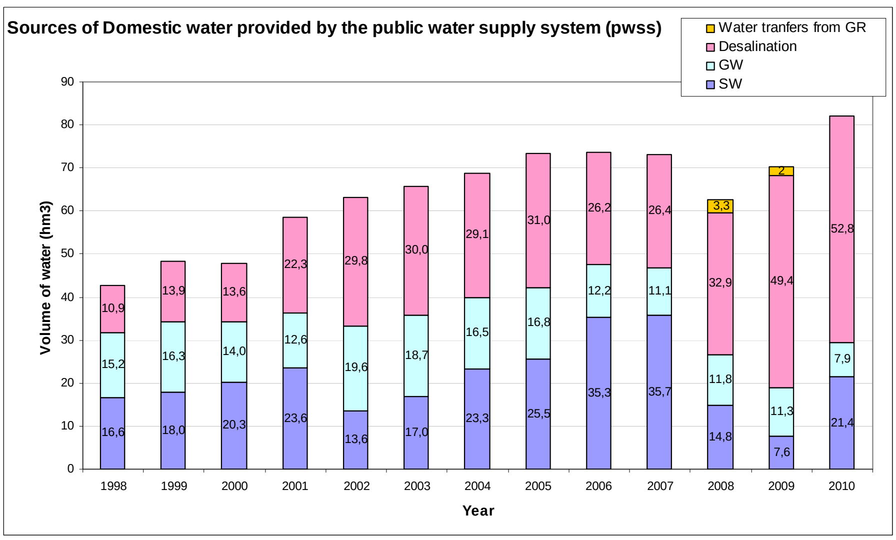


Figure 1.1 – Sources of domestic water provided by the public supply system in Cyprus from 1998 onwards.

Sources: WDD website http://www.moi.gov.cy/moa/wdd/wdd.nsf/0/0ac7d6e86ef8422ac2256e7e004404a7/$FILE/Diathesi_Ydrevsi_ENG.pdf, and the EEA WISE-SoE Reporting on Water Quantity http://www.eea.europa.eu/data-and-maps/data/waterbase-water-quantity-5

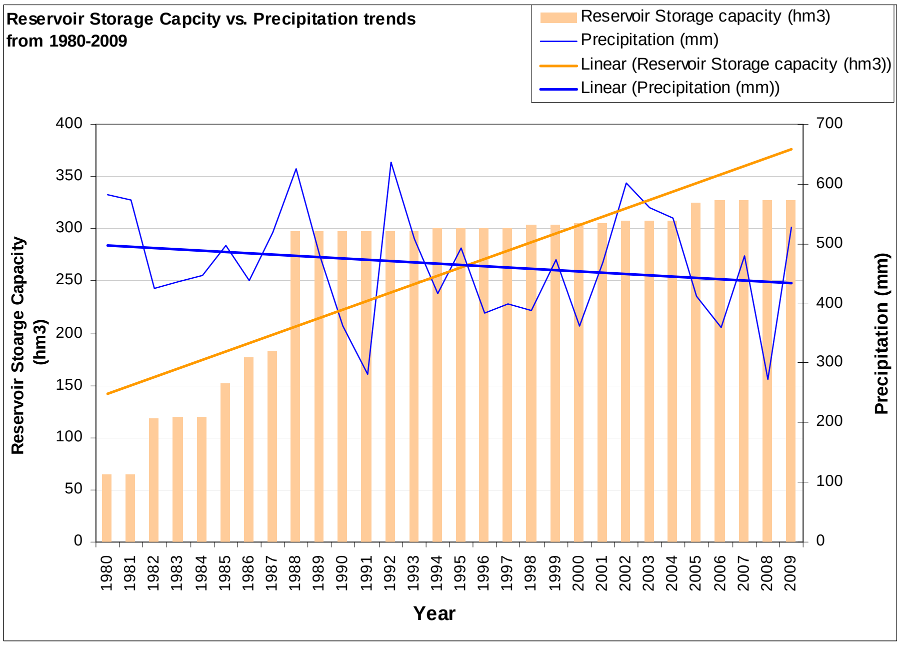
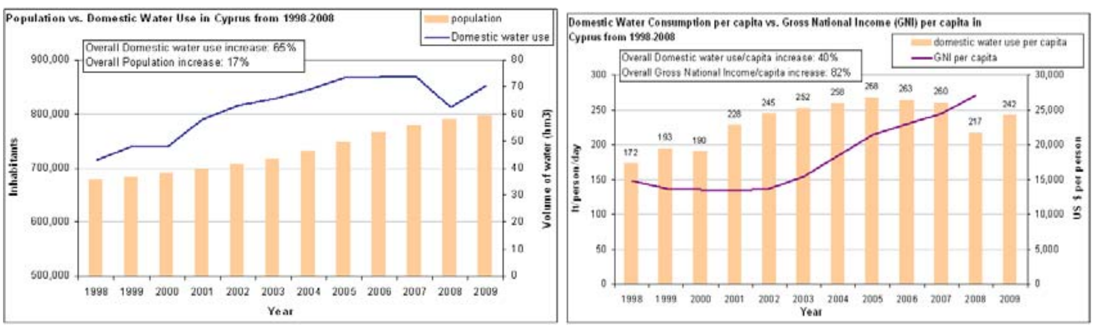


Figure 1.2 – Evolution of storage capacity and precipitation in Cyrpus from 1980-2009.

Sources: WDD website http://www.moi.gov.cy/moa/wdd/wdd.nsf/0/0ac7d6e86ef8422ac2256e7e004404a7/$FILE/Diathesi_Ydrevsi_ENG.pdf, and the EEA WISE-SoE Reporting on Water Quantity http://www.eea.europa.eu/data-and-maps/data/waterbase-water-quantity-5



(a) (b)

Figure 1.3 – Evolution of domestic water use in Cyprus, compared with (a) population, and (b) income per capita increase from 1998 onwards.

Sources: WDD website http://www.moi.gov.cy/moa/wdd/wdd.nsf/0/0ac7d6e86ef8422ac2256e7e004404a7/$FILE/Diathesi_Ydrevsi_ENG.pdf, the EEA WISE-SoE Reporting on Water Quantity http://www.eea.europa.eu/data-and-maps/data/waterbase-water-quantity-5, the World Data Bank, World Development Indicators (WDI) & Global Development Finance (GDF), World Bank. http://databank.worldbank.org/ddp/home.do, EUROSTAT, Statistics Database, Population and Social Conditions datasets, http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=demo_gind&lang=en

1.2 Key features

- **Policy Objectives**

The specific policy objective of the EPI was drinking water conservation especially since desalinated water was a major part of the domestic supply: saving valuable drinking water from the distribution network in households that is too expensive to be used gardens and toilet flashing, especially during drought periods. Secondary objectives related to water security, especially in periods of drought, and overall water saving.

- **Design and main elements**

The WDD subsidies target new works and installations at household level, which are located within the boundaries of a water district and connected to the Municipal and Communal water supply systems (PWSS). Four subsidies for domestic water saving have been launched gradually from 1997 to 2010 (the current subsidy period ended 06/12/2010):

1. Construction of borehole for the irrigation of household gardens (700 €) in 1997
2. Connection of the borehole with the toilet cisterns (700 €) (also applicable for schools, office premises, shops, institutions etc.) in 1997
3. Installation of a hot water recirculator (220 €) in 2007
4. Installation of a grey water recycling system (3000 €) (also applicable for schools, military camps, public buildings, gyms, hotels etc.) in 1999

The above rates are applicable from 2009 onwards, while lower rates were initially set and gradually increased (Table 1.1). The rationale behind the EPI was based on the fact that water used for flashing and garden irrigation constitutes a major micro-component of the domestic water use with a significant share in the consumption, and the same applies to laundry, dishwashing and shower water that can be recycled (Table 1.2). Nevertheless, no detailed study prior to the launch of the subsidies has been identified that assesses their impact and effectiveness or identifies a logical basis on how the subsidy amount has been set, with the exception of a pilot study on grey water recycling in 7 establishments in Nicosia (5 households, 1 hotel, 1 stadium) hat was run for 1.5 years prior to the subsidy as experimental work and identified the water saving potential (Kambanellas, C. A., 2007).

Table 1.1 - Subsides (in €) per water saving measure for the period 1997-2010

Subsidy	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010

Construction of borehole for garden irrigation	170	170	170	170	170	170	170	340	340	510	680	680	700	700
Connection of the borehole with the toilet cisterns*	170	170	170	170	170	170	170	342	342	510	680	680	700	700
Installation of a hot water recirculator											170	170	220	220
Installation of a grey water recycling system**			342	342	342	342	680	680	680	1050	1700	1700	3000	3000

Source: I.A.CO Ltd, 2011, Kambanellas, C. A., 2007

Note: * 2000-2003: €170 per connection (1-2 houses / offices / stores), €137 per connection (3–5 houses / offices / stores), €120 per connection (>5 houses / offices / stores), and €51 per supply outlet in institutions, schools etc. 2009-10: €700 per house, €600 per house (2-4 houses), €500 per house (>4 houses), €200 per supply outlet in institutions, schools etc.
** 2002: €342 per house. For the remaining buildings 20% of the system's installation price 2009-2010: €3000 per house. For the remaining buildings 40% of the cost (maximum amount €7000)

Table 1.2 – Potential savings from the subsidies' implementation

Subsidy	Estimated/expected saving on drinking water
Construction of borehole for the irrigation of private household gardens	On an average 4-person family consumption of 600 lt/day, 30% (180 lt/day) is used for garden irrigation, washing of cars, pavements, terraces etc.
Connection of the borehole with the toilet cisterns	On an average 4-person family consumption of 600 lt/day, 27% (162 lt/day) is used for toilet flashing
Installation of a hot water recirculator	A modern household can save up to 60 m3 per year
Installation of a grey water recycling system	Recycled water is to be used for watering gardens or flashing toilets. Laundry, dishwashing and shower water that can be recycled sum up to 50% of the household water use

Source: I.A.CO Ltd, 2011, Kambanellas, C. A., 2007

- **Delivery mechanism, monitoring and enforcement**

All subsidies were granted by the WDD following an application submission by the beneficiary (downloadable for the WDD website) and 2 inspections. In the case of borehole connection, installation of recirculators and grey water recycling systems, an inspection was carried by WDD officers after the application and prior to the commencement of the works. After works have been completed and within 6 months, an additional compliance inspection was carried by the WDD (after notification from the beneficiary), and once consistency check was approved, all the necessary paperwork and invoices were submitted by the beneficiary to get the grant. In the case of drilling a borehole, a permit was first to be obtained by the local

District office. This process involved again the above described steps, but additionally, the applicant should submit all the necessary paperwork for drilling a borehole to the local District Office (i.e. location plans, town planning permits) who would issue the permit after communication and approval by the WDD (a borehole application could be rejected depending on the condition of the aquifer and where the borehole was to be located). After November 2010 the later has changed and the permit is issued directly by the WDD without the interference of the local District Office, according to the new Unified Water Management Law. As this measure provisioned the installation of a water meter in the borehole, the beneficiaries had to also submit to the WDD a signed confirmation that a meter has been installed.

Regarding enforcement, although a cap of 250m3 groundwater abstraction per year was imposed to the new boreholes, the meters were not checked by the WDD for compliance with this restriction. Additionally, monitoring of the installations after strat-up or other safeguarding mechanisms were not implemented by the WDD, nor a follow-up survey in order to assess the EPI's effectiveness. Only 1 follow-up study has been identified to assess the actual performance on boreholes for garden irrigation: in 2004, potable water consumption of 20-30 households was monitored in a suburb of Nicosia, 12 months before the installation of a borehole and 12 months after the installation of a borehole, and concluded a 27% saving. In 2007-08 extreme drought influenced the beneficiaries into heavily applying for the subsidies (increase of 170% of the number of subsidies awarded in comparison with the previous relatively wet years) which was probably driven from their will to secure water.

2 Characterisation of the case study area (or relevant river basin district)

2.1 Environmental characterisation

Land Use

According to the land cover mapping report for Cyprus published in 2000, (Corine Land Cover, 2000), the land uses are presented in Table 2.1.

Table 2.1- Cyprus Land Uses

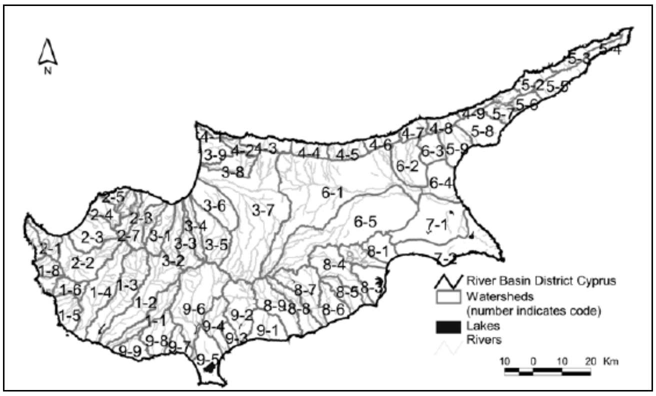
Land Use category	Area covered (ha)	% of area covered
Arable land and permanent crops	443,043 ha	47.89%
Forested land	407,858 ha	44.12%
Artificial surfaces	70.233 ha	7.63%
Wetlands	1,955 ha	0.21%
Water bodies cover	1,401 ha	0.15%

Source: Corine Land Cover, 2000. http://www.eea.europa.eu/data-and-maps/data/corine-land-cover-2000-clc2000-seamless-vector-database

Description of hydrology

Cyprus has a typical Mediterranean climate with mild winters, long hot, dry summers and short autumn and spring seasons. The average annual rainfall is about 500 m and ranges from 300 mm up to 1,100 mm. The variation in rainfall is not only regional but annual and often two and even three-year consecutive droughts are observed. The average maximum temperature in July and August ranges between 36°C on the central plain and 27°C on the Troodos mountains, while in January the average minimum temperature is 5°C and 0°C respectively. Evapotranspiration is high and corresponds to 80% of the rainfall.

Cyprus has been identified as one River Basin District. Hydrographically, the island of Cyprus is subdivided into 9 hydrological regions made up of 70 watersheds (Map 2.1). The area under government control contains 47 watersheds.



Map 2.1- Cyprus River Basin District and watersherds. Numbers present watershed number

Source: Republic of Cyprus, Ministry of Agriculture, Natural Resources and Environment, 2010.

Pressure and impacts analysis

Cyprus has experienced many drought episodes varying from below normal precipitation (81-90% normal) to severe drought (≤ 70% normal). The long term annual average (LTAA) precipitation from 1901-1970 was 541 mm, while the LTAA from 1971-2009 has fallen to 463 mm (Figure 2.1). The quantity of water falling over the total surface area of the free part of Cyprus (5,800 km2) is estimated at 2,750 million cubic meters (hm^3), but only 10% (275 hm^3) is available for exploitation, since the remaining 90% returns to the atmosphere as direct evaporation and transpiration. The rainfall is unevenly distributed geographically and there is great variation of rainfall with frequent droughts spanning two to four years. The average annual net rainfall of 275 hm^3 is distributed between surface and groundwater storage with a ratio 1:3 respectively. From the underground storage, approximately 1/3 flows into the sea.

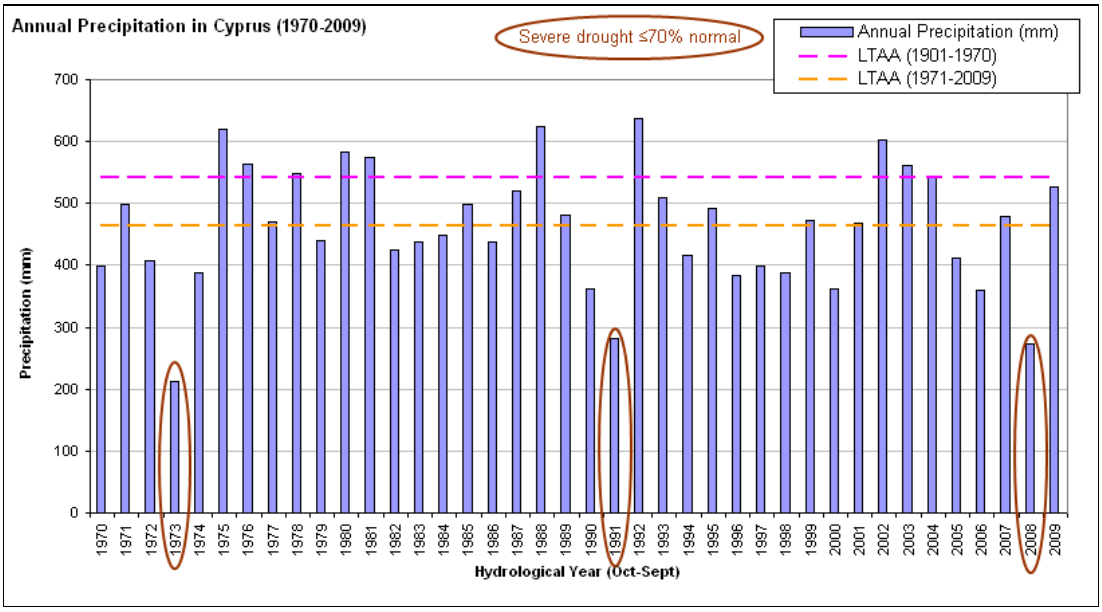


Figure 2.1- Annual Precipitation (mm) in Cyprus for the hydrological years 1970-2009

Source: EEA WISE-SoE Reporting on Water Quantity http://www.eea.europa.eu/data-and-maps/data/waterbase-water-quantity-5

Cyprus water abstraction (205 mio m3/year on average since 1998) comes from groundwater (75% on average) and surface water (25%), while additional water is supplied by desalination (24 mio m3/year on average since 1998) , water reuse and emergency water transfer (e.g. in 2008). About 52% of this abstracted water is provided to the users by the Public Water Supply System (PWSS) while the remaining 48% through self-supply (agriculture is the dominant user of self-supplied water). The 2008 annual water use per capita was 276m^3 (or 755 lt/cap/day), while the 2010 average water use per economic activity is presented in Table 2.2.

Table 2.2- Water use per sector in Cyprus

Water use category	% of water use
Domestic water use	29.6%
Tourism water use	4.9%
Industrial water use	3.0%
Agricultural water use	59.1%
Livestock water use	3.3%

Source: Republic of Cyprus, Ministry of Agriculture, Natural Resources and Environment, 2010.

Cyprus has experienced many drought episodes and water scarcity situations, with its groundwater resources being over-exploited and its water stress conditions reaching critical levels. Based on calculations of the Water Exploitation Index (WEI), which is defined as the percentage of total annual abstraction of the LTAA availability of water resources, Cyprus has been extremely water stressed since 1998 (WEI > 40%) with its groundwater resources being most stressed (Figure 2.2).

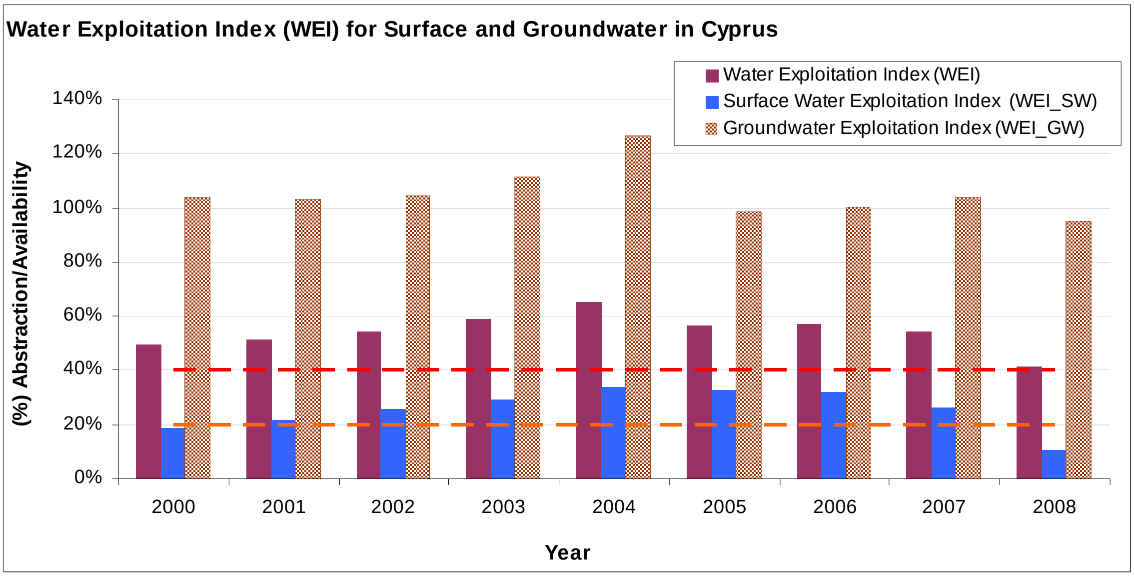


Figure 2.2- Comparison of the Water Exploitation Index (WEI) for Surface and Groundwater.

Source: Kossida, M., 2010.

Notes: (1) WEI is defined as Annual Abstraction over 30 years-LTAA Availability; (2) WEI_SW is defined as Annual Abstraction from Surface Water over 30 years-LTAA Surface Water; (3) WEI_GW is defined as Annual Abstraction from Groundwater over 30 years-LTAA Groundwater, (4) Comparing the two indicators we can see that the Groundwater is much over-exploited (95-127%), while SW exploitation is below 40% (10-34% demonstrating an overall increasing trend), and thus leveraging the WEI to unsustainable conditions.

2.2 Economic characterisation

Cyprus economy shows a positive growth rate for 2010 after the negative growth rate -1.7% during 2009 (Figure 2.3). Specifically, the growth rate is provisionally anticipated to increase by 1.0% for 2010, which is an indication that the economy has started to recover from the former economic slump which was exhibited during 2009. The main stimulus to growth is due to the expansion in the activities of Hotels and Restaurants, Transport, Storage and Communication, Financial Intermediation, Real estate, Renting and Business Activities, Education, Health and Social Work and Mining and Quarrying. The inflation rate based on the Consumer Price Index, measured at 2.4% in 2010 compared to 0.3% in 2009.

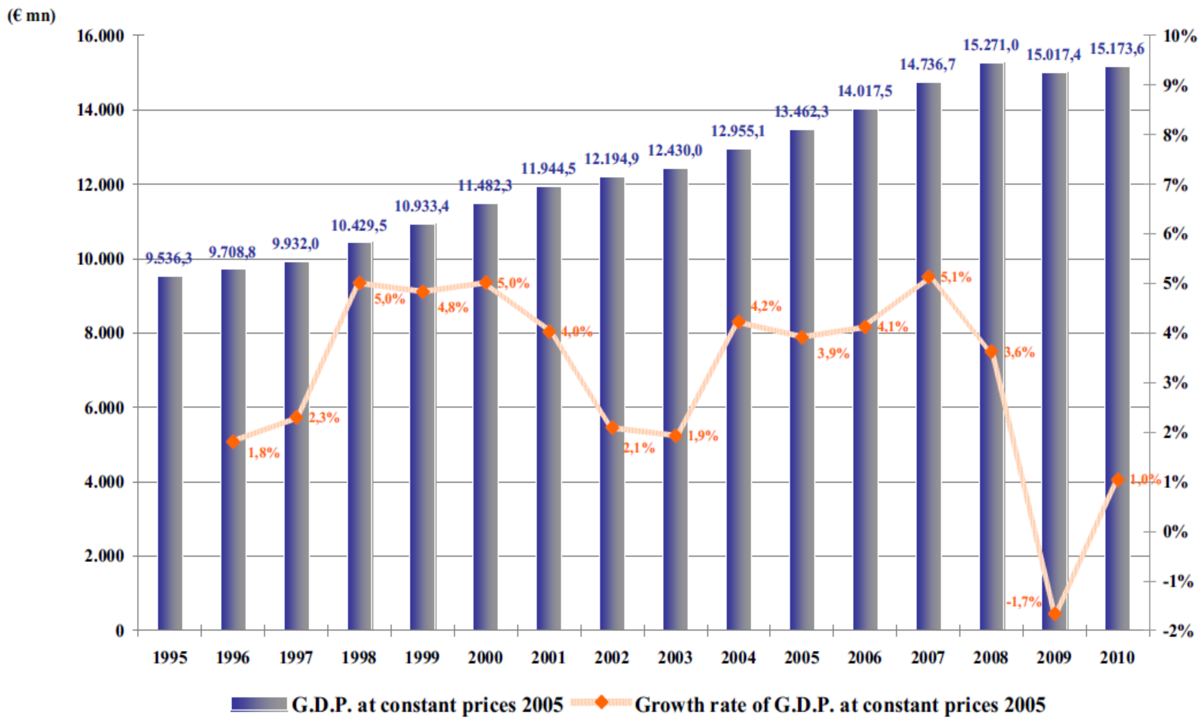


Figure 2.3 – Gross Domestic Product (GDP) and percentage annual change of GDP (Chain Volume Measures of 2005)

Source: Republic of Cyprus, Statistical Service, 2010

The most important economic sector of Cyprus is the tertiary, both in terms of economic output and employment, showing upward trends. The agricultural sector (primary), on the contrary, has experienced downward trends. In 2010, the primary sector exhibits a positive growth rate 1.4% in real terms, which is the first time after exhibiting negative growth rates for seven consecutive years. On the other hand, the secondary sector registers a negative growth rate for the second consecutive year. Particularly, a declined growth rate is exhibited in 2010 of -2.7% compared to -5.7% in 2009. Finally, the tertiary sector of the economy exhibits a positive growth rate 1.4% compared to the negative growth rate -1.3% in 2009 (Table 2.4).

Table 2.3 - Contribution of economic sectors in Cyprus

Economic sector	Economic output (% of GDP in 2010 - provisional)	Employment (% of 2007 Total)
Tertiary sector *NACE G- P (REV.1.1)*	81.3%	71.6%
Secondary sector *NACE C+D+E+F (REV.1.1)*	16.4%	20.7%
Primary sector *NACE A+B (REV.1.1)*	2.3%	7.9%

Sources: Republic of Cyprus, Statistical Service, 2010
Republic of Cyprus, Ministry of Agriculture, Natural Resources and Environment, 2010.

Table 2.4 - Percentage annual change of GDP by economic activity (chain volume measures of 2005**)

(%)

Economic Activity NACE REV. 1.1	2001	2002	2003	2004	2005	2006	2007	2008	2009*	2010*
Agriculture, hunting and forestry	4,2	6,1	-7,3	-5,0	-3,0	-11,8	-3,2	-7,5	-0,4	1,5
Fishing	3,9	-18,0	-3,5	40,5	-5,3	9,5	-3,9	-1,0	-0,9	0,8
Mining and quarrying	-9,8	11,1	3,0	8,0	0,9	-2,2	6,0	7,7	-17,6	11,7
Manufacturing	-1,3	0,2	2,5	0,6	-0,6	-4,9	2,1	3,3	-6,2	-1,6
Electricity, gas and water supply	10,3	11,2	6,4	4,9	3,1	4,4	4,0	-3,1	4,2	2,0
Construction	3,7	5,4	6,7	5,3	4,4	6,8	7,7	2,6	-6,9	-5,5
Wholesale and retail trade	8,9	2,6	-0,7	9,3	5,3	5,9	8,8	5,5	-6,6	0,2
Hotels and restaurants	1,2	-7,9	-5,7	-2,4	0,6	3,6	3,5	-3,4	-7,3	2,4
Transport, storage and communication	5,1	2,0	3,0	13,5	7,9	2,3	5,8	3,5	-5,7	1,5
Financial intermediation	3,6	0,3	-6,8	10,7	12,3	12,9	10,3	6,0	4,7	2,4
Real estate, renting and business activities	7,9	4,1	4,1	3,3	4,8	7,4	6,1	5,3	0,2	3,0
Public administration and defence	0,6	3,3	8,2	1,5	2,9	3,0	1,0	2,0	2,9	1,1
Education	2,5	4,4	4,3	1,1	2,1	3,0	2,1	7,3	3,9	2,1
Health and social work	1,6	3,3	3,4	1,5	2,4	3,3	2,3	6,2	3,4	1,5
Other community, social and personal services	3,2	1,4	1,0	2,3	1,5	2,6	4,7	3,7	-1,0	0,3
Private households with employed persons	20,7	14,2	16,1	16,4	10,5	5,6	4,8	14,5	23,0	10,5
Total Gross Value Added	**4,0**	**2,1**	**1,9**	**4,2**	**3,9**	**4,1**	**5,1**	**3,6**	**-1,7**	**1,0**
Plus: Imports duties Plus: Value added tax (net)	4,1	2,1	2,2	4,8	4,0	4,2	5,2	3,6	-1,7	1,0
Gross Domestic Product at market prices	**4,0**	**2,1**	**1,9**	**4,2**	**3,9**	**4,1**	**5,1**	**3,6**	**-1,7**	**1,0**

Source: Republic of Cyprus, Statistical Service, 2010
Notes: * Provisional data; ** The constant price series has been re-calculated with 2005 as new reference-base year and according to the chain-linking method.

2.3 Geographical characterisation

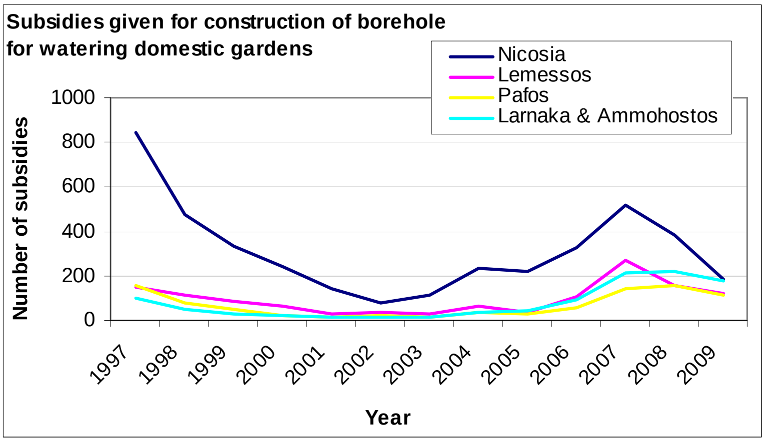
Cyprus is situated at the Northeastern part of the Mediterranean basin and is the third largest island in the Mediterranean with an area of 9,251 km2 and a population of 796,900 inhabitants (2008 data). Cyprus is dominated in its topography by two mountain ranges, the Troodos range in the central part of the island, rising to a height of 1,952 metres and the Pentadaktylos range in the north of the island, rising to a height of 1,085 metres. Between the two ranges lie the Morphou and Messaoria plains, which together with the narrow alluvial plains along the coast make up the bulk of the agricultural land of the island. Most of the rivers, which flow only in winter, have their sources in the Troodos mountains and only one substantial river has its source in Pentadaktylos.

3 Assessment Criteria

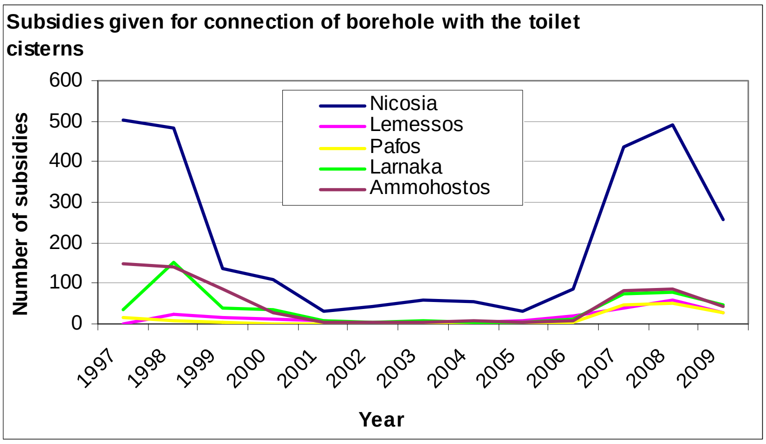
3.1 Environmental outcomes

Economic agents' response to the EPI

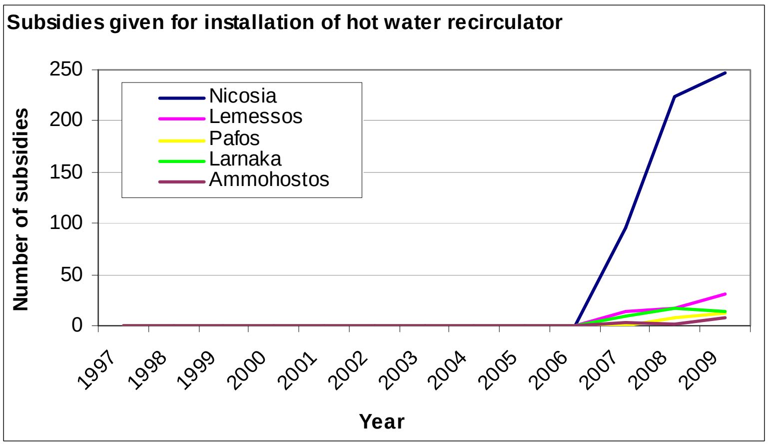
The WDD subsidies have targeted the domestic sector, households which are located within the boundaries of a water district and connected to the public water supply system of a municipality, while the installation of a grey water recycling system has also been applicable for schools, military camps, and public buildings. The response to each of the 4 subsidies per Water District for the period 1997-2011 is presented in Figure 2.1 (a-d).



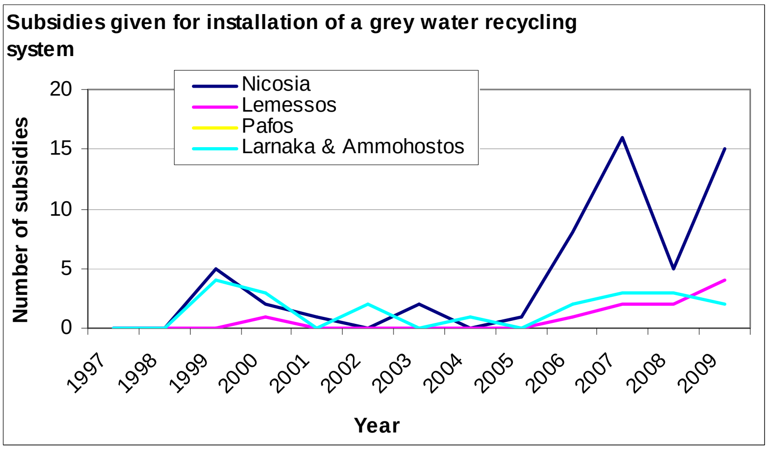
(a)



(b)



(c)



(d)

Figure 3.1 – Number of subsidies given per category and Water District for the period 1997-2009; (a) Construction of borehole for the irrigation of private household gardens; (b) Connection of the borehole with the toilet cisterns, (c) Installation of a hot water recirculator; (d) Installation of a grey water recycling system.

Source: Data provided by the Water Development Department (WDD) in I.A.CO Ltd, 2011

Among the 4 subsidy categories given from 1997-2009, the subsidies given for constructing boreholes for garden irrigation received high response (59% overall), while 34% of the total subsidies where given for connecting a borehole to toilet cisterns, 6% for installing hot water recirculators, and only 1% for installing grey water recycling systems. The vast majority (61%) of the subsidies were given in households of the Nicosia water district, 13% in Lemessos, 10% in Ammohostos, 9% in Larnaka and 9% in Pafos water districts. In Lemessos and Pafos districts the subsidies for construction of boreholes are highly dominating accounting for more than 80% of the total subsidies of these water districts, while in Larnaka and Ammohostos they are less than 50% with the subsidies for connection of boreholes to toilet cisterns being the dominant category there. By looking at the temporal evolution of the number of subsidies as compared with the respective precipitation (Figure 3.2), we can observe a pattern: the total number of subsidies paid pick-up in periods of low precipitation/drought events (e.g. 2007-2008), while it declines during periods where precipitation is relatively high (e.g. 2001-2004). These could convey a message on changes of the individuals' behaviour and their motivation in applying for subsidies: it looks like they are reactive rather than proactive, and their incentives relate to securing water for garden irrigation - subject to restrictions in periods of drought- rather than saving potable water.

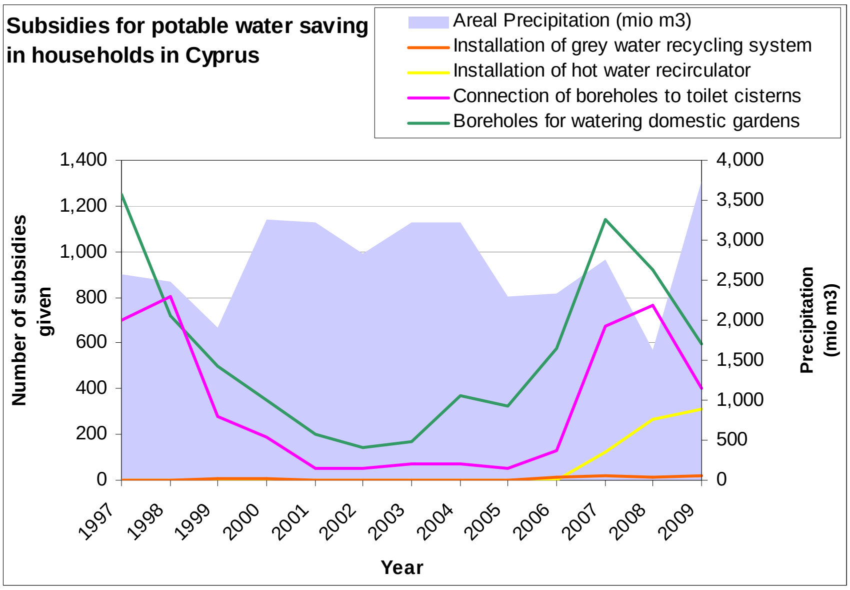


Figure 3.2 – Number of subsidies given per category as compared to areal precipitation (mio m^3) for the period 1997-2009

Source: Compiled by the authors. Data provided by the Water Development Department (WDD) in I.A.CO Ltd, 2011 and EEA WISE-SoE Reporting on Water Quantity http://www.eea.europa.eu/data-and-maps/data/waterbase-water-quantity-5

Reduction of pressure on drinking water supply

In order to assess the effectiveness of the EPI to reduce the pressure on domestic drinking water supply (policy objective), calculations of the total volume of water saved have been made based on the number of subsidies granted from 1997-2010 and assumptions on the potential savings induced by each subsidy category as listed below.

Assumptions involved in estimating the potential water saving for each type of subsidy:

1. The following water saving scenarios have been consider in the case of a borehole construction for garden irrigation: (a) 15 m3/month for a period of 8 months, used for garden irrigation and washing of terraces, pavements, cars, in middle size households (thus a total of 120m^3/year), and (b) 30 m^3/month

for a period of 8 months, used for garden irrigation, partial pool refilling, and washing of terraces, pavements, cars, in middle size households of relevant

2. high living standards (thus a total of 240m^3/year). For the calculations an average value was considered (thus 180 m^3/year, which represents 30% of the 600 lt/day typical 4-person family consumption). It is though considered that private boreholes allow for limitless use of water unless this is priced as high as the potable water. Thus, the calculated/potential water saving is overestimated as compared to the actual.
3. Water savings resulting from the connection of a borehole to toilet cisterns are estimated around 5m^3/month or 60m^3/year. This is based on the assumption that in an average 4-person family household with a daily consumption of 600lt, 27% is used for flushing toilets.
4. Water saving from the installation of hot water recirculator is estimated to 5m3/month or 60m^3/year.
5. Water saved by using grey water recycling system has been estimated based on 2 scenarios: (a) 15 m^3/month for a period of 8 months, used for garden irrigation and washing of terraces, pavements in a middle size household, and 5m^3/month for toilet flashing, a total of 180 m^3/year, and (b) 30 m^3/month for a period of 8 months, used for garden irrigation and washing of terraces, pavements in household with large size gardens, and 5m^3/month for toilet flashing, a total of 300 m^3/year. For the calculations and average value was considered (thus, 240 m^3/year).

Post-evaluation data (after the installation of the boreholes, recirculators and recycling systems) that would allow the direct estimation of the water savings are missing, and thus the proxy calculations can not be properly assessed for their accuracy. One study was identified, attempting to assess in 2004 the effectiveness of one of the subsidies, namely the construction of a borehole for garden irrigation, initiated by Stephanos Papatryphonos, a Senior Hydrogeologist of the Water Development Department. As quoted in Charalambous et al., 2011, the potable water consumption of 20-30 households was monitored in a suburb of Nicosia, 12 months before the installation and 12 months after the installation of a borehole. Average savings of potable water consumption in the households were calculated to be around 27% when a borehole was installed. This study was not carried out in other towns due to various reasons including the fact that other Water Boards were not willing to provide water consumption data for confidentiality reasons. Although this is a very small sample size the 27% finding compares well with the above mentioned assumptions, although we do not know certainly that they are exclusively attributed to the EPI (since a bundle of measures was launched at that time including water saving awareness campaigns, education etc.). Kambanellas, C. A., 2007, references another pilot study on grey water recycling that was run prior to the subsidy as experimental work. Seven grey water recycling systems were installed in Nicosia (5 in households, 1 in a hotel, 1 in a stadium) and were monitored for 1.5 years (from mid 1997 till end of 1998). In that period 220 m^3 of water had been recycled. For the hotel, the mean per capita drinking water consumption by guests of the pool that used the showers reached the amount of 40lt/day. This water was used for the irrigation of the gardens. For the stadium, the water that was recycled was that of the showers used by the football players, which amounted to 71% of the drinking water measured by the central water meter of the stadium. This water was reused for the watering of the lawn. For the five households, the mean per capita drinking water consumption amounted to 122lt/day, from which the grey water is 36lt/day or 33%. In the current calculations the value used of 240m3/year water saved is slightly higher than the study results, yet since only water from pool showers has been recycled in the hotel, we would expect a higher volume if all showers had been connected.

The net estimates of the potential saving of drinking water per year (from the subsidies granted each reference year) are presented in Figure 3.3, while the cumulative savings are presented in Table 3.1. The cumulative drinking water savings from all subsidies during the 14-year period 1998-2010 amount about 12,420,240 m^3 (or 12.42 mio m^3) and represent 1.50% of the total 1998-2010 domestic water use and 3.37% of the total desalinated water provided by the public water supply system (PWSS) in 1998-2010.

Domestic water use in these calculations is not limited to household consumption only, but also includes water consumed in restaurants, accommodation establishments, business etc. connected to the PWSS network. The above percentages vary from year to year: The water saving as % referring to the domestic water use by PWSS constantly increases (from 1.04% in 1998 to 2.10% in 2010) since the domestic consumption for garden irrigation and toilet flashing (the 2 dominant subsidies) is now substituted by self-supplied groundwater (boreholes). The water saving as % referring to the desalinated water provided by the PWSS is variable, with the maximum being observed in 2007 (4.69%) and the minimum in 2002 (2.34%), and as desalinated production significantly grows after 2007, this % is decreasing (Figure 3.4). It has to be emphasized that the calculation of cumulative water savings was performed by adding to a current year the savings that would also occur from all the subsidies of the previous years. This pre-assumes that the past installations (i.e. boreholes, recirculators, grey water recycling systems), as result of previous years' subsidies, are operational and fully functional every year, and maintained properly so that they can render the predicted estimated savings (e.g. pumps in old boreholes are maintained and thus groundwater abstraction for garden irrigation is applicable every, old recirculators are working etc.).

To assess the EPI's performance related to drinking water conservation, a comparison between the actual domestic water use provide by PWSS as reported from 1998-2009 (which includes the EPI implementation) has been compared to a baseline scenario of domestic water demand provided by PWSS if the EPI had not been applied. The same was done for the actual desalinated water provided by the PWSS vs. a baseline scenario of desalinated water demand by the PWSS if the EPI had not been applied. The annual comparisons are demonstrated in Figure 3.5, while the comparison for the total period 1998-2009 is presented in Figure 3.6. It is only after the year 2006 that the difference between the actual and baseline scenarios reaches 1 mio m³ per year.

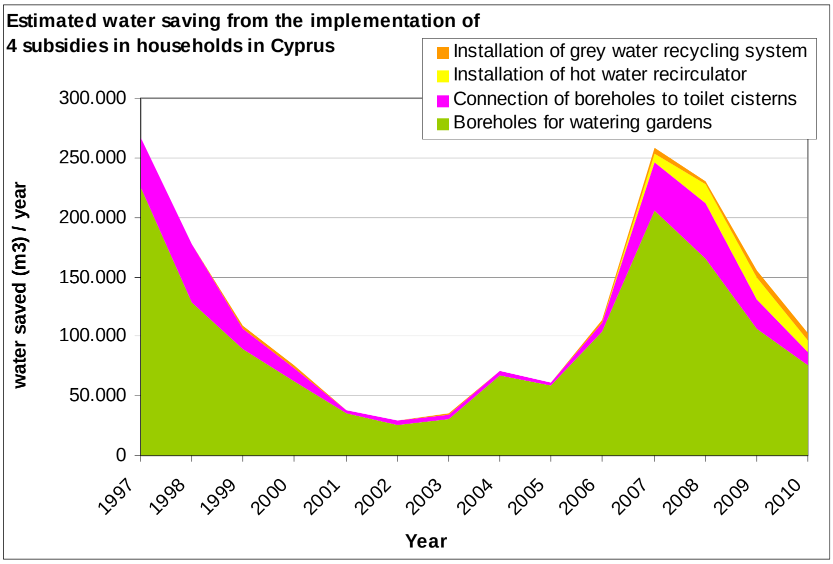


Figure 3.3 - Net estimate of potential drinking water saving per year (in m³) per subsidy category

Source: Compiled by the authors. Data provided by the Water Development Department (WDD) in I.A.CO Ltd, 2011

Table 3.1 – Cumulative estimates of potential drinking water saving in m³ per year for each subsidy category

	Construction of borehole for garden irrigation			Connection of the borehole with the toilet cisterns			Installation of a hot water recirculator			Installation of a grey water recycling system		
REFERENCE YEAR	Net # of boreholes	Cumulative # of boreholes	Potential Water Saving (based on 120 m3/yr and 240 cm3/yr average saving)	Net # of connections	Cumulative # on connections	Potential Water Saving (based on 60m3/yr saving)	Net # of recirculators	Cumulative # of recirculators	Potential Water Saving (based on 60m3/yr saving)	Net # of systems	Cumulative # of systems	Potential Water Saving (based on 180 m3/yr and 300 cm3/yr average saving)
1997	1,250	1,250	225,000	701	701	42,060	0	0	0	0	0	0
1998	717	1,967	354,060	806	1,507	90,420	0	0	0	0	0	0
1999	498	2,465	443,700	280	1,787	107,220	0	0	0	9	9	2,160
2000	348	2,813	506,340	187	1,974	118,440	0	0	0	7	16	3,840
2001	198	3,011	541,980	51	2,025	121,500	0	0	0	1	17	4,080
2002	142	3,153	567,540	54	2,079	124,740	0	0	0	2	19	4,560
2003	168	3,321	597,780	72	2,151	129,060	0	0	0	3	22	5,280
2004	371	3,692	664,560	71	2,222	133,320	0	0	0	1	23	5,520

2005	321	4,013	722,340	49	2,271	136,260	0	0	0	1	24	5,760
2006	575	4,588	825,840	129	2,400	144,000	0	0	0	11	35	8,400
2007	1,143	5,731	1,031,580	677	3,077	184,620	122	122	7,320	22	57	13,680
2008	921	6,652	1,197,360	763	3,840	230,400	265	387	23,220	10	67	16,080
2009	594	7,246	1,304,280	403	4,243	254,580	312	699	41,940	22	89	21,360
2010	420	7,666	1,379,880	185	4,428	265,680	163	862	51,720	27	116	27,840
TOTAL			10,362,240			2,082,300			124,200			118,560

Source: Compiled by the authors. Data provided by the Water Development Department (WDD) in I.A.CO Ltd, 2011

Table 3.2 - Cumulative drinking water saving from all subsidies during the 14-year period 1997-2010 as percentage of (a) the domestic water use and (b) the volume of desalinated water provided by Public Water Supply (PWSS)

Reference Year	Cumulative water saving (m^3)	Domestic Water Use provided by the PWSS (mio m^3)	Cumulative water saving as % of domestic water use provided by the PWSS	Desalinated water provided by the PWSS (mio m^3)	Cumulative water saving as % of Desalinated water provided by the PWSS
1997	267,060				
1998	444,480	42.71	1.04%	10.91	4.07%
1999	553,080	48.24	1.15%	13.94	3.97%
2000	628,620	47.94	1.31%	13.64	4.61%
2001	667,560	58.45	1.14%	22.25	3.00%
2002	696,840	63.04	1.11%	29.84	2.34%
2003	732,120	65.71	1.11%	30.01	2.44%
2004	803,400	68.86	1.17%	29.06	2.76%
2005	864,360	73.34	1.18%	31.04	2.78%
2006	978,240	73.73	1.33%	26.23	3.73%
2007	1,237,200	73.19	1.69%	26.39	4.69%
2008	1,467,060	62.76	2.34%	32.86	4.46%
2009	1,622,160	70.30	2.31%	49.40	3.28%
2010	1,725,120	82.10	2.10%	52.80	3.27%
TOTAL 1998-2010	**12,420,240**	**830.37**	**1.50%**	**368.37**	**3.37%**

Source: Compiled by the authors. Data provided by the Water Development Department (WDD) in I.A.CO Ltd, 2011, the WDD website http://www.moi.gov.cy/moa/wdd/wdd.nsf/0/0ac7d6e86ef8422ac2256e7e004404a7/$FILE/Diathesi_Ydrevsi_ENG.pdf, and the EEA WISE-SoE Reporting on Water Quantity http://www.eea.europa.eu/data-and-maps/data/waterbase-water-quantity-5

Note: The reported domestic water use is not limited to household consumption only, but also includes water consumed in restaurants, accommodation establishments, business etc. connected to the PWSS network.

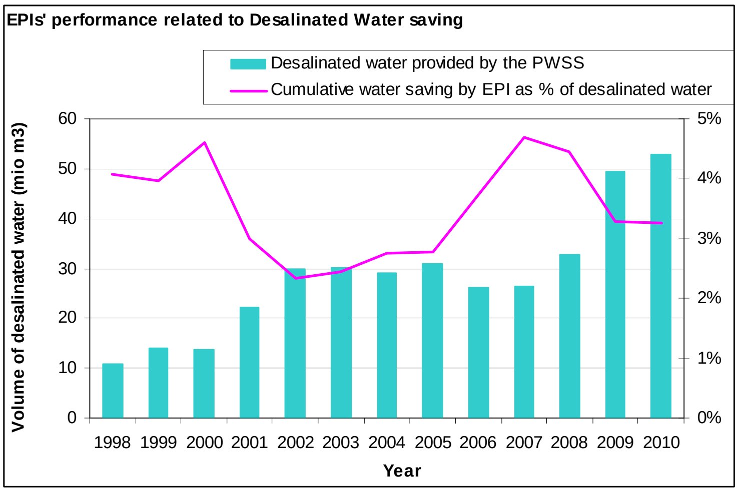


Figure 3.4 - EPI's performance related to desalinated water saving

Source: Compiled by the authors. Data provided by the Water Development Department (WDD) in I.A.CO Ltd, 2011, and the WDD website http://www.moi.gov.cy/moa/wdd/wdd.nsf/0/0ac7d6e86ef8422ac2256e7e004404a7/$FILE/Diathesi_Ydrevsi_ENG.pdf

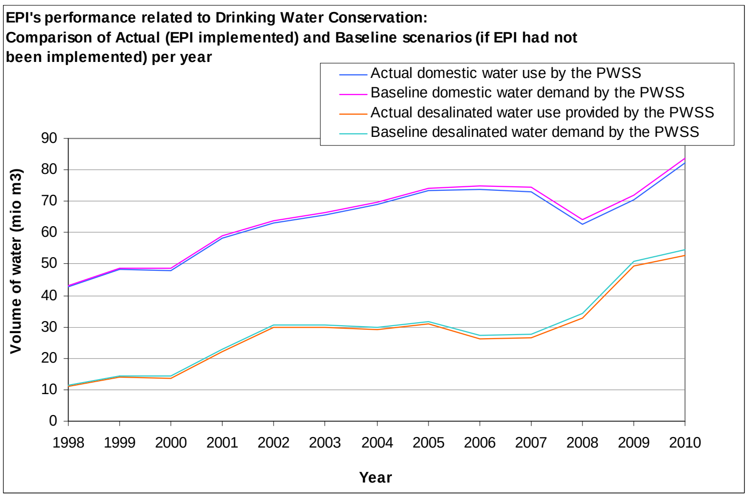


Figure 3.5 - EPI's performance related to Drinking Water Conservation: Comparison of Actual (EPI implemented) and Baseline scenarios (if EPI had not been implemented) per year.

Source: Compiled by the authors. Data provided by the Water Development Department (WDD) in I.A.CO Ltd, 2011, the WDD website http://www.moi.gov.cy/moa/wdd/wdd.nsf/0/0ac7d6e86ef8422ac2256e7e004404a7/$FILE/Diathesi_Ydrevsi_ENG.pdf, and the EEA WISE-SoE Reporting on Water Quantity http://www.eea.europa.eu/data-and-maps/data/waterbase-water-quantity-5

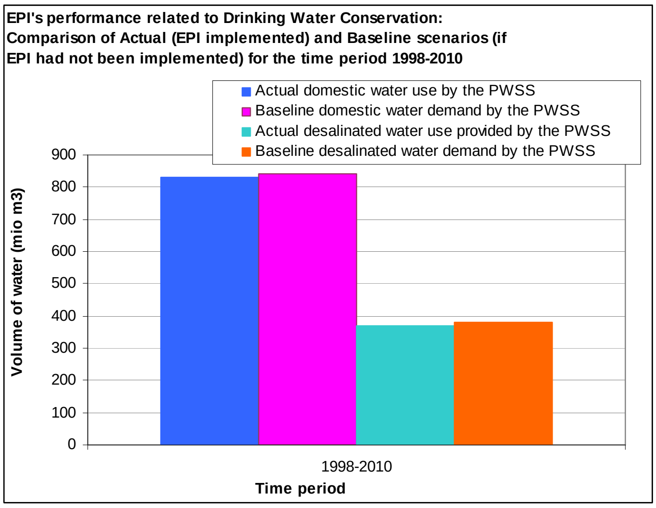


Figure 3.6 - EPI's performance related Drinking Water Conservation: Comparison of Actual (EPI implemented) and Baseline scenarios (if EPI had not been implemented) for the time period 1998-2010

Source: Compiled by the authors. Data provided by the Water Development Department (WDD) in I.A.CO Ltd, 2011, the WDD website http://www.moi.gov.cy/moa/wdd/wdd.nsf/0/0ac7d6e86ef8422ac2256e7e004404a7/$FILE/Diathesi_Ydrevsi_ENG.pdf, and the EEA WISE-SoE Reporting on Water Quantity http://www.eea.europa.eu/data-and-maps/data/waterbase-water-quantity-5

Impact on total domestic water use and groundwater resources

Although the EPI introduced savings in the drinking water supplied by the PWSS, its impact on the total domestic water use can not be clearly assessed. Assuming that the recalculates and grey water recycling systems were well maintained and functioning (since no actual monitor by the WDD has been conducted after the start-up) they would have resulted in overall saving of domestic water consumption. Yet, this can not be concluded for the boreholes' subsidy since the availability of free groundwater (no pricing for groundwater used from these boreholes) may have led the beneficiaries to over-pump and irrationally use excess water. Although in the design of the subsidy meters were provisioned to be installed in the boreholes in order to measure the consumption, and a pumping cap of 250m^3/year has also been introduced, enforcement by the WDD was very loose (practically non-existent) and thus no regular monitoring of the boreholes' meters has been implemented in order to (a) check whether the cap has been respected, and (b) maintain a register of the total abstracted volumes. The rational or irrational use of the boreholes relates to the individuals' behaviour (education, awareness, incentives) and whether they have a true water saving culture. The fact that this good has been provided for free (besides the additional initial cost of the borehole that may not have been covered by the subsidy) makes it even more difficult to restrain the use although 250m^3/year seems realistic for covering garden irrigation and toilet flashing needs. Even if we assume that the beneficiaries have respected the cap, the estimated drinking water saving from the irrigation boreholes has been calculated to range from 120-240 m^3/year depending on the household size, and the estimated drinking water saving from the connection of a borehole to toilet cisterns another 60m^3/year, thus 180-300 m^3/year from both measures. This potential volume of drinking water saved is in same cases smaller than the borehole cap and thus it may induce an increase in the overall domestic water use on a case by case depending again on the individual's behaviour. Concluding, the impact of the EPI on the overall domestic water use is unknown.

Furthermore, the borehole abstractions may have put additional pressure on the groundwater resources. WDD stated that groundwater levels and geology were considered in the evaluation of the applications, and that the aquifers where subsidies were finally approved are marginal and of poor quality and thus practically not exploitable for may uses. "Urban centers in general do not have large underground reserves. I believe that the criticism is directed at the large boreholes and not the small household boreholes. Such units can only pump 1-2 tones of water per day. The underground water in urban Nicosia, for example, is contaminated and could not be used for other purposes. So we are using this water for gardens and toilets and thus saving drinking water, which is more expensive, from being used for such purposes" Kyriakos Kyrou (Senior Water Board Plumbing Mechanic) stated to the Cyprus Mail (Cyprus Mail, 2008). It is indeed true that 250m^3/year from a number of borehole serving domestic purposes (assuming people do respect this cap) is not a significant volume, yet a comprehensive study on the cumulative effect of the boreholes (given especially the fact that many illegal wells do exist on the island) in the different districts should probably be undertaken prior to the launch of such measures in order to assess its environmental sustainability. Currently, no such assessment can be concluded, expect that, on the positive side, this subsidy has in some way allowed the government to have an idea of the number of domestic boreholes as it acts as an incentive for people to follow the procedure of applying and registering their borehole (as opposed to drilling it illegally).

Additional environmental benefits (energy and CO_2 emissions)

The main target of the EPI was to reduce demand for publicly supplied drinking water. Based on the observation that the EPI implementation started during the same period when desalination production to cover domestic demand has been initiated, and given the fact that desalinated water is currently the main domestic drinking water supply, it is fair to assume that the water savings induced would be substituting part of the desalinated water supply. Thus, the water savings from the subsidies can also be translated to equivalent energy savings (due to the decrease in desalination production needs) and corresponding CO2 emissions reduction. Desalination is a "power hungry process" resulting in significant greenhouse gases emission. Additionally, it has a slight impact on the marine environment, depending on the brine rejection conditions, and very high sound levels inside the plant (Lange, M. A., 2011). Desalination at current production (47.7 mio m^3/year) has a total electricity consumption of 217 GWh/year (equal to the 4.15% of the total 5,224

GWh/year EAC electricity production, Table 3.3). Based on the Cyrpus Energy Efficiency Report 2001, 762 gCO_2 emissions are generated per KWh produced. Thus, the total CO_2 emission generated from the desalination plants energy consumption account for 165,199 tones CO_2/year.

Each m^3 of water produced by desalination requires on average 4.5 KW (Manoli, A., 2010), thus 3.43 KgCO2 are generated per m^3 of water produced. The subsidies granted from 1998-2010 saved in total 12,420,240 m^3 of water, and assuming this volume would have come from desalination they resulted in a total 55,891,080 KWh of energy saving and 42,601 tones of CO_2 emissions saved for the entire period, or 3,277 tones/year on average. The energy and CO_2 estimated savings per year are illustrated in Table 3.4. Acknowledging of course that pumping from the garden boreholes consumes energy as well, the net savings would be somehow lower.

Table 3.3- Contribution of the desalination plants to the CO_2 emissions: Percentage of the combined power consumption to the total Electricity Authority of Cyprus (EAC) power generation

Year	Dhekelia %	Larnaka %	Moni %	Combined Percentage %
1997	1.02			1.02
1998	1.80			1.80
1999	2.30			2.30
2000	2.16			2.16
2001	1.95	1.00		2.95
2002	1.77	2.00		3.77
2003	1.72	1.88		2.60
2004	1.60	1.76		3.36
2005	1.59	1.86		3.45
2006	0.99	1.75		2.74
2007	0.98	1.69		2.67
2008	1.65	1.75		3.40
2009	1.75	1.75	0.65	4.15

Source: Manoli, A., 2010

Table 3.4 - Equivalent Energy and CO_2 emissions saving from the implementation of theEPI

Reference Year	Cumulative water saving (m3/year)	Equivalent Energy saving (KWh/year)	Equivalent CO_2 emissions saving (tones/year)
1998	444,480	2,000,160	1,525
1999	553,080	2,488,860	1,897
2000	628,620	2,828,790	2,156
2001	667,560	3,004,020	2,290
2002	696,840	3,135,780	2,390
2003	732,120	3,294,540	2,511
2004	803,400	3,615,300	2,756

2005	864,360	3,889,620	2,965
2006	978,240	4,402,080	3,355
2007	1,237,200	5,567,400	4,244
2008	1,467,060	6,601,770	5,032
2009	1,622,160	7,299,720	5,564
2010	1,725,120	7,763,040	5,917
TOTAL 1998-2010	12,420,240	55,891,080	42,601

Source: Compiled by the authors.

3.2 Economic Assessment Criteria

As discussed in Chapter 1 (EPI Background) the payments provided for each of the 4 measures were not kept constant throughout the implementation period 1997-2010; the amount of € paid varied among and within the intervention category, resulting thus in different costs for the WDD every year. It is not evident that the updates of the subsidies were based on specific studies or monitoring of the effectiveness of the EPI, but rather on add-hoc or spontaneous reaction of the WDD. Similarly a cost-benefit analysis previous to the launch of the measure or an ex-ante comparison with alternative measures has not been performed (at least to the best knowledhe of the authors). The total amounts of € paid in subsidies from 1997-2010 are presented in Table 3.5, while the grand total from all subsidies and years is about 5.5 million €. It is to be noted here that these payments do not represent the total cost of the EPI as transactions costs associated mostly with the implementation of the EPI (e.g. costs derived by the filed inspections) are not included.

Table 3.5 - Payments for subsidies for drinking water saving (in €)

Reference Year	Construction of borehole for garden irrigation	Connection of the borehole with the toilet cisterns	Installation of a hot water recirculator	Installation of a grey water recycling system
1997	212,500	119,170	0	0
1998	121,890	137,020	0	0
1999	84,660	47,600	0	3,078
2000	59,160	31,790	0	2,394
2001	33,660	8,670	0	342
2002	24,140	9,180	0	684
2003	28,560	12,240	0	2,040
2004	126,140	24,282	0	680
2005	109,140	16,758	0	680
2006	293,250	65,790	0	11,550
2007	777,240	460,360	20,740	37,400
2008	626,280	518,840	45,050	17,000

2009	415,800	282,100	68,640	66,000
2010	294,000	129,500	35,860	81,000
TOTAL 1997-2010	3,206,420	1,863,300	170,290	222,848
GRAND TOTAL 1997-2010 = **5,462,585 €**				

Source: Compiled by the authors. Data provided by the Water Development Department (WDD) in I.A.CO Ltd, 2011
Note: payments may be time delayed as compared to the implementation of the measures.

To assess the cost-effectiveness of the EPI, the unit cost of each m^3 of water saved has been calculated. This ratio of € spent per saved m^3 of drinking water has been calculated for each subsidy type and year to allow cross-comparison, and has additionally been compared with the selling prices of water from desalination plans (as formulated in 2009). To obtain this ratio (balanced cost), the total cost of the subsidy each year has been divided with the cumulative water saved from the subsidies granted the current plus all previous years, based on the assumption that the past interventions continue to be exploited by the beneficiaries (Figure 3.7).
In order to further assess the net amount of € paid each year for additional new savings, the total cost of subsidies of each year has been divided with the new savings generated explicitly that year. This was done in order to get a better insight on cost recovery per subsidy type and time period (Figure 3.8).

The overall average cost per m^3 saved from all the subsidies during the whole 1997-2010 period is **0.43€**. At the beginning of the implementation, the EPI comes at a high cost, e.g. subsidies provided for connection of a borehole to toilet cisterns in 1997 and 1998 result in 2.83 and 1.52 € paid per m^3 water saved respectively. As the EPI implementation progresses and water saving is accumulating over the years, the unit cost is decreased as low as 0.10 €/m^3 (years 2001-2005). A time frame of about 3 years was thus required for the EPI to become cost-effective as compared to the selling prices of the Desalination Plants and water tariffs. It has to de noted that during that period the amount paid per subsidy was kept at low levels (170€ for the boreholes, 340€ for the grey water recycling). From 2006 onwards the unit cost has highly and abruptly increased, reaching values higher than the desalinated water selling prices. The maximum is observed in 2007 where unit costs on m^3 saved are in the range of 2.5 € and continue to be high and above desalinated water selling prices for the following years. This change is probably due to the fact that the payments were significantly increased (700€ for the boreholes, 1,700€ followed by 3,000€ for the grey water recycling systems), as well as the number of subsidies given (dramatic increase of 100-400% in some categories). Apparently, as Cyprus was facing severe drought conditions during that period, the applications submitted were probably much more than in the previous years, leading us to conclude that the EPIs probably did not induced a change of behavior towards water conservation, but rather acted as a mean to individuals to secure domestic water using alternative free resources (they did thus decreased water supply risk), and people would probably have implement these measures even if the subsidies were not available. Looking further at the net cost of additional new savings generated every year, we can observe that after 2004 this becomes disproportionally high, implying that the increases in the amounts paid were probably too high (subsidies should probably have kept at lower rates). Thus, it is not clear whether the EPI contributed to increase the overall economic efficiency, as the average unit cost of the 1997-2010 period was indeed lower than that of the desalination plants, but there were several years where it was much higher (Figure 3.7).

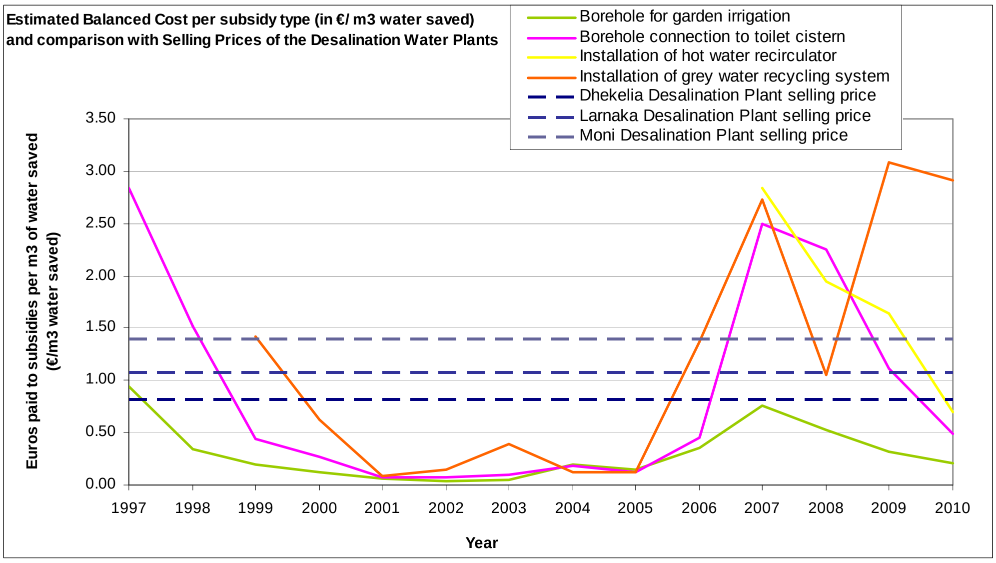


Figure 3.7 – Cost-effectiveness of EPI: Balanced cost per subsidy type (in €/m³of drinking water saved)

Source: Compiled by the authors.

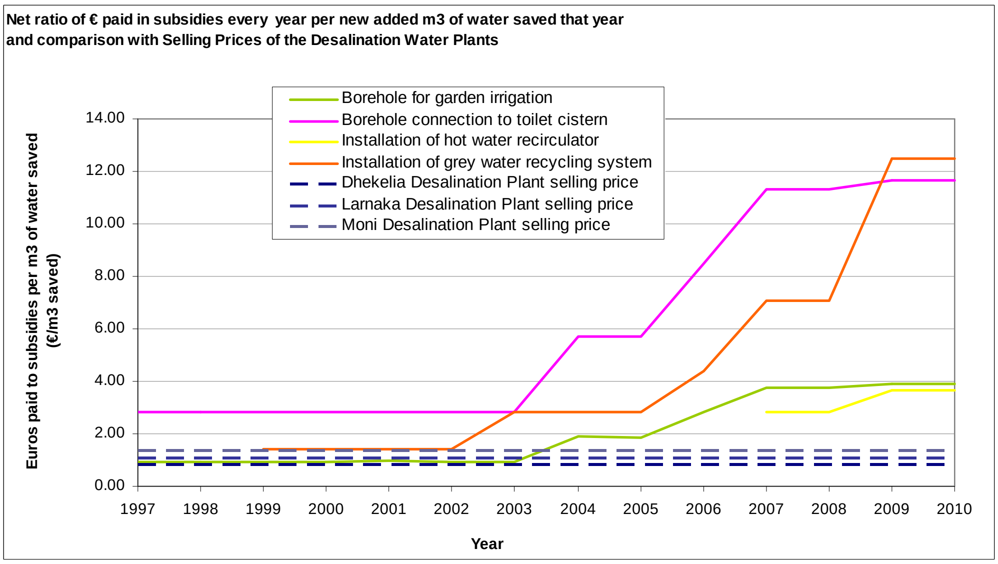


Figure 3.8 – Cost-effectiveness of EPI: Net ration of € paid in subsidies every year per new added/m³of drinking water saved.

Source: Compiled by the authors

The costs of the EPI implementation were exclusively burdening the WDD, while the beneficiaries could see a decrease in their water bills (since in the case of boreholes the volume of water used for gardening was now free of charge) having invested a small initial capital (the difference between the actual cost of drilling a borehole and the subsidy was paid by the individuals).

In parallel to the subsidies, the WDD had launched a bundle of measures targeting water saving and demand reduction: awareness campaigns, water reuse, water pricing, water metering installation, leakage reduction through replacement of old water supply networks. As these measures were complimentary, it is difficult to decouple the actual effect of the investigated EPI. Nevertheless, a comparison of the effectiveness of the subsidies with findings from other studies on alternative measures is presented in Table 3.6. The assumptions made in these calculations are presented in the footnotes. It is to be noted that this is an ex-post evaluation of the alternatives, and additional hidden costs may be not captured, yet it indicates that the average unit cost of the subsidies (from 1997-2010) is much lower than compared with other alternatives (e.g. networks replacement). On the otrher hand though, it must be kept in mind that the subsidies did not render net water savings, but saving on the domestiv drinking water instead, while due to groundwater abstraction the overall domestic water use might have increased and the contribution of the EPI

Table 3.6 – Water demand management measures and estimated savings

Measures	Water savings (mio m³/year)	Estimated costs (€)	Unit cost (€/m³)	Data coverage (years)
Replacement of aging water supply networks	3.3	49,125,517	1.35	2000-2010
Use of non-conventional water resources				2012-onwards
Recycled water	15.5[1]		*Based on new pricing study:* 0.87-1.06	2012-2015 and onwards
Desalinated water	51.1[2]		*Selling price:* 0.82-1.39	
Rainwater Harvesting	5[3]	2,200,000	0.44	
Subsidies for reducing drinking water demand	1.7[4]	5,462,858	0.43	1997-2010
Mandatory water restrictions on domestic water supply	3.8	-	-	2000-2010
Use of meters	7-18[5]	-	-	1986-2009
New Water pricing system	14 -35[6]		*Based on new pricing study:* 1.09-1.32	2012-2015 and onwards
Water saving campaigns	5.6[7]	4,311,000	0.76	2007-2009
Other measures and water	can only be			

management studies (e.g. WFD related studies)	evaluated on the long-term

Source: Compiled by the authors. Data from Charalambous et al., 2011, and I.A.CO Ltd, 2011

Notes:

[1] The current production of recycled water is 14.8 m^3/year (Larkou-Giannakou, 2010). Yet, the vast majority is produded in UWWTPs and used for irrigated agriculture. Only 1.9 m^3/year are produced in-situ from small communities, hospitals, military camps etc. and this volume is used for watering gardenrs and amenity areas, thus assumed here as used for domestic purposes. According to the Directive 91/271/EC water collection and treatment facilities in communities of 2,000 eq. population should be in place in Cyprus by 2012. Thus, the anticipated use of recycled water is to substitute approximately 26% of the total water use (currently it represents the 4.3%). The expected increase is at the range of 22% and assuming this is proportional to all water uses, the expected savings in the domestic water use would be (70.3 * 22%) 15.5 mio m^3/year.

[2] Current desalinated water supply (approximately 47.7 mio m^3/year) is not included. The amount includes the future plants to operate in Lemessos (40,000m^3/day max capacity), Pafos (40,000m^3/day max capacity) and Vassilikos (60,000m^3/day max capacity).

[3] The savings were in the range of 1 mio m^3 in each of the 5 main cities. The measure included installation of 2,750 tanks of 19,800 m^3 capacity each at community level. It is to be noted that these figures totally depend on the precipitation variability, and overall the measure was considered as non-successful (I.A.CO Ltd, 2011) and domestic level RWH should be considered instead.

[4] The total saving of the entire 1997-2010 period are 12,685,500 m3 as calculated in the previous section

[5] Water saving from meters installation is at the range of 10-25% of the domestic water consumption (= 70.3 mio m3/year in 2009).

[6] Estimating savings are at the range of 2-5% of the domestic water use (70.3 mio m^3/year in 2009).

[7] Estimating savings are at the range of 8% of the domestic water use (70.3 mio m^3/year in 2009) based on literature.

3.3 Distributional Effects and Social Equity

The government principle when water shortages arise in the country of Cyprus is "first come humans, then animals and finally plants". This rationale creates feelings of unfairness resulting in illegal drilling and pumping of groundwater. Conflicts and competition over water supply, mostly stemming from the lack of precipitation and the current development pattern are often in Cyprus. A good example demonstrating the complexity of issues is encountered in the Limassol region which is one of the most popular tourist destinations in Cyprus. In the same region, there is significant irrigation demand as agricultural production accounts for more than 25% of the fruit trees, 6% of vegetables and 20% of the table grapes production of the country. The area is considered water-rich, when compared to other areas of Cyprus. It also bears the most important water supply infrastructure works (through the Southern Conveyor Project). As a result, during drought periods, local farmers strongly protest against inter-basin water transfer, demanding that their water needs are prioritized over domestic and tourist demands, or demands of other areas.

In the case of this EPI, the beneficiaries' incentives into applying for a subsidy seem to stem from their motivation to secure water and interrupted supply for their gardens, t=rather to conserve water. Social inequalities can arise from the subsidies for boreholes. It looks like the motivation behind the beneficiaries was to secure uninterrupted water supply for their gardens, thus during dry periods when water supply is cut regularly and while some people are suffering from water shortages, others may water their gardens, causing aggravation. Furthermore, it rises questions on environmental cost recovery and whether money should be granted to people as they are already benefiting from acquiring an additional "free" water supply. On the other hand, in an interview for Cyprus Mail, Kytiako Kyrou (Senior Water Board Plumbing Mechanic) defended that contrary to what reason may dictate, licenses to drill boreholes are given every year and a large number of new boreholes were dug in 2008 (which was a year marked by an acute water crisis) causing hardship and inconvenience for those who could not afford their own borehole, thus the subsidy may have created opportunities for these people.

Additional conflicts may rise by the farmer's community. Although stated by the WDD that boreholes were approved on the basis that they were exploiting marginal aquifers of urban centers and of poor quality unsuitable for other users, public proof of evidence was lacking and thus farmers could assume that the drawdown may affect nearby irrigated agriculture and their wells' capacity.

Finally, given the process of the borehole subsidy, conflicts may arise between the WDD (executive level) and the Local District Offices (end-users level). Although the District Office grants the borehole permit, this is based on the decision of the WDD while the control of the District Office on this decision is minor. The criteria set by the WDD on this basis may be loose or not tailored to the specific prevailing conditions in each district (many of which use public supply wells) and thus initiate problems between institutions.

3.4 Institutions

The institutional setting in Cyprus evolves around 3 top-down levels (Figure 3.9):

1. Policy Level

At policy level, water management falls under four Ministries in Cyprus: (a) the Ministry of Agriculture, Natural Resources and Environment (MANR&E) which is responsible of water resources planning, allocation and technical support; (b) the Ministry of the Interior with the legal responsibility for local government through its Districts Officers, and an interest on water supply especially in touristic and industrial areas as well as control of groundwater permits; (c) the Ministry of Finance which is responsible for budget and financial issues (all expenditures are dealt from the Accountant General and the Budgeting Officer); (d) the Ministry of Commerce and Industry which is dealing with the water needs of the tourism and the industrial sectors.

2. Executive Level

At decision-making level the responsible actors are: (a) the Water Development Department (WDD) of the MANR&E which is responsible for implementing MANR&E's water policy for rational development and management of water. The WDD collects, processes, classifies and archives data relatively to water resources. It also plans, designs, constructs, operates and maintains water works; (b) the District Administration (DA) of the Ministry of Interior which is responsible for implementing and enforcing water laws with its main duty issuing groundwater permits. After November 2010, with the enforcement of the new Unified Water Management Law, the later has now become a responsibility of the WDD.

3. End-user level

When downscaling, a number of local organisations are responsible for water administration. The Municipal Water Boards and Village Water Commissions are responsible for domestic water supply; the Irrigation Divisions and Associations and WDD are dealing with irrigation and the Sewerage Boards with waste water collection and treatment.

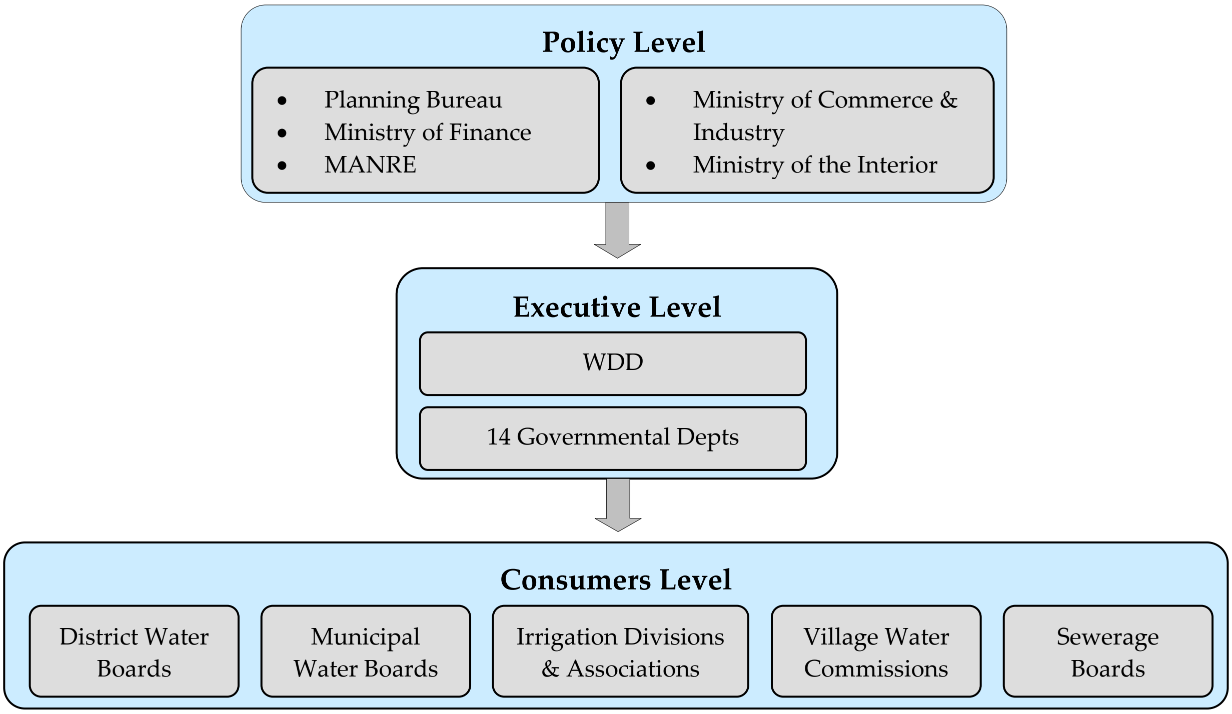


Figure 3.9 - The administrative, institutional and political setting of the water sector in Cyprus

Source: Aeoliki Ltd, 2009

- Domestic Water Supply

The government, and more specifically the WDD, is currently responsible for the construction, operation, administration and management of all Government Water Works related to freshwater provision, and the bulk water supply provision for domestic use (collection and storage of water in reservoirs, treatment, distribution of potable water to the cities and villages - approximately 80%). WDD is also responsible for obtaining the water from two desalination plants that are currently in operation located at the airports of Dhekelia and Larnaka. The Government obtained Build-Own-Operate-Transfer (BOOT) contracts from private companies which are responsible for the construction and operation of the plants. WDD also makes sure that the water is conveyed at the agreed quantities as well as in good quality for the supply to the population at Water Boards, Municipal Boards and Village Boards Level.

At the users' level, the domestic water is supplied to the population by the Town Water Boards, the Municipality Boards and the Village/Community Boards. Cyprus has four Water Boards in the main metropolitan areas: Nikosia, Limassol, Larnaka and Famagusta. Their operation is governed by the "Water Supply (Municipal & Areas) Law (Cap 350). The Water Boards obtain their bulk supplies from the WDD and partly from boreholes (1% in Nicosia, 30% in other Water Boards) or other sources developed and managed by themselves, subject to the prior approval of the Council of Ministers and the Parliament.

Table 3.7- Water services and responsibilities for domestic water supply

Service	Responsibility (Policy)	Responsibility (Investments)
Surface water abstraction, storage, treatment	Water Development Department	Water Development Department
Water desalination	Water Development Department	Private Sector
Groundwater abstraction	Town Water Boards (in the major metropolitan areas), Municipal Authorities (in smaller municipalities) Community Boards (in villages) Individual Users Water Development Department	Town Water Boards (in the major metropolitan areas), Municipal Authorities (in smaller municipalities), Community Boards (in villages) Individual Users Water Development Department
Water Distribution in urban areas	Town Water Boards Municipal Authorities Community Boards	Town Water Boards Municipal Authorities Community Boards
Wastewater collection and secondary treatment and recycled water provision	Sewerage Boards	Sewerage Boards
Tertiary wastewater treatment and recycled water provision	Water Development Department	Water Development Department

Source: Adopted from Aeoliki Ltd, 2009.

The design of the EPI was carried out solely by the WDD which is the actor responsible for implementing Cyprus water policy and managing the water resources. The fact that the implementation and enforcement of the EPI was single-handed carried out by the WDD as well (application evaluation, inspections prior and after the works) required a serious block of time, man-power and money, and probably created the incapability to monitor (e.g. the borehole meters) and follow up on the effectiveness of the measure. If responsibilities had been better shared among the executive and end-user levels (e.g. monitor carried by the Local District Office), the implementation might have been more successful, in terms of more rational selection of the beneficiaries based on specific additional local criteria (i.e. loose conditions when it comes to the selection of beneficiaries for borehole drilling are reported by some water officers, Charalambous et al., 2011), stronger enforcement of the EPI's constraints (i.e. respect of the groundwater abstraction cap), monitoring and assessment of its impacts and benefits that would allow update and re-design of the EPI. Regarding the construction of boreholes, the Local District Office was involved in granting a drilling permission, but not in the actual evaluation process; it was acting rather as an additional intermediate agent who was gathering paperwork to forward it to the WDD, burdening thus in a sense the process.

3.5 Policy Implementability

In Cyprus water legislation was mostly developed during the colonial era (1928-1950). The most important laws around water management in Cyprus are the following: Government Waterworks Law (Cap. 341, 1959), Wells Law (cap 351, 1959), Water Supply (Special Measures) Law (32/64), Water Supply (Municipal and Other Areas) Law (Cap 350), 25/1972, 31/1982, 172/1988, Water (Domestic Purposes) Village Supplies Law (Cap 349), 66/1990, New Uniform Management of Water Resources Law, November 2010. Detailed information on these laws is provided in the Annex.

The implemented EPI was aligned with the prevailing laws and policy setting, while no barriers linked to other policies could impede its implementation. In terms of flexibility, subsidies themselves are flexible and can be adjusted to local conditions, adequate planning is though required in the designing phase, as well as a follow-up on their effectiveness that can allow re-design (e.g. updating the amounts granted) and post-implementation adaptation when conditions change. Nevertheless, this has not happened in this case as a uniform approach regardless the local particularities has been applied, and although the amount paid for subsidies have been updated form 1997-2010 this adjustments has not been based on a post-implementation review. One study was identified, attempting to assess in 2004 the effectiveness of one of the subsidies, namely the construction of a borehole for garden irrigation, initiated by Stephanos Papatryphonos, a Senior Hydrogeologist of the Water Development Department. As quoted in Charalambous et al., 2011, the potable water consumption of 20-30 households was monitored in a suburb of Nicosia, 12 months before the installation and 12 months after the installation of a borehole. Average savings of potable water consumption in the households were calculated to be around 27% when a borehole was installed. This study was not carried out in other towns due to various reasons including the fact that other Water Boards were not willing to provide water consumption data for confidentiality reasons and, to the best of the authors' knowledge, did not serve the purpose of re-designing and adjusting the EPI, although this could be possible.

In terms of exemptions made, all subsidies were granted by the WDD following an application submission and two inspections. Local particularities were considered in this process, and if proved inadequate the subsidies were not given. For example, in the case of the construction of borehole the application could be rejected depending on the local condition of the aquifer where the borehole was to be located. However, it seemed that almost everyone was eligible for the subsidy which indicated loose conditions when it comes to the selection of beneficiaries for borehole drilling which was reported by some water officers (Charalambous et al., 2011). In the period 2007-2008 were extreme drought conditions prevailed, the number of subsidies drastically increased, demonstrating the fact that external factors in this case did not impede the functioning of the EPI as such. They did though probably led to spontaneous and poorly thought reaction in terms of economic efficiency, as the total amount paid for subsidies during that period was extremely high (both due to the increased numbers of subsidies, as well as to the increased grant per subsidy paid) resulting in a unit cost of 2.5€ for every additional m3 of water saved. Finally, the EPI had not provisioned for measures to monitor the achievement of policy objectives and to avoid negative effects. A cap of 250m^3 abstraction per year was imposed to the new boreholes; the meters though were not checked for compliance by the WDD or any other mechanism after the implementation of the subsidy.

Public participation, inclusion of stakeholders in the discussions and collective design were not pursued by the WDD, which, if incorporated, could have brought up issues of social equity and, most importantly, unsustainability of the measure, since economists and hydrologists could have picked up on issues of cost-benefit and groundwater overexploitation respectively. Regarding acceptability of the EPI, it was well taken by the users of domestic water supply, since in fact these were the real winners that could benefit even from an additional free resources (in the case of boreholes to the groundwater), yet, although no information is available, it is most likely that farmers would have opposed to it due to high water allocation conflicts. A good example demonstrating the complexity of issues is encountered in the Limassol region which is one of the most popular tourist destinations in Cyprus. In the same region, there is significant irrigation demand as agricultural production accounts for more than 25% of the fruit trees, 6% of vegetables and 20% of the table grapes production of the country. The area is considered water-rich, when compared to other areas of Cyprus. It also bears the most important water supply infrastructure works (through the Southern Conveyor Project). During drought periods, local farmers strongly protest against inter-basin water transfer, demanding that their water needs are prioritized over domestic and tourist demands, or demands of other areas, thus spending huge amounts on domestic subsidies (instead of potentially to other measures that can also secure agricultural water) can challenge the acceptance of the EPI as an alternative. Additional conflicts may rise by the farmer's community, since although stated by the WDD that boreholes were approved on the basis that they were exploiting marginal aquifers of urban centres and of poor quality unsuitable for other users, public proof of evidence was lacking and thus farmers could assume that the drawdown may affect nearby irrigated agriculture and their wells' capacity. Finally, given the process of the borehole subsidy, conflicts may arise between the WDD (executive level) and the Local District Offices (end-users level). Although the District Office grants the borehole permit, this is based on the decision of the WDD while the control of the District Office on this decision is minor. The criteria set by the WDD on this basis may be loose or not tailored to the specific prevailing conditions in each district (many of which use public supply wells) and thus initiate problems between institutions.

The subsidies were designed and implemented by the WDD which is mostly responsible for the water resources development. Yet, since the subsidies clearly relate with financial planning issues, we need to consider that re-designing of the EPI in economic terms may have required a more complex process due to the role of other involved parties. For financial matters the WDD has to consult with the MANR&E, the Planning Bureau for the authorization of funds and expenditure, the Ministry of Finance and the Accountant General for finance and tenders and the Loan Commissioners for loans for subsidized projects. It is also monitored from the Audits Office and has to justify any change from the original contracts for water development works. The WDD also uses the services of the Geological Survey Department, which includes the well drilling and testing. For personnel the WDD has to justify its requests to the Ministry of Finance. The WDD budgets are prepared by the Department, forwarded to the Ministry of Finance, are then inspected by the Bureau of Planning that requires sometimes further and more detailed explanations. This process of obtaining the release of the funds can be tedious. Moreover, planning ahead is not an easy task as budgets are sometimes approved by the House of Representatives. So, even if all approvals have been obtained, the Planning Bureau requires further approval for any changes that are needed to be made. Consequently, much time and effort is wasted during these processes. As mentioned before the WDD is bind on the Government procedures for all its actions. That could also be problematic and most importantly time consuming for the procedures, and might have been the root of poor planning of the EPI in terms of grants awarded per subsidy type and their respective updates.

Finally, regarding the EPI and sectoral policies, no specific barriers linked to other policies that posed problems to the successful implementation of the EPI have been identified. On the other hand, the EPI, and specifically the subsidies for boreholes may have put additional pressure on the groundwater resources. WDD stated that groundwater levels and geology were considered in the evaluation of the applications and that the aquifers were subsidies were approved are marginal and of poor quality and thus practically not exploitable for many uses. This approach indicates that the WDD does not see the environment as a whole, but instead is isolating potable water saving in the case of the specific objective of the EPI which results in other negative effects on the environment. For example, the WDD is abstracting groundwater in Nicosia with the excuse that is contaminated and could not be used for other purposes and so is subsidised to be used for garden irrigation. This goes against other policies in this specific case the Water Framework Directive. WFD is intended both to safeguard drinking water supplies and to prevent ecological damage. Similarly, among the goals of the WFD and Groundwater Directive is the good chemical status of the groundwater, and thus with the borehole subsidies the WDD could further deteriorate the bodies (since less quantity could results in less dilution), when in fact they should try to improve it.

3.6 Transaction Costs

Transaction costs have been identified in relation to the design, implementation and monitoring and enforcement.

- **Design costs**

No engineering or economic assessment studies have been identified regarding the design of the EPI prior to its implementation, with the exception of subsidies for the installation of grey water recycling systems (Kambanellas, C. A., 2007). Five years of research (1985-1991) and two years of experimental work (1997-1998) on a pilot scale led to launching this subsidy in 1999. Seven grey water treatment plants were installed and monitored in the region of Nicosia in mid 1997 (1 in a hotel, 1 in a stadium, and 5 in households). By the end of 1998 (1.5 years of operation) 220 m^3 of water had been recycled. This water was reused, without any problems, for the watering of the gardens of the hotel and the households, the watering of the lawn at the stadium and the flushing of the toilets of the households. Chemical analyses were performed by the Government General Chemical Laboratory and the Water Development Department, to verify the suitability of the water quality for the selected uses. Thus, design costs related to costs paid to researchers for designing the pilot study, the purchase and installation of 7 systems (about 1,400€ for each household and higher prices for the hotel and stadium), lab costs, and field trips expenses (assuming the labour cost of the involved WDD officers was included in their salary).

- **Implementation costs**

Based on the Citizen's Charter Report 2005 of the WDD, a series of actions are to be undertaken from the time of application until the subsidy is paid to the beneficiary.

Subsidy for boreholes in house gardens (process until November 2010):

- Obtain a valid borehole licence from the respective District Office (this involves: gathering all the necessary paperwork by the applicant –i.e. location plans, town planning permits etc.- and submission to the District Office, inspection by the WDD of the place where the borehole is to be drilled, final approval by the WDD, granting the licence by the District Office)
- The borehole must be drilled by a person with a professional licence (Applicants may be furnished with a list of licensees at the Water Resources Division or at the Department's District Offices).
- The subsidy is granted after the borehole has been drilled, inspection has been carried and the relevant form has been completed.

Subsidy for the connection of boreholes with lavatories:

- The applicant must file an application prior to the commencement of any connection work.
- The existing borehole must first be inspected by the WDD and technical advice be given on the method of connection (the inspection is carried out after the submission of the application and prior to the installation).
- The borehole is then connected to the lavatory (subject to approval by the WDD).
- The subsidy is granted after the connection is completed and after it has been inspected by the officers of the WDD (the applicant must notify the WDD to this effect). The officers must remain satisfied that the connection has been carried out in accordance with the WDD's instructions.

Subsidy for the installation of a recycling system for grey water:

- Prospective beneficiaries must file an application for the installation of the system prior to the commencement of any work.
- The sewage system of the building must first be inspected by the WDD and all the necessary advice be given for the installation of the system for the recycling of grey water (the inspection is carried out after the application has been filed and before the installation of the system).
- Installation of the recycling system (upon approval obtained by the WDD).
- The subsidy is granted after the system has been installed and inspected by the officers of the WDD (the applicants having notified the Department to this effect). The officers must remain satisfied that the installation has been carried out in accordance with the directions of the WDD.

Implementation costs are generated by the need for field inspection (2-3 times is total) and the interaction between the WDD and the District Office in the case of boreholes. The extra labour costs generated for the technicians who carry the inspections and the officers who examine the applications can be covered by their salary, yet transaction costs are still evident and associated with opportunity costs in this case.

- **Monitoring and enforcement costs**

The instrument had provisioned the installation and monitoring of water meters in the boreholes to secure that the cap of 250m^3/year groundwater abstraction is respected and also to assess the efficiency of the EPI. Nevertheless, monitoring and control activities have not been identified. Control of the borehole meters would imply field trips (and thus associated expenses) and monitor of the house meters to assess water savings would imply interaction with the District Offices, thus labour costs if additional personnel is required to run the assessment.

3.7 Uncertainty

While the policy objective of the EPI was clearly specified, its outcome (water savings) has not been quantitatively measured based on monitoring data, but it was calculated based on assumptions and literature reviewed expected performance. Only one follow-up study has been identified, assessing one of the measures (subsidies for drilling a borehole) for a very small sample size (20-30 households in Nicosia). The monitored 27% saving compares well with the proxies of the current calculations, yet we can not extrapolate this for all the 7,666 boreholes subsidies and all the regions. Furthermore, as a bundle of measures were launched at the same time (reduction of leakage through restoration of the networks, progressive block tariffs, meter installation, water saving campaigns etc.) we can not strictly attributed the measured savings on the EPI and decouple them from the overall impact of all the complementary measures. Uncertainty in the calculations which related with the EPI's performance on the specific policy objective is thus evident.

Under the broader assessment of the EPI's suitability as a demand conservation measure more uncertainty arises related to its selection and implementation. The conditions for providing subsidies to the applicants were very loose, almost everyone was eligible. Thus, insufficient screening or lack of specification of a target group, based on predefined criteria stemming from impact assessment, added to the uncertainty regarding the EPIs performance to be achieved. On the environmental assessment side, while savings from drinking water could be achieved, it was unclear whether an overall domestic saving would be achieved, since providing free water for gardening could trigger an increased insensitive use of this micro-component. Although meters were installed in the boreholes and groundwater abstraction was caped to 250m3/year, they were nearly never monitored by the officials to assess the overall environmental benefit or adverse impacts on groundwater.

Finally, uncertainty is evident regarding the incentives of the beneficiaries. It seems that their motivation was mostly to secure water and uninterrupted supply for their gardens (Charalambous et al., 2011), rather than to conserve water or save money from their water bills.

A synthetic Pedigree matrix describing the degree of uncertainty for the each of the most important information available on environmental outcomes, economic outcomes, distributional effects and social equity, and transaction costs is provided in the Annex (Table 0.1)

4 Conclusions

4.1 Lessons learned

From 1997-2010 a total of 13,172 subsidies have been granted (of which 59% for new boreholes, 34% for connection of boreholes to toilets, 6% for recirculators and 1% for grey water recycling systems installation). By looking at the temporal evolution of the number of subsidies as compared with the respective precipitation, it is observed that subsidies paid pick-up in periods of low precipitation/drought events, conveying a message that the motivation of the beneficiaries was securing uninterrupted water supply for their gardens, rather than conservation, and their behaviour reactive rather than proactive.

The cumulative drinking water savings (as estimated based on the number of subsidies and assumptions on potential savings) from all subsidies during the 14-year period 1998-2010 are about 12,420,240 m^3 (or 12.42 mio m^3) and represent 1.50% of the total 1998-2010 domestic water use and 3.37% of the total desalinated water provided by the public water supply system (PWSS) in 1998-2010. The above percentages vary from year to year. Although the EPI introduced savings in the drinking water supplied by the PWSS, its merit is questionable when it comes to the measures on boreholes use; access to free groundwater may have led the beneficiaries to over-pump and irrationally use excess water, thus causing adverse impact on groundwater and an overall increase in the domestic water consumption.

The fact that enforcement by the WDD was very loose (practically non-existent) and thus no regular monitoring of the boreholes' meters has been implemented in order to (a) check whether the cap has been respected, and (b) maintain a register of the total abstracted volumes, weakened the EPI's performance and its overall environmental benefit. On the positive side though, since the water saved from the subsidies would probably have originated from desalination, equivalent energy savings (due to the decrease in desalination production needs) and corresponding

CO_2 emissions reduction have been induced, estimated to a total 55,891,080 KWh of energy saving and 42,601 tones of CO_2 emissions saved for the entire period, or 3,277 tones/year on average.

The total amount of € paid in subsidies from 1997-2010 is about 5.5 million € (of which 59% for new boreholes, 34% for connection of boreholes to toilets, 3% for recirculators and 4% for grey water recycling systems installation). The overall average cost per m^3 saved from all the subsidies during the whole 1997-2010 period is 0.43€. To these costs though, transaction costs associated with the design and implementation of the EPI (e.g. expenses related to the inspections, labor expenses etc.), which are considerable have not been assessed by the WDD. At the beginning of the implementation, the EPI comes at a high cost, e.g. subsidies provided for connection of a borehole to toilet cisterns in 1997 and 1998 result in 2.83 and 1.52 € paid per m^3 water saved respectively. As the EPI implementation progresses and water saving is accumulating over the years, the unit cost is decreased as low as 0.10 €/m^3 (years 2001-2005). A time frame of about 3 years was thus required for the EPI to become cost-effective as compared to the selling prices of the Desalination Plants and water tariffs. From 2006 onwards the unit cost has highly and abruptly increased, reaching values higher than the desalinated water selling prices (maximum observed in 2007 was 2.5 €/m^3). This change is due to the fact that the payments where significantly increased, as well as the number of subsidies awarded (dramatic increase of 100-400% in some categories), supporting evidence that its cost-benefit clearly relates to the design parameters.

The overall performance of the EPI is subject to uncertainty. While drinking water conservation has likely been achieved, due to the fact that no monitoring was implemented all results are based on proxy calculations, and thus are subject to bias. The selection of boreholes as one of the subsidies creates ambiguity, regarding the adverse impacts on groundwater and the irrational use of a free water supply (thus resulting in an overall increase if domestic water use). Weaknesses in the design (no impact assessment prior to implementation, no research behind the selection and updates of the amounts paid, etc.) and enforcement of the EPI (no monitoring and follow-up) cause reservations regarding its effectiveness. In parallel to the subsidies, the WDD had launched a bundle of measures targeting water saving and demand reduction: awareness campaigns, water reuse, water pricing, water metering installation, leakage reduction. Thus, it is difficult to decouple the actual effect of the investigated EPI and the savings that are explicitly attributed to the subsidies.

While the EPI was aligned with the prevailing laws and policy setting and in terms of flexibility, it has the potential to be adjusted to local conditions, public participation, inclusion of stakeholders in the discussions and collective design were not pursued by the WDD, which, if incorporated, could have brought up issues of social equity, possible unsustainability of the measure as such, and useful suggestions for re-design and enhancement. Additionally, the whole process was much centralised, with the WDD as the single involved actor, whereas if a rational partition of responsibilities had been foreseen (i.e. carrying of the inspection by the Local District

Office) the burden would have been shared and thus enforcement and follow-up might have been possible allowing thus real ground evaluation of the EPIs effectiveness.

4.2 Enabling / Disabling Factors

The key enabling factors for this EPI to be successful are:

- Adequate design, prior to the implementation of measures, which is based on field research, survey, impact assessment and pilot applications.
- Public participation, involvement of the stakeholders in the discussions and collective design which can facilitate in identifying issues of social equity and possible unsustainability of the proposed measures (e.g. in relation to the amounts granted, the expected response, etc.).
- Enforcement and monitoring, that will allow the timely collection and analysis of data to assess the performance and re-evaluate the original design if needed.
- Share of responsibilities, involving regional authorities (in this case the Local District Offices) that could (a) convey local knowledge on the specific prevailing conditions of the areas, allowing thus the proper adaptation of the subsidies, and (b) perform the inspections thus reducing the burden and cost from the central agent (in this case the WDD).
- Awareness rising and targeted education of the beneficiaries in order for them to understand that their main incentive should be water conservation and not saving money from their water bill or securing uninterrupted watering of their gardens, avoiding thus irrational use.

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Annex

The most important laws around water management in Cyprus:

1. **Government Waterworks Law (Cap. 341, 1959)** This Law totally empowers the government to take any decision upon water. This means that the government can plan, design, construct, operate and maintain, any waterworks, to sell water, to buy water rights, to assess water rights, to fix water tariffs and to collect water sale bills. However, the law fails its purpose as it does not assign one authority to take upon the overall responsibility of the management of water resources and water works.
http://www.sba.mod.uk/SBA%20Legislation/Colonial%20Rev%20Ed%20%28Caps%29%20-%20Laws%20of%20Cyprus%20%281959%29/Caps%20308-354%20-%20Statute%20Laws%20of%20Cyprus%20%20Rev%20Ed%20Vol%20VI/CAP%20341.pdf
2. **Wells Law (cap 351, 1959)** allows the District officers to issue permits for the abstraction of groundwater. This law was partly improved with the **Water Supply (Special Measures) Law (32/64)** which gave to the Government the power to declare and designate areas for groundwater protection against overexploitation.
http://www.sba.mod.uk/SBA%20Legislation/Colonial%20Rev%20Ed%20%28Caps%29%20-%20Laws%20of%20Cyprus%20%281959%29/Caps%20308-354%20-%20Statute%20Laws%20of%20Cyprus%20%20Rev%20Ed%20Vol%20VI/CAP%20351.pdf
3. **Water Supply (Municipal and Other Areas) Law (Cap 350), 25/1972, 31/1982, 172/1988**
The law provides for the establishment of Water Boards for the control and management of water supplies in municipal and other areas, under the chairmanship of the District Officer. The law allows the creation of semi-governmental organizations (Water Boards) responsible for the development, treatment, distribution and provision of potable water within the boundaries of inhabited areas fixed by the Council of Ministers, for domestic and industrial purposes including tourism and recreational uses. Water tariffs are set by the Council of Ministers and approved by the Parliament.
http://sba.mod.uk/SBA%20Legislation/Colonial%20Rev%20Ed%20%28Caps%29%20-%20Laws%20of%20Cyprus%20%281959%29/Caps%20308-354%20-%20Statute%20Laws%20of%20Cyprus%20%20Rev%20Ed%20Vol%20VI/CAP%20350.pdf
4. **Water (Domestic Purposes) Village Supplies Law (Cap 349), 66/1990:**
This Law provides for the creation of village water Commissions for village water supply. The District Officer administers this law, and all requests for

studies and construction of water works are forwarded to the Water Development Department, which formulates and implements the water projects.
http://sba.mod.uk/SBA%20Legislation/Colonial%20Rev%20Ed%20%28Caps%29%20-%20Laws%20of%20Cyprus%20%281959%29/Caps%20308-354%20-%20Statute%20Laws%20of%20Cyprus%20%20Rev%20Ed%20Vol%20VI/CAP%20349.pdf

5. **New Uniform Management of Water Resources Law, November 2010**
"Water Entity" under the New Uniform Management of Water Resources Law that was voted from the Parliament in 2010 gives all the responsibilities of water management mostly to the Water Development Department. The WDD of the MANR&E is today the new unified water entity that is capturing everything that relates to water. One of the most important changes of the new law was the issue of permits to drill and abstract water, which is now in the jurisdiction of the WDD. The purpose of the new law was to achieve the harmonization of Cyprus with the Water Framework Directive (WFD 2000/60/EC).
http://www.moi.gov.cy/moa/wdd/wdd.nsf/All/0C82BD040D11E863C22577DE002E1138/$file/Eniea_Diaxirisi_Ydaton_2010.pdf?OpenElement

Table 0.1 - Synthetic Pedigree matrix for the illustration of the uncertainty associated with the study of the EPI

	Environmental outcomes	Economic outcomes	Distributional effects and social equity	Transaction costs
Variables/ Indicators	conservation of drinking water (policy target) impact on domestic water use impact on groundwater resources impact on energy and CO_2 emissions	Number of subsidies granted per category Total WDD cost Cost in € per m^3 saved	Beneficiaries' incentives Social inequalities User conflicts Institutional conflict	Design costs Implementation costs Monitoring and enforcement costs
Proxy	4 3 3 1	4 4 4	4 2 3 2	3 3 3
Empirical	3 0 0 2	4 4 2	3 0 0 0	3 1 1
Method	3	4	3	3

1	4	1	2
1	3	1	2
3		1	

Source: Compiled by the authors.

Note:
Proxy = variable used to describe the outputs/outcomes of the EPIs and their relationship to the policy target
Empirical = the basis on which the performance assessment draws
Method = analytical tool used to assess the effects of EPIs especially if not estimated directly using empirical data
The following uncertainty qualifiers have been used:

Code	Proxy	Empirical	Method
4	Exact measure	Large sample direct measurements	Best available practice
3	Good fit or measure	Small sample direct measurements	Reliable method commonly accepted
2	Well correlated	Modeled / derived data	Acceptable method, limited consensus on reliability
1	Weak correlation	Educated guesses / rule of thumb estimate	Preliminary methods, unknown reliability
0	Not clearly related	Crude speculation	No discernible rigor

Source: EPI-Water guidance document