Chapter 7
Subsidies for Drinking Water Conservation in Cyprus

Maggie Kossida, Anastasia Tekidou, and Maria A. Mimikou

Abstract This study investigates four subsidies for drinking water conservation initiated in Cyprus in 1997, namely: the construction of domestic boreholes for garden irrigation, the connection of a borehole to toilet cisterns for flushing, the installation of domestic grey-water recycling systems, and hot water recirculators. The policy objective on launching these incentives, presented here as an Economic Policy Instrument (EPI), was to reduce drinking water demand in households, partly supplied by desalination, especially during drought periods. Thus, the focus of reducing drinking water consumption was not directly linked to an overall reduction of the domestic water consumption. From 1997 to 2010 a total of 13,172 subsidies have been granted, amounting to EUR 5.5 million, resulting in a cumulative saving of 12.42 mio m^3 of water. The overall performance of this EPI is subject to uncertainty, while its overall usefulness as an EPI is questionable due to externalities, mainly related with its impact on the overall domestic water consumption and the exploitation of regional groundwater resources.

Keywords Cyprus • Drinking water conservation • Subsidies • Drinking water demand • Boreholes • Water recycling

7.1 Introduction

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 domestic boreholes for garden irrigation and connecting a borehole to toilet cisterns for flushing. These were

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followed in 1999 by additional subsidies to install domestic grey-water[1] recycling systems, and hot water recirculators[2] later on. During the same period (1997) public water supply of desalinated water had been introduced as a source for domestic water, with the purpose to reduce 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 this water was now coming from desalination and is thus too costly (in terms of production and supply) to be used for gardens and toilet flashing, especially during drought periods. From 1997 to 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 total calculated amount of euros paid for those subsidies is about EUR 5.5 million. 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.

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 (i.e. the average 1980s storage capacity has doubled in the 1990s) (Kotsila 2010). 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 and water scarcity problems. Thus, the business as usual baseline has been going through a major transformation (Charalambous et al. 2011; I.A.CO 2011).

7.2 Setting the Scene: Challenges, Opportunities and EPIs

Cyprus has a typical Mediterranean climate with mild winters, long, hot and dry summers, and short autumn and spring seasons. The average annual rainfall is about 500 mm, with a high spatiotemporal variability (ranging from 300 up to 1,100 mm), while 2–3-year drought events are often observed (Kossida et al. 2012). Evapotranspiration is high and corresponds to 80 % of the rainfall. Cyprus has been identified as one River Basin District for the purpose of the Water Framework

[1] Grey-water is defined here as domestic wastewater from laundry, dishwashing and showers.

[2] Hot water recirculators pull hot water from the water heater while they send back (at the same time) cooled-off water creating a closed loop. These systems conserve water (no wasting of water while waiting for the hot water to arrive to the tap) and use little energy.

Directive, and is subdivided into 9 hydrological regions made up of 70 watersheds (MANRE 2005). The area under government control contains 47 watersheds. In terms of land use, arable land and permanent crops are dominant (48 %), followed by forests (44 %). Wetlands and water bodies account for 0.4 % only (MANRE 2010). The most important economic sector is the tertiary, both in terms of economic output (81 % of the GDP) and employment (72 %), showing upward trends. The agricultural sector (primary), on the contrary, has experienced downward trends.

Cyprus has experienced many drought episodes varying from below normal precipitation (81–90 % normal) to severe drought (≤70 % normal) (WDD 2009). The long term annual average (LTAA) precipitation from 1901 to 1970 was 541 mm, while the LTAA from 1971 to 2009 has fallen to 463 mm (EEA 2011). The volume of water falling over the total surface area of the free part of Cyprus (5,800 km^2) is estimated at 2,750 mio m^3, but only 10 % (275 mio m^3) is available for exploitation, since the remaining 90 % returns to the atmosphere as direct evapotranspiration. The net rainfall is distributed between surface and groundwater storage with a ratio 1:3 respectively. From the groundwater storage approximately one-third flows out into the sea.

Cyprus water abstraction (205 mio m^3/year on average since 1998) comes from groundwater (75 %) and surface water (25 %), while additional water is supplied by desalination (24 mio m^3/year on average since 1998), water reuse and emergency water transfers (e.g. in 2008 from Greece). 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 276 m^3 (or 755 l/cap/day). The main water user is agriculture (59 %), followed by domestic (30 %), tourism (5 %), livestock (3 %), and industrial (3 %) (MANRE 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 here defined as the percentage of total annual abstraction of the 30 years-LTAA availability of water resources, Cyprus has been extremely water stressed since 1998 (WEI >40 %) with its groundwater resources being most stressed. Comparing the surface and groundwater exploitation indices separately we observe that the groundwater is much overexploited (95–127 %), while surface water exploitation is below 40 % (10–34 % demonstrating an overall increasing trend), and thus leveraging the WEI to unsustainable conditions (Kossida 2010).

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

7.3 The "Subsidies for Drinking Water Conservation" in Action

The WDD subsidies target new installations at household level, which are located within the boundaries of any water district and connected to the Municipal and Communal PWSS. Four subsidies for domestic water saving have been launched gradually from 1997 to 2010:

1. Construction of borehole for the irrigation of household gardens (EUR 700) in 1997
2. Connection of the borehole with the toilet cisterns (EUR 700) (applicable also for schools, office premises, shops, institutions etc.) in 1997
3. Installation of a grey-water recycling system (EUR 3,000) (applicable also for schools, military camps, public buildings, gyms, hotels etc.) in 1999
4. Installation of a hot water recirculator (EUR 220) in 2007

The above rates are applicable from 2009 onwards; lower rates were initially set and gradually increased. 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. Nevertheless, no detailed study prior to the launch of the subsidies has been identified that assessed their impact and effectiveness or identified a logical basis on how the subsidy amount has been set. The only prior application was a pilot study on grey-water recycling in seven establishments in Nicosia that was run for 1.5 years prior to the subsidy as experimental work (Kambanellas 2007).

All subsidies were granted by the WDD following an application submission by the beneficiary and two site inspections. Regarding enforcement, although a cap of 250 m^3 groundwater abstraction per year was imposed to the new boreholes, the water meters were not monitored by the WDD for compliance. Additionally, neither inspection of the installations after start-up or other safeguarding mechanisms, nor any follow-up survey to assess the EPI's effectiveness were implemented. Only one follow-up study has been identified to assess the actual performance on boreholes for garden irrigation. In 2007–2008 extreme drought influenced the beneficiaries into heavily applying for the subsidies (increase of 170 % of the number of subsidies awarded) probably driven from their will to secure water.

7.3.1 The EPI Contribution

7.3.1.1 Environmental Outcomes

Among the four subsidy categories, constructing boreholes for garden irrigation received high response (59 %), while 34 % where given for connecting a borehole to toilet cisterns, 6 % for installing hot water recirculators, and only 1 % for installing grey-water recycling systems. By looking at the temporal evolution of the

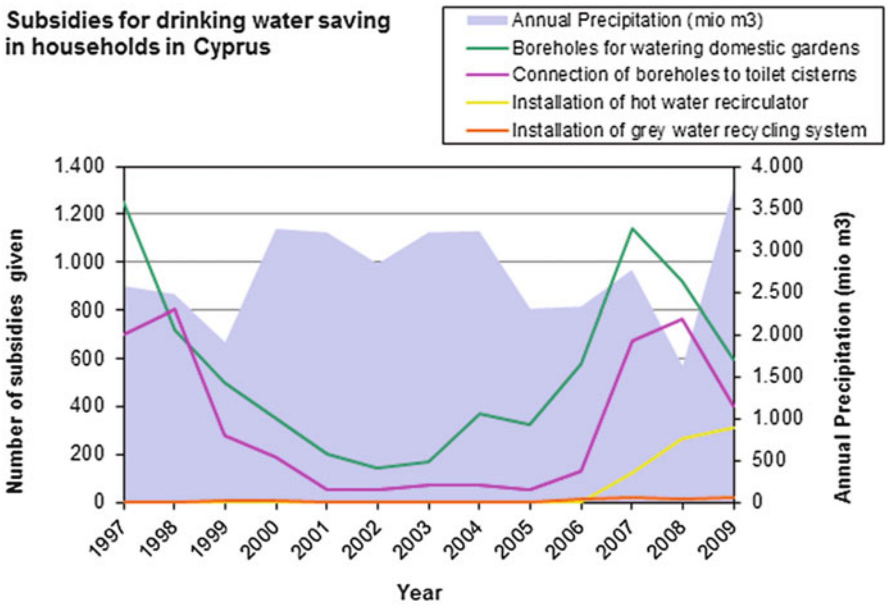

Fig. 7.1 Number of subsidies given per category as compared to annual precipitation (mio m^3) for the period 1997–2009 (Source: Compiled by the authors. Data provided by the WDD in I.A.CO Ltd (2011) and EEA (2011))

number of subsidies as compared with the respective precipitation (Fig. 7.1), we can observe the following pattern: the number of subsidies paid increased in periods of low precipitation/drought events (e.g. 2007–2008), while it declined during periods of relatively high precipitation (e.g. 2001–2004).

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 and assumptions on the potential savings induced by each subsidy category as listed below (I.A.CO Ltd 2011; Kambanellas 2007):

- On an average four-person family consumption of 600 l/day, a share of 30 % is used for outdoor purposes. Thus, using groundwater from boreholes for irrigation can cover this demand.
- On an average four-person family consumption of 600 l/day, a share of 27 % is used for flashing. Thus, supplying of borehole groundwater to toilet cisterns can cover this micro-component of use.
- Hot water recirculators can save up to 60 m^3/year of water.
- Laundry, dishwashing and shower effluents account for up to 50 % of the household water use. The operation of a grey-water recycling system can divert these volumes of water for outdoor use or for flashing (average saving 240 m^3/year).

Post-evaluation data that would allow the direct estimation of the water savings are not available, and thus the proxy calculations cannot be properly assessed for their accuracy. Only one follow-up study has been identified to assess the actual performance on boreholes for garden irrigation: in 2004, drinking water consumption of 20–30 households was monitored in a suburb of Nicosia, 12 months before and after the installation of a borehole, concluding that a 27 % reduction of drinking water consumption was achieved. Kambanellas (2007) refers to 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 (five in households, one in a hotel, one in a stadium) and were monitored for 1.5 years (mid-1997 till end-1998). In that period 220 m^3 of water had been recycled. In the current calculations the value used of 240 m^3/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 calculated cumulative drinking water savings from all subsidies during the 14-year period 1998–2010 amount to 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 PWSS (data for the calculations provided by I.A.CO Ltd 2011; WDD website; EEA 2011). The above percentages vary from year to year: The water saving as share of 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 two dominant subsidies) is now substituted by self-supplied groundwater (boreholes). The water saving as share of 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 %). As desalinated production significantly grows after 2007 this share is further decreasing (Fig. 7.2). It has to be emphasized that the

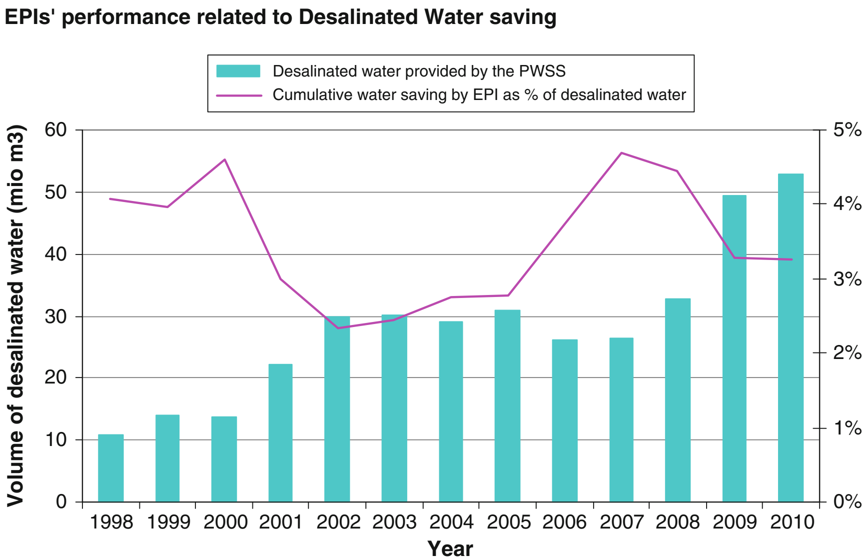

Fig. 7.2 EPI's performance related to desalinated water supply (Source: Compiled by the authors. Data provided by the Water Development Department (WDD) in I.A.CO Ltd 2011, and the WDD website)

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 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, old recirculators are working etc.).

Although the EPI introduced savings in the drinking water supplied by the PWSS, its impact on the total domestic water use cannot be comprehensively assessed. Assuming that the recirculators and grey-water recycling systems have resulted in overall saving of domestic water consumption, the same cannot be concluded for the boreholes' subsidy since the availability of free groundwater (no pricing) may have led the beneficiaries to over-pump and irrationally use excess water. The rational or irrational use of the boreholes (no monitoring and enforcement was implemented) relates to the individuals' behaviour (education, awareness, incentives, water saving culture). 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 approved are marginal and of poor quality and thus practically not exploitable for may uses. Nevertheless, 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 have been undertaken prior to the launch of such measures in order to assess its environmental sustainability. Currently, no such assessment can be concluded, except 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).

It is reasonable to assume that the induced water savings would be substituting part of the desalinated water supply. Thus, they can also be translated to equivalent energy savings (due to the decrease in desalination production needs) and corresponding CO_2 emissions reduction. Desalination at the current water production (47.7 mio m^3/year) implies a total electricity consumption of 217 GWh/year (Manoli 2010). Based on the Cyprus Energy Efficiency Report 2001, 762 gCO_2 emissions are generated per KWh produced. Thus, the total CO_2 emissions 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 2010), thus 3.43 $KgCO_2$ are generated per m^3 of water produced. The subsidies granted saved in total 12.42 mio 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 tons of CO_2 emissions saved for the entire period, or 3,277 tones/year on average. Acknowledging that pumping from the garden boreholes and the operation of recirculators consume energy as well, the net savings are in fact somehow lower.

7.3.1.2 Economic Outcomes

The payments provided for each subsidy were not kept constant throughout the implementation period; the subsidies 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 ad-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 knowledge of the authors). The total calculated amounts of euros paid in subsidies from 1997 to 2010 is about EUR 5.5 million (of which 59 % for new boreholes, 24 % for connection with toilets, 3 % for recirculators, 4 % for recycling) (Kossida et al. 2013). These payments do not represent the total cost of the EPI since transactions costs (e.g. costs derived by the field inspections) are not included.

To assess the cost-effectiveness of the EPI, the unit cost of each m^3 of drinking water saved has been calculated for each subsidy type and year, 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 during the current plus all previous years, based on the assumption that the past interventions continue to be exploited by the beneficiaries (Fig. 7.3). To further assess the net amount of euros paid each year for additional new savings, the total cost of subsidies of each year has been divided with the additional savings generated explicitly that year. This was done in order to get a better insight on cost recovery per subsidy type and time period (Fig. 7.3). The overall average cost per m^3 saved from all the subsidies during the whole 1997–2010 period is EUR 0.43 (Kossida et al. 2011). At the beginning of the implementation, the EPI comes at a high cost, e.g. subsidies provided for connection to toilet cisterns in 1997 and 1998 result in EUR 2.83 and EUR 1.52 paid per m^3 water saved respectively (note that the investment cost in these calculations is considered as a cost only in the year when the investment was made). As the EPI implementation progresses and water saving is accumulating over the years (benefit of previous investments), the unit cost is decreased to as low as EUR 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 be noted that during that period the amount paid per subsidy was kept at low levels (EUR 170 for the boreholes, EUR 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 are in the range of EUR 2.5/m^3 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 (EUR 700 for the boreholes, EUR 1,700 followed by EUR 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

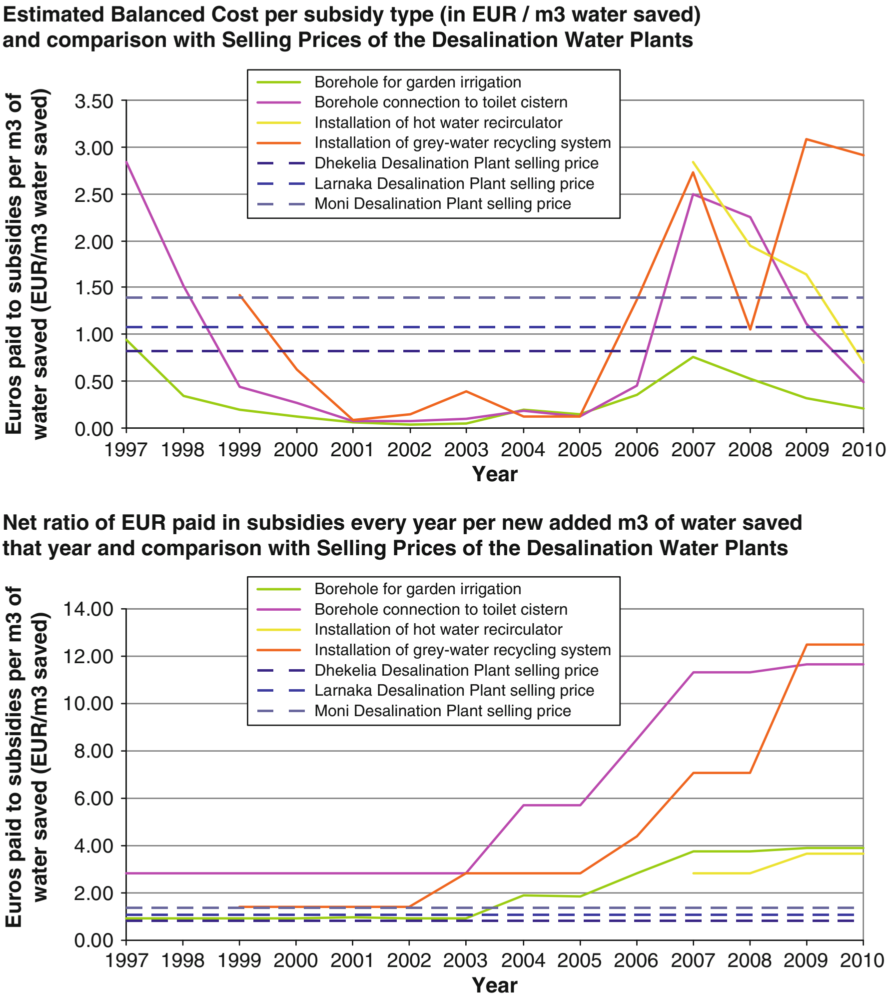

Fig. 7.3 Cost-effectiveness of EPI (*top*: Balanced cost per subsidy type (in EUR/m^3 of drinking water saved; *bottom*: Net ratio of EUR paid in subsidies every year per new added/m^3 of drinking water saved) (Compiled by the authors with data provided by the WDD in I.A.CO Ltd 2011)

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 might have after all 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 (Fig. 7.3).

7.3.1.3 Distributional Effects and Social Equity

The government principle when water shortages arise in Cyprus is "first come humans, then animals and finally plants". This rationale creates feelings of unfairness resulting in illegal drilling and pumping of groundwater. 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, rather to conserve water. As mentioned before, the observation that the number of subsidies increased in periods of low precipitation/drought events and declined during periods of relatively high precipitation (Fig. 7.1) possibly conveys a message on the individuals' responsive behaviour (rather than proactive).

Social inequalities can arise from the subsidies for boreholes: 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 brings up 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 (Cyprus Mail 2008) WDD senior staff defended that licenses to drill boreholes are given every year and a large number of new boreholes were dug in 2008 (year of 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).

7.3.2 The EPI Setting-Up

The institutional set-up in Cyprus is built in three levels (Aeoliki Ltd 2009): a policy level (cooperation among four 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 for planning, designing, constructing, operating and maintaining water works, and the District

Administration (DA) of the Ministry of Interior implementing/enforcing water laws) (Government of Cyprus 2010); an end-user level (local organisations like the Municipal Water Boards, the Village Water Commissions, the Irrigation Divisions and Associations, the Sewerage Boards).

The design, implementation and enforcement of the EPI were carried out solely by the WDD. This entails evaluation of applications, inspections prior and after the installation. The work load required substantial 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. monitoring carried by the Local District Office), the implementation might have been more successful: better 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.

Transaction costs have been identified in relation to the design, implementation and monitoring and enforcement. With regard to the design of the EPI, no engineering or economic assessment studies have been identified prior to its implementation, with the exception of subsidies for the installation of grey-water recycling systems (Kambanellas 2007). Five years of research (1985–1991) and 2 years of experimental work (1997–1998) on a pilot scale led to launching this subsidy in 1999. Thus, design costs related to costs paid to researchers for designing the pilot study, the purchase and installation of seven systems in Nicosia, lab costs, and field trips expenses (assuming the labour cost of the involved WDD officers was included in their salary). Based on the Citizen's Charter Report (WDD 2005), a series of actions had to be undertaken from the time of application until the subsidy is paid to the beneficiary (submission of application, preliminary inspection, approval, installation, final inspection, grant). Implementation costs are thus generated by the need for field inspection (two to three times is total) and the interaction between the WDD and the DO in the case of boreholes. These extra labour costs generated for the technicians and the officers can be covered by their salary, yet transaction costs are still evident and associated with opportunity costs in this case. The instrument had provisioned the installation and monitoring of water meters in the boreholes. 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 DO, thus labour costs if additional personnel is required to run the assessment.

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 and post-implementation adaptation when conditions change. Nevertheless, this has not happened in this case as a uniform approach has been applied, regardless the local particularities. Although the amount paid for subsidies have been updated from 1997 to 2010 these adjustments have not been based on a post-implementation review.

Regarding the selection of beneficiaries for borehole drilling, loose conditions were reported by some water officers (Charalambous et al. 2011). During the extreme drought of 2007–2008, the number of subsidies paid drastically increased (amounting to an investment cost of about EUR 2.5 million for the 2 years), demonstrating the fact that external factors probably led to spontaneous and poorly thought reaction in terms of economic efficiency (both due to the increased numbers of subsidies awarded, as well as to the increased grant per subsidy paid). A total of 3,504 subsidies were given for construction of new boreholes and connection to toilet cisterns, and 419 for installation of recirculator and grey-water recycling systems. The resulting unit cost for every m^3 of drinking water saved with these investment costs of the years 2007–2008 reached EUR 2.5 in some cases (e.g. for the subsidies regarding the connection of cisterns to boreholes and the installation of recirculators). The EPI had not provisioned for measures to monitor the achievement of policy objectives and to avoid negative effects.

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. This process of obtaining the release of the funds can be tedious, requiring much time and effort. The WDD is bounded 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 with negative effects on the environment. Although it was stated by the WDD that the aquifers where subsidies were approved are marginal and of poor quality and thus practically not exploitable for may uses, no pressure and impact analysis. This goes against environmental 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 groundwater bodies (since less quantity could results in less dilution), when in fact they should try to improve it.

7.4 Conclusions

From 1997 to 2010 a total of 13,172 subsidies have been granted. By looking at their temporal evolution in comparison with the respective precipitation, it is observed that subsidies 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 was reactive rather than proactive.

The fact that enforcement by the WDD was non-existent, and thus no regular monitoring of the boreholes' meters has been implemented, weakened the EPI's performance and its overall benefits. On the positive side, since the water saved from the subsidies would have originated from desalination, equivalent energy savings and corresponding CO_2 emissions reduction have been induced, estimated to a total of approximately 56 million KWh of energy saving and 3,277 tons of CO_2 emissions/year on average.

The overall average cost per m^3 of drinking water saved from all the subsidies during the whole 1997–2010 period is EUR 0.43 (based on the assumptions and necessary proxies made in this study). Additional transaction costs have not thought been assessed. At the beginning of the implementation, the EPI comes at a high cost, (e.g. EUR 1.52–2.83/m^3 in 1997–1998) since the investment cost is considered as a cost only in the year when the investment was made and water savings have not yet accumulated. As the EPI implementation progresses and water saving is accumulating over the years, the unit cost is decreased as low as EUR 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 abruptly increased, reaching values higher than the desalinated water selling prices. This change is due to the fact that the payments were significantly increased, as well as the number of subsidies awarded, 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, all results are based on proxy calculations, (due to lack of proper monitoring), and thus subject to bias. At the same time, there is no clear evidence that an overall reduction of the domestic water consumption has been achieved. The selection of boreholes as a subsidy 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 of the amounts paid, etc.) and enforcement of the EPI (no monitoring and follow-up) cause reservations regarding its effectiveness. There is no evidence that the implementation of the EPI would have been enacted even if the negative net benefit was recognised, yet the subsidies that related with the boreholes (two out of the four subsidy categories) could have been redrawn due to strong arguments by environmentalists (since these were the ones who also received strong criticism after implementation).

In parallel to the subsidies, the WDD had launched a bundle of demand reduction measures: 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 it has a flexibility potential to be adjusted to local conditions, public participation, inclusion of stakeholders and collective design were not pursued. If incorporated, these 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, 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 in turn real ground evaluation of the EPIs effectiveness.

For this EPI to be successful some key enabling factors and preconditions need to apply. Adequate design, prior to the implementation of measures, based on field research, survey, impact assessment and pilot applications, is essential. This design process needs to be collective, seeking public participation and involvement of the stakeholders in order to allow for the identification of issues of social equity and unsustainability (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 are further needed. A share of responsibilities among the competent authorities is essential during the implementation phase. Involving regional authorities that could (a) convey local knowledge on the specific prevailing conditions, and (b) perform the inspections, can allow the proper adaptation of the subsidies, while reducing the burden and cost from the central agent. Awareness rising and targeted education of the beneficiaries must have a central role. It is critical that they, as end-users, understand that their main incentive should be water conservation as opposed to saving money from their water bill or securing uninterrupted watering of their gardens, avoiding thus irrational use.

References

Aeoliki Ltd. (2009). *Institutional framework and decision making practices for water management in Cyprus*. INECO project report. Accessed 15 Sept 2014.

Charalambous, K., Bruggeman, A., & Lange, M. A. (2011). *Policies for improving water security, the case of Cyprus*. Project Report, WP4 Deliverable, CLICO FP7 project, March 2011.

Cyprus Energy efficiency report, January 2011. Accessed 15 September 2014.

Cyprus Mail. (2008). *Water authority defends new borehole subsidies*. http://www.cyprusedirectory.com/cyprusguide/cyprus.aspx?ID=8990. Accessed 15 Sept 2014.

European Environment Agency (EEA). (2011). *WISE-SoE reporting on water quantity, waterbase – water quantity*. Accessed 15 Sept 2014.

Government of Cyprus. (2010). *Unified water management law (in Greek)*. Official Government Gazette, Nicosia, Cyprus. Accessed 15 Sept 2014.

I.A.CO Ltd. (2011). *Report on the assessment of water demand management measures (in Greek)*. MANRE, February 2011.

Kambanellas, C. A. (2007). *Recycling of grey water in Cyprus.* Sustainable Water Management 1-2007, Water Development Department, Nicosia.

Kossida, M. (2010). Towards a Water Scarcity & Drought Indicator System (WSDiS). WS&D Expert Network. Helsinki, 30 Sept 2010.

Kossida, M., Tekidou, A., & Mimikou, M. (2011). *Subsidies for drinking water conservation in Cyprus*. Deliverable D3.1 – Review reports, WP3 EX-POST Case studies, EPI-Water project.

Kossida, M., Kakava, A., Tekidou, A., Iglesias A., & Mimikou, M. (2012). *Vulnerability to water scarcity and drought in Europe*. Thematic assessment for EEA 2012 Report. ETC/ICM technical report 2012/3. ISBN 978-80-85087-13-0.

Kossida, M., Tekidou, A., & Mimikou, M. (2013). *Assessing the role of subsidies as an economic policy instrument for water conservation: An ex-post evaluation in Cyprus*. In IWA 3rd conference on water economics, statistics, and finance, 24–26 Apr 2013, Marbella.

Kotsila, P. (2010). *The socio-environmental history of water development and management in the Republic of Cyprus*. MS thesis, Universitat Autònoma de Barcelona. Accessed 15 Sept 2014.

Manoli, A. (2010). *Desalination in Cyprus.* Presentation to the Spanish Cypriot Partnering Event, Nicosia.

Republic of Cyprus, Ministry of Agriculture Natural Resources and Environment (MANRE). (2005). *Water framework directive (2000/60/EC)*. EU Summary Report Article 5 & 6. Accessed 15 Sept 2014.

Republic of Cyprus, Ministry of Agriculture, Natural Resources and Environment (MANRE). (2010). *Water framework directive – reporting sheets on economics*. Nicosia, February 2010. Accessed 15 Sept 2014.

Republic of Cyprus, Ministry of Agriculture, Natural Resources and Environment (MANRE), Water Development Department (WDD) Website. http://www.cyprus.gov.cy/moa/wdd/Wdd.nsf/index_en/index_en?OpenDocument. Accessed 15 Sept 2014.

Water Development Department (WDD). (2005). Citizen's Charter', Press and Information Office, Republic of Cyprus 359/2005 – 2.000, ISBN 963-38-347-5. Accessed 15 Sept 2014.

Water Development Department (WDD). (2009). *Special report 2.1, economic analysis of water use, calculation of total cost of water services, identification of current levels of cost recovery) (in Greek)*. Accessed 15 Sept 2014.