WATER DEMAND MANAGEMENT AND WATER CONSERVATION POTENTIAL AND LIMITATIONS IN KATERINI, GREECE

by

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A research project report submitted in partial fulfilment
of the requirements for the award of the degree of
Master of Science
of Loughborough University

SEPTEMBER 2007

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Acknowledgments

I would like to thank my supervisor, Dr Sam Kayaga for his valuable help, support and guidance through the whole individual research project period.

I would also like to thank the General Director of the Muncipal Water and Sewerage Enterprise of Katerini for his help in finding the appropriate documents and his participation in an interview for the completion of this research.

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1 INTRODUCTION

1.1 Motivation

Life cannot be without water. Three quarters of the earth are covered with water, and 70% of the human body consists of water. Apart from the environmental value of water there is the economic side of it. Nearly all the products that are bought and sold contain water or need water to be manufactured. Our lives depend on water from the clouds in the sky to the water flowing from our taps. All these are very well known facts about water. No one can argue about the importance of water for human life and for life in general. Water is our most valuable natural resource.

Although it might seem that water is widely available, this is not the case. "75% percent of the earth's surface is covered by water. 97.5% of this water is contained in oceans, hence salty and unsuitable for drinking or irrigation. Of the remaining 2.5 % of freshwater, only 0.3 % is found in rivers and lakes, the rest is frozen in icecaps and glaciers" (Official Site of the International Year of Freshwater 2003) quoted from (IUCN, 2007). Most of the sources of water are polluted and abstracted water needs treatment before it can be consumed. More and more water resources become polluted. "It will also be necessary to consider water as an exhaustible resource" (UNESCO, 2007).

A solution that has been proposed by researchers for the urban water use is water demand management and water conservation. We could say that these are the two sides of the same coin. The utilities can develop water demand management strategies. One of the possible measures could be promoting water conservation to the users. So there are two views. From the water service provider's view it is Water Demand Management (WDM). From the consumers point of view it is Water Conservation (WC). These two concepts will be analysed later in this study. It is enough to say for now that a lot of research has been done about these concepts and there are a lot of actual implementations of such measures around the world. It seems that there are several benefits that can be gained by such strategies.

Although such plans have been successful with utilities in big cities, according to the literature review that was conducted, we have no evidence that this would be true for utilities in smaller towns. Further more, most case studies are focused on a few countries and there is not a global perception. So there is a place for a study that could go a step further by studying the potential of water demand management and water conservation and possible limitations in a small town.

The present study is going to assess the potential and limitations of water demand management and water conservation in a Greek town, Katerini. The town is of about 50.000 residents and is supplied by groundwater. Groundwater level has dropped the last years so there is a concern about the sustainability of the resource. Also there are high peaks in demand that are extremely difficult to be dealt with by technological solutions. So this town is a good example of a small town that could implement WDM and WC.

1.2 Research problem and questions

Water is a common good as well as an economic good. Conservation of water has economic, social and ecological benefits for both the utility and the users. But there are several limitations for the implementation of water conservation programmes that depend on several factors. *The problem is to identify the potential of applying water conservation programs and water demand management programs in small towns in Greece.*

In order to solve this problem a specific town can be selected and researched as a case study. The above problem can be further broke down on some questions that have to be answered in order to solve it. The research questions are:

- What is the current practice of the utility concerning water demand management and of the users concerning water conservation?
- What is the perception of the residents of the town of water conservation? Is there potential to accept such measures?
- What is the perception of the utility managers of water demand management? Is there potential for implementation of such programmes?

- What are the limitations for the implementations of water conservation and water demand management programs?

1.3 Report Layout

In section 2 the literature review that was conducted for the purpose of this research is presented. The literature review's focus was on water demand management for urban water amd especially for the domestic sector. First the literature review strategy was discussed. Then the limitations and the scope of the literature review was discussed. The general directions in the water sector are following. Then there is a section about water demand management. First a definition is given to Water Demand Management and then the rational of WDM and the benefits that can be gained are looked at. The next section talks about the different WDM measures. In the beginning there is a categorisation of WDM measures. Then the measures are discussed. The measures are divided into measures that are applied by the utility and in measures that are applied by the end user. The challenges of WDM are discussed and finally there is a brief summary of the findings from the literature review.

In section 3 the methodology of the research is presented. The methods of the research are described and the suitability of them is discussed. The research was a case study and three sources of data were used. These sources were utility data from records and documents, a survey among the costumers of the utility and interviews of key informants. Reasons for the decisions made in each part of the research are presented. The limitations and validity of the research is also discussed.

In section 4 the results of the research are presented and discussed. Results are presented first from the utility documents then for the questionnaire survey and finally for the interviews that were conducted.

In section 5 the conclusions and recommendations are presented.

2 LITERATURE REVIEW

2.1 Introduction

2.1.1 Literature review strategy

For the purpose of this research several kind of references were looked at. Sources of the literature data were the World Wide Web (www), the WEDC resources centre and the Loughborough University Pilkington Library.

Several kinds of references were looked at. There were books, scientific journals, professional journals, sites from the internet and managerial documents from the utility in Greece. There were also some references in Greek that were thought to be relevant to the subject of research.

The search for books was done with the aid of the library searching tool. This way some key books on WDM and WC were found. The search for journal articles was done through the Metalib system. After searching for the key terms a lot of articles were found but not all of them were available to Loughborough students. Very interesting articles were not able to be included in the literature review. Also common searching tools like goggle and yahoo were used for searches in the www. From this source articles that were not published in a scientific journal but were still interesting for the research were found.

2.1.2 Limitations, Scope

The literature review that was conducted for this research was focused on water demand management and water conservation/use efficiency. These subjects are very broad and had to be narrowed to the scope of the research.

So on water demand management the review was focused on urban WDM and mostly on developed countries since the research took place in a developed country. But several cases of developing countries were looked at because valuable lessons can be learnt from there especially when there are similar characteristics with the researched town.

On water use efficiency the research was focused on residential users and water use efficiency. Although irrigation and industry water use is take up more than 90% of the

water used in Greece the research focuses only on the residential use. Residential water use has to be of a higher quality and water needs treatment before it can be consumed. So despite the relative low quantity of residential water, the costs of the production might be so high that residential water use efficiency is as important as irrigation or industry water use efficiency. The efficient use of water in the urban sector has great importance in the overal context of water conservation. "Although representing only 9% of the total consumption, while agriculture counts for 83% and industry 7%, in economic terms, where real costs of treating water and wastewater to acceptable standards are included, it represents 45% of the total costs" (Do Céu Almeida et al., 2002).

What is more residential water in Greece is always provided by utilities while this is not the case for irrigation or industrial water. It is quite common that several industries and farmers draw water themselves so no utility is involved in this process.

Another subject that was briefly looked at was water economics. Since many water demand management strategies involve price change a research was done about water as an economic good and how people respond to price change of water.

2.2 Directions in the water sector

Populations around the world are constantly increasing rapidly. Industry and wealth are also increasing. This leads to increasing demand for products and as a consequence increased demand for water. What is more, water sources become more and more polluted. Although in some areas of the world there is adequate water of good quality, this is not the case for the whole world. There are areas of the world that are water scarce or have heavily polluted sources of water.

Trying to address these issues the Untied Nations Conference on Development and the Environment, also known as the Earth Summit, was held in 1992 in Rio de Janeiro, Brazil. The Dublin principles that were agreed upon by the Dublin Ministerial Conference that preceded the Earth Summit can be seen in Box 1.

The Dublin Principles
Principle No. 1: *Fresh water is a finite and vulnerable resource, essential to sustain*

life, development and the environment.
Since water sustains both life and livelihoods, effective management of water resources demands a holistic approach, linking social and economic development with protection of natural ecosystems. Effective management links land and water uses across the whole of a catchment area or ground water aquifer.

Principle No. 2: *Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels.*
The participatory approach involves raising awareness of the importance of water among policy-makers and the general public. It means that decisions are taken at the lowest appropriate level, with full public consultation and involvement of users in the planning and implementation of water projects.

Principle No. 3: *Women play a central part in the provision, management and safeguarding of water.*
This pivotal role of women as providers and users of water and guardians of the living environment has seldom been reflected in institutional arrangements for the development
and management of water resources. Acceptance and implementation of this principle requires positive policies to address women's specific needs and to equip and empower women to participate at all levels in water resources programmes, including decision-making and implementation, in ways defined by them.

Principle No. 4: *Water has an economic value in all its competing uses and should be recognized as an economic good.*
Within this principle, it is vital to recognize first the basic right of all human beings to have access to clean water and sanitation at an affordable price. Past failure to recognize
the economic value of water has led to wasteful and environmentally damaging uses of the resource. Managing water as an economic good is an important way of achieving efficient and equitable use, and of encouraging conservation and protection of water resources. (WMO, 1992)

Box 1The Dublin Principles for Water (Source: Moriarty et al., 2004)

As a result from these principles a new concept was emerged. The concept was Integrated Water Resource Management (IWRM). The basic idea of this approach is that is managing water resources in a holistic approach. Water should not be treated separately depending if it is used for irrigation, commercial or domestic purposes. Also management of water should be involving all stakeholders. An integrated view can provide a more effective management solving many of the above problems.

IWRM principles continued to evolve from the Dublin Principles. In addition UNEP-IETC (2003) has stated the need for water demand management as a basic component of Integrated Urban Water Resources Management (IUWRM). The principle components of IUWRM can be seen in Box 2.

Principle Components of IUWRM

Integrated Urban Water Resources Management (IUWRM) is a participatory planning and implementation process, based on sound science, which brings together stakeholders to determine how to meet society's long term needs for water and coastal resources while maintaining essential ecological services and economic benefits.

The principal components of an IUWRM system include:

- Supply optimization, including assessments of surface and groundwater supplies, water balances, wastewater reuse, and environmental impacts of distribution and use options.
- Demand management, including cost-recovery policies, water use efficiency technologies, and decentralised water management authority.
- Equitable access to water resources through participatory and transparent management, including support for effective water users association, involvement of marginalised groups, and consideration of gender issues.
- Improved policy, regulatory and institutional framework, such as the implementation of the polluter pays principle, water quality norms and standards, and market based regulatory mechanisms.
- Intersectoral approach to decision making, combining authority with responsibility for managing the water resource.

Box 2 Principle components Of Integrated Urban Water Resources Management (Source: UNEP-IETC, 2003)

In the past, the design for new infrastructure was based on projecting the demand of the service or good to be supplied and then searching for sources to cover this demand. "Up to now cities water supply was internationally confronted through a one side supply approach" (Hengeveld and De Vocht, 1982). This refers not only to water

infrastructure but to other services as well. An example for these services would be electricity or gas. This way of thinking resulted in constructing new projects to cover the demand and this had financial and ecological implications.

The consumers had to pay for the new infrastructure and the projects had ecological implications. Furthermore the sustainability was not a great issue in the past. People had not realised that resources are not infinite and one day they will be exhausted. So the need for a new approach became apparent.

In the last 20 years a new approach has emerged. Its application began in the power industry where it became obvious that the constant increase in demand could not be financially feasible. The need for new projects increased the cost of power too much both for the consumers and the supplier. The demand side approach is based on the concept that, demand is not the quantity of the good sold but the service that will provide to the end user (White and Fane, 2001). To make this clear we can have the next example.

If we assume that a consumer has a 15 litre flush toilet every time he flushes it uses 15 litres of fresh water. But in reality he does not need those 15 litres but he needs to flush his toilet. If the utility provides the consumer with a dual flush toilet or a low flush toilet the demand for the consumer will be satisfied but with less water consumed. Also it is not necessary to flush the toilet with water of drinking quality. Water with a lower level of quality would flush the toilet as well as the fresh water. At the above example the utility would use a technology measure to decrease demand but there are many other measures and in many forms and will be discussed later.

So “demand-side management (DSM) is an alternative (or, more accurately, complementary) approach to increasing supply infrastructure. It involves decreasing the demand for water through a mix of education, technology, pricing reform, regulation and recycling” (Brandles and Ferguson, 2003).

So an important part of IUWRM is Water Demand Management (WDM). There is also a global trend that is leading to WDM. In the next section this concept will be examined.

2.3 Water Demand Management (WDM)

2.3.1 Definition

Water Demand Management (WDM)

A simple definition of WDM was given by UKWIR (UK Water Industry Research) and it says that "water demand management refers to the implementation of policies or measures which serve to control or influence the amount of water used" (UKWIR/EA, 1996). Although this is a general and good definition it is very broad and cannot explain exactly what we mean by WDM.

Another definition was given by Derevill (2001). According to him: Water demand management has been defined as a practical strategy that improves the equitable, efficient and sustainable use of water. It achieves this by:

• stressing equitable access to water, reflected in a strategy that is specifically designed to improve service delivery to the poor;

• treating water as both an economic as well as a social good, and managing and pricing it accordingly;

• balancing the management of losses and consumption with new or augmented supplies; and

• managing the change from a supply driven to a demand responsive culture.

Although the above reference is according to the author targeting small towns of developing countries, which have a number of informal water sources it has the characteristics that can be applied in a town of a developed country.

According to DWAF (Department of Water Affairs and Forestry, SouthAfrica) (1999) water demand management is "the adaptation and implementation of a strategy (policies and initiatives) by a water institution to influence the water demand and usage of water in order to meet any of the following objectives: economic efficiency, social development, social equity, environmental protection, sustainability of water supply and services and political acceptability".

A more operational definition was given by Brooks (2006) and it proposes five components: (1) reducing the quantity or quality of water required to accomplish a specific task; (2) adjusting the nature of the task so it can be accomplished with less water or lower quality water; (3) reducing losses in movement from source through use to disposal; (4) shifting time of use to off-peak periods; and (5) increasing the ability of the system to operate during droughts. This definition brings out the drivers of water saving and permits the tracking of gains by the source of the saving. It is applicable to nations at different stages of economic development. It also shows how goals of greater water use efficiency are linked to those of equity, environmental protection and public participation. Taken together, these goals make water demand management less a set of techniques than a concept of governance.

2.3.2 Why Water Demand Management, Benefits

There are various benefits from WDM and they can be categorised in various ways. The most usual way of categorising the benefits of WDM is dividing them to financial benefits and ecological benefits. Another way is to divide the benefits depending on who is benefited. The benefits of WDM on various users are seen in Box 3.

Wringing more work from each drop of water sustains vital water supplies, lowers water bills, reduces the nee wastewater treatment, protects the environment, and creates wealth. Everybody wins:

- **Consumers.** Installing water-efficient faucets, showerheads, toilets, and other devices can substantially reduce household water and sewage bills, and it can save even more money on energy for heating wa The use of these devices may also reduce or eliminate such problems as an overflowing septic tank. An don't overlook the comfort factor—an efficient showerhead lets twice as many people use the shower before the hot water runs out!
- **Communities.** Some communities are physically short of water, or at least of uncontaminated water; sor must pay expensive pumping costs; and many are seeking ways to avoid paying enormous capital cost increase water storage or wastewater treatment capacity. Local budgets can be stretched only so far. community that avoids building a larger water or wastewater facility will have more money for other services.
- **Utilities.** Increasing water efficiency can enable utilities to reduce baseload and peak demand, making possible to postpone or avoid tapping new supplies, expanding storage, or expanding treatment faciliti Programs that promote efficiency can enable a utility to achieve more predictable patterns of demand and buy time for effective long-term planning. For these reasons, many utilities offer rebate programs th enable customers to install efficient fixtures at a reduced price or for free, thus saving consumers even m money.
- **Companies.** Using water more efficiently can reduce operating costs, often including fuel, chemicals, a labour.
- **The environment.** Water not consumed can save a river from a dam and a wetland from destruction. W not heated with fossil fuel means oil or gas not depleted, coal not burned, carbon not released to cause global warming, and sulphur not deposited as acid rain.
- **The economy.** Money not spent on wasted water and energy is used more productively to create jobs a strengthen local businesses.

Box 3 Water Demand Management Benefits (Source: Rocky Mountain Institute. Available at http://www.rmi.org/sitepages/pid280.php)

The most direct effect of a WDM program is the reduced consumption of water. This fact can have several direct and indirect benefits for both the consumers and the water service provider. This of course is true only if the services to the consumers are not affected by the program which was a basic part of the definition that we gave to WDM. The benefits from a WDM program will be discussed next.

Financial benefits

White (1998) suggest that there are financial benefits from a WDM program. The reduced amount of water consumed will result in reduced water bills to the consumers but also will save them energy. With water efficient devices as shower heads or washing machines that both use hot water, the need for energy to heat the water is

reduced as well. So there are savings in the electricity bill for the consumers. A case study from Kalgoorlie Boulder presented in Box 4 illustrates how this can be accomplished.

Kalgoorlie-Boulder, Western Australia WDM case study (White, 1998)

White (1998) mention in his paper a case study of a WDM program. The case study refers to Kalgoorlie-Boulder city. The need for reduction in water consumed arose from the fact that the city had a demand of 7,000ML/a which was the largest demand on the pipeline that provided the city with water. Also, the city was at the end of the pipeline so the operating costs for pumping the water were too high.

A water efficiency program was designed which was comprised of various measures like retrofitting dual flush toilets free of charge, information brochures and free water audits among others. The financial analysis of the program suggests that the financial benefits in reduced operating and capital costs will more than make up for the costs of the program. Based on the original budget, *the projected savings* to the Water Corporation are $AU 3.5 m and *$AU 2.8 m to the consumers over a 2.5 year period.*

Box 4 Kalgoorlie- Boulder case study

Other financial benefits from a WDM program are the reduced operating costs of the water treatment and water distribution system. The operating costs would be the cost for chemicals, and energy costs to pump the water. It is obvious that with less water consumed these costs will be reduced. A case study from Washington, USA which is presented in Box 5 supports this argument.

Washington suburbs, Maryland USA WDM case study

The Washington Suburban Sanitary Commission undertook a study to implement a WDM program. The aim of the program was to assess the feasibility of extending the life of available capacity in existing facilities and to possibly reduce the operating costs of these facilities.

The recommended program is going to reduce water demand by 18,900 m^3/day by 2020 and a $34 m capital savings from the deferral of several capital projects. Also *reduction of the operating costs is thought to be an additional $122 m.*

Box 5 Washington suburbs case study

White (1998) continuous to suggest that reduced water consumption results in reduced wastewater flows. This can save financial resources to the utility that will have to treat a smaller volume of wastewater. A research has shown that on the North coast of New South Wales a WDM program that would cost $AU2.6 m would save $AU2.4 m from not expanding the wastewater treatment plants.

The most important financial benefit from WDM is the delay or avoidance of expanding infrastructure to cover the increased demand. That infrastructure would be a new water source like a dam or borehole and the treatment plant to treat the raw water to the required quality. Financial benefits came from the savings of the opportunity costs of the capital that would otherwise had to be invested in a new scheme. It is sometimes more economical to implement a WDM program that to construct a new water project.

Apart from deferral of major infrastructure downsizing of the project is another benefit. The diagram presented in Figure 2-1explains this better. In this diagram the x axis is assigned with years and the y axis is assigned with the peak capacity of the assumed system. The continuous line represents the peak demand through the years without WDM and the split line represents the peak demand through the years with a WDM program that would reduce the consumption. It is obvious from the diagram that the capacity without WDM would reach its limits in year 2020 but with the implementation of WDM there can be a delay for approximately six years. What is more, the new infrastructure would have to be of reduced size for the life cycle that is proposed (until 2040).

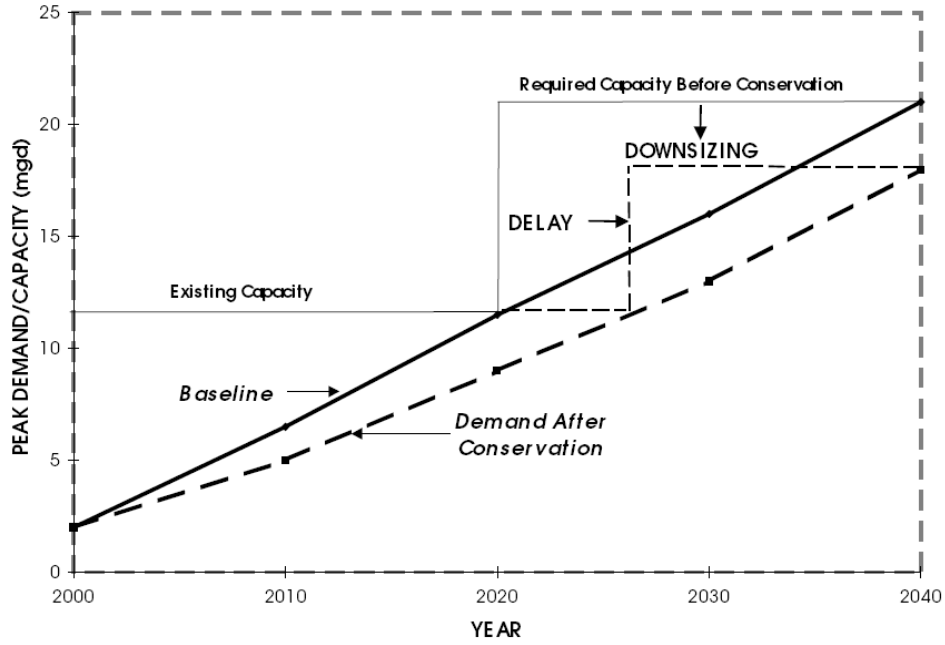

Figure 2-1 Deferral and downsizing of water schemes with Water Demand Management (Source: Maddaus, n.d.)

A case study to support this argument is presented in Box 6.

Lower Clarence, Australia WDM case study (Maddaus and Maddaus, 2001)
In the same paper Maddaus discusses about the Lower Clarence WDM program case study. The aim of the program was to defer the construction of a major water scheme for up to 16 years adding all the other environmental, economic and social benefits. The objective of the program was to improve water efficiency by various technological, education, regulation and pricing measures. The recommended program has a 1.3 cost benefit ratio and an average saving of 5.2 million liters per day over the 30 year life of the project. With this program deferral of the next water scheme was achieved by 12 years.

Box 6 Lower Clarence case study

Environmental benefits

The most obvious environmental benefit from WDM is the conservation of water. Water scarcity is a great problem in some countries. The need to sustain water sources for further development is nowadays obvious to scientists and governments. For this reason, governments in water scarce countries have placed regulations for the reduction of water consumption. A case study from Canbeera City is presented in Box 7 to illustrate this.

Canbeera city, Australia WDM case study (Turner et al, 2005)

Turner et all, 2005 describes a design of a WDM program in Canbeera city the capital of Australia. This program was designed as part of the development of a 50 years Water Resources Strategy. In order to design the appropriate program the Least Cost Planning method was followed. This method assesses all the possible measures to be implemented and suggests the mix of measures that meet the reduction in demand with the least cost. The purpose of the WDM program was to meet the growing demand of water without the need for a new dam and if possible to achieve water demand reduction targets set by the Government. These targets were 12% and 25% reduction in per capita water demand in years 2013 and 2023 respectively.

First of all the options for meeting the demand were selected. The options then were cost by a levelised cost which is cost in AU$/ m^3 of water saved. As we said every litre of water saved equals a litre of water produced. So with these options the water that would need to be produced by a new water infrastructure is substituted by water saved without lowering the levels of service. Also the possible savings for each of the option were estimated.

The final selection of the appropriate measures was selected with the criterion of the least cost providing the targets in demand reduction. Although the program is still in use it is expected to achieve the 2013 12% reduction in per capita demand with a total cost of $AU 45.2m and a levelised cost of 0.3 $AU/kL. Levelised cost is the cost per kL saved to the utility. The suite of demand management options developed could potentially defer supply augmentation requirements for many years.

Box 7 Canbeera City case study

White also suggests that there are indirect benefits from a WDM program as the reduction in CO_2 emissions resulting from the reduced energy consumption. In another paper (White and Fane, 2001) he adds some other indirect benefits that cannot be measured directly. These could be the cost of other water uses of water taken from a particular catchment and the costs related to water borne illnesses especially to developing countries. Also impacts such as phosphate and micronutrient loss from agricultural land effluent volumes released to the ocean and some pollution released to the environment.

Social benefits

Another benefit that is proposed by Vairavamoorthy and Mansoor (2006) and is more applicable to developing countries is the promotion of social equity. It is very common in developing countries that the more affluent consumers receive better water services and more water quantity. This results in a lower level of service to the poorer consumers. But with WDM the quantity of water consumed by the affluent users can be reduced so more water will be available for the poorer consumers. So WDM can promote social equity.

While in most developed countries water of appropriate quality for drinking and adequate quantity is the usual, this is not the case in developing countries. According to the World Health Organization, every year more than 2.2 million people around the world die from diseases associated with the lack of access to safe drinking water and inadequate sanitation as quoted by IUCN (2007). With WDM the available resources are managed and allocated better to the users. Quality of water is possible to become better in the long term, after the financial resources gained by the program are invested in improving the quality. So with WDM more people have access to water of improved quality. This way water born illnesses are reduced.

A summary of the benefits of a WDM program can be seen in Box 8.

Benefits from Water Demand Management

- **Financial:** Deferral in constructing new infrastructure for water and wastewater. Lower operating costs for the utility. Savings on water and energy bills on the consumers.
- **Ecological**: Manage available water sources to ensure environmental sustainability. Less pollution (Micro pollutants). Less CO_2 emissions.
- **Social**: Promote equity (developing countries). Less water borne illnesses.

Box 8 Summary of benefits of a Water Demand Management program

2.4 Water Demand Management Measures

In the previous section the need for WDM was justified and major benefits from a WDM program were identified. In this section the various measures that can be part of a WDM program will be looked at. First of all it has to be clear that a WDM program aims not only to reduce water use to the end users but also to reduce water use and water losses from the water service provider. The purpose of a WDM program is to reduce water use in total however possible this is.

2.4.1 Categories

According to Tate, 1990 WDM strategies can be divided into three categories: socio-political, economic and structural-operational.

Socio-political: Socio-political strategies include the strategies that are trying to change the users' behaviour towards water usage and water wastage. This can be accomplished through sensitization of the public by education programs or media campaigns. Many users are not familiar with the great value of water and there is great potential for water demand reduction if the consumer is informed and changes behaviours that uses water wastefully, or discover new ways of using water more wisely.

Economic: Such measures are based on the theory that water apart from a social good is an economic good. So the water market is obeying the laws of supply and demand. So an increase in water price would theoretically result in a lower consumption of water. Such measures apart from rise in the price of water include penalties for excessive water use or financial incentives for efficient use of water.

Structural-operational: These measures include technological and engineering solutions that aim to reduce water consumption without lowering the level of service to the consumer. Such measures include the promotion of water efficient devices, alternatives to water supply (e.g. rainwater harvesting , water recycling) and adoption of plants that require less water for irrigation or no water at all (xeriscapping). (Brandes and Ferguson, 2003)

Another categorisation of WDM measures is given by White and Fane (2001). According to him WDM measures aim to minimise either the overall or peak demand for water. The categories given are: increase system efficiency, increase end-use efficiency, promoting distributed sources of supply, substitute resource use and improve the market in resource usage.

A comprehensive list of various WDM measures is given by Jalil and Njiru (2006), where measures are divided into the supply level and the consumer level. This categorisation is very convenient for the purpose of this research. It also contains some measures that were not seen in other bibliographic references and are mostly concerned with the internal organisation of the water service provider and other institutional issues.

In the above references the measures mentioned were generally the same but there were some unique methods in each of the sources. In the next pages some of the WDM measures that were thought to be applicable for urban domestic use are going to be discussed.

For the purpose of this study the measures were categorised in the first level as measures that are applied by the utility and as measures that are applied by the consumers. This categorisation is not inclusive as measures need interaction from both the utility and the consumers in order to be successful but someone can see

whether the measures are mostly applied by the consumers or the utility. At a second level the measures were put in broad groups and were discussed.

2.4.2 Measures applied by the water service provider

Increase system efficiency

These measures aimed at water conservation by the utility and not by the consumer. There are several processes involved in the drawing, treatment and transportation of water. Losses are very common in these processes. The water service provider could reduce these losses by leakage detection and repair, change in system operation such as pressure reduction and changed to operational use of water as water main flushing or reservoir cleaning. All these measures could be described also as measures trying to reduce UFW.

The largest part of these losses is leakages from transmission mains and distribution networks and for a successful demand management program these losses have to be minimised. In order to achieve that, the utility has to implement a water loss management strategy.

There are various technologic solutions to aid achieving this objective. Some of these are leak detectors for detecting not visual leaks, pressure reduction valves, meters to meter the flow in different parts of the network and estimate losses and computerized systems to manage the network for the reduction of losses.

Economic measures:

There is a lot of discussion about whether water should be treated as an economic good or as a social commodity. The economics of water are analysed in many books and articles like (Kay et al, 1997), (Kayaga, 2007a). It is not on the purpose of this research to make complicated analysis of the economics of water.

It is enough to say for the scope of this research that water is nowadays commonly considered as both a social and economic good. According to Dublin principle No 4: Water has an economic value in all its competing uses and should be recognised as an economic good.

Since drinking water requires pumping, treating and distribution it requires financial resources. These resources have to be recovered by the costumers of the water service provider. For this reason there is a billing system in every utility referred as tariff. The ways a tariff can be constructed are various and serve different purposes. An explanation of the different kinds of tariffs and costs that should be recovered can be found in (Kayaga, 2007b).

The CAFES principles were developed by (Sansom et al, 2002). These principles are applicable to any water utility either small or large, in a developed or developing country. According to these principles a tariff should be conserving. That means that the structure of the tariff should promote conservation of water in a way that customers are able to pay for enough water to meet their needs without wasting water.

The concern for this research is how demand of water can be managed by economic measures like the change in price. Stephenson (1999) demonstrates in his paper the theory of how the price of water can affect consumption. Water is an economic good so the laws of supply and demand should apply for it. Although in theory this is true in reality things are different. According to the theory demand should be successfully managed by the use of tariffs. But as he concludes in his paper "The theoretical correct way to control consumption would be to charge marginal costs on the top consumption, but the administration and lifeline requirements make this difficult". He also states that "In fact water pricing experiences throughout the world (Dinar and Subramanian, 1997) show that external objectives of politicians or administrators can destroy the efficiency of water use control through tariffs".

A paper from Greece (Kolokytha et al, 2004) demonstrates a similar research with the one attempted in this report. In that research a questionnaire survey was conducted to a sample of 300 consumers of water in the town of Kozanh, Greece. The survey was trying to assess the level of acceptance of alternative WDM policies by the consumers. An important finding of the research was that although most of the consumers found that water was highly priced, when they were asked if they adjust the consumption of water according to the tariff 75% of the sample replied no. The town of Kozanh is very similar in characteristics with Katerini.

Another paper by (Fafouths et al, 2004) discusses about a similar research this time in the city of Thessaloniki and the town of Volos, Greece. In the same question as in the previous referred paper 80% of the consumers answered that they don't adjust demand according to the price of water in both of the cities. So there is strong evidence that water price by itself cannot control the water demand. Maybe other complementary measures are necessary.

There are other economic measures that could be placed by the utility to manage water demand. Penalties for large consumption of water can be an effective measure. The limits of the consumption should be carefully set and take into consideration various parameters that affect water consumption such as, property size, number of occupants and existence of a garden.

Education and information measures

The consumer is not always willing to do something to conserve water. After all the water flows from the tap. It is more convenient to use water as much as someone likes without considering the implications of this action. So it is the water service provider's responsibility to persuade the consumer to put some effort for water conservation.

In order to achieve this, the consumer needs to be informed and educated. Information is needed on the environmental impacts of water usage but also on indirect impacts to the consumer. By indirect impacts we mean the possibility of future water shortage to the consumer. Also information about different technologic solutions for water conservation that can be installed in the household can be provided. People are not always aware of the different options that they could use to save water. Also information about the benefits that the users can have with water conservation can be provided. Generally any information that can promote water conservation to the consumers can be provided by the water service provider.

2.4.3 Measures applied by the end user, Water Conservation (WC)

Apart from measures that are applied by the utility there are measures that are implemented by the utility but the application of them depends on the user. A term

that is mostly used by utilities to promote measures like this is Water Conservation (WC).

Baumann, 1987:174-179 after considering several definitions of water conservation comes to the following definition: "Water conservation is any beneficial reduction in water use or in water losses." As he says later water conservation practices are a specific subset of those practices which comprise efficient management of water resources. It is also important to note that on his definition the word beneficial is of great importance. The reduction in water use has to result in a net increase in social welfare.

For the scope of this research water conservation will be considered as the final user's efficient use of water. So the research will be focused on the conservation of water by the end users and more specific domestic users. The measures were grouped in use of water efficient appliances, practice of water saving behaviours and use of alternative water saving technologies and are discussed next.

Use of water efficient appliances

There are several appliances in a typical household that consume water. There is a potential in reducing the water consumed by these appliances by replacing them with water efficient appliances. "By installing more efficient water fixtures and regularly checking for leaks, households can reduce per capita water use from 74 to 52 gallons per day" (from 280 litres to 196 litres) (EPA, 2007). Some issues that were found in the literature concerning water efficient appliances are discussed in this section. The main source for this section was EA (2003) unless is otherwise stated.

White goods

White goods that use water and can potentially save water are considered the washing machine and the dish washing machine. These are machines that mainly need water to function. Apart from water these machines use electricity and detergent. With efficient machines savings on water, electricity and detergent could be achieved.

Manufacturers have realised that consumers are nowadays more informed and educated on environmental issues so they have developed new more efficient

machines regarding water, electricity and detergent use. Also some models are more effective regarding cleansing and noise production. They have also developed labels that inform the consumer on the energy use by each model. The rating of the labels is from A to the least use of energy to F to the most use of energy. This way the consumer can make the decision on which model to buy with the extra criterion of energy use.

Problems with ratings are that they are not independently assessed but its manufacturer rates the models of the company. So the reliability of the ratings is in question. Several studies in "Which" web site have proven that the manufacturers' claims are not always right.

There has been a drop in the prices of water efficient white goods and an increase in the variety of water efficient models available in the market. So there is an opportunity to promote the purchase of such goods to the users.

WCs

The WC is the most demanding water component of indoor household use. The water used in WCs in mainly for toilet flushing, showering, bathing and washing. The appliances involved in these tasks are toilet cisterns, shower heads, both tabs and taps. For each of these appliances there are solutions for water conservation.

Toilet cisterns are used to flush the toilet. Approximately 30% of house consumption is used for flushing the toilet according to Keating and Howarth (2003). When in the past cisterns used to use 12 litres of water per flush nowadays there are ultra low flush toilets that can flush with 4 litres. There are also dual flush systems that can flush with 6/3 litres per flush. The decision is in the user depending on the use of the toilet.

Concern about flushing systems is that although they might be technically perfect they are not always used correctly so the expected reduction in water use is not achieved. There are empirical beliefs that the users usually double flush the toilet because they are not satisfied by the single low flush resulting in an increase in water consumption rather than a reduction. But Keating and Howarth (2003) states that "the installation of cistern-displacement devices and retrofit dual-flush systems into real-life household situations can produce genuine water savings".

Water efficient shower heads can reduce water demand in the household. There are two ways that water efficient shower heads function. They either atomize water or they introduce air in the flow of the shower water. In both of these ways the water is spread in the outlet of the shower head, so less water is used for the same shower effect. Another method to reduce water used in the shower is to install a flow control valve. This valve is holding the flow constant to a low level.

Both of these measures can reduce the water consumption but there are some issues that can prevent this from happening. The user might take longer showers so the reduction in water consumption and the longer time in the shower even out. The reason for taking more time in the shower is that since water consumption is lower the hot water can last longer. So it is common that users exhaust the hot water.

Apart from showers people take baths often. Bath tubs can be water efficient as well. By selecting the proper size and shape of a bath tab depending on the size of the user water reduction can be achieved. But there is always the user's decision at the end on the level at which he /she is going to fill the bath tab.

Taps in the WC washbasin, can be water efficient. Water efficient taps work in the same way as the shower heads and are the most easily acceptable by the users because there is nothing to loose in terms of convenience or pleasure. Although water efficient taps are so simple to use they are not widely used.

Practice water saving behaviours

Apart from technologic solutions such as water efficient appliances, an effective way of reducing the consumption of water in the household is to practice certain behaviours that reduce the consumption of water without lowering the level of service. Many water using tasks in the household are done without thinking the wastage of water. People do not think about the implications of water wastage when they apply everyday tasks like brushing their teeth or washing the dishes. The water flowing from the tap seems to be plenty and infinite. But this is not true.

Water saving behaviours is simple things that users usually neglect of doing. Practices such as turning of the tap when brushing one's teeth can save water. Practices are

simple and do not need financial resources but the users are used in doing things their way.

Use of water saving alternative technologies

By "alternative technologies" we mean technologies that are not widely used. Without doubt a technology might be considered as alternative in one place but might be common in another place. For the researched country, Greece the alternative technologies that could save significant amounts of water are rainwater collection and grey water reuse. Both of these technologies are rare in Greece.

A promising technology but not yet fully developed is Grey water treatment and reuse. By this method we mean the treatment in the household level and on site reuse. The reuse of the treated water is mostly focused on flushing the toilet. Although there is certain water saving benefits in this technology there are concerns about the health risk associated with the in situ treatment of grey water (Warner, 2006).

Various technologies are available but there is controversy in the literature. The technology is not yet fully developed and there is a great variety of products. Although manufacturers advertise the good performance and efficiency of their products scientists have not come to a conclusion.

The fact that this is not a tested technology combined with the health risks make this technology less likely to be easily adopted by consumers. However, if consumers are recommended with criteria for buying the right product and they are informed about the benefits that this technology could have, it is possible to be acceptable.

The other more tested technology is rainwater collection. Rainwater is collected, treated and then used. Rainwater can be used either for non potable uses or even for potable uses. The basic prerequisite for the application of rainwater collection systems is adequate rainfall. These systems cannot be applied in areas where there is a low level of rainfall.

These systems are widely used in rural areas of Australia and other areas where the implementation of a water supply system is not economically feasible (Fewkes, 2006). This research is focused in Greece where rainfalls are not frequent in the summer

when water is mostly consumed. But with climate change shorter rainfalls with higher capacity there is an opportunity to research if these systems would be viable.

Other alternative technologies are waterless sanitation and using of plants that require less or no water for irrigation (xeriscapping). Waterless sanitation is mostly used in the commercial sector so it is beyond the scope of this study to discuss it further. Xeriscapping is used in the domestic sector and there is potential for implementing a measure like this in the researched area.

2.5 Water Demand Management Challenges

From the above sections it seems that the technological solutions exist and are very promising for reducing the water consumption in the domestic urban sector. But there are significant challenges that have to be overcome in order for a successful WDM program to be successful. There are also challenges to implementing WDM programs. The major challenges that were found in the literature and are applicable in the urban domestic sector are presented below. The major sources of these findings are from Jalil and Njiru, (2006) and Viessman, (1987) unless otherwise stated.

Education and training: There is lack of education among professionals in the water sector especially in issues regarding WDM. Most of the older professionals that have key places in utilities are oriented in the supply side approach. So WDM is neglected not because it is not applicable but because the decision makers are not completely aware of its purpose and benefits compared to the traditional supply side approach.

There is also lack of education to the consumers about the benefits of water conservation, water efficient appliances and environmental issues. Without having knowledge in issues like that the public cannot be engaged in doing something that will require effort and financial resources as WC.

Institutions: In some cases the institutions that are dealing with water issues are old and are operating under yesterday's policies and philosophies. There is also the issue of multiple institutions with no collaboration and lack of communication. Generally it is common that there is not a proper organizational structure of the involved institutions which makes decision making difficult and causes lagging. So decisions are often made based on demoded approaches.

Legislation: A government cannot rely on the utility's "good will" for the protection of the environment and the consumers. It is also important to have regulations about the responsibilities in the water sector. The government must place policies laws and regulations to ensure that the water supply sector is operating efficiently effectively and promotes the interests of the consumers. This includes the protection of the environment and ensuring the sustainable development. With proper regulations and policy the WDM can be promoted because of its benefits for the utility, the consumers and the environment.

The situation in many countries is not at all similar to the above. There is lack of a uniform water policy, laws and regulations that are not applied and do not have a united approach. So it is usual in some countries that there is not a proper framework for the utilities operation. There is no guidance and the WDM cannot be promoted.

Funding: WDM is a process that needs planning and implementation. For both of these steps funds are necessary to conduct the proper research and measurements, to develop the most appropriate program, to provide incentives to the consumers and purchase of hardware that is needed for the program. Although a WDM program can be financially beneficial in the long term funds are needed at the first steps to design and implement the program.

In many countries the situation is different. Funding for the water sector is based mostly on subsidies resulting in low budgets and declining infrastructure. There is a belief that water is a free good and anyone should use as much as he needs with low cost. This belief is starting to change in the most developed countries but is prevalent in low and middle income countries. Although water is a social good the costs for the production have to be recovered. What is more, costs for the development of new strategies that will be for the best of the consumers have to be paid by someone.

Level of implementation: Although it was shown that WDM has several benefits to all parts of the society it has to be decided the level of the implementation of such programs. As Maddaus, (n.d.) states, "the challenge today is to integrate demand management into long-range water supply planning to achieve an appropriate balance between capacity expansion and demand management". The reduction in demand has limits and development of new sources is sometimes necessary. The challenge is to

decide which is the appropriate level of covering demand by capacity expansion or demand management for offering the more benefits to the society.

Alternative technologies: There are various alternative technologies that could be part of a WDM program. Examples are in-house wastewater reuse and rainwater collection as discussed in section 2.4.3. Although this kind of technologies can reduce water consumption there are limitations that prevent their application in WDM programs. These limitations are mainly public acceptance and not appropriate technologic solutions developed for the local context.

There is a belief that although grey water re-use has financial benefits, it is not socially acceptable, hygienic or environmental friendly. Moreover, technologies for wastewater re-use in the house are not available in most countries and wherever they are, they are not developed according to the local conditions. These facts make it difficult to promote an alternative technology, unknown to most users, that could save water.

2.6 Summary of findings from the literature review

Increasing population and increasing industry has lead to increasing demand for water. This fact combined with the scarcity of water in many parts of the world and the pollution of water resources has lead to IWRM. The evolution of IWRM emphasizing on the economic value of water has produced a new approach to covering the demand for water, the WDM.

WDM can provide benefits to all parts of the society. Benefits are gained by the consumers, the communities, the utilities, the companies, the environment and the economy. The benefits are financial, environmental and social. Several case studies of WDM programs implemented around the world are proof that WDM can be applied in many cases and can provide the benefits without much cost to the society.

However most of the case studies are focused in big cities where there is an economy of scale and in situations where water scarcity was a great issue. Not many information where found in implementation of WDM programs in smaller towns.

WDM measures were looked at. For the purpose of this study they were divided in the measures applied by the utility and measures applied by the end user as Jalil and Njiru

(2006) proposed. It seems that the measures exist and are effective. Decision making tools have been developed through much research for the implementations of "soft" measures. And there are reliable technologies developed for the implementation of "hard" measures.

But if there are benefits to be gained from WDM and the solutions for implementing such programs are there, why isn't WDM so spread in the world? T seems that there is much more room for implementation of WDM programs. Despite the existence of many effective measures, there are major challenges that make the implementation of WDM difficult. These challenges are the lack of education and training in water professionals and bodies, lack of proper institutional organisation, lack of appropriate legislation, lack of funds, decision difficulties depending on the situation and lack of locally available alternative technologies.

It is obvious from this chapter that there are plenty of measures to include in a WDM strategy. The challenge is to pick the appropriate measures for the appropriate situation. The success of a WDM program is dependant on the social characteristics of the residents of the location to be implemented. It is also dependant on the perception of the responsible for water supply in WDM.

'It is not only about digging wells or improving the water mains. Water must be tackled within in a much wider framework. It concerns not only science and technology but also cultural and social aspects' explains Andras Szöllösi-Nagy, Director of UNESCO's Division of Water Sciences (UNESCO, 2007).

So if the question to be answered is whether there is potential for WDM in a specific area an assessment of the current situation should be made to identify the problems that WDM could potentially solve. Then the perception of the stakeholders should be assessed. The main stakeholders would be the utility and the consumers. The utility is mostly concerned with technical and scientific issues and these perceptions should be identified. But the perception of the consumers can be identified only by assessing their acceptability of such measures. This leads to the research that was conducted for this project and is explained in more detail in the next section.

3 METHODOLOGY

3.1 Method selection

The aim of this research as defined in section 1.2 of the report was to assess the potential of implementing a WDM program in Katerini, Greece. The research questions were also defined in the same section.

In order for these questions to be answered a research was conducted. Several research methodology books were consulted during the research design (Descombe,1998), (Greenfield, 1996) and it was decided that the design would be as described next.

The kind of research for this study was a case study. The research problem was focused on small towns. The case study method was selected because "Case studies allow for generalizations from a specific instance to a more general issue" (Cohen and Manion, 1995: 123) quoted from Blaxter et al, (2001: 73). Consideration is needed on the selection of the case if generalizations are to be made. The specific case has to have similar characteristics with the problem to be researched. However generalizations should be made carefully and not always apply. Several case studies of similar objects can contribute to a holistic view of the problem. So in the future other case studies can be researched and the results from all of them can provide a better view of the problem. The suitability of the location of the specific case was considered to be good for the following reasons.

- **Size:** The size of the town and the water utility is small and this is what the research is focusing at. There are a lot of similar sized utilities that the same results would be applicable.

- **Water source:** The specific utility uses groundwater as source. This is common in Greece and results would be applicable to other utilities with groundwater sources.

- **Convenience:** Due to the author's contacts and knowledge of the local situation the study of the specific town was feasible for the limited resources and time that was available for the completion.

- **Similarity:** The specific town does not have a special characteristic that makes it stand out from other small towns and this makes it a good case to be examined.

The nature of the research problem indicates that data have to be collected from several sources. The problem is not focused on one unit but on two. The units that had to be researched in order to answer the research questions were the water service provider of the town (utility) and the costumers of the utility. The reason for this was that, as it was discussed in the literature review, the success of a WDM program depends on both the utility and the costumers. Although the utility designs and implements the program, some of the measures focus on the users. So the success of these measures depends on the acceptability by the user and whether he/she decides to follow them.

Another reason for multiple sources of data is to support the validity and reliability of data. Triangulation of data makes the results from data more concrete, so research is more valid.

The sources of data were decided to be the consumers, the utility managers and documents from the utility. Data from the consumers provide information on their current practice regarding water conservation and their potential to accept new measures. Data from managers of the utility provide information on the current practice regarding WDM and the perception of the managers in WDM. So the willingness to implement such measures could be assessed. The documents from the utility were useful because they provide information in institutional issues, financial issues and sources of water. All these issues can help in detecting possible limitations in implementing a WDM program.

Data from the consumer was decided to be collected by the method of a survey. The reason for this selection was that surveys can give information about the general population by examining only a small sample of it. Results obtained from a survey can be very accurate and valid if it is well designed and administered. On the other hand there are issues of bias and the time limitations but generally it was thought that it would be the best way to get the necessary results in the time limits that existed.

Data from the utility managers were decided to be collected by face to face interviews. This selection was made due to the fact that interviews can provide accurate data from well informed and key positioned units. Managers of a utility are the people that make decisions on the short mid and long term time horizon for the operation of the utility. They are the people that will potentially decide the implementation of a WDM program and they are the most informed people on the water sector in the area. So they are the best target to interview and extract valuable information.

Data from the utility documents would be collected by a desktop study. The selection and collection of these documents would provide an insight into the utility's structure and financial status. Documents like that are not always easily accessible due to the sensitive nature of the data documented.

In the next sections the development of the methodology for each data collection method will be described.

3.2 Survey

After selecting the method of a survey for the data collection from the consumers, the questionnaire for the survey had to be designed. Several issues were considered in order to produce a well designed questionnaire to assist in getting the correct information.

Length: The length of the questionnaire would have to be one page in length. The reason for this was that surveyed users should not be intimidated by the view of a long questionnaire. People are busy and not always willing to appoint more than ten minutes for answering a questionnaire. The response then would be low and it would be possible that a low amount of questionnaires would be answered and results would not be valid.

Layout: The layout and presentation of the questionnaire would have to be designed in a way that it is easy to answer and friendly to the user. Issues like size of font and the answering way had to be considered.

Questions: The purpose of the questionnaire was to provide the necessary data for this research. But what kind of data is needed and which are the appropriate questions to obtain these data?

Language: The language used to express the questions needed to be simple and concise. Questions had to be clear so people could answer the questionnaire easily and would not misunderstand any of the questions.

Piloting: No matter how much effort is put in designing a questionnaire there is always the possibility that some questions are not clear or that it is not easy to be answered. For this reason a pilot questionnaire had to be designed first. After administering some of the pilot questionnaires and collecting comments from the respondents the final questionnaire had to be designed.

Questions

The research questions that were placed and are relevant to the end users of the utility demand that information was needed on: current practice on water conservation, perception of water conservation measures and potential for adopting water conservation technologies and measures.

These issues had to be translated into questions that would provide the necessary data. The questions of the questionnaire were divided into five categories:

- Environmental awareness: From these questions information about the respondent on his attitude on water shortage were gathered. This information is important because the acceptability of water conservation measures would depend on the user's environmental sensitization.

- Water conservation current practices: From these questions information about the respondent's current practice on water conservation was gathered. Questions were trying to assess the use of water efficient appliances, practices and alternative technologies such as rainwater harvesting and reuse of water in the household.

- Potential of adopting water conservation measures: These questions were focused on the user's willingness to use water efficient appliances, alternative technologies and practices. The user's responsiveness to water price was also assessed.

- Water conservation measures: There was an open question at the end of the questionnaire that was asking for possible measures that the utility could take for water conservation. By this question possible measures that the users would be willing to follow were discovered. It is very possible that if the users propose some measures they will be willing to follow them although this would not be always right.

Apart from the questions there was an introduction in the beginning informing the interviewee about the person who is responsible the purpose and the use of the data.

The pilot questionnaire can be seen in Appendix I and the translation of it in Appendix II. A few of the pilot questionnaires were administered by face to face interviews. This way the interviewer had direct contact with the interviewee so it was easier to spot ambiguous questions and other imperfections in the questionnaire. The sampling for the pilot questionnaire was random but it was tried to have interviewees for both sexes, various incomes and education background.

After piloting the questionnaire some corrections were made according to the feedback from the interviewees. Wording in some not clear questions and the layout changed. It was decided to produce a two page questionnaire with bigger font size so it was more attractive and easy to read. The final questionnaire can be seen in Appendix III and the translation in Appendix IV.

Administration

It was decided that the questionnaire should be administered by face to face interviews. This way the possibility of wrongly answered questionnaires that would have to be discarded would be less. The other possibility would be mailing the questionnaire and then wait for the correspondent to mail back the answered questionnaire. Due to lack of mail records, low response rates and limitations in resources this option was rejected.

Sampling

Sampling is very important for getting accurate results by questionnaire surveys. Characteristics of the population that may affect a research like the one in this report

would be, sex, age, education, income and whether the respondent is the water bill payer or not. Ideally the above characteristics of the general population should be retrieved from records and then the respondents should be selected in such a way that the sample is representative of the general population. Or the characteristics of each respondent should be recorded so the results would be weighted against these factors. None of these methods were possible because of the confidentiality that was required for the survey,

Instead random sampling was used. From the authors experience the population of Katerini is evenly distributed in terms of income and education. Six regions of the town were selected. Two high income two middle income and two low income regions were finally selected. The target was to collect 15 questionnaires from each region. So a street was randomly selected and a questionnaire was administered to every third house in that street. If the respondent was negative in answering the questionnaire the next house was selected and so on. If the house was a multi storey flat building the next floor was selected. This way, 80 questionnaires were administered in total.

Data handling

The data from the answered questionnaires were manually transferred to an answer sheet that can be seen in Appendix V. Counting the data was done three times to ensure that they were correctly transferred and minimize errors. The data were then entered to a spreadsheet software for further processing. The results from the survey are presented and discussed in section 4.2.

Bias

A disadvantage of a survey is the possible bias. People do not always tell the truth when answering to a questionnaire. Or they tell what they think is true for them but they might have a false perception.

In this survey the questions had to do with environmental awareness and water saving. It is possible that the respondents answered in a way that they would appear more conservative in water use or more environmentally friendly because this is what they would like to think of themselves. There is no solution to this problem and bias exists

always in a questionnaire survey. But to minimize bias the questions and the order of them were put in a way that would not make the respondents think that there was a "right or wrong" answer. Bias is also discussed in section 4.2.14 after considering the results from the survey.

3.3 Interviews

The research questions demanded data from the utility managers regarding: the current situation on WDM, perceptions on WDM and potential and limitations for implementing a WDM program.

The first step for this part of the research was to identify possible interviewees. After considering the structure of the utility, it was decided that the targets for the interviews would be the managers involved in the water supply and sewerage that had a higher education background. It was disappointing to see that the targets for the interviews were only 6! Despite the low number of possible interviewees the kind of interviews had to be decided.

It was decided that for the best results for getting the needed data a semi structured interview would be used. Several considerations lead to this decision. The author has no past experience with interviews which can be very difficult to handle and get valid results. So a structured interview was the first option. But in a structured interview there is greater possibility for bias, especially considering the fact that the interviewees would be the utility's employees. They would probably try to sound better than they really were. The less bias is in unstructured interviews but due to the author's inexperience this was thought to be a non feasible solution. So the semi structured interview was the prevailed method.

The main questions were prepared and several other issues that could come up were considered. Unfortunately it was not possible to do all the intended interviews. The targets for the interview were hard to reach because they were too busy. What is more there was a major rehabilitation in the wastewater treatment plant so most of the staff was too busy with that. Despite the efforts by the author's side only one interview was taken finally.

The interviewee was the General Director of the utility which gives value to the data as he was the most informed person in the utility. The interview took place in the director's office and was recorded by a cassette recorder. The contents of the cassette were then transferred to a transcript.

The analysis of the data from the interview was qualitative. Because of the low quantity of the data no computer was used for the analysis. From the interview all the relevant data that could be used for answering the research questions were identified. Apart from that data that obtained by other sources like utility documents or consumer survey were confirmed. This way triangulation was achieved. The results from the interview are presented in section 4.3.

3.4 Utility documents

The utility documents were searched in order to get information mostly about the current situation regarding WDM and tariff structure. Generally any information that would add something in answering the research questions was looked at.

Access to all the documents or other information like computer files, maps, and any other source of information was not always permitted. Sensitive data were not allowed to be looked at. The documents had to be searched and acquired in a short time because nuisance to the proper operation of the utility was caused.

Several documents were obtained like the pricing policy of the utility, the managerial plan for the next years, the structure of the utility and other intra organization documents.

Analyzing of the data from the documents was mostly qualitative. The data were searched and anything that would help answering the research questions was presented in section 4.1.

4 RESULTS AND DISCUSSION

In this chapter the results from the three sources of data will be analysed presented and discussed. These sources will be the utility documents, the questionnaire survey and the interviews.

4.1 Study setting

In this section the results from the grey literature of the utility and other sources of information will be presented. The purpose of this chapter is to present information about the town the utility and current water use, which will be useful in later stages of the research.

4.1.1 Katerini, Greece

Katerini is a town located in North Greece. The population of the town according to the 2001 National survey, which is the most current source of information about population, is 56,000 people. The inhabitants of Katerini are mainly occupied in the commercial sector and services. But there is extensive farming in the nearby area.

4.1.2 The utility

The responsibility of water supply to the inhabitants of Katerini is currently on a municipal enterprise. This organisation is called "Municipal Water and Sewerage Enterprise of Katerini" (MWSEK). All the data for this section of the report were taken by intra-organisation documents.

Structure of the utility

Data for this part of the report were taken from (MWSEK, 2006c). The utility has a structure to ensure its effective operation and the best results for the consumers. The managerial levels of the structure of the utility are:

- General direction with the general director as the head
- Service with the service supervisor as the head
- Department with department responsible as the head

- Office and workshop with office and workshop responsible as the head

The exact structure of the utility is described in Table 4-1.

Table 4-1 Structure of the utility

Structure of DEYAK
1. General direction which is comprised of: 1.0.1 General Director office 1.0.2 Administration, public relations and press office 1.0.3 Solicitor office 1.0.4 Programming, information and computerization office 1.0.5 External consultants' office 1.0.6. Quality assurance, safety and environment office *1.1 Operation and Maintenance department which is comprised of:* 1.1. 1 Department responsible office 1.1.2 Wastewater treatment, wastewater pumping and other electromechanical wastewater facilities workshop 1.1.3 Sanitary landfill workshop 1.1.4 Pumping station, reservoir and other drinking water electromechanical facilities workshop 1.1.5 Vehicle and machinery workshop *2. Technical service which is comprised of:* 2.0.1 Technical service supervisor office 2.0.2 Study and project supervision office 2.1 Network department which is comprised of: 2.1.1 Network responsible office 2.1.2 Drinking water network workshop 2.1.3 Sewerage network workshop 2.1.4 Solid waste workshop 2.1.5 Gas network workshop *3. Financial and managerial service which is comprised of:* 3.0.1 Supervisor office 3.1 Accounting office 3.2 Supply and logistics office 3.3 Costumer office 3.4 Administration and Staff office 3.5 Assistant staff office

The structure of the utility is constructed in a technical focus way. What is meant by this is that the structure is aiming at the effective operation and maintenance of the utility and at financial administration. There is not a research and development office which implies a lack in innovation and development.

Another issue is that the board which is the higher level of management is comprised of both staff from the utility and members of the municipal authority. This means that the board changes every time the municipal authority changes which usually happens every four years. So the higher level of management of the utility is not so stable and changes in the aims of the utility can occur.

Another important issue is the lack of expertise staff. When the total number of staff of the utility is 151 people, only 11 of them have a higher education engineering background and none of them has a postgraduate degree. This might result in adopting out of date methods for providing the consumers with the demanded water. Also it is possible that there is not further education of staff about new trends and techniques in the water sector.

Sources of water

Data for this part of the report were taken from MWSEK (2006a). The utility gets the raw water from several sources. Most of them are boreholes which provide groundwater but there are a few protected springs as well. More specific the sources of water and several characteristics are listed below.

- Vrontou boreholes and pumping station

At Vrontou location the utility has four boreholes and a pumping station to send water to the town. The maximum production of raw water at Vrontou location is 1540 m^3/h. If a 50% operation ratio is assumed (This means that the pumps will work only half the time), the capacity from this source would be 770 m^3/h. The characteristics of the boreholes can be seen in Appendix VI.

-Vrontou pumping station

The utility has also a pumping station at Vrontou with six centrifugal booster pumps. The pumping station can be seen in Picture 1. The characteristics of the pumps are 530 m^3/h maximum capacity each and 260 HP power each. The Vrontou pumping station can be seen in Picture .

Picture 1 Vrontou Pumping station

These booster pumps are connected by three in two main pipes of 500mm diameter each. The pipes are going from Vrontou to provide with raw water the main reservoirs at Svoronos location. Every time two of the pumps connected on each pipe are working and one is “stand by”. There is automatic control to switch the working and “stand by” pumps. So the total pumping capacity is 2120 m^3/h.

It is obvious that the pumping capacity is higher than the maximum production of water. This means that if there is an increase in demand the first priority would be to increase the production of raw water and not the pumping capacity.

-Collecting reservoir

There is a collecting reservoir at Vrontou with a capacity of 500m^3.

-Double main pipes from Vrontou to Main reservoirs at Svoronos

The water from Vrontou’s boreholes is transferred by the pumping station through two steel pipes of 500 mm diameter to the main reservoirs at Svoronos. By these pipes the New Effesos reservoirs and the old reservoirs at Svoronos are also provided with water.

-Automatic control

The system at Vrontou is fully automated and is automatic controlling: The starting and stopping of the borehole pumps and of the booster pumps. The reservoir's water level for starting and stopping of the pumps. The operating limits of the pumps. All

the data are transferred to the central offices of the utility by a phone line. There is the ability to fully monitor and control of the system from the offices.

- Pelekas boreholes and pumping station

At location Pelekas DEYAK has three boreholes and a pumping station to send water to the town. The characteristics of each borehole's pump can be seen in Appendix VII.

- Pelekas pumping station

The pumping station comprises of two centrifugal pumps with electric motors. Each motor has 50 HP power and maximum capacity of 120 m^3/h.

- Pelekas main pipes

The water from the Pelekas boreholes is transferred by the pumping station to the old reservoirs in Svoronos by a main pipe of 250mm diameter and 2500 m total length.

The total water production at Pelekas is 240m^3/h. Water from Pelekas is used by the utility as a backup in case of a break down or a power cut at Vrontou.

- Drystela Protected spring

This is the spring that provided with water the town of Katerini before the installation of the new systems. The spring is continuously providing with water the main town reservoirs. This source of water is of great importance because of its highest quality and minimum operating expenses due to the gravity flow. The average flow of the spring is approximately 150 m^3/h.

The water is transferred by gravity to the old ain reservoirs in Svoronos by a 250 mm diameter cast iron pipe of 17000m length and a second cast iron pipe of 150mm diameter and 17000 m length.

- Other sources

There are a few other boreholes with minor importance. These boreholes provide water in little settlements and in case of a break down. The total production capacity of these boreholes is 440 m^3/h.

From the above it can be seen that all of the water produced by the utility is ground water. This shows a high dependency in groundwater resources. A possible contamination of the groundwater with micro pollutants as dioxins would increase the cost of the water treatment greatly. Also if the groundwater level falls the costs for pumping will increase. Groundwater in the area is heavily used especially due to farms irrigation which also uses mostly groundwater.

Treatment of water is currently only chlorination. Due to the good quality of the groundwater no other form of treatment is required. The quality of the water from three different sources is presented in Table 4-2.

Water quality

Table 4-2 Quality of Katerini water sources

Parameter	Vrontou borehole	Pelekas borehole	Pieria spring	units	Typical values	Higher acceptable
pH	7.2	7.4	7.5	pH unit	6.5<pH<8.5	
Hardness	31	23	5	French		60
Cl-	10.6	24.8	1.8	mg/l Cl-	25	
NO_3-	27.5	49	0.3	mg/l	25	50
NO_2-	0	0	0	mg/l		0.1
NH_4-	0	0	0	mg/l	0.05	0.5
HCO_3-	384.3	372.1	79.3	mg/l		
SO_4-	9.4	29.4	6.9	mg/l	25	250
Fe++	0.01	0.02	0	mg/l		
Na+	5.4	16	6.3	mg/l	20	175
K+	0.5	1	1.4	mg/l	10	12
Ca+	60	52	16	mg/l	100	

Mg+	38.9	24.3	2.4	mg/l	30	50
Mn+	-	-	-	mg/l		
Conductivity	565	665	130.7	μs/cm	400	
Turbidity	0.2	0.2	0.4	Jackson	0.4	4

Key indicators

Data for this part of the report were taken from MWSEK (2006b). Several key indicators about the performance of the utility were obtained from the data that were available. These indicators will be very useful in analysing the present situation of water demand management of the utility, and the possible opportunities and limitations for change.

The most important indicator that was obtained is UFW. There was not data available for the exact calculation of this but the utility has estimated the UFW to be approximately 35%. The water that was paid for in 2006 is according to the utility 3,990,000 m^3. So we can calculate that the physical losses from the network and other administrative losses that are not paid for are 2,148,500 m^3.

The next important indicator is the tariff structure of the utility. From the data that was available the tariff structure was shaped and it can be seen on Figure 4-1.

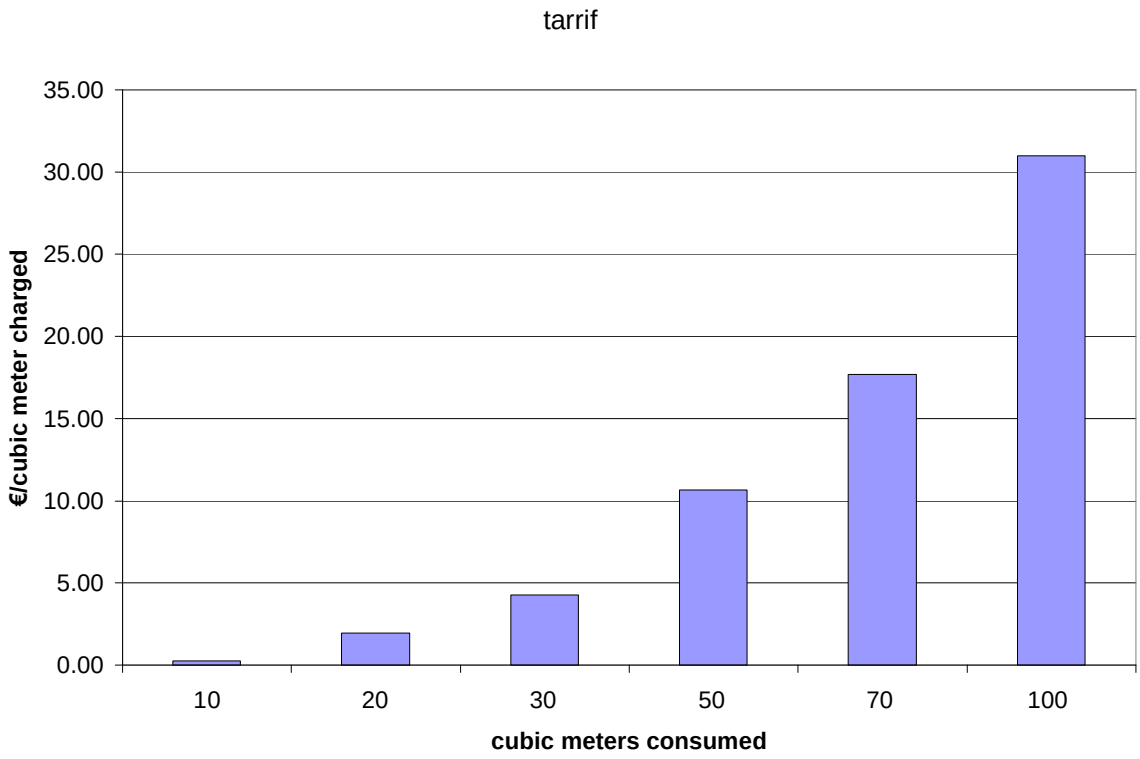

Figure 4-1 Tariff structure of MWSEK

It is obvious from the diagram that the tariff of the utility is an increasing block tariff which promotes water conservation. There is also a very low price for the first 10 cubic meters of water supplied to ensure that even the poorest can afford the minimum necessary needs for a person.

Apart from the money charged for the water consumed there are other charges like service charge and various taxes that are paid for the expansion and rehabilitation of he network and other new projects. So the total amount of money paid according to the consumption of water can be seen in Figure 4-2.

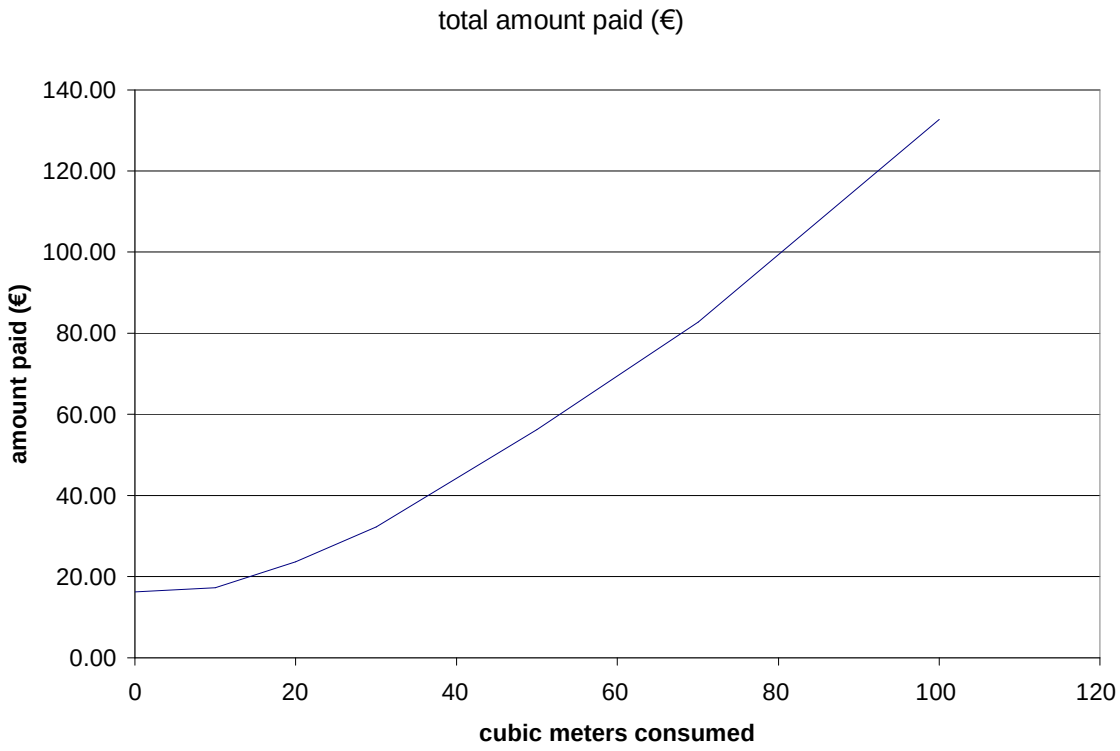

Figure 4-2 Total amount paid for water from MWSEK

More specific the different charges to the consumers according to the water consumed can be seen in Table 4-3. All the values are in €.

Table 4-3 Charges in water bill from MWSEK

M^3 consumed	**0**	**10**	**20**	**30**	**50**	**70**	**100**
Charging category							
Service fee	3.89	3.89	3.89	3.89	3.89	3.89	3.89
Consumption charge (€/m^3)	0.00	0.25	1.95	4.26	10.65	17.69	31.00
Sewerage fee	6.67	7.03	9.48	12.80	22.00	32.13	51.33
Special charge 80%	3.11	3.31	4.67	6.52	11.63	17.26	27.93
Meter coefficient	0.33	0.33	0.33	0.33	0.33	0.33	0.33
VAT 9%	0.35	0.37	0.53	0.73	1.31	1.94	3.14
VAT 19%	1.92	2.03	2.75	3.73	6.45	9.45	15.12

TOTAL	**16.27**	**17.21**	**23.61**	**32.27**	**56.26**	**82.69**	**132.76**

From this table someone can notice that there are various charges like taxes and special charges that users pay through their water bill. So the final water bill might not be representative of the water use. It is possible that consumers have the wrong impression of how their water usage is linked to the water bill.

Other useful indicators of the utility operation were also obtained. These include number of connections, population (estimated and surveyed), per capita consumption of water, employees per connection, employees per consumer, average price of water

A summary of the most useful indicators that were found is presented in Table 4-4.

Table 4-4 Useful indicators of DEYAK

Key operational indicators of MWSEK (2006)	
Population (Surveyed)	56,800
Water that was paid for (m^3)	3,990,000
UFW ($m^{3)}$	2,148,500
UFW (% unaccounted water/total water distributed)	35%
Number of costumers	29,880
Consumption (lpcd)	193
Consumption (lpmd)	365
Number of employees	151
Costumers to staff ratio	198
Population to staff ratio	377
Average price of water (€/m^3)	0.69

A population survey is conducted every ten years in Greece. Data for population are taken from the 2001 survey. The actual population is not the same as the surveyed population, but all the calculations were made according to the surveyed population for consistency reasons.

By costumers in the above is meant table the number of bills sent out. Consumption is given in two forms. One in litres per capita per day and one in litres per costumer per day. The average price of water is based on the utilities data.

From a survey conducted by the Municipal Water and Sewerage Enterprise Union it was found that MWSEK has a very low water average price compared to other similar in size utilities. According to the same survey, the above fact combined with the lower per capita consumption in Katerini result in a lower water bill up to 40% compared to other towns. The staff ratios are similar to other towns but there is a lack of expertise staff.

4.2 Survey results

It has to be noted at this stage that the questionnaire included of mostly qualitative questions which were answered by yes/no type answers. So the analyzing of the results was limited. It was not in the scope of this study to identify connections between variables. This would not contribute to answering the research questions. The analysis was qualitative and comments were made on its question. The results from each question are first presented.

4.2.1 Question 1

The results from question 1 are presented in

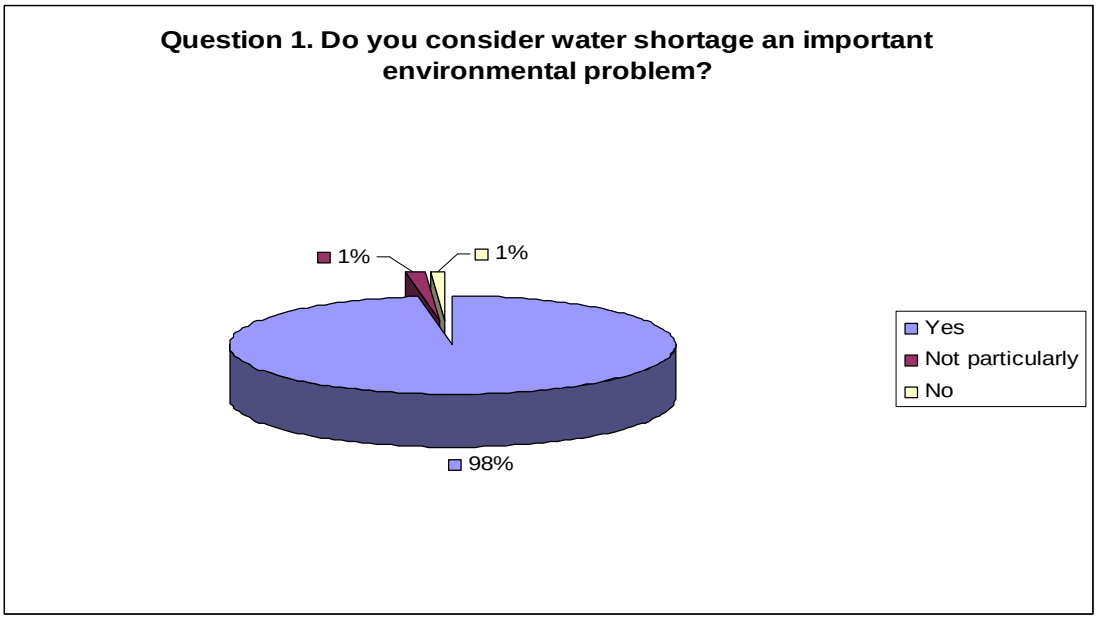

Figure 4-3.

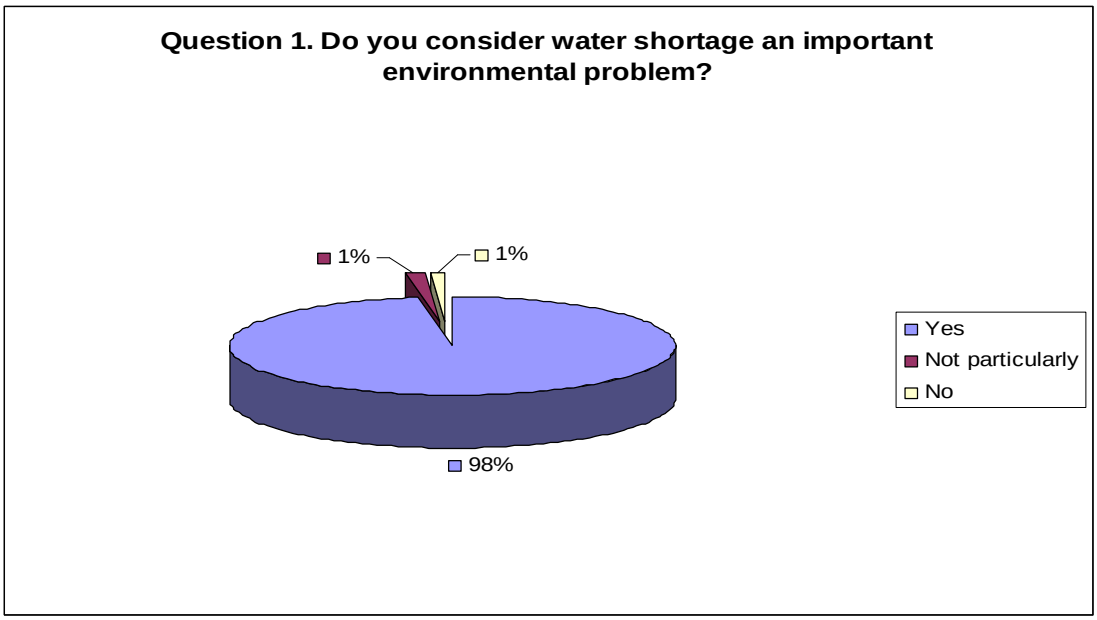

Figure 4-3 Question 1 Results

It is interesting that nearly all of the respondents answered that they consider water shortage as an important environmental problem. Although this fact does not guarantee that users will adopt any WDM measure, it clearly indicates that there is an environmental awareness which is positive for the implementation of a WDM program.

4.2.2 Question 2

The results from question 2 are presented in Figure 4-4.

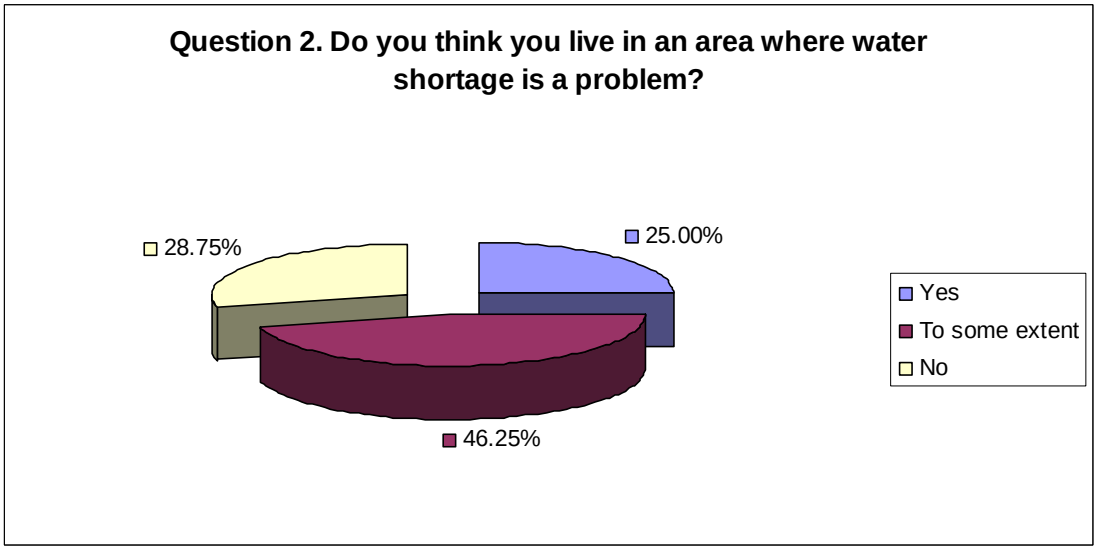

Figure 4-4 Question 2 Results

The results from question 2 shows that despite nearly all the respondents consider water shortage as an important environmental problem (as seen in question 1), only 25% of them think that the area of Katerini has a water shortage problem. This is reasonable because there are not water shortage problems for now. Any minor problems in water supply are caused by technical problems and high peaks in demand as it will be discussed in section 4.3. But this does not imply that there will not be a problem later and that water should be wasted.

However the results show that there are people that think that water shortage is a problem in the area so possibly they would be more willing to adopt any water conservation measures.

4.2.3 Question 3

The results from question 3 are presented in Figure 4-5.

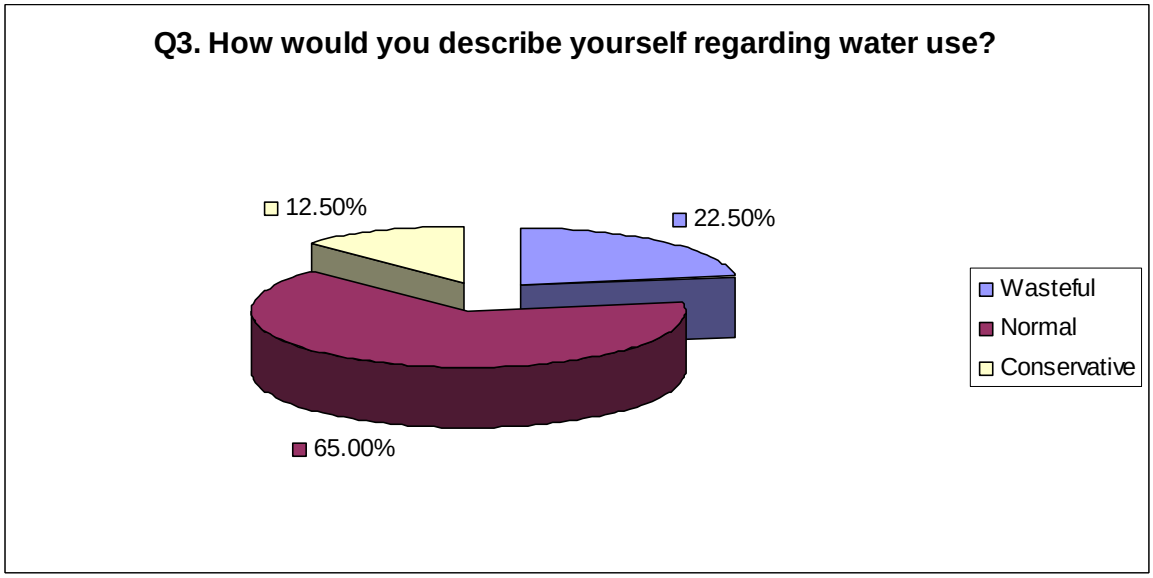

Figure 4-5 Question 3 Results

The results from this question show that only 12.5% of the respondents consider that they are conservative in water use. On the other hand there is a worthy percentage of 22.5% of users that "admit" that they are wasteful in water use. But the majority of the users consider themselves as normal in water consumption. There is a possibility that the users that consider themselves normal or wasteful would be more willing to adopt any water conservation measures.

4.2.4 Question 4

The results from question 4a are presented in Figure 4-5.

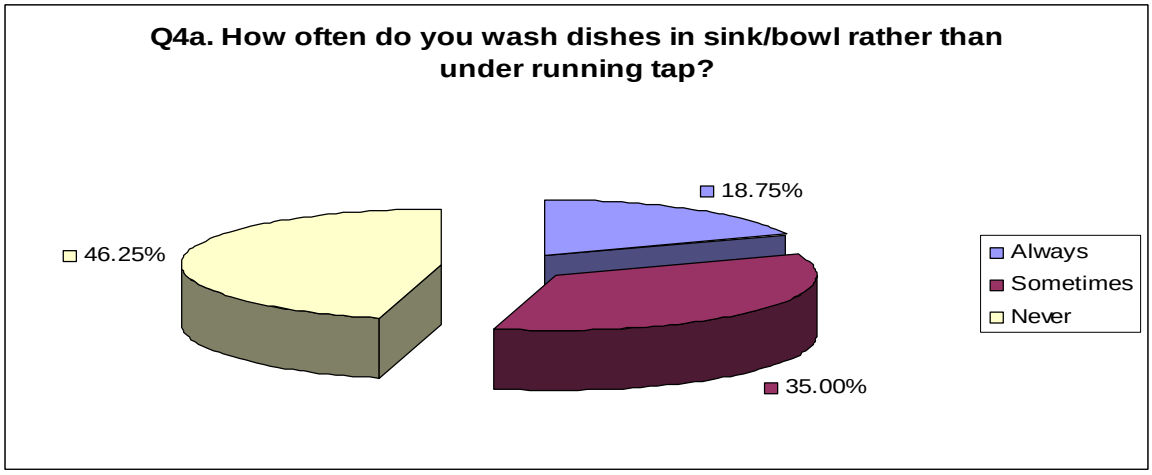

Figure 4-6 Question 4a Results

The results from this question shows that only a small proportion of the users apply this practice regularly. On the contrary, 46.25% of the respondents answered that they never wash the dishes this way. A reason for the low rate of applying this practice could be that users believe it is more hygienic to wash dishes under the running tap which shows that they do not "sacrifice" hygiene for water conservation. However this is only an assumption and is based only on the author's experience.

The results from question 4b are presented in Figure 4-7

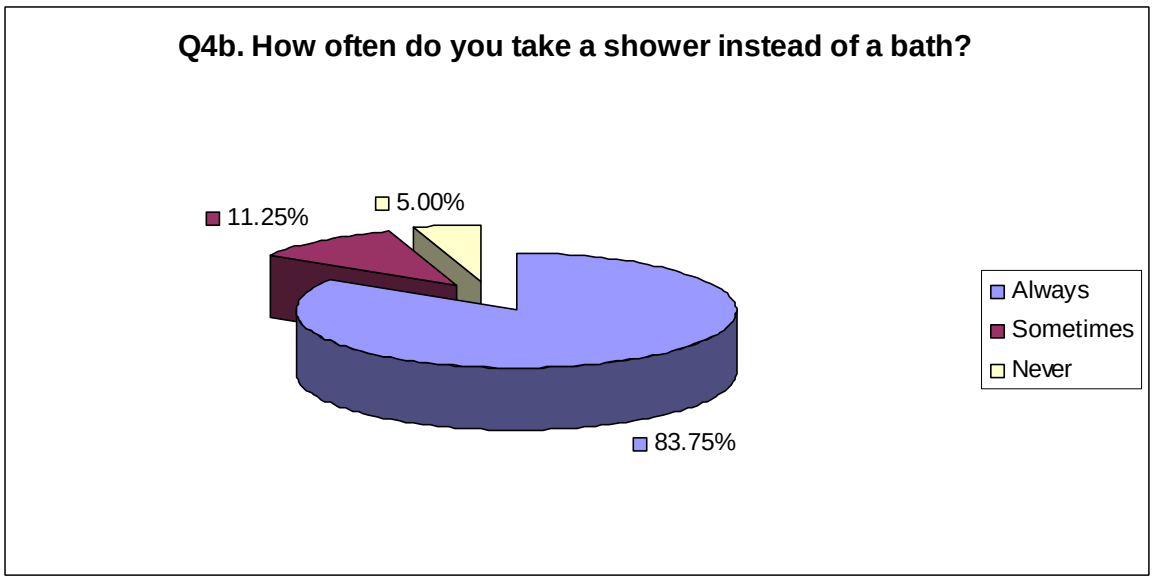

Figure 4-7 Question 4b Results

The results from this question indicate that a great proportion of the users always take showers instead of baths. This practice seems to be very common but it is not sure that it is used for water conservation reasons and not just for convenience. However it is obvious that this practice is very popular among users and if a water conservation program was to be implemented it would not need to focus on promoting this practice.

Results from question 4c are presented in Figure 4-8.

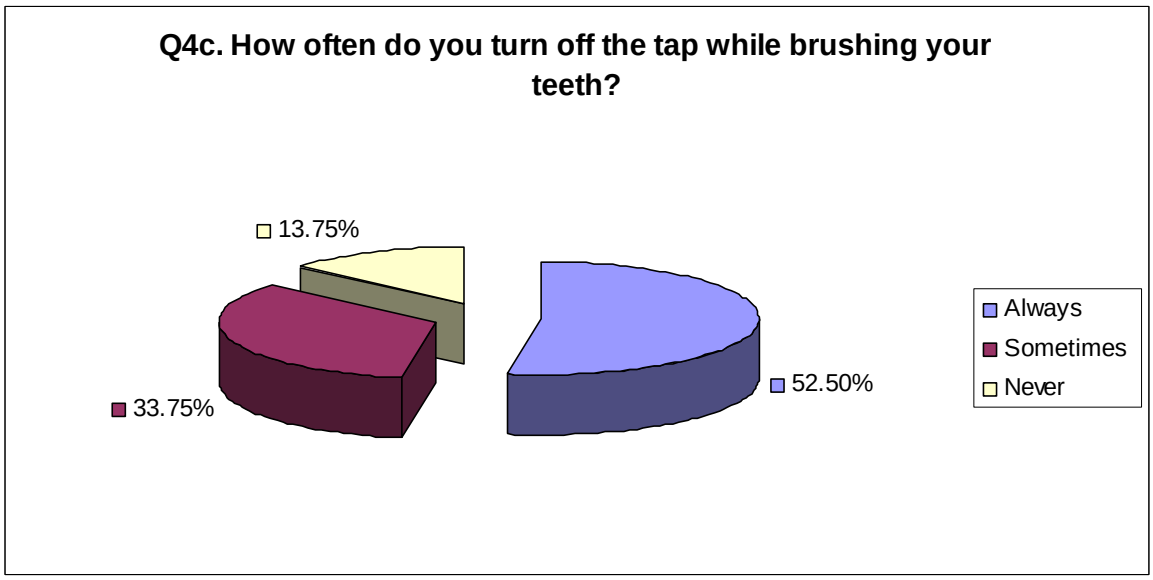

Figure 4-8 Question 4c Results

Results from this question show that a big proportion of the users turn off the tap while brushing their teeth. Also only a 13.75% of the respondents answered that they never do that. This is a practice that the only incentive for doing is water conservation. This could be either for saving on the water bill or environmental reasons. So the results show that users can adopt water conservation practices even if they require some kind of effort by them like turning of the tap.

The results from question 4d are presented in Figure 4-9

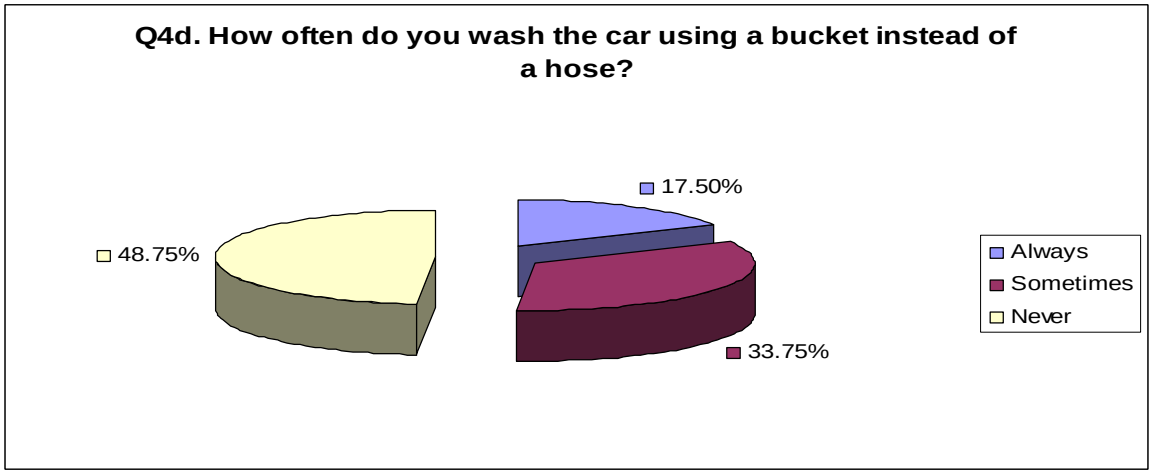

Figure 4-9 Question 4d Results

The results from this question indicate that this is not a very popular practice among users. 48.75% of the users never apply this practice. This could be for convenience reasons but also for effectiveness. It might be that users believe that the car cannot be cleaned very well without a hose. It seems that this practice is similar to the 4a the washing of the dishes.

The results from question 4e are presented in Figure 4-10

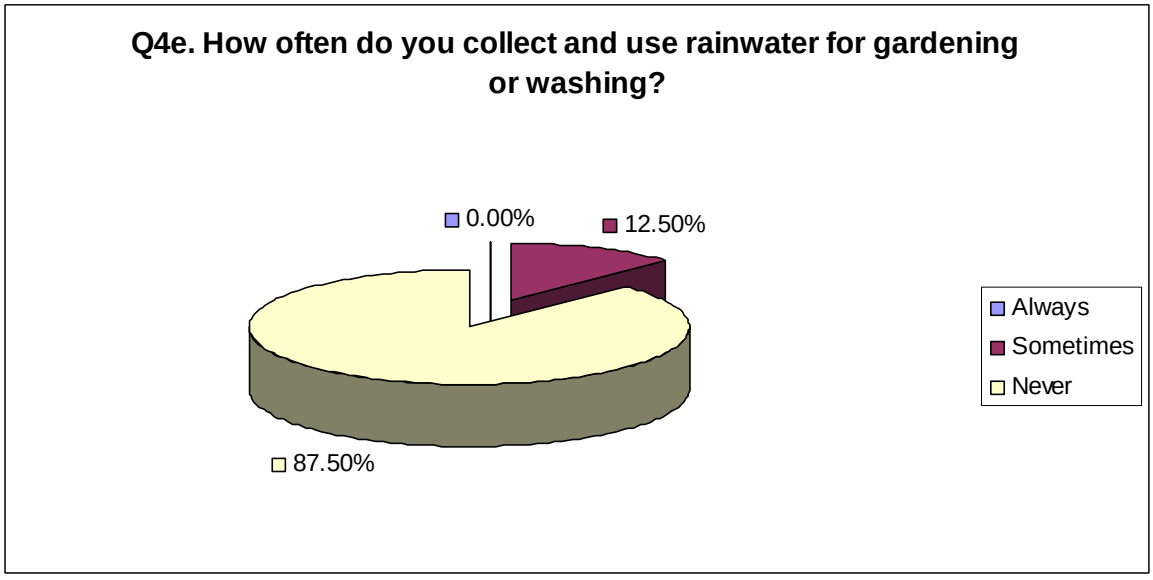

Figure 4-10 Question 4e Results

From the results of this question it is obvious that rainwater collection is very rarely practiced. 87.5% of the users never collect rainwater. From the author's experience this is due to the lack of widely available technology and the information of the

benefits of rainwater collection. Rainwater is not promoted by any governmental body in Greece. Even the users that apply this practice are doing it because there are no alternatives (remote locations) or for environmental reasons.

The results from question 4f are presented in Figure 4-11.

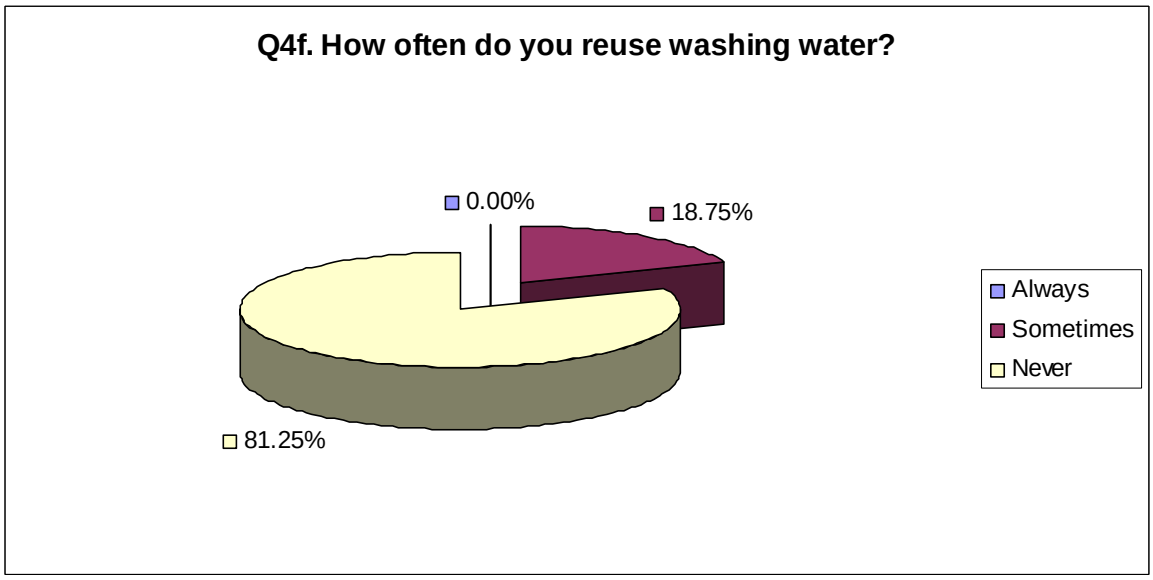

Figure 4-11 Question 4f Results

This practice is also very rare among users. But it is more common than rainwater collection. The reasons for this could be that no special technology is required. But the effort by the user is by far the greatest from all the mentioned practices.

It is very interesting to see the comparison of all the practices in question 4. This comparison is presented in Figure 4-12.

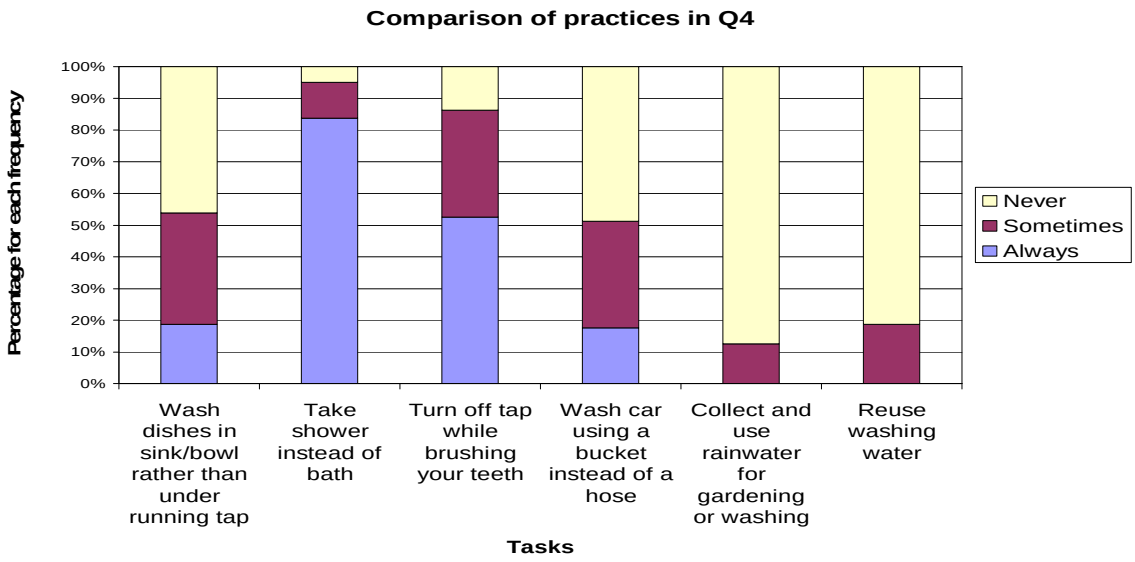

Figure 4-12 Comparison of practices in Question 4

From this figure the practices can be ranked from the more popular to the least one. The most popular practice is taking showers with turning off tap while brushing the teeth, wash dishes in sink/bowl, wash car using a bucket reuse washing water and collection of rainwater following.

From this ranking it can be noticed that the alternative technologies are the least popular probably due to locally available technology, high purchase cost and unfamiliarity with the concept. On the other hand taking showers is the most common practice but in the author's opinion is a matter of habit rather than a water saving practice. The fact that practices such as washing a car using a bucket and turning off tap when brushing the teeth are not applied frequently by the users shows that the users are not willing to give up more convenient practices without incentives.

4.2.5 Question 5

The results from question 5 are presented in Figure 4-13. Note that this question was only answered by the respondents who answered “never” in at least one task of question 4.

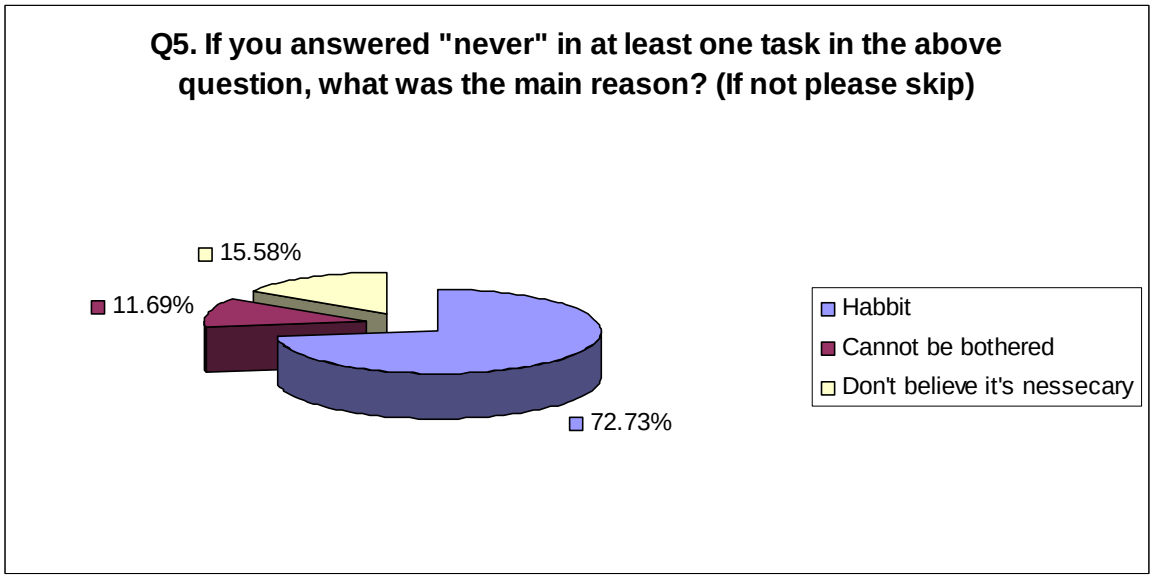

Figure 4-13 Question 5 Results

From the results of this question it can be seen that the majority of the users attribute their failure to apply some of the tasks to habit. The answer "cannot be bothered would imply that they don't sacrifice convenience for water conservation. The answer "don't believe is necessary" would imply that rational would convince them. But with this answer it is shown that to make people apply water saving practices someone needs to change their habits which is very difficult.

4.2.6 Question 6

The results from question 6a are presented in **Figure 4-14**. Note that this question was only answered by users who owned a dish washing machine.

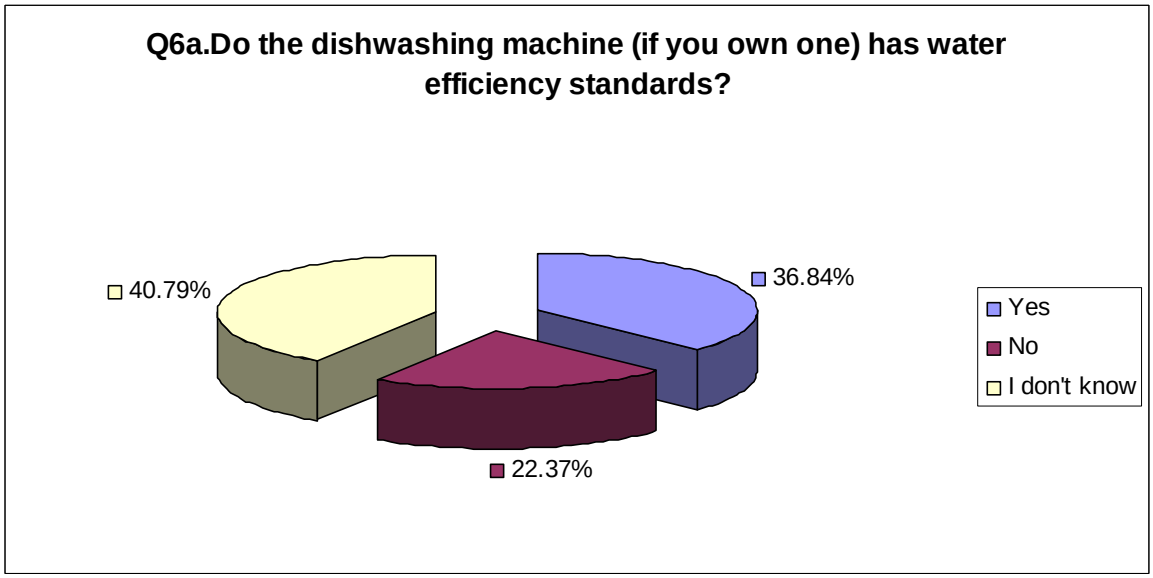

Figure 4-14 Question 6a Results

Results from this question indicate that a great proportion of the users do not know if their appliance has water efficiency standards. This shows that people are possibly not aware of the water efficiency standards or that they don't value them so much to know about them. It is also noticeable that more of the users that know about water efficiency standards own a water efficient dish washing machine.

The results from question 6b are presented in Figure 4-15.

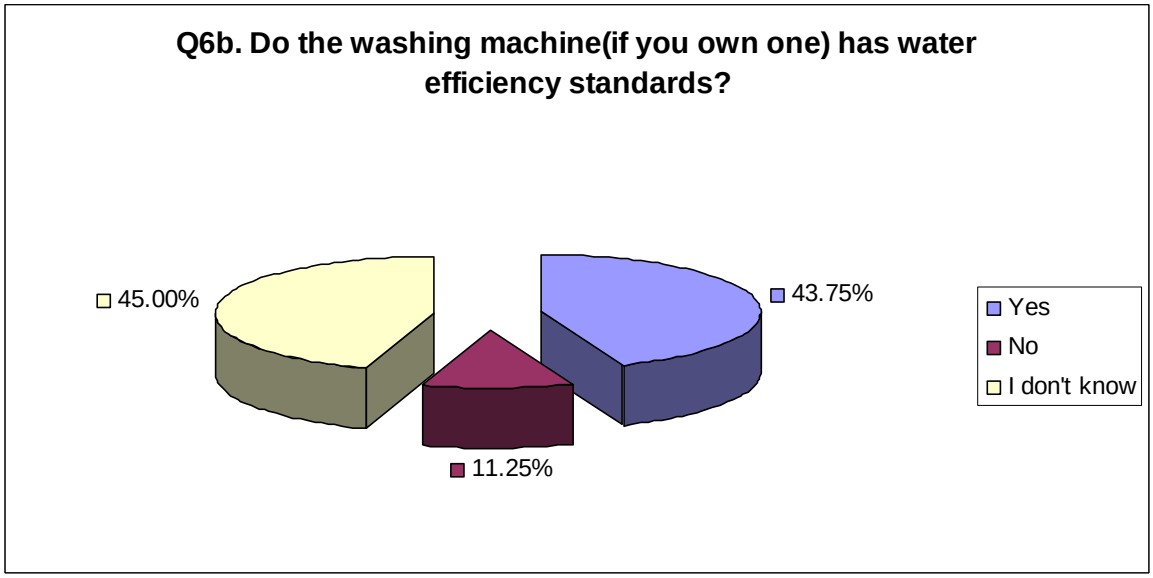

Figure 4-15 Question 6b Results

Results from this question are similar to the previous one. A great proportion does not know if there are water efficiency standards and from the respondents that know, the bigger percentage owns a water efficient washing machine.

The results from question 6c are presented in Figure 4-16.

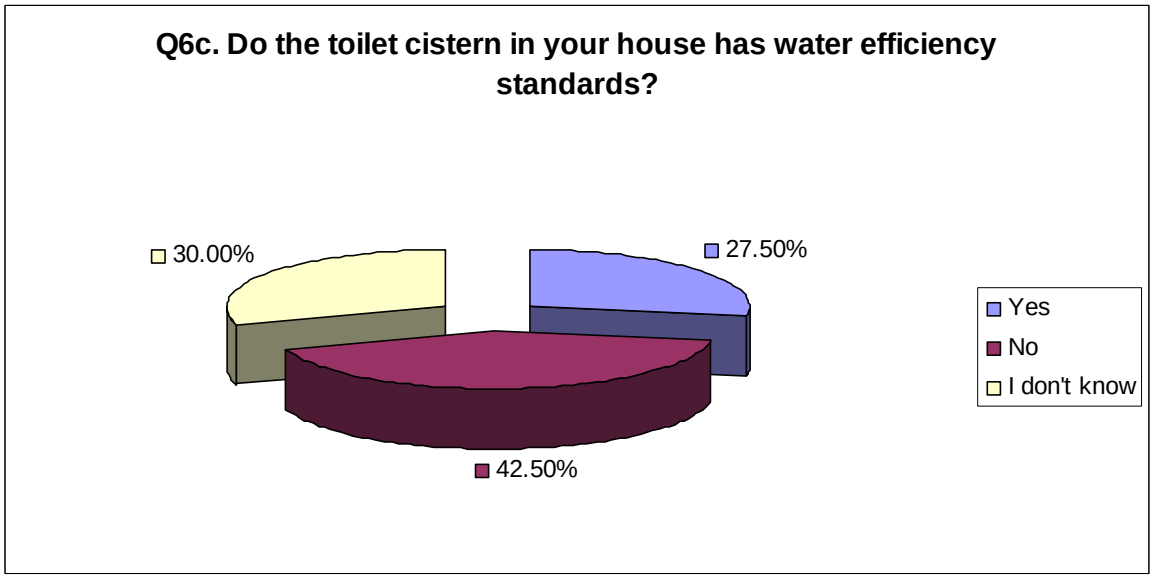

Figure 4-16 Question 6c Results

The results from this question are different from the two previous. Here it can be seen that more people are aware if their cistern is water efficient and most of them do not have a water efficient cistern.

The results from question 6d are presented in Figure 4-17.

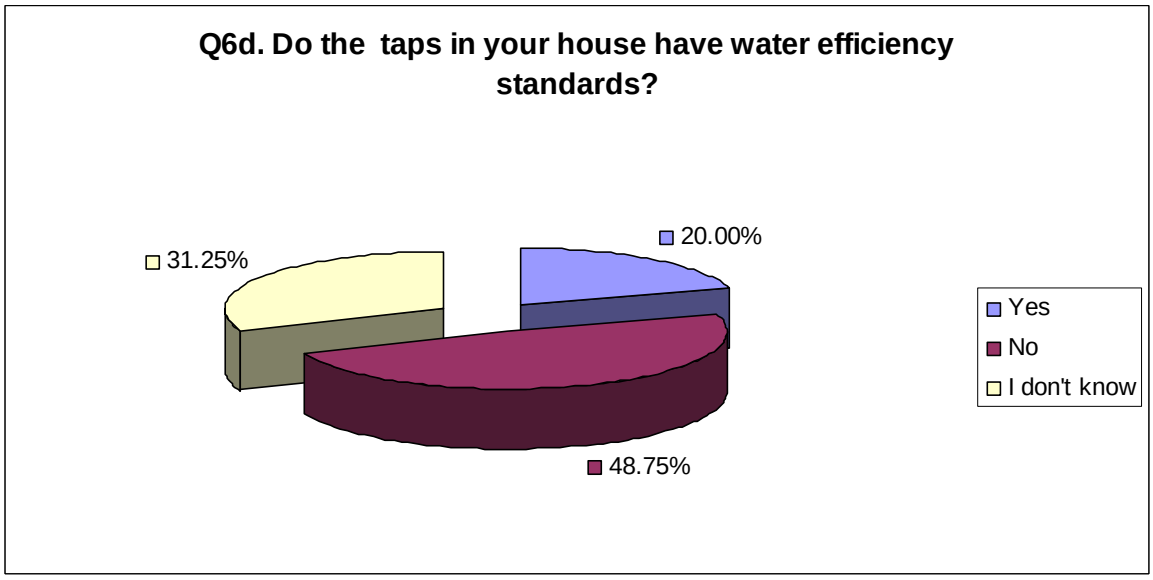

Figure 4-17 Question 6d Results

Once again results from this question show that a great proportion of the users do not know if their taps have water efficiency standards. From the users that know about it most of them answered that their taps are not water efficient.

The results from question 6e are presented in Figure 4-18.

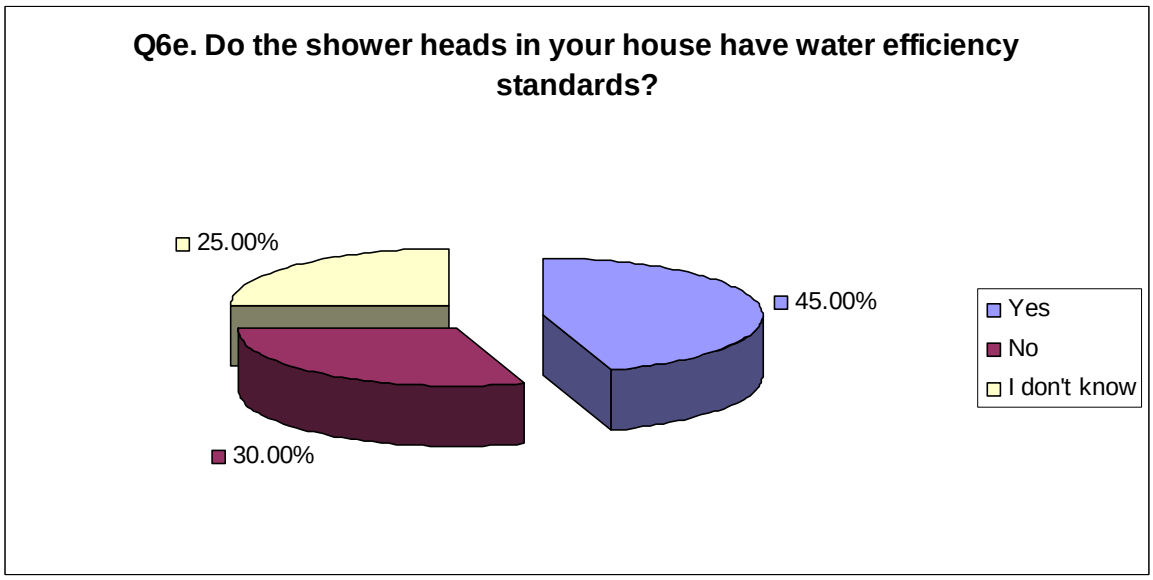

Figure 4-18 Question 6e Results

Results from this question show a smaller percentage of users that do not know if their shower head is water efficient or not. From the users that know about it the greater proportion answered that they have a water efficient shower head. It seems that users value the shower head more that other devices. This could be because of the pleasure that the user seeks from a shower. Due to the direct effect that a shower head has to the user, he/she is more concerned about the selection of the product.

It is interesting to see the comparison for the different appliances of question 6. This comparison is presented in Figure 4-19.

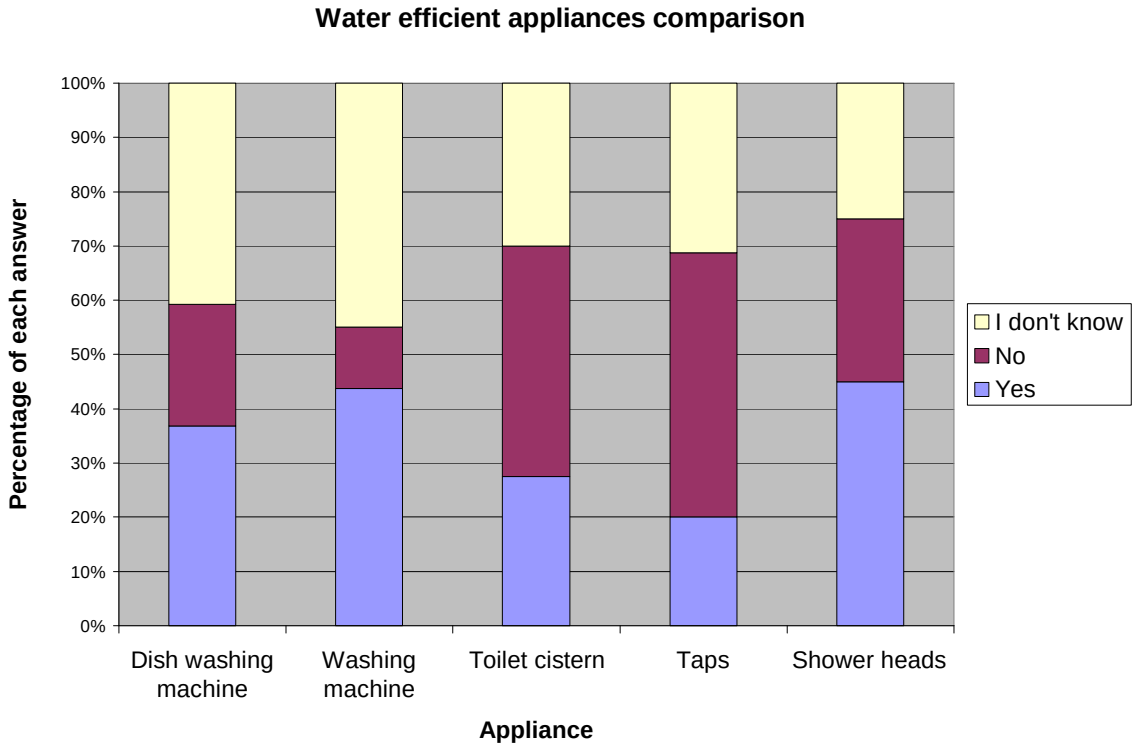

Figure 4-19 Comparison of appliances in Question 6

By comparing the results from all the appliances in question 6 we can notice that in all of them there is a high percentage (25%-40% approximately) of users that do not know if the appliance is water efficient or not. This fact shows that there is unfamiliarity in water efficiency standards by the users.

Users prefer to have water efficient dish washing machines, washing machines and shower heads that cisterns and taps. This agrees with the findings from the literature review in page 24, that water efficient white goods are nowadays widely available and in low prices.

4.2.7 Question 7

The results from question 7 are presented in Figure 4-20. Note that this question was answered only by users who had at least one water efficient appliance that they know of.

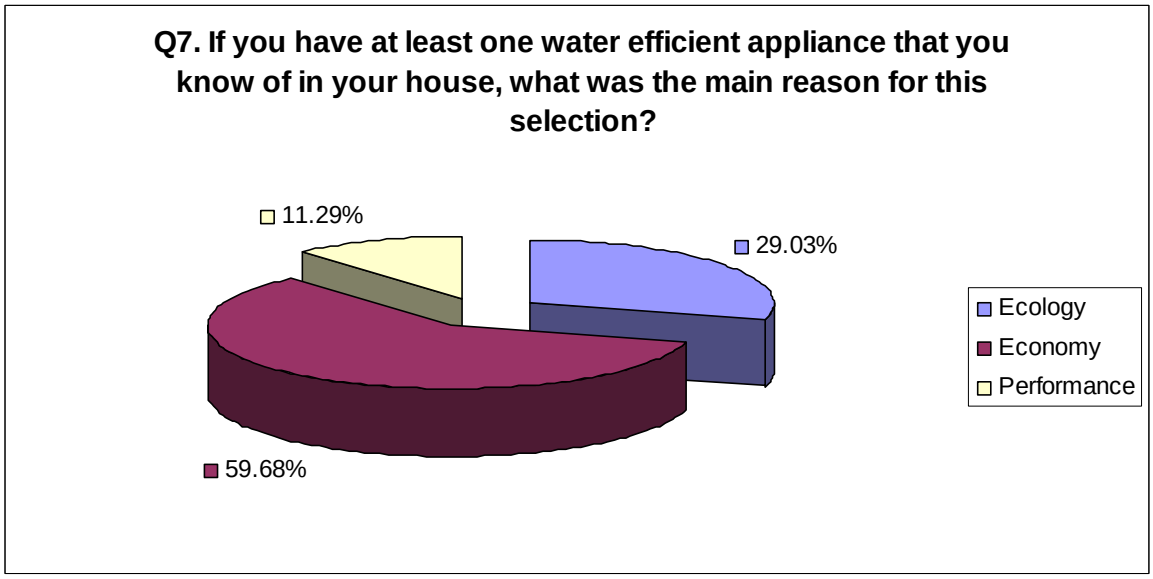

Figure 4-20 Question 7 Results

The results from this question show that although users are environmental aware they value economy more that ecology. Only a small proportion made the choice of buying a water efficient product due to performance reasons. People seem to realise that saving water in electric appliances also means saving energy and detergent that have increased costs compared to water.

4.2.8 Question 8

The results from question 8 are presented in

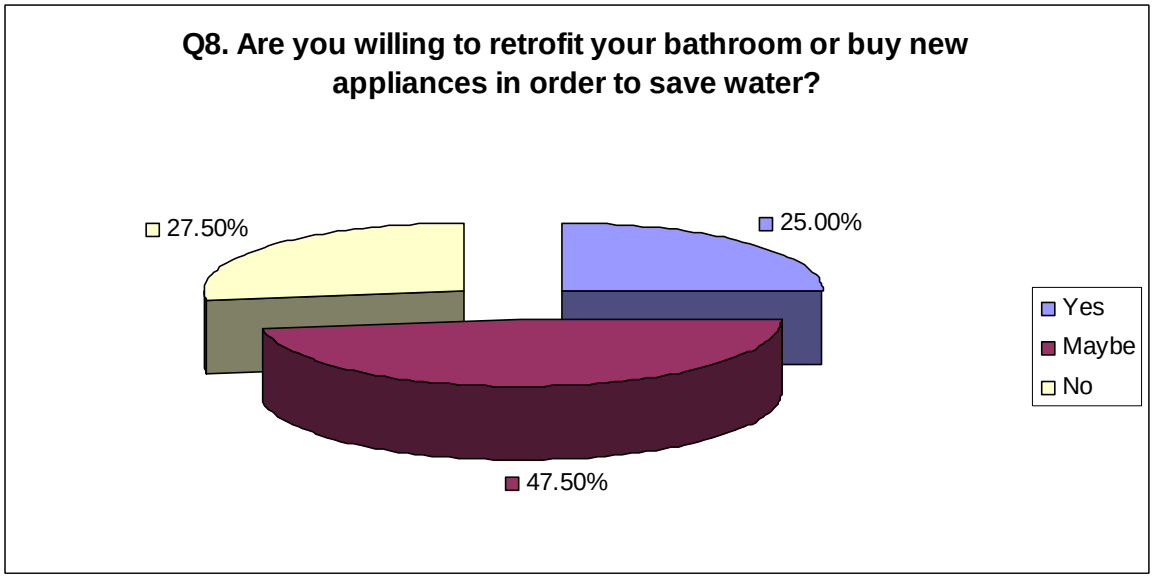

Figure 4-21 Question 8 Results

Results from this question indicate that a large proportion of the users (72.5%) are willing to retrofit their bathroom or buy new appliances to save water. Only a 27.5% of the users see this option negatively. This is very promising for the implementation of a water conservation program because there is great potential for user participation.

4.2.9 Question 9

The results from question 9 are presented in Figure 4-22.

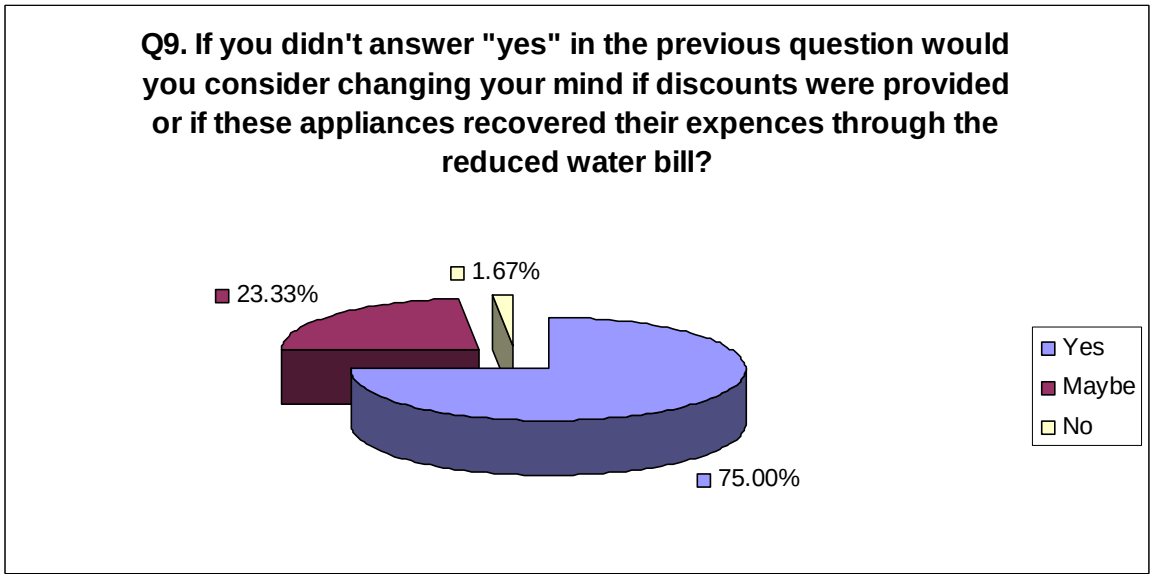

Figure 4-22 Question 9 Results

Note that this question was only answered by users that answered “maybe” or “no” in the previous question. Results from this answer shows that when incentives like price reductions and savings in water bills are introduced a great percentage of 75% would probably change their mind. Only a 1.67% of the users are totally negative in retrofitting their bathroom or buying water efficient appliances. This shows the great potential for a success of a water conservation program in the researched town.

4.2.10 Question 10

The results from question 10 are presented in Figure 4-23.

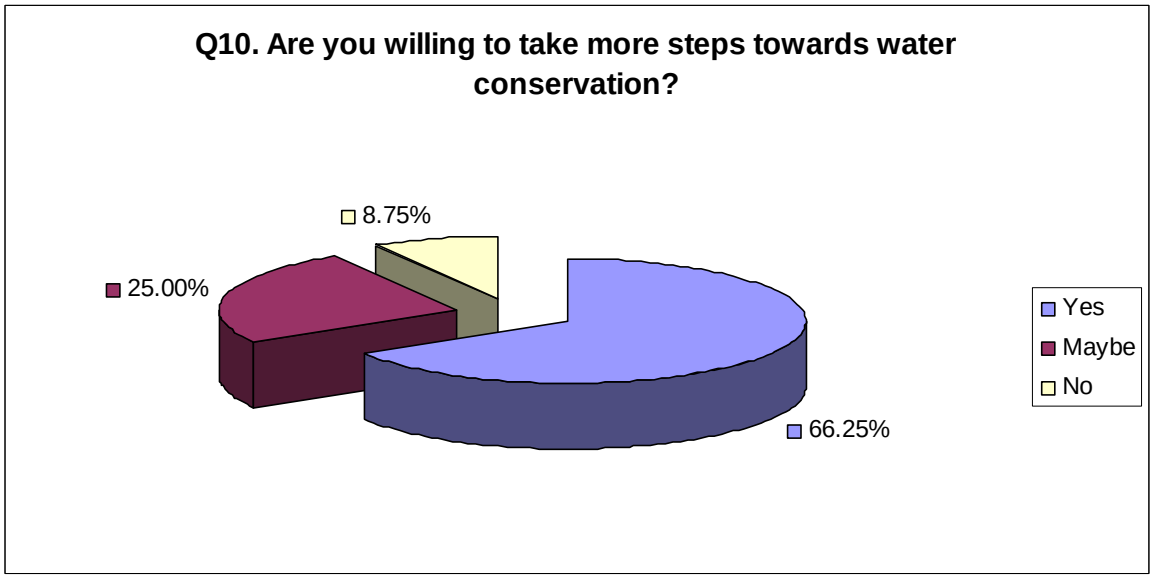

Figure 4-23 Question 10 Results

The results from this question once again indicate the acceptability of water conservation measures by the consumers. Although it is a very general question and does not propose any particular measure, the users seem to be willing to do something more for water conservation. Only an n 8.75% of the users is totally negative in doing something more for water conservation.

4.2.11 Question 11

The results from question 11 are presented in Figure 4-24.

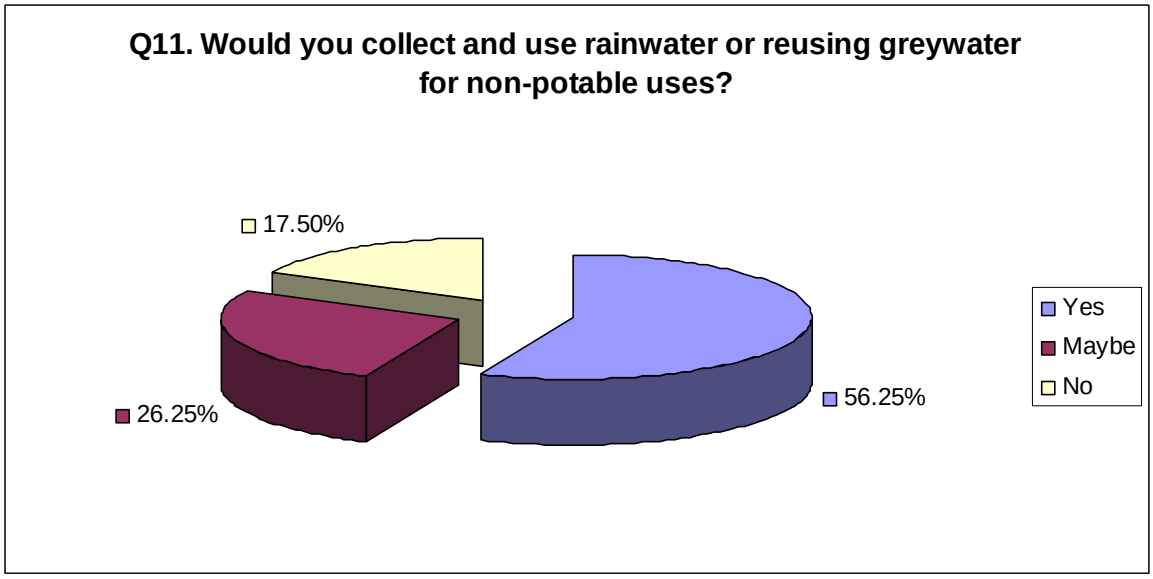

Figure 4-24 Question 11 Results

This question relates to question 4e and 4f. It was shown that rainwater collection and reusing of washing water is a very rare practice among users. For the results of this question it is obvious that a big percentage of users (56.25%) are willing to apply such a practice and only a percentage of 17.5% are totally negative in an option like this. This once again shows the acceptability of new alternative technologies and practices by the user.

4.2.12 Question 12

The results from question 12 are presented in Figure 4-25.

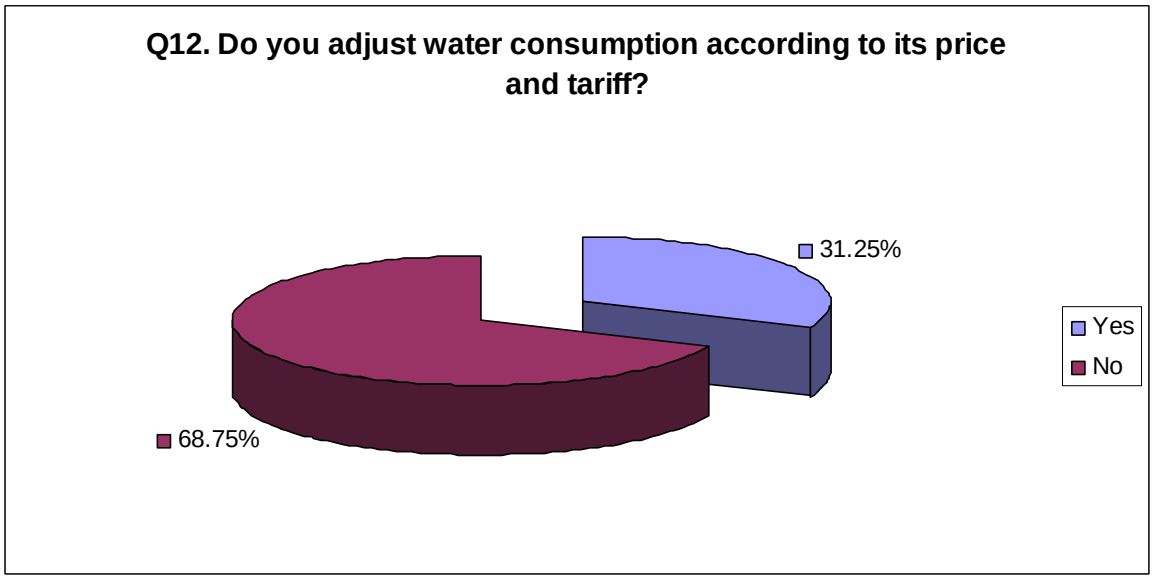

Figure 4-25 Question 12 Results

The results from this question indicate that the biggest proportion of the users (68.75%) do not adjust water consumption according to the water price and tariff. This could be a limitation in the success of an economic measure for water conservation. On the other hand the 31.25% of the users that adjust water consumption according to the price of water could reduce the total consumption of water if an economic measure was implemented. So although the greatest proportion of the user claim to be unaffected by water price the rest of the users could help to water conservation.

4.2.13 Question 13

Question 13 of the questionnaire was an open end question. There were no options for answering and users were free to answer or not. The purpose of the question was to let

the interviewees express themselves regarding the steps that the utility could take to promote water conservation.

An open end question was used for several reasons. First of all from the rate of response it could be identified the percentage of people that were more interested, enthusiastic and aware of water conservation. What is more an open end question is totally unbiased so it is more reliable and valid. Finally by asking the users to propose water conservation measures someone can discover what they would be more willing to adopt and encourage. So with this question the user's views on the utility measures were assessed.

The response rate from question 13 is presented in Figure 4-26.

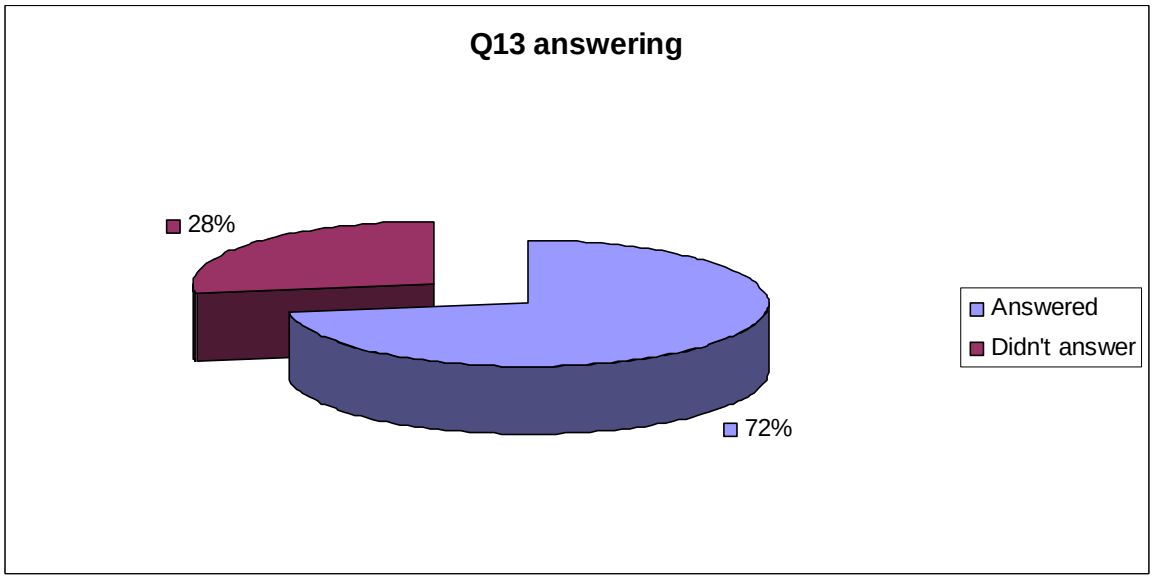

Figure 4-26 Question 13 Response rate

It can be understood from this figure that a 72% of the interviewees answered this question. This is very positive and means that most of the users are interested and knowledgeable on water conservation issues.

Since this was an open end question, the answers had to be categorised in order to be presented and conclusions to be drawn from them. Not all of the answers were relevant so the irrelevant answers were discarded. The categories that were decided and the different answers that were found in its categories are listed below.

Incentives for low consumption to the users: These included, generally controlling the consumption, bonuses for low consumption, penalties for high consumption, metering of all the consumers, and readjusting the tariffs to encourage water conservation. A very interesting proposal was that penalties were imposed to high consumption that would be set according to the consumer's needs e.g. persons in the household, size of property and existence of a garden or not.

Water loss management by the utility: These included, repair of leaks visible and not, rehabilitation of the network and generally reducing the losses in the network.

Subsidies for water efficient appliances: These included subsidies in different forms like reduction in price or retrofit programs.

Informing and education: These included informing on water shortage of the area, informing on future possible droughts, informing on ways to save water, education programs in schools and advertising for water conservation.

Recycling wastewater by the utility: These included recycling of treated wastewater for irrigation and public gardens watering.

Rainwater: These included rainwater collection by the utility and rainwater collection for the users promoted by the utility.

Other sources: These included abstracting water from rivers and desalination.

The results from question 13 are presented in Figure 4-27.

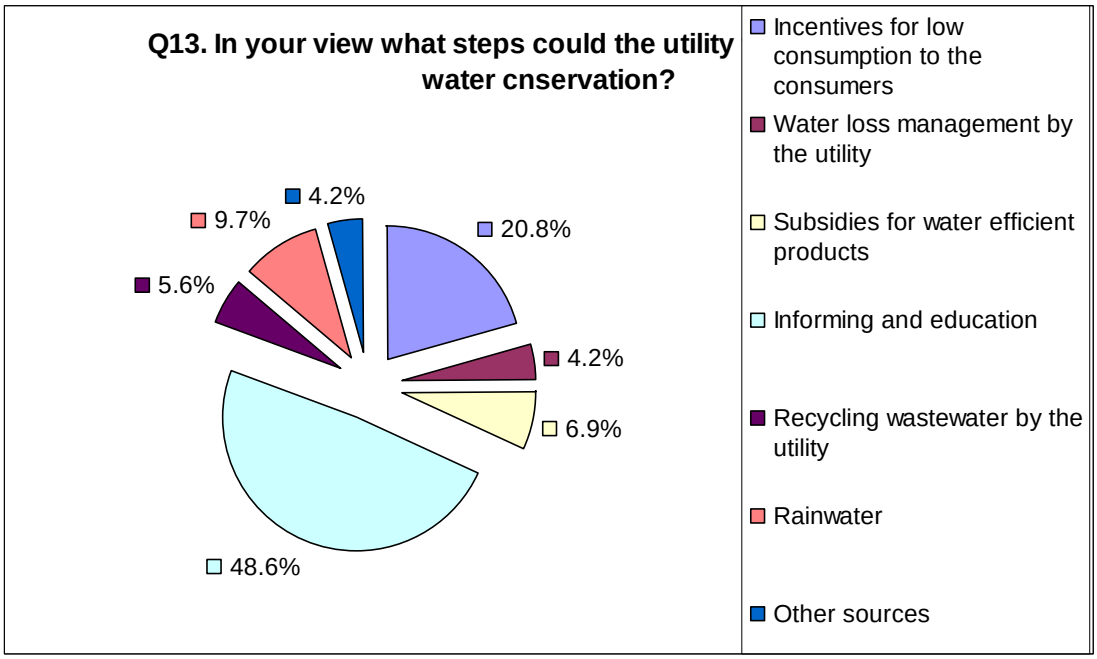

Figure 4-27 Question 13 Results

It has to be noted that the percentages for this question are not based in the number of interviewees but on the number a specific answer was given. This means that the percentages were calculated by dividing the number of times an answer was mentioned by the total number of individual answers.

The results from this question indicate that a great percentage of the answers especially compared to the other answers, proposes informing the public about water conservation. This would be possibly a very effective measure. Informing and education aims mostly at changing the mind set of the consumers and is not based on engineered solutions. It is the "soft" component of water conservation. It is the less costly option and still it is not practised by the utility.

The second measure in rank is incentives for low consumption which shows that consumers may want something back for their effort on conserving water. Although all of them seem to be environmentally aware they will be more motivated to conserve water with incentives, mostly economic.

Other measures that follow might not be applicable to the situation of Katerini. For example desalination would be too much costly due to the energy costs and rainwater collection is not at all widespread in Greece and it is not promoted by the officials. Other measures that had a low percentage of answers but are applicable to the specific

situation with great environmental and financial benefits are wastewater recycling and water loss management. The implementation of these measures is only dependant in the decision of the utility.

4.2.14 Summary of the findings from the survey

After analyzing the information from the survey, it was possible to draw some major conclusions about the consumers of the utility.

- Environmental awareness is very high among the consumers. Virtually all of them are aware of the water shortage problem and potentially they are interested in helping save water.

- There is a significant proportion of the users that consider themselves wasteful in water use. Although this was not a quantitative question it can be assumed that there are potential great savings in water by those users, if a water conservation program is to be implemented.

- The current situation in water saving practices is varying depending on the kind of practice. Practices like short showers are very popular but rainwater collection and grey water reuse is nearly not applied by anyone. People are used in applying or not some of the practices. Habit was the main reason for not applying some of the practices. Habits are most possible to change through education and advertising.

- There is ignorance concerning water efficient devices. From the answers of people that are aware of water efficient appliances it was found that the most popular appliances are the dish washing machine, the washing machine and shower heads. Users choose water efficient appliances mostly for economic reasons. There is great potential to increase the water efficient cisterns and taps in the households.

- Consumers are very positive in changing appliances to save water especially when financial incentives are offered. They also say that they are willing to try new unfamiliar technologies like rainwater collection.

- Most consumers claim that they do not adjust water consumption according to the water tariff. This is contradictory to the theory of economics of water. But there is potential for water savings from the less proportion of the users that are affected by price.

- Users want the water utility to apply water conservation measures. A great proportion of the consumers would like to see education and informing programs. Other suggestions include incentives for low consumption and subsidies for water efficient products.

4.3 Interviews

An interview was taken by the MWSEK General Director Mr Elias Zamanhs. The interviewee provided valuable information for answering the research questions as he is the top manager of the utility and a key informant. So although only one interview was taken the reliability of the data is very strong. The transcript from the interview is presented in Appendix VIII.

Findings from the interview

After analyzing the transcript major findings were discovered. The interview was mostly focused on the utilities views. The findings are presented below.

- There is no major problem with water scarcity in the area. Seasonal problems occur but they are only temporary. Generally there are no problems with water supply apart from the low pressure in high peak hours in the summer. The dependence of the utility to groundwater could cause problems later if demand continuous to grow or due to a pollution incident. Also the high agriculture demand could contribute to the reduction in the groundwater table.

- Currently WDM measures are not applied by the utility. Some form of WDM is the periodic publications in the local press that inform consumers about possible low pressure and encourages them to not being wasteful with water.

- There are thoughts of implementing some WDM measures in the future. These are Water Loss Management by detecting and repairing not visual leaks and

metering through the network. But there is not a consideration in implementing a WDM program.

- WDM is appreciated by the utility. Water conservation by the consumers is seen positively not only for the financial benefits to the utility but also for the environmental benefits that can be gained.

- Although WDM is appreciated and there is potential for implementation of a program, it is outclassed by major limitations. The water laws are ambiguous and not contextual. The various institutions that are responsible for water are competitive and not communicating effectively. There is lack of expertise staff in the utility. Finally there is not a uniform national water policy to encourage utilities to implement WDM.

5 CONCLUSIONS AND RECOMMENDATIONS

In this section the conclusions from the project will be presented. Although findings were presented in each of the sections the triangulation of the results produces new conclusions. By combining the findings from every section the following conclusions can be drawn.

- From the literature review it was found that the increasing demand in water and increasing pollution of water resources combined with the water scarcity lead to a relatively new approach to water supply. This approach is WDM.

  WDM has benefits to both the consumers and the utility. These benefits are proven by successfully implemented WDM programs around the world. But WDM programs were mostly implemented in big cities where there are economies of scale and great demands in water. The implemented WDM programs focused mainly at financial benefits for the utility. The development of a new water source for a big city, where the demands are huge, costs a lot more that a development in a small town. So the benefits from the deferral of a project like this can provide the financial incentive for a utility to invest in a WDM program. There is no certainty if this would be the same for a small town where costs for the development of water sources are usually lower. So despite the benefits that a WDM program can have it is not sure if the situation of a small town could let WDM give what it can.

- There are a lot of measures that can be part of a WDM program. All of the measures are scientifically developed to reduce water demand. Some of these measures aim at the utility while other aim at the end user.

  Water conservation was defined to be the water use efficiency by the end user. There are technologic solutions that are reliable and easy to install that can reduce water consumption in the household level. But there is always the component of the user acceptability and proper use of a technologic measure. Devices alone cannot reduce water consumption. It is the end user that utilizes these devices and as a result the reduction in consumption depends on the end

user. So the main barrier to water conservation is the social acceptability of water conservation measures.

- The implementation of a WDM program needs effort and resources by the utilities. Despite the benefits that a WDM program can provide utilities do not always choose this method for covering the demand. There are challenges that hinder the implementation of WDM.

  There is lack of educated and experienced staff that is not properly informed about the benefits of WDM. There is lack of a proper institutional organization. There is lack of appropriate legislation. There is lack of funds. There is difficulty in the decision of how much conservation is needed and there are not alternative technologies available locally.

- The researched town has enough water resources to cover the estimated demand for at least 15 years more. The utility is dependant on groundwater so there is a concern about possible future drop of the groundwater table due to excessive irrigation. There is also the possibility of pollution of the groundwater source. There is a problem of pressure reduction in the network due to high peaks in demand. These peaks usually happen in specific days and hours of the summer period. The drop in the pressure from the high peaks is very difficult to be solved technologically. It would need to resize the network or utilize pumps to raise the pressure. Both of these solutions have a high capital and operating cost. There is the opportunity for a WDM program to be implemented to solve this problem by reducing the peak demand.

- The utilities view in WDM is positive. The utility does not have a specific WDM program but applies partly some WDM measures. For example it tries to minimise losses from the network and it informs the consumers about water conservation.

- The limitations in applying a WDM in a town like Katerini agree partly with the findings from the literature review. The lack of expertise staff, the lack of institutional organization and the obsolete legislation make the implementation of WDM in a town like Katerini difficult.

- There are very positive results from the perceptions of Katerini about water conservation measures. It seems that consumers are very positive in saving water not just for environmental reasons but for the savings in financial resources. The barriers that do not let people save as much water as they are willing to are ignorance and habits. These can be overcome by education and advertising. Next steps could be retrofitting programs with economic incentives for low consumption. New alternative technologies like rainwater collection could also play important role in water conservation. But consumers demand from the utility to do its part by implementing a water loss management program.

- By combining all the findings we can conclude that Katerini has a potential for implementing a WDM program but there are limitations as well. The difficulty with the peaks in demand gives the opportunity to apply WDM to solve this problem.

  The success of a WDM program is very possible. The consumers are environmental aware and can appreciate the environmental benefits from a WDM program. There are also consumers that are willing to apply water conservation measures both for environmental and economic benefits. Even those who are not so positive in applying measures would maybe change their mind if economic incentives were given.

  The limitations as discussed previously are lack of expertise staff, lack of institutional organization and lack of appropriate legislation. There is also a limitation in applying alternative technologies like rainwater harvesting and greywater reuse. These technologies are not promoted by officials and are not widely available locally.

- It has to be noted that due to the short time of the research it was not possible to go into much detail. This study could be considered as a preliminary assessment of the situation in Katerini regarding WDM and WC. As a general conclusion it can be said that there is great potential for an implementation of a successful WDM program but further research is needed to go deeper into the problem.

- In this pat some recommendations can be made for future research. Similar studies to this can contribute as case studies in answering the question about the possibility of implementing WDM programs in small towns.

- Future research is also needed in the possibility of implementing alternative technologies in towns like Katerini. Are rainwater collection and grey water reuse feasible solutions for water conservation?

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7 APPENDICES

Ονομάζομαι Αραβίδης Αριστείδης. Είμαι φοιτητης στο πανεπιστήμιο του Loughborough της Μεγάλης Βρετανίας. Διενεργώ το παρακάτω ερωτηματολόγιο για την πτυχιακή εργασία μου. Σκοπός του ερωτηματολόγιου είναι να εκτιμήσει τις απόψεις των κατοίκων της Κατερίνης για την οικονομία νερού και το κατα πόσο διατίθενται να ακολουθήσουν τέτοια μέτρα.
Η συμπληρωση του ερωτηματολογίου δεν είναι υποχρεωτική, αλλά θα βοηθήσει την επιχείρηση ύδρευσης να εκτιμήσει τις απόψεις των κατοίκων για συγκεκριμένα θέματα και πιθανών να βελτιώσει τις υπηρεσίες της.
Οι πληροφορίες που θα προκύψουν απο το ερωτηματολόγιο θα χρησιμοποιηθούν μόνο για ακαδημαικούς σκοπούς. Επίσης το ερωτηματολόγιο ειναι ανώνυμο εμπιστευτικό και θα καταστραφεί μετά τη συμλήρωση της εργασίας. Ευχαριστώ για το χρόνο σας!
Παρακαλώ διαβάστε προσεκτικά τις ερωτήσεις και απαντήστε οσο πιο ειλικρινά μπορείτε στη δεξιά πλευρά της σελίδας, σημειώνοντας το κατάλληλο κουτί.

Ε1.Θεωρείται τη λειψυδρία σημαντικό περιβαλλοντικό πρόβλημα;	Ναι ☐	Οχι ☐	ιδιαίτερα Οχι ☐
Ε2. Πιστεύετε οτι ζείτε σε μια περιοχή που έχει πρόβλημα λειψυδρίας;	Ναι ☐	Οχι ☐	ιδιαίτερα Οχι ☐
Ε3. Πιστεύετε οτι προσωπικά, κάνετε κάτι για να εξοικονομήσεται νερό;	Ναι ☐	Οχι ☐	ιδιαίτερα Οχι ☐
Ε4. Πόσο συχνά κάνετε τα παρακάτω;	Πάντα	Μερικές φορές	Ποτέ
Πλύσιμο πιάτων στο νεροχύτη και οχι κατω απο τη βρύση	☐	☐	☐
Ντουζ αντί για μπάνιο	☐	☐	☐
Κλύσιμο βρύσης ενώ πλένετε τα δόντια σας	☐	☐	☐
Πλύσιμο αυτοκινήτου με κουβά αντι για λάστιχο	☐	☐	☐
Συλλογή και χρησιμοποίηση βρόχινου νερού για πότισμα ή πλύσιμο αυτοκινητου	☐	☐	☐
Επαναχρησιμοποίηση νερού απο πλύσιμο	☐	☐	☐
Κάτι άλλο που εξοικονομεί νερό			
Ε5.Αν απαντήσατε «ποτέ», σε κατι απο την παραπάνω ερώτηση ποιος ηταν ο κυριότερος λόγος;	Συνήθεια ☐	Απλά βαριέμα☐	Δε νομίζω οτι ειναι απαραίτητο☐
Ε6. Έχουν καποιες από τις ηλεκτρικές συσκευές που έχετε σπίτι σας (π.χ. πλυντήριο πιάτων/ ρούχων) προδιαγραφές χαμηλής κατανάλωσης νερού;	Ναι ☐	Οχι ☐	Δε γνωρίζω ☐
Ε7. Έχουν κάποιες απο τις συσκευές που βλέπετε δίπλα και έχετε στο σπίτι σας, προδιαγραφές χαμηλής κατανάλωσης νερού;	Καζανάκι ☐	Βρύσες☐	Κεφαλή ντουζ ☐ Αλλο .....
Ε8. Αν έχετε συσκευές με προδιαγρφές χαμηλής κατανάλωσης νερού σπίτι σας, ποιός ήταν ο κυριότερος λόγος για την επιλογή;	Οικολογία ☐	Οικονομία ☐	Απόδοση ☐
Ε9. Είστε διατεθειμένος να αλλάξετε το μπάνιο σας ή να αγοράσετε καινούριες συσκευές προκειμένου να εξοικονομήσετε νερό;	Ναι ☐	Ισως ☐	Οχι ☐
Ε10. Θα αλλάζατε γνώμη αν σας επιχορηγούσαν ή αν οι συσκευές αυτές εβγαζαν τα έξοδά τους μεσω του μειωμένου λογαριασμού νερού;	Ναι ☐	Ισως ☐	Οχι ☐
Ε11. Ειστε διατεθειμένοι να κάνετε κάτι παραπάνω για την εξοικονόμηση νερού;	Ναι ☐	Ισως ☐	Οχι ☐
Ε12. Θα χρησιμοποιούσατε βρόχινο νερό ή ανακυκλωμένο νερό για μη πόσιμες χρήσεις;	Ναι ☐	Ισως ☐	Οχι ☐
Ε13. Κατα τη γνώμη σας τι βήματα θα μπορούσε να κάνει η επιχείρηση ύδρευσης για να προωθήσει την εξοικονόμηση νερού;			
Ευχαριστώ και πάλι για το χρόνο σας!	Παρακαλώ υπογράψτε.....		

Appendix I Pilot questionnaire

My name is Aristeidis Aravidis. I am a student of Loughborough University, United Kingdom. As part of my MSc research project I am conducting the following survey. The purpose of this questionnaire is to asses the perception of the residents of Katerini of water conservation measures and their willingness to follow such measures. Answering this questionnaire is not compulsory, but it would help the utility to asses the perception of the residents about certain issues and possibly improve the services provided.
All information gathered from this questionnaire will be used for academic purposes only and will be presented only in analytical form. Furthermore it will remain anonymous, treated confidentially and be destroyed after the production of the final report.
Thank you for taking time to answer the questionnaire!

Please read carefully the question and answer as honestly as you can on the right side of the paper by ticking the appropriate box.

Q1. Do you consider water shortage as an important environmental issue?
Answers: Yes, Somewhat, Nat at all

Q2. Do you think that you live in an area where water shortage is a problem?
Answers: Yes, Somewhat, Nat at all

Q3. Do you think you do your bit to save water?
Answers: Yes, Somewhat, Nat at all

Q4. Please identify the frequency of doing the following water saving tasks:
-Wash dishes in a bowl/sink rather under tap
Answers: Every time, Sometimes, Never
- Take shower instead of bath
Answers: Every time, Sometimes, Never
-Close tap wile brushing your teeth
Answers: Every time, Sometimes, Never
-Wash car using a bucket instead of a hose
Answers: Every time, Sometimes, Never
-Collect and use rainwater for gardening or washing the car
Answers: Every time, Sometimes, Never
-Reuse washing water
Answers: Every time, Sometimes, Never
-Something else (Pease specify)……
Answers: Every time, Sometimes, Never

Q5. If you answered never in any of the above question's tasks what was the main reason?
Answers: Habit, Don't believe is necessary, Can't be bothered

Q6. Are there any water efficient electric appliances in your house?
Answers: Yes, No, I don't know

Q7. Are there any of the next appliances in your house water efficient?

Answers: Dual/low flush cistern, Spray taps, Shower head, Other (please specify)……

Q8. If you have some water efficient appliances in your house what was the reason for this selection?
Answers: Ecology, Economy, Performance

Q9. Are you willing to retrofit your bathroom or buy new appliances in order to save water?
Answers: Yes, Maybe, No

Q10. Would you change your mind if they were subsidized or if they covered their expenses through the water bill?
Answers: Yes, Maybe, No

Q11. Are you wiling to take more steps towards water conservation?
Answers: Yes, Maybe, No

Q12. Would you consider using rainwater or recycling greywater for non potable uses?
Answers: Yes, Maybe, No

Q13. In your view what steps could the utility take to promote water conservation?
Answers: (The answer was open on this question)

Thank you for answering!

Please sign

Appendix II Pilot questionnaire translation

Ερωτηματολόγιο

Ονομάζομαι Αραβίδης Αριστείδης. Είμαι φοιτητής στο πανεπιστήμιο του Loughborough της Μεγάλης Βρετανίας. Διενεργώ το παρακάτω ερωτηματολόγιο για την πτυχιακή εργασία μου. Σκοπός του ερωτηματολόγιου είναι να εκτιμήσει τις απόψεις των κατοίκων της Κατερίνης για την οικονομία νερού και το κατά πόσο διατίθενται να ακολουθήσουν τέτοια μέτρα.
Η συμπλήρωση του ερωτηματολογίου δεν είναι υποχρεωτική, αλλά θα βοηθήσει την επιχείρηση ύδρευσης να εκτιμήσει τις απόψεις των κατοίκων για συγκεκριμένα θέματα και πιθανών να βελτιώσει τις υπηρεσίες της.
Οι πληροφορίες που θα προκύψουν από το ερωτηματολόγιο θα χρησιμοποιηθούν μόνο για ακαδημαϊκούς σκοπούς. Επίσης το ερωτηματολόγιο είναι ανώνυμο εμπιστευτικό και θα καταστραφεί μετά τη συμπλήρωση της εργασίας. Ευχαριστώ για το χρόνο σας!

Παρακαλώ διαβάστε προσεκτικά τις ερωτήσεις και απαντήστε όσο πιο ειλικρινά μπορείτε στη δεξιά πλευρά της σελίδας, σημειώνοντας το κατάλληλο κουτί.

Ε1.Θεωρείται τη λειψυδρία σημαντικό περιβαλλοντικό πρόβλημα;	Ναι ☐	Όχι ιδιαίτερα ☐	Όχι ☐
Ε2. Πιστεύετε ότι ζείτε σε μια περιοχή που έχει πρόβλημα λειψυδρίας;	Ναι ☐	Όχι ιδιαίτερα ☐	Όχι ☐

Ε3. Πώς θα χαρακτηρίζατε τον εαυτό σας σε σχέση με την κατανάλωση νερού;

Σπάταλος ☐
Κανονικός ☐
Οικονομικός ☐

Ε4. Πόσο συχνά κάνετε τα παρακάτω;	Πάντα	Μερικές φορές	Ποτέ
Πλύσιμο πιάτων στο νεροχύτη και όχι κάτω από ανοιχτή βρύση	☐	☐	☐
Ντους αντί για γέμισμα μπανιέρας	☐	☐	☐
Κλείσιμο βρύσης ενώ πλένετε τα δόντια σας	☐	☐	☐
Πλύσιμο αυτοκινήτου με κουβά αντί για λάστιχο	☐	☐	☐
Συλλογή και χρησιμοποίηση βρόχινου νερού για πότισμα ή πλύσιμο αυτοκινήτου	☐	☐	☐
Επαναχρησιμοποίηση νερού από πλύσιμο	☐	☐	☐
Κάτι άλλο που εξοικονομεί νερό …….. …….....	☐	☐	☐

Ε5.Αν απαντήσατε «ποτέ», σε κάτι από την παραπάνω ερώτηση ποιος ήταν ο κυριότερος λόγος;

Συνήθεια ☐
Απλά βαριέμαι ☐
Δε νομίζω ότι είναι απαραίτητο ☐

Ε6. Έχουν κάποιες από τις παρακάτω συσκευές που έχετε σπίτι σας, προδιαγραφές χαμηλής κατανάλωσης νερού;	Ναι	Όχι	Δε γνωρίζω
Πλυντήριο πιάτων	☐	☐	☐
Πλυντήριο ρούχων	☐	☐	☐
Καζανάκι	☐	☐	☐
Βρύσες	☐	☐	☐
Κεφαλή ντους	☐	☐	☐
Άλλη συσκευή	☐	☐	☐

Ε7. Αν έχετε συσκευές με προδιαγραφές χαμηλής κατανάλωσης νερού σπίτι σας, ποιος ήταν ο κυριότερος λόγος για την επιλογή αυτή;

Οικολογία ☐
Οικονομία ☐
Απόδοση ☐

	Ναι	Ίσως	Όχι
Ε8. Είστε διατεθειμένος να αλλάξετε το μπάνιο σας ή να αγοράσετε καινούριες συσκευές προκειμένου να εξοικονομήσετε νερό;	☐	☐	☐
Ε9. Θα αλλάζατε γνώμη αν σας επιχορηγούσαν ή αν οι συσκευές αυτές έβγαζαν τα έξοδά τους μέσω του μειωμένου λογαριασμού νερού;	☐	☐	☐
Ε10. Είστε διατεθειμένοι να κάνετε κάτι παραπάνω για την εξοικονόμηση νερού;	☐	☐	☐
Ε11. Θα χρησιμοποιούσατε βρόχινο νερό ή ανακυκλωμένο νερό για μη πόσιμες χρήσεις;	☐	☐	☐

	Ναι	Όχι
Ε12. Ρυθμίζετε την κατανάλωση νερού σύμφωνα με το τιμολόγιο του;	☐	☐

Ε13. Κατά τη γνώμη σας τι βήματα θα μπορούσε να κάνει η επιχείρηση ύδρευσης για να προωθήσει την εξοικονόμηση νερού

……..……
……..……
……
……..……
……..

Ευχαριστώ και πάλι για το χρόνο σας!

Appendix III Final questionnaire

Questionnaire

My name is Aristeidis Aravidis. I am a student of Loughborough University, United Kingdom. As part of my MSc research project I am conducting the following survey. The purpose of this questionnaire is to asses the perception of the residents of Katerini of water conservation measures and their willingness to follow such measures. Answering this questionnaire is not compulsory, but it would help the utility to asses the perception of the residents about certain issues and possibly improve the services provided.
All information gathered from this questionnaire will be used for academic purposes only and will be presented only in analytical form. Furthermore it will remain anonymous, treated confidentially and be destroyed after the production of the final report.
Thank you for taking time to answer the questionnaire!

Please read carefully the question and answer as honestly as you can on the right side of the paper by ticking the appropriate box.

Q1. Do you consider water shortage an important environmental problem?
Answers: Yes, Not particularly, Not at all

Q2. Do you think you live in an area where water shortage is a problem?
Answers: Yes, Not particularly, Not at all

Q3. How would you describe yourself regarding water use?
Answers: Wasteful, Normal, Conservative

Q4. How often do you do the following tasks?
--Wash dishes in a bowl/sink rather under tap
Answers: Every time, Sometimes, Never
- Take shower instead of bath
Answers: Every time, Sometimes, Never
-Close tap wile brushing your teeth
Answers: Every time, Sometimes, Never
-Wash car using a bucket instead of a hose
Answers: Every time, Sometimes, Never
-Collect and use rainwater for gardening or washing the car
Answers: Every time, Sometimes, Never
-Reuse washing water
Answers: Every time, Sometimes, Never
-Something else (Pease specify)……
Answers: Every time, Sometimes, Never

Q5. If you answered never in any of the above question's tasks what was the main reason?
Answers: Habit, Don't believe is necessary, Can't be bothered

Q6. Do some of the following appliances that you have in your place, have water efficiency standards?
-Washing machine
Answers: Yes, No, I don't know

-Dish washing machine
Answers: Yes, No, I don't know
-Cistern
Answers: Yes, No, I don't know
-Taps
Answers: Yes, No, I don't know
-Shower head
Answers: Yes, No, I don't know
-Something else (please specify)……..
Answers: Yes, No, I don't know

Q7. If you have appliances with water efficiency standards what was the main reason for this selection?
Answers: Ecology, Economy, Performance

Q8. Are you willing to retrofit your bathroom or buy new appliances in order to save water?
Answers: Yes, Maybe, No

Q9. Would you change your mind if they were subsidized or if they covered their expenses through the water bill?
Answers: Yes, Maybe, No

Q10. Are you wiling to take more steps towards water conservation?
Answers: Yes, Maybe, No

Q11. Would you consider using rainwater or recycling greywater for non potable uses?
Answers: Yes, Maybe, No

Q12. Are you adjusting water use according to its price and tariff?
Answers: Yes, No

Q13. In your view what steps could the utility take to promote water conservation?
Answers: (The answer was open on this question)

Thank you for answering!

Appendix IV Final questionnaire translation

Q1. Do you consider water shortage an important environmental problem?
Answers: Yes (78), Not particularly (1), Not at all (1), Total (80)

Q2. Do you think you live in an area where water shortage is a problem?
Answers: Yes (20), Not particularly (37), Not at all (23), Total (80)

Q3. How would you describe yourself regarding water use?
Answers: Wasteful (18), Normal (52), Conservative (10), Total (80)

Q4. How often do you do the following tasks?
--Wash dishes in a bowl/sink rather under tap
Answers: Every time (15), Sometimes (28), Never (37), Total (80)
- Take shower instead of bath
Answers: Every time (67), Sometimes (9), Never (4), Total (80)
-Close tap wile brushing your teeth
Answers: Every time (42), Sometimes (27), Never (11), Total (80)
-Wash car using a bucket instead of a hose
Answers: Every time (14), Sometimes (27), Never (39), Total (80)
-Collect and use rainwater for gardening or washing the car
Answers: Every time (0), Sometimes (10), Never (70), Total (80)
-Reuse washing water
Answers: Every time (0), Sometimes (15), Never (65), Total (80)
-Something else (Pease specify)……
Answers: Every time, Sometimes, Never

Q5. If you answered never in any of the above question's tasks what was the main reason?
Answers: Habit (56), Don't believe is necessary (12), Can't be bothered (9), Total (77)

Q6. Do some of the following appliances that you have in your place, have water efficiency standards?
-Washing machine
Answers: Yes (28), No (17), I don't know (31), Total (76)
-Dish washing machine
Answers: Yes (35), No (9), I don't know (36), Total (80)
-Cistern
Answers: Yes (22), No (34), I don't know (24), Total (80)
-Taps
Answers: Yes (16), No (39), I don't know (25), Total (80)
-Shower head
Answers: Yes (36), No (24), I don't know (20)
-Something else (please specify)……..
Answers: Yes, No, I don't know

Q7. If you have appliances with water efficiency standards what was the main reason for this selection?
Answers: Ecology (18), Economy (37), Performance (7), Total (62)

Q8. Are you willing to retrofit your bathroom or buy new appliances in order to save water?

Answers: Yes (20), Maybe (38), No (22), Total (80)

Q9. Would you change your mind if they were subsidized or if they covered their expenses through the water bill?
Answers: Yes (45), Maybe (14), No (1), Total (60)

Q10. Are you wiling to take more steps towards water conservation?
Answers: Yes (53), Maybe (20), No (7), Total (80)

Q11. Would you consider using rainwater or recycling greywater for non potable uses?
Answers: Yes (45), Maybe (21), No (14), Total (80)

Q12. Are you adjusting water use according to its price and tariff?
Answers: Yes (25), No (55), Total (80)

Q13. In your view what steps could the utility take to promote water conservation?
Answers: (The answer was open on this question) Answered (58), Did not answer (22), Total (80)
After categorizing
Incentives for low consumption (15), Water losses management by the utility (3), Subsidies for water efficient appliances (5), Informing and education by the utility (35), Recycling wastewater by the utility (4), Rainwater (7), Other sources (3), Total (72)

Appendix V Data transfer answer sheet

Appendix VI Vrontou boreholes pumps characteristics

Borehole	Diameter (inches)	Max flow (m^3/h)	Motor power (HP)
A	14	340	190
B	14	430	260
C	14	340	190
D	14	430	260

Appendix VII Peleka's Boreholes pumps characteristics

Borehole	Diameter (inches)	Max flow (m^3/h)	Motor power (HP)
A	8	80	40
B	8	80	40
C	8	80	40

Transcript of interview with General director of MWSEK Mr Elias Zamanhs

Question: Do you think there is a water shortage problem in the area?

Reply: For now water is of adequate quantity to cover the needs of Katerini's population.

Q: What do you think about the sustainability of the water sources that the utility uses to cover demand?

R: The utility relies in groundwater only. The sources of the utility are boreholes and protected springs. These sources have variations in the groundwater table from season

to season. This is mainly due to the over drawing of water by the agriculture needs, especially during the summer. During the summer the demand is bigger and rainfall is less so groundwater is not renewed and the table level falls. But this effect is just temporary and later the water level returns to its usual levels. The main water source of the utility is at the foothills of mountain Olympus where water is plenty.

In some of the auxiliary sources the effect might be stronger but these sources are only used to cover local needs.

So in my opinion there is no problem in the short term. But in the future with increasing demand and possible pollution of the groundwater there might be a problem and other sources of water will have t be searched.

Q: So the needs in water can be covered regarding quantity. What about the peaks in demand? Is there a problem?

R: It is possible that a drop of pressure in the network occurs. This is due to the extremely high peaks in demand especially in the summer and specific days and hours of the day.

Q: Does the utility do something about this problem?

R: The utility informs the consumers about the possibility of pressure drop and encourages them not to use water for unnecessary uses. But the problem is researched and we try to solve the problem in a technical way as well.

Q: What about the losses from the network? Is something done about that?

R: Apart from the unavoidable losses, that the utility cannot do anything, we try to repair as quickly as possible any visible leaks. However we have estimated that the UFW is approximately 35% which is similar to same size utilities.

Q: Is there an issue with illegal connections to the network and if yes how is this dealt with?

R: Illegal connections are not a big issue for our utility. There are very few illegal connections and we are trying to eliminate them by convictions to the court.

Q: What is the pricing policy of the utility?

R: The utility is charging water by a rising block tariff. The charge €/m^3 is rising according to the consumption. This way we try to promote water conservation.

Q: What is the situation regarding the regulation, legislation and institutions that are responsible for water?

R: AS we speak the governmental bodies that are responsible for water are: ministry of agriculture, ministry of development, ministry of Environment urban planning and public projects, prefectures, municipalities, institute of geology and mineral exploration, local institutes of land reclamation Universities, individuals and dozens of other services and institutions. There is no communication and coordination and they function in a competitive and contradictory way.

There is an ambiguous and nearly chaotic situation regarding management and as a result there are conflicts for the use of specific water resources.

As for legislation there is a vague situation. There is a main law that was never applied as a whole because several Presidential orders were not published. There also several other laws about water without cohesion and uniform approach. The directive by the European Union about water 2000/60 EU will have to be applied but there is not compliance with the main law. There are also many directives from the EU. A coding is needed especially in pollution issues. There is much space for improvements in the water laws.

Q: Does the utility promote water conservation to the consumers this period?

R: The utility publishes to the local press ads that promote water conservation from time to time.

Q: Do you think something more should be done on this matter? And if yes what would that be?

R: Water is the most valuable natural resource so water conservation can be seen only as a positive thing. Apart from the environmental benefits there are financial benefits for the utility from the reduction in operating costs. There are some possible measures like the promotion of water efficient appliances or the reconstruction of the water tariff. There is also the option of reusing the treated water from the wastewater treatment plant.

There are technologies that can be used for water conservation but they are not widespread. More research is needed and pilot implementations so the benefits and the costs will be more obvious. This way the acceptability by the consumers of such measures will be discovered.

The utility is willing to adopt such measures in its program. But coordination is needed by a responsible institution. A general board should be responsible for the water issues nationally. So a national water policy will be able to be designed and implemented.

Q: In your opinion what other measures could be implemented for Water Demand Management by the utility?

R: There is an option for the reduction of UFW. The utility is thinking of implementing a Water loss Management program. It is considering ways of repairing non visible leaks by special leak detection equipment.

The utility is also considering of installing meters to the water sources so it will have a better view on water losses and manage them in a more effective way.

Q: In your opinion, which are the limitations to implementing Water Demand Management programs in utilities with similar characteristics as yours?

R: I believe that currently managers of such utilities are overloaded with supervisory and administrative responsibilities and they cannot focus on more important issues like setting goals and objectives for the utility.

There is also a lack of expertise staff in utilities. There are always new trends and research in the sector and we cannot stay informed. Consultants are necessary to inform us for solutions for a more efficient and environmental friendly operation of the utility.

Finally there is not a single institution that is responsible for the water sector and this results in a chaotic situation. More coordination is needed. A national water policy is essential for the encouragement of implementing WDM measures.

Q: Do you have something to add?

R: I believe that the problem is not technical. There are the technological solutions to help in WDM. But the problem is in governance. Without the proper coordination and

Appendix VIII Transcript of interview with General Director of MWSEK Mr Elias Zamanhs