

# Water demand and rates policy in provincial cities in Greece

M. Gratziou, M. Andreadaki, M. Tsalkatidou

Democritus University of Thrace, School of Engineering, Department of Civil Engineering, Xanthi, 67100, Greece

**Abstract:** This paper explores several social parameters that contribute in the formation of water rates policy in Greece and analyzes the impact on water demand by the application of different tariffs. The water demand function is estimated, based on the financial theory of water demand, in regions with different economic and cultural characteristics correlating water consumption to consumers' income, type of residence and their cultural identity. Seasonal variations in water demand for each consumer category are calculated and the elasticity of water demand is estimated in relation to the price. The behavior of several provincial cities in Greece is compared. This research was based mainly on data of the last 12 years collected from the archives of the Water Supply and Drainage Boroughs (WSDB) of various provincial cities in Greece, on the collection of questionnaires and on data from the Greek bibliography.

**Key words:** Urban water, demand forecast, pricing policy

## 1. INTRODUCTION

Two discernible dimensions exist in water management: i) the physical, that refers to water supply and its availability, and ii) the socioeconomic, referring to the social and economic conditions, activities and factors that form water demand. Our paper focuses on the latter and we estimate water demand in Greek cities based on the financial water demand theory. The impact on water demand by the application of different tariffs is also analyzed for consumers' of varied economic status.

## 2. WATER DEMAND ESTIMATION

### 2.1 Demand categories

Water demand is typified by several decisive interactive factors that differentiate according to its usage, namely household/domestic, industrial and commercial, agricultural or by public complexes.

The financial theory of water demand considers water as: i) *a final good*, that is being pursued self-righteously, its demand being a final demand and its user being the consumer, or ii) *an input to the production* of another good or service, its demand being a derived demand, partly depending on the demand of the produced goods and of the applied technology for goods production, and its user being the producer. In the first case demand is affected by the preferences of the consumers or the preference of water instead of other products and is a utility function, whereas in the second case water demand is a production function. The different characteristics of the utility function and the production function can affect the observed water demand by the consumers or the producers. Based on these two economic categories, domestic use is considered as final demand by the consumers, while industrial and even more so commercial, agricultural and public use are treated as derived demand by the producers (Baumann *et al.*, 1998).

## 2.2 Urban water demand categories

In a provincial municipality, water usage falls within the following categories: residential, professional (stores, offices, restaurants, hotels etc), by public complexes (schools, hospitals and offices), by public services (parks and fields irrigation, fire fighting, streets and waste bins cleaning), industrial (industries within city limits) and agricultural (tillage within city limits). The greatest proportion of good quality urban water is consumed domestically.

Water demand for every usage category, for a given region and a particular time span, is expressed by the number of users and the average percentage of usage that is determined by a set of explanatory variables, different for each field. When estimating the total quantity of the used water, one should also consider among the remaining consumptions, water lost due to leakage of the distribution system.

### 2.2.1 Household use of urban water

The explanatory variables, that determine the percentage of water usage in the domestic field, include the consumer's income, the price of water, the size and type of residence (detached houses or block of flats), the housing density, the climate (temperature, rainfalls etc), the quality of the provided water, peoples' habits (personal hygiene, domestic and car washing etc), or even the characteristics of the existing appliances.

Domestic use of water can be indoor or outdoor. Indoor water use depends mainly on the residents' habits and the type of the appliances utilized, while outdoor water use is mainly related to the size of the space, its style and the climate. For a given type of tillage, the irrigation demands per m<sup>2</sup> can vary depending on soil type, terrain slope, amount and type of watering, air temperature, and other factors such as different knowledge, attention and care (Kiefer and Dziegielewski, 1991). Although outdoor use represents only a third of the total domestic use (Davis *et al.*, 1996), it is more important than indoor use as a source of variation in space and time.

Another decisive factor in domestic water demand is the age of the plumbing installation in the building and the personality of the user, elements that affect the frequency of breakdowns-leakages and their timely restitution.

### 2.2.2 Industrial use of urban water

Industrial use of water represents a typical example of demand created by a producer for inflow and varies greatly for every industry. In provincial Greek cities, the industries that use the biggest amount of water (i.e. fresh water inflow) are food, beverage, paper production and chemical substances industries. Industries differ in every urban area therefore the total industrial water demand can vary greatly in different cities. The majority of (small) industries are in possession of their own wells and many of them recycle water, so that their consumption of urban water refers only their need for high quality water. A distorted distribution of water consumption is noticed, if one compares the several industries that are located within urban areas. On the contrary, even though water consumption varies greatly in populated areas, its distribution is far less distorted in comparison to that of small industries. Commercial- professional and other uses almost end up between urban and industrial use (Baumann *et al.*, 1998).

## 2.3. Urban water use forecast

Urban water use and household use in particular grows every year due to the ever growing population and constantly improving living standards of the consumers. Based on prior demand and the climatic and socio-economic parameters of past and present conditions, we can predict future water demand. It should be noted however, that industrial use of water greatly changed within the

last 30 years. Water demand in this sector, in contrast to the residential sector, exhibited an impressive drop, not only in relation to the output volume or to employment but also in absolute terms. The data predict that the downward trend in water consumption for industrial purposes will continue, possibly at a lower rate (Baumann *et al.*, 1998).

To estimate water demand for urban use, econometric equations, adjusted to the financial water demand theory, are used. The prediction methods are classified according to the way they explain the past use of water as:

- i) Time extrapolation model (much too simplistic for virtually any application),
- ii) Bivariate models (linear form or per capita requirements method or unit use coefficient method),
- iii) Multivariate models (linear or log-linear),
- iv) Multivariate requirements models This approach reduces the degree of subjectivity in the analysis, but the major disadvantage is the fact that the model reflects on the correlation between the variables rather than causation. The model may not be robust over time, cannot be replicated in the future and there is a risk of incorporating correlations, which may appear in the data (Bolland, 1993).
- v) Econometric demand models describing the true economic demand for water. They include one or more variables representing the price and the tariff structure. They may also include a variable that describes the income of water user or ability/intent to pay. An econometric demand model is IWR-MAIN, a complicated method of water demand. The major disadvantage of these models is that one must use appropriate personal data.

If the sectors are small, and/or is difficult to collect the data, and/or the data collection is costly and time-consuming, the simple bivariate model may be the best compromise.

### 3. URBAN WATER SUPPLY IN GREECE

#### 3.1 Urban water supply mechanisms

In Greece, the responsibility for supplying urban water and disposing of urban wastewater rests, mainly, with municipalities. Private sector generally provides just bottled water.

Water supply-drainage of the population in Greek provincial cities is realized by legal person private law companies that belong to the local administration, but operate autonomously. Clean water supply and the wastewater treatment and disposal operations are administrated separately but belong to the same borough. Water supply companies of three major Greek cities (Athens, Thessalonica and Volos) are the only ones under special status quo, operating as joint-stock companies. Two of these are in the Greek stock market.

Every Water Supply and Drainage Borough (WSDB) aims at providing proper and integrated services to its consumers and is responsible for water quality, timely interventions in cases of droughts, maintaining the water supply and drainage network, expanding the network etc.

The urban water provision mechanism is described in the following figure (Figure 1) showing the relation between the user/consumer, the borough proving the 'good' and the regulator of the process. In most cases the regulator is the Mayor and the City Council. Usually the user pays the due directly to the water supply company. In some cases, the WSDB receives the payment through the regulator.

Every house, flat and professional or industrial unit is supplied with a hydrometer to measure the urban water consumption. The hydrometer readings are regularly registered, although not every WSDB registers the readings with the same frequency each year (they are done either bimonthly, or once per trimester or even once every four months; rates are collected accordingly). No hydrometers are in place to register water use in a few agricultural municipalities, meaning that the rates are constant and independent of water consumption.

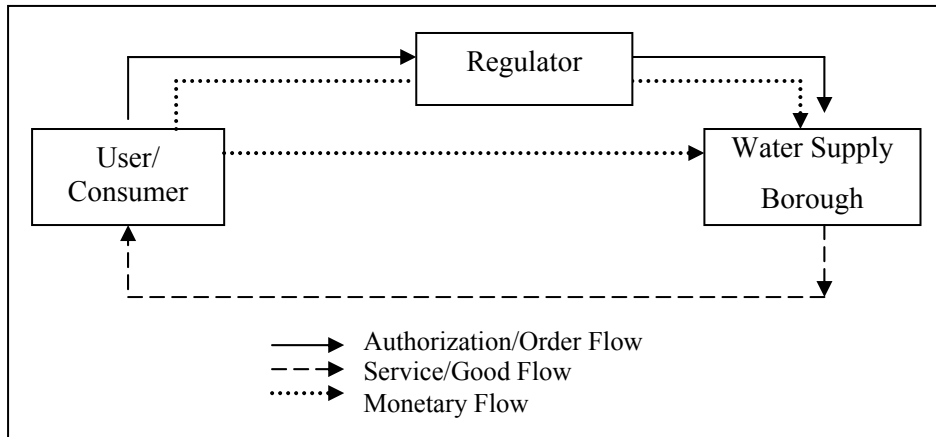


Figure 1. Urban water supply mechanism. Relation between user, borough and regulator.

### 3.2 Urban water pricing- Rates policy

Besides being alert when facing technical issues, WSDBs, like all enterprises, should secure their incomings to be financially viable. That means implementing policies that ensure replenishment and water quality to satisfy the consumers as well as the financial resources to ensure their viability in accordance to the principles of viable management for water resources conservation.

Until today, in most of the Greek WSDBs no policy for the utilization of the economic methods aiming at viable management has been implemented and also there have been no coordinated efforts for urban water cost accounting according to its real and full economic value.

Every WSDB determines its own rates policy. Their incomings are mainly from charging their clients (revenue bonds) and partly from state subsidies. Rates can differ according to use, year and municipality. Rate types can be either uniform, i.e. irrespective of the user type, or according to the user type. In the latter case they can be categorized as household/ domestic, professional, industrial and agricultural. As an example we can mention two neighboring cities of similar size in Northern Greece, Komotini where till today a uniform rate is applied and Xanthi where from 1992 rates were determined according to use type (domestic or industrial), and since 2002 separate professional and agricultural rates were formed (Gratziou and Andreadaki, 2005).

Rate types can be distinguished by including or not the drainage and wastewater treatment rates in their charges. In Xanthi for example there are regions where no drainage network is in place or where wastewater is not treated (Figure 2) resulting in different rates (Andreadaki, 2004).

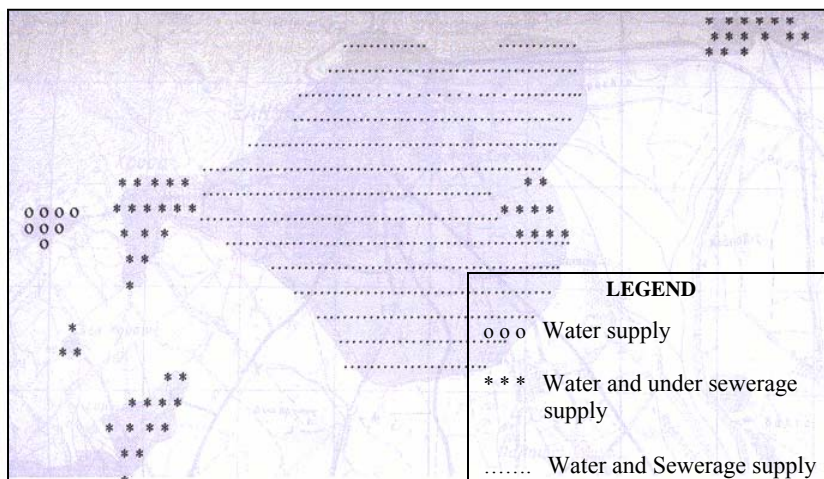


Figure 2. Types of water rates according to the drainage provided in Xanthi.

The rate structures usually preferred by the Greek WSDBs are: i) one-time charge (when new customers are connected to the water system) and a monthly flat charge, irrespective of the consumption. This charge is preferred by very small mainly agricultural municipalities, ii) one-time charge, flat charge and uniform –rate variable charge combination, iii) one-time charge and scale tariffs with decreasing-block rates combination, iv) one-time charge and scale tariffs with increasing-block rates combination, and v) a combination of cases iii) and iv).

Block numbers can vary. For example the Xanthi WSDB between 1992-1995 used an urban water rate with 5 blocks and an increasing scale, between 1996-1998 a 7 blocks rate with decreasing scale up to 50m<sup>3</sup> while for greater consumptions the scale became increasing, for the years 1999-2002 had 3 blocks with increasing scale, whereas today it uses 4 blocks with increasing scale.

Certain WSDB choose from time to time, especially during dry seasons (e.g. Thessalonica 1988-1991), seasonal rates with increased prices for the summer months as a water policy measure for consumption control and water saving.

Special rates such as life-line rates, which offer low-income customers some initial quantity for use at a reduced price, are not applied in Greece. The only cases that have been highlighted are those of oil refinement industries; special contracts grant them lower water rates (Mentes, 2001).

## 4. URBAN WATER DEMAND IN GREECE

### *4.1 Description of the research procedure*

Our study for water demand estimation in Greek cities consists of two sections. The first focuses on consumptions and the other on registering users' satisfaction by the provided services from the WSDBs and exploring their intention towards a change of current rates policy. Data collection in the first case was mainly realized by accessing the consumption and rates WSDB archives while for the second case we relied on questionnaires addressed to a random sample and literature data.

#### *4.1.1 Consumptions*

Total urban water use can be described by time, spatial and sector coefficients. Water demand for each sector at a given area and time period is estimated, as mentioned previously, based on the number of users and the average percentage of water use as it is determined by a set of explanatory variables that in the domestic sector include user's income, water price, residence type, housing density, air temperature and rainfalls.

Data from 4 typical provincial Greek continental cities were collected. For each year the seasonal consumption data and the number of hydrometers were registered. Data were registered for at least the last decade, for users as a whole and separately for each use category i.e. agricultural, domestic, industrial and professional, whenever separate rates are applied.

Domestic use can be divided in water use by detached houses and flats. These two types of housing generally differ in water use due to financial and demographical reasons. An important difference is the outdoor space that is very restricted in blocks of flats; usually an administrator is responsible for the maintenance of the whole block (watering included). Demographically, flats are related with smaller families, although it is exactly the opposite in low income areas where large families live in one apartment. International literature reports that apartment residents usually use fewer water consuming appliances when compared to people living in detached houses (Williams and Byung, 1986), but we cannot claim the same for the case of Greece.

The financial characteristics of the user and the selling price of the water are also directly related with water demand. The economic approach treats the per capita water consumption as a behavior phenomenon, which is represented by a water demand function for users of a restricted budget. So the cities were divided in sectors based on the building characteristics (detached houses– blocks of

flats) and the socioeconomic status of the residents (neighborhoods or relatively high, average and relatively low income, ROM neighborhoods). Obviously no great economic differences exist among the population in provincial Greek cities. The cities of Xanthi and Komotini have some neighborhoods with predominantly Christian or Muslim population. These neighborhoods were examined separately in order to study whether there were any differences in water demand that possibly resulted from different cultural habits. Consumption data were collected from the WSDB archives per sector/neighborhood for every year and season.

At this stage of our research we did not manage to collect complete and accurate data of the monthly rainfalls and temperatures, for a precise relation between water consumption and these parameters to be established. Based on the Köppen ranking the climate of the region can be described as ‘Mediterranean or Mesothermal climate’ with warm and dry summers (Anestis *et al.*, 2005).

#### 4.1.2 Tariffs

The scale of tariffs applied each year was registered and the average water price was estimated by:

$$p = \frac{[r_1 q_1 + r_2 (q_2 - q_1) + r_{i+1} (q_{i+1} - q_i) + \dots + r_j (Q - q_{j-1})]}{Q} \quad (1)$$

where:

$r_i$  = the block  $i$  price

$q_i$  =  $m^3$  correspondent to block  $i$

$p$  = average price of water

$Q$  = total quantity of water consumption

Consumption and the average price were compared for each sector and consumer type. When practicing economic policy it is useful to know the size of the change in water demand corresponding to a change in its price, so price elasticity of demand,  $\epsilon$ , was calculated.

$$\epsilon = \frac{\Delta Q}{\Delta P} \cdot \frac{\frac{(P_1 + P_2)}{2}}{\frac{(Q_1 + Q_2)}{2}} \quad (2)$$

where:

$Q_1$  = quantity of water consumed at a price  $P_1$

$Q_2$  = quantity of water consumed at a lower price  $P_2$

$\Delta P = P_1 - P_2$

$\Delta Q = Q_2 - Q_1$

The action against inflection of the water prices was based on the consumer’s price index.

#### 4.1.3 Questionnaires

Questionnaires research focused on the household use of urban water. The procedure took place during the years 2003, 2004 and 2005. Residents from the municipalities of Xanthi, Komotini, Alexandroupolis and Ioannina were interviewed. The cities were divided in sectors according to the type of residence (block of flats- detached houses) and the economic and cultural status of the residents. In each sector 50 questionnaires were completed by door to door personal interview based

on the printed questionnaire. The sample was randomly selected and it was considered representative.

The questionnaire variables can be classified as qualitative and quantitative. The questionnaire consisted of 20 questions. At the beginning the characteristics of the sample are defined (i.e. region and type of house, income, education of the surveyed, number of people living together). These are followed by questions about their consumption habits and the uses of water, e.g. whether there is a dishwasher or a washing machine in the house and their size, how often these devices are used, how often they have a shower or a bath, whether they leave the tap open while having a shower/bath, how often they water their garden, whether they wash their car at home etc.

The questionnaire includes questions regarding the state and age of the plumbing installations in their houses, whether they experienced any breakdowns and their frequency (e.g. in the hydrometer or water-closet). There are questions examining their quality of life and also their satisfaction of the water quality and the services provided by the WSDB. We registered the will of the citizens to be surcharged in order for the water quality and services to improve, and their opinion towards rates policy (i.e. tariff rates and structure).

Finally, a group of questions was about the way user self-definition towards water economy (e.g. wasteful or normal use, regulating consumption based on water rates). The questionnaire followed the guidelines of studies realized by other researchers for different cities (Mentes, 2001; Fafoutis *et al.*, 2005; Kolokitha *et al.*, 2005; Milopoulos *et al.*, 2005). This way the questionnaire becomes comparable and we can draw statistical conclusions regarding the habits of the Greek citizens and their opinions about urban water policy matters.

Two questions that existed at the beginning of the research were later removed. One was about the name at which the bill was registered and the second referred to the change in number of the family members throughout the duration of the study. These questions aimed at controlling the individual bills of the people in question, as they were registered in the WSDB, in order for the results to be comparable regarding their self-definition towards water economy. There was a negative reaction among the surveyed citing personal data protection and therefore the idea was abandoned.

## **4.2 Survey results**

### **4.2.1 Consumptions**

Data analysis lead us to the conclusion that in Greek provincial cities the biggest water consumption is that of the domestic sector accounting for over 80% (as registered by the respective WSDB measurements) in the sample we studied. Between 8.5-9% is used by public complexes (hospitals, educational institutions, other services). Water for professional use is around 6-7%, while for industrial and other/remaining uses it is less than 4%. In Thessalonica (the second biggest city in Greece) based on information from the Water Supply and Drainage Company household water consumption comes close to 70%, professional use accounts for 8%, public use for 4%, while industry consumes around 18% (Mentes, 2001).

For domestic use, per capita water consumption is generally lower in blocks of flats in comparison to detached houses (Figure 3). Based on our records the typical daily water use for domestic purposes was 0.45m<sup>3</sup> per house in detached houses and 0.32m<sup>3</sup> in flats. The per capita water use was estimated at 0.160m<sup>3</sup> and 0.114 m<sup>3</sup> respectively. In perspective it can be mentioned that in USA, the household water used daily during a typical year is as an average around 0.567m<sup>3</sup> per house for detached houses and 0.416m<sup>3</sup> for blocks of flats (Baumann *et al.*, 1998). The average daily consumption per inhabitant in a provincial city, ranged from 115L to 130L (Ioannina 124.9L, Xanthi 123.8L, Komotini 114.7L, Alexandroupolis 128.7L), whereas in Thessalonica it was reported as 170L (Mentes, 2001).

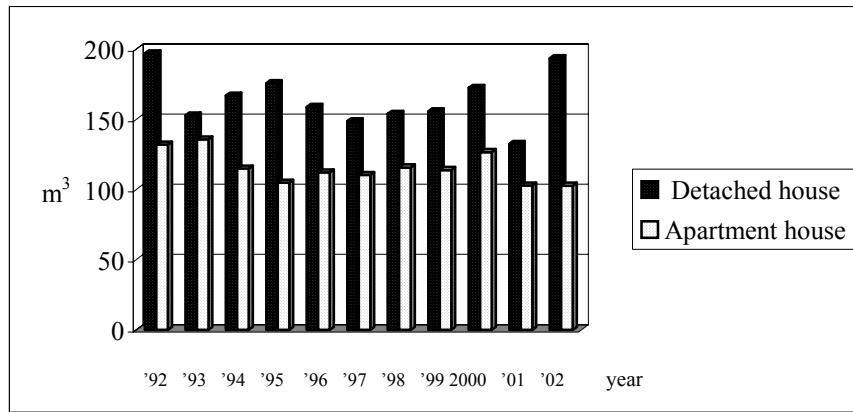


Figure 3. Annual water consumption per hydrometer in Xanthi.

The greatest consumptions were observed, as it was expected, during the summer period, and they were especially high in the detached houses regions, obviously due to more frequent gardens' watering (Figure 4).

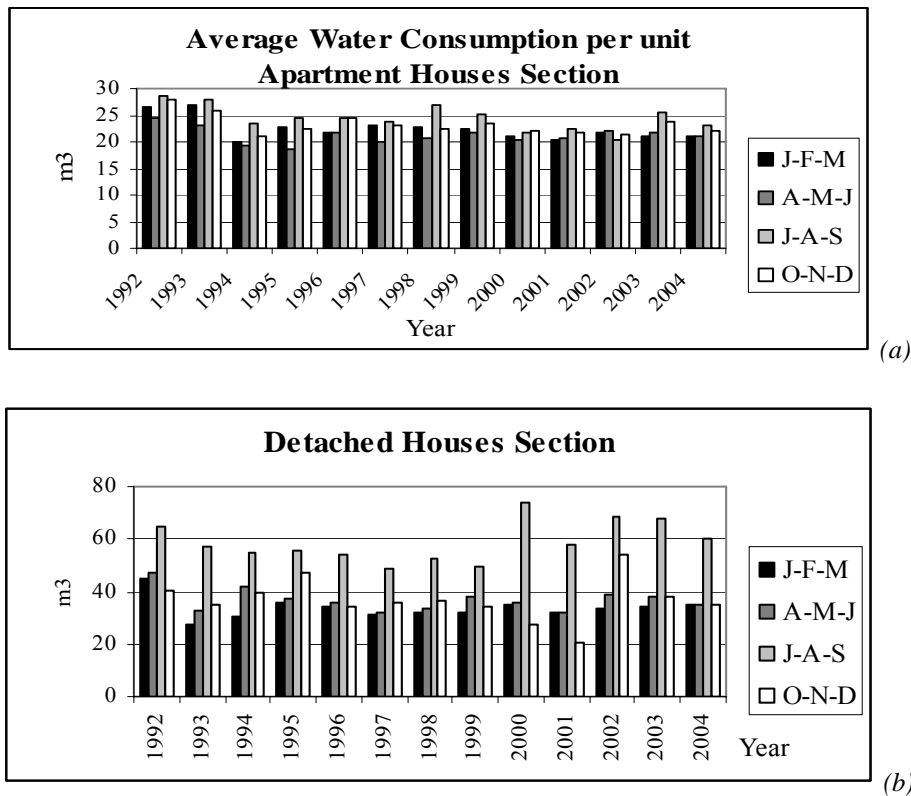


Figure 4. Seasonal fluctuation of the average water consumption a) blocks of flats and b) detached houses.

The greatest water demand in Komotini (Figure 5) and in Ioannina was observed from March till June. During the hot months of July and August water consumption decreased. This can be explained by the fact that a noticeable number of students, living in these cities, is away for the summer vacations as is the case for several inhabitants too.

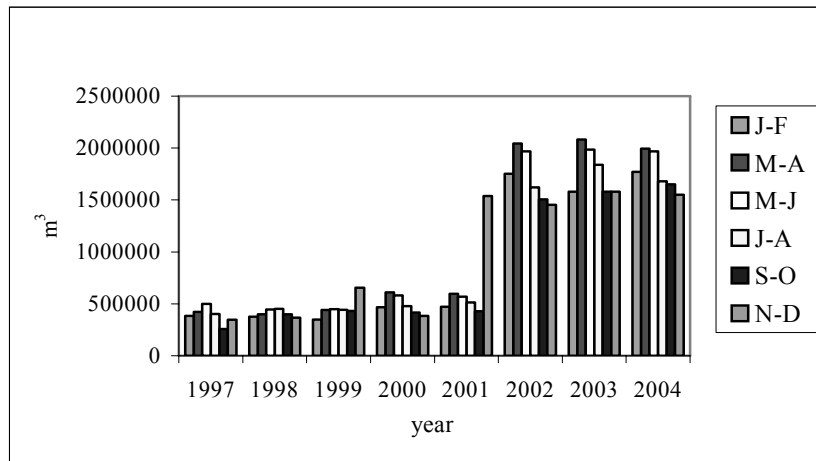


Figure 5. Seasonal variation of the average water demand in Komotini.

The surplus in water demand during the summer period is given by:

$$\Delta Q = 0.8778 Q - 6090 \text{ m}^3 \quad (3)$$

where

$Q$  = the urban water consumption during the winter period,  $\text{m}^3$ .

Water consumption is related to the type of building and the economic-living standards of the residents. Table 1 presents the average annual consumption per house for regions of diverse building types and economic-living standards.

Table 1. Average annual water consumption per house/ hydrometer

Building type Income	Detached houses			Blocks of flats
	Relatively high	Average	Low	Average
Average annual water consumption ( $\text{m}^3$ )	165	143	97	126

For higher incomes, the average daily water consumption is 160L per capita, while for the weaker economic classes (ROM) it is only 66L. Average incomes consume daily an average of 136.5L per capita in detached houses and 120L per capita in flats. The annual water consumption for outdoors use in detached houses accounts for almost 12% of the annual total consumption. No differences in consumption were observed between Muslim and Christian population.

#### 4.2.2 Pricing- Water price elasticity demand

At this point we will attempt to analyze the way bills are registered in the archives of the Companies. Each year is divided in 4 trimesters or 6 bimonthly periods. By the end of each trimester or bimonthly period an issue of the personal consumption bills is compiled. This issue consists of 'books', where the bills per sub region are registered, according to the provided services, the type of use and the spatial distribution. At the end of each 'book', total consumptions and the respective trimester/bimonthly charges for the sub region in question are registered.

Some cities apply a uniform rate charge, irrespective of use, and others use separate rates for residential, professional, industrial and agricultural use. Nowadays rates structure in the studied areas is one-time charge and increasing-block rates. At certain times a combination of increasing and decreasing-block rates was chosen. The number of blocks, their consumption limit and their corresponding water price differs for every city, year and rate type. It should be noted that domestic

use water, when separate rates are used, has the lowest rate while industrial water the highest (up to 88.5% more expensive than domestic water and 30% more than professional rates).

The increase in water tariffs generally resulted in a decrease in demand (Figure 6). This cutback in demand was more evident in regions with lower income residents. Every time water prices increased, consumption dropped, initially, by around 8.5% for the financially disadvantaged classes while during the latest increases consumption dropped only by 3%. The water price increase did not affect high income consumers.

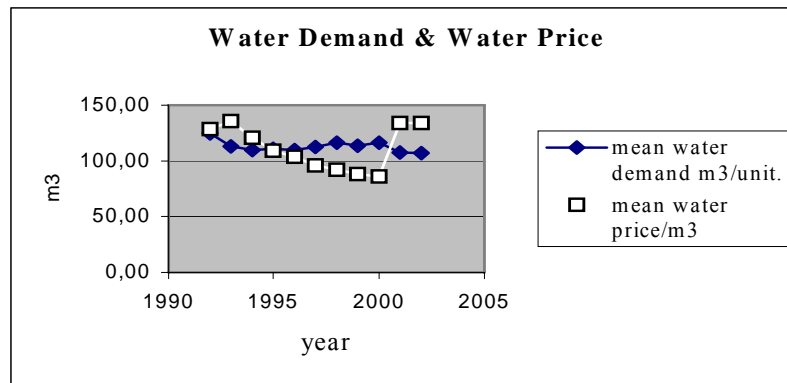


Figure 6. Change in the average annual water demand per hydrometer in conjunction to the average water price per  $m^3$ .

Our inquiry concluded that, in the Greek provincial cities where the research was conducted, water demand was elastic up until a few years ago ( $|\text{Water price elasticity demand}| > 1$ ), whereas recently it became inelastic ( $|\text{Water price elasticity demand}| < 1$ ) with elasticity ranging from -0.55 to -0.24. During the last decade, WSDB policy resulted in an average annual reduction of water consumption for household purposes by 35-40%. We cannot estimate however whether this reduction should be attributed exclusively to water rates or to the improvement of the hydraulic installations or perhaps even in the greater awareness on water preserving issues. Water demand for industrial purposes was also inelastic with an elasticity of -0.33. Babin *et al.* (1982) reported the water elasticity demand of the USA industry in 1972 as -0.56. (Baumann *et al.*, 1998)

#### 4.2.3 Social dimensions of water demand management

Questionnaires processing provides us with information regarding consumers' behavior and tendencies towards water policy issues. We believe that this record serves in the assessment of the social constituents that enter into water policy.

70% of the surveyed consider water rates expensive and only 23% believe that by increasing water rates, per capita demand will decrease. 79% stated that water rates don't determine the water they consume and 75.5% of the sample, meaning 3 out of 4 consumers, indicated that a cutback in water consumption will reflect upon their quality of life. This percentage opines, as mentioned already, that it consumes exactly the amount of water necessary to cover its everyday needs. 24.5% believe that they can cut back on water consumption without jeopardizing their living standards and this percentage was mainly traced within the detached houses and high income categories, where 1 out of 2 users claimed to be able to cut down on the amount of water consumed. This percentage is significant if one considers that these residents consume the largest water quantities. Only 21.7% of the surveyed is prepared to accept a raise in water rates, with surcharge not exceeding 10%, for the provided services by the water supply company to be upgraded. Consumers consider that water tariff rates are already high and are generally pleased by the services provided.

Asked to characterize themselves based on how economically they use water, 70% defined themselves as rational consumers, 12% as wasteful and 18% as moderate consumers.

When asked about water preservation means, 42% believes that emphasis should be placed on informing and educating the citizens, 43% suggests technical improvements and 15% proposes financial measures.

As for the tariff structure, 48% prefers to be charged according to consumption, 28% agrees with the flat charge and scale tariff, 22% desires a uniform price, independent of consumption, and 2% suggests charge to be based on residence size.

About water quality, 45% drinks tap water, 20% filtered tap water, 13% bottled water and 22% tap and bottled water. Generally over 60% stated its satisfaction with the provided water quality.

Finally, it should be noted that during the last decade the number of hydrometers is rapidly increasing. While the urban population increased by almost 40%, according to the National Statistics Service, the hydrometers grew over 60%. Therefore, population projection (based on the regional demographic data) should not be used in the analysis of future water demand. Taken that water price demand is no longer elastic and for the reasons mentioned in paragraph 2.3, a simple bivariate model is suggested. The total water demand for urban purposes can be given by

$$Q_{\text{tot}} = 425100 + 165.75 Y_1 + 157.21 Y_2 + 86.78 Y_3 + 98.306 Y_4 \quad (4)$$

where:

$Y_1$  = number of hydrometers in high income detached houses

$Y_2$  = number of hydrometers in average income detached houses

$Y_3$  = number of hydrometers in low income detached houses

$Y_4$  = number of hydrometers in average income blocks of flats

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## REFERENCES

- Andreadaki, M.: 2004. Estimating water demand- Application on a WSDB, Dissertation, Department of Civil Engineering, Democritus University of Thrace.
- Anestis, T., Petalas, C. and Tsihrintzis, V.: 2005. Approach of the water consumption characteristics in the municipality of Xanthi. Proceedings of the 5<sup>th</sup> National Conference of the Greek Water Resources Management Commission. Integrated Water Resources Management, 6-9 April, Xanthi. (In Greek)
- Babin, F. Willis, C. and Allen, G.: 1982. Estimation of substitution possibilities between water and other production inputs. American Journal of Agricultural Economics.
- Baumann, D.D., Boland, J.J. and Hanemann, M.: 1998. *Urban water demand Management and Planning*, Mc Graw-Hill.
- Boland J.J.: 1993. Pricing Urban Water: Principle and Compromises. Water Resources Update; 9: 7-10.
- Davis W.Y., Beezhold M.T., Opitz E.M. and Dziegielewski B.: 1996. ACT-ACF Comprehensive Study Municipal and Industrial Water Use Forecasts. Volume I; Technical Report. PMCL. Carbondale IL.
- Fafoutis C., Mentis A., Milopoulos G. and Liakopoulos A. 2005. : Examination and correlation of water demand management parameters in Thessalonica and Volos. Proceedings of the 5<sup>th</sup> National Conference of the Greek Water Resources Management Commission. Integrated Water Resources Management, 6-9 April, Xanthi. : 381-388. (In Greek)
- Gratziou, M. and Andreadaki, M.: 2005 Water demand and pricing policy in the municipal supply enterprise of Xanthi. Proceedings of the 5<sup>th</sup> International Conference on Environmental Technology, 3-6 February, Athens.: 176-177. (In Greek)
- Kiefer J.C. and Dziegielewski, B.: 1991. Analysis of Residential Landscape Irrigation in S. California. Research report prepared for Metropolitan Water District, of S. California- Planning and Management Division., Los Angeles, CA.
- Kolokitha E., Milopoulos G. and Amanatidou E.: 2005. Social and economic dimensions in urban water management. Water saving in the city of Kozani. Proceedings of the 5<sup>th</sup> National Conference of the Greek Water Resources Management Commission. Integrated Water Resources Management, 6-9 April, Xanthi. : 375-380. (In Greek)
- Mentis, A.K.: 2001. Managing water demand-Development of an integrated evaluation system of the alternative policies of water demand management. PhD Thesis, Department of Civil Engineering, Aristotle University of Thessalonica, Thessalonica. : 64,92-120, 131. (In Greek)

- Milopoulos N., Kolokitha E. Mentis A. and Bigiatzaki K.: 2005. The role of the social factor in the saving of household water. The case of the city of Chania, Crete. Proceedings of the 5<sup>th</sup> International Conference on Environmental Technology, 3-6 February, Athens. : 64-65. (In Greek)
- Williams M. and Byung, S.: 1986, The demand for urban water by customer class. *Applied Economics*; 18: 1275-1289.