WATER PRICE ELASTICITY AND PUBLIC ACCEPTABILITY ON CONSERVATION OPTIONS IN THE CITY OF VOLOS, GREECE

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ABSTRACT

Efforts to satisfy increasing demand have often been concentrated principally on constructing new water systems, thus increasing the supply of water. The relationship between water abstraction and water availability has turned into a major stress factor in the exploitation of water resources. There is a wide recognition nowadays that there is a need for strategies for the sustainable use of water resources and water demand management. In the city of Volos, Greece, the number of water meters has been tripled from 1979 to 2006 while yearly water production has increased 2.62 times these 27 years. The fact that water sources have remained stable has created a disruption of water balance. In order to explore new approaches toward sustainable water management in the water supply sector, evaluate various aspects of current water policy, investigate the perspectives of water saving and evaluate water price elasticity in the city of Volos, Greece, a survey concerning the residential sector has been performed recently. All qualitative data were gathered through questionnaire with the method of personal interview. The questionnaire examines social features of consumers, water use patterns, water conservation methods, water pricing issues and the level of water services. Water quality, water demand and water availability issues, water-related problems, as well as public information concerning water and environmental issues, public reactions to price changes and public willingness to pay in the residential sector are the main aspects examined and analyzed. The influence of some selected variables in water conservation, such as the price of water, the size of the dwelling, the indoor and outdoor uses, the educational level, the income of consumers as well as rainfall and temperature levels, is examined, hierarchically set and residential water demand curve is calculated using the fixed effects and random effects model.

Keywords: analytical hierarchy process, public participation, residential water price elasticity, water conservation, water demand management.

1 INTRODUCTION

Residential water use refers to water for household needs such as drinking, food preparation, sanitary reasons, cleaning and washing in the house, cleaning and washing of a car, filling of a swimming pool and watering lawns and gardens. Residential water consumption is usually the most important use in an urban context [1], and its management results in the most controversial decision from a socioeconomic point of view [2].

In the past, most of the attempts to satisfy the increased water demand led to a more intensive exploitation of water resources. This one-sided management of water has caused not only the gradual depletion of water resources but also their qualitative degradation. During the last years, all efforts to conserve water balance for demand and supply have focused on managing water demand. Water demand can be defined as the adaptation and implementation of effective policies and initiatives by a Water Utility to influence the water demand and usage of water in order to meet any or even all of the following objectives: economic efficiency, social development, social equity, environmental protection, sustainability of water supply and services and political acceptability.

To achieve the above objectives, a number of instruments, which are interdependent, have been developed and the most effective way for their application depends on the prevailing local conditions.

Within this framework lie the study and evaluation of suitable social interventions as well as the application of financial methods and measures that could contribute significantly to saving water, which are nowadays the top choices of a sustainable water policy [3, 4].

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A successful way to manage water demand is to define the variables that affect it in every sector of water use (agricultural, residential, industrial, commercial, etc.). Water use relationships are in the form of mathematical equations that express water use as a mathematical function of one or more independent variables. The mathematical form and the selection of the independent variables depend on the type and aggregation of water demand.

According to the availability and the type of data, many applications and statistical models are found in the international bibliography, which evaluate the water demand curve in the residential sector and define the factors that affect water demand as well as the way they affect each other. Studies have performed a variety of methods and econometric models depending upon the nature and availability of data in order to estimate water demand [5–7].

The level of residential demand varies considerably from household to household depending on the socioeconomic factors and household characteristics. The potential key factors affecting residential water consumption and that have been used in studies of residential water demand mostly refer to water price, population, income, household size, weather, family composition, number of taps in the housing unit, educational status of the head of the household, number of water using habits, time of the year and others, which are represented by various and different expressions.

2 DESCRIPTION OF THE STUDY AREA

The research took place in the wider region of the city of Volos. The Municipal Water Utility of the city of Volos, which is responsible for the municipalities of Volos, Nea Ionia and Esonia, supplies the urban complex of Volos (120,000 residents) with an estimated average water consumption of about 350 liters per counter per day.

The broader study area has been divided into four main sectors, according to the segregation of the Municipal Water Utility of the city of Volos (Fig. 1). Sectors 1, 2 and 3 cover the municipality of Volos, whereas sector 4 the municipalities of Nea Ionia and Esonia.

A total of 112 questionnaires were collected. From these, 100 were considered to be completely filled in and suitable for further use. Information concerning the number of residents of each sector

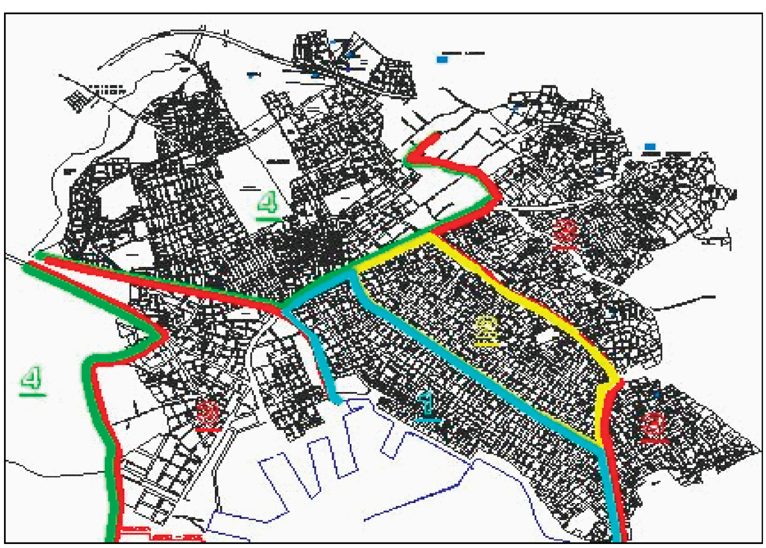

Figure 1: The four main sectors in the city of Volos.

was retrieved from the National Statistical Service and the percentage of each sector's participation in the sample was calculated. Thus, 33 water consumers from the first sector, 19 from the second and third sector and 29 from the fourth sector were examined. Probability sampling was the method applied, and personal interviews of the respondents were taken.

The questionnaire used in the interview consists of three parts. In the first part, the social characteristics of the sample are being inquired (sex, age, education, etc.), defining the sample's identity. The second part contains questions regarding water consumption and uses in the urban area of Volos (outdoor water use, leakages, use of water conserving devices, etc.). Furthermore, it contains questions where factors which eventually affect water consumption as well as parameters which contribute to water saving are being evaluated and graded. Finally, in the third part, consumers' willingness to be informed and take part in water conservation programs and their willingness to pay in order to improve the services provided by the Municipal Water Utility are being inquired.

3 INITIAL SURVEY RESULTS CONCERNING WATER ISSUES

3.1 Water pricing policy

The pricing policy for the residential sector that was applied in the city of Volos till 1985 was a uniform rate with a fixed monthly service charge corresponding to a minimum water consumption of 5 m^3/month. The increasing block tariff has been adopted since then. In this pricing scheme, the first block is charged at a low rate, while the consecutive blocks can be charged at prices that will discourage the consumers from indulging in unnecessary use. In this study area, the residential customers were being charged based on a three-block increasing rate structure from 1985 to 1991 and according to a four-block increasing pricing scheme from 1991 to 1997. Since then, five water blocks have prevailed combined with a fixed service charge of 15 m^3/trimester. Table 1 shows the price for each block for the residential sector.

Despite the increase of the water price, especially for high consumers, 57% declare that the contribution of water bill to their family income is less than 1%.

Furthermore, 51% of the sample is willing to contribute financially in order to improve the services provided by the Municipal Water Utility. The 49% of the respondents who are not willing to pay extra for service improvements indicates the low reliability of the utility's infrastructure and services and the prevailing opinion of many consumers that water is a social good. The majority of those who are willing to pay for the amelioration of water services (42%) would accept an amount up to 30€ annually, whereas only very few would consent to a higher amount (from 45€ to 300€ annually).

Table 1: Water price structure in the city of Volos from 1997 to 2005.

	Price structure (€/m^3)								
m^3/3 months	1997	1998	1999	2000	2001	2002	2003	2004	2005
0–15	0.32	0.34	0.35	0.36	0.36	0.37	0.38	0.39	0.4
16–38	0.38	0.4	0.42	0.43	0.44	0.45	0.46	0.48	0.5
39–60	0.5	0.53	0.54	0.56	0.57	0.59	0.61	0.64	0.67
61–80	0.5	0.53	0.54	0.56	0.59	0.62	0.65	0.69	0.73
>81	0.56	0.59	0.61	0.63	0.68	0.73	0.79	0.86	0.93

3.2 Water conservation devices

The use of water saving devices indicates how sensitive consumers are in water issues. Retrofitting also provides one of the most effective short-term options for reducing water demand. The most frequently used include low-flush toilets, low flow faucets and showerheads. Only a very small percent (5%) owns water-conserving devices. Yet, it is important that a vast number of those who do not use water-conserving devices would be interested in being informed as well as in participating in water-conservation programs. Various channels of communication can be used for program publicity. For a particular program to be effective, the channel of communication should be chosen with regard to the target population.

3.3 Outdoor water use – construction of a dual water supply network

The construction of a dual water supply network refers to the wastewater reuse. Wastewater reuse contributes to demand management in that it enhances the efficiency of a water supply system by supplying reused water to activities which otherwise would have utilized potable water from the distribution system. The most common form of wastewater reuse is the use of effluent coming from wastewater treatment works for agriculture and industrial procedures. Wastewater reuse is also practiced to a lesser extent in large households and detached houses.

In the case of the urban complex of Volos, the gray water reuse concerns the washing of balconies and the watering of plants.

It has been proven in California that the prohibition of certain outdoor uses, such as washing of sidewalks and outdoor areas, can lead to a 29% decrease in water consumption [8]. Water consumed for outdoor uses need not be of high quality (drinking water).

Therefore, the construction of a dual water supply network seems to be a very important parameter. In this study, 79% of the sample consumes water for outdoor uses.

3.4 Control of leakages

Water leakages are usually due to lack of maintenance or failure to renew and replace aging systems and form real losses of water losses. Water losses are inevitable in distribution systems and real losses cover mainly leakage from pipes, reservoirs, etc. Control of leakages minimizes the difference between the available supply and projected demand and also the vulnerability of the system to supply shortages. Furthermore, water metering on demand has attracted a lot of attention in the past. There are documented case studies that suggest that meter adoption motivates water savings (at least in the short term) in terms of total volume [9] and can help reduce peak demands [10].

In all, 61% of the sample checks for network leakages. This means that a significant part of the consumers deals with possible network damages and the consequent water leakages. The leakage control entails significant benefit since water is being conserved. The majority of those controlling water leakages (27%) checks for damages once per year, whereas another 15% checks once per month and 13% checks once every 2 months.

3.5 Awareness and participation in water conservation programs

It is evident that all the above components, which contribute to water conservation, directly or indirectly, affect consumers and hence a public awareness campaign will also contribute to this direction. The main goal of the campaign should be to raise the consumers' awareness of the urgency to conserve water in order to avert a crisis situation in the future. Unfortunately, past implementation of any demand management program was based solely on the decisions of water planners without consultation of the public and this top–down approach has led to the failure of many initiatives.

In this study, the overwhelming majority of consumers (90%) wish to be informed by the Municipal Water Utility of the city of Volos on the water supply problems of the city as well as on water-related issues.

Therefore, the Water Utility should take advantage of their willingness in order to communicate with the consumers and promote its future plans. As far as the way of information is concerned, most of them wish to be informed directly by the Water Utility through a special edition dispatched together with the water bill. Local media (radio, TV and newspapers) seems to play a very important role in informing the public, whereas magazines and other means (i.e. internet) are considered less important.

Moreover, 87% of the sample would be willing to take part in water conservation programs. This conclusion is of tremendous importance because before applying any water conservation program, one should check the possibility of failing to achieve the goal, which is the decrease in water demand.

4 SOCIAL CONSIDERATIONS IN WATER DEMAND MANAGEMENT INSTRUMENTS

The analytical hierarchy process (AHP) structures an objective hierarchically and guides the analyst through a sequence of pairwise comparison judgments. AHP is an approach of decision making that involves structuring multiple-choice criteria into a hierarchy, assessing the relative importance of these criteria, comparing alternatives for each criterion and determining an overall ranking of the alternatives. It is one of the well-known methods of multicriteria analysis and has been performed in many different cases.

The AHP is performed in order to assess the involvement of the five conservation measures (CMs) analyzed above in water demand management according to consumers' perception. A linear additive model is developed; it uses procedures for deriving the weights and the scores achieved by alternatives, which are based, respectively, on pairwise comparisons between water CMs and between groups according to their educational level (G).

Consumers are divided according to their educational level into primary (P), secondary (S) and tertiary (T). Water CMs include the following: implementation of effective water pricing policy (CM1), use of water conservation devices (CM2), construction of a dual water supply network (CM3), control of leakages (CM4) and public awareness and participation in water conservation programs (CM5).

4.1 Steps of the AHP

The AHP performed consists of three levels. The first level denotes the overall goal, which is the evaluation of water conservation options. The second level includes the ordering of consumers according to their educational level. The last level of the hierarchy describes the proposed water CMs, which are to be evaluated.

In the next step of the AHP, the groups of consumers in the second level of the hierarchy are compared with each other to determine the relative importance of each group in accomplishing the overall goal. The easiest and visually most structured way of doing this is to prepare a matrix with the groups listed at the top and on the left. In this study, each possible combination of different groups is examined and six matrices evokes.

In the second level of AHP, water CMs are evaluated in relation to different ordering of consumers. Values from 1 (lowest) to 10 (highest) are set. Taking into account the weights of the five CMs, the final weight for each measure is given by eqn (1):

$$w_{2,j} = \sum_{i=1}^{N} w_{1,i} w_{ij}, \qquad \text{with } i = 1, 2, 3, \ldots, N \quad \text{and} \quad j = 1, 2, 3, \ldots, M. \tag{1}$$

where $w_{2,j}$ is the weight of conservation measure CM_j in the second level, $w_{1,i}$ is the weight of group G_i in the first level, w_{ij} is the weight of conservation measure CM_j for the group G_i and $\sum_{i=1}^{N} w_{1,i} = 1$, $\sum_{j=1}^{M} w_{2,j} = 1$.

4.2 Total weights of water CMs

In Table 2 the final weights of water CMs for the six different cases are presented.

Irrespective of the educational level of consumers in the first level of AHP, the control of leakages constitutes the most effective measure leading to water conservation. Water leakages in the level of final use represent the loss of important quantities of water via the escapes from taps that run also from the pipes of internal installation.

The second most important factor in water conservation constitutes, for the majority of groups, public awareness and participation in water conservation programs. The high eagerness of consumers (90%) towards environmental education and information proves that their involvement in water conservation programs is essential to decrease water consumption levels. Moreover, it has been proved that in periods of drought or problems in the abstraction of water, the application of such programs decreased water consumption levels.

The use of water saving devices strongly contributes to water conservation. Only 5% of consumers use such appliances, while 87% have declared their willingness to participate in water conservation programs. The installation of water saving appliances (dual flush interactive toilet, flow control valves, etc.) is an effective measure of water conservation and should be included in any administrative plan.

The application of appropriate water pricing policy receives the last place of hierarchy almost in all cases, meaning that an increase in water price will not lead to water conservation. The price of water is very low in relation to the income of consumers. In all, 57% declares that it contributes less than 1% to consumer's income, while for 37% it fluctuates from 1% to 5%. Even if the change in water price constitutes an important factor of determination of water demand, this result is expected as the AHP describes the consumers' opinions, who certainly disagree with any increase in the price of any resource.

Table 2: Final weights of water CMs.

TSP		TPS		STP		SPT		PTS		PST	
CM4	0.33	CM4	0.33	CM4	0.33	CM4	0.33	CM4	0.33	CM4	0.33
CM5	0.24	CM5	0.26	CM2	0.23	CM2	0.23	CM5	0.26	CM5	0.24
CM2	0.22	CM2	0.21	CM5	0.23	CM5	0.23	CM2	0.21	CM2	0.22
CM3	0.11	CM3	0.12	CM1	0.10	CM1	0.10	CM3	0.12	CM3	0.11
CM1	0.09	CM1	0.08	CM3	0.10	CM3	0.10	CM1	0.08	CM1	0.09

However, actually the increase in the price of water can even result in short-term changes in the consumers' behavior, contributing in this way to water conservation. The fact that water consumption is reduced in such cases depends on the value of elasticity of water demand, which is calculated in the next section.

5 ELASTICITY OF WATER DEMAND

A matter of great interest in analyzing the economic demand for water is consumers' responsiveness to price differences. One measure of this concept of responsiveness is called the price elasticity of demand and is equal to the proportionate difference in the quantity purchased divided by the proportionate difference in price paid [11].

Equation (2) is a basic and simple equation that can describe some observations (y), which depend on a set of variables (x) and can take the following form [12]:

$$y_{it} = \alpha + \sum_{k=1}^{K} \beta_k x_{kit} + \nu_t + u_{it}, \quad \begin{array}{l} i = 1, \ldots, N, \\ t = 1, \ldots, T. \end{array} \tag{2}$$

where, y is the dependent variable in observation i at time t, x_{kit} is the vector of specific selected variables, α, β_k are the coefficients to be estimated, v_i is the unexpected regime of the dependent variable and u_{it} is the error term.

There are three types of data: time series, cross-sectional and panel data. Time series data include observations that are taken at regular time intervals. In cross-sectional data, observations are taken at one time but for different entities. Panel data combine both the time series and the cross-sectional observations to form a single data matrix.

There are three kinds of explanatory variables (x). There are variables that differ between different consumers but remain constant with time, variables whose values change with time but remain constant for all consumers and variables that change between consumers and with time.

In order to solve eqn (2), all the appropriate variables (x) that explain the dependent variable (y) should be found. Of course, this is impossible. The variables that are missing from the matrix of variable (x) (mainly because there are no data for them), but influence the dependent variable y, are considered to take part in the equation via the residuals v_i and u_{it}. The degree that the missing variables influence the dependent variable is expressed by these residuals (v_i and u_{it}). The residuals v_i differ between the consumers, but remain constant for each consumer throughout the time. The residuals u_{it} are the 'common' residuals of equations of this kind. That is to say, they have zero mean value, they are not connected with (x), with the residuals v_i, with themselves and have constant fluctuation. The solution of the above equation should be derived in many ways and researchers use the most appropriate method according to the type of the available data.

In this case, there are residential consumers (multiple cases) who are observed at many time periods. Consequently, panel data (cross-sectional time series data) exist. There are two kinds of information in cross-sectional time series data: the cross-sectional information reflected in the differences between subjects (consumers) and the time series or within-subject information reflected in the changes within subjects over time.

The sample consists of the 100 residential consumers, who were interviewed through the questionnaires mentioned in the survey performed. Water consumption levels are inserted in the model as time series data and were provided by Municipal Water Utility of the city of Volos in the form of 3-month period water consumption records from years 1997 to 2005 (36 time series observations in total).

Price structure and changes in pricing policy were also collected by Municipal Water Utility of the city of Volos. There are different expressions of water price (average, marginal and difference) that have been used in various studies of water demand and the adequate specification of the price in water demand models is an econometric issue of great importance.

The average price is defined as the water bill paid by the consumer divided by the amount of water consumed. The marginal price (MP) is the price that a consumer should pay, according to the water price structure, for the next cubic meter of water. This principal is based on consumers' attempt to optimize their utility function. The difference variable depicts the difference between the real water bill and the bill that should be paid if all the bulk of water was valued according to MP. In this study, MP and the difference variable have been calculated for each residential consumer participated in the survey and used. Both of them are adjusted by the consumer price index.

Three variables that are selected from the initial survey are cross-section data and are inserted in the model as dummy variables (variables with only two values, zero and one). The first one is used in order to quantify the consumers who use water for outdoor purposes (doutd), the second defines the educational level of consumers (dedu1, dedu2) while the third their financial situation (dinc). If a consumer uses water for outdoor purposes, the dummy variable 'doutd' equals 1, otherwise it equals 0. In order to insert the nominal variable that declares the educational level of consumers (nominal variable with two levels – primary educational level and secondary educational level), a set of two dummy variables (edu1 and edu2) is created. If a consumer possesses first-degree education, then 'edu1' equals 1 and 'edu2' equals 0. If the consumer's income does not exceed the amount of 12,000€ per year, the dummy variable 'dinc' equals 0, otherwise it equals 1. The size of the dwelling in square meters (continuous variable) is also stated in the model.

Monthly climatic data (T: temperature in °C and R: precipitation in mm) were collected from the records of the meteorological station of the city of Volos and both these continuous variables are inserted in the model.

In order to derive direct price elasticity estimates of demand for water, a log transformation of eqn (2) was used and by replacing all the explanatory variables, eqn (3) results.

$$\begin{aligned}\ln(\mathrm{C}) = {} & a_1(\ln \mathrm{MP})^2 + a_2(\ln \mathrm{MP}) + a_3(\ln \mathrm{D})^2 + a_4(\ln \mathrm{D}) + a_5\mathrm{m}^2 + a_6\mathrm{doutd} \\ & + a_7\mathrm{dedu1} + a_8\mathrm{dedu2} + a_9\ln(\mathrm{R}) + a_{10}\ln(\mathrm{T}) + a_{11}\mathrm{dinc} + c. \end{aligned} \tag{3}$$

where, C is the water consumption, MP is the marginal price, D is the difference price, m^2 is the size of the residence, doutd is the dummy variable for outdoor uses, dedu1 and dedu2 are the dummy variables for educational level, R is the precipitation, T is the temperature, dinc is the dummy variable for income, a_{1-11} are the coefficients of the explanatory variables and c is the standard term.

5.1 Water demand curve

In order to analyze the panel data, eqn (3) is solved twice using the fixed effects and the random effects Generalised least squares (GLS) model with the statistical package STATA [13]. Fixed effects regression is the main technique used for analysis of panel data and is used when omitted variables that differ between cases but are constant over time have to be controlled. The changes in the variables over time are used to estimate the effects of the independent variables on the dependent variable. In order to control both the omitted variables that differ between cases but are constant over time and the omitted variables that change over time but are constant between cases, the random effects regression model is also used.

For a single change in water tariff (change both in the prices and in the lower and upper limits of the consumption scales), reaction of consumers can be described from the sum of the MP and the difference variable (D). The second-degree equation that results after the addition of coefficients of

MP and D and keeping all the other variables constant (setting their mean values as coefficient) is described in eqns (4) and (5) for the fixed effects and random effects model, respectively:

$$\ln(C) = -3.632(\ln P)^2 - 0.953(\ln P) + 3.288. \quad (4)$$

$$\ln(C) = -3.700(\ln P)^2 - 0.995(\ln P) + 3.271. \quad (5)$$

Water demand curves that were estimated using the equations above are presented in Fig. 2 and differ slightly. They are both asymptotic for null price of consumption. The highest value of water consumption Q reaches 28.5 and 28.1 m^3/quarter, respectively, for the fixed effects and random effects model. These consumption values correspond to the mean of the second scale of consumption (down limit 16 m^3 and upper limit 38 m^3). This result means that only the first two of the six scales of the increasing block tariff of Municipal Water Utility of the city of Volos are actually used by the majority of consumers.

Although random effects model gives better *P* values as they are a more efficient estimator, fixed effects model works best when fewer cases and more time periods exist. Moreover, in order to check the most efficient model and to choose between the fixed effects and the random effects model, the Hausman test was performed. This tests the null hypothesis that the coefficients estimated by the efficient random effects estimator are the same as the ones estimated by the consistent fixed effects estimator. The insignificant *P* value (prob > chi-square smaller than 0.05) indicated that fixed effects model should be used.

The own price elasticity is negative and less than unity in absolute value, so the water demand in the city of Volos is relatively inelastic and water consumption changes less than proportionately with price. A 10% increase in price can lead to the reduction of water consumption to 9.53%. The high

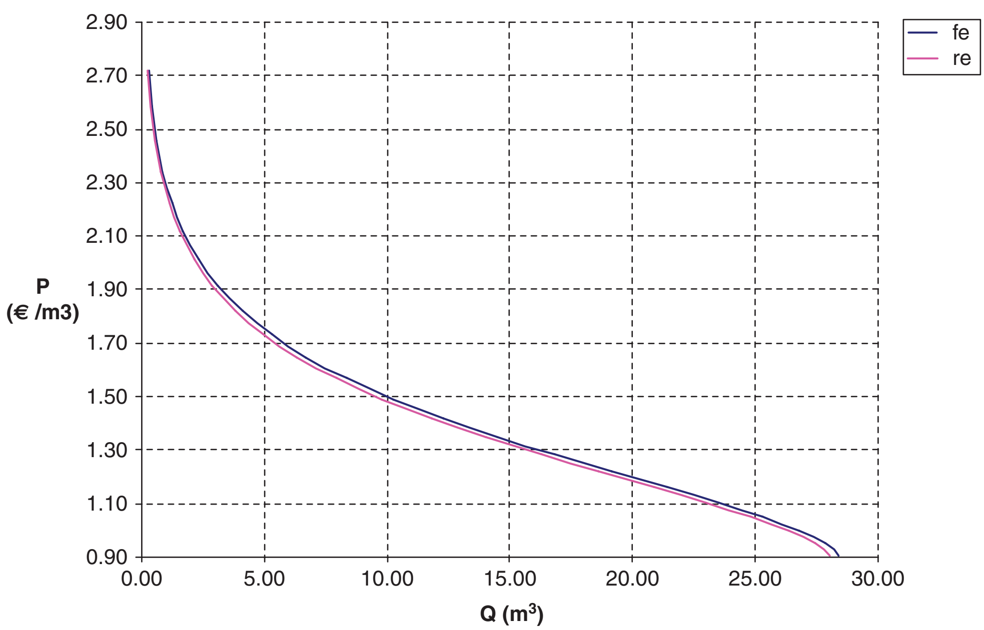

Figure 2: Residential water demand curve. fe, fixed effects model; re, random effects model.

value means that the current water policy can act as an incentive to water conservation. It is evident that the increasing block rate structure (higher increases in prices for high water consumptions) helps water conservation. In this rate structure, residential water users have the incentive to remain in lower levels of consumption (first and second) where the price is significantly lower. Moreover, in 2006, the Water Utility of the city of Volos added two more scales in the water rate structure, implementing small scaling in the upper scales. This practice will also strongly contribute to water saving.

The model's coefficient for temperature (T) is 0.02, meaning positive in sign and statistically significant (P value < 0.05). It has the expected sign as a 10% increase in temperature values leads to a small increase of 0.2% in water consumption. However, the coefficient of precipitation (R) is 0.19 and is estimated with the opposite sign than expected.

6 CONCLUSIONS AND SUGGESTIONS

It is evident that Water Utilities face the challenge of developing new water policies by adopting advanced technologies for demand management through a series of incentives, reuse of treated wastewater, installation of water saving and conservation equipments, consumer's awareness and education while simultaneously should introduce changes in pricing procedures and cost recovery in order to comply with the principle of full cost pricing, referred to the Water Framework Directive.

The high water price elasticity indicates that water pricing strongly contributes to water conservation. Water demand curve presents that only the first two blocks are actually used by the majority of consumers, as the maximum consumption level belongs to the mean level of the second block of the existing pricing scheme in the city of Volos (low margin: 16 m^3 and high margin: 38 m^3). Thus, a further division of this block is recommended, including simultaneously higher prices in each block, which will provide consumers a pure financial incentive to conserve water. Of course, any increase in water prices should be based on a sound and broadly accepted planning and Water Utility should assure consumers that they are not being used to take advantage of the situation to increase profits.

More billing periods are also suggested as users who are more frequently billed might be expected to understand better the tariff structure and the relation between water consumption and the size of the bill.

Moreover, as retrofit programs are widely accepted by the public as effective tool for water conservation, efforts of implementation of such programs should be launched. The efficacy of them is expected to be positive if the equipment is offered free to the consumers and if they are high-profile and aggressively managed.

Public's contribution as well as the general environmental education of consumers is considered of great importance for the successful implementation of demand management programs. Campaigns should be worked out in order to actuate consumers toward low water consumption technologies and generally a demand-oriented water use policy. Social marketing campaigns such as public broadcasting announcements, brochures, bill inserts, advertising, special public events, internet sites, door-to-door campaigns, newspaper articles and radio–television programs as well as special seminars and workshops with specific water users are examples of effective dialogue-based water conservation instruments, which not only encourage behavioral change but also enhance the concept of public participation.

Finally, the construction of a dual water supply network contributes to demand management as it supports the efficiency of the water supply system by supplying reused water to activities which otherwise would have utilized potable water from the distribution system. If this option is decided, protection of water users (health implications), protection of the environment (groundwater pollution) and social acceptability should also be considered.

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