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ANALYSIS

The sustainable residential water use: Sustainability, efficiency and social equity. The European experience

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ABSTRACT

The present paper traces the operational conditions governing the sustainable use of water in cities. Towards this objective, the paper first proposes a new comprehensive definition for the sustainable use of water. Next, efficiency in use is proposed as a fundamental instrument in achieving sustainability, in spite of prevailing opinions maintaining that sustainability and efficiency aim at different and probably conflicting objectives.

In this light, several pricing modes that inhibit efficiency are examined and their effects are defined. In this context, egalitarian pricing which, nevertheless, prevents efficiency, is also systematically evaluated until it is ascertained that it does not serve social equity in the use of water, in the long run. All the more, the present paper advocates that certain egalitarian pricing systems such as the increasing block rates – most prevalent at this time – may have the reverse effect than the one intended and hence, in the long run, impose negative impacts on the welfare of low incomes. As a result, full-cost prices are proposed as a necessary instrument for the sustainable use of water; an instrument that promotes social equity in the long run. The assumptions of the study are examined in a comparative analysis of representative European pricing systems and urban management modes.

1. Introduction

The intensified scarcity of water resources of "good" quality emerges as a crucial environmental problem on a global level. Water resources, indispensable to human life and socio-economic processes, are being exploited by an ever-increasing population and a growing economic production (WRI, 1997; WWC, 2003). The severe problems of scarcity of "good" quality resources result in:

- Increasing competition for accessibility to water resources of "good" quality
- Intensified water deficits in regions prone to drought
- Degradation of the water ecosystems
- Further deterioration in the quality of water resources

Under the pressure imposed by these problems, a new area of water policy has emerged in Europe. Responding to this issue, the Water Framework Directive has created the context of an effective policy to confront the degradation of water resources on the one hand and the intensified water scarcity on the other (WFD, 2000). The prime objective in the new policy era is defined as the sustainable use and management of water resources (WFD, 2000; Kaïka, 2003). Q1 Q2

The present article initially offers a new dialectical and comprehensive definition for the sustainable use of water resources. Then, "efficient water use" is proposed as an instrument that promotes sustainable use and management of water resources. It is quite often accepted that the objectives of "sustainability" and "efficiency" in the use of natural resources differ substantially between them; moreover, in

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some cases, these targets are found in competition against each other (Bromley, 1990). The present paper comes in contrast with the above as it asserts that efficient use can indeed promote sustainable use when it comes to water resources (Baumann et al., 1998; Rogers et al., 2002).

Water prices are the major means of efficient use and the prime requirement for the promotion of such use is full-cost prices. In practice, however, water prices seem to be lagging behind full costs in the majority of cities in both developed and developing countries (Rogers et al., 2002; OECD, 1998; Pearce, 1999; Dalhuisen et al., 2003; Bithas, 2006). The present paper comes to systematically examine the causes and the effects of inappropriate prices and to define the effects of underpricing, non-metering and increasing block rates. It is indicated that to set prices that trail behind full costs induces overuse and misallocation of water. Furthermore, the paper comes to the conclusion that both non-metering and increasing block rates, besides reducing efficiency, inhibit the pursuit of social equity in the long run. It is in this context that the appealing cause of setting prices that lags behind full costs – also known as egalitarian pricing since it presumably ensures sufficient provision of water for low-income households – is evaluated. Contrary to the prevalent opinion that low prices enhance equity, the paper advocates that, low prices reduce social equity, in the long run, as far as the accessibility to water resources is concerned. When prices are appropriately set so as to approach full costs, equity will improve in the long run as well (Rogers et al., 2002).

The paper focuses on the European level, in a comparative context, and examines how water prices are defined in five European cities with representative characteristics. The pricing systems of Athens, Amsterdam, London, Seville and Tel-Aviv have been assumed as representative in institutional, technological, climatic and socioeconomic terms. These pricing systems are analyzed and compared with the efficient prototype and the conditions of sustainable use. What emerges from this analysis and comparison is that underpricing, non-metering and other pricing modes do not promote efficient use prevail. The case studies also make it apparent that one of the main reasons behind inappropriate pricing is the so-called egalitarian pricing. The manner in which the present paper has been structured has as follows:

First, a new definition for sustainable water use is proposed. Second, efficient use is examined as an instrument that promotes sustainability. Then, the effects of several prevailing pricing modes (non-metering, increasing block rates, prices based on underestimated costs) are examined. Next, the water pricing systems in five European metropolitan cities are systematically evaluated. Lastly, relevant conclusions are drawn. The empirical analysis in the five European Case Cities is based on the European research project METRON (2000).

2. The sustainable use of water

One of the gravest problems in the contemporary management of water resources is the intensified scarcity of good quality resources. This scarcity is becoming increasingly poignant, both in western societies and in the developing countries. An ever-growing population, an ever-broadening economic growth and the ever-spreading adoption of the western consumption pattern are the main reasons behind higher water usage and hence behind the intensified scarcity of water resources (WRI, 1997;WWC, 2003). At the same time, environmental pollution substantially reduces the resources of good quality available. More often than not, water scarcity has an impact on both contemporary and future generations since a substantial part of water resources in use, especially in the more drought-prone areas, are exhaustible ones.

In this context, the objective of sustainable use of water resources holds great appeal and characterizes policy targets worldwide. With this direction in mind, the current European policy explicitly states the sustainable management of water resources as its prime objective (WFD, 2000; Kaïka, 2003).

What, in practice, can the sustainable use of water resources be? Broadly speaking, defining sustainable use of water resources may be an easy task: the sustainable use is that pattern of use which ensures satisfaction of needs for both the present and future generations. Such a definition is not far from the general definition of sustainability: "the development that meets the need of present generations without compromising the ability of the future generations to meet their own needs" or as "a pattern of social and structural economic transformations which increase the benefits available in the present without jeopardizing the likely potentials for similar benefits in the future" (WCED, 1987). However, such a definition becomes problematic whenever the current and future generations somehow find themselves competing for access to water resources. Whenever the use of water by the present generation has an impact on the water's potential accessibility by future generations – and this is a recurrently typical case – then, the proposed definition proves unsuccessful in leading to the prescription of an effective policy. The problem of competition among the current potential users becomes less complicated as it is presumably resolved by means of the allocation arising from the water market or other allocation modes in which all potential users–stakeholders are participating.

The crucial issue at hand is to establish a criterion to resolve the competition between present and future generations to access water resources of good quality. This problem is a historic one for the realm of economic analysis of natural resources. Although, an interesting dialog on the issue was initiated years ago, no criterion was generally accepted as underlying the inter-generational allocation of natural resources (Solow, 1986; Georgescu-Roegen, 1976). Nevertheless, in the case of water, one may propose certain conditions for sustainable use even in cases where potential inter-generational competition may be the issue:

- To use exhaustible renewable resources within the limits of their natural regeneration rate so that future use is safeguarded.
- To avoid unnecessary use and to promote rational use of non-renewable resources so that, in time, their accessibility is extended.

However, even these conditions may not be broadly accepted since they cannot ably answer a crucial question: Why should current generations confine their use of water and satisfaction thereof for the sake of the use and benefits enjoyed by future generations? An answer to this question is

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further stumped when one takes into consideration that future generations will be endowed with advanced technology thus increasing the productivity of resources available to them, and therefore meeting their needs with fewer water resources. Such a rationale could undermine and suspend any action plan towards sustainable use of water resources and water scarcity would inevitably be further intensified.

To overcome this impasse and for the sake of designing a rational policy towards sustainability, a dialectical criterion defining the sustainable use of water resources may be proposed: the avoidance of any kind of welfare losses in the use of water resources. We assert that such a criterion could establish a reasonable ground of action and regard it as a condition necessary for sustainability in the case of water resources and particularly for the so-called "developed" nations of the world.

In order to avoid welfare losses, efficient use of water resources should prevail for every generation. Efficient use is defined as that pattern of use that maximizes the socio-economic welfare under a given set of preferences and income (Bromley, 1990; Pearce, 1999). Efficient use requires two distinct conditions (Bithas, 2006).

- The aggregate use of water should be confined within the so-called optimum use. Any further use would bring about more social costs than benefits and therefore lead to welfare losses.
- The aggregate use should be allocated among users, so that any reallocation will not increase the aggregate welfare.

Evidently, the efficient use is defined in conformance to the Pareto criterion, as modified by Hicks–Kaldor, for the maximization of social welfare (Pareto, 1906; Hicks, 1939,1940). However, two reasons might serve in questioning the appropriateness of efficient use to promote sustainable use. First, one may assert that the efficient use reflects the preferences and characteristics of the present generation exclusively. Future generations are not and cannot be present and therefore their interests are not taken into account (Bromley, 1990; Georgescu-Roegen, 1976). Broadly speaking, the argument may hold true, yet, we insist that, in the case of water, present and future generations share similar preferences since the needs for water are based mainly on the biological characteristics of the human race inherent in each and every generation. Therefore, it is logical to assume that future generations may be satisfied if they can have access to as many water resources as the current generations enjoy today. This condition increases in probability if the efficiency prevails in current use.

Second, efficient use depends on the wealth and the incomes of individuals. Thus, any reallocation of wealth or income will bring about a completely different form of efficient use (Bromley, 1990). Could all different forms of efficient use arising from different allocations of wealth, support the sustainable use? The strong rationale of this argument becomes somewhat relaxed due to a very empirical reason. The spending of individuals on water represents but a minute percentage of their income, a mere 0.5–1% (METRON, 2000; OECD, 1998; Rogers et al., 2002). This effect makes efficient use less sensitive to different allocations of income and wealth. In this context, the efficiency depends largely on biological needs and preferences, with wealth-income having a much lower effect (Dalhuisen et al., 2003; METRON, 2000; OECD, 1998).

In this context, we insist that efficient use supports sustainability because efficient use avoids unnecessary use and therefore, at the very least, reduces the unnecessary scarcity of water resources. If anything, inefficient use, being higher than the efficient one, further exacerbates water scarcity. As a result, future generations will find themselves left with fewer water resources when inefficient use prevails.

3. The basic economics of the efficient use and forms of water market

The conditions of the efficient use are:

- The aggregate optimum use is defined when the marginal costs of using water equal the marginal benefits.
- The optimum allocation of the aggregate use, among potential users, is defined when the marginal benefits of all users are equal to one another.

Fig. 1 represents diagrammatically the conditions of the efficient use. Curve FMC represents the total marginal costs for using water resources. Essentially, the total costs consist of the aggregation of the operational, investment, opportunity, user/scarcity, and the environmental costs (Pearce, 1999; Briscoe, 1997; Dalhuisen et al., 2003; Bithas, 2006).

The analysis of Fig. 1 is based on two indicative users. MB_1 and MB_2 give the marginal benefits of users 1 and 2 respectively; the horizontal summation of MB_1 and MB_2 defines MB_{1+2} being the aggregate marginal benefits curve. The aggregate optimum use is defined by the equation of marginal benefits and marginal costs, at the intersection of FMC and MB_{1+2}. The optimum use is OA.

The allocation of the total use OA that maximizes the aggregate benefits of the two users is identified when users 1 and 2 use OQ_1 and OQ_2 water respectively and hence their marginal benefits equal one another.

The efficient use may, to some extent, be approached in a competitive market where both the producers and the consumers aim at maximizing their benefits. In such a market, the price of water is expected to reflect all actual costs of using water. However, many reasons inhibit the function of a competitive water market. The prevailing reason is the economic characteristics of the water sector that do not favor competition (Bithas, 2006). Specifically, the high cost of the initial investment creates conditions resembling the characteristics of a "natural" monopoly. This may explain the operation of only one or a limited number of water companies in the majority of urban systems.

However, even if a competitive water market did exist, there could be factors that would prevent full-cost pricing. For one thing, the owners of water resources may ignore environmental and other external costs emerging from the exploitation of resources. For another, the use of non-renewable resources may not fully take into account the foregone benefits of future generations. As a result, full-cost pricing and efficient use cannot prevail in the majority of cases. In this context, a government intervention seems to be necessary in setting prices. Such an intervention requires appropriate

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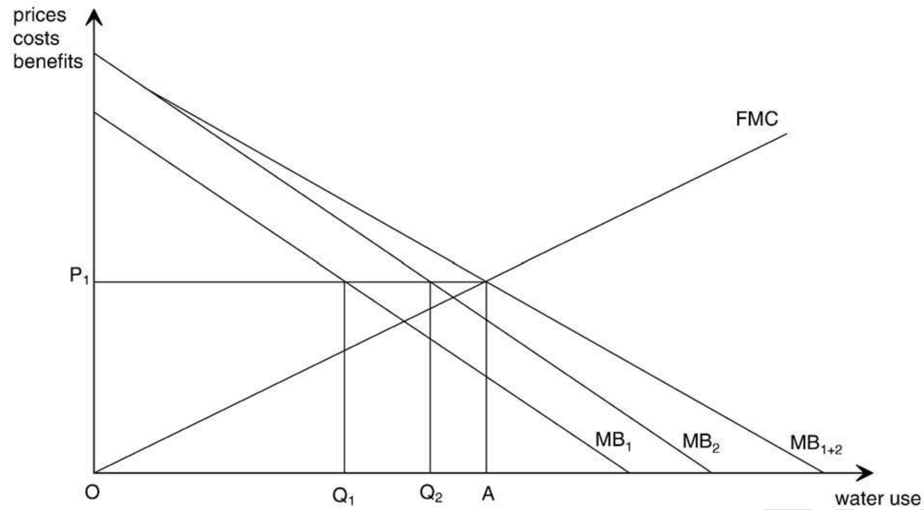

Fig. 1 – The efficient use of water.

costing and pricing systems that systematically takes into account all costs of water and set prices. The costing and pricing system should systematically take into account environmental, opportunity and user costs and should suitably set the market prices.

4. Underpricing and non-metering: efficiency and social equity

The effects of setting prices lower than the full costs of water use are traced, through Fig. 2. Curve LRMC represents long run marginal costs. Curves d_1 and d_2 give the marginal benefits of two indicative users, while d_c, being the curve representing the aggregate marginal benefits, defines the demand curve in a competitive water market. The market price reflecting full costs, is P_A. P_A defines OA optimum water use. Then, the efficient allocation is: OB water for user 1 and OC for user 2.

More often than not, the so-called "external costs" (environmental, user-scarcity, opportunity costs) are not systematically taken into account by the pricing system. In the majority of cases, the operational costs of water companies form the "indicator" for defining prices. In this context, water prices are defined on the basis of the underestimated marginal costs curve PLRMC in Fig. 1; PLRMC curve is assumed to indicate, more or less, the operational costs of water use. Prices set on the basis of PLRMC curve will result in OD water use that is higher than OA, with OA representing the efficient use.

Another reason behind the prevention of efficient use is the lack of metering in water use. Under conditions of lack of metering, consumers are charged a fixed amount regardless of their actual water use. Then, the criterion of consumers for defining water use is their preferences since their payment is fixed. In this context, a rational consumer will use water until his marginal benefits veer towards zero. In Fig. 2, consumers 1 and 2 will use OE and OZ quantity of water, respectively. The aggregate consumption is then raised to OH level, which is considerably higher than the efficient use OA.

It has been argued that, more often than not, underpricing water in urban areas is justified on the basis of egalitarian

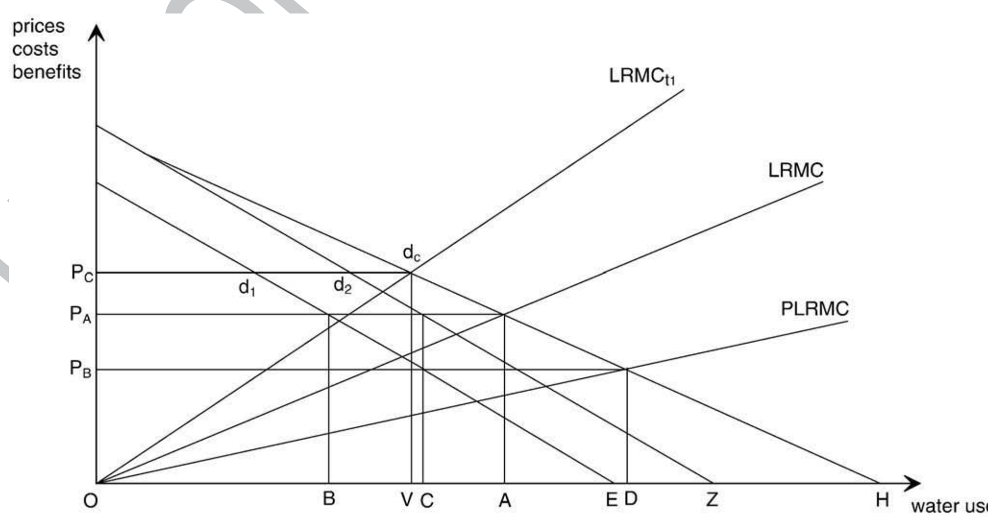

Fig. 2 – The effects of underpricing.

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arguments. The argument goes that water is a natural asset irrevocably and irrefutably indispensable for the biological existence of human beings. Therefore, water should be priced in such a way that its accessibility by low-income consumers is ensured and social equity is increased. We aim at questioning the conclusion of this argument.

Although water is a biological necessity of life, water is not a purely natural asset any longer. The current use of water, and especially the urban use, requires a production process, which involves transport, treatment and delivery of water. So, using water ends in having to "sacrifice" scarce social resources and gives rise to substantial costs. It has been demonstrated that underpricing results in severe over-consumption. Over-consumption further intensifies water scarcity. Increased scarcity raises the costs of using water resources. Such a chain of events violates the conditions of sustainable water use: first, the actual total use overcomes the optimum use and thus welfare losses are created; second, the increasing costs, induced by higher scarcity, cause further losses of social welfare, since more socioeconomic resources need to be sacrificed for using water. These cost increases are mainly owed to the following reasons:

- The exploitation of new water resources found far from urban agglomerations
- The exploitation of resources found deeper underground
- The exploitation of water resources of less-than quality
- Higher requirements for transport and treatment

The increased costs for water use are diagrammatically presented by $LRMC_{t1}$ curve, in Fig. 2, which gives the marginal costs of using water when the scarcity of water has intensified. Essentially, the new conditions of scarcity define a new economic status. The new optimum use is at OV, while the full-costs price is P_C. It is evident that the new framework of efficient use, caused by the intensified scarcity, results in higher prices and lower optimum consumption. We assert that even if the "actual price" differs from "full costs" price, the "actual price" will tend to reach higher levels compared to the conditions prevalent before the intensified scarcity. Likewise, any egalitarian price will gradually rise as well, when scarcity is intensifying.

In the real world, the actual water price is usually set to reflect the operational costs of using water (METRON, 2000). The increasing scarcity causes higher operational costs and therefore higher actual prices. In this context, even though the price charged to low-income households is defined at levels lower than those of full costs, the intensified scarcity will increase this price in the long run. Whatever the rule applied for adjusting prices to low incomers may be, it is the new conditions of scarcity that will eventually define the relevant prices at higher levels.

In the light of these findings, we assert that the egalitarian pricing policy causes the opposite effects from those intended. In the long run, the low-income households will have to pay more for water because of the intensified scarcity induced, among other reasons, by the egalitarian underpricing of previous periods. This brings forth the question of water being made appropriately accessible to low-income households when intensified water scarcity becomes an issue. In the long run, it is quite probable that low-income earners will probably be the ones to be hit more intensely, since they will be forced to pay higher prices and thus come to be excluded from accessibility to water that suffices for their biological needs.

We demonstrate that egalitarian rationale-based underpricing is probably problematic and produces the reverse effects than those desired, in the long run. Thus, we suggest that water prices should reflect the actual full costs of water so that efficient use prevails. The aggregate use of water should not exceed the socially optimum level and the actual price should reflect full costs. By doing so and by avoiding wasting water, opportunities are created for effective egalitarian policies both for the short and the long run. In this context, it seems that policies that are not based solely on prices, should be traced to serve the needs of low-income earners.

5. The increasing block rates and the social equity

A pricing system advocated as capable of serving both efficient use and egalitarian objectives is that of setting prices in increasing block rates (Rogers et al., 2002; Whittigton, 1997). It Q8-9 is assumed that increasing block rates serve two targets:

– Achieving social equity in water use. Consumers face lower prices for those water quantities that are basic to their biological needs, while more specialized use carries higher prices. Thus, low-income earners pay relatively low prices for the satisfaction of their basic needs.
– Promoting water savings, since higher consumption is accompanied by higher charges.

We assert that increasing block rates cannot effectively promote the objective of social equity, since consumption blocks are designed on the basis of an implicit assumption concerning each individual's water use, whereas block rates are estimated on the basis of household consumption. Therefore, the outcome of the increasing block rates depends on the number of members in each household. Thus, it stands to reason, that a household with a high number of members is charged a higher price. To illustrate that, let us consider the following simple example. Let us assume two blocks for consumption:

Block 1: 0 to 2A lit
Block 2: 2A lit to ∞

Consumption A has been implicitly defined as the individual's "necessary" consumption in the conditions of the example. Evidently, the "necessary" consumption is a dialectical concept and cannot irrefutably be defined. However, in the real world, the authorities define such a "necessary" consumption, taking into account the prevailing social perception and the technological characteristics of each case study. After the basic individual consumption has been defined for the conditions of the example, let the first block (0 to 2A lit) be charged 1€/lit, while the second block (2A lit to ∞) is charged 2€/lit. Two households with two and four members respectively will be compared. Assume for simplicity's sake that all individuals consume exactly quantity A. Table 1 gives the estimations for both households: the total costs, per capita cost and the average price.

It appears that the four-member household is charged an actual average price that is 50% higher than the price charged to the two-member household. Thus, it would be safe to assume that households with more members are charged a higher price. This conclusion questions one of the basic objectives of the increasing block rates, that is, egalitarian pricing. This conclusion becomes even stronger if one accepts that households with a high number of members have, more often than not, lower per capita income and include children and retired seniors. To conclude, pricing based on increasing block rates may be ineffective in promoting social equity in the use of water when the synthesis of households is not taken into account. The number of persons in each household should and must be taken into account by the pricing system whenever increasing block rates are involved.

6. The European experience

6.1. *The case cities*

Five European metropolitan cities have been studied as to their pricing systems in order to test the assumptions and the conclusions of the analysis in preceding sections. Specifically, the cities of Athens, Amsterdam, London, Seville and Tel-Aviv are systematically examined. Tel-Aviv can be probably characterized as a «European» city only marginally, but it is studied because of its interesting characteristics, located as it is in a drought area. Data and information for the analysis have been obtained within the framework of the European research project METRON (2000) and are derived from the sources listed below:

- Publications and financial data of water companies
- Publications and financial data of water authorities
- 100 interviews with decision makers and experts on the case studies

Details can be found in the report of METRON (2000) as well in Dalhuisen et al. (2003) and Bithas (2006). To some extent, the case cities are representative ones because of their geographical, climatologic, economic, institutional and other characteristics.

6.2. *Athens*

Athens is a city of approximately 3,100,000 inhabitants (ESYE, 1991). The length of the distribution network ran approximately 7,000,000 m. The water use in households came to 98–115 lit/day/capita (Germanopoulos, 1990; ESYE, 1991; METRON, 2000). The city is located in an area that, apart from being prone to droughts, trails far behind the necessities of the city in terms of water resources with the result that the water system of Athens is largely dependent on remote water resources (Tsakiris 1990).

Table 1 – Costs and prices for two indicative households

Households	Total Consumption	Total Cost	Per Capita Cost	Average Price
Household 1 (two members)	A+A	2A	A	1€/lit
Household 2 (four members)	4A	6A	1,5A	1,5€/lit

The development of the water system has been always financed by the Greek state (investment costs). Until recently, part of the operational costs of the water system was also covered by public funds. This has been changed the last years and the pricing system aims at covering the operational costs. On the other hand, environmental, opportunity and user/scarcity costs are not taken into account although some of them are noticeable. In this context, water prices are set to reflect the average operational costs of water provision. As a result, water prices are substantially lagging behind full costs. Prices are designed in increasing block rates, which have been designed to promote social equity and sufficient provision of low-income households with water. The 95% of indoor water use is actually metered on a regular basis. Although the issue of sustainable water is crucial in Athens it seems that at least an important factor, the efficient use, does not give the right incentives towards sustainability. Indeed, efficiency cannot prevail because significant water costs are totally ignored, with the result that actual use overwhelms the optimum one.

6.3. *Amsterdam*

In 1998, the population of Amsterdam came to about 750,000 inhabitants but in recent years this number has been on the increase. The water system serves approximately 392,307 households, with a distribution network of 2087 km. The per capita water consumption is estimated at approximately 160 lit/day/capita (NIPO, 1997; OFS, 1998). Q10

The decisive characteristic of the pricing system in Amsterdam is the lack of metering in 96% of the household connections. The manner in which water charges are estimated has as follows: every four months and depending on the size of the house they occupy, households pay a fixed fee, which derives from the crucial parameter of the “accounting units” under consideration. An “accounting unit” in Amsterdam is: any room larger than 6 m^2, a kitchen, a bathroom, and a garden not exceeding 65 m^2. Ten is the maximum number of “accounting units” that can be charged to a household with the charge for every “accounting unit” standing at 10 Euros. Single-occupancy households get a reduction of 33.3% on the total of their water bill (AWSC, 1999).

Recent studies indicate that the lack of metering induces an “overuse” of water at 12% (IVAM, 1996,1997). The pricing Q11-12 system fails to relate the actual use of water to its charges and consumers are induced to use water until their marginal benefits approach zero. It is thus evident that the lack of metering prevents efficient use of water. On the other hand, the pricing system governing water use in Amsterdam seems to serve social equity by ensuring sufficient provision of low-income households with water.

Water charges are defined in such a manner as to cover the operational costs of water provision (Vitringle, 1996). Indeed, Q13 operational costs are relatively high since raw water requires considerable processing and adjustment of its quality in order to meet the appropriate standards for domestic use. At the same time, other categories of costs are not systematically taken into account. Investment costs are financed by public funds. Opportunity and user/scarcity costs are not noticeable because of the relative abundance of water resources in the Netherlands. Environmental costs do exist but the management of water resources is effective and eliminates any substantial impact on the environment and the salient resources. As a result, the substantial obstacle standing in the way of efficient use of water in Amsterdam is the lack of metering since users are probably being tempted to overuse water.

6.4. *London*

London is a city of 7,100,000 inhabitants, the biggest city in the European Union. All the more, London presents a dense population estimated at 4480 inhabitants per km^2. Water use comes to approximately 140 lit/day/capita according to 1991 data. Like Amsterdam, London lacks a metering system for domestic water use, with 82% of household connections in England lacking any metering. Water prices are set administratively, on the basis of property values and then are topped by a fixed charge. Thus, they do not reflect the actual use of water.

Until 1974, water prices were kept considerably low thanks to systematic subsidizing of water companies by government. As a result, revenues of water companies did not suffice to finance maintenance of and new investments on the water system. Budgetary constraints that began as a practice around 1974 set the conditions for a new era in water pricing. Between 1974 and 1979 the average water charges increased by over 97% (METRON, 2000; Bithas, 2006) and, after the extended privatisation in 1989, water charges continued to rise. In that period, water prices were supervised by a regulatory authority (OFWAT) that championed public interests. At present, consumers in tandem with OFWAT are exerting pressure for reductions in water prices (Kallis and Coccossis, 2002).

The water system in London followed a long, historical path of development by private utilities. In this context, investment costs were financed mainly by private water companies (Laski et al., 1935; Bolton, 1988; Hassan, 1998). On the other hand, opportunity, user/scarcity and environmental costs are not taken into consideration by the pricing system. Opportunity costs are negligible, as there seems to exist an abundance of water resources. The same holds true of user/scarcity costs. Although environmental costs do exist, the environmental management system is quite advanced and therefore severe environmental impacts are avoided. In effect, environmental costs might prove to be negligible in the end. As a result, the main cause behind inefficient uses being the lack of metering. The lack of metering, in combination with the relatively high fixed water charges, creates conditions of intense water use. Consumers are induced to use water until their marginal benefit drops towards zero with the result that overuse prevails. On the other hand, private utilities come to enjoy net benefits because of relatively high water charges. This cocktail strengthens inefficiency in water use since there is no economic signal connecting actual water charges with actual water use.

6.5. *Seville*

The water supply system of Seville serves a population of 1,200,000 inhabitants. To this, an approximate 1,700,000 tourists are added every year visiting the region for an average stay of 1.9 days. The domestic water use is estimated to be an approximate 145 lit/day/capita (METRON, 2000; Mucillo et al., 2000; Kallis and Coccossis, 2002). The pricing system is based on increasing block rates while the majority of the connections are metered. Prices are set to cover the costs of Seville's water company. The water company shoulders the following costs:

- A substantial part of the investment costs
- A substantial part of the opportunity costs
- A part of the environmental costs

Investment costs were financed jointly by the state and the water company. Since the region is relatively prone to droughts, the water system necessitates high investment costs for transportation and processing of the water. Opportunity costs are substantial in the region owing to the scarcity of water resources and are not estimated with real conditions in mind. Rather, the water company pays the municipalities, which are spatially related to the water resources, an amount that is defined administratively.

Similarly, environmental costs are not systematically estimated either. It should be noted, however, that the water company has been systematic in financing environmental restoration projects. In turn, user/scarcity costs are not taken into account although the use of non-renewable resources is substantial in drought periods. As a result, water prices substantially approximate the actual costs of water use since investment, opportunity, environmental and operational costs are all taken into consideration albeit inadequately in some cases; it is only user costs that are completely ignored. In this context, efficient use is indeed being pursued to a certain degree. Nevertheless, the system of increasing block rates seems unable to effectively support social equity in the use of water.

6.6. *Tel-Aviv*

Tel-Aviv represents a case-city that is characterized by spells of intense heat lasting for almost half of the year while, at the same time, the region itself is relatively droughty. The actual residents of Tel-Aviv are estimated at only 350,000 (Tal, 2000) but its water system serves a population of 600,000–700,000. The domestic water use is estimated at approximately 190 lit/day/capita (METRON, 2000; Bithas 2006).

Water prices are defined in a manner that covers the operational costs of the water company with the addition of a fixed amount that goes to the local authorities. Water prices are estimated on increasing block rates. The fragility of the water system in the region led to the development of a national water management system under strict state supervision. In this context, the costly infrastructure has been financed by the state since 1950 the year during which the development of the water system commenced. Environmental, opportunity and user costs are completely ignored.

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Table 2 – Characteristics concerning sustainability and efficiency in the 5 case studies

Characteristics	Amsterdam	Athens	London	Seville	Tel-Aviv
Prices lagging behind full costs	–	Much	–	Short	Much
Based on own estimations the difference between full costs and actual prices are about:	–	30%–40%	–	15%	30%–40%
Non-metering	Yes	No	Yes	No	No
Increasing block rates	No	Yes	No	Yes	Yes
Prices promoting efficient use	No	No	No	To a certain degree	No
Prices promoting sustainable use	No	No	No	No	No
Prices promoting egalitarian principles in short run	Yes	Yes	–	Yes	Yes

It is worth mentioning that until 1993 government subsidized the operational costs of the water company by up to 40%, while in 1997 the subsidies were reduced to 20% (METRON, 2000).

As a result, the pricing system in Tel-Aviv cannot promote efficient use, at least not under the current conditions of water use. Although the issues of sustainability and water saving are crucial for the region the pricing system does not steer users towards sustainable use.

7. Conclusions

The present paper defines sustainable use of water as the avoidance of losing social welfare in the use of water. Then, the efficient use may be seen as an instrument for the achievement of sustainability. Water pricing is the practical means towards approaching efficient use. Full-cost prices can promote efficient use and therefore sustainability. In this context, two common causes of inefficient use are analyzed: non-metering induces consumers to "maximize" water use while the ignorance of the "external costs" causes a use beyond the one that maximizes social welfare.

Next, the paper examines the effects of egalitarian pricing. What is ascertained from the analysis is that egalitarian pricing that proposes low prices, in one pattern or another, causes increased scarcity. In turn, increased scarcity sets in motion a process of water prices on the upraise which, over time, will inevitably push egalitarian prices upwards as well. In addition, the most common pattern of egalitarian pricing – increasing block rates – cannot promote social equity since it does not take into account the number of members involved in each household.

The paper analyzes five indicative and representative case cities in Europe: Athens, Amsterdam, London, Seville and Tel-Aviv. Not one of the pricing systems applied by the case cities leads effectively to efficient use (Table 2). [Q15] In the cases of Athens, of Tel-Aviv and, to a smaller extent, of Seville, water prices are defined lower than full costs. In addition, in Athens, Seville and Tel-Aviv the pricing system is based on increasing block rates without taking into account the number of members in each household. In consequence, the target of social equity in the use of water is not sufficiently served.

In Amsterdam and London, the lack of metering induces consumers to maximize the actual use. Since the consumer pays a fixed amount, regardless of his use, he exclusively defines his actual use according to his preferences and whims. More often than not, the consumer will use water until his marginal benefit becomes zero and result in the aggregate consumption reaching levels considerably higher than the optimum one.

Based upon the cases reviewed in this paper, we maintain that full-cost pricing does not prevail because of inappropriate perceptions and institutional settings, historical conditions and misinterpretation of equity objectives, all leading to underpricing and overusing the water. The scarcity of resources is intensified and therefore water costs steadily increase. And once costs have increased, actual prices – whatever the framework of their definition may be – will inevitably increase as well.

Such an evolution eliminates the appeal of underpricing as a means towards the promotion of social equity. Social equity cannot be served in the long run since water costs are driven upwards due to the intensified scarcity.

To conclude, full-cost pricing should be a reference point for setting water prices if the objective of sustainability is adopted. Social equity should be brought about by its inclusion in all other appropriate instruments and not by the underpricing of water use. Further research is needed into the development of pricing systems that serve social equity and, at the same time, ensure efficient use. Furthermore, some other non-economic instruments may essentially serve the objectives of social equity.

On the other hand, the paper does not advocate that full-cost pricing and efficient use is the sufficient condition for sustainable water use. Rather, we insist that efficient use is one of the necessary conditions for sustainable use and that, indeed, inefficiency is a cause of un-sustainability. However, additional policies – beyond efficiency – and relevant instruments should be developed and applied in order to ensure sustainable water use.

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