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ISSUES ON DEVELOPING A SUSTAINABLE WATER PRICING

Simona FRONE[1], Dumitru Florin FRONE [2]

[1]Institute of National Economy, at the Romanian Academy, 13 Calea 13 Septembrie, sector 5, 050711, Bucharest, Romania, Phone: +4021/318.24.67, Fax: +4021/318.24.71, Email: simona.frone@yahoo.com
[2]University of Agricultural Sciences and Veterinary Medicine, Bucharest, 59 Marasti, sector 1, 011464, Bucharest, Romania, Phone: +40 21 318 25 64/232, Fax: + 40 21 318 28 88 , E-mail : ffrone@hotmail.com dffrone@yahoo.com

Corresponding author: simona.frone@yahoo.com

Abstract

This paper aims to highlight some of the main issues and challenges raised by developing and implementing the most appropriate and efficient approach for water pricing, to induce a sustainable water management (in its both edges of demand and supply). Therefore, we analyse some of the most important theoretical or mathematical models of water pricing developed so far. We follow with a review of opinions, approaches and some personal judgement and recommendations on the actual opportunity, principles, effectiveness and role of an efficient water pricing in fulfilling the multiple goals of sustainabilty.

Keywords**:** *sustainable water management, efficient water pricing, sustainable cost recovery, equity*

INTRODUCTION

The oldest debate in the literature on water pricing is whether to price water by its average cost (based on financial reasons of cost recovery) or by its marginal cost (based on the economic reasoning of promoting an efficient use of the resource).
Essentially, a resource is considered to be used efficiently if the benefit for society from consuming the last or marginal unit of the resource, is the same as the cost of obtaining it (including the opportunity cost of foregoing other alternative uses).

MATERIAL AND METHOD

As we try to point out below, although marginal cost pricing is consensually recognized as the most efficient way to price water, its implementation depends on the characteristics of water supply and demand [1].
We aim to highlight some of the main issues and challenges raised by developing and implementing the most appropriate and efficient approach for water pricing, to induce a sustainable water management (in its both edges of demand and supply).
Therefore, we analyse some of the most important theoretical or mathematical models of water pricing developed so far. We follow with a review of opinions, approaches and some personal judgement and recommendations on the actual opportunity, principles, effectiveness and role of an efficient water pricing in fulfilling the multiple goals of sustainabilty.

RESULTS AND DISCUSSIONS

As concerning the development of theoretical approaches and models of water pricing, although important to the water utility manager or to the water supply industry regulator who have to present precise water pricing schemes to customers in the specific conditions they operate in [2], theoretical water pricing models are quite scarce and disperse in the scientific literature.
In the glory years of neoclassical economics, authors [3] mainly supported:

-the use of marginal cost pricing of water, opposing the practices of average cost pricing (for the efficiency reasons above mentioned);
-price differentials for on-peak and off-peak demand (introduction of a summer peak-load differential or surcharge in price).
Another author, Riordan [4] compared typical average cost pricing techniques with a proposal of multistage marginal cost pricing, finding that the latter is able to provide a 10-20% increase in total net benefits. When supply approaches capacity, the price necessarily rises, keeping demand within capacity constraints. Some dynamic programming techniques were employed to derive optimal capacity expansions and their adequate timing for urban water supply treatment facilities.
In a more recent study, the authors [5] analyze a constrained water pricing method (where there are constraints on the magnitude of price changes allowed in a change from average cost pricing to an optimal marginal cost pricing rule). They find a scheme which, although less efficient than the optimal marginal water pricing derived in their model, can still increase benefits to society when compared to actual average cost pricing practices.
Further outstanding contributions are by other authors [6], who developped a model of water pricing with the ability to reflect variations in water supply on the price of water (supply-based water pricing model) and to consider the revenue constraints of the water providing agency. The authors assessed the impact of the pricing policy on water use, land use and energy use, through a simulation technique applied to a water district in U.S.A.
As mentioned in the beginning of the paper, water scarcity is one major issue of concern which must be taken into consideration for an efficient water pricing, able to shape sustainable water management and infrastructure development.
Therefore, aware of the need for determining the scarcity rent of water, Moncur and Pollock [7] considered the case of a water utility with groundwater as its only source, using a nonrenewable resource efficient extraction model to determine the scarcity value and further the efficient path of price in the future.
The scarcity value of water takes in consideration the future increase in costs determined by the necessity to use costly backstop technologies (such as desalination) to satisfy water demand.
In another study to be cited [8], authors developed a model which may help to determine the efficient pricing for increasing the effectiveness of water conservation measures.
They calculated a reduction factor in water use as a function of water price elasticity as follows:

$$R_t=1.0- (P_1 / P_2)^e,$$

where
R – reduction factor;
P_1 – initial price
P_2 – final price
e- elasticity of demand, which is a measure of how strongly the quantity demanded responds to change in price
The paper of Crowley [9] demonstrates that since a price increase will tend to depress demand, it must consequently decrease sale of water.
Therefore, authors proposed a polynomial relationship between consumption of water and its price, to be also applied to the present relationship between sale of waterworks and price of water.
Their mathematical formula was chosen for two reasons:
1.the agreement with economic theory, according to which, as the price of water increases its consumption falls;
2.the graphical representation of this relationship is a convex curve, which does not cross either vertical or horizontal axe.
Since y is proportional to the inverse of x, hence a_2 must be negative. When a_2 equals zero, changes of prices have no effect on demand.

$$y_t = a_1 x_t^{a_2},$$

where:
y_t - sale of water in period t
x_t - price per unit of consumption in period t,
a_1 - constant,

a_2 - a coefficient which measures the elasticity of demand.

According to this formula, as the price of water increases, its consumption decreases in an asymptotic way (the reverse is also true).

A large inelasticity of demand in households occurs when coefficient a_2 has a value between –1 and 0. When a_2=-1, then y_t is proportional to $1/x_t$ (reverse of x_t), small changes of x_t cause almost proportionate changes in y_t.

Another contribution to pricing for the water scarcity was made by Griffin [10] who demonstrates that the price of water should also include non-accounting opportunity costs such as:

-marginal value of raw water (surface and fully renewable ground water sources, in scarcity situations);

-marginal user cost (to take into account the sacrifice of future uses in unrenewed groundwater supplies);

-marginal capacity cost (when the water supply possible for the capacity installed is less than the water demand).

We should mention also a more recent model of sustainable water pricing in Central and Eastern Europe [11]; the results of this model show that the decrease of water consumption in households leads to a significant increase of water price. Water saved by domestic consumers leads to a decrease of water production by waterworks and declining utilisation of the waterworks capacity.

Nevertheless, the relationships presented concern only the circumstances in which volumetric tariff system is applied. In reality, the authorities provide subsidies and do not allow introducing too high prices.

Sustainable water pricing may though require an evolution from a too rigid doctrine since marginal-cost pricing does not always and entirely reflect the real needs of the water systems and the served communities.

From the perspective of sustainable water resources management there are also other major concerns [12]:

(1) a purely economic market approach may not adequately protect natural ecosystems because environmental values (also referred to as ecological services) are rarely quantified or transacted in the market;

(2) true markets for water cannot be established within the existing complex system of water laws and water rights;

(3) water marketing can cause economic dislocations in economies that depend on water but which cannot compete with the highest bidders (for instance rural economies may lose access to water that would be transferred to higher value uses in urban areas).

Therefore, a thorough neo-classical interpretation of “water as economic good”, stating that water should be priced at its economic value, so the market will then ensure that the water is allocated to its best uses, has led to a considerable misunderstanding on the 4th Dublin water principle [13].

This purely economic pricing of water would damage the interests of the poor and make irrigated agriculture virtually unfeasible.

As a result, a number of disclaimers were added to the fourth Dublin principle, stating that water is also a “social” good and that water should be affordable to the poor and rural inhabitants.

In an alternative school of thought there is no such confusion, beeing in agreement with the other Dublin principles and the concept of IWRM.

Here, in the papers of Green [14], water economics is understood to “deal with how best to meet all human wants” making the right choices about the allocation and use of water resources on the basis of an integrated analysis of all the advantages and disadvantages (costs and benefits in a broad sense) of alternative options.

So, some economists [13] state that considering water as an economic good is mainly about making integrated choices, and not about determining the right price of water. They even consider water pricing as the pitfall of the concept “water as an economic good.”

There are other authors sharing the quite similar opinion that basic economic principles provide necessary but not always sufficient input to the process of designing water rates [15].

How efficient, important and comprehensive must be water pricing to provide for a sustainable water management and development?

Ideally, a sustainable water pricing should :

(1) reflect true costs and therefore induce efficient water production and consumption;

(2) promote the achievement of least-cost solutions for the provision of water service (optimization of water infrastructure and operation);

(3) be equitable in terms of incorporating cost-sharing practices as needed to enhance affordability of the water service;

(4) ensure the long-term viability of the water utility.

A recent study [16] also states that 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. However, the author agrees that additional policies – beyond efficiency – and relevant instruments should be developed and applied in order to ensure sustainable water use.

We also believe that, due to the difficulties involved by the practical implementation of water pricing with full-cost recovery, a sustainable water pricing should allow for sustainable cost recovery (SCR), a concept introduced in the Camdessus report with at least three main features :

• an appropriate mix of tariffs, taxes and transfers to finance recurrent and capital costs, and to leverage other forms of financing;

• predictability of public subsidies to facilitate investment (planning);

• tariff policies that are affordable to all, including the poorest, while ensuring the financial sustainability of service providers.

A sustainable cost recovery strategy for the water sector aims to sustainably cover costs through a combination of three sources of revenues: tariffs (or other charges linked with water use), taxes (in the form of subsidies from national or local governments) and transfers (from international donors or local charities) – the "3Ts" [17].

Final users and local or international taxpayers are those who actually pay for water. External sources of finance that must be repaid (loans, bonds, etc.) or compensated (equity), can only bridge the gap between finance needs and available resources, particularly for investment costs that could not be covered up front through revenues alone.

In our view, the most important issue in sustainable water pricing and other policies for sustainable water management is to never forget, disconsider or neglect any of the four dimensions of sustainability (Table 1).

Table 1. Main issues and policy objectives for sustainable water management

Objective: **Environmental sustainability** Policy: **Discourage depletion of critical natural capital** • Guarantee the preservation of ecological functions of water natural capital • Minimise the use of "supply side" solutions to water scarcity • Use efficiency - Encourage water saving - Discourage wasteful water use • Minimise the alteration of natural flow patterns	Objective: **Financial sustainability** Policy: **Guarantee long-term reproduction of physical assets** • Compensate the resources that are used as inputs in water-related activities • Cash flow should guarantee the conservation of value of physical assets • Cost efficiency: minimise lifecycle costs of services, *i.e.* the creation of physical capital and operation and maintenance costs • Cost recovery should be for optimized costs only
Objective: **Economic efficiency** Policy: **Water is allocated to the most beneficial uses and economic resources are not wasted** • Allocation efficiency:	Objective: **Social equity** Policy: **Access to affordable water at fair and equitable conditions** • Identify "water needs" and allocate

- Allocate water with priority to uses with highest value to society as a whole - Compare costs of water management and water-related services with their value, *i.e.* do not misallocate economic resources • Regulation should ensure optimal risk allocation among stakeholders (including users and taxpayers)	water in a way that is not skewed by concentration of power • Structure tariffs so that lower-income users can have access to and afford to use WSS services • Achieve an equitable way to share the cost of managing water resources

Source: Own interpretation based on table 1.1., p.25, Pricing water resources and water and sanitation services, OECD, 2010

CONCLUSIONS

Although the environmental, economic, financial and social objectives of a water management policy implemented for a sustainable and efficient water pricing can support one another, sometimes they can also give rise to potential conflicts and necessary trade-offs.

However, sustainability can achieve a balance among these goals, representing a whole that is larger than the sum of the parts considered separately.

Still, the implementing of a really sustainable water pricing system by the water management authorities and companies, with all the involved principles and features, may be a difficult task.

Some practical strategic steps for this may require:

-the long-term planning of financial management, investment, development, and pricing at water companies;

-economic optimizing of the activity taking advantage of economies of scale (for instance through aggregation and regionalization) of water utilities, since achieving least-cost operations provides a basis for long-term efficiency;

-proper economic assessment of the costs of water and WSS provision;

- acknowledgement of the cost-price-demand correlation (function);

-sending accurate price signals that reflect marginal costs;

-addressing equity concerns of policy choices which have distributional consequences;

-continuous monitoring of the costs and revenues;

-making the neccessary price adjustments, when needed.

Further theoretical and empirical research will be dedicated to the analysis and comparision of the effectiveness and sustainabilty of different models of water pricing, as implemented in Romania and other mainly European Union member countries.

Another important issue of further research is the correlation between the pricing of water and the evolution of water use and demand.

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