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Analysis of water prices in urban systems: Experience from three basins in southern Portugal

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Abstract: The economic analysis of water uses is one of the main components of river basin management plans (RBMP), as established by the Water Framework Directive. Thus the first-generation RBMP for Portuguese river basin districts (RBD) 6 – Sado/Mira, 7 – Guadiana and 8 – Ribeiras do Algarve included a thorough economic analysis of urban drinking water supply (WS) and wastewater drainage and treatment (WWDT) systems. This paper summarizes results on the role of prices, encompassing the assessment of cost-recovery levels, the discussion of tariff structures, the estimation of residential water-demand elasticities and an appraisal of affordability conditions. RBD7 had the lowest cost-recovery levels, namely in WWDT, but revenue was insufficient to guarantee financial equilibrium in all RBD. As for tariff structures, they were far from complying with the economic regulator's recommendations or meeting economic efficiency criteria. The estimated residential water-demand elasticities indicate that climate change may have a strong impact on demanded quantity, whereas price has a significant but limited impact on moderating demand, illustrating the need for a combination of price and non-price policies. On the other hand, low price elasticities imply that price increases could be effective in writing off tariff deficits. Average household expenses with water services were still substantially lower than the OECD recommended threshold, although tariff increases need to be done in a way that ensures access to the poorer households.

Key words: water economics; cost recovery; water supply; wastewater; water tariffs; residential water demand; affordability

1. INTRODUCTION

The economic analysis of water uses, in its broadest sense, is one of the essential components of modern River Basin Management Plans (RBMP). In Europe, most of the legal requirements concerning economic analysis originate in the Water Framework Directive (WFD) (Directive 2000/60/EC), which was the first legal instrument to incorporate economic requisites into water policy. In particular, Article 5 refers the economic analysis of water uses as integral to the characterisation of each River Basin District (RBD), and Article 9 highlights the principle of cost-recovery and the role of prices as an incentive for efficient water use. Other aspects are detailed in a European guidance document (WATECO, 2002). Maestu and Gomez (2011) list the expected contributions of economic analysis to the implementation of the WFD, many of which we present in this paper for the Portuguese case, namely the estimation of water demand, including price-elasticity, the analysis of cost recovery, and the role of the pricing instruments.

This is an important contribution to the literature since, in spite of the legal framework, the majority of subsequent RBMP at a European level handled economic analysis superficially, prompting the European Commission to identify the development of economic instruments as a key element for future action (EC, 2007), because "full exploitation of these economic instruments will contribute to truly sustainable water management." A more recent document (EC, 2012), which assesses the state of WFD implementation, notes that pricing is still far from being transparent or efficient. A few authors have already produced research discussing the manifold goals attached to pricing policies (efficiency, cost recovery, universal access and simplicity) and describing the complex structures commonly encountered (Barbéran and Arbués, 2009; Bithas, 2008; García-Valiñas, 2005; Martins et al., 2013a; Martins et al., 2013b; Montginoul, 2007; Monteiro, 2009; Ruijs, 2009). It is, however, uncommon to find a more complete analysis of pricing within the context of RBMP.

Some research has been devoted to other aspects of economic analysis. As noted in Martin-Ortega (2012), the economic analysis required for WFD implementation had two phases: the first included the characterisation of water uses, scenarios and potential for cost recovery; and the second focused on the selection of programmes of measures to meet good ecological status along with possible assessments of disproportionality of their costs when compared to their benefits. Research on the latter focuses on hydro-economic modelling (Heinz et al., 2007), cost-effectiveness analysis (Berbel et al., 2011; Martin-Ortega and Balana, 2012) and the assessment of costs and benefits through stated preference methods such as contingent valuation (Brouwer, 2008) and choice experiments (Hanley et al., 2006; Stithou et al., 2012; Martin-Ortega et al., 2011). However, reports on the former are written in the national languages of each country and the role of pricing is seriously neglected. This paper contributes to fill this gap.

Portugal duly presented its first economic characterisation report in 2005 (INAG, 2005) and in the same year the country's Water Act (Law no. 58/2005) was approved, clearly stressing the economic analysis of water use and the role of price policies. This paper presents some elements of the economic analysis for urban systems that was performed in the RBMP of three RBDs in Southern Portugal: RBD6 – Sado/Mira, RBD7 – Guadiana, and RBD8 – Algarve. In particular, it summarizes results on the role of prices, encompassing the assessment of cost-recovery levels, the discussion of current tariff structures, the estimation of residential water-demand elasticities and the appraisal of affordability conditions. The data refers to 2008, which was the latest year available at the time of plan development (for more detailed information, including additional results of economic analysis such as agricultural use and cost-effectiveness, see NEMUS-ECOSSISTEMA-AGROGES (2011a and 2011b) and NEMUS-HIDROMOD-AGROGES (2011)). In the following section cost-recovery levels are discussed. Then in Section 3 the existing tariff structures are analysed in light of the characteristics of water markets. Section 4 shows water demand estimations for the residential sector, including relevant elasticities, and finally Section 5 analyses affordability of water services.

2. INDICATORS RELATED TO COST RECOVERY

Although urban systems usually represent a relatively small percentage of overall water use (abstracted annual volumes are equivalent to less than 10% of consumption in RBD6 and 7 and about 22% in RBD8), they are nonetheless a priority because of their role in supply to the population.

The main source for the data presented in this paper is the National Inventory of Water Supply and Wastewater Systems (INSAAR), which covers both WS and WWDT systems. Therefore, we begin by presenting cost-recovery indicators published in the INSAAR 2008 report (INAG, 2010a) for the final services rendered to consumers (this does not include transactions between utilities within each RBD).

Table 1 shows that cost-recovery is far from adequate, with manifestly lower levels in WWDT, both for our RBDs and for mainland Portugal (Portuguese Autonomous Island Regions are excluded from the national numbers throughout the paper). In order to provide a fuller picture, it is necessary to understand why these levels are so low, distinguishing between the various components that make up the cost-recovery indicator. This is the goal of the remainder of the present section.

Unfortunately, INSAAR's database is not complete. Although survey response has improved, there are still considerable gaps, especially in economic data. Therefore, each indicator we show in the rest of the paper comes with the number of utilities that provided information (the different methodological options and the full list of utilities are discriminated in the RBMP).

Table 1. Cost-recovery levels for WS and WWDT: RBD6, RBD7, RBD8 and mainland Portugal (PT) (2008).

	RBD6	RBD7	RBD8	PT
Cost-recovery level WS	96%	45%	75%	82%
Number of WS utilities	26	27	19	293
Cost-recovery level WWDT	65%	21%	49%	48%
Number of WWDT utilities	25	32	18	298

Source: INAG (2010a, 2010b, 2011)

2.1 Volumes

In all RBD, the great majority of utilities provide both WS and WWDT services. The present work discriminates not only between WS and WWDT services, but also between services rendered to final consumers (retail services) and transactions between utilities (bulk services).

The first important question about urban networks is which customers are served. Figure 1 shows data for the volume of water supplied (WS) and drained (WWDT), for retail services. RBD8 shows significantly higher volumes. The majority of water supplied to urban systems, whether invoiced or supplied free of charge, goes to the Residential sector. As for other uses, the separation by sector is based on the existence of distinct tariffs that allow utilities to classify data, and to complicate matters not all utilities make the same discrimination. Commercial/Services represent between 11% and 15% of water supply, while between 13 and 15% of water supply goes to other sectors. This classification encompasses a wide range of uses, from institutions such as schools, hospitals and fire departments, to specific activities such as tourism, although this last category is not always identified separately. Water supply to agriculture sector is almost inexistent, except in RBD7. Water supply to Industry is also quite low, especially in RBD6 and 7. Obviously, these figures do not convey the economic importance of these water uses, as the majority of water taken by agriculture and industry users does not come from urban systems.

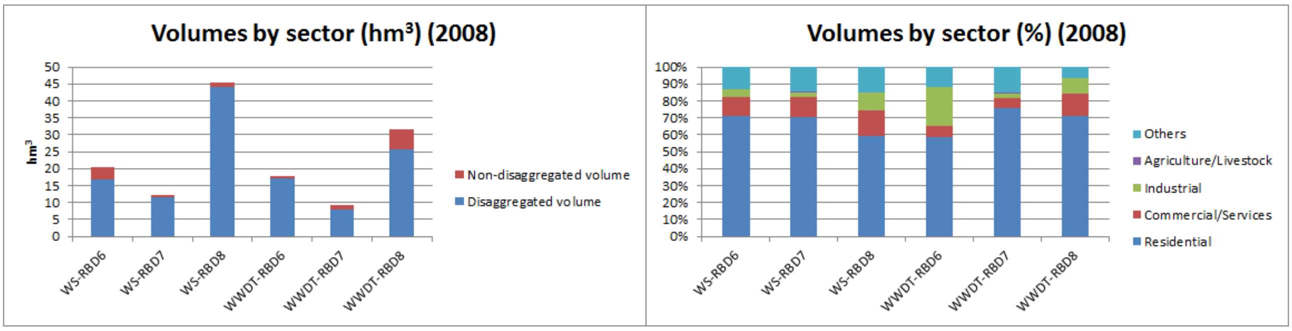

Figure 1. WS and WWDT volumes: RBD, RBD7 and RBD8 (2008). Number of utilities with information: WS: RBD6: 21, RBD7: 23, RBD8: 17; WWDT: RBD6: 16, RBD7: 18, RBD8: 10. [Source: INAG (2010a, 2010b, 2011) and information requests to water utilities (own calculations)]

Turning now to wastewater, the data generally shows a lower volume of drained water than supplied, as would be expected. Nonetheless, in RBD6 the Industrial sector is responsible for a much larger part of drained water (23%), than that of water supplied to this sector (5%). This significant difference can be explained by the fact that many industrial units have their own water abstraction and supply systems (namely in Sines), but then discharge onto urban drainage and treatment networks. In RBD8, the Residential sector shows a much higher weight in the volume of drained water (71%) than of supplied water (59%); the remaining sectors indeed account for a much smaller part of drained water in this area.

2.2 Revenues and costs

With respect to the economic data, Figure 2 summarises the existing data for unit revenues and costs (€/m^3) relative to retail services in the RBDs under analysis and for Portugal, for comparison, showing that a portion of the revenues comes from non-tariff sources. While total unit revenues for WS in all three RBDs are lower than the national average (1.26 €/m^3), for WWDT only RBD7 has lower unit revenues (0.42 €/m^3) than the national average (0.62 €/m^3). All monetary data is in euros at constant 2008 prices. Note that WS indicators can be considered more reliable, as they generally include more utilities than the WWDT data.

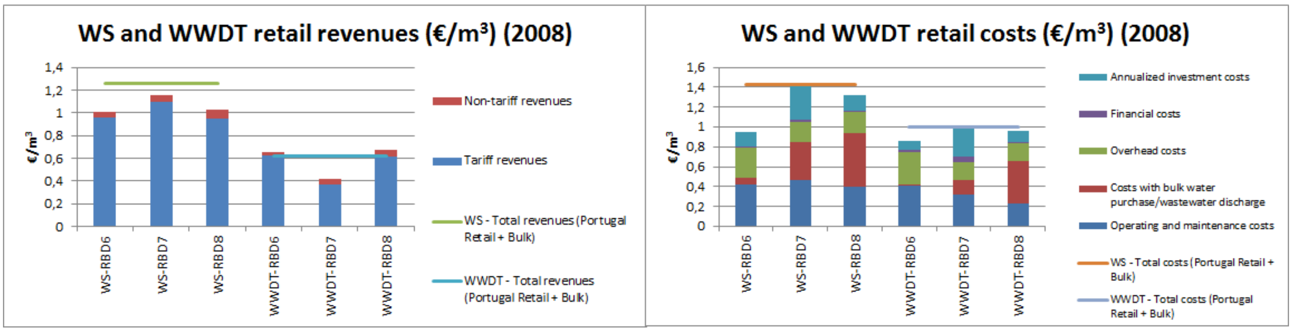

Figure 2. Unit revenues and Costs: RBD, RBD7, RBD8 and Portugal (2008). Number of utilities with information: WS: RBD6: 18, RBD7: 20, RBD8: 15; WWDT: RBD6: 12, RBD7: 13, RBD8: 10. [Source: INAG (2010a, 2010b, 2011) and information requests to water utilities (own calculations)]

The most important indicators for analysing costs, apart from the overall value of unit costs, are the partitions into: operating and maintenance costs, which in principle depend more directly on volumes and which include items such as electricity, staff and intermediate products; water purchasing/discharging costs; investment costs; overhead costs; and financial charges, which represent a small proportion of total costs for retail services. Original data is again sourced from INSAAR, where utilities filled out 2008 values for each item as well as yearly investment figures since 1987, excluding investment in dams. Utilities do seem to have some difficulty presenting data for the different cost categories (INAG, 2010a). Recently, the Sector Regulator (ERSAR) took on the task of gathering and validating utilities' data so the quality of information should improve in coming years (see ERSAR, 2014).

Figure 2 also shows significant differences between unit costs for retail services, with RBD6 showing the most favourable figures for both WS (0.95 €/m^3) and WWDT (0.86 €/m^3), which is why it has better cost-recovery levels. There is also a great disparity in the cost structure between RBDs. This reflects the different options taken while managing retail and bulk systems. Operation and maintenance costs have a relevant expression, especially in RBD6 where they represent nearly 45% of WS unit costs and 48% of WWDT unit costs. In contrast, in RBD8, utilities use bulk services a lot more, with water purchase costs reaching notable values (around 41% for WS and 44% for WWDT). In RBD7 investment costs bear more weight (26% for WS and 30% for WWDT). Overheads are also considerable in all RBDs, although RBD6 shows noticeably higher figures (32.2% for WS and 38.6% for WWDT).

As for bulk services, a complete analysis cannot be carried out because of the reduced number of utilities that provided information. Still, it is worth stressing the much more significant weight of financial charges, almost always above 10%, and which in RBD7 actually make up the majority of costs for some utilities. On the other hand, investment efforts are visible in the cost data, especially in RBD8 for water supply, where investment costs go beyond 50% of total costs. As usual, Operation and Maintenance Costs also make up a reasonable component of total costs.

As referred in the Introduction, the legal goal of adequate cost recovery still has not been achieved in Portugal, and the gap between revenues and costs is especially significant for WWDT. Table 2 presents cost-recovery levels for retail systems, separating WS and WWDT.

Table 2. Cost-recovery levels in retail services: RH6, RH7 and RH8 (2008).

	RBD6	***RBD7***	***RBD8***
WS	*106%*	*80%*	*78%*
	(85%)	*(72%)*	*(91%)*
WWDT	*67%*	*43%*	*73%*
	(90%)	*(52%)*	*(89%)*

Note: between brackets we show the % of supplied/drained volume for the utilities with enough information to be included in the calculations for each case. Source: INAG (2010a, 2010b, 2011) and information requests to water utilities (own calculations)

The results for retail WS suggest that costs are already being completely recovered in RBD6, although cost-recovery levels for WWDT are considerably lower, indicating that, in practice, WS is subsidizing WWDT. In RBD7, overall cost recovery is worse, but there is also a significant difference between WS and WWDT, although the data is less complete. In RBD8 both WS and WWDT have more similar cost-recovery levels, still far from sustainable.

Some multi-municipal systems, which constitute the majority of bulk services, also have problems with financial sustainability. The 2008 Annual Report of the Water and Waste Sector in Portugal (RASARP) (ERSAR, 2009) indicates that approved tariffs for water supply and wastewater were lower than those considered necessary in many systems throughout Portugal, including a relevant number of those active in the Southern RBDs under analysis. In the ensuing years there has been an effort to adjust approved tariffs, and the RASARP 2010 (ERSAR, 2011) informs that some of the above-mentioned utilities are "moving towards a tariff which will allow recovery of costs and concession charges". However, there are cases such as the Águas do Norte Alentejano, where the approved tariff in 2010 was 0.6223 €/m^3, which is one of the highest bulk tariffs in the country yet is still lower than the figure required for financial sustainability, reflecting the difficulty in ensuring tariff balance in a region with large networks and low population density. These tariff insufficiencies in bulk services, combined with severe delays in payment by municipalities, contribute to the high levels of financial charges and can endanger the financial sustainability of the whole system.

A final observation on cost recovery has to do with investment subsidies. As utilities can only recover costs that were in fact incurred, calculation of cost-recovery levels takes into account annualized investment costs net of subsidies. Although INSAAR's database includes a field for subsidies, most utilities did not completely fill it out. In the Alentejo river basins (RBD6 and RBD7), declared subsidy values range from 2% to 12% of investment costs, which is much lower than the effective subsidy levels for 2000-2007. During this period, reimbursement rates for Structural and Cohesion Funds oscillated between 48% and 69%, depending on the component (WS and WWDT) and on the system (bulk or retail). In RBD8, the 2% declared subsidy rate is again much lower than actual subsidy percentages, which ranged from 50% to 75%.

It is important to remember that the objective is to attain an adequate recovery of all costs, including not only financial costs but also environmental and scarcity costs. Although estimates for the latter do not exist in Portugal, a new water resource charge (TRH) came into effect in 2008, partly in order to internalize such costs. This is described in the next section.

3. ANALYSIS OF THE WATER MARKET

Apart from ensuring cost recovery, water prices also have the fundamental role of contributing to an efficient use of the resource. This reflects a balance between the price paid for an additional unit of water (marginal price) and its marginal cost, ensuring that only units that generate a benefit that is higher than their cost are consumed. The only costs that can be recovered by the tariff per se are those actually incurred by utilities. Additionally, consumers can be taxed (for example to cover environmental or regulation costs) or part of the costs can be covered with subsidies (given the overall objective of providing universal access to water).

In practice, Portuguese tariff structures often do not promote efficiency goals. This is due to the geographical fragmentation of services, but also to the fact that water is an essential resource and thus carries social and political weight. In this section a simplified analysis of the theoretical characteristics of the water market is presented, and an analysis of the tariff structures of RBD6, 7 and 8 is carried out, considering Article 9 of the WFD as well as national guidelines. For an analysis of the different goals that can be attributed to water tariffs, see Monteiro (2009).

3.1 Efficiency in water allocation

The water market comprises a set of characteristics that make its economic analysis complex. The first important one is a decreasing average cost of production as quantity increases due to the coexistence of high fixed costs and low variable costs. Water supply and wastewater drainage and treatment are thus classic examples of sectors with strong economies of scale, given the sizeable investment in infrastructures, as well as fairly constant marginal costs – the cost of supplying (or treating) an additional m^3 does not vary significantly with the amount of water supplied (or effluent treated).

In Figure 3, the marginal cost of an operator is represented by the constant *MC* line, while the average cost is the *AC* curve. Average costs are always higher than marginal costs due to average fixed costs, which also explain the decreasing slope of *AC*.

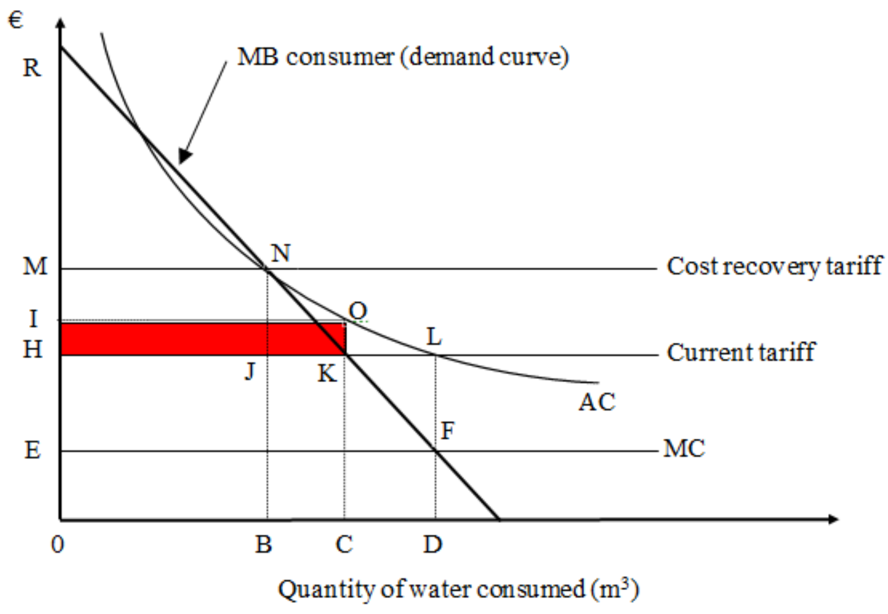

Figure 3. Analysis of the water market excluding environmental costs.

This kind of cost structure does not support the involvement of several operators, so that typically the best solution for water supply (or effluent treatment) is a local monopoly. In fact, in a hypothetical competitive equilibrium (point F), the revenue associated with a price E, equal to marginal cost, would be insufficient to cover the costs for producing (or treating) quantity D. In situation F the operator might not make a loss if the fixed part of the tariff covered the difference. This would be possible as long as the fixed tariff (which provides access to the service and guarantees cost-recovery) was superior to the net benefit obtained by the consumer. The split between fixed and variable components is, in fact, an important issue in the search for a balance between the goals of efficiency and cost recovery. The aim of legal instruments is therefore not to get a competitive equilibrium, but rather to reach a situation where operators achieve an adequate recovery of their average costs. This would correspond, for example, to point N in Figure 3.

A lower than necessary tariff has two immediate consequences. On one hand, if we have a negatively-sloped demand curve, a larger (C>B, see Figure 3) quantity of water (or effluent) is consumed (or treated); on the other hand, a tariff deficit accumulates, which in Figure 3 is equivalent to area [HKOI] in red. Naturally, the necessary rise in prices implies a loss of welfare for consumers, which will be larger the lower is demand-price elasticity, that is, the less quantity varies in response to a tariff variation. The fact that water is an essential good means that price elasticity is normally low.

3.2 The Portuguese water resource charge (TRH)

Even if financial costs were fully covered by utility's water tariffs, however, there could still be insufficient recovery of non-financial costs such as those associated with environmental and resource costs, implying an inefficiently high level of consumption. As referred in section 2, one of the aims of the Portuguese TRH is to internalise environmental and scarcity costs in the price mechanism, even though the actual values stipulated for the charge were set rather arbitrarily, as these costs are difficult to estimate. In the static water market model, the introduction of a charge such as the TRH will induce lower consumption levels; ideally, the value of the charge will be set so that only units with a marginal cost (including environmental and scarcity costs) that is higher than the marginal benefit conferred to the consumer will be used, thus eliminating the problem of overconsumption.

The TRH has five components (water abstraction, extraction of sand and other inert materials and occupation of State water public domain, effluent discharge and use of water subject to public water management) not all of which are applied to all users. Calculations are always based on the application of a unit rate to relevant quantities, and the first component has a scarcity coefficient to reflect water availability conditions in different Portuguese basins. To get a feel for the numbers involved in the river basins under analysis, Figure 4 summarises the amount charged by the Alentejo and Algarve river basin district agencies for 2009 (the first full year in which the TRH was charged), by sector. The figures come to around 3.8 million Euros in RBD6 and 7, and 3 million Euros in RBD8, including all sectors and components.

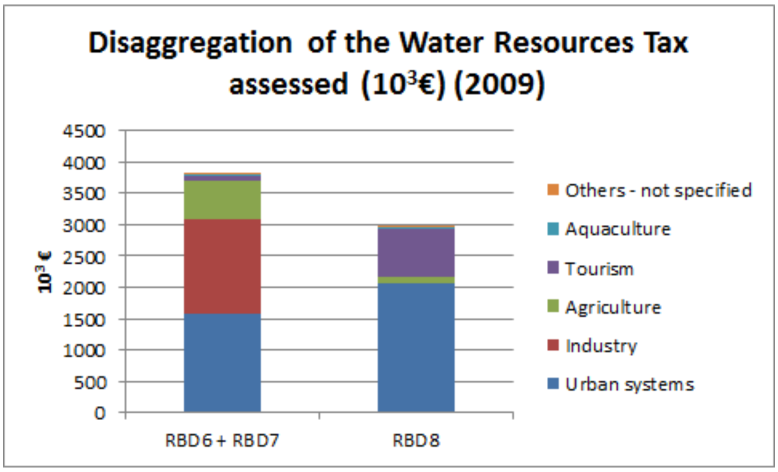

Figure 4. Assessed TRH by sector: RBD6+RBD7 and RBD8 (2009). [Source: ARH Alentejo, ARH Algarve]

Analyzing the data by sector shows that urban systems are the largest contributors to the TRH, especially in RBD8 where they account for 69% of TRH revenue. Note that TRH revenues from urban systems represent 3.1% of the tariff profits from water utilities with information from RBD6 and 7, and 1.9% in RBD8. Also, these charges are passed on to final consumers. Industries not linked to urban networks make up 35% of RB6 and 7's joint revenues, but do not contribute at all to RBD8's. It should be noted that Agriculture only pays water use components, as the TRH does not require payments for diffuse contamination. The remaining sectors contribute only residually to the TRH, the only exception being the Tourism sector, which makes up 25% of the TRH in RBD8 due to the watering systems for golf courses and to beach support services at public maritime locations.

3.3 Analysis of water tariff structures

Apart from not covering costs, the retail tariffs applied in Portugal have another problem, which is their complexity. There are many tariff structures in the country, with differing blocks and calculation methods, as well as tariff components based on factors other than water volume (especially in the case of WWDT). As noted in Recommendation 1/2009 (IRAR, 2009) "These tariffs have, in many cases, no technical or economic justification, both in terms of their structure and their values, failing to give end-users any guidance towards a more efficient use of the services". The remainder of this section will present the characteristics of retail tariff structures for RBD6, 7, and 8.

In all these river basin districts, utilities present tariff structures that discriminate among sectors, as well as somewhat different fixed and variable components for each sector. Although a large number of sectors are described in INSAAR's database, we will present only three aggregates: Residential, Commercial (which in general includes Commercial/Services, Industry, and State), and Non-Profit. Different economic activities tend to have similar prices in most utilities, while many charge lower tariffs for non-profit activities. This aggregation is compatible with the Recommendation 1/2009 (IRAR, 2009), which also defends social tariffs for low-income residential users and seasonal differentiation when justified. Interestingly, a more recent and thorough analysis of non-residential tariffs finds that the highest tend to be charged by utilities to State entities (Silva, 2012). Rodrigues (2012) shows that tariff structures are still far from complying with ERSAR recommendations, as well as criteria for economic efficiency, as it will also be shown here.

In RBD6 and RBD7 almost all utilities discriminate between residential and other sectors, while in RBD7, 13.2% do not. With respect to WWDT, there are a larger number of entities that do not separate tariffs by sector.

Figure 5 shows the type of WS tariff structure for each sector in each RBD. The most frequent situation is a combination of a fixed component with a variable component. From the point of view of incentive pricing, it is important to detect whether consumer expenditure does in fact depend on consumption (see Section 4). Available data shows that the fixed component is a significant factor. For example, over 20% of WS revenues in RBD6 and 7 come from the fixed component, while in RBD8 these figures are a little lower (17.2%). On this topic, note that Law no. 12/2008 states, in its Article 8, that tariffs "that do not correspond directly to a cost that the utility incurred" cannot be charged to consumers. This led some utilities to remove the fixed component of the tariff that year – this is particularly visible in RBD8. However, the Law does not mandate removal of the fixed component, only requiring that it be grounded in incurred, and presumably fixed, costs.

The fixed component in WS tariffs, when present, depends on the pipe diameter (in mm), with the most frequent pipe diameter in the residential sector being 15mm. The variable component, which is charged by all utilities to the Commercial sector, and in most cases to all other sectors as well, may take on different forms. For example, there may be a single price per m^3, or different blocks with increasing or decreasing prices. In practice, decreasing blocks are never employed in Portugal, and the vast majority of utilities apply increasing tariffs, especially in the residential sector where all tariffs with a variable component have this configuration.

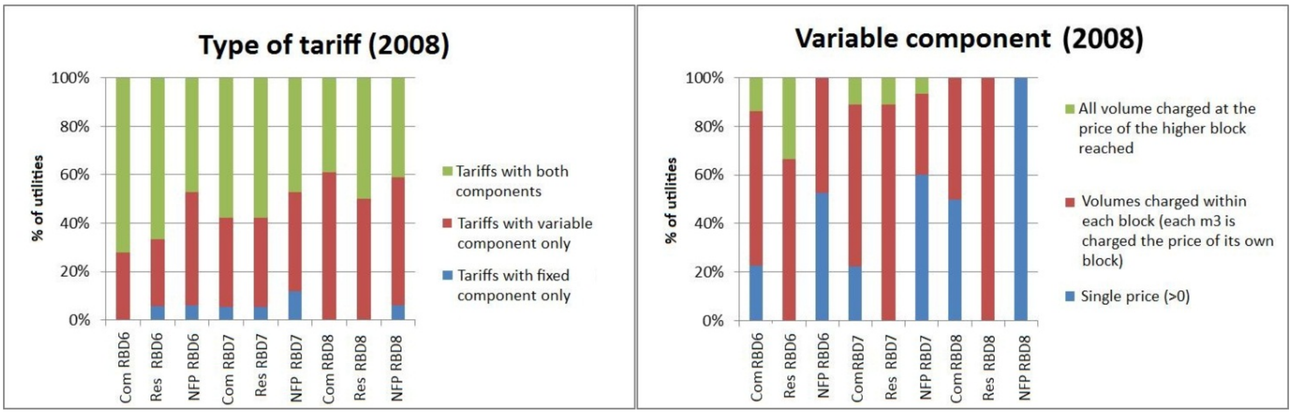

Figure 5. Tariff structures for WS by sector: RBD6, RBD7 and RBD8 (2008). [Source: INAG (2010a, 2010b, 2011) and information requests to water utilities (own calculations)]

The use of blocks with increasing prices has become more popular in many OECD countries (OECD, 2010), and in Portugal it is already a rooted practice. It allows the first few m^3 of water to be provided at a reduced price, in line with the principle of universal access to water. In the upper blocks, the price is higher, thus contributing to finance supply costs and discouraging overconsumption. A noteworthy aspect has to do with the different formulas used for calculating payments. The volume of water supplied can be invoiced in two different ways: by charging each m^3 at the price of the corresponding block, or by charging all m^3 at the price of the maximum block that was reached. A non-negligible portion of utilities in RBD6 and 7 uses the latter formula for residential consumers, although it is no longer used in RBD8. Where applied, this formula results in the appearance of “peaks” in the marginal tariff, taking on quite high values at block limits.

The most common number of blocks for the residential sector is 4 in RBD8 and 5 in RBD6 and 7, although the maximum number of blocks we found was 29 (!). In contrast, ERSAR recommends 4 blocks for residential users. It should be noted that there is no economic basis for a high number of blocks or for marginal price “peaks”.

Considering tariff evolution over time, Figure 6 shows that from 1998 to 2008 tariffs (at constant 2008 prices) generally increased, with a tendency for a higher increase at higher consumption levels, although some tariff increase in the first m^3 is also seen, except in RBD8, where the removal of the fixed component by a few utilities led to a decrease in the average tariff for lower consumption rates.

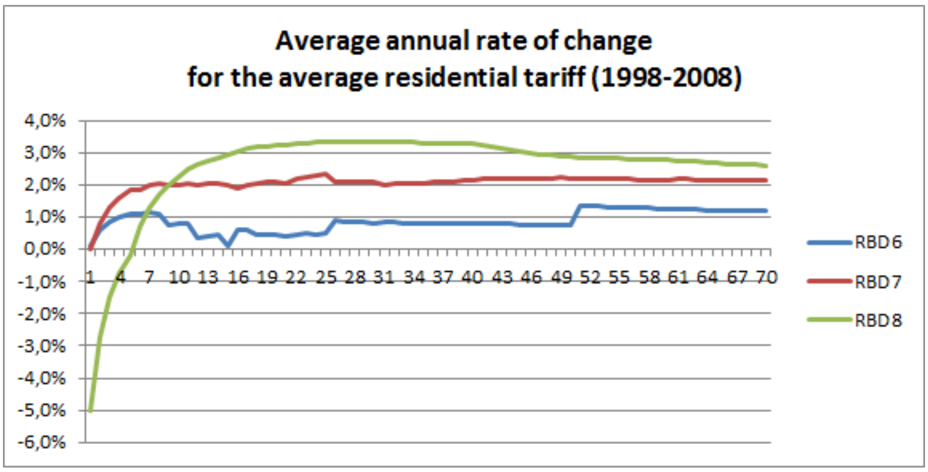

Figure 6. Evolution of the average residential tariff for WS, by consumption level: RBD6, RBD7 and RBD8 (98-08). [Source: INAG (2010a, 2010b, 2011) and information requests to water utilities (own calculations)]

An additional element that could be applied in tariff structures is seasonal differentiation, which makes sense from an efficiency point of view. In effect, in areas where water scarcity is more pronounced during Summer, either due to natural water availability or to increased demand (especially in areas with seasonal tourism or large irrigated areas), water prices should be higher during that time of year. None of the utilities in the RBDs under analysis implement seasonal differentiation, despite their climate characteristics – summers in Southern Portugal are hot and dry. This kind of tariff should be implemented, especially in areas with significant seasonal tourism.

Finally, tariff structures for WWDT are more difficult to analyze. These tariffs can also be separated into a fixed and a variable component. However, the fixed component, which does not depend on water volume, can either be a constant figure or it can depend on characteristics such as pipe diameter, property value, or the gross construction area, thus making the calculation of average tariffs largely unviable.

4. ESTIMATION OF WATER DEMANDS

We estimated two residential water demand functions (one for RBDs6 and 7, managed by the River Basin District Administration (ARH) of Alentejo, and another for RDB8, managed by ARH Algarve) including as exogenous variables socio-economic variables (such as supply and wastewater tariffs, disposable income) and climate variables (temperature and precipitation). A random effects estimator for panel data (correcting for autocorrelation in the error term) was used, after the existence of specific effects and independence from the regressors was confirmed.

For RBD6 and 7 instrumental variables were used to address endogeneity issues (both the validity and relevance of the adopted instruments were tested). This was unnecessary for RDB8 as exogeneity of price-related regressors was confirmed. We tested the logarithmic against the linear functional form. The linear specification was preferred for RBD6-7 (results were inconclusive for RDB8), which may be an argument to support the efficiency of block tariffs when there are limits to the use of the fixed component of the tariff to reach cost recovery (Monteiro and Roseta-Palma, 2011). Reported data refers to the linear form of the search function.

Results in Table 3 show a negatively sloped but price-inelastic demand. The values of -0.18 (RBD6-7) and -0.04 (RBD8) for price elasticity can compared to those of Martins and Fortunato (2007), which calculated an elasticity value of -0.558, based on data from five Portuguese municipalities, whereas Monteiro and Roseta-Palma (2011) estimate price-elasticity values between -0.133 and -0.121 for the whole country.

Table 3. Water demand elasticity with respect to selected regressors.

Regressor	*Elasticity RBD6-7*	*Elasticity RBD8*
Marginal price	*-0,18 ***	*-0,04*
Per capita disposable income	*+0,21 ****	*+0,11*
Maximum temperature – annual average	*+0,83 **	*+0,82 ***
Maximum temperature – annual average for the period 1941-1991	*+1,15 ***	-
Evapotranspiration – annual average for the period 1941-1991	*+1,27 ****	-
Average annual precipitation - 1931/32-1996/97	*+0,58 ****	-
Difference between evapotranspiration (annual average 1941-91) and average annual precipitation - 1931/32-1996/97	-	*+0,38 **

***, ** and * stand for significance at the 0.01, 0.05 and 0.1 level

As expected, the results suggest that water demand depends positively on variables such as disposable income, maximum temperature and potential evapotranspiration. The significant positive relationship between water consumption and long-term annual average precipitation obtained in RBD6-7 is somewhat surprising. The water demand is very inelastic with respect to income. These results are in agreement with the literature (Monteiro and Roseta-Palma, 2011) and with the fact that water is an essential good with low possibilities for substitution. Water demand is more elastic with respect to temperature variations, especially in the long run.

5. AFFORDABILITY OF PUBLIC WATER SERVICES

Access to water can be taken to incorporate both the physical access to networks and the ability of households to pay for these services. This section addresses these two dimensions. The main indicators of access to water services deal with population coverage. WS and WWDT indices show satisfactory coverage rates, especially for WS where they are always above 93% (reaching 100% in RBD7). However, these seemingly favorable levels of service conceal important requirements in terms of network and equipment renovation, which will entail considerable financial investment (MAOTDR, 2007).

As for affordability, we assess the average water bill in the different regions, and compare this value to household disposable income. Table 4 compares values for the average annual water bills in RBD6, RBD7, RBD8, and Portugal. These values refer to consumptions of 120m^3 and 200m^3 for the residential sector, assuming a 15mm pipe diameter. The average values for RBD6, 7, and 8 are always below those obtained for the country as a whole, but the dispersion of values observed in all those regions, resulting from extreme tariff variability, is notable.

Table 4. Weighted average water bill €/year: RBD6, RBD7, RBD8 and Portugal (2008).

Service	*Volume*	*Indicator*	*PT*	*RBD6*	*RBD7*	*RBD8*
WS	*120 m^3*	*Average water bill*	*106*	*90*	*90*	*75*
		Range	*[15-203]*	*[28-138]*	*[15-154]*	*[32-153]*
	200 m^3	*Average water bill*	*187*	*167*	*159*	*138*
		Range	*[26-383]*	*[87-269]*	*[26-254]*	*[59-242]*
WWDT	*120 m^3*	*Average water bill*	*51*	*47*	*51*	*54*
		Range	*[0-168]*	*[0-139]*	*[6-139]*	*[13-112]*
	200 m^3	*Average water bill*	*81*	*88*	*84*	*81*
		Range	*[0-344]*	*[0-223]*	*[11-223]*	*[13-170]*

Source: INAG (2010a)

Portuguese average daily per capita consumption (157 L.Hab./Day) is inferior to those observed in RBD6 (183 L.Hab./Day), RBD7 (163 L.Hab./Day) and RBD8 (274 L.Hab./Day; the highest figure by far). Still, considering average income and family size, even for annual consumption levels of 200 m^3 the weight of the total water bill on average income is 1,35% in RBD6, 1,70% in RBD7 and only 1,03% in RBD8. All values are thus below the 3% threshold proposed by the OECD and used in an ERSAR study on affordability (ERSAR, 2010a). Notwithstanding, the water bill may exceed the 3% threshold in families affected by unemployment and poverty. Potential family-support policies, including social tariffs [measure envisaged in the Recommendation (IRAR, 2009) but not widely used], may be particularly important in these cases.

6. CONCLUSION

The need to weigh different goals and the crucial role of water in societies ensures that pricing water services will always remain a delicate balancing act. Economic analysis enables useful insights in the process of water resource management, both in demand and in supply. This paper summarizes relevant components of the economic analysis in urban systems performed in the first-generation RBMP for River Basin Districts 6 – Sado/Mira, 7 – Guadiana, and 8 – Algarve in southern Portugal. It focuses on the role of prices (tariffs or charges) as instruments of cost recovery and as efficiency incentives and it also discusses service affordability. Thus it contributes to a literature which has hitherto neglected the application of economic methods to river basin plans. It can also be useful to policy-makers who wish to further develop such applications, in accordance to European legal requirements.

Our cost-recovery calculations are mostly based on original INSAAR data but the analysis was performed separately for bulk and retail systems. RBD7 shows the lowest cost-recovery levels, especially in wastewater. Moreover, revenues are not enough to guarantee the necessary financial equilibrium in any of the RBD, although some cross-subsidisation of wastewater by water supply is likely.

Analysis of tariff structures reveals these are still far from complying with ERSAR recommendations, as well as criteria for economic efficiency. In particular, despite tariff complexity, not all utilities use fixed and variable components. In the Residential sector the number of blocks tends to be high, and in RBD6 and 7 consumption is occasionally charged at the rate of the final block that was reached, which has no economic foundation and distorts the message transmitted by unit prices. The absence of seasonal differentiation, which would make sense given the climatic characteristics of these regions, is also noteworthy.

The estimation of water demand elasticity for the Residential sector indicates that long-term climate changes may have a strong impact on water demand quantities, and also confirms that price has a significant but limited impact on moderating water demand. The latter illustrates the need to combine tariff policies with non-price measures for conservation. On the other hand, it shows that price can be a good instrument to eliminate current tariff deficits.

Finally, our assessment of the affordability of water services allows us to conclude that there is still a margin for tariff increase, since the average water bill is substantially lower than the maximum threshold recommended by the OECD. However, given the high tariff variability and the economic conditions, tariff increases should safeguard access to these essential services by disadvantaged households.

The improvement of the available data on volumes and service costs would prompt additional research in the field and better water resource management. Further research is on-going regarding consumer reaction to price, using survey data at the household level, and the potential insights from behavioural economics to improve the accuracy of demand and elasticity estimates.

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