EPI WATER

Evaluating Economic Policy Instruments for Sustainable Water Management in Europe

WP3 EX-POST Case studies

Increase in the pollution charge at Serpis River Basin.

Deliverable no.: D3.1 - Review reports
15 December 2011

Grant Agreement no. 265213
FP7 Environment (Including Climate Change)

COOPERATION

Deliverable Title	D3.1 - Review reports
Filename	Increase in the pollution charge at Serpis River Basin
Authors	Hernández-Sancho, F.; Molinos-Senante, M. and Sala-Garrido, R. (University of Valencia)
Date	15/12/2011

Prepared under contract from the European Commission
Grant Agreement no. 265213
FP7 Environment (including Climate Change)

Start of the project: 01/01/2011
Duration: 36 months
Project coordinator organisation: FEEM

Deliverable title: Review reports
Deliverable no. : D3.1

Due date of deliverable: Month 11
Actual submission date: Month 12

Dissemination level

X	PU	Public
	PP	Restricted to other programme participants (including the Commission Services)
	RE	Restricted to a group specified by the consortium (including the Commission Services)
	CO	Confidential, only for members of the consortium (including the Commission Services)

Deliverable status version control

Version	data	Author
1.0	November 2011	Hernández-Sancho, F.; Molinos-Senante, M. and Sala-Garrido, R. (University of Valencia)
1.1	December 2011	Hernández-Sancho, F.; Molinos-Senante, M. and Sala-Garrido, R. (University of Valencia)

Executive Summary

Definition of the analysed EPI and purpose

The instrument is focussed on water and is an increase in pollution charge in order to reduce water consumption and pollution contributing to achieving the good ecological status for water bodies.

The increase in the pollution charge has two main objectives:

- Economic objective: ensure the cost recovery of the wastewater treatment process as a consequence of the application of the polluter pays principle.
- Environmental objective: reduce the consumption and pollution of water in order to maintain the ecological flow even in during droughts.

Regarding environmental objectives, specific goals were not defined. In the case of the economic objective, an increase in the pollution charge has been estimated based on the investment and operation costs of the measures implemented in the two largest wastewater treatment plants (WWTPs) located in the watershed.

The research interest in this case is based on:

- The potential of extrapolation to other Mediterranean river basins in which the achievement of the good ecological status is conditioned by the quality of the discharge of the WWTPs.
- Demonstrating the importance of the valuation of environmental benefits to justify the economic feasibility of the necessary measures to fulfil the objectives set by the Water Framework Directive (WFD).
- Providing evidence on how the payment capacity may condition the achievement of a good ecological status for EU water bodies.

The increase in the pollution charge was implemented in 2010. For this reason, there is no statistical information relative to the reduction in water consumption. Through the implementation of the instrument, measures to improve the effluent from two WWTPs have been financed and so contributing significantly to the improvement of the quality of the river. In this sense, there is information relative to the improvement in the organic matter and phosphorus concentration after the implementation of the measures in WWTPs. The current version of the instrument is the result of a well designed and planned process.

Introduction

An increase in the pollution charge has been implemented in the Serpis river basin – which is located in the region of Valencia (Eastern Spain), within the Jucar River

Basin District. It is a typical Mediterranean watershed. In order to fulfil the Water Framework Directive some measures needed to be implemented.

Because effluent from WWTPs represent a high percentage of the total stream flow, accounting for up to 50% during winter and 90% during summer, water administrations have established that it was necessary reduce water consumption and improve the quality of the effluent from the WWTPs.

In this context, the increase of the pollution charge was considered a good instrument for achieving the economic and environmental objectives – taking into account the principle of polluter pays and the cost recovery.

From the economic point of view the intended objective was to recover the investment and operational costs of implementing measures in WWTPs. Because the increase in the pollution charge was defined taking into account this premise, the objective has until now been achieved.

Regarding environmental objectives, the quality of the river has improved significantly but it is difficult to evaluate what percentage is attributable to the instrument. In relation to social aspects, no significant impacts have been found relative to affordability.

Legislative setting and economic background

The approval of the increase in the pollution charge did not require the adoption of any legislation or regulation. The Valencian government Act 2/1992 establishes that the powers for approving pollution charge belong to the 'Entidad Pública de Saneamiento de Aguas Residuales (EPSAR)' and therefore as an autonomous administration it can approve its own pollution charge. However, we must remember that the power for water management at the watershed level belongs to the state administration.

For the implementation of the EPI is unnecessary to consider and remedy the externalities derived.

The performance of the instrument is not affected by institutional constraints. However, it is very important to have available information concerning the elasticity of the demand curve for fixing the increase in the charge so that the defined objectives are achieved.

The EPI was implemented in 2010 in the middle of an economic crisis. However, independently of this circumstance the WFD requires the recovery of costs. For this reason, one of the criteria for determining the increase in the pollution charge was to recover the costs of investment and operation of the measures implemented in the WWTPs.

There were no economic distortions in the implementation of the instrument and no vested interests.

Water rights did not affect the design and implementation of the increase in the pollution charge since the tax is levied on water consumption by domestic users.

Brief description of results and impacts of the proposed EPI

Despite the fact that the EPI was implemented in 2010, it can be considered that it has succeeded because the quality of the Serpis River has increased. Nevertheless it is difficult to know the percentage of this improvement that is attributable to the increase in the pollution charge.

The increase in the pollution charge has enabled the financing of the cost of the measures implemented in the largest WWTPs aimed at improving effluent quality. Moreover it has been demonstrated that the benefits of these measures overcome the investment and operation costs. Hence their implementation is feasible in economic terms. It has also been verified that there are no problems of affordability regarding the increase implemented.

The environmental outcomes of the implementation of the EPI are subject to high levels of uncertainty because there is no statistical information on the reduction in water consumption. However, it is estimated that a reduction of 10% can be achieved. Also a comparison of pollution charge in Spanish regions reveals that there is room to increase the pollution charge in the SRB and achieve additional reductions in water consumption.

Education has revealed as an essential factor for the effectiveness of the instrument in social terms. It is important to make citizens aware about the real costs of water supply and wastewater treatment in order to contribute to modifying their behaviour. The willingness of citizens to pay for improving the quality of the river is higher than the increase in the pollution charge. Therefore, the instrument was well accepted.

Transaction costs were not taken into account neither in the design nor implementation of the instrument. However, they can be considered as insignificant. Hence, they did not affect the environmental, economic, and social impacts derived from the increase in the pollution charge.

The environmental outcomes from the instrument were vaguely defined and subject to high uncertainty. Hence, it is not possible to quantify the difference between the intended and actual outcomes. Regarding economic objectives, the target of cost recovery has been achieved at a 100% level.

Conclusions and lessons learnt

The main lessons learnt from increasing pollution charge are as follows: (i) the increase in the pollution charge has partially contributed to increasing the water quality of the SRB and a significant reduction in water consumption is expected; (ii) the estimation of the cost of the measures implemented in the WWTPs has been used to determine the increase in the pollution charge necessary to recover all the costs; (iii) in the SRB there are no problems of affordability in relation to the increase in the

pollution charge; (iv) cooperation between state and regional administration was essential for the implementation of the EPI; (v) pollution charge is a flexible instrument since the increase is defined depending on the objectives to be achieved and the elasticity of water demand; (vi) the main transaction costs are the ex-ante costs and they are associated with the research needed to define the increase in the pollution charge; and (vii) while economic objectives were clearly defined, environmental objectives were vaguely established.

As the elasticity of water demand is known, the willingness of citizens to pay for improving the quality of the river and having a clear institutional framework are the essential items for the success of the instrument. However, the lack of awareness of some citizens relative to the charge paid for sanitation service is the main disabling factor.

The design of the instrument would be improved if a social pollution charge was considered as an exception to be applied in some special conditions.

Table of Contents

1 EPI Background

The Serpis River Basin (SRB) constitutes a clear example of a Mediterranean watershed in which wastewater discharged from the wastewater treatment plants (WWTPs) of the basin represent a high percentage of the total stream flow, accounting for up to 50% during winter and 90% during summer time. In addition, WWTPs are responsible for up to 90% of the river's annual load of solids, organic matter, and nutrients.

Based on the characteristics of the SRB, the Jucar River Basin Authority (CHJ) found that to fulfil the objectives set by the Water Framework Directive (WFD), it was necessary reduce water consumption and, indirectly, water load. Moreover, it was also necessary to improve the quality of the effluent from the two largest WWTPs in the SRB (Alcoy and Font de la Pedra). Out of all the WWTPs that discharge effluent into the SRB (affecting water quality), these two plants have the largest treatment capacity. In 2009, the treatment flow rate of the Alcoy plant was 20 825 m^3/day and it served a population equivalent (PE) of 127 271 inhabitants. The Font de la Pedra WWTP has a nominal flow rate of 15 000 m^3/day with a PE of 60 701. Table 8.1 shows the list of measures defined by CHJ relative to the WWTPs contributing to achieving the good ecological status of the SRB.

Table 8.1- Measures contributing to achieve the good ecological status in the SRB

Measures relative to WWTPs	
1	Improvement of secondary treatment in Alcoy WWTP for BOD_5 to 25 mg/l.
2	Improvement of secondary treatment in Alcoy WWTP for P to 1 mg/l.
3	Improvement of secondary treatment in Font de la Pedra WWTP for P to 2 mg/l.
4	Tertiary treatment of 10 000 m^3/day in Alcoy WWTP for BOD_5 to 10 mg/l and P to 0.5 mg/l.
5	Tertiary treatment of 2 500 m^3/day in Font de la Pedra WWTP for BOD_5 to 10 mg/l and P to 0.5 mg/l.

Source: Jucar River Basin Authority (CHJ), (2008)

The first three measures are aimed at improving the secondary treatment processes at the WWTPs of Alcoy and Font de la Pedra. The last two measures include the implementation of tertiary treatment technologies (at a rate of about 50% in the Alcoy WWTP and 20% in the Font de la Pedra WWTP), which would facilitate the quality of effluent beyond the value required by legislation for the pollutants organic matter measured as biological oxygen demand (BOD_5) and phosphorus (P). Once the effluent is discharged into the river, the required water quality status would be achieved, since dilution and dispersion processes would further reduce the concentration of organic matter and phosphorus in the river down to the necessary levels.

The increase in the pollution charge has two main objectives:

- Economic objective: ensure the cost recovery of the wastewater treatment process as a consequence of the application of the polluter pays principle.
- Environmental objective: reduce the consumption and pollution of water aiding to maintain the ecological flow even in scarcity situations.

In the area of study, the pollution charge is calculated based on volume and pollution content of the water. In order to achieve the objectives previously defined, the water administration set-up in 2010 an increase in the pollution charge around 10% depend on the municipality size. The main advantage of this instrument is that it is not an additional charge, but only an increase in a one already well known by citizens. The limitation is related to the levels of tariffs in which an incentive to reduce consumption occurs, given that the water demand curves for urban uses sometimes stretch with some inelasticity and so they can be very high with respect to the current pollution charge.

Regarding environmental objectives, specific goals were not defined. In the case of the economic objective, to ensure its fulfilment, the new charge for sanitation have been estimated based on the investment and operation costs of the measures implemented in Alcoy and Font de la Pedra WWTPs.

There are two main reasons that justify the increase in the charge. In the SRB, the pollution charge levied on water consumption and its payment is made through the water bill, therefore it is an adequate instrument for reducing water consumption. As a consequence of the cost recovery principle, the measures implemented in the WWTPs aimed to achieve the good ecological status must be paid by users. The revenue obtained by increasing the pollution charge enables financing the investment and operational cost for improving the effluent from WWTPs.

Currently there is no statistical information relative to the reduction of water consumption. Nevertheless, it is monitored since in most of the municipalities located in SRB water consumption is metered. Regarding the economic objective, it is verified that the revenues from the pollution charge enable a recovery of the cost of the wastewater treatment. At this moment, no safeguarding mechanism has been implemented to avoid negative side effects. However, the administration has planned the creation of a social exemption aimed at preventing disadvantaged people from being affected by the increase in the pollution charge.

Given the level of competence for environmental aspects in Spain, cooperation between the state administration responsible for water management at the watershed level and the regional administration responsible for sanitation and wastewater treatment in the Valencia region was necessary for implementing the instrument.

Public participation has played a minor role in the design of the instrument, only months before the increase in the pollution charge some informative campaigns were developed that were aimed at preventing future litigations.

There were no unexpected events that influenced the performance of the instrument.

2 Characterisation of the case study area (or relevant river basin district)

The SRB is located in the region of Valencia (Eastern Spain), within the Jucar River Basin District (Figure 8.1). The basin covers an area of 990 km², and is about 75 km in length. The basin has a Mediterranean climate, with an annual average temperature of 16.3 ºC, and an annual average precipitation level of 630 mm.

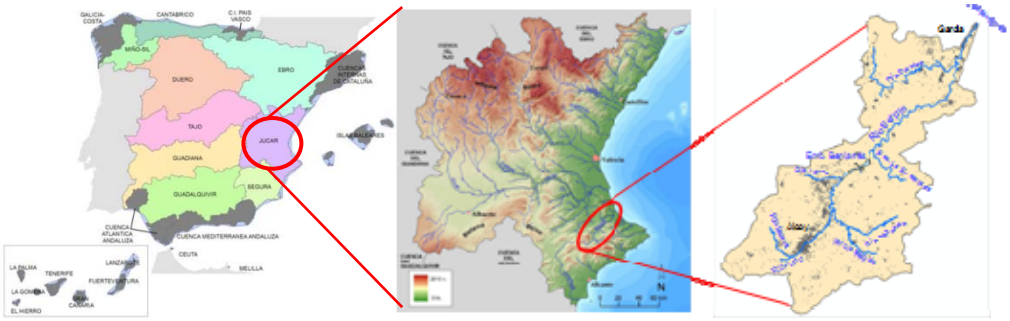

Figure 8.1- Localisation of Serpis River Basin

Source: Jucar River Basin Authority (CHJ), (2011)

The land use of the SRB is shown in Table 8.2. The two main uses are agricultural and forestry, representing 47% and 49% respectively. Wetlands and water bodies represent less than 1% of the total area.

Table 8.2- Land use of Serpis River Basin

Land use	Artificial areas	Agricultural areas	Forest	Wetlands	Water bodies	TOTAL
Surface (ha)	3 102.87	46 408.15	48 091.91	273.28	577.60	98 453.81

Source: Jucar River Basin Authority (CHJ), (2008)

Of the agricultural areas, approximately 41% of the total area is irrigated, while the rest (59%) is dry. Six units of agricultural demand (UAD) depend of the Serpis River. Figure 8.2 shows the percentage of surface that corresponds to each UAD.

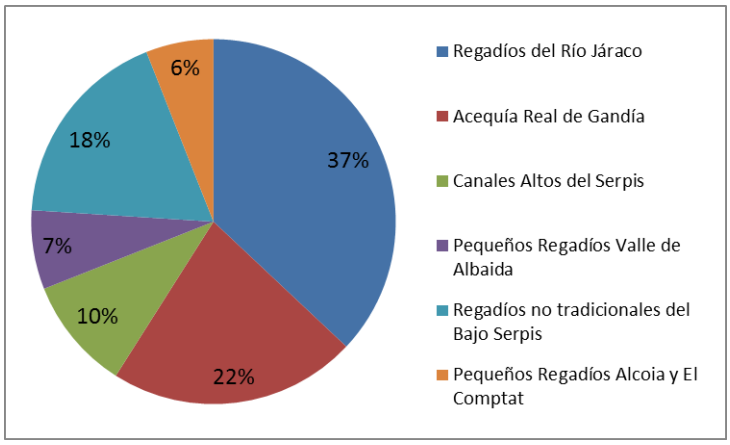

Figure 8.2- Percentage of each unit of agricultural demand

Source: Jucar River Basin Authority (CHJ), (2005)

The total population of the SRB is 228 389 inhabitants. Towns with populations over 15 000 inhabitants are Alcoy and Gandia. Due to summer season tourism, there is a growth in the population of over 15%, more so in Gandia. According to the CHJ, the current urban demand (year 2009) is 28.7 hm^3/year and it is estimated that by 2027 it will be around 34.0 hm^3/year.

In the SRB, there are several points of interest from an environmental point of view. However, it is worth noting the wetland of Pego - Oliva given that it is included in the RAMSAR list. In this context, the CHJ fixed the volume required for environmental purposes at 12 hm^3, which means an approximate flow of 100 l/s. In the coastal area, there are some problems of marine intrusion due to excessive extraction and drainage of wetlands. The river basin plan estimated that a throughput of coastal aquifers to the sea of 21 hm^3/year should be maintained to avoid the saline front advances.

The SRB domain comprises 12 surface water bodies, 13 groundwater bodies, and 1 heavily modified water body (Beniarrés reservoir). At present, the main use of water in the basin is agriculture (75%; mainly citrus orchards and vegetable crops), followed by urban supply (21%; mainly from groundwater) and industry (4%; primarily textile industry).

The total amount of natural runoff is 85.89 hm^3/year (of which, 38.4% are surface resources and 61.6% are groundwater resources). Table 8.3 shows the surface and groundwater resources in the SRB. The volume of conventional available resources is 130 hm^3/year: 81% are groundwater resources, 13% is obtained through the regulation of the water in the Beniarres reservoir; and the remaining 6% comes from irrigation returns. In relation to non-conventional resources, the reuse of the regenerated water contributes 4.5 hm^3/year.

Table 8.3- Surface and groundwater resources in Serpis River Basin

Characteristics	Quantity (hm^3/year)
Conventional resources	
Groundwater resources	105.0
Regulated surface resources	17.0
Irrigation return flow	8.0
Non-conventional resources	
Wastewater reuse	4.5
TOTAL OF AVAILABLE RESOURCES	**134.5**

Source: Jucar River Basin Authority (CHJ), (2005)

The course of the Serpis River, before reaching the sea, crosses more than 50 municipalities. Most of these municipalities have installed WWTPs. Specifically, there are 30 plants that receive wastewater from the main urban and industrial areas, and these treat around 31 hm^3/year. In total, 24 of the 30 plants discharge treated water to the River, while the remaining six discharge treated water into the sea.

In the SRB, water quality is associated with different uses. Hence, water quality is better in the upstream water bodies where there is less use, and worsens in the middle and lower basin where there is much more use. The most important water quality problem is the severe eutrophication process in the Beniarres reservoir, which is mainly due to polluted discharges originating from urban and industrial areas. In addition to this pollutant load, the Serpis river has a low flow rate due to the high water consumption of the municipalities located upstream of the reservoir, which are supplied by groundwater. Hence, wastewater discharge from the Alcoy and Font de la Pedra WWTPs represents a high percentage of the total stream flow, accounting for up to 50% during winter and 90% during summer time.

From an administrative point of view, the SRB consists of three sub-regions: L´Alcoià, El Comtat, and La Safor. The total population of the three sub-regions is 228 389 inhabitants. The population density is high (Table 8.4) for L´Alcoià and La Safor while for El Comtat it is low. This is because the first two sub-regions include several municipalities whose main economic activity is tourism.

Table 8.4- Population density in *Serpis River Basin*

	L´Alcoià	El Comtat	La Safor	MEAN
Population density (Inhabitants/km^2)	201.2	70.9	352.6	**230.7**

Source: Valencian Statistical Institute (IVE), (2011)

As regards the economic activities of the SRB (Table 8.5), the economic structure of the sub-regions of L´Alcoià and El Comtat differ considerably from the productive structure of the La Safor. In the first two, the main economic activity is industry with a weight greater than 50% of the total employment. In contrast, in La Safor the service sector, mainly tourism, represents more than 60% of employment.

Table 8.5- Employees and percentage for each economic sector in *Serpis River Basin*

	L´Alcoià (Employees)	El Comtat (Employees)	La Safor (Employees)	L´Alcoià (%)	El Comtat (%)	La Safor (%)
Agriculture	496	634	5 638	1.16	6.12	9.26
Industry	23 315	5 434	18 385	54.55	52.45	30.19
Services	18 932	4 291	36 886	44.29	41.42	60.56
TOTAL	**42 743**	**10 359**	**60 909**	**100.00**	**100.00**	**100.00**

Source: Valencian Statistical Institute (IVE), (2011)

As an approximation to the gross domestic product, Table 8.6 shows the average income per capita for the three sub-regions composed SRB.

Table 8.6 - Average income per capita in the Serpis River Basin

	L´Alcoià	El Comtat	La Safor	MEAN
Income (EUR/inhabitant)	931.14	1 159.74	1 241.64	**1 126.08**

Source: Valencian Statistical Institute (IVE), (2011)

3 Assessment Criteria

3.1 Environmental outcomes

Pricing can be used effectively to implement incentives to reduce pollution, decrease pressure on water resources, and produce greater efficiency in the allocation of resources. Water demand analyses show that differences in water consumption can be partially explained by the differences in the price of water, but we must point out that, in general, urban demand is inelastic, yielding a value of - 0.65 (MARM, 2005).

Figure 8.3 shows the demand curve of water for urban uses in the Valencia region. The adjustment is based on water prices and consumption of 125 municipalities in the region of Valencia for the period 2000-2003. To achieve a reduction of 1% in water consumption an increase of 1.54% in the price is required.

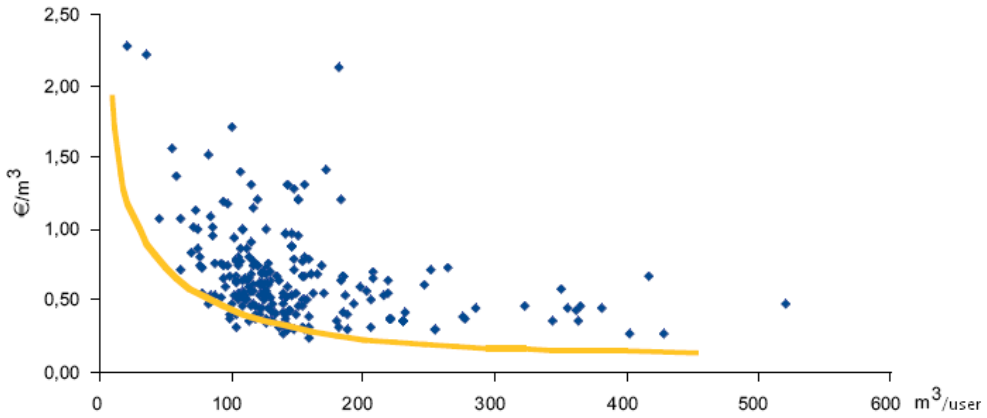

Figure 8.3- Urban water demand in Valencia region

Source: Spanish Ministry of Environment, Rural and Marine (MARM), 2007

Since the increase in the pollution charge was implemented in the year 2010, there is no current information available on the reduction in water consumption. However, it should be taken into account that in the Valencia region the pollution charge levied water consumption and its payment is made through the water bill. Hence, by using the water demand curve shown in Figure 8.3 it is estimated that a reduction of 7 m^3/inhabitant·year can be achieved. This figure equals approximately 10% of the consumption prior to the increase in the charge. Taking into account the number of inhabitants of the SRB the total reduction in water consumption is around 1.5 hm^3/yr.

In order to shed light on the potential of this kind instrument for improving water management, Figure 8.4 shows pollution charge in the 17 regions of Spain. The price paid by the users for sanitation is very variable as the minimum value is 0.34 EUR/m^3 for the region of Canary Islands while maximum corresponds to the region of Balearic Islands with a price of 0.81 EUR/m^3.

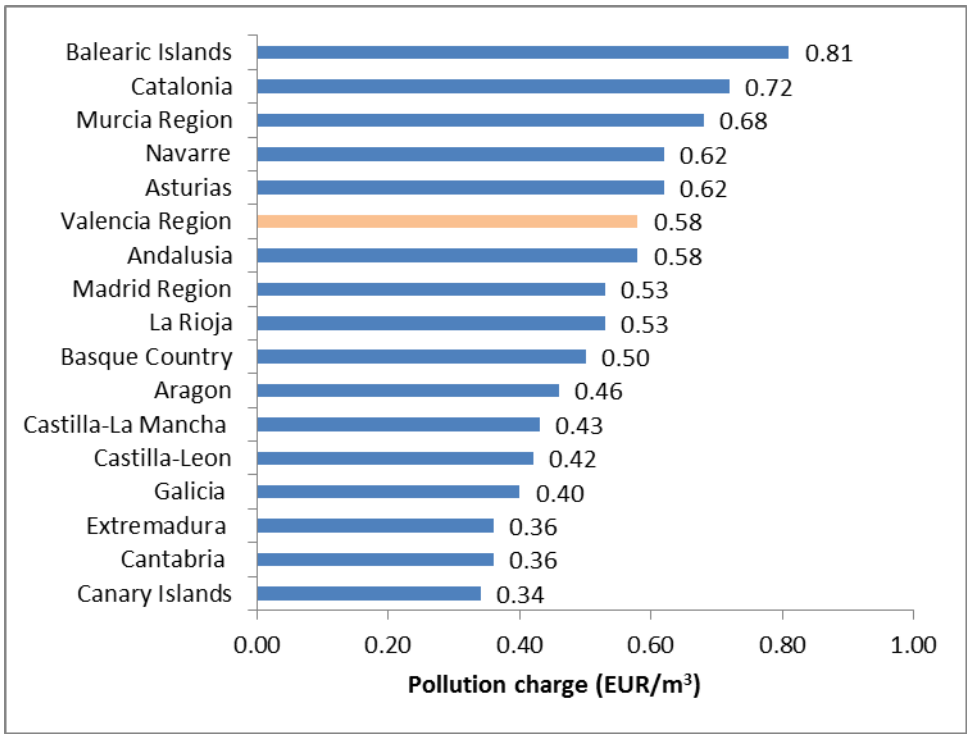

Figure 8.5- Pollution charge in Spanish regions for 2009

Source: Own elaboration from the Spanish association of water supply and treatment (AEAS), 2011

In the majority of countries, the pollution charge levied on water consumption and its payment is made through the water bill. Therefore, and in order to show if there is room to increase water price to reduce water consumption and indirectly water pollution Figure 8.5 presents average tariffs for water and wastewater services. The data show that in half of the countries, wastewater services can represent a higher share of the water bill than water supply.

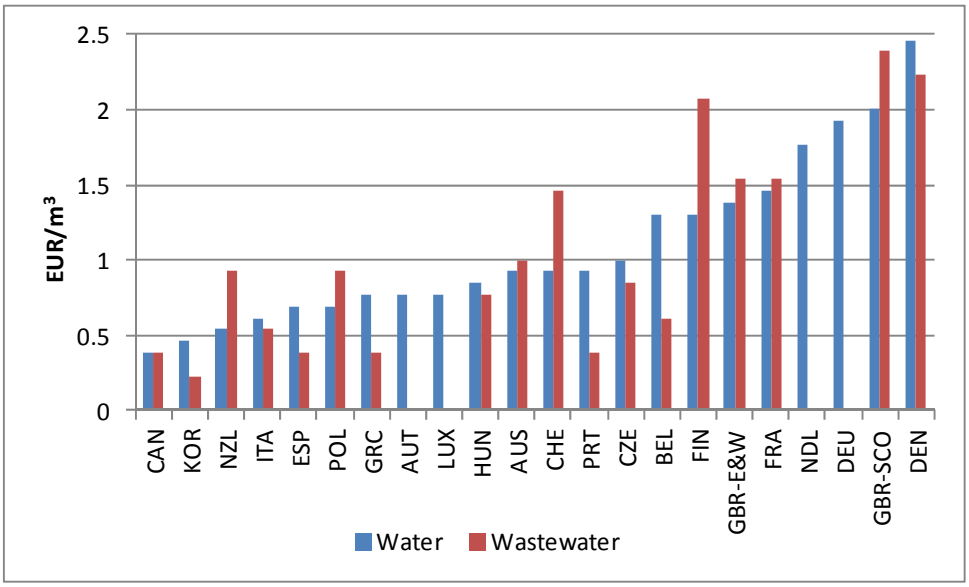

Figure 8.6- Unit price of water supply and sanitation services, 2008

Source: Own elaboration from OECD (2011)

The data shows large discrepancies across countries: prices can vary by a factor 10 or more. This derives from differences in the cost of providing the service. This reflects policy choices as well. Denmark has distinctively high prices for water supply and sanitation, which reflect efforts to incorporate as much of the economic and other costs of the services into tariffs.

In the past, the construction of most of the WWTPs located in the region of Valencia was financed by the European Regional Development Fund (ERDF). However, since 2007 the Valencia region is no longer objective 1, and therefore the perceived resources have been reduced. In the context, pollution charge is an adequate mechanism to reduce water demand and consumption and, indirectly water loads.

Another objective of increasing pollution charge was to improve the quality of the WWTPs effluent in order to achieve the good ecological condition of the Serpis River. In this context, it is highlighted that the implementation of the WFD in Spain is delineated in the Water Planning Instruction (WPI). In the specific case of the SRB, the thresholds for good ecological status were based on the criteria of provisional value, current legislation, and the same threshold for all ecotypes (Table 8.7).

Table 8.7- Maximum thresholds for different status in some physical chemistry indicators for Serpis River

Quality	BOD_5 (mg/l)	P (mg/l)
High	< 3	< 0.20
Good	3 - 6	0.20 - 0.40
Moderate	6 - 10	0.40 - 0.70
Poor	10 - 25	0.70 - 2.00
Bad	> 25	> 2.00

Source: Jucar River Basin Authority (CHJ), 2008

The implementation measures (Table 8.6) had facilitated the quality of effluent beyond the value required by legislation for the pollutants BOD_5 and P. Once the effluent is discharged into the river, the required water quality status is achieved, since dilution and dispersion processes reduce the concentration of organic matter and phosphorus in the river down to the necessary levels.

Table 8.8 shows the concentration of effluents after the improvement of wastewater treatment. It is verified that the implementation of the measures has enabled the achievement of a good ecological status since organic matter and phosphorus concentrations are lower than the maximum threshold established by the CHJ (Table 8.7).

Table 8.7- Water quality on Serpis River Basin

Quality	No measures are adopted	Measures are adopted
BOD_5 (mg/L)	17.211	5.895
P (mg/L)	0.976	0.372

Source: Jucar River Basin Authority (CHJ), 2011

Although the implementation of the effluent from Alcoy and Font de la Pedra WWTPs has significant positive impacts, it also involves negative impacts such as an increase in the consumption of energy and in the generation of sewage sludge (Table 8.9).

Table 8.9-Environmental parameters associated to WWTPs in Serpis River Basin

	ALCOY WWTP		FONT DE LA PEDRA WWTP	
	Without measures	With measures	Without measures	With measures
Energy consumption (kWh/m^3)	0.23	0.27	0.31	0.34
Sludge generation (Kg wet matter/yr)	5 933 690	6 584 125	5 373 280	6 242 428

Source: Valencia Sanitation and Wastewater Treatment Authority (EPSAR), 2011

The environmental benefits derived from improving the quality of the Serpis river were quantified through contingent valuation methodology. Moreover, the shadow prices of the pollutants removed in the wastewater treatment have been quantified using the distance function approach. In this context, wastewater treatment is viewed as a productive process, in which a desirable output (clean water) is obtained together with a series of undesirable outputs or pollutants (suspended solids, nitrogen, phosphorus, etc.). A shadow price for these pollutants may be considered as the equivalent of the environmental damage that is avoided, since if wastes are dumped without control the environment would be negatively impacted. Hence, the avoided costs that are estimated using the shadow price methodology, represent an

approximation of the economic value of the environmental benefits obtained from the treatment process aimed to improve water quality.

By using this second approach it was estimated that with the measures implemented to increase the quality of the WWTPs effluent, the environmental benefits to the SRB was quantified at 6 623 693 EUR/yr. Specifically, the improvement in the secondary treatment has meant an environmental benefit of 3 764 032 EUR/yr while the remainder is attributable to the implementation of the tertiary treatment. Nevertheless, it should be taken into account that not all the benefits can be attributed to the EPI itself. Therefore, the uncertainty associated with the environmental benefits derived from the increase in pollution charge is high.

3.2 Economic Assessment Criteria

Because one of the aims of increasing pollution charge was to improve the quality of the Serpis River, the economic assessment was focussed on analysing the economic feasibility of the implementation of the measured aimed to increase the quality of the effluents of the Alcoy and Font de la Pedra WWTPs. At the same time, checks have been made for the possible existence of disproportionate costs.

The cost benefit analysis (CBA) is the obvious tool for assessing the feasibility and the existence of disproportionate costs. It is important to remember that according to WFD, when carrying out a CBA, all market and non-market costs and benefits must be assessed and financially estimated.

The WPI (Art. 8.2.4) indicates that the cost of the measures should include: (i) investment cost (IC) and (ii) operation and maintenance costs (OMC) discounted to present value terms. Specifically, the WPI prescribed the use of annualised unit costs. The quantification of the environmental benefits was made by measuring the willingness to pay (WTP) and the willingness to accept compensation (WTA) through the contingent valuation method (CVM).

The estimation of the IC (Table 8.10) was performed based on several sources such as the cost functions developed by the Spanish Ministry of the Environment, through the Technical Guidelines for the Evaluation of Measures (TGEM) and data collected in the A.G.U.A. Programme (Actions for the Management and Use of Water). These costs functions have been modelled using real data from Spanish WWTPs.

Table 8.10- Measures, cost functions, unit costs, and total investment costs in EUR for the implementation of measures in SRB

Description of the measure	IC function	Cost (EUR)
Improvement of secondary treatment in Alcoy WWTP for BOD_5 to 25 mg/L	-	2 500 000
Improvement of secondary treatment in Alcoy WWTP for P to 1 mg/L	$IC = 23.69\ X^{0.8713}$	664 226
Improvement of secondary treatment in Font de la Pedra WWTP for Pto 2 mg/L	$IC' = 1\ 242.3\ X^{0.7727}$	616 882
Description of the measure	**Unit IC (EUR/m³/day)**	**Cost (EUR)**
Tertiary treatment of 10,000 m³/day in Alcoy WWTP for BOD_5 to 10 mg/l and P to 0.5 mg/L	185 - 398	3 980 000
Tertiary treatment of 2,500 m³/day in Font de la Pedra WWTP for BOD_5 to 10 mg/l and P to 0.5 mg/L	185 - 398	995 000

* Alcoy has 127 271 PE and Font de la Pedra has 60 701 PE. Where *X* is the design population expressed in population equivalent (PE), while IC is the investment cost of secondary treatment improvements expressed in EUR and IC is the total investment cost in EUR.

Source: Spanish Ministry of the Environment, Rural, and Marine (MARM) (2004, 2009)

With respect to the measures aimed at improving secondary treatment, Table 8.4 shows that the total IC is EUR 3 781 108, of which approximately 66% is related to the improvement of the secondary treatment process at the Alcoy WWTP to increase the performance of organic matter removal. With respect to measures focused on tertiary treatment, IC amounts to EUR 4 975 000. Given that the volume of water treated at the Alcoy WWTP is greater than that at the Font de la Pedra WWTP, 80% of IC corresponds to action at the Alcoy facility, and 20% to that at the Font de la Pedra facility.

OMC have been quantified as the difference in costs between before and after the implementation of the measures. Because the measures did not include an increase in the flow of treatment but an improvement in the removal efficiencies of BOD_5 and P, the cost functions developed by Hernández-Sancho et al. (2011) were used to quantify the OMC for these measures. In this case, the data used to model costs was taken from WWTPs located in the region of Valencia.

Equation 1 shows the operational and maintenance cost function for secondary treatment and Equation 2 its equivalent for tertiary treatment.

$$OMC = 2.5180 \cdot V^{0.7153} \cdot e^{(0.007A + 1.455BOD + 0.258N + 0.243P)} \quad (1)$$

$$OMC = 3.7732 \cdot V^{0.7223} \cdot e^{(0.6721BOD + 0.1958N + 0.7603P)} \quad (2)$$

where, *OMC* is the total operational and maintenance cost for secondary treatment in EUR/yr; *V* is total volume of wastewater treated in m^3/year; *A* is the age of the WWTP in years; *BOD* is the biological oxygen demand removal efficiency; *N* is the nitrogen removal efficiency, and *P* is the phosphorous removal efficiency.

It is shown that OMC of basic measures amounted to 189 821 EUR/yr, of which 81% is associated with the improvement of the secondary treatment at the Alcoy WWTP. With respect to the tertiary treatment implementation, the total OMC is 644 702 EUR/yr of which 75% is contributed by the Alcoy WWTP (Table 8.11).

Table 8.11- Operation and maintenance costs for measures in EUR/yr in SRB

Description of the measure	OMC (EUR/yr)
Improvement of secondary treatment in Alcoy WWTP	154 596
Improvement of secondary treatment in Font de la Pedra WWTP	35 225
Tertiary treatment of 10 000 m^3/day in Alcoy WWTP	481 277
Tertiary treatment of 2 500 m^3/day in Font de la Pedra WWTP	163 426

Source: Hernández et al., (2011)

The estimation of the environmental benefits derived from the improvement of water quality in SRB was made using the CVM. Note that according to the EPI described in this case study, the payment vehicle chosen was an increase in the current water bill issued every two months. It was regarded as the most appropriate with regard to the credibility of the hypothetical market since it is plausible and familiar to the population surveyed. Respondents were also asked about their WTA in the hypothetical case that the projected improvements in water quality were not accomplished.

The survey results showed that households were WTP between 108 EUR/yr and 112 EUR/yr for the referred improvement in water quality. As the question asked about compensation in the current water bill, the annual compensation that should be paid by each family would be about EUR 53.

Because the aim of the study was to assess the economic feasibility of the implementation of the measures in WWTPs, it was necessary aggregate the individuals´ benefits in order to compare these with the total costs of the project. In this context, the aggregation criterion was the number of houses in the SRB (121 739 households). This data has been provided by the Spanish Institute of Statistics. By considering two constant discount rates of 1% and 3% and a lifespan of 25 years, the net social benefit from water quality improvement was calculated (Table 8.12).

Table 8.12- Net social benefits from water quality improvement (EUR).

	WTP		WTA	
Discount rate	1%	3%	1%	3%
Net present value (EUR)	14 349 879	1 710 008	70 878 617	45 900 492
Benefit-cost ratio	1.22	1.03	2.10	1.77

Source: Del Saz-Salazar et al., (2009)

The net present value ranges from a minimum value of EUR 1 710 008, if the discount rate considered is 3%, to a maximum value of EUR 14 349 879 when the chosen discount rate is 1%. The benefit-cost ratios are, respectively, 1.03 and 1.22 for the two discount rates considered. A second comparison is between the costs and the compensation that users would require for forgoing the water quality improvement while sustaining the same level of wellbeing. In this case, for both considered discount rates, the compensation required by people is higher than the costs of achieving the quality improvement with the net present value.

Results show that the improvement in the good ecological status of water bodies in the SRB is feasible in economic terms and cannot be considered as a case of disproportionate costs. Moreover, the CVM has verified that people are WTP an increase an increase of €18 (bimonthly) in pollution charge in order to improve the quality of the Serpis River.

Once the costs of implementing the measures were estimated it was possible calculate the increase in the pollution charge paid by the residents of the SRB that would be necessary to recover their cost. Hence by considering the equivalent annual cost of the measures (Tables 8.10 and 8.11) and the number of households in the SRB (which is 105 835) it was estimated the increase in the pollution charge necessary to finance both the investment and the maintenance of measures to improve the water quality of the Serpis River.

It was calculated that the increase required in payments per each household of the SRB is approximately 10 EUR/year. Bearing in mind, that the charge of sanitation is bimonthly, the increase in the pollution charge was around EUR 1.70.

In this context, it is important to know that the funding for the costs of management, exploitation, and, where appropriate, construction and improvement of the WWTPs located in the region of Valencia is performed through a pollution charge, which is collected by the regional authority for the sanitation of wastewater (EPSAR).

The pollution charge levied on water consumption and its payment is made through the water bill. For the period 2003-2011 the pollution charge are as follows (Table 8.13).

Table 8.13- Pollution charge at Valencia Region

Municipality size	Consumption charge (EUR/m³)								
	2003	2004	2005	2006	2007	2008	2009	2010	2011
500-3 000	0.103	0.113	0.128	0.145	0.164	0.185	0.188	0.202	0.202
3 001-10 000	0.134	0.147	0.165	0.185	0.207	0.232	0.243	0.253	0.253
10 001-100 000	0.165	0.182	0.202	0.224	0.249	0.276	0.288	0.298	0.298
> 100 000	0.196	0.216	0.238	0.262	0.288	0.317	0.325	0.342	0.342
Municipality size	**Service charge (EUR/yr)**								
	2003	2004	2005	2006	2007	2008	2009	2010	2011
500-3 000	10.44	11.48	12.97	14.66	16.57	18.72	19.78	20.40	20.40
3 001-10 000	14.19	15.61	17.48	19.58	21.93	24.56	25.17	26.77	26.77
10 001-100 000	17.55	19.31	21.43	23.79	26.41	29.32	30.02	31.67	31.67
> 100 000	19.73	21.70	23.87	26.26	28.89	31.78	32.59	34.32	34.32

Source: Valencia Sanitation and Wastewater Treatment Authority (EPSAR), 2011

The pollution charge has been analysed while bearing in mind the small size of the municipalities in the SRB – most have fewer than 3 000 inhabitants. Taken into account that the water consumption per household in SRB was approximately 250 m³/yr, in 2008 the revenue achieved per household was 46.25 EUR/year. In that year, it was decided to increase the pollution charge to reduce water consumption and, indirectly water loads. The new charge must be enough to finance the investment and maintenance of measures implemented on WWTPs. On the basis of the cost of the measures, the pollution charge (variable part) in the year 2009 increased to 0.202 EUR/m³, which represents a rise of 9.2% over the previous year.

The increase in the pollution charge has not lead to a cost saving for water users; in fact they have to pay more for the use of the same amount of water. However, it has eased water consumption and lead to an improved ecological status for the SRB, and so the EPI has introduced additional benefits for society.

Winners and losers after increasing the pollution charge are not well defined. It can be considered that water users are losers because they have to pay more for water, but on the other hand since the charge revenues is used to improve environmental quality of the SRB they can also be considered as winners.

The instrument does not have an important risk-reducing role in the area.

There was not any evidence of asymmetric information.

3.3 Distributional Effects and Social Equity

The water administration was the stakeholder involved in the choice and design of the instrument. Nevertheless, the main stakeholders affected by the implementation of the instrument were the residents of the SRB. The increase in the pollution charge is an instrument that did not affect the productivity of the local community. Nevertheless, it was necessary to assess the affordability for citizens of the increases

in the tariff. In doing so, the average value of the available gross income of households (AGIH) in the region of Valencia in 2008 was considered as a reference. The results showed that the increase required in the pollution charge was viable since it represented a percentage of 0.02% with respect to AGIH.

In short, it is reasonable to believe that there are no problems of affordability with respect to the increased pollution charge. Regarding the equity of the measure, we should take into account that the pollution charge is collected through the water bill and therefore, it charges the consumption of water. Thus, the contribution of each household depends on consumed water and not on income.

Based on interviews with the main neighbour's organizations, the distributional effects and equity regarding the increase in pollution charge can be summarized as follow. The implementation of the EPI has resulted in an improvement in drinking water quality since the water quality has improved in general terms. Nevertheless, studies to evaluate this improvement have not been made. Education is essential for the effectiveness of the EPI since one of its aims is to reduce water consumption. Campaigns were carried out to inform citizens about the reasons for the increase in the pollution charge. After the implementation of the instrument the time for leisure purposes has not changed. However, due to the increase in the quality of the environment, citizens carry out more activities in the vicinity of the river, especially sport. The increase in the pollution charge has not affected the employment of the local community. Regarding environmental issues, the implementation of the EPI has enabled an improvement in the local environment and local resident perceive this as an important aspect relative to life quality. The availability of water has increased slightly since the increase in the pollution charge and this has resulted in a decline in urban water consumption and the availability of water for other activities is greater. At the beginning of the process, resident associations showed their discontent with the instrument. Therefore, the administration organised meetings in the affected municipalities explaining the reasons for the increase and the final use of additional revenue. After this process of participation, there were no significant complaints.

3.4 Institutions

Given the level of powers for environmental aspects in Spain, the sanitation service has to be made municipality level. However, in the Valencia region the regional administration has assumed the competence relative to sanitation and wastewater treatment in order to guarantee the service even in small municipalities that do not have enough economic resources.

The Valencian Act 2/1992 establishes that the aim of the pollution charge is to finance the operation and maintenance cost of the sanitation and wastewater treatment facilities, and in some cases, construction.

In the context of the institutions, it is important to highlight that one of the objectives of increasing the pollution charge is to achieve a good ecological status of the SRB.

This is a responsibility of the state administration through the Jucar River Basin Authority (CHJ), which works as a functionally autonomous unit. In fact, the National Water Quality Plan: Sewage and Treatment (2007-2015) has already included the basic measures for improving the quality of the SRB.

The CHJ belongs to the chart of the Ministry of Environment, within the State Administration. According to the Spanish Water Act, the general functions of this administration are as follows: (i) preparation, monitoring, and update of the river basin plan; (ii) administration and control of the public hydraulics domain; (iii) administration and control of the general interest exploitations; and (iv) project construction and exploitation of the works developed with the basin authority and state funds.

It must be taken into account that the pollution charge is collected by the regional authority for sanitation of wastewater (EPSAR) which is a regional administration. Thus, a close cooperation between the two institutions was and is still necessary.

The fact that the state and regional administration had to cooperate in order to implement the EPI was a barrier to overcome. At first other mechanism were considered, however, since the final use of the pollution charge is to finance the operation and maintenance of the WWTPs it was considered as a good instrument. Moreover, taking into account that the increase in the quality of the effluent contributes to improving the quality of the river, and therefore, it is enjoyed by the inhabitants of the area then everybody should pay.

In this context, the EPSAR has played and still plays an essential role since the operation of the WWTPs is essential for achieving the good ecological status of SRB. The EPSAR was created in 1992 through the Act 2/1992 as an independent entity. The two main functions of EPSAR are: (i) manage the operation of the facilities and perform works of sanitation and wastewater treatment; and (ii) collect, manage and distribute the pollution charge.

The increase in the pollution charge has not changed the existing institutions, but constitutes a good example for implementing the same instrument in other watersheds.

The implementation of the instrument has not failed since most of the defined objectives are being achieved. Nevertheless, the fact that the powers of management of water resources at the watershed belong to the state while the pollution charge is raised through a regional administration has complicated the process because there is a certain overlap in the functions of each administration.

3.5 Policy Implementability

The use of the increase in the pollution charge is an instrument that can be adapted to local circumstances in the sense that the increase is decided ex-ante implementation. As well some modification ex-post implementation also can be

made. In this context, the administration plans to create a social exemption for the disadvantaged people. Under this concept, citizens who meet certain conditions may be excluded from the increase in the charge. Because the instrument has been implemented recently it is not yet implemented but is estimated to be in force by 2012.

This EPI presents a wide margin to be adjusted once it has been implemented. In other words, if after carrying out the measures, it is verified that the increase in the pollution charge does not enable the recovery of the costs; then next year it is possible to additionally increase the pollution charge as it is reviewed annually.

Nowadays, there is no exception in the sense that the increase in the pollution charge has been applied in all municipalities and in all households. However, if it is verified that some users are too poor to face the increase in the pollution charge, and so exceptions can be made.

Public participation did not play a vital role in the design of the EPI since the administration did not carry out any public participation process. However it was considered indirectly because the board of participation of the EPSAR is composed of representatives of the regional and local administration, trade unions, business organisations, associations of consumers and users, associations of managers of water supply services, and sanitation and environmental organisations.

In the phase of the EPI implementation, the generic CHJ protocol for public participation was followed. This was based mainly briefings involving the local community and environmental organizations, representatives of the local administration, and neighbour associations. The aim was to explain the reasons for increasing the pollution charge and the final use of the income earned. At the end of the public participation process, the briefings were conducted for the general public in order to make sure of the acceptance of the increase and avoid future litigations. After the information campaigns, the perception of the citizens improved significantly which facilitated the implementation of the EPI since complaints, mainly from neighbourhood organizations, were minimized.

The cooperation and coordination between the state and regional administration was essential in the success of the EPI. The responsibility to achieve good ecological status of water bodies corresponds to the State while the one to wastewater treatment management belongs to regional administration. Thus, initially the state administration had to contact with regional administration to raise the necessary collaboration between the two administrations. In fact, this was the most complicated point in the implementation process and once it was solved the rest of the process was developed without difficulties. It should be noted that the idea of increasing the pollution charge to reduce water consumption and contribute to the achievement of good ecological status of water bodies in the SRB was originally suggested by the state administration (CHJ) which has the power for the management of interregional basin management. However, powers in the field of sanitation and wastewater

treatment belong to the regional administration. For this reason, collaboration between both administrative levels was necessary.

The implementation of the EPI was conditioned by the Water Framework Directive since it introduces the cost recovery and polluter pays principles. Hence, it has enabled to justify the increase in the pollution charge. Moreover, one of the measures considered necessary to achieve the good ecological status of water bodies was the reduction of water consumption and the implementation of the instrument has contributed to this end. The main barrier to the effectiveness of the EPI was ignorance about the cost paid for the water supply and sanitation service.

Table 8.14-Interaction between the EPI and other relevant policies

EPI Policy Objective: Reduce the consumption and pollution of water		
Other sectorial policies	**Objectives of sectoral policies**	**Synergies and Barriers**
Water Framework Directive	Achieve the good ecological status of water bodies by December 2015	++ Polluter pays and cost recovery principles justify the increase in the pollution charge.

3.6 Transaction Costs

For the increase in the pollution charge, the literature does not specifically define the concept of transaction cost.

The main participants involved in the instruments are the residents of the SRB and water administration (state and regional). Initially, only the state administration through the CHJ was implicated in the design of the EPI. However, after analyzing the options to improve the quality of the Serpis River in terms of the legal distribution of powers, the need to involve the regional administration through the EPSAR became clear. In this regard, cooperation between both administrations is one of the keys to the success of EPI.

The mechanism to choose this instrument to reduce water consumption is unclear. The quantification of the increase in the pollution charge (EPI design) was performed between both administrations since CHJ knew the type of measures to be implemented and their cost, while EPSAR had detailed information on the characteristics of the pollution charge. The implementation process was not taken too long given the goodwill of both administrations.

Before the implementation of the instrument, a contingent valuation study was made to ensure that local people were willing to accept an increase in the pollution charge. Transaction costs were not considered in the planning or design of the EPI.

No other instruments were applied in combination with the increase in the pollution charge. However, it is noted that at the same time, water administration and municipalities made an important effort to make users aware about the importance of reducing water consumption to increase the quality of the river. For this purpose, several educational programs were developed mainly in schools. Also meetings were organised with associations of neighbours and environmental organizations.

The most important transaction cost were the ex-ante costs mainly associated with the phase of research and obtaining the information needed to establish the increase in the pollution charge. It was not possible to discover the economic resource investment made at this stage. Other ex-ante transaction costs are associated with the information campaigns conducted in the municipalities in order to reduce the litigation processes from neighbours associations.

Because the vehicle of payment of the pollution charge is the water bill, it can be considered that the ex-post transaction cost are minimal since it is not an additional charge, but only an increase in an existing charge.

3.7 Uncertainty

From the implementation of the instrument the environmental objectives were not clearly specified since the aim was to reduce water consumption and indirectly water loads. The targets were vaguely defined in line with decreasing the volume of water consumed. Economic objectives were more clearly defined in the sense that the increase in the pollution charge should be enough to recover the cost of improving the effluent from the WWTPs as established by the water administration.

After the implementation of the instrument it has been confirmed that the quality of the river has increased and that part of this improvement is due to the reduction in water consumption. However, it is unclear how much the increase in quality is attributable to the increase in the pollution charge. Because most of the increase in the pollution charge was for recovering the cost of the implementation of measures at Font de la Pedra and Alcoy WWTPs there is no uncertainty in the fulfilment of this objective.

If there has not been an increment in the pollution charge, reducing household water consumption would have been implemented by another type of instrument – such as the improvement of efficiency in the distribution networks. As regards the recovery of the costs of the improvements in the WWTPs, the increase in the pollution charge is the only viable instrument since in applying the principle of who pollutes pays, the cost of wastewater treatment must be charged to users.

The increase in the pollution charge was introduced after checking that the users would be willing to pay more in the water bill if this helped improve the quality of river water. Therefore, it can be said that is was an appropriate tool at the time of introduction.

4 Conclusions

The challenge of achieving the good ecological status of water bodies at SRB highlighted the need to reduce water consumption and increase the quality of the effluents from WWTPs – taking into account the cost recovery principle. In this context, water administration at state level believed that increasing the pollution charge was a good instrument for fulfilling economic and environmental objectives.

Cooperation was necessary between the state and regional administrations increasing the pollution charge since the competence relative to water management at watershed level belongs to state administration, but regional administration is responsible for sanitation and wastewater treatment services.

4.1 Lessons learned

Although the EPI has been implemented recently, it can be said to have succeeded since both environmental and economic objectives have been achieved. The quality of the river has improved significantly as a result of the reduction in water consumption and above all due to the effluent from the largest WWTPs has an improved quality. The revenue obtained from the pollution charge pays for cost of the wastewater treatment process.

Taking into account the assessment framework from this case study some lessons may be learned:

- Environmental outcomes: the increase in pollution charge has contributed partially to increasing the water quality of the SRB. Although currently there is no statistical data relative to the reduction in water consumption, it is expected that it would be around 10%. By considering pollution charge in other Spanish regions there is room for additional increase in the charge.
- Economic assessment: The estimation of the cost of the measures implemented in the WWTPs aimed to contribute to achieving a good ecological status for water bodies and enabled a determination of the increase in the pollution charge necessary to recover all the costs. Moreover, the willingness of the users to pay for improving the quality of the SRB is higher than the real cost needed.
- Distributional effects and social equity: there are no problems of affordability in relation to the increase in the pollution charge. The improvement in the quality of the environment is perceived as an important aspect relative to the quality of life of the local community.
- Institutions: responsibility for water management at watershed level belongs to the state administration while the regional administration though EPSAR is the responsible for sanitation and wastewater treatment.

Hence, cooperation between both administrations was essential for the implementation of the EPI.

- Policy implementability: pollution charge is a flexible instrument since the increase is defined – depending on the objectives to be achieved and the elasticity of the water demand according to local circumstances. Public participation did not have a significant role in the design of the instrument, but it did play more significant role in the implementation process in order to avoid litigation.
- Transaction costs: The main participants involved in the instrument are the residents and water administration. The main transaction costs are the ex-ante costs and they are associated with the research needed to define the increase in the pollution charge. The ex-post transaction costs are minimal since the vehicle of payment of the pollution charge is the water bill.
- Uncertainty: while economic objectives where defined clearly, environmental objectives were vaguely established without specifying the reduction in water consumption to be achieved. It is unknown the part of the improvement in the quality of the river that is attributable to the increase in the pollution charge.

There has not been any unintended consequence as a result of increasing the pollution charge.

Although the design and implementation of the instrument is based on the cost of wastewater treatment and it has been checked that in general terms there are no problems of affordability, we consider that it is essential to develop a social exemption for the pollution charge. Our proposal is that this kind of exemption can only be applied if households do not consume more water than that level established in the first tranche of billing. Some criteria to be considered in order to benefit from this special exemption could be: households with all members out of work, or on minimum pensions, etc.

4.2 Enabling / Disabling Factors

Bearing in mind the possible use of this instrument in other watersheds there are some key factors that have contributed to its success. Firstly, it is essential to establish the elasticity of water demand in the area in which the instrument is going to be implemented. Sometimes for various causes, at current rates and charges, water demand is inelastic and therefore, there is no room for reducing water consumption. Secondly, it is very important to establish the willingness of the users to pay. In other words, if the increase in the pollution charge is lower than the willingness to pay there will be no problems of payment acceptance. Although the research needed to establish this willingness to pay may represent the highest transaction cost, it is essential to develop this kind of study. Finally, the institutional framework should be

defined as clearly possible as possible in the sense that the administration with the power to increase the tariff should be well defined, as well as the final use intended for the revenue. The acceptance of the payment by users increases if the revenue is destined to improve the environmental quality of the river.

There are two main disabling factors that may prevent the EPI from achieving its objective. The first is related to the current pollution charge. If the demand is inelastic, achieving a reduction in water consumption means increasing the pollution charge significantly, and this may cause problems of affordability. The second factor is the lack of awareness of some users of the charge paid for sanitation service. If users are unaware of this cost, then their behaviour will be unaffected by an increase in the pollution charge.

5 References

CHJ, 2005. (Jucar River Basin Authority). *Report for the European Comission about articles 5 and 6 of the Water Framework Directive.* Available from: www.chj.es. (Accessed on 15 November 2011) (In Spanish).

CHJ, 2008. (Jucar River Basin Authority). *Development of methodology and tools for the determination of a program of measures to comply with the Water Framework Directive. Pilot Study Serpis River Basin.(In Spanish).*Working Paper, October 2008.Valencia.

CHJ, 2011. (Jucar River Basin Authority). Available from: www.chj.es (Accessed on 15 November 2011). (In Spanish).

Del Saz-Salazar, S., Hernández-Sancho, F. and Sala-Garrido, R. 2009. The social benefits of restoring water quality in the context of the Water Framework Directive: A comparison of willingness to pay and willingness to accept**.** *Science of the Total Environment*, 407, 4574 – 4583.

EPSAR, 2011. (Public Entity of wastewater treatment of the Valencia Region). Available from: http://www.epsar.gva.es/sanejament/index.aspx (accessed on 15 November 2011) (In Spanish).

Hernández-Sancho, F., Molinos-Senante, M. and Sala-Garrido, R., 2011. Cost modelling for wastewater treatment processes. *Desalination*, 268, 1 – 5.

IVE, 2011. (Valencia Statistical Institute). Available from: www.ive.es (Accesed on 15 November, 2011). (In Spanish).

MARM, 2004. (Spanish Ministry of Environment, Rural and Marine). Programa A.G.U.A. (Actions for management and use of water) (In Spanish) Available from: http://www.mma.es/secciones/agua/entrada.htm (accessed on 15 November 2011) (In Spanish).

MARM, 2007. (Spanish Ministry of Environment, Rural and Marine). *National Plan for Water Quality: Wastewater Treatment.*(In Spanish). Available from:

http://www.mma.es/secciones/medios_comunicacion/prensa/notas_pre/2007/06/PlanNacionalCalidadAguas.pdf (accessed on 15 November 2011) (In Spanish).

MARM, 2008.(Spanish Ministry of Environment, Rural and Marine).*Water Planning Instruction*. Order MARM/2656/2008 of 10th of September. BOE nº 229, of 22th of September, 2008. (In Spanish).

MARM, 2009.(Spanish Ministry of Environment, Rural and Marine).*Technical Guidelines for the Evaluation of Measures*. Working Paper, November 2009. Madrid. .(In Spanish).

Molinos-Senante, M.; Hernández-Sancho, F. and Sala-Garrido, R. 2011. Assessing disproportionate costs to achieve good ecological status of water bodies in a Mediterranean river basin. *Journal of Environmental Monitoring*, 13, 2091-2101.

OECD, 2011. *Pricing water resources and water and sanitation services*, OECD, Paris.

6 Data Sources

CHJ, 2005. (Jucar River Basin Authority). *Report for the European Comission about articles 5 and 6 of the Water Framework Directive.* Available from: www.chj.es. (Accessed on 15 November 2011) (In Spanish).

CHJ, 2008. (Jucar River Basin Authority). *Development of methodology and tools for the determination of a program of measures to comply with the Water Framework Directive. Pilot Study Serpis River Basin.(In Spanish).*Working Paper, October 2008.Valencia.

EPSAR, 2011. (Public Entity of wastewater treatment of the Valencia Region). Available from: http://www.epsar.gva.es/sanejament/index.aspx (accessed on 15 November 2011) (In Spanish).

IVE, 2011. (Valencia Statistical Institute). Available from: www.ive.es (Accesed on 15 November, 2011). (In Spanish).

MARM, 2004. (Spanish Ministry of Environment, Rural and Marine). Programa A.G.U.A. (Actions for management and use of water) (In Spanish) Available from: http://www.mma.es/secciones/agua/entrada.htm (accessed on 15 November 2011) (In Spanish).

MARM, 2007. (Spanish Ministry of Environment, Rural and Marine). *National Plan for Water Quality: Wastewater Treatment.*(In Spanish). Available from: http://www.mma.es/secciones/medios_comunicacion/prensa/notas_pre/2007/06/PlanNacionalCalidadAguas.pdf (accessed on 15 November 2011) (In Spanish).

7 Annexes

Subsequently is presented the matrix regarding distributional effects of the EPI implementation from the point of view of citizens.

Indicator	Direction of change				
	--	-	0	+	++
Material Living Standards					
Health					
Education					
Personal Activities					
Employment					
Environment					
Security					
Political Voice					
Social connections and relationships					

Key

Grades assigned directly by interviewees

In order to complete the assessment of the uncertainty, pedigree matrices for the environmental outcomes, economic objectives and social equity of the instrument are as follow:

Table A.1- Pedigree matrix for environmental outcomes

	Reduction in water consumption	Improve water quality
Objective to be assessed	Not defined	P and BOD_5 concentrations
Proxy	3	3
Empirical	1	3
Method	2	3

Table A.2- Pedigree matrix for economic objectives

	Cost recovery
Objective to be assessed	100%
Proxy	4
Empirical	3
Method	3

Table A.3- Pedigree matrix for social equity

	Social acceptance	**Affordability**
Objective to be assessed	Not defined	Increase in water tariff below than 1% of AIGH
Proxy	3	3
Empirical	3	3
Method	3	3