

DISPROPORTIONATE COSTS IN THE WATER FRAMEWORK DIRECTIVE: THE CASE OF A MEDITERRANEAN RIVER BASIN

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ABSTRACT

The Water Framework Directive (WFD) seeks to achieve the good ecological status of all European Community water bodies by 2015. To achieve this objective, economic consideration of water management must be given in all decision-making processes. Exemption (time or level of stringency) from the objectives of the WFD can be justified by proving that the cost of implementing measures is disproportionate to the benefits. This paper addresses the issue of disproportionate costs through a cost-benefit analysis (CBA). To predict the costs, function costs method is used. The quantification of environmental benefits is more complex, because they are not determined by the market. As an alternative to stated preference methods, we use the distance function approach to estimate the environmental benefits of improving water quality. Subsequently, we apply this methodological approach to a Mediterranean River Basin in Spain. The results show that the achievement of good status could not be rejected based on the criterion of disproportionate costs in this river basin. This paper illustrates that CBA is a useful tool to inform policy and decision making. Furthermore, it is shown that economics, particularly the valuation of environmental benefits, plays a crucial role in fulfilling the environmental objectives of the WFD.

1 INTRODUCTION

The Water Framework Directive (WFD) is possibly one of the most ambitious and far-reaching environmental legislations to date. The ultimate aim of the WFD is to sustainably manage water at the river basin level and to attain the good ecological status of water quality across Europe by 2015 (Moran and Dann, 2008).

The use of economic tools and principles to realise the ecological objectives of this Directive is a novel and interesting component. Economics is to be an integral factor in the development of river basin plans, and in designing the programme measures to fulfil the environmental objectives of the WFD (Strosser, 2006). Within the implementation of the WFD, a programme of measures must be established. Article 11 of the WFD

distinguishes between basic measures and supplementary measures. Basically, there are two methods for the economic evaluation of water-management programmes: (i) Cost-Benefit Analysis (CBA) and (ii) Cost-Effectiveness Analysis (CEA). Within the context of the WFD, the most widely accepted method is CEA, because it allows the outcomes of a programme to be measured in terms of physical units. However, CBA has the advantage of measuring the net benefits of a programme in monetary terms (Aulong et al., 2009). Hence, CBA is complementary to CEA, as it ensures the economic rationality of investments by guaranteeing that the benefits outweigh the costs.

The WFD offers the possibility of temporal derogation or less stringent objectives when actions may be technically infeasible or result in disproportionately high costs compared to the benefits obtained (i.e. “disproportionate costs”; Heinz et al., 2007). From an economic perspective, CBA is the obvious tool for assessing disproportionate costs, by using either the net present value or the cost-benefit ratio as decision criterion. The costs and benefits of the WFD measures must be collated and compared to achieve good ecological status. A technical issue of CBA is that it requires both market and non-market costs and benefits to be assessed and estimated economically. Usually, project costs are determined by the market being easily quantifiable. In contrast, the quantification of environmental benefits is much more complex because they are not determined by the market, and therefore require the application of monetary valuation methods to achieve unit homogenisation. Thus, the estimation of environmental benefits from the implementation of the WFD has a crucial role in the ultimate goal of the European standard (Crabtree et al., 2009).

Significant effort is being devoted to applying tools to measure the environmental benefits related to WFD (e.g. Del Saz-Salazar et al., 2009; Birol et al., 2010). Methods that are commonly used for the economic valuation of environmental goods (stated preference methods) are based on the demand approach. Despite the overwhelming popularity of these methods of quantification, their use is subject to debate (e.g. Jacobs, 1997; Clark et al., 2000). Therefore, alternative methods have been developed to address this issue. For example, the pioneering work of Färe et al. (1993) used the concept of distance function, which is a valuation methodology that has been developed for undesirable outputs with no market value but substantial environmental effects. This alternative method is derived from a “cost of production perspective”. In the context of the WFD, the distance function approach may be applied when measures to achieve water quality targets are based on increasing the quality of effluent produced from wastewater treatment plants (WWTPs). In the Mediterranean region, a vast majority of river basins are characterised by a very low flow rate, particularly in summer when both the demand and air temperatures are higher. Hence, the most common set of measures is based on implementing treatment systems that are able to increase the removal efficiency of wastewater pollutants.

This study examines the issue of disproportionate costs of WFD implementation using the case study of Serpis River Basin (SRB), which is a Mediterranean river basin in Spain. We used the CBA tool as the decision criterion, by comparing the costs and benefits derived from the implementation of measures to realise the proposed WFD objectives. We used various cost functions to estimate the costs. The environmental benefits derived from improving the water quality of the river basin was quantified using the distance function approach. We aimed to (i) evaluate the economic viability of the basic measures, which allows decision makers to justify the economic feasibility of

implementing such measures and (ii) evaluate the economic viability of the supplementary measures. In this case, the objective is to determine whether the SRB is in a situation of disproportionate costs, and hence justify its exemption from the requirement of achieving good ecological status.

2 CASE STUDY: THE SERPIS RIVER BASIN

The Serpis River Basin (SRB) is located in the Region of Valencia (Eastern Spain). The basin covers an area of 990 km², and is about 75 km in length. The course of the Serpis River, crosses more than 50 municipalities. Most of these municipalities have installed WWTPs. Specifically, there are 30 WWTPs that receive wastewater from the main urban and industrial areas, treating around 31 Mm³/year. In total, 24 of the 30 plants discharge treated water to the Serpis River, while the remaining six plants discharge treated water into the sea. The three most important WWTPs are: Font de la Pedra (4,568,705 m³/year to the river); Alcoy (7,601,125 m³/year to the river), and Gandia (17,519,623 m³/year to the sea) (EPSAR, 2011).

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 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 represent a high percentage of the total stream flow, accounting for up to 50% during winter and 90% during summer time (CHJ, 2008).

The implementation of the WFD in Spain is delineated in the Water Planning Instruction (WPI) (MARM, 2008). Based on the characteristics of the SRB, the CHJ found that both the basic and supplementary measures are designed to increase the quality of effluent from Alcoy and Font de la Pedra WWTPs. In 2009, the treatment flow rate of the Alcoy plant was 20,825 m³/day. Biological treatment processes removed nitrogen and phosphorus by using activated sludge (AS). The Font de la Pedra WWTP includes the secondary treatment process of extended aeration (EA) with nutrients removal. The treatment flow was 12,517 m³/day (EPSAR, 2011).

Table 1 shows the list of basic and supplementary measures defined by CHJ. The three basic measures are aimed to improve the secondary treatment processes at the WWTPs of Alcoy and Font de la Pedra, to fulfil the objectives set by Directive 271/91/CEE. Supplementary measures include the implementation of tertiary treatment technologies which would facilitate the quality of effluent to increase beyond the value required by legislation for the pollutants BOD₅ and P.

Table 1. Basic and supplementary measures for SRB.

Basic Measures	
1	Improvement of secondary treatment in Alcoy's WWTP for BOD ₅ to 25 mg/l.
2	Improvement of secondary treatment in Alcoy's WWTP for P to 1 mg/l.
3	Improvement of secondary treatment in Font de la Pedra's WWTP for P to 2 mg/l.
Supplementary Measures	
1	Tertiary of 10.000 m ³ /day in Alcoy's WWTP for BOD ₅ to 10 mg/l and P to 0.5 mg/l.
2	Tertiary of 2.500 m ³ /day in Font de la Pedra's WWTP for BOD ₅ to 10 mg/l and P to 0.5mg/l.

3 METHODOLOGY

3.1 CBA as a tool for the identification of disproportionate costs.

The concept of disproportionate costs is inadequately defined in the WFD. From an economic viewpoint, CBA serves as an appropriate starting point to address the issue of disproportionate costs (Görlach and Pielsen, 2007). CBA allows for the comparison of costs and benefits to achieve improvements towards attaining good ecological status. The net profit of each measure is the difference between benefits and costs:

$$NP = \sum Bi - \sum Ci \quad (1)$$

where NP is the net profit, Bi is the value of the benefit item i, and Ci is the value of the cost item i. If the NP is greater than zero this indicates that the benefits of the measure outweigh the costs, and therefore it is justified economically. On the other hand, if the NP is negative this means that the costs exceed the benefits, and therefore the measure is not viable in economic terms. Given the public good nature of the WFD objectives, the government may be willing to accept an NP of less than zero. The question then becomes how many times the costs may exceed the benefits before the involved programme of measures is deemed disproportionate (Brouwer, 2008).

3.2 Cost of implementing measures.

The WPI indicates that the cost of the measures should include (i) Investment Cost (IC) and (ii) Operation and Maintenance Cost (OMC). IC and OMC are the direct financial costs of the measure for both the public administration and the economic agents (Berbel et al., 2011).

The cost of each measure is defined as:

$$TC = IC + OMC \quad (2)$$

where TC is the total cost; IC represents the investment cost, and OMC is the operational and maintenance costs.

The cost of the measure must be adjusted for the time period in which it occurs. For this reason, investment, operation and maintenance costs must be discounted to “present value” terms. Therefore, the Total Annualised Economic Cost (TAEC) is calculated by adding the annualised IC to the annual OMC as:

$$TAEC = \frac{r \cdot (1+r)^t}{(1+r)^t - 1} \cdot IC + OMC \quad (3)$$

where TAEC is the total annualised economic cost; IC represents the investment cost; OMC is the operational and maintenance costs; r is the discount rate; and t is the useful life-span of the measure.

3.3 Environmental benefits from implementing measures.

Given that the set of measures (both basic and supplementary) defined to achieve good status in the SRB consists of improving the quality of effluent from the WWTPs of Alcoy and Font de la Pedra, the quantification of environmental benefits was made by using the distance function approach (Färe et al., 1993), which allows for the calculation of the shadow prices of pollutants removed during wastewater treatment.

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.

The works of Hernández-Sancho et al. (2010); Molinos-Senante et al. (2010) and Molinos-Senante et al. (2011), demonstrate the validity of this method as an alternative to traditional methods, to obtain an approximation of the environmental benefits derived from wastewater treatment. This methodology is based on the concept of distance function which measures the difference between the outputs produced in the process under study and the outputs of the more efficient process.

The relationship of duality between the distance function and the revenue function creates a link between the relative and absolute prices (Färe et al., 1993). Under the assumption that the distance and revenue functions are differentiable, the Lagrange multiplier method and Shephard's dual lemma enable us to calculate shadow prices.

This deduction of shadow prices for the undesirable outputs means that it must be assumed that the shadow price of an absolute desirable output coincides with the market prices. If m is a desirable output with a market price of r_m which is equal to its shadow price (r_m^0), and if m' is each of the undesirable outputs and $r_{m'}$ is the shadow price of each undesirable output, for all $m' \neq m$ the absolute shadow prices are given by (Färe et al., 1993):

$$r_{m'} = r_m^0 \cdot \frac{\partial D_0(x, u) / \partial u_{m'}}{\partial D_0(x, u) / \partial u_m} \quad (4)$$

In order to implement the expression of the shadow price (Eq. 4), it is necessary to parameterise an output distance function. The translog function offers the greatest flexibility, and is therefore the most frequently used for this purpose. If applied to a problem with k units, n inputs y m outputs the formula is:

$$\begin{aligned} \ln D_0(x^k, u^k) = & \alpha_0 + \sum_{n=1}^N \beta_n \ln x_n^k + \sum_{m=1}^M \alpha_m \ln u_m^k + \frac{1}{2} \sum_{n=1}^N \sum_{n=1}^N \beta_{nn} (\ln x_n^k) (\ln x_n^k) + \\ & \frac{1}{2} \sum_{m=1}^M \sum_{m=1}^M \alpha_{mm} (\ln u_m^k) (\ln u_m^k) + \sum_{n=1}^N \sum_{m=1}^M \gamma_{nm} (\ln x_n^k) (\ln u_m^k) \end{aligned} \quad (5)$$

Optimisation is a widely used method for estimating empirical distance functions (e.g. Färe et al., 2006). In this study, optimisation is carried out using linear programming, since it always guarantees that the production of global optima.

Like costs, environmental benefits must be expressed in the present value. Hence, the discount rate “ r ”, should also be applied to the estimated benefits.

4 RESULTS AND DISCUSSION

4.1 Cost of implementing measures

Several cost functions published in the literature have been used to characterise both

the IC and the OMC of each of the identified measures.

The estimation of the IC, for both basic and supplementary measures, is performed based on the cost functions developed by the Spanish Ministry of the Environment, through the Technical Guidelines for the Evaluation of Measures (TGEM) (MARM, 2009.) In the case of basic measures, the IC refers to the adequacy of current secondary treatment processes to fulfil the UWWD requirements. However, the TGEM does not include any cost function to quantify the IC regarding the adequacy of the parameter BOD₅ to 25 mg/l at the Alcoy WWTP. Therefore, data collected in the A.G.U.A. Programme (Actions for the Management and Use of Water) (MARM, 2004) was selected for the remainder of the calculations, the values of which were updated to the year of reference. With respect to supplementary measures, the TGEM indicates that tertiary treatment already supplements existing secondary treatment processes with nutrient removal. Table 2 shows the cost functions that were used to estimate the costs of the basic measures, the unitary IC of supplementary measures, and the estimated total IC for implementing each of the measures.

Table 2. Measures, cost functions, unitary cost and total IC in € for the implementation of basic and supplementary measures in SRB.

BASIC MEASURES		
Description of the measure	IC function	Cost
Improvement of secondary treatment in Alcoy's WWTP for BOD ₅ to 25 mg/l	-	2,500,000
Improvement of secondary treatment in Alcoy's WWTP for P to 1 mg/l (option 1)	$IC = 23,69 X^{0.8713}$	664,226
Improvement of secondary treatment in Alcoy's WWTP for P to 1 mg/l (option 2)	$IC = 2,32 X + 287,365$	582,634
Improvement of secondary treatment in Font de la Pedra's WWTP for P to 2 mg/l	$IC' = 1,242.3 X^{0.7727}$	616,882
SUPPLEMENTARY MEASURES		
Description of the measure	Unitary IC (€/m ³ /day)	Cost
Tertiary of 10.000 m ³ /day in Alcoy's WWTP for BOD ₅ to 10 mg/l and P to 0.5 mg/l.	185 - 398	3,980,000
Tertiary of 2.500 m ³ /day in Font de la Pedra's WWTP for BOD ₅ to 10 mg/l and P to 0.5 mg/l.	185 - 398	995,000

where X is the design population expressed in PE, while IC is the investment cost of secondary treatment improvements in € and IC' is the total investment cost in €.

For the quantification of the OMC of basic measures, we must take into account that the actions to be implemented are an improvement of existing secondary treatment processes in the WWTPs. Therefore, the cost of these measures is quantified as the difference between current WWTP costs and future costs after improvement of the secondary treatment process. In doing so, the cost functions developed by Hernández-Sancho et al. (2011) are used because additional variables to that of the role that the economies of scale in the determination of costs, such as the efficiency in removing various pollutants are included. The operational and maintenance cost function for secondary treatment with nutrient removal is as follows:

$$OMC = 2.5180 \cdot V^{0.7153} \cdot e^{(0.007A + 1.455BOD + 0.258N + 0.243P)} \quad (6)$$

where, OMC is the total operational and maintenance cost for secondary treatment in €/year; V is total volume of wastewater treated in m³/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.

Table 3 shows the OMC under current treatment levels (current cost) and treatment levels once actions to improve pollutants removal efficiency are implemented (improved cost). The difference between the improved cost and the current cost is the OMC associated with the implementation of the measure.

Table 3. OMC in current scenario and with the implementation of basic measures in €/year.

Description of the measure	Current cost	Improved cost	Cost of the measure
Improvement of secondary treatment in Alcoy's WWTP for BOD ₅ to 25 mg/l and P to 1 mg/l	1,117,260.2	1,271,855.7	154,595.6
Improvement of secondary treatment in Font de la Pedra's WWTP for P to 2 mg/l	835,215.0	870,440.3	35,225.3

When taking into account that supplementary measures require the implementation of treatment technologies characterised as a tertiary type, the OMC quantification of such measures is based on the function developed by Hernández-Sancho et al. (2011) to quantify the costs associated with this type of treatment:

$$OMC = 3.7732 \cdot V^{0.7223} \cdot e^{(0.6721BOD + 0.1958N + 0.7603P)} \quad (7)$$

where, OMC is the total cost for tertiary treatment in €/year; V is the total volume of wastewater treated in m³/year; BOD is the biological oxygen demand removal efficiency; N is the nitrogen removal efficiency; and P is the phosphorous removal efficiency. Table 4 shows the OMC for supplementary measures.

Table 4. OMC in €/year for supplementary measures.

Description of the measure	Cost
Tertiary treatment of 10.000 m ³ /day in Alcoy's WWTP for BOD ₅ to 10 mg/l and P to 0.5 mg/l.	481,276.8
Tertiary treatment of 10.000 m ³ /day in Font de la Pedra's WWTP for BOD ₅ to 10 mg/l and P to 0.5 mg/l.	163,425.5

4.2 Environmental benefits from implementing measures.

The expression of the environmental benefits in monetary terms was estimated by calculating the shadow prices of the pollutants that were removed during the wastewater treatment process. The value of shadow prices after the implementation of the measures will be greater than obtained under current treatment methods, since the effluent quality would be higher, and therefore the environmental benefits derived from the treatment

process would also be greater. The difference between the value of the current shadow prices and that resulting after the adoption of basic measures, provides information on the economic value of environmental benefits derived from ensuring that the UWWD requirements are fulfilled. However, implementation of the basic measures is not enough to achieve good ecological status in the SRB. This is because the difference between the environmental benefits after implementing basic and supplementary measures indicates exclusively environmental benefits from the implementation of supplementary measures. The quantification of the environmental benefits achieved as a result of the implementation of supplementary measures, allows for the assessment of whether these measures can be categorised within the disproportionate costs for the SRB, consequently justifying exemption (in time or level of stringency) from achieving the environmental objectives defined by the WFD.

Although the defined measures relate to only two WWTPs, at present the SRB has 24 operational facilities that discharge effluent into the river basin. All WWTPs carry out a similar process, from which a desirable output is obtained (treated water) and four pollutants: suspended solids (SS), nitrogen (N), phosphorus (P), and organic matter measured as biological oxygen demand (BOD₅) are removed. The improvement of the treatment process is focused on implementing measures based on the levels of BOD₅ and P parameters. However, the introduction of technological improvements in WWTPs has also resulted in associated improvements in the removal of other pollutants, such as N and SS. Statistical information for the year 2008 was supplied by the regional wastewater treatment authority (EPSAR).

Following the methodology described in Section 3.3, the shadow prices for pollutants were estimated for each of the 24 WWTPs for current level of treatment. Moreover, shadow prices for Alcoy and Font de la Pedra WWTPs have been estimated for the three levels of wastewater treatment; (i) current, (ii) with the addition of basic measures, and (iii) with the addition of supplementary measures. Table 5 shows the values that were obtained for the Alcoy and Font de la Pedra WWTPs.

Table 5. Shadow prices for pollutants in €/Kg for the three levels of treatment: current, with basic measures (Basic) and with supplementary measures (Supplem.).

	ALCOY WWTP			FONT DE LA PEDRA WWTP		
	Current	Basic	Supplem.	Current	Basic	Supplem.
SS	-0.232	-0.251	-0.271	-0.141	-0.204	-0.237
BOD ₅	-0.520	-0.862	-1.784	-0.473	-0.601	-1.371
N	-6.660	-6.953	-8.531	-7.183	-8.720	-9.135
P	-5.676	-10.789	-21.051	-4.157	-9.371	-17.806

When considering the volume of pollutant removal in the treatment process (Kg/year), and the shadow price expressed in €/Kg for each of the pollutants (Table 5), we can calculate the total environmental benefits resulting from the treatment of wastewater under the current conditions of treatment and with subsequent technological improvements (i.e. basic and supplementary measures) in €/year (Table 6). These values allow the economic value of environmental benefits to be obtained with respect to increasing the quality of water in the entire SRB.

Table 6. Environmental benefits of wastewater treatment in €/year.

	SS	BOD ₅	N	P	TOTAL
ALCOY WWTP					
Total with current treatment	432,338	1,254,410	1,051,251	284,942	3,022,941
Total with basic measures	492,565	2,668,526	1,726,733	1,005,280	5,893,103
Total with supplementary measures	546,129	5,726,339	2,296,957	2,041,515	10,610,940
Increase result of implementing the basic measures	60,226	1,114,116	975,482	720,338	2,870,162
Increase result of implementing the supplementary measures	53,564	3,057,813	570,225	1,036,235	4,717,837
FONT DE LA PEDRA WWTP					
Total with current treatment	241,401	983,257	724,551	26,601	1,975,810
Total with basic measures	351,552	1,021,829	1,331,125	165,173	2,869,680
Total with supplementary measures	424,790	2,557,219	1,510,244	463,775	4,956,029
Increase result of implementing the basic measures	110,151	238,573	406,574	138,573	893,870
Increase result of implementing the supplementary measures	73,239	1,535,390	179,118	298,602	2,086,349
SERPIS RIVER BASIN (24 WWTPs)					
Total with current treatment	900,406	3,601,926	1,805,392	315,969	6,623,693
Total with basic measures	1,070,784	4,986,620	3,155,442	1,174,879	10,387,725
Total with supplementary measures	1,197,586	9,579,823	3,904,785	2,509,716	17,191,910
Increase result of implementing the basic measures	170,378	1,384,694	1,350,050	858,910	3,764,032
Increase result of implementing the supplementary measures	126,802	4,593,203	749,343	1,334,837	6,804,186

Once both the economic costs and environmental benefits have been identified and quantified, the net profit associated with the implementation of basic and supplementary measures in the SRB can be calculated.

4.3 Net profit

Net profit is calculated by comparing the total environmental benefits derived from improving water quality in the SRB against the necessary costs (IC and OMC) to implement basic and supplementary measures. First, the useful life-span of the measures must be decided. According to the TGEM (MARM 2009) recommendations, basic and supplementary measures are assigned different life-spans. For basic measures, the useful life-span is projected to be 20 years. For supplementary measures, the useful life-span is projected to be 15 years. In addition, the discount rate must be selected, to express both the costs and benefits as present values. To test the sensitivity of the results, two different discount rates were applied. Following the work of Almansa and Martínez-Paz (2011), discount rates of 3% and 2% were used.

Table 7. Total costs, environmental benefits and net profit in €/year for two discount rates.

Description of the measure	i = 2%			i = 3%		
	TOTAL COST	ENV. BENEFIT	NET PROFIT	TOTAL COST	ENV. BENEFIT	NET PROFIT
Improvement in secondary treatment in Alcoy	348,110	2,346,563	1,998,453	367,282	2,135,038	1,767,756
Improvement in secondary treatment in Font de la Pedra	72,951	730,803	657,852	76,689	664,926	588,237
Total basic measures	421,061	3,077,366	2,656,305	443,971	2,799,965	2,355,994
Tertiary treatment for 10,000 m ³ /day in Alcoy.	791,022	4,041,382	3,250,360	814,668	3,754,749	2,940,081
Tertiary treatment for 2,500 m ³ /day in Font de la Pedra	240,862	1,787,203	1,546,341	246,774	1,660,447	1,413,673
Total supplementary measures	1,031,884	5,828,585	4,796,701	1,061,441	5,415,195	4,353,754

A comparison of the environmental benefits against the total costs associated with each measure in annual terms is shown in Table 7. Clearly, for the two scenarios considered (discount rate values of 2% and 3%), the net profit of all measures is positive. This result shows that improving water quality in SRB is both environmentally and economically beneficial.

For the implementation of basic measures, the value of the benefits exceeds the present value of the costs, with a ratio of 7.3:1 when using a discount rate of 2% and with a ratio of 6.3:1 when using a discount rate of 3%. Therefore, the improvement of secondary treatment at the Alcoy and Font de la Pedra WWTPs to ensure compliance with the UWWD, is not only a legal obligation but also economically rational.

Regarding supplementary measures, the benefit-cost ratio is slightly lower than that recorded for the basic measures, with a ratio of 5.6:1 and 5.1:1 assuming discount rates of 2% and 3%, respectively. Hence, the achievement of good ecological status of water bodies in the SRB cannot be considered as a case of disproportionate costs. This means that the Spanish State cannot claim exemption, either in time or with respect to the implementation of the WFD objectives in the SRB. Consequently, by December 2012 the programme of measures should be operational to achieve the good ecological status of the waterbodies of the SRB.

5 CONCLUSIONS

The WFD motivates far-reaching changes and a fundamental reorientation in water management in the European Union. This action includes the attainment of specified environmental targets for all water bodies by 2015, whereby economic considerations must also be taken into account in all decision-making processes that affect water management. Of all economic parameters within the WFD, the concept of disproportionate costs is presented as a key aspect to achieve the good ecological status of bodies of water. This is because MS are permitted to request a postponement of the environmental objectives (time or level of stringency) by proving that the costs of implementing measures are disproportionate to their benefits.

From an economic perspective, CBA represents an appropriate tool for addressing the issue of disproportionate costs. The fact that there is no market value of the environmental benefits that arise from the implementation of the WFD, increases the complexity of performing a CBA. For this purpose, the present study used the function

distance approach as an alternative to traditional stated preference methods. The costs of implementing measures were estimated using cost functions.

We applied this approach to the Serpis River Basin, and showed that in basins where the measures are based on improving WWTP, the quantification of the shadow prices of pollutants removed during the wastewater treatment process presents an equally good alternative to other monetary valuation methods. One of the main advantages of using the cost production rather than demand approach, is that problem of the aggregation of benefits is avoided. Furthermore, the scale at which the assessment of disproportionate costs takes place also presents a vital issue when using other monetary valuation methods. For the SRB, our results show that both the implementation of basic and supplementary measures to achieve good ecological status is economically viable. The net profit that is gained as a result of improving water quality in the river clearly shows the exemption of environmental objectives based on the issue of disproportionate costs cannot be justified in the SRB.

In conclusion, we would like to emphasise that this paper used the CBA approach, due to the ambiguity with which the concept of disproportionate cost is defined in the WFD. The CBA is a tool that allows policy and decision makers to be informed about the net profit of the achievement of good status in freshwater river basins. However, disproportionate costs are not the same as economic efficiency, as this would require that legislation clearly defines disproportionate as costs exceeding benefits, which is not the case in any of the European Directives where similar escape clauses have been included. Finally, the application of economics to water management is challenging, and requires the ability to credibly value non-market costs and benefits. For the WFD objectives to be implemented successfully, a greater integration of economic and technical aspects with participatory and decision-making processes must be accomplished.

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