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Economic analysis for exemptions to achieve the environmental objectives in groundwater bodies

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Abstract: This paper analyses and compares the use of cost-benefit analysis (CBA) for exemptions and disproportionate cost decision according to the implementation of Water Framework Directive Article 4 in groundwater bodies in the Spanish River Basins. Data has been obtained from both, the hydrological plans for the first planning cycle (2009-2015) and for the second one (2015-2021). Results show the evolution in the scope of good chemical and quantitative status of groundwater bodies in both planning cycles, and the different methodologies used to justify economically exemptions to achieve the environmental objectives in such bodies.

Keywords: groundwater management, water economics, Water Framework Directive, cost-benefit analysis, disproportionate cost, exemptions.

1. Introduction

On 23 October 2000, the "Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy" or, in short, the EU Water Framework Directive [1] (or even shorter the WFD) was adopted. By means of this Framework Directive, the EU provides for the management of inland surface waters, groundwater, transitional waters and coastal waters in order to prevent and reduce pollution, promote sustainable water use, protect the aquatic environment, improve the status of aquatic ecosystems and mitigate the effects of floods and droughts.

The environmental objectives are defined in Article 4 - the core article - of the Water Framework Directive (WFD). The aim is long-term sustainable water management based on a high level of protection of the aquatic environment. Article 4.1 defines the WFD general objective to be achieved in all surface and groundwater bodies, i.e. good status by 2015, and introduces the principle of preventing any further deterioration of status. There follow a number of exemptions to the general objectives that allow for less stringent objectives, extension of deadline beyond 2015, or the implementation of new projects, provided a set of conditions are fulfilled.

An integral part of the environmental objectives set out in Article 4 are the so-called exemptions. Article 4.4, 4.5, 4.6 and 4.7 describe the conditions and the process in which they can be applied. These exemptions range from small-scale temporary exemptions to mid and long term deviations from the rule "good status by 2015", and include the following aspects:

- The extension of the deadline, in other words, good status must be achieved by 2021 or 2027 at the latest (Article 4.4) or as soon as natural conditions permit after 2027;

- The achievement of less stringent objectives under certain conditions (Article 4.5);
- The temporary deterioration of the status in case of natural causes or "force majeur" (Article 4.6);
- New modifications to the physical characteristics of a surface water body or alterations to the level of bodies of groundwater, or failure to prevent status deterioration of a body of surface water (including from high status to good status) as a result of new sustainable human development activities (Article 4.7).

The term "disproportionate costs" (or disproportionately expensive) is used in Article 4.4, 4.5 and 4.7 of the WFD. Disproportionality, as referred to in Article 4.4 and 4.5, is a political judgement informed by economic information, and an analysis of the costs and benefits of measures is necessary to enable a judgement to be made on exemptions. It was already concluded in the WATECO guidance [2-3] that, given the uncertainty around estimates of costs and benefits one should bear in mind that,

- Disproportionality should not begin at the point where measured costs simply exceed quantifiable benefits;
- The assessment of costs and benefits will have to include qualitative costs and benefits as well as quantitative;
- The margin by which costs exceed benefits should be appreciable and have a high level of confidence;
- In the context of disproportionality the decision-maker may also want to take into consideration the ability to pay of those affected by the measures and some information on this may be required.

From the logic of the WFD is becomes clear that an assessment of disproportionate costs only makes sense after a combination of the most cost-effective solutions has been identified. Most importantly, for all cases where an exemption is applied, all measures that can be taken without involving disproportionate costs should still be taken to reach the best status possible. In cases where exemptions are considered the consequences of non-action (i.e. foregone benefits) need to be weighed against the specific costs of the measures.

The objective of this paper is the analysis of the implementation of Water Framework Directive Article 4 in groundwater bodies in the Spanish River Basins and identify the different methodologies used to justify economically exemptions to achieve the environmental objectives in such bodies. Section 2 describes the materials and methods that have been used, section 3 shows the results and finally, section 4 contains the conclusions.

2. Materials and Methods

Data has been obtained from both, the hydrological plans for the first planning cycle (2009-2015) and for the second one (2015-2021) of Spanish IBWAs (inter-basin water agencies) [4-14], which account for 87% of the Spanish area and 64% of population.

The location of BWAs is showed in Figure 1.

Figure 1. Location of inter and intra basins in Spain
Source: Adapted from MAGRAMA, http://www.magrama.gob.es

The main characteristics of the inter-basins under study are summarized in Table 1.

Table 1. Main characteristics of the Spanish inter-basins

River Basin	Area (km²)	Area over Spain (%)*	Population (no. of inhabitants)	Population over Spain (%)**	Number of regions in Spain
Western Cantabrian	19,002	3.8	1,656,626	3.6	5
Eastern Cantabrian	6,405	1.3	1,297,494	2.8	3
Minho-Sil	17,619	3.5	825,851	1.8	3
Douro	78,859	15.6	2,222,532	4.8	8
Ebro	85,569	16.9	3,226,921	6.9	9
Tagus	55,781	11.1	7,273,871	15.6	5
Jucar	42,851	8.5	5,178,000	11.1	4
Guadiana	55,527	11.0	1,443,707	3.1	3
Guadalquivir	57,527	11.4	4,480,321	9.6	4
Segura	20,234	4.0	1,884220	4.3	4

* It means the area that each river basin takes up in Spain. ** It means the population of each basin over the total population in Spain.

Source: River Basin Management Plans 2015-2021

3. Results

Table 2 and Table 3 show the number of groundwater bodies in each IBWAs and their global status (quantitative and chemical) in the River Basin Management Plans 2009-2015 and in the River Basin Management Plans 2015-2021, respectively.

Table 2. Global status of groundwater bodies in the River Basin Management Plans 2009-2015.

River Basin	Groundwater bodies	Quantitative Status		Chemical Status		Global Status		Global Status (%)	
	Number	Good	Poor	Good	Poor	Good	Poor	Good	Poor
Minho-Sil	6	6	0	5	1	5	1	83.3%	16.7%
Eastern Cantabrian	28	28	0	26	2	26	2	92.9%	7.1%
Western Cantabrian	20	20	0	20	0	20	0	100.0%	0.0%
Douro	64	59	5	50	14	48	16	75.0%	25.0%
Tagus	24	24	0	18	6	18	6	75.0%	25.0%
Guadiana	20	9	11	7	13	5	15	25.0%	75.0%
Guadalquivir	60	42	18	44	16	33	27	55.0%	45.0%
Segura	63	22	41	39	24	16	47	25.4%	74.6%
Jucar	90	60	30	63	27	50	40	55.6%	44.4%
Ebro	105	104	1	82	23	82	23	78.1%	21.9%
TOTAL	**480**	**374**	**106**	**354**	**126**	**303**	**177**	**63.1%**	**36.9%**

Source: River Basin Management Plans 2009-2015

Table 3. Global status of groundwater bodies in the River Basin Management Plans 2015-2021.

River Basin	Groundwater bodies	Quantitative Status		Chemical Status		Global Status		Global Status (%)	
	Number	Good	Poor	Good	Poor	Good	Poor	Good	Poor
Minho-Sil	6	6	0	4	2	4	2	66.7%	33.3%
Eastern Cantabrian	20	20	0	19	1	19	1	95.0%	5.0%
Western Cantabrian	20	20	0	20	0	20	0	100.0%	0.0%
Douro	64	60	4	49	15	48	16	75.0%	25.0%
Tagus	24	24	0	18	6	18	6	75.0%	25.0%
Guadiana	20	9	11	5	15	4	16	20.0%	80.0%
Guadalquivir	86	65	21	62	24	54	32	62.8%	37.2%
Segura	63	22	41	35	28	15	48	23.8%	76.2%
Jucar	90	56	34	67	23	46	44	51.1%	48.9%
Ebro	105	104	1	81	24	81	24	77.1%	22.9%
TOTAL	**498**	**386**	**112**	**360**	**138**	**309**	**189**	**62.0%**	**38.0%**

Source: River Basin Management Plans 2015-2021

In global terms, there haven´t been substantial changes in the overall status of groundwater bodies between both cycles. The total percentage of groundwater bodies in good status was 63.1% in the first planning cycle and 62.0% in the second one. So that, the IBWAs have had to define exemptions of the rule of "good status" in the groundwater bodies in both cycles.

Table 4 and Table 5 indicate which kind of exemptions defined in Article 4 have been defined in both cycles. As we said before, Article 4.4, 4.5, 4.6 and 4.7 describe the conditions and the process in which they can be applied and include the following aspects:

- The extension of the deadline, in other words, good status must be achieved by 2021 or 2027 at the latest (Article 4.4) or as soon as natural conditions permit after 2027;

• The achievement of less stringent objectives under certain conditions (Article 4.5);
• The temporary deterioration of the status in case of natural causes or "force majeur" (Article 4.6);
• New modifications to the physical characteristics of a surface water body or alterations to the level of bodies of groundwater, or failure to prevent status deterioration of a body of surface water (including from high status to good status) as a result of new sustainable human development activities (Article 4.7).

Results show that in both cycles exemptions haven´t been established for the reasons indicate in Article 4.6 and Article 4.7 in none of the Spanish IBWAs. The most of exemptions (83.3% in the first cycle and 77.2% in the second one) include the extension of the deadline (Article 4.4) and the achievement of less stringent objectives (Article 4.5), 16.7% in the first cycle and 22.8% in the second one.

Table 4. Exemptions in groundwater bodies in the River Basin Management Plans 2009-2015.

River Basin	Exemptions				
	4.4	**4.5**	**4.6**	**4.7**	**TOTAL**
Minho-Sil	1	0	0	0	1
Eastern Cantabrian	1	0	0	0	1
Western Cantabrian	0	0	0	0	0
Douro	3	14	0	0	17
Tagus	6	0	0	0	6
Guadiana	15	0	0	0	15
Guadalquivir	25	0	0	0	25
Segura	36	10	0	0	46
Jucar	37	3	0	0	40
Ebro	21	2	0	0	23
TOTAL	**145**	**29**	**0**	**0**	**174**

Source: River Basin Management Plans 2009-2015

Table 5. Exemptions in groundwater bodies in the River Basin Management Plans 2015-2021.

River Basin	Exemptions				
	4.4	**4.5**	**4.6**	**4.7**	**TOTAL**
Minho-Sil	2	0	0	0	2
Eastern Cantabrian	1	0	0	0	1
Western Cantabrian	0	0	0	0	0
Douro	8	8	0	0	16
Tagus	6	0	0	0	6
Guadiana	9	3	0	0	12
Guadalquivir	25	6	0	0	31
Segura	34	14	0	0	48
Jucar	35	9	0	0	44
Ebro	22	2	0	0	24
TOTAL	**142**	**42**	**0**	**0**	**184**

Source: River Basin Management Plans 2015-2021

Finally, IBWAs have to justify the reasons why their groundwater bodies are not going to achieve the environmental objectives, that is, they have to justify the exemptions to their compliance. IBWAs use the economic analysis and the term "disproportionate costs" (or disproportionately expensive) for that. It means that if reaching the objectives in time should be disproportionately costly, either the 2015 deadline may be extended, or the objective may be relaxed.

One key consideration in the decision on exemptions is in proportion to what costs are considered as disproportionate, i.e. the choice of the reference point. One obvious candidate are the (monetised) benefits of implementing the WFD. Other options include the resources available to those who have to pay for WFD implementation, or the cost of comparable measures in other locations. Spanish IBWAs have used a classical cost-benefit in the judgement on the disproportionality of costs: in this understanding, costs are considered as disproportionate if they exceed the monetised benefits of achieving 'good status' in a water body (or, possibly, if costs exceed benefits by a certain "safety margin"). Ultimately, the judgement on the disproportionality of costs will be a political decision and it will depend on how far the ability-to-pay of affected parties can serve to justify an exemption.

4. Conclusions

The most of exemptions established in groundwater bodies in Spanish IBWAs include the extension of the deadline (Article 4.4) and the achievement of less stringent objectives (Article 4.5).

The common economic analysis realized in the Spanish IBWAs according to justify the exemptions in the implementation of Water Framework Directive Article 4 in groundwater bodies, use the cost-benefit analysis (CBA) for exemptions and disproportionate cost decision.

Author Contributions:

The authors contributed equally to this work.

Conflicts of Interest:

The authors declare no conflict of interest.

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