



Evaluating Economic Policy Instruments for Sustainable Water Management in Europe

Case study:

Lower Ebro (Spain): Voluntary agreement for river regime restoration services

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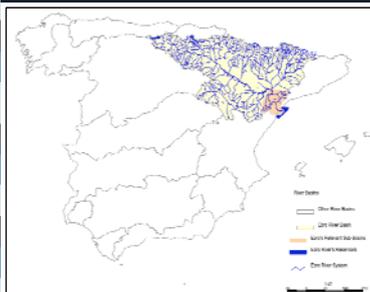
Berlin, January 26th-27th 2012



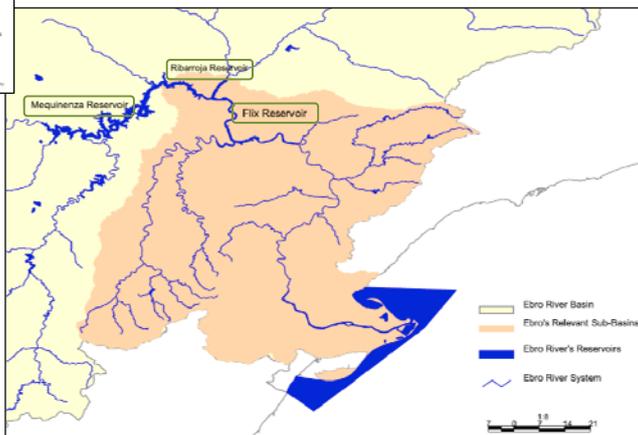
The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) / grant agreement n° 265213 – project EPI-WATER "Evaluating Economic Policy Instrument for Sustainable Water Management in Europe".



1. Ebro River Basin and Study Site



✧ The study site is located downstream the Mequinenza-Ribarroja-Flix dam system and corresponds to the **sub-basin of Lower Ebro (Bajo Ebro) (3 869 km²)**.



Dam system in the Lower Ebro
 Source: Own elaboration from Ministry of the Environment, 2011

2. The problem (I)

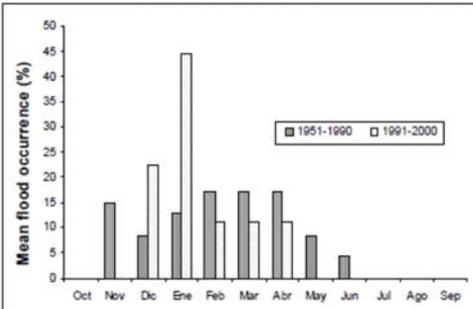


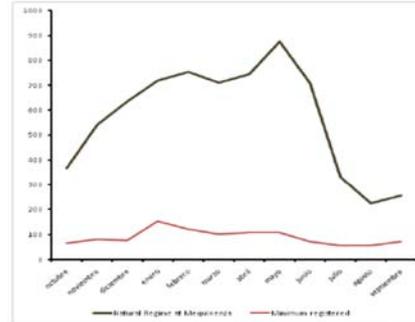
Figure 2. Monthly distribution of annual maxima in the lower Ebro in relation to large dam construction (data from the gauging station n° 27 in Tortosa)

◇ The change in the river morphology reduced flood frequency and magnitude, also reduced sediment load and altered the river's ecology.

◇ All that have produced detrimental effects over many water services: reduced health (infestation of black fly), navigation, salt control in the delta, banks erosion, channel incision, lack of self-depuration potential...

◇ High consumptive demand (1 203 hm³/yr) and lower runoff have increased drought frequency during the last decade, although they are still moderate and there are no relevant quantitative problems.

◇ Most significant pressures are on the qualitative side and stem from the construction of the dam system.



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3. The problem (II)

◇ As a compound effect of the previously described, **macrophytes (visible algae and other flora species)** have proliferated.

◇ Apart from its environmental impact, macrophytes are detrimental to power generation facilities and their removal through mechanical means is costly. **This provides incentives for hydropower companies to cooperate via flushing flows (FF).**



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4. May blamed dams become a river restoration option?

✧ The system, which significantly modified the morphology of the Lower Ebro River (NE Spain), is made up of **Mequinenza** (1964; with a volume of **1 530 hm³** and a capacity of **324 MWh**), **Ribarroja** (1968; **218 hm³**, **262.8 MWh**) and **Flix** (1948; **5 hm³**, **42.5 MWh**) dams.



Mequinenza dam



Ribarroja dam



Flix dam



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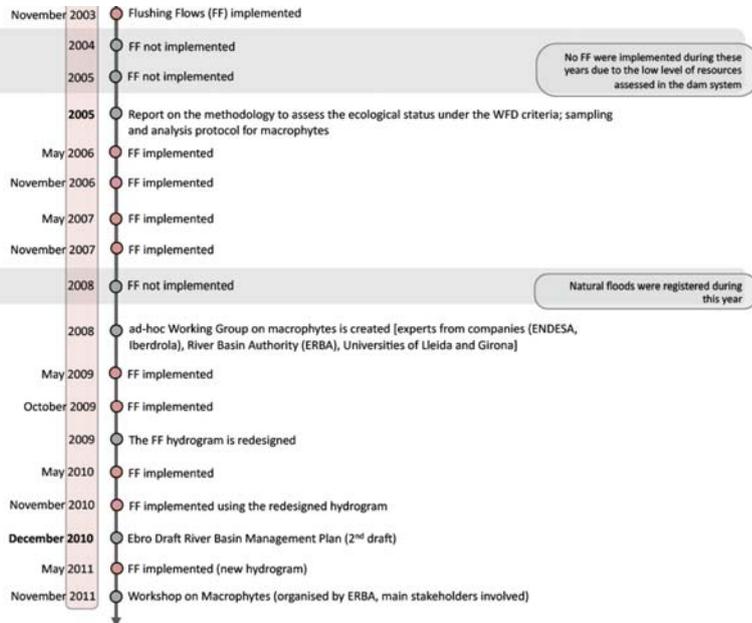
5. Lower Ebro: Voluntary agreement for river regime restoration services

- ✧ **Flushing Flows (FF)** use dams that alter river systems as tools to artificially reproduce some of the functions performed in the past by the natural river regime.
- ✧ The EPI > In 2002, the hydropower company (Endesa), the water authorities (Ebro River Basin Authority, ERBA) and the scientific community coordinated efforts to establish and promote a voluntary agreement to produce FF **for the partial restoration of the river regime in the Lower Ebro to improve the ecological potential of the river** and control and remove the excess of macrophytes from the river channel.
- ✧ These efforts were integrated in the design of the river management plan (RMP) and ended up with an agreement to deliver two controlled floods every year (in spring and autumn): delivery of more than 30 million m³. The duration of flushing flows (between 2002-2007) varied between 13.5 and 22 hours.
- ✧ Since 2003 a series of controlled floods has been implemented, with the exception of 2004 and 2005 (dry years), and also 2008 and spring of 2009 (natural floods).



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> Implemented controlled floods



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6. Environmental outcomes (I): drivers

- ◇ The dam system provides water for **irrigation, urban supply, hydropower, nuclear power station cooling, industry and recreational activities.**
- ◇ The main activity affecting the river morphology is hydropower.
- ◇ The **dam system** is privately managed and thus it is assumed to **follow common optimization rules aimed at maximizing the value of the expected flow of benefits** along the entire life span of the reservoir.
- ◇ The profit-maximizing company can be assumed to simultaneously make two kinds of decisions:
 - On one side, **choosing how much water to use every day.**
 - On the other, **choosing how to distribute the daily water used along the day.**
- ◇ **The EPI implies** that the hydropower company has to face **another constraint when deciding on the daily amount and distribution of water.**



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7. Environmental outcomes (II): status

- ✧ FF since 2003 have resulted in **macrophyte removal rates as high as 95%** in areas close to the dam.
- ✧ However, removal rates have been reduced both in intensity and extension since 2003.
- ✧ **Flushing flows with its current design are not enough to keep macrophytes under control** in the long term.
- ✧ Alternative systems such as new designs of artificial floods and the use of mechanical tools are being considered to avoid macrophyte proliferation
- ✧ On the other hand, **flushing flows are also tested means to enhance biological productivity of the physical habitat, to entrain and transport sediments for the restoration of the river channel, to remove pollution loads and improve the water quality, to control salt intrusion and to supply sediments to the delta and the transition waters** (ecotones).



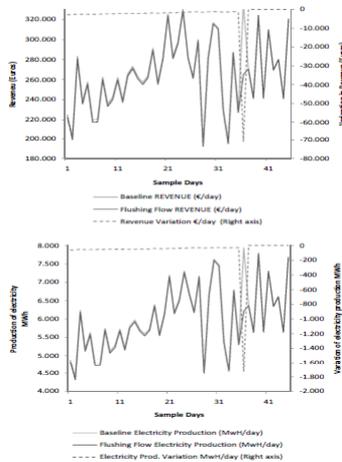
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8. Economic Assessment Criteria (I): Cost-effectiveness

- ✧ FF prevents the company from adapting power output to those moments of the day when energy prices are at their peak .
- ✧ **Artificial floods require 36 million cubic meters along 16 hours**, which implies an **average cost of EUR 76 000 in the autumn flood and EUR 33 000 in the spring flood (0.002 €/m³)**,
- ✧ The estimate daily revenue of the company is EUR 250 000 (thus, losses mean only 0.16% of the average yearly revenue)
- ✧ On average energy losses equal 0.06% of the yearly hydroelectricity production with a standard deviation of 0,04%.
- ✧ Although uncertain, flood cost is significantly lower than the best available alternative to remove macrophytes (which guarantee voluntary participation of the firm)
- ✧ Potential external costs (reductions in renewable, energy production increase in carbon emissions are not significant.
- ✧ Avoided costs along the river are significant (pest controls, dredging, bank restoration,)



9. Economic Assessment: Impacts on Private Revenue and Electricity Production



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10. Economic Assessment Criteria (III): Benefits

- ◇ No need to conduct a valuation study, nor a fully-fledged cost benefit analysis to demonstrate that the EPI leads to a welfare improvement both from a private and social perspective.
- ◇ Nevertheless, costs (even without considering avoided costs to third parties) are lower in at least one-magnitude degree than the most likely value of expected benefits of any river restoration program.

Author (s)	Method ¹	Location	Valuation	WTP (USD 2008)
Magat et al., 2000	CV - IB	Colorado and North Carolina, USA	All aquatic species	114-377
Loomis et al., 2000	CV - IB	Platte River, Colorado, USA	Ecosystem services	252
Desvousges et al., 1983	CV - DC	Unspecific	Recreation	111-220
Loomis, 1998	CV	Mono Lake, California	Recreation and use value	156
Colby, 1993	CV	Western, USA	Minimum instream flow	40-80
Berrens et al., 1998	CV	New Mexico, USA	Minimum instream flow	73
Loomis, 1996	CV	Elwha River, Washington, USA	Dam Removal	59
González and Loomis, 1996	CV	Mamayas River, Puerto Rico	Minimum instream flow	27
Matthews et al., 1999	CV - IB	Minnesota, USA	Quality improvement	15-22
Johnston et al., 2005	Meta-analysis	USA	81 Studies: WTP Water Quality Changes	11
Brown and Duffield, 1995	CV	Minnesota, USA	Minimum instream flow	6.7

Willingness To Pay (WTP) for different river restoration programmes

Source: Different sources

Notes: (1) CV: Contingent Valuation; CV-IB: Contingent Valuation with Iterative Bidding; CV-DC: Contingent Valuation with Dichotomous Choice questioning.



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11. Distributional Effects and Social Acceptability

- ◇ The EPI assessed is a **voluntary agreement** between the energy company generating hydropower and the ERBA on behalf of the public interest.
- ◇ A **financial compensation** to the hydropower company, which was part of negotiations between the energy company and the river authorities, **was not finally included in the agreement**.
- ◇ Equity issues at stake are not especially remarkable. No significant distributional consequences can be directly associated to the introduction of this EPI.



12. Institutions

- ◇ Voluntary agreements are on its own innovative institutional arrangements.
- ◇ Learning by doing led to a progressive increase in the benefits of the cooperative arrangement, and finally made side payments redundant (as in other case studies particularly the PES).
- ◇ The EPI is **implemented at an intra-basin level**, which avoids significant transaction costs in a traditionally controversial basin.
- ◇ Scope for extending these agreements to other areas of water policy is limited by existing regulations and property rights.



13. Policy Implementability

- ✧ FF requires the **co-ordination of different water policy goals** regarding the **river restoration** and also **sectoral interests** at stake.
- ✧ The co-ordination level of significant stakeholders is remarkable so far.
- ✧ As a result, the Ebro River Basin Management Plan 2010-2015 includes a **specific Action Plan to tackle macrophyte** massive growth.
- ✧ **Macrophytes removal has proved to be the catalyst for agreement and reconciliation of public good concerns and private interests. As a result other public goods at stake in the river restoration programmes might have been fading.**
- ✧ Nonetheless, this EPI is consistent with efforts within the WFD implementation.



14. Transaction Costs

- ✧ Public private partnership to support research and development projects conducted by independent research centres lead to a substantial reduction in:
 - Search costs (as the most effective options both to remove macrophytes and river restoration were assessed by a credible third part.
 - Bargaining (as both parts do not come with independent and asymmetric information obtain from their own research bodies).
 - Agreement, monitoring and enforcement (by credible, independent and transparent monitoring)
- ✧ However, there were **significant start up (sunk costs)**, mostly based upon research projects.
- ✧ These projects add up to at least EUR 500 000.



15. Uncertainty

- ✧ **Indicators** considered assessing the performance of the EPI mostly come from scientific works and are based on sound methodologies.
- ✧ Uncertainties over benefits do exist but are not relevant for decisions. Benefits are uncertain but positive. From a financial perspective costs are lower than in the best available alternative, and costs are lower in one degree of magnitude than best available WTP measures.
- ✧ **Current financial costs** are uncertain, depending on every year rainfall and runoff, but those differences are compensated in the long term (and not relevant for a long term agreement).
- ✧ **Measures on macrophytes removal** rates are highly precise and are based on the best available practice consisting on taking small samples along the river, but changing river conditions (in particular water quality) make effectiveness of Flushing Floods uncertain.
- ✧ **Other ecological indicators** are obtained according to different methodologies and are well correlated.



16. Conclusions

- ✓ Payments for environmental services (PES) are **difficult to implement** in societies with advanced water regulations and institutions.
- ✓ **The FF experience in the Lower Ebro is a unique example of voluntary public-private partnerships for the partial re-naturalization of a significantly modified river.**
- ✓ The case study also shows how the public interest in restoring water ecosystems can make use of the potential gains for water users to build a self-enforcing cooperation agreement.
- ✓ FF puts the **emphasis on the objectives that private partners share with the public** to obtain their voluntary participation.
- ✓ The success of FF depends on the implementation of **complementary policies** to recover the ecological status, such as properly defined and enforced environmental flows.





Thanks!

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