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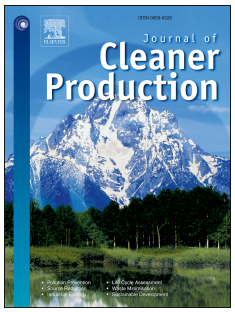

Environmental flow management: An analysis applied to the Ebro River Basin

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Environmental flow management: an analysis applied to the Ebro River Basin

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Abstract:

Environmental flows (EF) define the quantity, timing and quality of river flows needed to preserve freshwater ecosystems while assuring the continuity of human use. Insofar as they reduce water availability and condition agricultural and industrial uses, EF represent a constraint, but they also hold out new opportunities for development. This study focuses on the final stretch of the Ebro River (Spain) and on the competing environmental uses of water (the Ebro Delta is a biosphere reserve) and economic uses (irrigation and electricity generating). Environmental flows in the Ebro Delta are currently managed only from the Mequinenza dam and reservoir in eastern Aragon, and the resulting outflows have more than once driven the level of the reservoir down to critical environmental levels in recent years. In general, this management policy has also caused a range of negative environmental and economic impacts in the area. However, other alternatives exist, which could foster both more cooperative and equitable flow allocations, and the development and sustainability of the Ebro Basin. To this end, we develop a water management model to simulate scarcity scenarios and measure the associated environmental flow default rates assuming current productive uses. Our findings confirm that it is not possible to guarantee EFs in the delta without reservoir-based water management so as to ensure the compatibility of EFs with the irrigation and hydroelectric activities. Moreover, the existence of more equitable and cooperative water management options would reduce water pressures on Mequinenza dam and so help fulfill the subsidized irrigation commitments established in Aragonese Lower Ebro Plan.

Keywords: Environmental Flows, Water Resource Management, Ebro River Basin, Game Theory

1. Introduction

The importance of water for life, for the environment, for human beings and for industries of all kinds is indisputable. However, the quality and availability of the resource are affected by numerous variables, including increases in upstream use and climate change (Alcamo et al., 2007; IPCC, 2014), spontaneous revegetation and so forth, all of which combine to diminish fresh water availability (Gerten et al., 2008). The European Water Framework Directive (WFD) was enacted partly in response to declining water availability (European Communities, 2000). In particular, the WFD requires member States to achieve good ecological status (GES) in all water bodies and river basins, and to establish Environmental Water Requirements (EWR) and regulate environmental flows (EF) in all of Europe's rivers, defining the quantity, timing and quality of the water flows necessary to ensure sustainability under variable conditions, see Acreman and Ferguson (2010). In this context, our study focuses on the final stretch of the Ebro River (Spain) analysing the competing EF and other economic uses in the Ebro Delta (a Biosphere Reserve).

In economic terms, EFs present a serious constraint, particularly for arid and semi-arid regions, because they reduce the volume of water available for consumption and condition agricultural and industrial uses (Bonsch et al., 2015). However, the GES of water bodies and river EF also provide environmental and economic benefits for users and non-users alike, see Ilija Ojeda et al. (2008), Loomis (2000), and Perni et al. (2012). In fact, environmental flows often generate new development