Climate change and water management in the Ebro Basin

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The Ebro river in Zaragoza, Spain © Vladimir Sheliapin

The pressure on water resources has been mounting worldwide with water scarcity becoming a widespread problem in most arid and semiarid regions around the world. Global water extractions have increased from 600 to 3,900 km^3 in the last century, which is almost twice the rate of population growth. Both water scarcity and water quality problems result from the intensive growth of population and income. This degradation of water resources has resulted in 35 percent of the world population living under severe water scarcity. Furthermore, about 65 percent of global river flows and aquatic ecosystems are under moderate to high threats of degradation[1].

Climate change would exacerbate the degradation of water resources in arid and semiarid regions, by reducing water availability and increasing the frequency and intensity of extreme drought events[2]. Spain is one of the regions where water resources will suffer large negative effects from climate change. The Ebro Basin of Spain is presented as a case to explore water management options for addressing the effects of climate change on water scarcity and droughts.

The Ebro Basin extends over 85,600 km^2, covering a fifth of the Spanish territory, and carrying one of the largest stream flows in the country. The irrigation area in the basin is considerable although the pressure on water resources from population and economic activities is less severe than in other Spanish basins. The river flow at the [illegible]stem, a problem found in other Spanish southeastern basins. Despite that, the new water plan of the Ebro basin indicates that the limit of extractions has been reached in most watersheds, especially in the basin southern tributaries[3].

The Ebro basin renewable resources are estimated at 14,600 Mm^3, and these resources sustain 8,400 Mm^3 of water extractions, of which 8,050 Mm^3 are surface water resources (including 200 Mm^3 of inter-basin transfers to the Basque and Catalonia regions) and 350 Mm^3 are groundwater resources (Table 1). Extractions for agricultural production amount to about 7,680 Mm^3 (92%) to irrigate 700,000 ha of field crops (wheat, barley, corn, rice, and alfalfa) and fruit trees. Extractions for urban water supply are 360 Mm^3 serving 3 million inhabitants, including households and network connected industries and services. Direct extractions by industries amount to 160 Mm^3, and there are also non-consumptive extractions for cooling (3,100 Mm^3) and hydropower (38,000 Mm^3).

The fraction of consumptive extractions per year over renewable resources is 60 percent, and further pressures from economic activities have to be curtailed to avoid the gradual closing of the basin. This is not consistent with the planned demand in the basin for 2027, which is projected to increase by 30 percent (Table 1), while climate change impacts would reduce water availability 10% in 2040 and up to 30% in 2100[4].

Sector	Agriculture	Urban	Industry	Total
Surface water	7,420	320	110	7,850
Groundwater	260	40	50	350
Total current demand	**7,680**	**360**	**160**	**8,200**
Total demand by 2027	**9,800**	**430**	**380**	**10,610**

Table 1. Current and future w ater demand in the Ebro Basin (Mm3). Source: Confederacion Hidrografica del Ebro. (2013)

The current water extractions are already bringing about noncompliance with the minimum environmental flow thresholds established in the previous basin plan of 1998. Noncompliance is occurring in between 10 and 30 percent of the river gauging stations[5], with high noncompliance events in the Gallego and Guadalope tributaries. The Ebro river flow in Zaragoza (middle Ebro) and Tortosa (mouth) also shows significant noncompliance events. The basin river flows have been stable during the last decade, but the implementation of the Water Framework Directive (WFD) involves higher minimum thresholds for environmental protection. Some measures have been taken to curtail water extractions in aquifers with serious overdraft problems (Alfamen, Campo de Cariñena, Campo de Belchite), and new programs are being prepared to fulfill the new monthly flow regimes by improving the measurements of flows, and verifying concession licenses (rivers Aragon, Gallego, Cinca, Segre, Noguera-Pallaresa, and along the Ebro).

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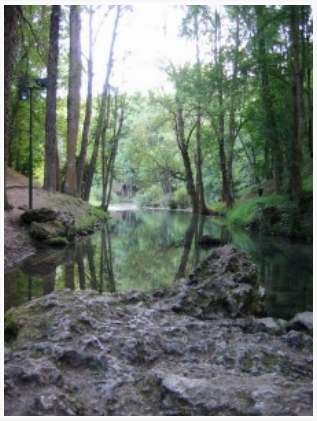
The set of measures laid out in the 2014 Ebro basin plan to achieve the WFD objectives includes investments of 4.8 billion Euros: 2.75 billion for environmental objectives, 1.63 billion for satisfying water demand, and 0.42 billion for coping with extreme events. The main investments for environmental objectives are wastewater treatment plants and irrigation modernization, together with protection of the Ebro Delta and elimination of chemical pollution sediments in Flix. The main investments for satisfying water demand are irrigation facilities in Cataluña, Aragón and Navarra.

The Ebro drought plan was approved in 2007 and it is part of the new Ebro basin plan. It includes a system of hydrological drought indicators, drought management rules for the watershed boards, and urban emergency plans. There are progressively stringent drought measures for the whole basin as drought severity intensifies. There are also specific measures for each watershed, which are taken by the watershed boards.



The source of the Ebro river in Fontibre, Spain © Eduardo Sola

The drought plan allocates water among users following the priority rules that guarantee the provision of urban, industrial and environmental demand, while giving lower priority to irrigation. During severe drought events, all water stakeholders are involved in the Drought Board with full power to manage water resources in order to mitigate economic and environmental damages. Drought damage costs in the Ebro could be considerable, with estimates of 400 million Euros during the last 2005 drought (agriculture 280 million, urban sector 18 million, energy sector 90 million, and environment 20 million)[6].

One key issue for water management in the Ebro basin is adaptation of water resources to the upcoming effects of climate change, which would exacerbate water scarcity and the intensity and frequency of droughts. Solving this adaptation issue requires more sustainable water management in the basin, backed by suitable policy instruments.

The policy approach in the Ebro basin is institutional, based on the cooperation among stakeholders inside the basin authority. There is a strong tradition of cooperation among water user associations dating back centuries in all Spanish basins.

The experiences in water governance worldwide show two different approaches for the management of water scarcity. One approach is economic instruments such as water markets and water pricing, where water is managed as a private good. The other approach is institutional instruments based on collective action, where water is managed as a common pool resource. Water markets seem more suitable than water pricing for allocation of irrigation water[7]. Water pricing is a good instrument for urban networks, but it fails in irrigation because of its common pool resource characteristics. Nevertheless, economic instruments can be introduced in irrigation provided that irrigation water is transformed into a private good.

Water markets and collective action are alternative approaches to achieve welfare gains in the form of private and social benefits. Both approaches are intertwined though, because the water trading experiences worldwide indicate that markets tend to disregard third party effects, including environmental impacts[8]. Well functioning water markets would require a great deal of cooperation by stakeholders within a strong institutional setting. Conversely, the institutional approach in basins such as the Ebro would work better by using carefully designed economic instruments. These incentives would introduce more flexibility into the institutional process of decision making and implementation leading to sustainable water management.

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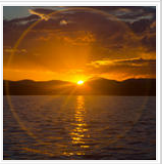

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