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Towards the assessment of climate change and human activities impacts on the water resources of the Ebro catchment (Spain)

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Worldwide studies modelling the hydrological response to global changes have proven the Mediterranean area as one of the most vulnerable region to water crisis. It is characterised by limited and unequally distributed water resources, as well as by important development of its human activities. Since the late 1950s, water demand in the Mediterranean basin has doubled due to a significant expansion of irrigated land and urban areas, and has maintained on a constant upward curve. The Ebro catchment, third largest Mediterranean basin, is very representative of this context. Since the late 1970s, a negative trend in mean rainfall has been observed as well as an increase in mean temperature. Meanwhile, the Ebro River discharge has decreased by about 40%. However, climate alone cannot explain this downward trend. Another factor is the increase in water consumption for agricultural and domestic uses. Indeed, the Ebro catchment is a key element in the Spanish agricultural production with respectively 30% and 60% of the meat and fruit production of the country. Moreover, population has increased by 20% over the catchment since 1970 and the number of inhabitant doubles each summer due to tourism attraction. Finally, more than 250 storage dams have been built over the Ebro River for hydropower production and irrigation water supply purposes, hence regulating river discharge. In order to better understand the respective influence of climatic and anthropogenic pressures on the Ebro hydrological regime, an integrated water resources modelling framework was developed. This model is driven by water supplies, generated by a conceptual rainfall-runoff model and by a storage dam module that accounts for water demands and environmental flow requirements. Water demands were evaluated for the most water-demanding sector, i.e. irrigated agriculture (5 670 Hm3/year), and the domestic sector (252 Hm3/year), often defined as being of prior importance for water supply. A water allocation module has also been implemented in the model. The ability of water resources to satisfy the water demands is assessed by computing a water allocation index which depends on site priorities and supply preferences. This modelling framework was applied to eight sub-catchments, each one representative of typical climatic or water use conditions within the basin, over the 1971–1990 period. The results show the interest of integrated modelling to address water resources vulnerability. The hydrological response to climatic and anthropogenic variations witnesses the influence of both these pressures on water resources availability. Moreover, the water allocation index makes it possible to highlight the growing competition among users, especially during the summer season. The developed methodology hence provides us a more complete analysis to support decision-making compared to uncoupled analysis. This study is a first step towards evaluating future water resources availability and ability to satisfy water demands under climatic and anthropogenic pressures scenarios.