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Influence of hydrological models in the assessment of sustainability index performance. Application case: Duero River Basin

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Sustainability index was created to quantify the sustainability of water resources systems, with the aim of facilitating the evaluation and comparison of water management policies. In this study, sustainability is defined as the geometric average of resilience, reliability and vulnerability. Hydrological models seek to represent the different processes involved in the rainfall-runoff and the generation of river flows through mathematical formulations that allow having a conceptualization of a river basin.
The aim of this work is to connect the results of hydrological models with a water allocation model and, with the results, calculate the sustainability indices.
The methodology conducted was to work with two different hydrological models whose results were the input for the water allocation model of the Duero river basin and calculate the sustainability of the agricultural and urban demands. The two hydrological models used were the Integrated System for Rainfall-Runoff Modelling (SIMPA, by its Spanish acronym) and the Soil and Water Assessment Tool (SWAT). The SIMPA model was developed by the Spanish Hydrographic Studies Centre (CEDEX) and allows obtaining hydrological runoff series anywhere in the Spanish territory. The SWAT model, which was developed by the Agricultural Research Service of the United States Department of Agriculture, is a physically-based, basin- scale, continuous-time model that operates on a daily time step. The Aquatool-SIMGES (Andreu et al., 1996) is a water allocation model that transforms hydrological basins into an internal network flow optimisation problem to find a compatible solution with the physical constraints, system priorities and other management requirements. Sustainability index, reliability, resilience and vulnerability were obtained for urban and agricultural demands in the water management model using MATLAB subroutine.
The case study is in Duero river basin, it is one of the most important hydrological systems of the Iberian Peninsula, due to both, its size (97,290 km2), and volume of river discharges. Duero river basin is a transboundary river shared with Portugal (20%). It is characterized by a Mediterranean climate with continental features (considerable thermal oscillation). Due to the duality of the topography, there are differences in the climatic conditions, with precipitations in mountainous areas above 1,000 mm, and semi-arid environments in the plateau (precipitations lower than 400 mm). Most rain falls from October until May, with a dry period in summer.
Results show that there are differences in the water allocation among models, SWAT model average runoff is a 24.5% higher than SIMPA's. However, in general, sustainability results are very similar. For urban demands, sustainability index shows very high performance in both models except in one area where SIMPA model shows lower values. For agricultural demands, SWAT model shows higher values of vulnerability in six areas, but sustainability remains very high.
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