EGU22-9862
https://doi.org/10.5194/egusphere-egu22-9862
EGU General Assembly 2022

Assessing the impact of climate and water demand change on hydrology and water resources in the Turia river basin, Spain

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Adapting water systems to climate is one of the most significant challenges. Nowadays, the research focus has been shifted from understanding climate change phenomena to studying its impacts on water resource systems in detail. Facing this challenge requires rigorous methodologies that increase the confidence in the climate models outputs, consider the physical complexity of our systems, and consider other factors such as population growth or the use of technologies enabling water saving.

This study presents a robust methodology to estimate climate change impacts on a complex water resources system, including changes in water consumption. It relies on a modelling chain involving climate, hydrological, and water resource system models. Future hydrological scenarios are generated by forcing a conceptual lumped hydrological model by bias-adjusted climate change CMIP5 scenarios. A joint meteorological-hydrological innovative process is used to assess and rank each scenario according to its performance in reproducing the climate and streamflow historical patterns and the streamflow change signal between two periods in a basin. Hydrological projections are used to feed a water resource system model, which includes the main physical and management complexities. By using this model, two complementary impact characterizations were defined: 1) assessing the impacts on the system only as a result of climate change; and 2) incorporating complexities inherent to the basin on top of climate change scenarios, such as the increase in water demand associated with population growth and the improvement in water use efficiencies after adopting better technologies.

This methodology is applied to the Turia River Basin (eastern Spain), a highly regulated system characterized by a strong variation in seasonal streamflows, intensive water use in urban and agriculture, and recurrent droughts. The system demands are supplied by surface and groundwater resources, water transfers from the neighboring Jucar river basin, and reclaimed wastewater reuse. The 18 available climate change trajectories from EURO-CORDEX for RCPs 4.5 and 8.5 were evaluated, and 12 were selected due to their satisfactory meteorological and hydrological performance. A water resources system model was built in the AQUATOOL Decision Support System (DSS) shell. We found that the entire water resources system could suffer

significant adverse impacts even in the short term. Moreover, the projections show decreases in the water storage in reservoirs, increases in pumped water from aquifers, and increments in deficits to urban and agricultural demands. However, the methodology results also concluded that improvements in irrigation efficiencies in the Turia basin are an efficient measure to face the impacts of climate change.

Acknowledgements:

This study has been supported by the ADAPTAMED project (RTI2018-101483-B-I00), funded by the Ministerio de Economía y Competitividad (MINECO) of Spain including EU FEDER funds; the SÀPIDES project (INNEST/2021/276) funded by the Agència Valenciana de la Innovación (AVI), from the Generalitat Valenciana; and the *Subvencions del Programa per a la promoció de la investigación científica, el desenvolupament tecnològic i la innovació a la Comunitat Valenciana* (PROMETEO) under the WATER4CAST project.