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Exploring the response of the Jucar basin (Spain) to future climate conditions through a combination of climate models' outputs and synthetic streamflow generation

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Climate model outputs are only able to cover a tiny part of the uncertainty space when it comes to assess water resources management in a climate change context. Moreover, recent studies have pointed out that the uncertainty envelope of traditional stochastic methods using historical data fully contains the ensemble of climate model projections. To combine both approaches, we characterize significant changes in the streamflow time series statistics under several climate change scenarios and use this information to generate a wide range of synthetic time series from the historical data. The vulnerability of the water resource system is assessed using these synthetic time series as inputs for a basin management model.

The proposed methodology is applied to the upper sub-basins of the Jucar river system (Eastern Spain), where the main reservoirs are located. Relevant climate variables (precipitation and temperature) are extracted from multiple combinations of global and regional climate models and two climate changes scenarios (RCP 4.5 and RCP 8.5). To obtain the future reservoir inflows, three conceptual rainfall-runoff models are calibrated and validated (Temez, GR2M and HBV-light). Shifts in relevant statistics for the system performance (monthly mean, monthly standard deviation, inter-monthly autocorrelation...) are identified by comparing the historical streamflow time series and the modelled ones, and weighted in accord with their impact on the system response. To generate synthetic streamflow time series, we use this information to define an objective function, which will be minimized using resampling techniques and the simulated annealing algorithm.

The aim of this scheme is to assess the vulnerability of the system in relation to a wider range of future conditions than the ones derived from climate models, in order to design flexible adaptation strategies. Thus, the synthetic time series are used as inputs for a basin management model implemented in GAMS (General Algebraic Modeling System).