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Effects of climate and irrigation changes on the water balance of a Mediterranean catchment

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Climate change will strongly impact the water cycle of Mediterranean catchments as a result of the changes in precipitation patterns and increased temperature. However, effects of climate change are difficult to predict with precision and are often influenced by land-use or water management choices. In agricultural catchments, irrigation is of particular interest because of its importance for cultivation in semi-arid climate and because of its strong impacts on hydrological processes. Interactions between irrigation and climate change impacts are likely to be important and should be considered when studying the future of a catchment. However, they are still difficult to quantify. A better understanding of the differences in climate-change sensitivity between irrigated and non-irrigated catchments would allow a finer description of local climate change effects.

In this study, we compared the impacts of climate change in various irrigation scenarios, including a scenario without irrigation. Our case study was a relatively small catchment (about 7.5km^2) in north-east Spain, called the Lerma catchment. This catchment was not irrigated prior to 2006, but 54% of its surface is now used for irrigated agriculture. This transition to irrigated agriculture was closely monitored and data on hydraulic heads, discharge and daily irrigation volume are available. Based on these measurements, a coupled surface-subsurface model of the catchment was developed using the *pde*-based model HydroGeoSphere. The model performs well for both irrigated and non-irrigated periods. Future climate was predicted using four regional climate models from the ENSEMBLE project (P.van der Linden and J.Mitchell, ENSEMBLES: Climate Change and its Impacts [...], Met Office Hadley Center, 2009) and two downscaling methods, including one based on a weather generator. Four irrigation scenarios, based on projected potential evapotranspiration changes, were compared.

Our results show a shift in the climate sensitivity of the catchment as a result of the irrigation changes. In the scenarios with irrigation, low flow and hydraulic heads were more sensitive to climate change, probably because of the increased connectivity between surface and subsurface, resulting from the higher water table. Hydraulics heads decreases of about 0.7m with the present irrigation, but of only about 0.1m in the scenarios without irrigation. On the contrary, peak flow increased more in scenarios without irrigation. In summer, actual evapotranspiration showed an increase of about 10% with future irrigation, but a decrease of about 5% without irrigation.