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Hydrological and agricultural impacts of small reservoirs: a numerical exploration based on a catchment in south-west France

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Small reservoirs are dams built to intercept and store runoff water, thus providing water in agricultural areas for crop irrigation. Small reservoirs are presented by some stakeholders as a relevant strategy for adapting agriculture to climate change in regions with irregular rainfall over the year. However, the reservoir network can have a significant cumulative hydrologic impact, particularly on stream flow, which in turn can affect other water uses and the quality of downstream aquatic environments.

Here we present a numerical exploration of the impact of small reservoirs on hydrology and crop production in an agricultural catchment. The modelling is based on Mhydas-Small-Reservoirs, a model coupling hydrology, crops and farmers' water management decisions. A 20 km² catchment area in south-west France is used as a case study.

Several catchment situations were considered. These situations combine different levels of reservoir use (current situation with 26 reservoirs of which only 13 are exploited to irrigate crops, a situation with no reservoirs at all, a situation where reservoirs currently not exploited are used for irrigation) and different climatic years (dry, wet and average rainfall year).

The simulations were analysed with respect to crop yields and different water balance terms (stream flow, ET, irrigation abstraction). The simulations showed that the reservoirs decreased the annual stream flow. However, the direction (reduction or increase) and intensity of the impact on stream flow varied over time from month to month and also spatially along the stream network. The impact on crop yields was variable from crop to crop. Overall, the results show that the impact of small reservoirs on crop yields depends partly on the capacity of the small reservoir to intercept and store water.

These are exploratory results. The main conclusion drawn is that the Mhydas-Small-Reservoirs model has the capacity to estimate in time and space the impact of small reservoirs on the agricultural and hydrological functions of agricultural catchments.