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DAHM-Reservoir: An agro-hydrological model for agricultural catchment with small water reservoirs

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In agricultural areas where water is a limited resource, farmers and managers have been building small water reservoirs, sometimes in large numbers. Small reservoirs are infrastructures mainly used to store runoff water during the wet season to support irrigation water demand during the dry season. However, the development of small reservoirs in a catchment can have a significant cumulative effect on the hydrological cycle and on the stream flow (Habets et al., 2018). The cumulative effect is complex and still difficult to understand at present. The cumulative effect is a result of interactions between (i) agricultural activities, which determine the crop water demand and control the hydrological processes that generate the water resource, (ii) reservoir management, which involves number and location of reservoirs and decisions of reservoir water uses, and (iii) the hydrological functioning of the catchment, which controls the filling of reservoirs.

Numerical modelling is an interesting approach to quantify cumulative effect and understand the interactions that underlies them, provided that it is possible to benefit from a model that explicitly takes into account a wide spectrum of hydrological and agronomic processes, including reservoirs, in a spatially distributed manner and at time steps compatible with hydrological and agronomic processes. Some models have already been used to simulate a watershed with reservoirs, but none of them fulfilled all the characteristics mentioned above. We therefore have developed such a new and original spatially distributed model, called DAHM-Reservoir, using the OpenFLUID platform (Fabre et al., 2019). This model explicitly represents the main elements of an agricultural catchment (agricultural fields, non-agricultural plots, stream reaches, reservoirs, soils, groundwater) and the water fluxes between them, whether these fluxes are hydrological or anthropogenic.

The main processes coupled in DAHM-Reservoir are those involved in the hydrological functioning of catchment and reservoirs (infiltration, evaporation, transpiration, runoff, groundwater flow, river transfer, etc.), in the growth and yield of crops (tillage, irrigation, seeding and harvesting), and farmer decisions related to crop and water management (water withdrawal decisions based on farmer's demand for crop irrigation, downstream water restitution according to regulation) (Therond and Villerd, 2018). DAHM-Reservoir reuses the representation of elementary processes already implemented in other models (MAELIA, SWAT, MHYDAS). The interests of this model will be discussed based on an application to a catchment in southwestern France.

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