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How much water remains? Incorporating publicly available irrigation data to improve meso-scale hydrological model performance in dryland environments

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Being responsible for about 70% of the world's freshwater use, agricultural irrigation practices have a strong impact on water budgets in dryland environments and will increase to do so, as an increase in irrigated areas worldwide is expected. In semi-arid catchments, irrigation can account for a substantial proportion of the water budget, especially during the dry season. Consequently, due to the limited water resources, these catchments rely on adequate water management practices. Water withdrawal from groundwater, river flow or reservoirs for irrigation purposes alter the overall hydrological balance. Being aware of such important impacts on the regional (meso-scale) water budget, hydrological models should improve their capability to account for them, including typical operational data availability and constraints. Thus, the answers on water management issues should be addressed, such as, how do these withdrawals alter the rivers' flow regime and water yield? How do they affect sustainability of regional water resources, both in a seasonal and long-term time scale? Can public irrigation data be used to improve the performance of a catchment model?

To account for this particular anthropogenic interference with the hydrological cycle a novel irrigation module is introduced to improve meso-scale hydrological models' performance for such hydro-climatic conditions. We implemented this module into WASA-SED, a hydro-sedimentological model tailored for semi-arid catchments on the meso-scale, now enabling to account for irrigation practices in the modelling process. The module allows to represent water abstraction from different sources (ground water, river, reservoirs), inter- and intra- basin transfers and seasonality of irrigation schemes. As a test case, a semi-arid catchment with excellent irrigation data in the Rio Sao Francisco basin, Brazil, was chosen to investigate exemplarily the impact of irrigation operations on the low river flows in the dry season. Using publicly available irrigation data as input for this module, it could be shown, that including irrigation practices into the modelling process helps to improve the model's performance.

Furthermore, modelling results can be used to estimate the real water withdrawal rates, as there is uncertainty about how much water the users actually withdraw, because irrigation data from the Brazilian authorities shows the maximum withdrawal rates, as defined in contracts for water use for river water, but not the actually used water rates, which might be different (less or sometimes even more) than the contracts' maximum rates. Whether the users withdraw more or

less water than officially granted is uncertain. The model's results can be used to estimate realistic withdrawal rates as well as to predict further irrigation potential in the given catchment. Likewise, the effect of exploiting different sources for irrigation water (i.e., rivers, reservoirs, and groundwater) can be analysed in terms of their reliability and effect on the river system.