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Development and Evaluation of a Parsimonious Agro-hydrological Model to Assess Agricultural Managements Strategies for Climate Change Adaptation

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Abstract: While simple crop and hydrological models are limited with respect to the number and accuracy of the processes they incorporate, complex models have high demand for data. Due to these limitations, there is a need for new agro-hydrological models that can simulate the impact of agronomic and environmental changes on both crop productivity and water availability in agricultural catchments, without vast data requirements for model input and calibration. AquaCrop-Hydro was developed to fill the need for a such a parsimonious, physically sound and widely applicable agro-hydrological model. The model was developed by linking the process-based AquaCrop crop water productivity model with a conceptual hydrological model via the soil water balance. Model evaluation showed that AquaCrop-Hydro performed well to simulate crop productivity and runoff at the catchment outlet of an agricultural catchment in Belgium. Crop yield was simulated with a relative root-mean-square error of 7-37%, while runoff was simulated with a model efficiency of 0.64 on a daily basis and 0.82 for 10-daily and monthly flow volumes. Furthermore, AquaCrop-Hydro was applied to simulate the impact of climate change and related adaptation management strategies on crop production as well as water availability for the same catchment. This study showed that AquaCrop-Hydro combines the benefits and functionality of the physically based AquaCrop model and a conceptual hydrological model. Being process-based, AquaCrop-Hydro can simulate the effect of management and environmental changes and consequently support sustainable water management from field to catchment scale. Especially in data-scarce regions, the model can provide good estimates while releasing from the burden of high data and calibration requirements.

Keywords: AquaCrop-Hydro; crop water productivity; water availability; climate change; agricultural management