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Satellite-based Soil Moisture Could Enhance the Reliability of Agro-hydrological Modeling in Large Transboundary River Basins

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A b s t r a c t

Satellite-based observations of soil moisture, leaf area index, precipitation, and evapotranspiration, facilitate agro-hydrological modeling thanks to the spatially distributed information. In this study, the Climate Change Initiative Soil Moisture dataset (CCI SM, a product of the European Space Agency (ESA)) adjusted based on Soil Water Index (SWI) was used as an additional (in relation to discharge) observed dataset in agro-hydrological modeling over a large-scale transboundary river basin (Odra River Basin) in the Baltic Sea region. This basin is located in Central Europe within Poland, Czech Republic, and Germany and drains water into the Baltic Sea. The Soil and Water Assessment Tool+ (SWAT+) model was selected for agro-hydrological modeling, and 26 discharge stations and soil moisture (for topsoil and entire soil profile) were calibrated for 1476 sub-basins during 1997–2019. Kling–Gupta efficiency (KGE) and SPAtial EFficiency (SPAEF) were chosen as objective functions for runoff and soil moisture calibration, respectively. Two calibration strategies were compared: one involving only discharge data (single-objective), and the second one involving discharge and satellite-based soil moisture (multi-objective). In the single-objective approach, the average KGE for discharge was above 0.60. In the multi-objective approach, the accuracy for the main discharge stations significantly increased (KGE above 0.67) compared to the single-objective approach. The results show that in this transboundary river basin, adding satellite-based soil moisture into the calibration process could improve the accuracy and consistency of agro-hydrological modeling.

Keywords: hydrology, gridded datasets, flood, drought, active and passive sensors.

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