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Calibration of the water table fluctuation method based on groundwater recharge model using easily available data

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Groundwater recharge is a key input in groundwater resources management. However, it is not directly measurable, and even the parameters for indirect estimation are difficult to obtain and verify. We developed a hydrological model that facilitates reliable calibration of specific yield of an aquifer, thus enabling groundwater recharge estimation by the water table fluctuation method. The novel soil moisture deficit model is based on existing bucket models. It features two parallel soil water reservoirs which capture all incoming precipitation. Groundwater recharge is generated only when the reservoirs are overfilled after satisfying evapotranspiration. The only input data required are easily measurable (and typically available) time series of precipitation and air temperature, and long-term record of water table fluctuations in wells for calibration. The model parameters, most importantly specific yield, are calibrated by comparing the modelled water table to the observed water table. The calibrated specific yield and the observed water table levels then serve as inputs for water table fluctuation method for estimation of groundwater recharge. The model was tested on 9 wells in the lowland along the river Elbe (Czech Republic). The wells are situated in highly permeable alluvial aquifers with unconfined water table. The wells were selected for the study because decades of water table records are available, and their water table exhibits multi-year fluctuations. The values of specific yield obtained by model calibration ranged from 5% to 17%, which is realistic for the studied aquifer type. The results were compared to a previous study conducted in the Czech Republic, in which the long-term mean groundwater recharge was estimated. Our results lie within the range indicated for the sites. Furthermore, the presented method provides the temporal distribution of groundwater recharge, thus broadening the knowledge of groundwater recharge dynamics. Besides this, the method can potentially be used to estimate the groundwater recharge under future climate conditions.

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