

Large scale integrated surface – subsurface hydrological model to assess climate change impacts on groundwater resources.

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Estimating the impacts of climate change on groundwater represents one of the most difficult challenges faced by water resources specialists. One difficulty is that simplifying the representation of the hydrological system often leads to discrepancies in projections. We present here an improved methodology for the estimation of the impacts of climate change on groundwater reserves, where a physically-based surface – subsurface flow model is combined with advanced climate change scenarios for the Geer basin (465 km²), Belgium. Coupled surface–subsurface flow is simulated with the finite element model HydroGeoSphere. The simultaneous solution of surface and subsurface flow equations in HydroGeoSphere, as well as the internal calculation of the actual evapotranspiration as a function of the soil moisture at each node of the defined evaporative zone, improve the representation of interdependent processes like recharge, which is crucial in the context of climate change. More simple models or externally coupled models do not provide the same level of accuracy. Climate change simulations were obtained from 6 regional climate model (RCM) scenarios that were downscaled using a quantile mapping bias-correction technique that, rather than applying a correction only to the mean, forces the probability distributions of the control simulations of daily temperature and precipitation to match the observed distributions. The same corrections are then applied to RCM scenarios for the future. The combined use of an integrated surface – subsurface modeling approach, a spatial representation of the evapotranspiration processes and sophisticated climate change scenarios improves the robustness of projections of climate change impacts on groundwater reserves. For the climatic scenarios considered, the integrated

flow simulations show that significant decreases are expected in the groundwater levels (up to 8 meters) and in the surface water flow rates (between 9% and 33%) by 2080.