Simulating river-aquifer interactions in southern Ontario – implications for water management

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ABSTRACT
Integrated water management aims to provide sufficient water for all uses in a watershed, including drinking water, water for agriculture or the industry, and water for ecosystems. Integrated flow models are useful tools to help achieve water management goals. The objective of this research was to simulate long-term sustainability of groundwater availability for agriculture, considering future climate stresses and potential land use changes. The study focuses on the Lower Whitemans Creek subcatchment (65 km^2), part of the Grand River watershed (Brant County, Ontario). The local aquifer comprises the shallow and unconfined Norfolk Sand plain from which irrigation for specialty crops is drawn. The research site is instrumented with 10 groundwater monitoring wells, two electrical conductivity-temperature loggers and two stream gauging stations in the Creek. A gauging station has been monitoring flowrates at the subcatchment outlet since 1960. The integrated SWAT-MODFLOW software was used to simulate flow in the study area. The model was calibrated to reproduce measured flowrates from 1960 to 2017 and measured heads from 2010 to 2017. Given the short head time series, the calibration targets also included reproducing the temporal response of heads and the memory effect of the aquifer, as determined from time series analysis. The model confirms that the Lower Whitemans Creek can be fed by the aquifer in wetter years, but that in dryer years, groundwater inflows to the river decrease significantly and total flows can drop below ecosystem stress levels. The model is used to investigate the impacts of water pumping for irrigation and of different types of land uses on the study area. This project will provide guidelines for the Grand River Conservation Authority to plan future water uses in the area and to guide adaptation scenarios for future climate change conditions.