EGU General Assembly 2022

EGU22-6409
https://doi.org/10.5194/egusphere-egu22-6409
EGU General Assembly 2022

Long-term impact of land use change on the simulation of distributed regional-scale groundwater recharge in cold and humid climates

Emmanuel Dubois[1,2], Marie Larocque[1,2], Philip Brunner[3], and Sylvain Gagné[1]
[1]Université du Québec à Montréal (UQAM), Department of Earth and atmosphere sciences and GEOTOP Research center, Montréal, Canada (dubois.emmanuel@courrier.uqam.ca)
[2]GRIL Research Center, Département de sciences biologiques, Université de Montréal, Montréal, Canada
[3]The Center for Hydrogeology and Geothermics (CHYN), University of Neuchâtel, Neuchâtel, Switzerland

Although the long-term impacts of climate change on the different water budget components have been widely studied, numerous challenges in accounting for land use (LU) changes in regional scale hydrologic simulations remain. As it can be challenging to map the evolution of LU and incorporate the changes in models, models are often calibrated with the hypothesis that LU is constant through time. Therefore, little is known about the quantitative impact of LU change on the water budget components and more specifically on the regional-scale groundwater recharge (GWR), although it is widely accepted that GWR depends on LU. The objective of this work was to assess the impact of LU changes on the simulation of regional-scale GWR and identify the magnitude of changes to produce significant changes in GWR. GWR was simulated with a transient-state spatialized superficial water budget over three regional-scale watersheds (>2 000 km^2) in the cold and humid climate of southern Quebec (Canada). The model computes snow accumulation and snowmelt, as well as soil freezing to provide spatially distributed runoff, actual evapotranspiration, and GWR fluxes with a monthly time step on a 500 m x 500 m grid. Four versions of the model are calibrated over the 1990-2017 period considering constant LU, constant LU and rainfall interception in forested areas, transient LU (annual time step, two data sources), and transient land use and rainfall interception in forested areas. The model versions with transient LU performed better and were calibrated with sets of statistically different parameters while the model versions with rainfall interception did not systematically enhanced the calibration results. Because the observed LU changes were relatively limited during the 1990-2017 period in the study areas, the simulated variables with the four versions were not significantly different. To assess the joint effects of LU change and climate change on GWR, two scenarios of future LU changes were developed and combined with climate change scenarios to simulate future GWR. Results were analyzed to identify the type and intensity of LU changes necessary to produce significant changes in GWR.