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Uncertainty assessments and hydrological implications of climate change in adjacent catchments of a large rapidly urbanizing watershed

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There is a great deal of uncertainty associated with hydrological simulations and climate change projections. Here we evaluate the potential long-term impacts of climate change on local hydrology of rivers in the Lake Simcoe watershed (LSW), the largest inland lake in south central Ontario. The LSW is rapidly urbanizing, leading to changing rainfall-runoff relationships. The runoff ratio is increasing across the LSW and there have been more quickflow events in the recent years.

Using a statistical downscaling approach, a forty year baseline period (1960-2000) of predictand series (observed daily precipitation and air temperature) were used in conjunction with Canadian General Circulation Model 3 (CGCM3) predictors to project possible future climate in the Lake Simcoe region. The historical data imply that local weather conditions in the LSW have evolved over the forty year period and potentially suggest warmer and wetter conditions in the recent time. There was a significant positive increase in historical baseline air temperature (Mann-Kendall (MK) = 3.15, P<0.01) and precipitation (MK = 2.90; P<0.01). This translated to an historical increase of approximately 0.7 C in air temperature and approximately 6.3% in precipitation between 1960 and 2000. Both the CGCM3 driven A1B and A2 scenarios predicted an increase in mean annual temperature of 1.4 C and 1.2 C, respectively, in the first half of the 21st century relative to the baseline period. The scenario predictions also suggested the possibility of increasing winter temperatures, shorter winter regimes and slightly extended springs. Both scenarios projected significant increases in rainfall and declines in snowfall. We observed a significant monotonic increase in growing season length of 5-26% (relative to 200 days over the baseline period) under the IPCC A1B and A2 scenarios.

To further evaluate the impacts on local hydrology, we coupled the CGCM3 scenario predictions with HBV rainfall-runoff model to predict possible hydrological responses in an ensemble of LSW catchments. The results suggest future increases in the evapotranspiration regime in the watershed. More runoff was projected in the winter and less in the spring towards the end of the century as a result of decline in snow cover. The HBV simulations for the catchments display similar parameter behaviour but differ in the parameter that controls the baseflow recession. While the hydrological response of adjacent catchments could be explained by a similar pattern of behavioral parameter sets to simulate present day runoff conditions, it is not clear if ranges of parameter used for calibration would hold for the future because of land use changes.