Sustainability in the City and Beyond

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Projecting 21st century change in the hydroclimatology of the Athabasca River Basin with Coordinated Downscaling Experiment (CORDEX) data

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The climate of central Alberta is highly continental and prone to severe inter-annual variability in both temperature and precipitation. As such, the Athabasca River, which is already stressed for water due to high human and industrial demands (i.e., tar sands processing), is extremely vulnerable to impacts of the anthropogenic climate changes of the 21 st century. Due to its unique geographical location, with the Rocky Mountains to its west, the sub-arctic tundra to its north, and the semi-arid plains to its south, it is important to project whether the resulting changes to the hydroclimate of the Athabasca River Basin (ARB) will be beneficial or detrimental to water management efforts in the area. We present an assessment of the projected changes in ARB temperature, precipitation, total runoff, and climate moisture index (CMI, a measure of effective moisture) between 2011 and 2100 from a large set of Coordinated Regional Climate Downscaling Experiment (CORDEX) regional climate models (RCMs). As the RCMs presented some discrepancy among each other and when compared to observed data –especially for precipitation values – bias correction was necessary. For observed temperature and precipitation data, we used ANUSPLIN climate data between 1971 and 2000, and for observed runoff data we used the Water Survey of Canada (HYDAT) measured runoff for the Athabasca River below Fort McMurray. The CMI was computed using a modified Penman-Monteith equation for potential evapotranspiration (PET).

The projected RCM simulations over the ARB show an average annual increase in temperatures of 6 degrees C for the 2071-2100 period under RCP 8.5, with a prominent increase in summer, which is partially compensated for by an increase in year round precipitation of ~0.3 mm/day. Correspondingly, CORDEX RCMs also suggest a significant increase in annual average runoff, with a distinct shift to an earlier springtime melt pulse. However the projected increases in precipitation and total runoff are spread over the entire year and not concentrated during summer, when they will be most needed. This results in a major decrease in summertime CMI (i.e., Precipitation – PET), which augurs towards a more stressed water availability in the future for the region if we maintain our current pace of ARB agricultural and industrial activities.

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