Impacts of a changing climate and wildfire on sediment and organic carbon yields: an improved hydrological simulation in the Elbow River watershed

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Hydrological processes control water contaminants, such as sediments and nutrients, and their cycling and transport in landscape and river systems. Globally, increasing temperatures and changing precipitation patterns indicate growth in occurrence and intensity of extreme events (e.g. wildfire and storms), and these impacts have been observed in Alberta. Factors such as earlier snowmelt and less summer precipitation make both water quantity and quality less predictable in the semi-arid region of southern Alberta. For example, snowmelt and rainfall entrain sediments and nutrients to streams via surface runoff, and likely changes in climate pattern or removal of vegetation through wildfire exacerbates erosion, thus increasing sediment and organic carbon (OC) export from watersheds. Treating the dissolved fraction of in-stream OC in drinking water is particularly concerning due to harmful disinfection by-products. Decades of wildfire prevention have resulted in higher forest connectivity, which in combination with hotter and drier weather, has augmented the potential for highly destructive wildfires. The Elbow River watershed (ERW) in southern Alberta is overdue for a wildfire and spans diverse landscapes, originating in the Rocky Mountains in the west, and flowing through forests, then agriculture, after which it enters the Glenmore Reservoir of Calgary in the eastern part of the watershed. In this study, we hypothesize that overall water quantity will decrease, and that in-stream sediment and OC will be more erratic under changing climate and likely wildfire events in the future. Our goal is to apply an improved Soil and Water Assessment Tool (SWAT) model to assess the impacts of climate change and wildfire on sediment and OC by simulating hydrological processes controlling their loads and transport from landscape to the stream and into the reservoir.

The SWAT hydrologic model was improved by integration of an instream organic carbon module and was used to simulate the complex land and in-stream processes, including water, sediment and OC loads and transport. Model calibration involved statistically comparing outputs (i.e. streamflow, sediment and OC yields) to measured values, and adjusting physical parameters to obtain outputs that better represented watershed processes. The next step will be to analyze the magnitude of change in streamflow, sediment and OC yields under 18 climate change scenarios. Impacts of wildfire will then be simulated by changing model input parameters based on literature to imitate post-fire conditions in specific areas according to local historic wildfire records. Results of these scenarios may be useful for water management and treatment options.

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