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The impacts of future climate change and sulphur emission reductions on acidification recovery at Plastic Lake, Ontario

J. Aherne[1], M. N. Futter[2], and P. J. Dillon[1]
[1]Environmental and Resource Studies, Trent University, Peterborough, Canada
[2]Watershed Ecosystems Graduate Program, Trent University, Peterborough, Canada

Abstract. Climate-induced drought events have a significant influence on sulphate export from forested catchments in central Ontario, subsequently delaying the recovery of surface waters from acidification. In the current study, a model chain that employed a statistical downscaling model, a hydrological model and two hydrochemical models was used to forecast the chemical recovery of Plastic Lake sub-catchment 1 (PC1) from acidification under proposed deposition reductions and the A2 emission scenario of the Intergovernmental Panel on Climate Change. Any predicted recovery in stream acid neutralising capacity and pH owing to deposition reductions were clearly offset by large acid effluxes from climate-induced drought events. By 2100, ANC is predicted to show large variations ranging between 10 and −30 $\mu mol_c\ L^{-1}$. Similarly, predicted pH in 2100 is lower (>0.05 of a pH unit) than the value simulated for 2000 (pH 4.35). Despite emission reductions, the future scenario paints a bleak picture of reacidification at PC1 to levels commensurate with those of the late 1970s. The principal process behind this reacidification is the oxidation of previously stored (reduced) sulphur compounds in wetlands during periods of low-flow (or drought), with subsequent efflux of sulphate upon re-wetting. Simulated catchment runoff under the A2 emissions scenario predictes increased intensity and frequency of low-flow events from approximately 2030 onwards. The Integrated Catchments model for Carbon indicated that stream DOC concentrations at PC1 will also increase under the future climate scenario, with temperature being the principal driver. Despite the predicted (significant) increase in DOC, pH is not predicted to further decline (beyond the climate-induced oxidation scenario), instead pH shows greater variability throughout the simulation. As echoed by many recent studies, hydrochemical models and model frameworks need to incorporate the drivers and mechanisms (at appropriate time-scales) that affect the key biogeochemical processes to reliably predict the impacts of climate change.

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