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Agriculture in the Boreal Forest: Understanding the Impact of Land Use Change on Soil Carbon for Developing Sustainable Community Food Systems

David Bysouth[1], Merritt Turetsky[2], and Andrew Spring[3]
[1]Department of Integrative Biology, University of Guelph, Guelph, Canada (dbysouth@uoguelph.ca)
[2]Institute of Arctic and Alpine Research, University of Colorado Boulder, Boulder, USA (Merritt.turetsky@colorado.edu)
[3]Laurier Centre for Sustainable Food Systems, Wilfrid Laurier University, Waterloo, Canada (aspring@wlu.ca)

Climate change is causing rapid warming at northern high latitudes and disproportionately affecting ecosystem services that northern communities rely upon. In Canada's Northwest Territories (NWT), climate change is impacting the access and availability of traditional foods that are critical for community health and well-being. With climate change potentially expanding the envelope of suitable agricultural land northward, many communities in the NWT are evaluating including agriculture in their food systems. However, the conversion of boreal forest to agriculture may degrade the carbon rich soils that characterize the region, resulting in large carbon losses to the atmosphere and the depletion of existing ecosystem services associated with the accumulation of soil organic matter. Here, we first summarize the results of 35 publications that address land use change from boreal forest to agriculture, with the goal of understanding the magnitude and drivers of carbon stock changes with time-since-land use change. Results from the literature synthesis show that conversion of boreal forest to agriculture can result in up to ~57% of existing soil carbon stocks being lost 30 years after land use change occurs. In addition, a three-way interaction with soil carbon, pH and time-since-land use change is observed where soils become more basic with increasing time-since-land use change, coinciding with declines in soil carbon stocks. This relationship is important when looking at the types of crops communities are interested in growing and the type of agriculture associated with cultivating these crops. Partnered communities have identified crops such as berry bushes, root vegetables, potatoes and corn as crops they are interested in growing. As berry bushes grow in acidic conditions and the other mentioned crops grow in more neutral conditions, site selection and management practices associated with growing these crops in appropriate pH environments will be important for managing soil carbon in new agricultural systems in the NWT. Secondly, we also present community scale soil data assessing variation in soil carbon stocks in relation to potential soil fertility metrics targeted to community identified crops of interest for two communities in the NWT. We collected 192 soil cores from two communities to determine carbon stocks along gradients of potential agriculture suitability. Our field soil carbon measurements in collaboration with the partnered NWT communities show that land use conversions associated with agricultural development could translate to carbon losses ranging from 2.7-11.4 kg C/m^2 depending on the

type of soil, agricultural suitability class, and type of land use change associated with cultivation. These results highlight the importance of managing soil carbon in northern agricultural systems and can be used to emphasize the need for new community scale data relating to agricultural land use change in boreal soils. Through the collection of this data, we hope to provide northern communities with a more robust, community scale product that will allow them to make informed land use decisions relating to the cultivation of crops and the minimization of soil carbon losses while maintaining the culturally important traditional food system.