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Carbon Emissions from Active Horticulture Peat Extraction Sites in Canada: Five Years of Field-based Measurements

Miranda L. Hunter[1], Laura Clark[2], Rebecca J. Frei[3], Ian B. Strachan[4], Nigel T. Roulet[2], and Maria Strack[1]

[1]Department of Geography and Environmental Management, University of Waterloo, Waterloo, Canada (mlhunter@uwaterloo.ca)

[2]Department of Geography, McGill University, Montreal, Canada

[3]Department of Geosciences, Idaho State University, Pocatello, United States of America

[4]Department of Geography and Planning, Queen's University, Kingston, Canada

Peat extraction substantially alters the carbon dynamics, peat structure, and hydrology of peatland sites. In Canada, companies install drainage ditches every ~30 m, dividing the sites into fields of peat bounded by ditches, and remove the surface vegetation and upper acrotelm. Peat is then vacuum harvested, processed, and sold for horticulture use. Despite this disturbance covering only a small percentage of Canadian peatlands, the shift from being a net sink to a net source of carbon during the 15-35 years of extraction makes them an important system to study.

We conducted research at eight actively extracted peatland study sites in Quebec (Eastern Canada) and Alberta (Western Canada), ranging from 3–28 years post the start of extraction. Our objectives were to i) assess spatial distribution of CO_2 and CH_4 emissions; 2) assess seasonal and interannual variability of these emissions; and 3) understand their environmental drivers. To do this, we employed measurement techniques at the plot and ecosystem scale.

Plot scale chamber-based measurements of CO_2 and CH_4 were conducted weekly to biweekly from May to September at eight sites from 2018 to 2022, with each site being measured in at least one study year. The drainage ditches were hotspots of carbon emissions with around double and at least seven times the CO_2 and CH_4 emissions respectively, of the fields. Time since the start of extraction was a useful metric to estimate current CO_2 emissions when sites were within one bog complex. More research will be required to extrapolate emissions to other locations however, as peat substrate quality differences between locations also contributed to variation in carbon loss.

Ecosystem scale measurements of daytime March to October CO_2 and CH_4 emissions were conducted at a subset of the study sites for two to three years using the eddy covariance technique. We observed comparable March and April CO_2 emissions to those in July, highlighting the importance of thaw dynamics on the yearly carbon budget. Interannually, CO_2 emissions were lowest during a dry summer, suggesting a moisture limitation for decomposition at the surface under severe drainage. We found weak dependence of CO_2 emissions on soil temperature, though it was strongest when the water table was within the top 40 cm of the peat.

This research will aid in validating Canada's emission factor values for peat extraction, which are currently based on a few measurements in Quebec at post extracted, unrestored peatlands. Using several different assumptions for wintertime emissions, we estimated annual CO_2 budget of 256 – 385 g C m^{-2} yr^{-1}, which agrees with Canada's current Tier 2 emission factor value of 310 g C m^{-2} yr^{-1}. Methane emissions accounted for < 1 g C m^{-2} yr^{-1}. This research will also support process-based models looking at the effect of site management, and the changing climate, on carbon emissions from these sites.