Impact of land-use on total and proportional respiration rates in Maritime boreal ecoregions

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Purpose: Boreal carbon cycling is controlled naturally by fire disturbance, climate, hydrology, snowmelt, soil heterogeneity, acidity, low availability of nitrogen and phosphorus, mycorrhizae distribution, and plant cover. Each factor interacts with others in complex ways, creating a system characterized by high carbon storage, and shaped by natural and anthropogenic disturbance. Farming these lands can lead to permanent losses and drastic alteration of carbon pools. Conversely, farming marginal, low fertility boreal soils might be managed to enhance C storage while satisfying local food security needs. The impact of agriculture on soil C storage is yet to be effectively quantified and initial results offer inconsistent assessments, reflected in data-scarce policy development. To address this gap, we employed systematic boreal research to answer the question: 'what are the primary factors controlling boreal C cycling?'

Methods: We examined soil carbon in over five hundred unique sites across the Atlantic region of Canada and analyzed it to see what factors (especially climatic or soil type) C cycling depended on. We hypothesized that C cycling (as measured by POx-C and respiration) was dependent on precipitation, parent material, and land use, and further, that there was a predictive relationship between POx-C and respiration.

Results: Results show that average respiration rates can be consistently categorized along land use types. For example, wetland soils have a bimodal distribution of either very high or very low respiration values; this is linked to pedological and hydrological factors, as low-respiring wetland soils are always mineral bogs, and the high-performing soils are organic bogs. While forests are associated with the largest absolute respiration rates, the organic matter in farmed lands is proportionally more labile (i.e., more respiration per percent soil organic matter).

Conclusion: Our study highlights the importance of perspective in interpretation of measurements of soil C cycling (respiration); differentiating between total and proportional respiration is critical to sensible assessment of the impact of land-uses and potential land-use changes (and thus management recommendations). This dataset supports modeling of carbon cycling in Atlantic Ocean-influenced boreal ecoregions, informing future management decisions.