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Resource access roads impact carbon dynamics of boreal forested peatlands

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Peatlands play a significant role in global greenhouse gas (GHG) cycling as they store a significant amount (approx. 550 Gt) of organic carbon in the form of peat. The boreal region of Canada has one of the highest densities of peatlands. However, they have been impacted by various linear disturbances including winter roads, pipelines, seismic lines, oil sand drillings (well-pads), and resource access road construction. A more than 217,000 km long road network has been constructed on the boreal region of Canada to explore and extract natural resources (e.g. oil sands and forestry). Roads on peatlands are raised by placing mineral fill on the compressed peat underneath. Therefore, the road itself acts as a dam and limits the hydrological connection between fragmented parts of the peatland. The resulting hydrological variation may lead to altered GHG emissions, plant community, microbial activity, and soil biogeochemistry in peatlands. However, few studies have quantified the impacts of access roads on boreal peatland carbon dynamics. Therefore, we conducted a study focusing on the impacts of roads on carbon dynamics of a forested bog and a shrubby fen near Peace River, Alberta, Canada. Data was collected in 2016 and 2017 from May to August. The data plots represented three factors: 1) side of the road (upstream and downstream), 2) distance from a culvert (<2 and >20 m), and 3) and distance from either side of the road (2, 6, 20 m).
Results from 2016 showed that, overall, the ground layer of the bog was a source (1.66 g CO_2 m-2 d-1) and the fen was a sink (-19.06 g CO_2 m-2 d-1) of CO_2. In 2017, the ground layers of both the bog and fen were sinks of CO_2 (-1.35 g CO_2 m-2 d-1 and -19.06 g CO_2 m-2 d-1, respectively). In general, hydrologic effects of the road were less at the fen due to the orientation of the road relative to the local slope of the peatland. At this site, variation in C fluxes relative the road was also small, but there was an overall reduction in C sink function due to plant community disturbance. At the bog, flooding occurred on the upstream side of the road. This was more severe far from culverts and close to the road. When culverts were in place, water was moved across the road, but wet conditions were created on the downstream side due to concentration flow. This resulted in higher CH4 emissions close to the road and reduced CO_2 uptake so that the area near the road had a greatly reduced C and GHG sink function than undisturbed areas, even when culverts were present.
However, the carbon flux varied depending on the side of the road, distance from the road, and the distance from the culvert. In our presentation, we will present the main findings of our study and show how resource roads have the potential to alter the carbon dynamics of peatlands. Also, we will recommend measures how the road associated impacts could be minimized.