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Linear disturbances in boreal peatlands: Hotspots of methane emission

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Across Canada's boreal forest, at least 600,000 km of linear disturbances including cutlines and roads crisscross the landscape to facilitate resource exploration and extraction. As the boreal forest consists of up to 50% peatland, many of these linear disturbances also cross peatland ecosystems. Although more permanent access roads may involve the placement of mineral soil fill, most linear disturbances only involve clearing the area of trees to allow the passage of equipment and vehicles. This change in canopy cover and the compression of the peat by heavy equipment alters local thermal, hydrological and ecological conditions, likely changing greenhouse gas flux on the disturbance and possibly in the adjacent peatland.

I studied CO_2 and CH_4 along triplicate transects crossing a winter road through a poor fen near Peace River, Alberta, Canada. Sample plots were located 1, 5 and 10 m from the road on both upstream and downstream sides with an additional three plots in the centre of the road. Productivity of the overstory trees, when present, was also determined. The winter road thawed earlier, had a shallower water table and a significantly higher graminoid cover than the adjacent peatland. Tree productivity and CO_2 varied between the plots in the adjacent peatland, but there was no clear pattern in relation to distance from the road. The plots on the winter road acted as a greater or similar sink of CO_2 as the adjacent peatland, depending on the specific conditions at the study plot. The most significant change was a substantial increase in CH_4 emissions, with plots on the winter road emitting on average (standard deviation) 1100 (550) mg CH_4 m^{-2} d^{-1} compared to 49 (73) mg CH_4 m^{-2} d^{-1} in the adjacent peatland. Since the hydrologic impact of cutlines is likely less than winter roads, the increase in CH_4 efflux may not be as extreme in all cases. Nonetheless, assuming that peatland accounts for $\sim$30% of the boreal region and a 150 day emission period for CH_4, and a perturbation in CH_4 efflux of only half that measured in this study, linear disturbances in Canadian peatlands could induce a land-use change emission of 0.05 Mt CH_4 yr^{-1}.