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Simulating the exchange of carbon in Canadian pristine, disturbed and restored peatlands

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Approximately 1.19 x 10^6 km^2 of Canada is covered by peatlands containing over 110 to 150 Gt C. Most are relatively pristine. A tiny area (~ 0.21 x 10^6 ha) of Canadian peatlands is affected by land-use change. The most common land disturbances are due to agriculture, fossil fuel and mineral exploration and extraction, and the creation of hydroelectric reservoirs. A small area of peatlands (~350 km^2) is disturbed by peat extraction for use in horticulture. We have simulated the emissions of CO_2 from pristine, extractive and restored peatlands using the Coupmodel. Coupmodel reproduces the exchanges of energy, water and carbon well for pristine peatlands and shows their sensitivity to changes in water storage. We have also successfully simulated the emissions from peatlands that are undergoing extraction. Our results show that extraction converts a peatland from a sink of ~ 20 to 100 g C m^{-2} yr^{-1} to a source of ~ 150 – 200 g C m^{-2} yr^{-1}. Finally, we have simulated peatlands that have been restored using ecological approaches (e.g. the moss transfer technique). They return to being a sink in the same range of undisturbed peatlands 14 years after restoration. The sink strength is a function of water table depth. Simulations also show that the restored peatlands are relatively insensitive to climate change over the projected conditions for the next one hundred years. The key to successfully simulating the carbon dynamics of pristine and disturbed peatlands is to be able to simulate the hydrological and thermal conditions well. We demonstrate Coupmodel's capabilities against measurements from pristine, disturbed and restored peatlands. Simulating the biogeochemistry beyond the range of measurements can provide insight for emissions accounting, climate-smart management, and land-use decisions.