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# The simultaneous effects of groundwater table dynamics on greenhouse gas emissions and phosphorus leaching in drained peatlands

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Boreal peatlands are long-term reservoirs of carbon, and vast peatland areas are drained for variable land-use activities. Drainage of peatlands leads to elevated emissions of greenhouse gases (GHG) measured as carbon equivalents, increased leaching of nutrients, and loss of soil carbon and biodiversity. Negative GHG impacts can be reduced by raising groundwater table level (GWT), which in turn may cause leaching of nutrients such as phosphorus (P) from decaying peat layers, increasing the risk for eutrophication of water bodies. Traditionally, emissions and leaching impacts are studied separately and thus it is essential to produce more knowledge about the simultaneous effects of groundwater table conditions on GHG emissions and P leaching.

Our studies explore how different GWT levels and dynamics affect greenhouse gas emissions ($CO_2$, $N_2O$, $CH_4$) and P leaching risk in drained peatlands. The study areas are in North Ostrobothnia, Finland and share a similar geological history. They include afforested peatland, cultivated peatland with varying peat depths, abandoned peat field, and pristine peatland. The potential P leaching risk is studied with chemical extractions of P from different soil depths. Simultaneous GHG emissions and P leaching with different GWT levels and variable dynamics are studied with a column experiment in controlled conditions. The actual GHG emission dynamics in field conditions are studied with static dark chamber and snow gradient methods and linked to functional vegetation diversity, which is studied with visual cover estimations.

Our studies increase scientific understanding of P retention and leaching processes as well as GHG emission dynamics within drained and decomposing peat soils in different GWT conditions and with different land use forms. This knowledge is essential e.g., in Finland, where extensive peatland drainage in the 1900th century has led to considerable GHG emissions and elevated nutrient leaching from large areas. Currently, national climate policy sets pressures for GHG emission reductions in drained peatlands, and these reductions must be made by avoiding further P leaching to water bodies and sea areas. Land use changes may be unavoidable in some cases, and our study setup with multiple land uses provides information for correct decision-making.