

The climate impact of peatland management: Legacies from the past and challenges for the future

Northern peatlands are unique ecosystems that provide a wide range of ecosystem services and benefits. My research focuses on their role in regulating the global climate through the long-term accumulation of carbon in peat and the exchange of two powerful greenhouse gases (GHGs) – carbon dioxide (CO₂) and methane (CH₄) – with the atmosphere. Specifically, since the end of the last glacial period, the formation of natural peatlands has contributed to a net cooling effect on the global climate. About a century ago, however, humans began draining vast areas of peatlands to create new land for agriculture and forestry. An undesired legacy of these drainage activities is that the lowered water levels create conditions that accelerate the decomposition of accumulated peat, leading to substantial peat loss and increased GHG emissions with associated negative effects on the climate. Today, extensive restoration programs are underway at both national and international scales, aiming to mitigate GHG emissions from drained peatlands and to restore them back towards their natural state. However, because peatlands are biogeochemically complex ecosystems, developing effective mitigation strategies remains a considerable challenge. Overcoming these challenges requires an in-depth understanding of the processes that regulate peatland-climate feedbacks.

The goal of my research is to improve our understanding of how management activities influence the biogeochemistry and GHG dynamics in drained and restored peatland ecosystems in the Nordic region. I am interested in elucidating the relationships among the individual components of the peatland C cycle and other GHGs, such as CH₄ and nitrous oxide, in relation to their distinct network of environmental drivers. For this purpose, I use micrometeorological and chamber-based methods to quantify GHG fluxes, monitor a suite of meteorological and soil environmental variables, and collect comprehensive vegetation data.

In my docent lecture, I will present my research on the C cycle and GHG exchanges across natural, managed, and restored peatlands. I will begin by outlining the key processes and controlling factors that regulate peatland GHG exchanges and present alternative scientific methods for quantifying GHG fluxes and emission budgets. I will then summarize my key research findings, which include: i) new insights into the controls of the CO₂ balance in natural peatlands, ii) the climate impact of cultivating degraded peatlands with bioenergy crops, iii) GHG flux assessments in degraded peatlands restored with the moss layer transfer technique, and iv) the GHG balance of drained and rewetted boreal peatland forests. Furthermore, I will highlight the need for multidisciplinary research to adequately evaluate and optimise the multiple benefits provided by restored peatland ecosystems. Through my research, I aim to deliver the detailed empirical understanding that is necessary to support governmental stakeholders and policymakers in developing climate-responsible and sustainable management strategies for northern peatlands.