Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Institutionen för mark och miljö

International Peatland Society

TORV Forsk

Peatlands for Environment, Economy and Society

International Peatland Society Convention 2025
Book of Abstracts

Editors: Sabine Jordan, Örjan Berglund, Anna-Helena Purre
Uppsala 2025

Peatlands for Environment, Economy and Society
International Peatland Society Convention 2025

Sabine Jordan	Sveriges lantbruksuniversitet, Institutionen för mark och miljö, sabine.jordan@slu.se
Örjan Berglund	Sveriges lantbruksuniversitet, Institutionen för mark och miljö, orjan.berglund@slu.se
Anna-Helena Purre	IPS, anna-helena.purre@peatlands.org

Utgivningsort: Uppsala
Utgivningsår: 2025
Omslagsbild: Örjan Berglund

Bibliografisk referens: Jordan, S., Berlgund, Ö., Purre, Anna-Helena. (2025). Peatlands for Environment, Economy and Society. International Peatland Society Convention 2025.

Nyckelord: Peat, Peatlands

DOI: https://doi.org/10.54612/a.2ulieccdav
ISBN (elektronisk version): 978-91-8124-003-0

Sveriges lantbruksuniversitet
Fakulteten för naturresurser och jordbruksvetenskap, Fakulteten för skogsvetenskap
Institutionen för mark och miljö, Jordbrukets vattenhushållning och Skogsmarkens biokemi

Welcome!

It is with immense pleasure and great anticipation that we welcome you to the International Peatland Society (IPS) Convention 2025, hosted in the historic and inspiring surroundings of Gysinge, Sweden. This Book of Abstracts brings together dedicated research, reflecting a shared commitment to understanding the peatlands as essential ecosystems.

This convention is a proud collaborative effort, bringing together the International Peatland Society, the Swedish University of Agricultural Sciences (SLU), and the Swedish Peat Research Foundation (Stiftelsen Svensk Torvforskning). Together, we are delighted to present a program and a collection of abstracts centered on the timely and critical theme: "Peatlands for Environment, Economy and Society". This theme reflects the complex, interconnected roles that peatlands play and the urgent need for integrated approaches to their management and responsible stewardship.

Peatlands stand at a crucial intersection of global challenges and opportunities. They are essential for biodiversity, climate regulation, and water management, yet they also hold significance for various economic activities and cultural heritage. The research compiled within these pages explores this multifaceted nature, offering insights into peatland restoration, after-use strategies, ecological functions, archaeological significance, and the socio-economic dimensions of their sustainable utilization.

This meeting serves as a proof to the vibrant and growing global community dedicated to peatland science and stewardship. We extend our heartfelt gratitude to all the authors for their valuable contributions.

We look forward to stimulating discussions, the forging of new collaborations, and a convention that not only shares knowledge but also inspires innovative solutions for the wise use of peatlands for generations to come.

Welcome to Gysinge and the IPS Annual Convention 2025!

Sabine Jordan & Örjan Berglund, SLU & TorvForsk

Anna-Helena Purre, IPS

Table of Contents

Opening ceremony

Keynote

Peatland Restoration and after-use

Peatland Restoration and after-use (Poster)

Peatlands and archaeology & dendrochronology

Peatlands and archaeology & dendrochronology (Poster)

Peatlands and Climate Change

Peatlands and Culture

Peatlands and Education, Communication and Publicity

Peatlands for Agriculture

Peatlands for Agriculture (Poster)

Peatlands for Forestry

Peatlands for Growing Media

Peatlands for Growing Media (Poster)

Scaling Up Wetland Rewetting in Sweden: Coordinated Action for Biodiversity and Climate Mitigation

Authors: Emma Bergman; Emma.Bergman@Naturvardsverket.se

Affiliation: Naturvårdsverket, Klimatklivsenheten, 106 48 Stockholm

The Swedish Environmental Protection Agency is coordinating wetland efforts with a focus on national and international commitments, primarily on biodiversity and greenhouse gas emissions.

Large parts of Sweden's wetlands have been drained and thus lost since the early 19th century, and are still being impacted by drainage and other water operations, forestry, nitrogen deposition, damage from vehicles and by no longer being cut for fodder production or grazing. Climate change and invasive species also pose a threat to wetlands. Since 2021, rewetting to reduce greenhouse gas emissions has gained increased focus from the government. There is a need to redirect funds to fertile peatlands that leak the largest amounts of greenhouse gases, while taking conflicting interests into account. New forms of data collecting and monitoring need to be developed and legal obstacles addressed in order to scale up and improve the effects of rewetting efforts.

Rewetting agreements for reducing greenhouse gas emissions

Authors: Hillevi Eriksson

Affiliation: Swedish Forest Agency, Dragarbrunnsgatan 78 B 75320 Uppsala, Sweden

Corresponding/presenting Author: Hillevi Eriksson, hillevi.eriksson@skogsstyrelsen.se

Since 2021, the Swedish Forest Agency (SFA) has a governmental assignment to carry out rewetting in cooperation with forest owners through so called rewetting agreements. Nutrient-rich peatlands are prioritized for rewetting agreements due to their higher rate of peat decomposition and, thus, greenhouse gas emissions. The agreements are signed to last for 50 years. They apply to the area also if the estate changes ownership. Before an agreement is signed, an investigation is carried out by the SFA, to determine the site fertility, frame the ‘impact area’ and make sure there are no legal hinders.

The agreement gives SFA the right to carry out rewetting. This is normally obtained through ditch blocking, using trained contractors with excavators. Before the ditch blocking is carried out, the areas are sometimes harvested, fully or partly.

Up until May 2025, about 362 rewetting agreements were signed covering ca 1130 hectares. On around 40 % of those, ditch blocking has been carried out so far. The average of greenhouse gas emission reduction is estimated to be around 8-9 tons of carbon dioxide equivalents per hectare and year.

Rewetting Agricultural Peatlands in Sweden: Balancing Climate Action and Food Security

Authors: Anna Haglund Ståhl

Affiliation: Swedish Board of Agriculture, Skeppsbrogatan 2 553 29 Jönköping, Sweden

Corresponding/presenting Author: Anna Haglund Ståhl,
anna.haglundstahl@jordbruksverket.se

The Swedish Board of Agriculture is addressing the challenge of managing drained peat soils to align climate action with the goal of long-term sustainable food production. Although organic soils constitute a small share of Sweden's agricultural land, they contribute considerably to greenhouse gas emissions. Rewetting is identified as a key mitigation measure, offering additional benefits such as improved biodiversity and climate resilience. In light of new EU legislation and national climate ambitions, efforts are underway to scale up rewetting of agricultural peat soils. This involves identifying priority areas, supporting farmers through knowledge and incentives, and navigating legal and administrative complexities to enable effective land use transitions.

Peatlands in Sweden and agricultural use

Authors: Kerstin Berglund

Affiliation: Swedish University of Agricultural Sciences, Department of soil and environment, P.O. box 7014 75007 Uppsala, Sweden

Corresponding/presenting Author: Kerstin Berglund, kerstin.berglund@slu.se

The total area covered by organic soils (peat and gyttja soils) in Sweden has lately been estimated to be approx. 6 million hectares (15 % of the total land area of Sweden). About 1.5 million hectares are affected by drainage (areas within 50 m from a ditch). Forest land on organic soil was estimated to be 1.5 million hectares (12 % of all forest land) and agricultural land including pasture 230 000 hectares or 7 % of all agriculture land. In 1946, the area of cultivated organic soils (peat and gyttja soils) was at its peak and was estimated to be approx. 700,000 ha which corresponded to 20 % of the total area of agricultural soils. A lot of cultivated peatland areas have been abandoned since then, mainly due to insufficient drainage.

In the west of Sweden, where precipitation is higher, bogs are the dominating peat type while fen peats dominate in the east. Mixed mires dominate in the north. The average peat depth is 1-3 m and decreases going north. The most common type of cultivated organic soil in Sweden is sedge peat (Carex), followed by forest swamp peat originating usually from deciduous forest. Gyttja soils with varying amounts of clay are commonly found in central and southern Sweden. Soils with a coarser texture and, in general, lower amounts of gyttja are found in coastal areas of northern Sweden.

Peatlands have always been important to farmers. The historical background behind the reclamation of peatlands for agriculture in Sweden was a growing population which led to an increased need for food and fodder. More arable land was needed and the solution was the reclamation of peatlands. The big scale reclamation of peatlands was to a large extent projects initiated by the authorities to mitigate severe socioeconomic risks related to emigration to USA, food security, unemployment and poverty. The farmers were often very reluctant and negative since the drainage projects involved a lot of hard work.

But things change. Subsidence has always been a problem for the farmer, mainly causing drainage and bearing capacity problems. With climate change the focus is now on CO_2 and N_2O emissions from drained peatlands and with the EU Nature restauration law, rewetting drained peatlands is high on the agenda. But with climate change comes more extreme weather and in the very dry year in 2018 a lot of abandoned agricultural peatlands were used to secure fodder production when the grass production on mineral soils was limited by drought.

Deciphering biogeochemical and hydrological patterns across a heterogeneous boreal landscape

Authors: Hjalmar Laudon

Affiliation: SLU, Barrskogsgränd 17 90686 Umeå, Sweden

Corresponding/presenting Author: Hjalmar Laudon, hjalmar.laudon@slu.se

Boreal landscapes are often heterogeneous in terms of how the mosaic of forest and peatlands regulate and exchange biogeochemical and hydrological signals both laterally downstream and vertically with the atmosphere. The basis for my presentation will be on the Krycklan Catchment Study (www.slu.se/Krycklan) located in northern Sweden, which provides a unique field experimental platform for hillslope to landscape-scale research on long-term ecosystem dynamics in the boreal landscape. The site is designed for processes-based research needed to assess the role of external drivers such as forest management, climate change, and long-range transport of pollutants on soils, atmosphere, groundwater, streams and lakes. In my presentation I will discuss some examples of how Krycklan has developed into a state-of-the-art field infrastructure for experimental and hypothesis driven research, maintained the long-term climatic, biogeochemical, hydrological and environmental data collection of highest quality, and how this has supported the development of new models and guidelines for research, policy and management.

Swedish Peat Production in Transition: Balancing Use, Restoration, and Resilience

Authors: Pia Holmberg

Affiliation: The Swedish Peat Association 'Svensk Torv', c/o Hasselfors Garden AB, Box 1813, 701 18 Örebro, Sweden

Corresponding/presenting Author: Pia Holmberg, pia.holmberg@hasselforsgarden.se

The Swedish peat industry offers a sustainable model of production and supports national preparedness and the shift to a greener, more resilient society. Peat is only harvested from historically drained peatlands—areas already altered and now emitting greenhouse gases. This allows the industry to reduce emissions while restoring ecosystems.

Strict regulations ensure sustainability from production to after-use. Restoration is mandatory and pre-financed, turning degraded land into carbon sinks and biodiverse habitats.

White, brown, and black peat are produced using various methods. Most horticultural peat comes from southern and central Sweden, while energy peat production and use, mainly in the north, is declining.

Peat remains vital for horticulture, animal welfare, and food security. Domestic use dominates, but export demand is growing. Sweden’s model shows how peat production can align with climate goals and societal resilience.

The wetland inventory of Sweden

Authors: Urban Gunnarsson

Affiliation: SLU Swedish Species Information Centre, Box 7007

SE-750 07 Uppsala, Sweden

Corresponding/presenting Author: Urban Gunnarsson, Urban.Gunnarsson@slu.se

Sweden is a large country and covers large environmental gradients giving a rich diversity of wetlands.

Historically large campaigns of peatland and wetland inventories were performed by for example von Post and Granlund and the Swedish Geological Survey in the first part of last century. Several studies on the ecology of mire systems were done making new insights to autecology of the ecosystems.

The Wetland Inventory of Sweden (SWI), that started in the early 1980-ies and ended in 2004, covered most large peatland below the alpine region. The inventory gave many important results about the wetlands in Sweden, occurrences of wetland types, nature conservation values, threats to wetlands, wetland regions and information about their vegetation. There were, however, no continuation in the wetland inventory even if the environment is continously changing.

To monitor the wetlands after SWI, several monitoring programs have been starting. A satellite-based inventory was started by Swedish Environmental Protection Agency (SEPA). The inventory reviled areas with high rates of change, within open wetlands during 10-year periods. Beside this inventory the National Forest Inventory (NFI) analyses field plots every five years, including mires, and National Inventories of Landscapes in Sweden (NILS) do special inventories for the habitats of the EUs habitat directive that are less common (e.g. raised bogs). Other national and regional inventories also cover less frequently occurring habitats. Beside the more regular monitoring programs there have been some special studies of historical intensely studied mire areas.

In the report to EUs habitat directive some of the main results are used to assess the conservation status of the different wetland types. Some of the results from the analysis of trees on mires in the NFI-data showed that the abundance of trees has increased on mires all over Sweden. Other compilations of the monitoring data have also been done in several publications. A continued monitoring of wetlands is essential for the future management of wetlands.

From stone axes only to human skulls mounted on wooden stakes – The impact of wetland archaeological excavations on the picture of the Stone Age in Sweden

Authors: Fredrik Hallgren

Affiliation: Stiftelsen Kulturmiljövård (The Cultural Heritage Foundation), Pilgatan 8D

72130 Västerås, Sweden

Corresponding/presenting Author: Fredrik Hallgren, fredrik.hallgren@kmmd.se

Within Stone Age research, Southern Scandinavia (Denmark and the adjacent Swedish province of Scania) are famous for well preserved Stone Age wetland sites with rich organic find assemblages. The picture looks quite different in Sweden north of Scania, where Stone Age sites typically are found only on dry land. On these latter sites the find assemblages consist almost exclusively of tools and waste of stone, the rare organic materials found are cremated bones, charred hazelnut shells and charcoal – materials that have been preserved thanks to being burned and thus having become more resistant to decomposition.

The contrast in Mesolithic assemblages between southern Scandinavia and central and northern Sweden can seem puzzling. The eye-catching finds of tools and objects of bone, antler and wood from Denmark and Scania have been preserved thanks to residing in moist and oxygen-poor wetland layers. But bogs and wetlands are not unique to the southern end of Scandinavia, but occur throughout the Scandinavian peninsula. Are there no archaeological finds in the wetlands further north?

That there actually exist Stone Age finds in wetlands in Central and Northern Sweden becomes clear if one studies the archival reports of stray finds found by laymen during ditching and peat extraction in the late 19th and early 20h century. During this period occasional examples of bone and antler tools like harpoon points, leister points and slotted points were reported from both Southern, Central and Northern Sweden. Reports of finds ceased when spades were replaced by machines in ditching and peat extraction.

When professional archaeological fieldwork was established as a discipline in Sweden in the 20th century, the old finds from wetlands were seemingly forgotten. An archaeological practice was established that dictated that wetlands are of no archaeological interest in the regions to the north of Scania. The status quo remained until circa the 1990ies. During the last 30 years a series of wetland excavations and discoveries has created a renewed interest in wetland archaeology in Sweden. We no longer have assemblages that only contain stone axes, but also have complex sites that for example include ritual contexts with human skulls mounted on wooden stakes.

Yeasts for climate-smart high-value products from plants grown in paludiculture

Authors: Volkmar Passoth

Affiliation: Swedish University of Agricultural Sciences, Department of Molecular Sciences, Box 7015 75007 Uppsala, Sweden

Corresponding/presenting Author: Volkmar Passoth, volkmar.passoth@slu.se

Yeasts are unicellular microfungi with an enormous phylogenetic ecological, and metabolic diversity. In connection with this, some yeast species also have a great potential to convert diverse biomasses to high-value compounds.

Through paludiculture, peatland after-use in combination with rewetting, climate-smart cultivated plants can be produced in synergy with other sustainable development goals. This plant biomass represents a promising substrate for conversion by yeasts. Apart from the known processes of ethanol or single cell protein generation, production of microbial oil by oleaginous yeasts represents a relatively new approach. Several lignocellulosic biomasses have been demonstrated to be useful as substrate for yeast cultivation after according pre-treatment. Reed (*Phragmites australis*) represents a lignocellulosic resource, which conversion to bioethanol has already been proven. Since it belongs to the grasses, its composition of cellulose and hemicellulose is comparable to that of for instance wheat straw. The conversion of straw to ethanol or biolipids results in a positive energy balance with decreased greenhouse gas (GHG) emissions. Oleaginous yeasts have the potential to generate oil, carotenoids and other biochemicals from lignocellulose hydrolysates and by this to transform a low-value substrate into a high-value product. Due to its comparable fatty acid composition, microbial oil can replace vegetable oil in food, feed and other applications. Developing processes for generating additional values out of paludiculture on formerly drained peatlands can be a driving force for re-wetting and thus reduce GHG emissions to the atmosphere.

Mire Climate Protection Projects of the NABU Climate Fond – A tool for peatland restoration and climate protection – Two examples from Sweden

Authors: Bernd Hofer

Affiliation: Chair of IPS Comission Peatlands and Environment / CEO Hofer & Pautz GbR, Buchenallee 18 48341 Altenberge, Germany

Corresponding/presenting Author: Bernd Hofer, hofer@hofer-pautz.de

The NABU Climate Fund has been restoring drained peatlands in Northern Germany in cooperation with donors from the private sector since 2009. In recent years, these activities have been significantly stepped up in cooperation with REWE Group and Volkswagen, among others, and have also been extended to other European countries.

Thanks to the voluntary commitment of the private sector to climate protection, NABU has larger sums at its disposal to rewet and develop drained peatlands in the interests of climate protection. The aim is to avoid current greenhouse gas (GHG) emissions, to safeguard existing carbon stocks and to restore peat-accumulating vegetation in the long term, thereby restoring the carbon sink functions of peatlands. Positive effects on the biodiversity of these peatlands are an intended synergy.

By using example areas, the process of the voluntary climate protection projects is explained:

- Screening / initial assessment of the areas

- Baseline recording and establishment of monitoring

- Planning of measures, application and permission process

- Technical implementation of the measures

- Accompanying monitoring, necessary optimization, reporting

The projects run for a period of 25 years. The climate effect will be calculated and documented, but there is no direct sale of carbon credits. The donors only have the option of including their contribution in their sustainability reporting and using it for their marketing.

In future, clear guidelines and rules for voluntary climate protection are required throughout Europe for the certification of saved GHG emissions and carbon storage in order to avoid the misuse of certificates, as has taken place in the Global South in the past, and to motivate the private sector in its commitment.

Scaling functions from peat mosses to peatlands

Authors: Gustaf Granath

Affiliation: Department of Ecology and Genetics, EBC, Uppsala University, Norbyvägen 18D 75236 Uppsala, Sweden

Corresponding/presenting Author: Gustaf Granath, gustaf.granath@ebc.uu.se

Sphagnum mosses play a pivotal role in the functioning of boreal and temperate peatlands, particularly through their influence on hydrology, carbon accumulation, and nutrient cycling. While considerable progress has been made in understanding *Sphagnum* ecology, it is still unclear if species-specific functional traits can be linked to ecosystem-level processes. Trait variation among *Sphagnum* species can significantly alter peatland functions, yet the mechanisms and extent of these effects are still poorly understood. In this talk, I will highlight the importance of species identity and their traits in shaping peatland dynamics and explore key knowledge gaps that should be addressed to improve predictions of peatland responses to environmental change and restoration.

Peatland restoration and the path to net zero: direct field measurements demonstrate an intact Australian *Sphagnum* peatland is a strong carbon sink.

Authors: Samantha Grover, Meerruppage Gunawardhana, Sarah Treby, Torben Callesen, Ewen Silvester

Affiliation: RMIT University, 124 La Trobe St 3001 Melbourne, Australia

Corresponding/presenting Author: Samantha Grover, samantha.grover@rmit.edu.au

Peatlands' role in the global carbon cycle (C) is well recognised, with their very existence evidence of their role as net C sinks over the longer term. Drainage, both intentional and incidental, can turn these long term sinks into large C sources. However, considerable uncertainty remains around the C balance effect of peatland restoration, due to the methane greenhouse multiplier. This paper presents the first net C balance study of a *Sphagnum* peatland from the Australian Alps, a nationally protected threatened ecological community. We measured the net ecosystem exchange of CO_2 (NEE), methane emission (CH_4), and aquatic fluxes of dissolved organic C (DOC) and dissolved inorganic C (DIC), over a two-year period. The study peatland is a rare example of this ecosystem in good ecohydrological condition, in contrast to the widespread degradation of these mountain peatlands via feral animal impact, fire and drainage for hydroelectricity generation. Overall, the peatland acted as a strong net C sink of 292.5 g C m^{-2} yr^{-1}. The annual net ecosystem carbon balance (NECB) exhibited distinct intra-annual variability, shifting from a strong C sink in the growing period (444.1 g C m^{-2} $period^{-1}$) to a C source in the non-growing period (151.6 g C m^{-2} $period^{-1}$), when the peatland was covered by up to 1.5 m of snow. Estimates of non-CO_2 fluxes were relatively small: emission of CH_4 was 2.4 g CH_4–C m^{-2} yr^{-1}; DOC flux was 8.7 g C m^{-2} yr^{-1}; and evasion flux was 18.5 g C m^{-2} yr^{-1}; together comprising <10 % of annual NECB. The large observed net C uptake suggests that the carbon sequestration potential of these ecosystems is globally very high, likely due to their occurrence in a temperate region with a relatively long growing period. As the focus of the management of these landscapes widens from hydroelectricity and tourism to include contributing to the national path to net zero, active peatland restoration could yield net C gains. Monitoring the net C impact of active restoration of degraded Australian mountain peatlands is a critical next step on this path.

Microbial Community Structure and Functional Groups in Rewetted and Cultivated Peatlands

Authors: Bettina Müller, Volkmar Passoth, Eva Weber, Örjan Berglund, Sabine Jordan

Affiliation: Swedish University of Agricultural Sciences, Box 7014 75007 Uppsala, Sweden

Corresponding/presenting Author: Bettina Müller, bettina.muller@slu.se

Peatlands harbour extensive microbial populations with broad metabolic capabilities, closely linked to peat characteristics (e.g., peat quality) and land-use practices. A better understanding of the composition and functional potential of microbial consortia in peat soils can provide valuable insights into the mechanisms behind greenhouse gas (GHG) emissions from organic soils.

To investigate this, peat soil samples were collected from diagnostic peat horizons and living biomass in a former extracted and rewetted peatland dominated by a peat moss layer (*Sphagnum spp*.). Additional samples were obtained from three agriculturally utilized fields, where ongoing experiments include sand mixing, liming, and cultivation trials with various grass species.

Key soil parameters were assessed both in situ and in the laboratory. These included the degree of peat decomposition, peat type, pH, soil temperature, electrical conductivity, and the carbon-to-nitrogen (C/N) ratio. The bacterial and archaeal community compositions were analyzed via Illumina sequencing of the partial 16S rRNA gene. Downstream data analysis was conducted using the DADA2 pipeline, resulting in an abundance table that was evaluated for overall microbial composition, with a specific focus on functional groups such as methanotrophs, methanogens, nitrifiers, denitrifiers, and sulfate-reducing bacteria.

The fungal community composition was determined using traditional plate count techniques.

Does the EU Green Deal's "carrot and stick" approach enhance peatland restoration projects in Latvia?

Authors: Ilze Ozola

Affiliation: Dr.geol., Jelgava str.1 LV-1006 Riga, Latvia

Corresponding/presenting Author: Ilze Ozola, ilze.ozola@epicentrs.lv

Latvia is intensifying its peatland restoration efforts, with ambitious recultivation plans driven by the "carrot" (Just Transition Fund) and "stick" (EU Green Deal targets) approach. This initiative, offers substantial financial support to the restoration efforts, currently making it a central tool in peatland recultivation.

The Just Transition Fund promises over 180 million to support the transition away from peat-based energy until 2030. Most of the funding will receive public infrastructure for business development (€46 million) and emission-free municipal transport (€21 million). Approximately €5 million (or 3.26%) is allocated specifically for peatland habitat restoration, particularly in protected nature areas. A Peat Research Platform will be established with a total budget of €5.98 million. An additional €1.92 million from the JTF has been allocated to Latvia’s planning regions for the inventory and development of restoration plans for at least 9,000 hectares of historic peat extraction sites, including municipal and privately owned lands. It might be that the "carrot" promised was much larger, and what actually got delivered for real shift away from energy-peat seems to be just the skin of that carrot. But even the skin is still a valuable support for revitalizing degraded peatlands.

The results of the LIFE Restore project (2014-2020) indicate that, as of January 1, 2016, 50 179 hectares, were identified where peat extraction had either previously taken place or was still ongoing. Peat extraction is ongoing on 15,008 hectares of land. Of the 18 010 hectares where extraction had ceased or been completed, approximately 10 200 hectares have active extraction licenses, that will need to be restored in collaboration between the peat producer and the landowner with the expenses covered by both parties. For the restoration of the remaining areas (historical peat extraction sites), up to approximately 8 000 hectares, the JTF funding is available. In total funding is available to restore around 13 600 hectares, including both historical peat extraction sites and specially protected nature areas.

It may even be beneficial that Latvia has been slow to act on peatland recultivation thus far. Until recently, the focus has been on forestry and berry cultivation. Now, with the additional funding, updated policies, and a more comprehensive understanding, the country is in a much stronger position to undertake high-quality peatland restoration efforts.

Peatland research at the Geological Survey of Finland – solutions for sustainable land uses

Authors: Maija Lampela, Jukka Turunen, Liisa Maanavilja, Lauri Ikkala, Oona Allonen, Tuija Vähäkuopus

Affiliation: Geological Survey of Finland, P.O. Box 96 (Vuorimiehentie 5) 02151 Espoo, Finland

Corresponding/presenting Author: Maija Lampela, maija.lampela@gtk.fi

The Geological Survey of Finland (GTK) has a long tradition of mapping peatland habitat types and peat resources of Finland starting from year 1942. The primary purpose was to locate peat resources for various uses and to serve as a foundation for planning peatland utilization. Currently, the mapped area covers approximately one-fourth (2.3 Mha) of Finnish peatlands with more than 1.8 million research points. The data is used for example for assessing peat reserves, peat carbon storage and the natural state of peatlands, or in planning restoration, further use of cutaway areas, solar power plants or other land uses. Based on these foundations and excessive new data collection, GTK has recently produced numerous nationwide open spatial datasets on peatlands. These datasets include classifications of the natural state, peatland site types, fertility status categories, drainage status and land use in peatlands.

GTK's current research on peatlands includes a variety of topics, including carbon sinks and reserves, greenhouse gas (GHG) fluxes, impact of peatland fires, peatland restoration, *Sphagnum* moss harvesting and cultivation, palsa mires and natural rich fens, after-use of peat cutaways, paludiculture and energy transition. We are also expanding our capacity in GHG measurements, geophysical survey methods and environmental monitoring with drones. These topics are realized in several research projects funded currently by Horizon EU, Just Transition Fund of EU, European Regional Development Fund, Research Council of Finland and ministries. Our collaborations span from nationwide to Europe and beyond. GTK is willing to expand its international research collaboration on the sustainable use of peatlands. In addition to research, GTK provides solutions for peatland use planning and GHG monitoring for commercial customers.

Rewetting with integrated paludiculture vs. afforestation as after-uses for extracted peatlands in nemo-boreal Sweden: Assessing carbon-related ecosystem functions

Authors: Sabine Jordan, Eva Weber, Örjan Berglund

Affiliation: Swedish University of Agricultural Sciences, Box 7014 750 07 Uppsala, Sweden

Corresponding/presenting Author: Sabine Jordan, sabine.jordan@slu.se

This study aimed to assess the climate-regulation and biomass provisioning function of rewetting with integrated paludiculture and afforestation as after-uses of extracted peatlands in nemo-boreal Sweden. Specific objectives were to evaluate and compare soil and biomass carbon (C) storages, carbon dioxide (CO_2) and methane (CH_4) emissions, C balances as well as the biomass production of both after-uses.

Peat mineralisation at afforested sites led to high C losses that could not be compensated with organic litter formation. Natural recolonisation by trees was slow, while the rewetted site revegetated rapidly. The biomass C accumulation of rewetted sites were found to successfully compete with the one of afforested sites, when given the same time to develop. Carbon gas emissions were significantly higher at afforested sites, almost twice as high as emissions from the rewetted site. Methane emissions did not contribute considerably to C losses in the first years after rewetting. Overall, results indicated that C neutrality could be achieved approx. 12 years after rewetting. Afforested biomass compensated for some C losses, but a C balance close to zero was not reached. Findings suggested that the biomass production of paludiculture is similar to the yield of afforested sites.

Rewetting maximised the C regulation function of extracted peatlands. Integrated paludiculture and afforestation were both found to have similar economic benefits, while higher climate-regulation functions were discovered for paludiculture. Hence, it was recommended to rewet extracted peatlands at areas with no monetary pressure, while paludiculture can meet the demand for economic benefits. Afforestation should only be considered for areas, where rewetting is not practicable.

The Archaeological Heritage of industrial peatlands in Ireland

Authors: Ellen O'Carroll, Ben Gearey, Caitríona Moore, Claire Nolan, Lauren Schotter & Ben Spillane

Affiliation: University College Cork, 5 Sharavogue, Glenageary Co. Dublin A96W1H9 Dublin, Ireland

Corresponding/presenting Author: Dr Ellen O Carroll, eocarro@tcd.ie

The archaeology of Ireland's industrial peatlands, comprising sites and artefacts exposed, impacted and often destroyed by drainage and peat extraction, is perhaps some of the most fragmented in the country. Nonetheless, almost 40 years of survey, excavation and palaeo-environmental work have generated an immense archive of data and a unique resource of knowledge on the distribution and character of peatland archaeology on a national scale. With the end of industrial cutting, the Irish Peatland Archaeology Across Time Project (IPeAAT; funded by the IRC COALESCE INSTAR+ scheme), has compiled and assessed these datasets to gain a better understanding of the timing, nature and purpose of human activity in Ireland's peatlands, in relation to economics, environment and climatic changes. This paper outlines the approaches and key results of the project, including the construction of a relational national database incorporating information drawn from detailed investigation of archaeological excavations and associated data including palaeo-environmental analyses and chronology. The application of spatial and chronological modelling to this national database has allowed for the identification and analysis of key patterns of human activity in a variety of peatland environments over time.

Stone Age sites in every bog? Recent excavations at Dagsmosse, Tjugestamossen and Ekebymossen

Authors: Fredrik Hallgren

Affiliation: Stiftelsen Kulturmiljövård (The Cultural Heritage Foundation), Pilgatan 8D 72130 Västerås, Sweden

Corresponding/presenting Author: Fredrik Hallgren, fredrik.hallgren@kmmd.se

This paper presents the results of the last decade of surveys and excavations of Stone Age remains in the peat bogs Dagsmosse in Östergötland and Tjugestamossen and Ekebymossen in Närke, East Middle Sweden. Each of these bogs were lakes in the Stone Age, and later developed into fens and then into raised bogs. Dagsmosse and Ekebymossen are today utilised for commercial peat extraction, an activity that unearth, expose and destroy Stone Age remains. The Tjugestamossen bog was ditched for agricultural purpose in the late 19th centuary, recently a series of artificial wetlands has been created in the former bog, exposing and destroying Stone Age remains.

The archaeological investigations at Dagsmosse have located a number of Mesolithic sites that are between 10 000 and 6500 year old. At that time, Dagsmosse was a shallow lake/lakes with extensive reed fens. Surveys, small scale excavations, coring with a russian sampler and use of ground penetrating radar has let us glimpse a Stone Age landscape with bays, coves and islands where the Stone Age hunter-gatherers once roamed. Rows of preserved wooden stakes still stand on the bottom of the ancient lake, likely the remains of fences that ushered the fish towards woven basket traps. We have also found fishing and hunting equipment: barbed leister-points and harpoons of bone and antler. Net sinkers of stone are abundant, and a few beautifully carved wooden net floaters have also been found. Settlement sites and hunting stations were located on the small reed islands in the Dagsmosse lake. The settlement site that is most well-preserved – Dagsmosse Jussberg – contain a house/hut structure with a semi-subterranean floor with alternating layers of applied flooring and waste material like animal bones and hazel nuts but also tools of bone, antler and stone. On the brink of the shore, there is a refuse layer that extends into the former lake, where it reaches 1,5 m in thickness.

The more limited survey of the constructed wetlands at Tjugestamossen gave examples of Mesolithic finds and structures similar to that of Dagsmosse with constructions of wooden stakes, animal bones as well as tools of bone and antler. At Ekebymossen a series of Late Neolithic stationary fish traps of the type “katsa” were located, excavated and documented.

Tracking Rapid Ecosystem Changes and Long-Term Climate Dynamics Using Tree-Ring Data from Peatland Trees

Authors: Johannes Edvardsson, Loïc Francon, Silvia Piccinelli, Karolina Janecka, Emma Kritzberg, Magdalena Wiedermann, Nils Cronberg, Veiko Lehsten, Christophe Corona and Markus Stoffel

Affiliation: Department of Geology, Lund University, Lund, Sweden, Sölvegatan 12 22352 Lund, Sweden

Corresponding/presenting Author: Johannes Edvardsson, johannes.edvardsson@geol.lu.se

Healthy peatlands are globally important long-term greenhouse gas (GHG) sinks, contributing to vital carbon sequestration, biodiversity, and freshwater purification. However, climate change, increased nitrogen deposition, and anthropogenic activities can significantly impact these ecosystem services. Reduced carbon sequestration is expected if drier conditions transform moss-dominated peatlands into tree-covered landscapes. Such vegetation shifts also reduce biodiversity and accelerate peat degradation, which is believed to contribute to freshwater brownification. The growing body of evidence for accelerating tree colonization in many Scandinavian peatlands is therefore alarming.

Despite the global significance of peatland ecosystems, we still lack a holistic and integrated understanding of the processes linking tree colonization with hydrology, biodiversity, and carbon sequestration. In this presentation, I will provide an overview of studies addressing (i) ongoing peatland processes, including monitoring of tree growth, hydrology, and GHG fluxes, and (ii) comparisons between current tree colonization and similar past events (e.g., during the Holocene Thermal Maximum), using subfossil trees.

To study ongoing processes, we monitor living Scots pine trees at four peatlands in southern Sweden. This monitoring employs dendrometers to measure tree growth in real time and pressure sensors to track hydrological changes, with data collected at hourly resolution. To gain deeper insights into the factors controlling tree growth, we have also conducted wood anatomical studies and analysed variations in stable carbon ($\delta^{13}C$) and oxygen ($\delta^{18}O$) isotopes in tree rings.

For long-term processes, I will present ongoing initiatives to develop multi-millennial Scandinavian tree-ring width (TRW) chronologies from subfossil pine and oak trees. Approximately 1,000 pine and 1,500 oak trunks extracted from Danish and southern Swedish peatlands have been analysed. Currently, the dataset comprises a mix of absolutely dated, radiocarbon-dated, and yet-to-be-dated TRW records, spanning the last 8,000 years. In addition to reconstructing Holocene climate development, this material enables the study of periods when peat bogs expanded and buried trees, as well as serving as a dating tool for archaeological wood objects

Cultural heritage and nature conservation in peatlands – field of conflicts and synergies

Authors: Mirjam Briel

Affiliation: Archaeological state office of Schleswig-Holstein; Deutsche Gesellschaft für Moor- und Torfkunde, Arnimstraße 39c 23566 Lübeck, Germany

Corresponding/presenting Author: Mirjam Briel, mirjam.briel@alsh.landsh.de

In view of advancing climate change and the global loss of biodiversity, the protection of peatlands and the rewetting of formerly drained peatlands is becoming increasingly important. Peatlands act as effective carbon sinks and therefore make a key contribution to climate regulation. At the same time, they represent highly specialised habitats that are essential for numerous endangered plant and animal species.

Today, over 20 % of the world's peatlands are drained. In recent years, rewetting projects have been increasingly initiated under political pressure, as their climate-relevant potential is being highly recognised.

However, viewing peatlands solely from the perspective of nature conservation and climate protection is insufficient. The rewetting programms present significant challenges for the preservation of archaeological heritage – particularly because the archival function of peatlands is seldom acknowledged or considered within the framework of nature conservation efforts.

To this day, it is rarely recognised and acknowledged that peatlands are not only ecologically important, but also of great cultural and natural historical significance. Due to their special conservation conditions, peatlands preserve organic materials over thousands of years that are quickly decomposed in mineral soils. They preserve artefacts of human origin, animal remains as well as plant pollen and seeds, which are regularly and thus relatively chronologically stored in the peat. Peatlands thus function as unique archives of cultural, natural and climatic history, the beginnings of which often date back to the late glacial period.

As rewetting measures often require far-reaching interventions into the peat body, there is a risk that these valuable archives – the archaeological as well as the natural ones – might be irreversibly destroyed. It is therefore essential to reconcile ecological objectives with the protection and investigation of archaeological and scientific findings. An interdisciplinary exchange between the different stakeholders and the active involvement of the local population are decisive prerequisites for the sustainable and holistic development of moorland landscapes as cultural landscapes.

Wetland archaeology in northern Germany – challenges of archaeological monument preservation in relation to rewetting projects.

Authors: Mirjam Briel

Affiliation: Archaeological State Office of Schleswig-Holstein; Deutsche Gesellschaft für Moor- und Torfkunde, Arnimstraße 39c 23566 Lübeck, Germany

Corresponding/presenting Author: Mirjam Briel, mirjam.briel@alsh.landsh.de

The peatlands of central Europe, especially in central and northern Europe, began to develop around 12,000 years ago after the end of the Weichselian Ice Age. In Germany, bog-rich areas are mainly concentrated in the North German Plain and the Alpine foothills. With around 600,000 hectares, Lower Saxony has the largest area of peatlands of all the federal states - around a third of all German peatlands are located there. Around 70 % of this area is used for agriculture today. Around 10 % of Schleswig-Holstein's landscape was also once covered by mires; however, around 90 % of northern Germany's peatlands have now been severely damaged or completely destroyed by drainage, agricultural use and peat extraction. Today, rewetting projects are being carried out on many areas, which is also attracting the attention of archaeologists:

In addition to their ecological significance, the peatlands of the North German Plain have an outstanding function as archives of human cultural history and as comprehensive natural archives of landscape development and thus of local climate history. The ‘bog archaeology’ of northern Germany is internationally renowned for an extraordinary number and variety of archaeological finds dating back to the late glacial period.

Archaeological artefacts and findings from different eras - from the Late Glacial reindeer hunters to Middle Stone Age hunters and fishermen, Neolithic farmers to Bronze Age and Iron Age path networks - provide insights into socio-cultural developments, technological innovations, mobility, religious practices, conflicts and adaptation strategies to changing environmental conditions.

The so-called bog bodies, which have been found not only in northern Germany but throughout northern Europe, are particularly impressive evidence. They allow an extraordinarily direct access to the past - a look into the face of past times, so to speak.

The speech will provide an overview of peatland archaeology in northern Germany, present famous sites and findings, and look at both the archaeological and scientific archives of the peatlands, as well as the challenges of archaeological monument preservation in relation to rewetting projects and examples of successful cooperation with nature conservation.

Retrieving Osseous Biographies – created, used and deposited wetland finds

Authors: Sara Gummesson

Affiliation: Stockholm University, Lilla Frescativägen 7 114 18 Stockholm, Sweden

Corresponding/presenting Author: Sara Gummesson, sara.gummesson@ofl.su.se

Osseous production has generally been understudied in relation to, for example, lithic technology. This is partly due to the fact that preserved osseous material from the Stone Age is unusual. The ongoing research project Retrieving Osseous Biographies addresses a gap in archaeological knowledge about manufacturing processes, traditions, knowledge transmission and social contact networks of osseous craft during the Stone Age, by studying four unique museum collections of osseous items. The project is funded by the Swedish Research Council, with the main purpose to investigate how osseous craft developed among hunter-fisher-gatherer societies across the Baltic Sea region, c. 9,500-3,000 BCE.

In the eastern Baltic Sea area there are several exceptionally well-preserved osseous collections that in general have not been accessible to wider academic circles due to political and language barriers. Likewise, there are several understudied well-preserved objects in the collections of the National History Museum, in Stockholm. Most part of these finds have been recovered in wetland areas, often in association of peat cutting, or drainage of peatlands for agricultural purposes.

These objects have been typologically attributed to different parts of the Stone Age, but large parts of the finds are actually undated. The project encompasses a series of new analysis including artifact studies, osteological and taphonomic analyses, radiocarbon dating and ZooMS- analysis. Bones also contain biodata about animals and environmental conditions, information that can provide insights into human choices, trade and exchange of objects or raw materials. The project also covers investigating the environments in which these objects were created, used and deposited through palaeoecological fieldwork.

Preliminary results suggest that similar morphology may be seen on different types of implements throughout large time spans. Not surprising but important we have been able to connect northern Sweden to larger geographical distribution areas of beaver mandible tools. We have identified long- distance communications (artefact mobility) between a fresh water environment in Uppland, Sweden with human utilization of deep-sea marine mammals.

Reconstructing the Paleoenvironmental Evolution of Lake Kolon (Hungary)

Authors: Tamás Zsolt Vári, Pál Sümegi, Elemér Pál-Molnár

Affiliation: Department of Geology, University of Szeged, Hungary, 2 Egyetem street H-6722 Szeged, Hungary

Corresponding/presenting Author: Tamás Zsolt Vári, varitamaszsolt@gmail.com

The paleoenvironmental evolution of Lake Kolon (Danube–Tisza Interfluve) over the past ca. 27,000 years was reconstructed using a multi-proxy analysis of a central core sequence. This study integrated geological, ecological, historical, and analytical techniques, including loss on ignition, grain size, magnetic susceptibility, water-soluble geochemistry, pollen, malacology, macroelement analysis, sedimentology, radiocarbon dating, WD-XRF, and XRPD, to assess the lake's development and its response to environmental change.

Pleistocene wind-blown sand formed the base between (440–282 cm) for an oligotrophic lake (282–222 cm), transitioning to a calcareous mesotrophic lake phase (222–172 cm). Peat accumulation and eutrophication (172–122 cm) commenced at the Pleistocene–Holocene boundary, followed by a substantial peatland phase (122–32 cm). At the top (32–0 cm), a hydromorphic soil developed.

Correlations were identified between: (1) clay, organic matter, and elements of organic origin (Na, K, Zn); (2) magnetic susceptibility, sand, inorganic matter, and inorganic elements (Fe, Al, Ti, Na, K, P); and (3) carbonate content and carbonate-derived elements (Ca, Mg).

The sediment mineralogy is dominated by smectite, illite, calcite, and quartz. Major elemental constituents include CaO, SiO_2, Al_2O_3, and Fe_2O_3, while Sr, Zr, and Pb are enriched as trace elements in the upper sediment layers, likely due to anthropogenic influence.

Forest fires occurred at the end of the Last Glacial Maximum (LGM), with a shift from boreal forest-steppe to temperate deciduous forest at the Pleistocene–Holocene boundary. Human-induced environmental changes, including the development of open parkland and pasture use from medieval times, are also documented.

This type of reconstruction is crucial for understanding how ecosystems respond to climate change over time, which has broader implications for modern-day conservation efforts and managing ecosystems in the face of ongoing climate change.

Global peatlands – their management, emissions and mitigation – first results from global data collection

Authors: Anna-Helena Purre

Affiliation: International Peatland Society, Chair of Scientific Advisory Board, Suuruspääntie 11 C 9 40520 Jyväskylä, Finland

Corresponding/presenting Author: Anna-Helena Purre, anna-helena.purre@peatlands.org

The Scientific Advisory Board (SAB) of IPS has initiated several projects to develop and distribute fact-based information about peatlands and commit to sustainable use of peat and peatlands. Among other activities, SAB initiated the global data collection campaign in autumn 2024. Data is collected to support the membership needs of IPS, to develop peatland related materials and to provide input to several projects of IPS. Peatland areas under different management and after-use types, emissions related to these land-uses (including pristine) and after-uses, and mitigation measures applied in each country to decrease the impacts of peatland land-uses and gathered. Responses from national experts but also publicly available sources were used.

The first results indicate large variability in data availability and reporting between the countries and regions, but also land-uses. Large data gaps are in less-developed parts of the World. Detailed data is available for many northern peatland-rich countries, and generally in countries reporting wetland-related emissions in National Inventory Reports. In Europe, the main peatland uses are agriculture and forestry, whereas peatland drainage for forestry is very small-scale in Canada and in the Netherlands. Peat extraction covers minuscule areas in all countries where it occurs and is generally well documented and after-uses applied (rewetting in Europe, moss-layer-transfer technique in Canada). Mitigation measures applied in e.g. agricultural and/or forestry-drained peatland soils are often less documented. Still the reporting level is variable and lacking in many peatland areas e.g. in Asia, Africa and South America where significant emissions could occur. Even when data about total peatland area is available in these regions, their management and related emission estimates are lacking. This complicates the targeted mitigation actions.

The main mitigation measures applied to counteract peatland related emissions and habitat degradation in different countries vary between the main peatland land-use type (although rewetting is main approach for all land-uses), historical background and current directions, land ownership and legislative and environmental conditions. Most of the restoration work is done in developed countries on northern hemisphere whereas large emissions could occur elsewhere.

We thank all the experts who provided their input and we call for further help to fill in the available data gaps in our database and support it in it’s regular updates!

The separate roles of vascular plants and *Sphagnum* mosses in regulating the boreal peatland carbon cycle

Authors: Antonia Hartmann, Kyohsuke Hikino, Gillian Simpson, Järvi Järveoja, Sandra Jämtgård, Mats Öquist, Mats. B. Nilsson, Matthias Peichl

Affiliation: Department of Forest Ecology and Management, Swedish University of Agricultural Sciences, Sweden, Skogsmarksgränd 17 90183 Umeå, Sweden

Corresponding/presenting Author: Antonia Hartmann, antonia.hartmann@slu.se

Northern peatlands are an important sink for carbon. Peatland carbon uptake and release are influenced by abiotic and biotic factors (eg. vegetation composition, plant phenology). Plant functional types (PFTs) exhibit differing phenological patterns and responses to environmental factors, leading to seasonal shifts in their respective contributions to peatland net ecosystem CO_2 exchange. Further, the presence of vascular plants may regulate methane (CH_4) emissions by introducing a plant-mediated transport pathway and increased substrate supply for CH_4 production. However, detailed knowledge on the separate responses of PFT-specific production and respiration of CO_2 and CH_4 to abiotic and biotic factors on daily to sub-seasonal scales are currently missing. In this study, we analysed high-resolution CO_2 and CH_4 flux data collected from an automated chamber system installed across experimental vegetation removal plots (separating vascular plants and *Sphagnum* mosses) over three growing seasons at the oligotrophic minerogenic mire Degerö Stormyr. Further, bi-weekly soil solution samples from multiple depths were analysed for organic acids and sugars in order to estimate seasonal variation of substrates supporting methane production. We found that *Sphagnum* mosses contributed 49-55% of the growing season ecosystem gross primary production (GPP), with temporal variation between the key phenophases (green-up: 51-60%, peak 40-44% and senescence 47-58%). Key drivers for seasonal variations in daily moss and vascular plant GPP were photosynthetically active radiation and plant phenology. However, the relative importance of the environmental controls varied among the key phenophases. Vascular plants contributed 78-87% of the growing season autotrophic respiration (RA) and 38-39% of ecosystem respiration. Regression analysis revealed a higher daytime temperature sensitivity of moss RA compared to vascular plants during peak season and senescence. We observed significantly higher CH_4 emissions with the presence of vascular plants and an increased sugar concentration in late summer, which suggest higher rates of plant-mediated CH4 transport and increased substrate supply for methanogenesis via root exudation during senescence. These findings call for a better understanding of how vascular plants and *Sphagnum* mosses contribute to regulating CO_2 and CH_4 fluxes under varying environmental conditions to improve predictions for future northern peatland carbon cycle-climate feedbacks.

Hydrology and Drainage Assessment in The Maludam Peninsula Peatland Landscape for SMPEM Project, Sarawak

Authors: Asang Hurai, Stephen Teo Ping

Affiliation: Forest Department Sarawak (Sustainable Management of Peatland Ecosystems in Malaysia), Level 15, East Wing, Bangunan Baitul Makmur II, Medan Raya, Petra Jaya 93050 Kuching, Malaysia

Corresponding/presenting Author: Asang Hurai, asangh@sarawak.gov.my

This study investigates the climate, river systems, and groundwater levels within the Maludam Peninsula Peatland Landscape in Sarawak, Malaysia, to provide a better understanding of the landscape's hydrology dynamics. Analysis indicates that the study area receives moderate annual rainfall, with historical data from 2000-2020 indicating a mean of 3,574 mm at Maludam Station and 3,020 mm at JPS Beladin Station. Despite moderate rainfall, the low-lying topography and proximity to rivers contribute to frequent flooding. The river system in the Maludam Peninsula is defined by the Batang Saribas and Batang Lupar river basins, which influence the region's hydrology. Sg Maludam, traversing the peat dome within Maludam National Park, plays a crucial role in groundwater recharge and peat soil moisture regulation. The interconnected river networks and the region's topography are vital in shaping the hydrological dynamics and sediment transport processes. The relatively flat terrain within the national park resulted in minor variations in groundwater levels, while significant differences were observed outside the park due to varying peat thicknesses and land use. The average groundwater level, estimated using the Sentinel-1 C-SAR and a contextualised regression model, was approximately -0.04 m, indicating a low fire risk in the area. Validation using the Root Mean Square Error (RMSE) demonstrated a good fit between estimated and observed groundwater levels, with an RMSE of 0.08 m, confirming the model's accuracy. Overall, this study underscores the importance of understanding the interactions between climate, hydrology, and groundwater levels in managing the Maludam Peninsula Peatland Landscape, particularly in the context of peatland sustainability and fire risk mitigation.

Climate protection in peatlands needs data – establishing peatland registers in Lower Saxony, Germany

Authors: Eva Rosinski, Bernd Hofer

Affiliation: Hofer & Pautz GbR, Buchenallee 18 48341 Altenberge, Germany

Corresponding/presenting Author: Eva Rosinski, rosinski@hofer-pautz.de

Lower Saxony's peatlands are part of the Atlantic peatland region, which exhibits the highest rate of peatland degradation in Europe, with 68% of its original areas lost. Around one third of Germany's peatland areas are located in Lower Saxony, making it the country's most peatland-rich federal state. Accordingly, Lower Saxony bears particular responsibility for preserving peat soils as important landscapes and habitats.

To meet this responsibility, regional and local climate protection strategies increasingly plan for the implementation of peatland restoration and conservation measures. Yet, the available cartographic information on peatlands is still largely based on surveys from the 1950s and 1960s and remains limited to large-scale mapping. Consequently, reliable, detailed data on the current distribution and condition of peatlands is lacking. To close these knowledge gaps and provide a sound basis for action, several peatland-rich counties and municipalities have launched initiatives to establish peatland registers. The Hofer & Pautz GbR has already successfully completed several such projects, while work is currently ongoing in other areas. Additional regions have also expressed interest, highlighting the high relevance of current data.

For the creation of such registers, existing soil data was consolidated, critically assessed, and – crucial for ensuring data quality – supplemented and validated through targeted field-based soil investigations. Beyond updating the distribution of peat soils, a central focus was placed on quantifying the climate protection potential: biotope types were used as indicators of greenhouse gas emissions, while carbon storage was derived from the collected stratigraphic data. Furthermore, the rewetting potential was assessed by analyzing physical site characteristics, such as the climatic water balance. Due to the lack of comprehensive hydrological data, hydrological conditions had to be inferred primarily from relief parameters. Additionally, spatial constraints such as land availability and parcel configuration were factored into the assessment. The outcome is a priority list that enables a targeted comparison of greenhouse gas reduction and rewetting potential with site-specific conditions and feasibility aspects. Thus, the peatland register becomes a key instrument for prioritizing climate protection measures and provides an essential foundation for political and administrative decision-making.

Reconciling climate change impacts on the northern peatland carbon cycle

Authors: Matthias Peichl, Koffi D. Noumonvi, Joss Ratcliffe, Sijia He, Antonia Hartmann, Gillian Simpson, Kyohsuke Hikino, Järvi Järveoja, Hjalmar Laudon, Mats Öquist, Mats B. Nilsson

Affiliation: Swedish University of Agricultural Sciences, Skogsmarksgränd 17 90183 Umeå, Sweden

Corresponding/presenting Author: Matthias Peichl, matthias.peichl@slu.se

Northern peatlands are a key component of the global carbon cycle and climate system through the ecosystem-atmosphere exchanges of carbon dioxide and methane. At the same time, climatic changes are expected to exert feedbacks on their biogeochemical cycles. At present, however, we lack the comprehensive empirical data necessary for thoroughly evaluating these peatland carbon cycle-climate feedbacks. A key limitation is that experimental studies explore carbon cycle responses primarily at the plot-scale (i.e., few m^2) and rarely span over more than one decade. Plot-scale experiments, however, cannot account for catchment-scale feedbacks of altered water and energy balances due to shifts in vegetation and related transpiration dynamics, while the lack of long-term (i.e., multi-decadal) experiments limits our understanding of the temporal trajectory of ecosystem responses to perturbations. The Kulbäcksliden Research Infrastructure (KRI) located in Northern Sweden includes replicated catchment-scale and multi-decadal plot-level experimental set-ups across four adjacent peatland field stations, thus providing a unique opportunity to reconcile climate change impacts on the carbon cycle of northern peatlands. I will present results on i) the initial effects of catchment-scale N addition on the peatland ecosystem-atmosphere exchanges of carbon dioxide and methane based on eddy-covariance measurements, and ii) the comparison of short-term (10 years) versus long-term (30 years) effects of key climate change factors (i.e. warming, increased N, and enhanced soil frost) on carbon fluxes, altogether highlighting the value of ecosystem-scale and long-term experiments for enhancing our understanding of peatland carbon cycle-climate interactions.

Comparative Analysis of N_2O Fluxes from Different Forest Types in Tropical Peat Swamp Forests in Sarawak, Malaysia

Authors: Muhammad Zarul Shazreen, Nur Azima Busman, Faustina E. Sangok and Lulie Melling

Affiliation: Sarawak Tropical Peat Research Institute, Lot 6035, Kuching-Kota Samarahan Expressway 94300 Kota Samarahan, Malaysia

Corresponding/presenting Author: Muhammad Zarul Shazreen, zaruls@sarawak.gov.my

Tropical peat swamp forest (PSF) has been converted to agricultural land, and this may affect its functions as a crucial sink for nitrous oxide (N_2O). An evaluation of the N_2O fluxes from PSF soils as reference datasets is therefore necessary to estimate the impact of land conversion on N_2O emissions. However, compared to soil carbon dioxide and methane fluxes, the data on the N_2O fluxes from PSF is limited, especially from different forest types within these ecosystems. This study investigates the temporal variations of soil N_2O fluxes from four different forest types in Maludam National Park, Sarawak: Mixed Peat Swamp (MPS), Alan Batu (ABt), Alan Bunga (ABg), and Padang Alan (PA). These forest types differ in dominant plant species, vegetation diversity, and forest structure. Monthly N_2O flux measurements were conducted from January 2021 to December 2023 using the closed chamber method, in parallel with the monitoring of environmental variables. The highest mean N_2O flux was recorded in the MPS forest (3.92 μg N m^2 h^{-1}), followed by ABt (-0.53 μg N m^2 h^{-1}), ABg (-0.63 μg N m^2 h^{-1}), and PA (-2.47 μg N m^2 h^{-1}) forests. The higher N_2O flux in MPS can be attributed to prolonged fluctuations in groundwater level (GWL) below the soil surface, which can promote nitrification. Previous studies showed that MPS soils contain higher ammonium content compared to other forest soils, which may serve as an available substrate for nitrification. MPS forest also exhibited greater temporal variation in N_2O flux with the annual flux in 2022 (66 g N m^2 yr^{-1}) being higher than in 2021 (23 g N m^2 yr^{-1}) and 2023 (11 g N m^2 yr^{-1}). This increase in 2022 may be associated with prolonged low GWL from February to October 2022 in MPS forest. Although other forest sites experienced similar decreases in GWL, soil N_2O fluxes were not substantially affected, indicating differences in their responses to environmental changes. Environmental variables such as GWL, soiland air temperatures showed weak correlations with soil N_2O fluxes, suggesting that other factors, such as soil physicochemical properties, may also significantly influence flux variation. Further investigations will assess the impact of soil physicochemical properties on N_2O fluxes. In conclusion, this study highlights the variability of N_2O fluxes across different forest types and provides important reference data for N_2O fluxes inventory of tropical peatlands.

Development and carbon accumulation dynamics of a minerotrophic fen during the last millennium, northeast China

Authors: Shengzhong Wang, Yanmin Dong; Hongkai Li; Zhiwei Xu; Lu Yu; Yuhan Yang

Affiliation: Key Laboratory of Geographical Process and Ecological Security in Changbai Mountains, Ministry of Education, School of Geographical Sciences, Northeast Normal University, No. 5268, Renmin Street, Nan'guan District, Changchun 130024 Changchun, China

Corresponding/presenting Author: Shengzhong Wang, szwang@nenu.edu.cn

Peatlands are terrestrial ecosystems with high carbon sequestration efficiency, providing critical feedback on climate change. It is crucial to understand how peatland development and carbon accumulation respond to various factors to reveal the future direction of these carbon reservoirs under changing climatic conditions. To assess the impact of climate and hydrological conditions on the development and carbon accumulation of peatlands, 15 peat core samples were analyzed to examine the processes of lateral expansion in the Dongfanghong (DFH) peatland, a minerotrophic fen located in the Changbai Mountains of northeast China. Accelerator Mass Spectrometry ^{14}C, total organic carbon, dry bulk density, testate amoebae, $\delta^{13}C$ of α-cellulose in *Carex spp*. and plant macrofossil analyses were conducted on a high-resolution peat core. The proxies were used to calculate carbon accumulation rate (CAR) and reconstruct water table depth as well as surface moisture and vegetation development of the DFH peatland. Our findings indicated that the DFH peatland was initiated at 1011 cal. CE and experienced paludification during the last millennium. The expansion of the DFH peatland was primarily determined by hydrological conditions rather than climatic factors such as total solar irradiance and regional temperature. The rapid expansion between 1500 and 1700 cal. CE was likely resulted from relatively low precipitation and a decrease in water table/surface moisture. CAR generally correlated with total solar irradiance, regional temperature, and precipitation, suggesting that climate may be crucial for CAR in DFH peatlands over multi-centennial timescales. However, the increased CAR under relatively dry conditions suggested that the CARwere regulated by hydrological conditions over a centennial timescale. This study highlighted the important roles of climate and hydrological conditions in the lateral expansion and CAR of the minerotrophic fen and that there may be a threshold for hydrology during the process of peatland development and carbon accumulation.

Peat: Latvia's brown marble as a medium for art and design

Authors: Ilze Ozola

Affiliation: Dr.geol., Jelgavas str.1 LV-1004 Riga, Latvia

Corresponding/presenting Author: Ilze Ozola, ilze.ozola@epicentrs.lv

Peat, known for its ecological role as a carbon sink, is also a unique and valuable material for artistic expression. This abstract explores how Latvian peat can be considered Latvia's version of brown marble, emphasizing its aesthetic and cultural in contemporary art. There are many reasons to choose peat as an art medium, several of them:

- symbolism and story - peat, formed over thousands of years from decayed plant material, evokes themes of renewal, regeneration, and the life cycle.
- historical layers - peat carries a layered narrative from ancient ecosystems, adding depth to sculptures and evoking a sense of time, continuity, and the connection of past and present.
- texture and color - peat's earthy texture and rich earth tones including deep browns and blacks offer a distinctive aesthetic, perfect for sculptural expression that connects the artwork to the land.
- ease of shaping: compared to harder materials like stone or even wood, peat is softer and integration with other materials: peat can be easily integrated with wood or stone.

Presentation will also describe several projects in Latvia have highlighted peat's creative potential:

- "Vārdene" peat sculpture exhibition (2024) - this exhibition features 12 sculptures made from peat, created by Ginta Kristjansone, each representing ancient Latvian words. The installation connects these forgotten words with peat, symbolizing what is buried yet valuable, much like the words themselves.
- Peat Amphitheater Solstice (2021) - created by Jānis Gutāns-Grasis the first peat amphitheater in Latvia, designed as a nature concert hall within a Kaigu Bog peat extraction site (SIA "Laflora"), hosts concerts and performances utilizing the bog's natural acoustics.
- International Peat Sculpture Festival in Latvia (2019) brought together international artists to create large-scale peat sculptures, showcasing peat as an artistic medium.
- "Earth Sounds" (2014) - created by E. Ameriks, D.Lavrentjevs, and N.Šaumanis, this installation blends sculpture and primitive percussion instruments from around the world. The 12 instruments, used as pedestals for 12 peat sculptures, symbolize the cyclical nature of life, connecting sound, rhythm, and nature.

These projects demonstrate peat's versatility and importance, offering a meaningful way to raise awareness about value of both peatland and peat as valuable resources while showcasing its potential in modern art.

Bogshoeing in peatlands: opportunities and challenges for sustainable public engagement

Authors: Ilze Ozola

Affiliation: Dr.geol., Jelgava str.1 LV-1004 Riga, Latvia

Corresponding/presenting Author: Ilze Ozola, ilze.ozola@epicentrs.lv

Bogshoeing, a form of walking on wet peatland surfaces using snowshoes. It enables people to explore peatlands in a fun and attractive way. When done appropriately, it raises awareness and supports nature tourism. However, without proper management, it can harm sensitive habitats. This presentation shares Latvia's experience and practical insights on how to balance public access with peatland protection.

Bogshoeing has grown in popularity across Europe as a form of eco-tourism and public engagement. In Latvia and other peatland-rich countries, bogshoeing offers a unique opportunity to connect the public with these ecosystems - fostering awareness of their biodiversity, carbon storage capacity, cultural significance, and their role as a valuable natural resource, particularly as a source of peat. Especially in regions where peatlands are abundant but often misunderstood or even feared, such experiences help demystify these seemingly strange or unwelcoming landscapes. By engaging directly with bogs, people can overcome misconceptions, develop a sense of curiosity and respect, and come to recognize peatlands as something uniquely valuable - something to be understood, appreciated, and proudly protected as part of their national heritage.

This presentation explores both the benefits and limitations of bogshoeing as a tool for peatland outreach and recreation. On the positive side, bogshoeing raises public interest, supports local tourism economies, and encourages nature-based education without the need for invasive infrastructure.

However, there are also challenges. Unregulated or frequent use of the same routes may lead to vegetation damage, disturbance of wildlife habitats, and potential trampling of delicate moss layers. The activity must therefore be carefully managed, with attention to carrying capacity, route planning, guide training, and seasonal restrictions.

The presentation will share examples from Latvia's bogshoeing practices, including school tours, public hikes, and pilot tourism routes, while proposing practical guidelines for how to balance access with protection.

As peatlands become increasingly recognized for their climate and ecological importance, bogshoeing can play a valuable role in their public narrative - if implemented with care.

Best practices in peat and peatland education for the general public

Authors: Ilze Ozola (1,2), Laimdota Kalniņa (2,3), Iluta Dauškane (2,3), Normunds Stivriņš (1,2,3)

Affiliation: 1 - Latvian National Peatland Society, Lake and Peatland Research Center, 2 - Lake and Peatland Research Center, 3 - University of Latvia, 1 and 3 - Jelgava str.1, Riga, Latvia 2 - Puikule, Limbazu distr., Latvia 1 and 3 LV-1004. 2 LV-4063 Riga, Latvia

Corresponding/presenting Author: Ilze Ozola (1,2), ilze.ozola@epicentrs.lv

In Latvia, public awareness of peatlands, their distribution, and management remains limited. While some people know about bogs with nature trails, many are unaware of distribution of peatlands and peat extraction sites. A recent survey revealed that understanding peat extraction leads to more positive attitudes toward it. Additionally, knowledge about peatland environments reduces fear and increases comfort when visiting them.

Education plays a crucial role in changing perceptions. Direct engagement with peatlands through guided tours is one of the most effective ways to educate the public. Education plays a crucial role in changing perceptions. While it is easier to move in peat extraction sites, not all peat producers are willing to allow the general public to enter due to concerns about safety, fire risks, fears of negative attitudes, and limited time resources, especially during the busy spring and summer months when peat extraction is most active. Nonetheless, experiencing these environments firsthand helps people understand their significance.

Visual aids and simple educational materials can further enhance understanding. Projects like "Peat in a Jar" effectively demonstrate peat formation and its importance. Inspired by Irish practices, this project allows participants to create small peat bogs in jars, highlighting the environmental and economic value of peat.

For children, activities like plant identification or treasure hunts focused on bog plants are engaging and foster a sense of connection to nature. For children and adults, incorporating tools like microscopes, corers and showing peat extraction machinery can enrich the educational experience.

Lastly, encouraging public feedback and discussion helps ensure decisions about peatland management are informed. Engaging the public in conversations about peat's ecological, economic, and cultural significance is essential for sustainable management.

In conclusion, hands-on experiences, simple materials, and public engagement are key to fostering understanding and support the responsible use of peat and peatlands.

Influence of Land Use Conversion on Degree of Humification and CO_2 Flux in Tropical Peat Soils in Sarawak

Authors: Amelia Jackob, Akira Watanabe, Rosazlin Abdullah, Nur Azima Busman, Faustina Sangok, Lulie Melling

Affiliation: Institute of Biological Sciences, Faculty of Science, University Malaya, 50603 Kuala Lumpur, Wilayah Persekutuan Kuala Lumpur and Sarawak Tropical Peat Research Institute, 94300 Kota Samarahan, Sarawak, Malaysia, 94300 Kota Samarahan, Sarawak, Malaysia 94300 Kota Samarahan. Sarawak, Malaysia

Corresponding/presenting Author: Amelia Jackob, amelia.j@sarawak.gov.my

Tropical peatlands are major carbon (C) reservoirs, playing a key role in climate change mitigation. However, increasing agricultural expansion into peatlands has affected peat properties and soil organic carbon (SOC) dynamics. This study aimed to evaluate the effect of land use change on the degree of humification and biodegradability of SOC. Soil samples (0–25, 25–50, 50–75, and 75–100 cm) collected from a drained secondary peat swamp forest (SF) and oil palm plantation (OPP) were used. The degree of humification of SOC was assessed using pyrophosphate solubility index (PSI) and humic acids (HAs) content, which was expressed as the percentage of total C present as HAs (% HA). Soil samples were incubated under aerobic and anaerobic conditions for 28 days and the rate of carbon dioxide (CO_2) production was determined at an interval of 1–7 days. The PSI and % HAs of the 0–25 cm depth soils were significantly higher in OPP compared to SF, suggesting that the more aerobic conditions in the OPP resulting in the higher degree of humification. However, PSI and % HA of the 25–100 cm depth soils were lower in OPP than in SF. This could be due to the impacts of historical logging activities in SF prior to 1990s, which may have disturbed and degraded the deeper peat layers, reducing their capacity for humic substance accumulation and preservation. This effect was not observed in the top layer of forest soils, possibly due to periodical litter supply in forest may keep SOM with a low degree of humification in the surface soil. The rate of CO_2 production under aerobic conditions was higher than that under anaerobic conditions at all depths. Despite the difference in the degree of humification, aerobic CO_2 production rates potential did not differ significantly between two kinds of the surface soils. In contrast, the rate of CO_2 production in 25–75 cm depth layer soils under aerobic conditions was significantly higher in OPP soil than in SF soil, corresponding to the lower degree of humification in OPP soil. These findings suggest that land use change altered the degree of humification of peat SOC and its relationship with biodegradability.Long-term monitoring and field study is important to assess the impact of land conversion in tropical peatland on degree of humification and soil CO_2 emissions.

Effects of Successive Oil Palm Cultivation on Chemical Properties of Tropical Peat Soil and its Influence on Plant Growth and Nutrient Concentration

Authors: Jicqueline Ratai, Christopher Teh Boon Sung, Tan Ngai Paing, Hasmah Mohidin, Nur Azima Busman, Faustina Elfrida Sangok and Lulie Melling

Affiliation: Sarawak Tropical Peat Research Institute, Lot 6035, Kota Samarahan Expressway 94300 Kota Samarahan, Sarawak, Malaysia

Corresponding/presenting Author: Jicqueline Ratai, jicqueline@sarawak.gov.my

The successive cultivation of oil palms is a common agricultural practice that is carried out when the trees have reached the end of their productive life and can no longer produce an economically viable yield. While previous research has largely focused on binary comparisons between intact forests and agricultural land, the cyclical nature of oil palm cultivation and its dynamic effects on tropical peatlands have not yet been explored. In this study, the effects of successive oil palm cultivation on the chemical properties of tropical peat soil across three land-use stages are investigated: peat swamp forest, first-generation oil palm (1st Gen) and second-generation oil palm (2nd Gen). Peat soil samples (0–50 cm depth) were taken from the selected sites using a peat auger. The functional groups of the soil organic matter (SOM) were analysed using ATR-FTIR spectroscopy (Attenuated Total Reflectance – Fourier Transform Infrared). In addition, the pyrophosphate solubility index (PSI), the carbon-nitrogen ratio (C/N) and the cation exchange capacity (CEC), important indicators of the peat humification were evaluated. To further investigate the effects of soil chemical changes on plant development, a polybag experiment was conducted using the collected soil as a planting medium to assess the growth and nutrient concentration of the oil palm seedlings. The ATR-FTIR spectra showed a lower polysaccharide content and higher aromatic, phenolic and carboxylic functional groups in 2nd Gen soils. A similar trend was observed for PSI, C/N ratio and CEC, indicating a higher degree of decomposition in 2nd Gen soil. In the polybag experiment, PSI showed a significant positive correlation ($p < 0.05$) with root dry weight of oil palm seedlings, suggesting that increased humification promotes a more extensive and branched root system. Overall, this study shows that long-term cultivation of oil palm leads to significant changes in SOM composition, potentially affecting plant growth and nutrient dynamics. These results emphasize the need for field-scale studies to better understand the broader ecological impacts of successional oil palm cultivation on tropical peatlands and provide valuable insights for sustainable management strategies.

Is there a future for grassland on peat soils in the Netherlands?

Authors: Jos Schouwenaars, J.J.H. van den Akker1, R.F.A. Hendriks1, I.E. Hoving1 and T.H.G. Wils1,2

Affiliation: 1 Wageningen Research; 2 Delft University of Technology, The Netherlands, - PO Box 9101 6700 HB Wageningen, The Netherlands

Corresponding/presenting Author: Jos Schouwenaars, josschouwenaars@kpnmail.nl

The Dutch peat meadow area covers about 185,000 ha. Ditch water levels were lowered up to 60 cm below soil surface in the western peat meadow areas and up to 120 cm below surface in Friesland. Peat oxidation of the 220,000 ha peatlands in agricultural use causes an emission of 4.2 Mt CO_2 $^{y-1}$. The Dutch Climate Agreement requires a reduction of this annual CO_2-emission with 1 Mt CO_2-eq $^{y-1}$ in 2030. To reduce CO_2-emissions, groundwater levels in summer must be raised by land-use change to wetlands or paludiculture or maintaining grasslands with high groundwater levels by irrigation or infiltration via submerged drains. Will the peat meadows survive as grassland?

Impact of Land-Use Change on Soil CO_2 Emission in Tropical Peat Swamp Forests

Authors: Nur Azima Busman, Faustina E. Sangok, Akira Watanabe, Lulie Melling

Affiliation: Sarawak Tropical Peat Research Institute, Lot 6035, Kuching-Kota Samarahan Expressway, Kota Samarahan, Sarawak

Malaysia 94300 Kota Samarahan, Malaysia

Corresponding/presenting Author: Nur Azima Busman, nurazima.b@sarawak.gov.my

Conversion of peat swamp forests (PSF) to oil palm plantations (OPP) significantly affects soil carbon dioxide (CO_2) flux, but the extent of this impact remains uncertain, especially across different conversion stages. Oil palm trees typically have a commercial life span of 25 years (1st cycle), after which they are replanted for a 2nd cycle. As soil experiences prolonged aerobic conditions during the 1st cycle, soil organic matter remained may be more resistant to decomposition, possibly resulting in lower CO_2 flux during the 2nd cycle. To evaluate the long-term impact of land use change on soil CO_2 flux, continuous soil CO_2 flux measurements were conducted at two sites: (1) PSF converted to the 1st cycle of OPP, covering three phases – PSF (Jan 2016–Feb 2017), land preparation (Mar 2017–Apr 2018), and OPP (May 2018–Apr 2023), and (2) OPP transitioned from the 1st cycle (Jan 2011–Oct 2018) to 2nd cycle (Sep 2024–Feb 2025). Soil CO_2 flux was measured monthly using the manual chamber method, and environmental properties were also recorded. At the first site, groundwater level (GWL) decreased from −15 cm (PSF) to −80 cm during land preparation due to drainage. GWL dropped further to −113 cm in the 1st year after OP planting, and then gradually increased to −52 cm by the 5th year. Soil temperatures increased from 26.7°C (PSF) to 29.2°C (2nd year OPP), then decreased to 28.2°C (5th year OPP) as the OP canopy developed. The average soil CO_2 flux in PSF was 175 mg C m^{-2} h^{-1}, which did not differ significantly from that during land preparation (235 mg C m^{-2} h^{-1}). The average soil CO_2 flux during the first three years after OP planting ranged from 302 to 320 mg C m^{-2} h^{-1}, significantly higher than that in PSF, but decreased to 238 and 227 mg C m^{-2} h^{-1} in the 4th and 5th years, possibly due to the consumption of labile C. At the second site, soil CO_2 flux during the 2nd cycle of OPP ranged from 111–206 mg C m^{-2} h^{-1} with an average of 170 mg C m^{-2} h^{-1}. Comparatively, flux during the 1st cycle, varied from 41–284 mg C m^{-2} h^{-1} with an average of 114 mg C m^{-2} h^{-1}, suggesting minimal impact of replanting on soil CO_2 flux. Fluxes are expected to decrease further as the oil palms mature in the 2nd cycle. In conclusion, our results show that the impact of conversion to OPP is more pronounced during the first three years after OP planting but diminishes over time. Ongoing monitoring in the 2nd cycle is crucial to assess the long-term impact of replanting on soil CO_2 flux.

Temporal Dynamics of N_2O Emissions from Agriculturally Managed Peat Soils: The Impact of Nitrogen Fertilization and Rainfall Timing

Authors: Sebastian Kuśmierz, Örjan Berglund, Katarzyna Kuśmierz

Affiliation: Department of Soil and Environment, Swedish University of Agricultural Sciences, Lennart Hjelms väg 9 756 51 Uppsala, Sweden

Corresponding/presenting Author: Sebastian Kuśmierz, sebastian.kusmierz@slu.se

Peat soils play a crucial role in global ecosystem functioning due to their significant carbon sequestration potential. However, drainage and subsequent agricultural management accelerate organic matter decomposition, leading to increased greenhouse gas emissions. While numerous agro-climatic measures have been investigated to mitigate carbon dioxide (CO_2) emissions, only a few have demonstrated long-term effectiveness. In regions where peatland rewetting is not feasible, agricultural practices that enhance primary production and crop residue incorporation are recommended. However, these practices often necessitate nitrogen (N) supplementation despite the inherent nutrient richness of histosols, potentially creating temporary N surpluses that drive nitrous oxide (N_2O) emissions. Given that N_2O is 273 times more potent than CO_2 as a greenhouse gas for a 100-year timescale, effective emission reduction strategies are critical. We hypothesized that timing N fertilization in relation to precipitation events could significantly reduce N_2O fluxes. To test this, we conducted a controlled mesocosm experiment where fertilization followed standard protocols, and precipitation was simulated at intervals of 0, 1, 2, 5, 7, and 14 days post-fertilization, with an additional no-rainfall control. N_2O concentrations were measured daily using a closed-chamber technique coupled with an Innova 1312 photoacoustic gas analyzer, and fluxes were calculated by integrating the area under the concentration-time curve after baseline correction. Results demonstrated a significant relationship between fertilization-precipitation timing and N_2O emissions. The highest emissions occurred when precipitation followed shortly after fertilization, while emissions declined progressively with increasing time intervals between fertilization and rainfall. This suggests that allowing sufficient time for biomass uptake of N prior to precipitation reduces the risk the rainfall-derived local anaerobic conditions risks associated with the denitrification, the primary driver of N_2O emissions. Our findings confirm the initial hypothesis and indicate that optimizing the temporal intervals between fertilization and rainfall presents a simple yet effective strategy to mitigate N_2O emissions from fertilized peat soils.

PALUDICULTURE – OPPORTUNITIES AND CHALLENGES FOR STRATEGIC MANAGEMENT DECISIONS

Authors: Carla Muche, Claudia Heindorf, Dina Hamidi

Affiliation: German, Roslinsväg 6 21755 Malmö, Sweden

Corresponding/presenting Author: Carla Muche, camu0004@stud.slu.se

Paludiculture integrates climate mitigation with agricultural production.

Peatlands are highly efficient carbon sinks, storing vast amounts of carbon despite covering only 3 % of the global land surface. In Germany, about 95 % of peatlands have been drained, contributing to roughly 7% of the nation's greenhouse gas emissions. Around 72 % of these areas are used for agriculture, highlighting the urgent need for sustainable land use and peatland restoration.

Paludiculture with peat moss (*Sphagnum* sp.) and sundew (*Drosera* sp.) offers a promising cultivation method on rewetted peatlands, combining climate protection with economic potential. While *Sphagnum* serves as a renewable peat substitute, *Drosera* has pharmaceutical applications.

This thesis aims to address a research gap by analyzing the Nature's Contributions to People (NCP) provided by these species. The NCP concept expands the idea of ecosystem services by including regulating, material, and non-material contributions. A literature review, complemented by interviews with experts, practitioners, and farmers, forms the basis for a SWOT analysis of *Sphagnum* and *Drosera* paludiculture.

Strengths include spontaneous spread, traditional uses, and biodiversity benefits. Weaknesses involve limited profitability, water availability, and negative perceptions. Opportunities lie in pharmaceutical production and species protection, while threats include knowledge gaps and low acceptance among farmers.

For effective climate action, future efforts must focus on water management and legal frameworks to support viable production. A socially sustainable approach must also consider individual perceptions and cultural values. As current literature lacks insights into non-material benefits, future research should explore how people relate to these species and their cultivation systems.

Grassland Conversion on Temperate Peat and Organic-Rich Soils: A Systematic Review of Greenhouse Gas Emissions and Implications for Climate and Land-Use Policy

Authors: Örjan Berglund, Alena Holzknecht, Magnus Land, Jacynthe Dessureault-Rompré, Lars Elsgaard, and Kristiina Lång

Affiliation: SLU, Box 7014 75007 Uppsala, Sweden

Corresponding/presenting Author: Örjan Berglund, orjan.berglund@slu.se

Peatlands play a central role in the climate–land use–society nexus, providing essential ecosystem services while contributing significantly to greenhouse gas (GHG) emissions when drained for agriculture. Conversion of cropland to grassland on organic soils is often proposed as a mitigation measure, yet the scientific evidence supporting its effectiveness remains limited. To evaluate this strategy's potential benefits and limitations, we conducted a systematic review of peer-reviewed field studies examining GHG emissions—specifically CO_2, CH_4, and N_2O—from peat and organic-rich soils in temperate and boreal climates.

Out of more than 10,000 screened records, 37 studies were included that met strict criteria for comparability in terms of soil type, drainage, and climate. The synthesis revealed no consistent CO_2 or CH_4 emissions reduction following grassland establishment. A mean decrease in N_2O emissions of 7.55 kg N_2O ha^{-1} yr^{-1} was observed in grasslands compared to croplands. However, this effect varied with management, particularly crop type and fertilisation. When root crops were excluded, the N_2O difference was substantially smaller, suggesting that emission reductions are not uniform across systems.

Moreover, fertilised grasslands often showed increased net ecosystem exchange (NEE) and net ecosystem carbon balance (NECB), potentially counteracting benefits from lower N_2O emissions. These findings challenge current IPCC emission factors, which assume that grasslands on organic soils consistently emit less than croplands.

The policy implications are significant. While grassland conversion may offer targeted benefits under certain conditions, it cannot be considered a universally effective mitigation strategy. Updated emission factors and land-use guidance must reflect management intensity and site-specific conditions.

This review calls for more adaptive, evidence-based approaches that integrate environmental, economic, and climate objectives in the broader context of peatlands and society. Long-term field trials with detailed soil and hydrological data are essential to refine emission estimates and support smarter policy decisions. As nations seek to meet their climate targets, effective peatland management will ensure that environmental actions align with societal needs.

Mercury deposition and redox transformation processes in peatland constrained by mercury stable isotopes

Authors: Chuxian Li, Martin Jiskra, Mats B. Nilsson, Stefan Osterwalder, Wei Zhu, Dmitri Mauquoy, Ulf Skyllberg, Maxime Enrico, Haijun Peng, Yu Song, Erik Björn & Kevin Bishop

Affiliation: Swedish University of Agricultural Sciences, Lennart Hjelms väg 9 SE-750 07 Uppsala, Sweden

Corresponding/presenting Author: Chuxian Li, chuxian.li@slu.se

Peatland vegetation takes up mercury (Hg) from the atmosphere, typically contributing to net production and export of neurotoxic methyl-Hg to downstream ecosystems. Chemical reduction processes can slow down methyl-Hg production by releasing Hg from peat back to the atmosphere. The extent of these processes remains, however, unclear. Here we present results from a comprehensive study covering concentrations and isotopic signatures of Hg in an open boreal peatland system to identify post-depositional Hg redox transformation processes. Isotope mass balances suggest photoreduction of HgII is the predominant process by which 30% of annually deposited Hg is emitted back to the atmosphere. Isotopic analyses indicate that above the water table, dark abiotic oxidation decreases peat soil gaseous Hg0 concentrations. Below the water table, supersaturation of gaseous Hg is likely created more by direct photoreduction of rainfall rather than by reduction and release of Hg from the peat soil. Identification and quantification of these light-driven and dark redox processes advance our understanding of the fate of Hg in peatlands, including the potential for mobilization and methylation of HgII.

Peatland ditching and export of dissolved organic carbon to downstream surface waters

Authors: Emma Kritzberg, Antonis Myridakis, Dimitrious Floudas, Håkan Wallander, Johanna Gaber, Alice Gredeby

Affiliation: Lund University, Sölvegatan 37 223 62 Lund Lund, Sweden

Corresponding/presenting Author: Emma Kritzberg, emma.kritzberg@biol.lu.se

Browning - that freshwaters are becoming increasingly brown - is widely observed in northern regions., It is caused by increased leaking of dissolved organic carbon (DOC) and iron (Fe) from the catchment. Peatlands and coniferous forests are important source areas for this loading of DOC and iron. Recent research demonstrates the important role of land-use as an underlying driver of browning. This can be due to the buildup of organic soil layers under coniferous forests, which sustain high DOC and Fe export, but it may also be linked to the parallel practice of ditching peat soils to promote forestry. The current project aims to determine the importance of peatland ditching, and subsequent afforestation, as a driver of browning, by enhancing material export of DOC. The project makes use of historical information on land-cover change (aerial photographs) and, field measurements in peatland gradients with different influence of ditching and afforestation. It will make a significant contribution by understanding the controls of lateral export of organic carbon from peatlands, which typically offset 20-50 % of the net atmospheric uptake.

Low molecular weight organic acids mobilize soil organic phosphorus for enzymatic hydrolysis in a temperate montane peatland

Authors: Meng Wang

Affiliation: Northeast Normal University, 5264 Renmin Street 130024 Changchun, China

Corresponding/presenting Author: Meng Wang, wangm581@nenu.edu.cn

The stability of carbon (C) stocks in peatlands is intricately linked to phosphorus (P) bioavailability. Given that organic P compounds (P_o) can make up to 89% of total soil P in these ecosystems, it is vital to understand their role in regulating plant productivity and organic matter decomposition. Despite this significance, the mechanisms controlling P bioavailability remain poorly understood. Plants and soil microorganisms primarily regulate the release of soil P via low-molecular-weight organic acids (LMWOAs) and modulate the hydrolysis of P_o through phosphatase enzymes, particularly phosphomonoesterase, phytase, and phosphodiesterase. This study investigated the role of LMWOAs, derived from root exudates of dominant vascular plants and *Sphagnum* leachates in a temperate montane peatland, in facilitating the release of P. We also quantified the ability of these plants to hydrolyze P_o from various LMWOA-extracted fractions by adding phosphomonoesterase, phytase, and phosphodiesterase. The results show that peatland plants predominantly exuded muconic, azelaic, 3-hydroxybutyric, and malonic acids. The concentration of enzymatically hydrolyzed P_o in the water-extracted fraction was 8.1 ± 3.4 mg kg^{-1}. Notably, azelaic and malonic acids were effective in releasing over 58% of soil P (330-798 mg kg^{-1}), with more than 88% of this P being in organic form. In the azelaic and malonic acid-extracted fractions, the concentration of enzymatically hydrolyzed P_o concentration was 123.7 ± 32.1 mg kg^{-1}, accounting for 23% of the LMWOA-extracted P_o. Phytase, the most important phosphatase enzyme, accounts for 66% (47–88%) of the enzymatically hydrolyzed P_o (81.9 ± 20.9 mg kg^{-1}). Our study demonstrates that LMWOA-mediated release of P_o is an essential prerequisite for enzymatic hydrolysis of P_o in organic peat soils. However, only a small portion of LMWOA-extracted P_o can be hydrolyzed by phosphatase enzymes. The different composition and efficacy of LMWOAs from species of different plant functional types highlight the necessity to consider changes in vegetation composition, as this could significantly impact P dynamics in peatlands and, consequently, the stability of their C stocks.

Assessing the hydrological impact of clear felling of commercial forestry on a blanket bog site in Ireland

Authors: Muhammad Jehanzaib, Raymond Flynn, Vicky Preece, Hannah Lehnhart-Barnett , Devin F. Smith , Oisín Leonard, Tiernan Henry, W. Berry Lyons, Anne E. Carey, Peter Croot

Affiliation: School of the Natural and Built Environment, Queen's University Belfast, Belfast BT9 5AG, United Kingdom Earth & Ocean Sciences, School of Natural Sciences, University of Galway, Galway H91 TK33, Ireland School of Earth Sciences, The Ohio State Univ, University Rd BT7 1NN Belfast, United Kingdom

Corresponding/presenting Author: Muhammad Jehanzaib, m.jehanzaib@qub.ac.uk

Commercial forestry plantation on blanket bogs can disrupt natural hydrological processes. Although clear-felling reduces interception, and partially restores water table levels, the persistence of systematic artificial drainage, installed to facilitate tree growth, is suspected to alter runoff regimes. A twelve-month investigation aimed to assess the legacy of forestry-associated drainage on the hydrological regime of a blanket bog in the west of Ireland. A flume installed upstream of the forest monitored flow from a relatively intact 193ha blanket peat-covered catchment, lacking systematic artificial drainage; measurements at a second, downstream flume incorporated supplemental discharge from an additional 21ha of the clear-felled site. TOPMODEL simulations from the upstream monitoring point, incorporating topography, provided a suite of calibration parameters to simulate runoff from the relatively intact peatland. However, application of these parameters to the downstream catchment, when compared with observed data, indicated that forestry-associated drainage increased streamflow by up to 106%. The highest monthly streamflow increase was observed in February (275 %), while the lowest was recorded in September (16 %), in comparison to intact blanket bog. Seasonal analysis further highlighted the impact of the legacy of forestry-associated drainage on streamflow, with the highest increase observed in winter (237 %) and the lowest in summer (24 %). It was also observed that flood peaks during the winter period and in response to discrete heavy rainfall events throughout the year were significantly higher in the formerly afforested sub-catchment. Reduced interception losses and lower permeability peat are suspected contribute to elevated runoff, relative to undisturbed conditions. These findings provide potentially useful insights for water managers, regulators, and policymakers, supporting informed decision-making and effective management strategies for peatland forestry and water resource planning.

Fungal-Mediated Brownification: Investigating DOC and Iron Export from Drained Peatlands

Authors: Alice Gredeby, Dimitrios Floudas, Håkan Wallander, Antonios Myridakis, Emma Kritzberg

Affiliation: Lund University, Kontaktvägen 10 223 62 Lund, Sweden

Corresponding/presenting Author: Alice Gredeby, alice.gredeby@biol.lu.se

Peatland drainage and climate change are altering hydrological and ecological conditions, potentially intensifying brownification— the increasing influx of terrestrially derived dissolved organic carbon (DOC) and iron (Fe) into surface waters. While extensive research has explored how declining water tables accelerate peat decomposition and greenhouse gas emissions, the effects on lateral DOC and Fe export to surface waters remain less understood. Emerging evidence suggests that the encroachment of trees and ericaceous shrubs in drained peatlands could enhance brownification by altering soil microbial communities and decomposition dynamics. Fungi associated with these vegetation changes could play a key role, as their decomposition activities may mobilize DOC and Fe from peat into aquatic systems. Different fungal functional groups likely contribute to brownification in distinct ways, depending on their ecological roles. Ericoid and ectomycorrhizal fungi selectively extract nutrients from organic matter to support their host plants, whereas saprotrophic fungi decompose a wider range of organic material to meet their nutrient demands. To investigate the influence of different fungal functional groups on DOC and Fe dynamics, we employ a combination of ecological field studies, mesocosm experiments, and pure culture phenotyping. This study aims to elucidate the role of fungal-driven DOC and Fe export from peatlands and its broader implications for aquatic ecosystems.

Environmental impact of horticultural peat – not just black and white

Authors: Alexander Sentinella

Affiliation: Growing Media Europe, Rue Belliard 40 1040 Brussels, Belgium

Corresponding/presenting Author: Alexander Sentinella, alex.sentinella@growing-media.eu

Horticultural peat has become emblematic of environmental concerns in growing media, often reduced to a binary debate between “peat” and “peat-free.” While well-intentioned, this framing risks oversimplifying the true environmental trade-offs and overlooking the broader production system in which peat is used. We draw on recent developments in growing media life cycle assessment (LCA) calculation, including the Growing Media Environmental Footprints Guideline (GMEFG), to evaluate the footprint of horticultural peat in a more holistic and evidence-based manner.

Peat-based growing media are frequently associated with high carbon emissions, particularly at the point of extraction and end-of-life. However, when assessed across the full life cycle—including downstream effects on plant growth, input use efficiency, and end-of-life dynamics—alternative materials do not always offer clear environmental advantages. For instance, some peat-free substrates may require increased fertiliser or irrigation inputs, potentially offsetting reductions in raw material emissions. Others may affect crop yields or growing system compatibility, introducing indirect impacts that are not captured in constituent-level comparisons. Furthermore, emerging data on partial carbon retention in soils post-use calls into question assumptions of complete peat oxidation, suggesting current footprint models may overestimate actual emissions in some contexts.

We argue that sustainability decisions should not be based solely on material origin but rather on functionally equivalent comparisons within real-world application settings. This requires moving beyond volume-based assessments toward system-level LCA approaches that account for plant productivity, resource use, and local environmental conditions. In doing so, more nuanced and context-specific strategies can be developed for reducing horticultural impacts while supporting evidence-based peatland conservation. Acknowledging the complexity of peat’s environmental profile is essential for advancing both sustainable horticulture and responsible peatland management.

Peat Extraction Sector Strategy: Upscaling peatland restoration through nature-based solutions in the landscape

Authors: Alhassan Ibrahim, Anna-Helena Purre; Kirsty Blackstock

Affiliation: James Hutton Institute, Craigiebuckler AB15 8QH Aberdeen, Scotland

Corresponding/presenting Author: Alhassan Ibrahim, alhassan.ibrahim@hutton.ac.uk

While Europe's Peat Extraction Sector operates on a small fraction of peatlands, it has played a role in peatland management for decades, leading after-use practices such as rewetting and site rehabilitation. This expertise presents an opportunity for the sector to contribute to landscape-scale peatland restoration. However, constitutional rights, funding constraints, and complex landscapes limit efforts to prioritize restoration on peat extraction sites and support broader peatland recovery.

This presentation introduces the Horizon 2020 MERLIN project's Peat Extraction Sector Strategy, designed to address these challenges and leverage opportunities for a transformative shift in the sector's role. The strategy underscores the need to scale up and embed rewetting, which is a common industry practice in many areas, and appropriate revegetation within wider peatland management. Developed through a literature review, MERLIN case studies, and extensive engagement with industry actors, NGOs, and umbrella associations, the strategy positions the Peat Extraction Sector as a key player in climate resilience, habitat conservation, and sustainable peatland management.

To achieve this, the strategy outlines five key actions:

1. Build knowledge to improve understanding of nature-based solutions for peatland restoration and their relevance to the sector.

2. Enhance after-use plans to prioritize rewetting and revegetation of peat extraction sites.

3. Establish partnerships with landscape authorities to integrate peat extraction site restoration into broader land management strategies.

4. Advance policy and regulatory frameworks to make landscape-scale restoration a core licensing requirement where possible.

5. Develop viable business incentives to support restoration beyond peat extraction sites.

Each action details expected outcomes, role of actors, and timelines, emphasizing a need to balance ecological priorities with economic feasibility. While the strategy lays the foundation for upscaling restoration, its success depends on strong industry commitment and cross-sector engagement.

The MERLIN Peat Extraction Sector Strategy calls on industry leaders, policymakers, investors, and environmental NGOs to collaborate in advancing this vision. By aligning the sector's expertise with wider restoration goals, the sector is uniquely positioned to drive sustainable peatland stewardship, pioneering responsible, innovative, and climate-aligned after-use practices.

Growing medium from *Sphagnum* moss – Sustainability of harvesting in Finland

Authors: Maija Lampela, Jukka Turunen, Liisa Maanavilja, Oona Allonen, Lauri Ikkala

Affiliation: Geological Survey of Finland, P.O. Box 96 (Vuorimiehentie 5) 02151 Espoo, Finland

Corresponding/presenting Author: Maija Lampela, maija.lampela@gtk.fi

Harvested or cultivated *Sphagnum* moss as a renewable natural resource has been proposed as an environmentally sustainable alternative for horticultural peat. In the RahKoo project, we investigated the environmental impact as well as economic potential and social sustainability of *Sphagnum* moss harvesting and cultivation in Finland in years 2021-2024. We studied the greenhouse gas emissions, regeneration, water quality impacts, the extent and location of potential harvesting areas, and economic impacts of *Sphagnum* moss harvesting. We also performed a life cycle analysis for *Sphagnum* moss harvesting and cultivation.

To assess the regeneration of moss after harvesting, along with factors affecting it, we used drone imaging and machine learning combined with field observations. Results from sites harvested up to 7 years ago showed that new *Sphagnum* moss covered only an average of 7% of the area, with no trend related to time since harvesting. These results highlighted the need for regenerative measures such as water level regulation and reintroduction of *Sphagnum* moss to the harvesting areas to ensure the sustainability of the moss harvesting activities.

To assess the country-wide potential for *Sphagnum* moss harvesting, we performed a spatial analysis on Finnish peatlands based on criteria defined through stakeholder engagement. The criteria for harvesting suitability were categorized to regulatory requirements, moss yield and production cost. The resulting area suitable for *Sphagnum* moss harvesting in Finland was 241 000 ha indicating high potential for upscaling the activity. To be used in planning of the harvesting activities, the results of the analysis were delivered as a freely available country-wide spatial dataset on the potential *Sphagnum* moss harvesting sites. Discussions with stakeholders revealed also a clear need for a regulatory framework to ensure environmental sustainability of the activity.

Based on the results of the life cycle analysis and the data produced in the project we can conclude that using *Sphagnum* moss as a growing medium could be a sustainable solution for both climate and biodiversity, but it requires ensuring moss regeneration in harvesting areas.

ESTONIAN PEAT DATABASE AND ALTERNATIVE VALORIZATION OPPORTUNITIES FOR PEAT

Authors: Mall Orru, Kadriann Tamm, Dmitri Goljandin

Affiliation: Tallinn University of Technology, Ehitajate tee 5 19086 Tallinn, Estonia

Corresponding/presenting Author: Mall Orru, mall.orru@taltech.ee

Estonia is the one of the richest in northern Europe existing natural peat reserves. 22 % of the territory is taken up by peatlands. Peat reserves in Estonia have been rated 2.3 billion tons, currently active deposits 0.95 billion tons. Economic proved reserves are 250 million tons. Wise use of Estonian peat contributes independence, supporting climate goals sustaining local jobs and communities in rural regions. A digitized peat research database has been compiled in Estonia (completed in 2021). It contains peat research data (laboratory analyses, plans, maps). 560 peat deposits have been well studied. For so far database has been compiled, which highlights the data collected during the geological mapping (up to 2021) and the information in the list of deposits in the environmental register. The database clearly shows the botanical composition, characterization and distribution of peat, made from over 160,000 analyses. The list of data is helpful in making horticultural assessments in future work.

The analysis revealed possible alternative uses for peat, including horticultural peat, i.e. the great potential role of additional value addition in the circular economy together with other secondary raw materials. The field of use of peat as a material is wide. The main area of peat use is growing media for the horticultural sector. Peat therefore plays an important role in ensuring food security. For horticultural purposes, it is also possible to produce humic substance-based fertilizers and growth stimulants from well-decomposed peat. Peat is useful material producing bitumen, peat wax, activated carbon, in balneology, cosmetics. The results of research conducted in Estonia have shown that there are possible technologies to keep greenhouse gas emissions in circulation and produce valuable products in parallel. A million ton per year extraction is optimal from an industrial perspective.

Therefore, it is necessary to seriously consider expanding the scope of land use change measures or implementing the following more favorable measures in terms of marginal cost. Most importantly, it has been a cultural asset to Estonia for over 300 years.

“10 Years Responsibly Produced Peat (RPP): Achievements and the Path Forward in the EU”

Authors: Maureen Kuenen, Hein Boon

Affiliation: Foundation Responsibly Produced Peat, Galgeweg 38 2691 MG 's-Gravenzande, The Netherlands

Corresponding/presenting Author: Maureen Kuenen, kuenen@responsiblyproducedpeat.org

Ten years ago, Responsibly Produced Peat (RPP) launched its practical and adaptable certification scheme to prevent biodiversity degradation resulting from peat extraction. To date, 132 extraction sites have been certified—demonstrating that responsible practices have become standard across a significant part of the European peat industry.

As climate change and nature restoration become as critical as biodiversity, and EU legislation calls on Member States to take greater environmental responsibility, RPP is evolving to meet these broader challenges.

The focus is to more fully embed climate and restoration priorities into its after-use criteria, ensuring responsible choices that consider ecological and climate impacts.

Looking ahead, RPP aims to remain a trusted and relevant certification scheme and invites the industry and other stakeholders to actively contribute to shaping the future of responsible after-use.

The Development of Growing Media and the Swedish Consumer Market

Authors: Pia Holmberg

Affiliation: Hasselfors Garden AB, Fredsgatan 23 701 26 Örebro, Sweden

Corresponding/presenting Author: Pia Holmberg, pia.holmberg@hasselforsgarden.se

The Swedish consumer market for growing media began developing in the late 1950s. The demand for peat litter declined, and peat factories that had been thriving during World War I and II closed down. Peat had been known as an excellent soil improver for a long time, and gardening as a leisure activity increased. Hasselfors Bruk, a company owning many of these peat factories, invested in product development. Along with new packing methods and packaging materials, initially using cardboard and paper bags, garden peat was test-launched on the consumer market in 1958. The test exceeded expectations.

The new packing technique with peat in compressed 180-liter bales with colorful prints made it possible to expand the market. Only a few years later, smaller packages were also launched. Lime and fertilizers were added to make more valuable products. Peat as growing media for professional growers was introduced. But the competition on the market also increased. Influenced by developments in the Netherlands and Germany, a new product range with ‘potting soils’ was introduced at the beginning of the 1970s. The products had higher moisture content and were mixes of white and black peat; the black peat had earlier been left on the bog.

While the demand for the peat products stagnated, the soil market expanded. During the 1980s, the product portfolio widened with both potting and garden soils, now packed in plastic bags of many sizes. Different mixes of peat, bark, clay, manure and sand were made, and special soils developed the market. The 1990s brought increased sales volumes through bundle pricing and wider distribution channels, including DIY stores, grocery stores, and petrol stations. Organic soils with natural fertilizers like chicken or cow manure were among the most popular products and still are.

From a distance, the Swedish soil industry has monitored the peat debate and the development of peat-free products in England and other countries. Peat in growing media has not been much questioned in Sweden earlier, but with fewer new permits, the availability of peat will nonetheless be declining. The demand for peat-free products is still very low, but the growing media industry is once again investing in product development to introduce more new circular raw materials into the products. Plastic bags are also being questioned, and again we are wishing to pack our products in paper, like it all started in the late 1950s.

Reliable and transparent tracking the use and re-use of raw materials and greenhouse gas inventories: fate and behaviour of peat after its 'active' utilisation phase

Authors: Sabine Jordan, Ain Kull, Martin Küttim, Bernd Hofer

Affiliation: Swedish University of Agricultural Sciences, University of Tartu, Tallinn University, Hofer & Pautz GbR, Box 7014 75007 Uppsala, Sweden

Corresponding/presenting Author: Sabine Jordan, sabine.jordan@slu.se

Peat after its intended use (e.g. as horticultural substrate in greenhouse landscapes, as substrate for tree seedlings or bedding material) in the consumer country must not end up unused as waste. The peat circulation after this phase must be reconsidered, as the remaining carbon in the utilised peat substrate can be recycled for a further value-adding production of other goods and thus for the substitution of other raw materials and the improvement of the carbon stocks in mineral soils and soil health. This contributes to the fact that the whereabouts and the reduced emissions of the peat are credited to the consumer country and the respective national climate reporting becomes statistically more reliable. This calculation basis can and should be used to adjust the calculations of peat emissions in the country of production. By including peat utilisation in other systems and in recycling in the future, peat emissions can be reduced. However, this also means that the emission factor will change from a static dimension to a flexible one that is adapted to the respective applications.

To be able to adapt domestic mitigation accounting to real emission figures (in situ & ex-situ), it is important to not only capture the life span of peat from its drainage and extraction to its trading but also including its after-use phase and its great importance for a sustainable circular economy, for example as soil improver. Information on the fate and behaviour of peat after its 'active' utilisation phase would close knowledge gaps and would make tracking the use and re-use of raw materials and greenhouse gas (GHG) inventories more reliable and transparent. This would also contribute to a fair share of the accounted and reported GHG emissions for producing and consuming countries. To achieve these fair goals, basic scientific research is needed to identify and analyse the various uses of peat after its 'active' phase.

We are looking for people from research and practice with expertise in the field of peat decomposition, GHG fluxes and climate reporting who would like to participate as potential members of a consortium to be founded for a research project intended for peat recycling. It would be desirable if the members could contribute with their experience from different geographical locations.

Special Issue

Soils of Peatlands Around the World: Properties, Values and Recent Advances

Guest Editors

Dr. Samantha Grover
Dr. Fereshteh Shahriari

Deadline

31 December 2025

soil systems

IMPACT FACTOR 2.9

CITESCORE 5.3