Society of Wetland Scientists

Europe Chapter

ANNUAL MEETING 21

JUNE 29 — JULY 2, 2026

ČESKÉ BUDĚJOVICE, CZECH REPUBLIC

SOCIETY of WETLAND SCIENTISTS
Europe Chapter

www.swseurope2026.cz

Welcome Message

Wetlands are important landscape components which provide numerous benefits to us humans as well as being important systems in their own right. The focus of the 21st annual meeting of the Society of Wetland Scientists (SWS) Europe chapter is on the connectivity of wetlands within a landscape context. It is thus quite appropriate that this year's meeting is in České Budějovice, Czech Republic. Located at the confluence of the Malše and Vltava (Moldau) rivers, České Budějovice is the main city of South Bohemia and, thus, is greatly entwined in the lives of all in this region. There are numerous hydrologic connections associated with this locale. The Vltava River links České Budějovice to the Šumava Mountains, where the river's source is located. Downstream, the Vltava links České Budějovice, via its connection with the Labe (Elbe) River, into which it empties north of Mělnik in northern Bohemia, with the North Sea and all of the lands in between. The inflows and outflows from innumerable streams and fields, springs and forests provide a geographic link to the habitats, people and places upstream of the city. Additionally, what happens in the city as well as upstream affects and connects these areas and residents to those downstream.

There are also historical hydrologic connections. As with other places, many of the original wetlands in and around České Budějovice have been drained and converted into agricultural fields or buried under stone, metal or concrete. Over the centuries, the two rivers have been straightened and channelized, changing the flow of the rivers and restricting the water connections between river and floodplain.

The consequences of such actions are well-known, from poorer water quality and decreased diversity to the increased likelihood of catastrophic floods. This was clearly seen in August 2002 when, because of two weeks of constant and heavy rains, the changes to the entire river system, severing the links between the rivers and their floodplains, led to such a large flood. Many buildings were damaged at great cost to the infrastructure. Fish, such as carp, normally confined to the many fishponds in the region as well as those in the Třeboň basin, soon found themselves being flushed from the flooded ponds with the result that they could be had for free while swimming in the streets of Prague.

However, the damage was much less in areas that still had large expanses of wetlands, such as the Wet Meadows (Mokré Louky) near Třeboň. There, the wetlands performed as they always had, containing the flood waters and releasing them slowly thus decreasing the flood surge to downstream areas. Because of these wetlands, Třeboň was mostly spared the deprivations of the flood while České Budějovice, located along those constricted and channelized rivers with little or no remaining natural floodplain wetlands, had flood waters in its main square.

Such practices and events are not confined to South Bohemia, for examples can be found throughout Europe as well as worldwide. The presentations that will be given at this meeting are illustrative of the shared, global reality of the connectivity of and threats to wetlands. There will be presentations noting the deprivations imposed by wetland loss. But not all will be gloom, with many of the presentations showcasing the actions and policies of restoring wetland ecosystems, bringing

back or improving those lost or severely restricted wetland functions. Such actions need the support of the general public. Thus, there is an entire session devoted to the inclusion of the local human population and how to improve the socio-ecological framework that is so necessary for having any chance of meeting our goals.

The conference has two plenary speakers as well as eight sessions of oral presentations, a poster session and two field trips, the first to restored and natural peatlands in the Šumava Mountains while the second will visit wetlands in the Třeboň Basin Biosphere Reserve. In addition, there will be a short explanatory workshop for writing letters to your favorite wetland or to a wetland that is, in some way, important to you. Wetlands are not only important in providing goods and services to us humans, but they have intrinsic value in their own right.

This is the 21st meeting of the SWS Europe chapter. These meetings had a rather humble beginning in 2005 with a small number of wetland enthusiasts descending upon Bangor, Wales. This has been followed by subsequent meetings being held every year, with the exception of the Covid epidemic, in almost all parts of Europe. This is the third meeting to be held in the Czech Republic, following on the second meeting in Třeboň in 2006 and the 2011 meeting in Prague, which coincided with the annual meeting of the entire SWS. Here, you will hear and meet fellow wetland enthusiasts, some well-known not only in Europe but globally. In the capital city of South Bohemia, scientists and practitioners representing at least 16 countries will come together, from across Europe to the US and Japan.

To all, I bid a very hearty welcome and an enjoyable and fruitful meeting.

Keith Edwards

Chair of the Organising Committee

Welcome from the SWS Europe Chapter President

Water moves quietly across landscapes, linking places that often appear disconnected and shaping patterns of life in ways we are only beginning to fully understand. In this continuous flow, wetlands emerge not as isolated features, but as living expressions of connection—spaces where water, matter, and life converge, transform, and move onward.

The community of Society of Wetland Scientists and practitioners know that no single discipline is enough to understand or protect these complex, living systems. Wetlands sit at the crossroads of water, soil, biodiversity, climate, and human livelihoods, where biogeochemistry meets governance and local knowledge reshapes our models and maps.

This conference, and the abstracts you will find in this booklet, reflect that rich diversity of approaches to wetlands. Together, they bring into dialogue field observations and remote sensing, ecological theory and social practice, policy analysis and on-the-ground restoration, different geographies and different ways of knowing. For me, as a woman, mother, and scientist who believes in human society and sees science as a vital tool to help us understand the Earth and the mysteries it holds, this diversity is not a challenge to reduce, but a strength to nurture.

Our hope is that the sessions you will attend become fertile ground for new connections and shared understanding—places where disciplines can meet, individual projects can resonate, and more cohesive stories and actions for wetlands can emerge.

Columba Martinez Espinosa

President of the SWS Europe Chapter

SOCIETY of WETLAND SCIENTISTS
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Scientific Committee

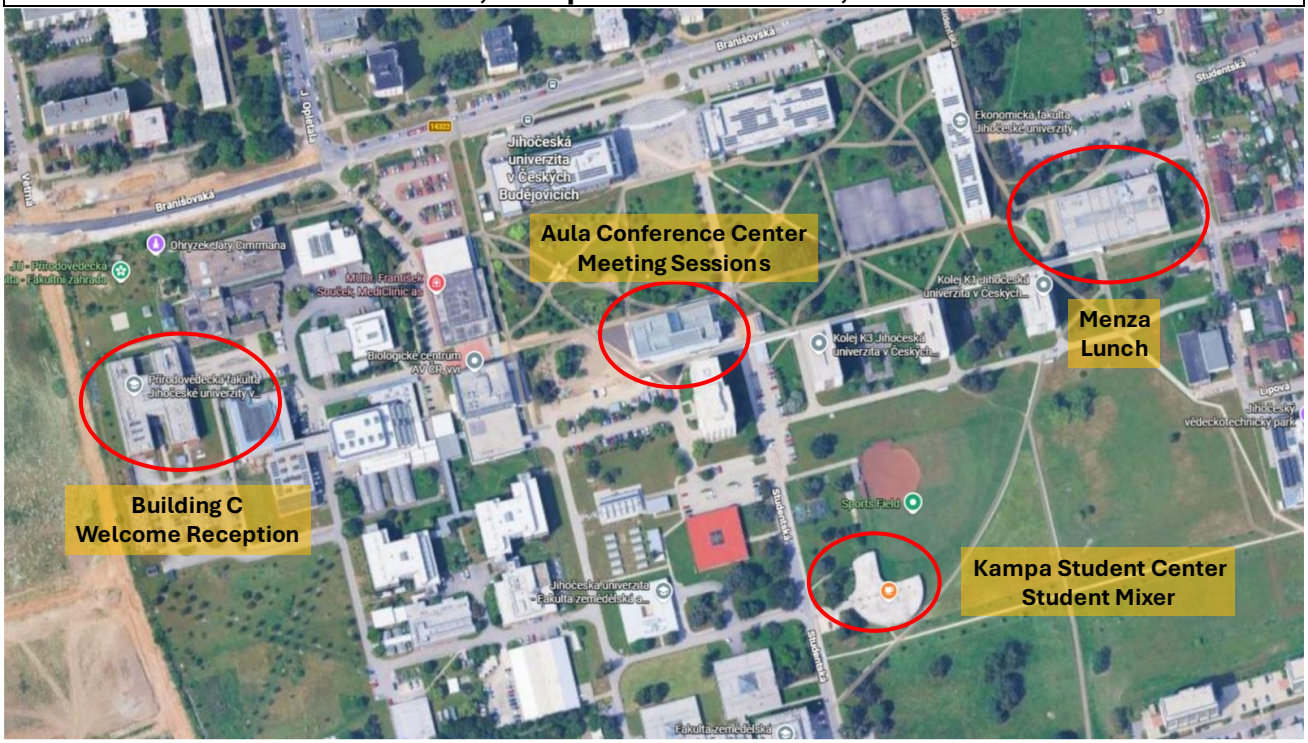
- **Marta Baumane** – Aarhus University, Denmark
- **Marija Chobanova** – Ss. Cyril and Methodius University in Skopje, North Macedonia
- **Keith Edwards** – University of South Bohemia in České Budějovice, Czechia
- **Tomáš Hájek** – University of South Bohemia in České Budějovice, Czechia
- **Jan Květ** – University of South Bohemia in České Budějovice, Czechia
- **Andrea Kučerová** – Institute of Botany of the Czech Academy of Sciences, Czechia
- **Luca Marazzi** – Independent Freshwater Ecologist, United Kingdom
- **Tomáš Picek** – University of South Bohemia in České Budějovice, Czechia
- **Petra Straková** – University of South Bohemia in České Budějovice, Czechia
- **Zuzana Urbanová** – University of South Bohemia in České Budějovice, Czechia

Organizers and Supporters

SWS Europe 2026 Schedule

Monday, June 29, 2026
Registration and Welcome Reception, Building C, 17:00–20:00

Student mixer, Kampa Student Center, 20:00–24:00



Tuesday, June 30, 2026 – Aula Conference Center	
8:00	**Registration, Aula**
8:30	**Opening of Conference**
9:00	**Plenary 1 – Libuše Vlasáková** – Czech Wetlands of International Importance
9:40	***Session 1 – Vegetation dynamics and ecosystem functioning*** **(Chair: Zuzana Urbanová)** **Ivana Bufková** – Specifics of hydrological restoration in mountainous spring areas **Mara Pakalne** – Raised bog restoration for climate change mitigation **Mar Albert-Saiz** – Long-term GPP trends and temperature-water table controls in a climate-manipulation experiment at a temperate fen **Valentine Anstett** – Responses of aquatic plant communities to environmental fluctuations in Mediterranean temporary lagoons: implications for coastal wetlands management
10:30	**Coffee Break**
11:00	**Marta Baumane** – Restored wetlands – interplay between environmental variables, above- and below-ground plant traits and carbon cycling **Šárka Sedláčková** – *Inventory of the state of springs in Horský Potok basin (Šumava PLA, Czech Republic)* (2–5 min) ***Session 2 – Peatlands, paludiculture and innovative land uses*** **(Chair: Jessica Reyes Rojas)** **Raija Laiho –** Rethinking forestry on peatlands: Paludisilviculture as a novel management approach **Mari Könönen** – Impacts of ericoid shrubs on peat processes in forested fen and bog **Kristina Jarmalaviciene** – Long-term moisture regimes in a wooded raised bog identified from Sentinel-1 SAR time series **Hanna Rae Martens** – Influence of solar panels on microclimatic conditions and plant growth in a rewetted peatland PV site **Wetland Restoration 1** **Maria Dorothea Aljes** – Management of downy birch (*Betula pubescens* Ehrh.) succession on a rewetted sloping wooded mire **Vít Toman** – *A methodological approach to selecting suitable locations for landscape-scale wetland restoration* (2–5 min)
12:20	**Lunch**
13:45	***Session 3 – Socioecological systems, governance and rights of wetlands*** **(Chair: Matthew Simpson)** **Luca Marazzi** – Wetlands in the crossfire: Impacts of armed conflicts on wetland ecosystems **Columba Martinez-Espinosa** – Bridging science and action: Protocols empowering civil society on advocacy & restoration **Héléne Vanvelk** – From resistance to ownership: Building lasting stakeholder support for urban and peri-urban wetland restoration **Martina Eiseltová** – Training in wetland restoration – A path toward a sustainable future **Marta Stachowicz** – *ServiPeat – a tool for assessing co-benefits of peatland rewetting* (2–5 min) **Ute Susanne Kaden** – *Science into action: Digital tools for environmental education and citizen science in floodplains and wetlands* (2–5 min) **Héléne Vanvelk** – Putting plans into practice: a practical case study on wetland restoration **Marija Chobanova** – *Reframing wetland valorization: a content-specific, hydrology-driven approach for the Monospitovo wetland (North Macedonia)* (2–5 min)
14:55	**Coffee Break**

15:25	***Session 4 – Paleoecology and bioindicators for wetland resilience*** **(Chair: Tomáš Picek)** **Jan Květ** – Two partial revivals of a drained Pannonian shallow lake **Robert Arthur Hindson** – Reconstructing peatland change: Hydrology, pollution and restoration at Fenn's, Whixall and Bettisfield Moss **Dominik Zak** – Iron is the key in rewetted peatlands but not the only one **Lan Zirkelbach** – Comparison of traditional and molecular methods of macroinvertebrate identification for ecosystem quality assessment in the littoral zone of Lake Bohinj **Igor Zelnik** – Epipelic and planktonic diatom communities in the limnocrene spring Zelenci reveal an increase in trophic values **Natalia Kuczyńska-Kippen** – Functional zooplankton indicators of trophic status and ecosystem resilience in small and shallow water bodies **Alexis Roy** – Threat to savanna landscapes or essential protection against desertification? The dual role of hydroperiod in dryland wetlands
17:00	**Poster Session**
18:00	**SWS Europe Business Meeting**

Wednesday, July 1, 2026 – Aula Conference Center	
9:00	**Plenary 2 – Gillian Davies – What's next: Building on achievements to advance rights of wetlands!**
9:40	***Session 5 – Hydrology and ecohydrology of functional wetlands* (Chair: Luca Marazzi)** **Columba Martinez-Espinosa** – Biochemical modelling – guided collaborative governance for admissible nutrient fluxes in eutrophic Mediterranean lagoons **Elisabeth Bondar-Kunze** – Restoring rivers, shifting communities: Divergent multi-taxa responses to hydromorphological measures **Marina Abramchuk** – Ecohydrological landscape analysis explains drying of near-natural rich fens in the upper Biebrza Valley **Matthew Simpson** – Extreme wetland restoration
	Workshop – write a letter to a wetland (Chair: Columba Martinez-Espinosa)
10:45	**Coffee Break**
11:15	***Session 6 – Vegetation and peatland dynamics* (Chair: Tomáš Hájek)** **Karel Prach** – Peatlands in central Europe – their degradation and possible restoration **Izolda Matchutadze** – Twenty-five year dynamics of *Sphagnum* moss species and functional restoration in world's first percolation Ipsani 2 mire, Georgia (Saqartvelo) **Blandine Dunoyer** – Hidden plant diversity in Mediterranean temporary lagoons: Insights from an *ex-situ* propagule bank experiment **Nik Ojdanič** – Fraction mapping of wetland vegetation with Sentinel-2 using synthetic spectral mixtures **Jeroen Lea Krols** – The hydrological restoration potential of small landscape depressions in the Nete catchment in Belgium: An ecosystem services-based approach
12:30	**Lunch**
14:00	***Session 7 – Wetlands and climate change* (Chair: Andrea Kučerová)** **Cornelius Oertel** – Measuring GHG emissions in a rewetted forested peatland as part of the German peatland monitoring **Sunova Saha** – Hydrological restoration and vegetation recovery control greenhouse gas trade-offs in rewetted peat extraction areas **Rashat Alibekov** – Complexities in hydrological modelling of depressional wetlands and their restoration efforts: A systematic review **Martyna Wietecha** – Airborne remote sensing for assessing hydrological stress and cooling effects of urban wetlands **Rinda Kustina** – *Issues of peatland restoration across scales: A review and meta-analysis* (2–5 min) ***Wetland Restoration 2*** **Yaşar Çağdaş** – Participative mapping to improve restoration in Türkiye's deltas **Marta Baumane** – *Assessing wetland restoration success through the dark diversity concept* (2–5 min)
15:10	**Coffee Break**

15:40	***Session 8 – Nutrients, contaminants and greenhouse gases* (Chair: Columba Martinez-Espinosa)** **Brian Sorrell** – The influence of water table level and grazing on carbon accumulation in salt marshes **Renske Vroom** – Nutrient mobilization and export from rewetted fens **Carl Christian Hoffmann** – Nitrogen and phosphorus losses and retention before and after rewetting of a pump-drained agricultural wetland **Jan Vymazal** – Nitrogen and phosphorus compartmentalization in *Phragmites australis* and *Phalaris arundinacea* in constructed wetlands for wastewater treatment **Mayang Christy Perdana** – Driving micropollutant removal in greywater via manganese- and iron-amended constructed wetlands **Laura Kuusemets** – Linking microbial communities to nutrient and metal cycling in European wetlands under different management regimes
17:00	**Closing and award ceremony**
19:00	**Conference Dinner – Solnice Restaurant**

Thursday, 2 July	
8:00	**Field Trips: Buses depart from parking area near Výstaviště**

Interactive Conference Map

Scan the QR code to find the conference venue, parking, public transport stops, gala dinner venue, excursion departure point, and other important locations.

https://mapy.com/s/mohepekufu

Plenary Speakers

SOCIETY of WETLAND SCIENTISTS
Europe Chapter

WHAT'S NEXT: BUILDING ON ACHIEVEMENTS TO ADVANCE RIGHTS OF WETLANDS!

Gillian Davies

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Key words: Rights of Nature, ecocentric, transformative change, climate change, triple threat

It has been seven years since the idea for a Declaration of the Rights of Wetlands (Declaration of RoW) was first discussed at the 2019 SWS Annual Meeting in Baltimore, Maryland, USA. Since that time, global awareness of, interest in, RoW and the role of science and scientists in the Rights of Nature movement, has grown tremendously. Additionally, a disproportionate number of Rights of Nature declarations, laws, and policies are focused on wetlands (as defined by the Ramsar Convention on Wetlands), even if RoW isn't directly mentioned. Why are Rights of Wetlands and of Nature resonating with so many people, communities, and even governments around the world? Why has the global Rights of Nature movement taken such an interest in scientists and science? What has been accomplished in seven years, and where are we headed? Now that a strong foundation for RoW has been established, how do we advance RoW in different contexts and at different levels, from communities to national governments, to global multilateral environmental agreements such as the Ramsar Convention on Wetlands and the Convention on Biological Diversity? This presentation will explore these questions, share RoW accomplishments to date, approaches to RoW implementation, and a suite of materials, trainings, and tools that have been created to facilitate RoW implementation at both the community and governance levels.

Acknowledgement

I would like to acknowledge the wetlands of the world for teaching me so much, and for being there. I would like to acknowledge the members of the Rights of Wetlands Initiative who have travelled together on this journey of transforming our relationship with wetlands and Nature, especially Nick Davidson, Siobhan Fennessy, Max Finlayson, Kai Huscke, Ritesh Kumar, Bill Moomaw, Erin Okuno, Dave Pritchard, Matt Simpson, and Bethanie Walder. I would also like to acknowledge the Kichwa Original Peoples of Sarayaku, Ecuador, for sharing their ancestral knowledge so generously with us.

CZECH WETLANDS OF INTERNATIONAL IMPORTANCE

Vlasáková Libuše

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Key words: international, list, Ramsar, wetland

In 1990, the Czech Republic became a contracting party to the Convention on Wetlands of International Importance, especially as Waterfowl Habitat (the so-called Ramsar Convention, hereinafter referred to as the “Convention”). This is the first modern international convention focused on the protection and wise use of natural resources and one of the few conventions protecting a specific type of habitat.

The Convention currently has 172 contracting parties.

The basic obligation of each Contracting Party, upon accession to the Convention, is to include at least one of its wetlands in the “List of Wetlands of International Importance” (Article 2.4 of the Convention), which is maintained by the Secretariat of the Convention. Wetlands included in the List must meet at least one of the nine precisely defined criteria for wetlands of international importance in terms of ecology, biodiversity and uniqueness of the habitat. The inclusion of a wetland site on the List is a confirmation of the exceptional quality and uniqueness of the given wetland on an international scale and a confirmation of its importance for the protection of biological diversity.

Currently, 2433 wetlands around the world are included in the List of Wetlands of International Importance, with a total area of approximately 254 million ha.

Since its accession to the Convention, the Czech Republic has gradually included 14 wetlands in the List that meet the criteria for wetlands of international importance, namely: Šumava Peatlands, Třeboň Fishponds, Břehyňský and Novozámecký Fishponds, Lednice Fishponds, Litovelské Pomoraví, Poodří, Krkonoše Mountains Mires, Třeboň Peatlands, Floodplains of Lower Dyje River, Liběchovka and Pšovka Wetlands, Punkva Subterranean Stream, Krušné Hory Mountains Mires, Jizera Headwaters and Spring and Mires of the Slavkov forest. Two of the listed wetlands are also registered as transboundary wetlands (Krkonoše Peatlands, Jizera Headwaters). The Floodplains of the Lower Dyje River are part of the trilateral Czech-Slovak-Austrian Floodplain of of the Dyje, Morava and Danube confluence.

Acknowledgement

www.ramsar.org, www.mzp.cz

Oral Presentations

SOCIETY of WETLAND SCIENTISTS
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ECOHYDROLOGICAL LANDSCAPE ANALYSIS EXPLAINS DRYING OF NEAR-NATURAL RICH FENS IN THE UPPER BIEBRZA VALLEY

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Key words: Earth observation, ecohydrology, landscape, rich fen, peatland

Fen peatlands of the Biebrza National Park (NE Poland) are considered one of the last near-natural percolation rich fens in Europe. The Upper Biebrza Basin encompasses valuable plant communities dominated by brown mosses and small sedges, on over-6-m-deep peat accumulated in a post-glacial valley. Recent field observations reveal expansion of woody vegetation (*Betula pubescens*, *Salix spp.* and *Alnus glutinosa*) and a water table drop of up to 80 cm below the surface during summer months. The extreme-rich fen communities suffer from expansion of grasses and decline of rare species. The vegetation is kept open by conservation mowing, in attempt to compensate for the effects of the low water table. Under current hydrological conditions, peat accumulation is doubtful, whereas the upper peat layer progressively decays.

We hypothesized that the observed fen degradation is driven by catchment-scale drainage on the first place, with a secondary effect of regional trends of climate change. We analysed Earth observation time series (2000–2022) from Landsat satellites at 30 m resolution to derive annual land cover classifications and intra-annual changes in vegetation and moisture indices to trace shrub and trees encroachment on the fens and to estimate groundwater recharge potential in the catchment. Additional information was derived from meteorological data (rainfall, temperature, evapotranspiration) and monitoring of groundwater level and quality by Polish Geological Institute. We gathered data on water level, pH, EC and main ions in 8 wells in the settlements on a neighbouring mineral hill. We analysed peat stratigraphy of the fen and its drained part and described vegetation.

Integrated assessment of the gathered information allowed to develop a conceptual ecohydrological model of peatland's functioning in its catchment. The observed rich fen habitat degradation most probably has several reasons. The fen is hydrologically linked to the drained peatland in the upper part of the landscape. This drainage could have intercepted the groundwater flow towards the rich fen, increasing water discharge to regulated brook. LULC data indicate reduction of groundwater recharge in the catchment, driven by increased groundwater consumption by the rapidly expanding dairy farming in the region.

LONG-TERM GPP TRENDS AND TEMPERATURE–WATER TABLE CONTROLS IN A CLIMATE-MANIPULATION EXPERIMENT AT A TEMPERATE FEN

Albert-Saiz Mar, Stróżecki Marcin, Rastogi Anshu, Juszczak Radoslaw

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Key words: climate change, gross primary production, peatland, vegetation, water table depth

Peatlands are major carbon sinks, yet long-term warming and drying may alter both the magnitude and the dominant controls of gross primary productivity (GPP). We studied a temperate, groundwater-fed poor fen in western Poland hosting a long-term in situ climate-manipulation experiment. Within a ~0.25 ha floating-mat plant community, passive warming and combined warming plus reduced growing-season precipitation are applied to replicated plots, alongside nearby unmanipulated controls. This design couples replicated climate treatments with continuous chamber-based CO_2 fluxes and detailed hydrological and meteorological monitoring, enabling a process-based assessment of how air temperature and water-table depth (WTD) regulate GPP under realistic field conditions.

We applied the temperature-dependent rectangular hyperbolic (TRH) GPP model to a four-year record (2021–2024) from control (CR_C), warming (CR_W) and warming plus reduced precipitation (CR_WP) triplicates. Daily chamber GPP (TRH) was aggregated to annual sums, and long-term trends were extracted using singular spectrum analysis of daily series. From co-located measurements we derived annual growing degree days (base 0 °C), mean air temperature and mean WTD for each of nine plots. Annual GPP ranged from roughly −400 to −1150 g CO_2 m^{-2} yr^{-1} across sites and years.

All treatments remained net CO_2 sinks, but long-term GPP trajectories diverged. Controls showed a marked increase in sink strength (long-term GPP from about −2.4 to −1.2 g CO_2 m^{-2} d^{-1}), whereas CR_W and CR_WP converged to weaker sinks (≈ −2.0 g CO_2 m^{-2} d^{-1}) despite similar increases in growing-season thermal sums. To quantify driver importance, we fitted per-treatment regressions between annual GPP and standardized GDD, mean temperature and mean WTD. In CR_C and CR_W, interannual GPP variability was dominated by thermal metrics, with relatively small WTD effects. In contrast, in CR_WP the standardized effect of WTD became comparable to or larger than that of temperature, indicating a shift from temperature- to water-table limitation under combined warming and reduced precipitation and highlighting the vulnerability of floating-mat productivity to hydrological change.

Acknowledgement

This research was supported by the National Science Centre of Poland (NCN; projects 2016/21/B/ST10/02271 and 2020/37/B/ST10/01213)

COMPLEXITIES IN HYDROLOGICAL MODELLING OF DEPRESSIONAL WETLANDS AND THEIR RESTORATION EFFORTS: A SYSTEMATIC REVIEW

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Key words: upstream depressional wetlands, hydrological modelling, literature review, wetland restoration.

Climate change is intensifying precipitation variability in Flanders, Belgium, where extremely wet periods are increasingly followed by severe droughts, heightening both flood and water-scarcity risks. In response, regional programmes increasingly promote catchment hydrology restoration to strengthen landscape water resilience. This is particularly relevant because agricultural drainage has caused the loss of nearly 75% of wetlands over the past 50 years, leaving a mosaic of drained upstream depressional wetlands (UDWs). UDWs are small, temporarily wet depressions surrounded by uplands that fill mainly through precipitation and subsurface inflow and connect to surrounding waters through groundwater, subsurface flow, and episodic surface overflow. Despite their small size, they can regulate groundwater availability, attenuate peak flows, retain sediments and nutrients, improve water quality, and support biodiversity. However, the hydrological role of UDWs and the effects of their restoration remain difficult to quantify and predict. Because these wetlands are small, numerous, and hydrologically complex, their cumulative effects are often poorly represented in conventional hydrological models. This limits the use of modelling for spatially explicit restoration planning and evaluation of nature-based solutions.

To address this gap, we conducted a systematic literature review following the PRISMA 2020 framework to synthesise current knowledge on depressional wetland restoration and its representation in hydrological models. A total of 3,084 records were retrieved and screened, of which 318 papers were selected for full-text analysis and systematically coded in a structured database. Preliminary results reveal five recurring challenges: structural uncertainty arising from model assumptions and simplifications; parameterisation uncertainty in representing restoration measures; inadequate spatial and temporal resolution to capture small-scale processes; limited long-term data for calibration and validation; and difficulties in scaling site-level restoration effects to catchment-scale assessments. The review highlights the need for more robust and transferable modelling approaches to support wetland restoration planning and strengthen catchment resilience.

Acknowledgement

This project has received funding from the Research Foundation Flanders (FWO)-SBO RECHARGE project (SBO project No. G002625N) through The Water4All 2023 Joint Transnational Call on "Aquatic Ecosystem Services"

MANAGEMENT OF DOWNY BIRCH (*BETULA PUBESCENS* EHRH.) SUCCESSION ON A REWETTED SLOPING WOODED MIRE

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The landscape of the forest-dominated low mountain range Solling, located in southwest Lower Saxony (Germany) naturally contains a considerable amount of mire formations. Conversion of mires into spruce plantations over the past 200 years led to severe degradation, both quantitative and qualitative. The probably largest wooded mire complex of formerly 530 ha has decreased to just half its size. Between 2019 and 2022 within a huge restoration project an area of 70 ha was clear cut and all ditches filled with either sawdust and seals of mineral soil as sectional barriers or mineral soil. Within the dried-out upper peat layer downy birch established a dense succession pioneer thicket following restoration work. To test for both cost-effective and ecologically viable options to reduce the growth of downy birch four different types of management were carried out on sub plots of the restoration area in 2025: sheep grazing with prior mulching, sheep grazing without mulching, mulching at one meter height and thinning of already larger stands of birch. At each site, permanently marked plots were established to monitor development of ground vegetation and shrub species. Each site has a corresponding control site with no birch management and similar treatment prior to the management. One extra site was established in a nearby peatland with an old downy birch stand as a reference for a possible target state. Prior to restoration monitoring of groundwater levels have been carried out since 2014 and provide valuable insights regarding the effects of rewetting on the hydrological system of the mire complex. The talk will present innovative restoration methods (in brief), as well as the study design and hypotheses about the effect of the different management approaches taking into consideration the results of the hydrological monitoring and will include an outlook for further rewetting of still forested areas.

Acknowledgement

We are grateful for funding from the Lower Saxony Ministry for Agriculture, Food and Consumer Protection

RESPONSES OF AQUATIC PLANT COMMUNITIES TO ENVIRONMENTAL FLUCTUATIONS IN MEDITERRANEAN TEMPORARY LAGOONS: IMPLICATIONS FOR COASTAL WETLANDS MANAGEMENT

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Key words: Climate change, Coastal Wetlands Habitat, Mediterranean ecosystem, Submerged macrophyte, Temporary lagoon.

Temporary wetlands are among the ecosystems most sensitive to environmental variability. Changes in climate regimes can alter the hydrological and physicochemical dynamics of these systems, directly influencing plant communities. Understanding how environmental variability shapes biological assemblages, therefore, represents a key challenge for assessing the responses and resilience of wetlands to ongoing environmental change. Mediterranean Temporary Lagoons (MTLs) are shallow saline water bodies typically formed in topographic depressions lying below sea level, with an endorheic hydrological cycle characterised by winter inundation and summer desiccation. Plant species inhabiting these systems are highly specialised and adapted to strong seasonal fluctuations, tolerating long periods of both flooding and drought across a gradient of submergence depths. Under ongoing climate change, however, the flooding regime of MTLs may become severely disrupted, with delayed inundation, reduced water inputs, or even the absence of flooding in some years. Such alterations may also modify salinity conditions by altering groundwater fluxes.

This study investigates how temporal variability in environmental conditions shapes the structure of submerged macrophyte communities in Mediterranean Temporary Lagoons. We surveyed 120 plant communities between 2020 and 2025 across several lagoons over the French Mediterranean coast, allowing us to identify sites showing the strongest compositional shifts over time.

Our results reveal clear changes in community composition over the monitoring period, including the decline of several characteristic species associated with altered hydrological conditions. Among these, *Althenia filiformis* and *Ruppia maritima* showed a marked decrease in occurrence. We discuss the implications of these shifts for the resilience and long-term functioning of Mediterranean Temporary Lagoons and highlight potential management pathways to support the persistence of this threatened wetland habitat.

TRACE ELEMENT AND NUTRIENT CONTAMINATION IN SALTMARSH SEDIMENTS OF CHICHESTER HARBOUR, UK: INFLUENCE OF LAND USE AND ANTHROPOGENIC ACTIVITIES

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Key words: anthropogenic sources, coastal wetlands, saltmarsh, sediment contamination, trace elements

Coastal wetlands provide an important ecosystem service through estuarine filtration of contaminants. However, these systems are increasingly exposed to contamination from a range of sources, leading to alterations to ecosystem functioning and resilience to other stressors. This study investigates the distribution, sources, and contamination levels of trace elements in saltmarsh sediments within one of the largest areas of salt marsh in NW Europe (Solent). Surface sediment samples were collected from sites representing three contrasting land-use categories: areas influenced by boatyards and marine activities, marshes adjacent to agricultural land, and relatively pristine sites with minimal anthropogenic disturbance. Concentrations of zinc (Zn), iron (Fe), lead (Pb), copper (Cu), were determined using inductively coupled plasma optical emission spectrometry (ICP-OES). Spatial patterns were evaluated using multivariate statistical approaches including principal component analysis (PCA) and cluster analysis, together with pollution indices such as the enrichment factor (EF), geo-accumulation index (Igeo), and pollution load index (PLI). The results indicate that trace element distribution is controlled by both natural sediment characteristics, including mineralogical composition and grain size, and anthropogenic inputs associated with coastal infrastructure and agricultural activities. Elevated enrichment factors and geo-accumulation index values were observed at sites influenced by boatyard operations and agricultural runoff, indicating localised anthropogenic enrichment of Pb and Cu. The pollution load index further highlights spatial variability in sediment quality across the harbour, with higher contamination levels recorded in impacted environments compared to relatively undisturbed marshes. These findings demonstrate that saltmarsh sediments within the Solent system reflect the combined influence of natural sedimentary processes and human activities. The study highlights the role of land-use practices in shaping contaminant distribution in NW European saltmarsh ecosystems and provides a scientific basis for improved monitoring and management of coastal wetlands exposed to multiple anthropogenic pressures.

Acknowledgement

The author thanks Dr. Ray Ward for supervision and guidance, and the fieldwork team for assistance in sample collection. This research was supported by Queen Mary University of London. Additional thanks to local landowners and the Chichester Harbour Conservancy for granting access to sampling sites.

RESTORED WETLANDS – INTERPLAY BETWEEN ENVIRONMENTAL VARIABLES, ABOVE- AND BELOW-GROUND PLANT TRAITS, AND CARBON CYCLING

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Key words: Agricultural landscape, carbon cycling, ecological filters, plant functional traits, wetland restoration

Wetlands are crucial for biodiversity and climate change mitigation. Vast wetland areas have been lost through land-use change. Thus, restoration efforts have gained attention globally.

We assessed relationships between environmental conditions, above- and below-ground plant traits and carbon cycling in restored wetlands in Denmark, both grazed and ungrazed, compared to a baseline in near-natural wetlands.

Wetland plant species strategy varied from acquisitive to conservative on the leaf economics spectrum. More conservative species tended to have larger root diameters and higher percentages of root aerenchyma. At the community level, we found no evidence for differences in the suite of traits expressed in restored and near-natural wetlands.

Environmental and carbon cycling variables were not consistently different between treatments. Average summer carbon fluxes were highly variable, but net ecosystem exchange was negative, which means sequestration of CO_2. Groundwater level was the main environmental factor affecting CO_2 exchange in summer, with drier sites tending to fix more carbon. Most plant traits did not have significant relationships to carbon cycling in wetlands. Our results show that, for carbon cycling, plant community trait composition appears less important than abiotic environment, suggesting that ecosystem functions can be restored, even in cases where plant biodiversity is not.

ASSESSING WETLAND RESTORATION SUCCESS THROUGH THE DARK DIVERSITY CONCEPT

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Key words: Dark diversity, edna, Microbial communities, Plant communities, Wetland restoration

Europe has been a hotspot for wetland loss. To reverse this negative trend, wetland restoration has increasingly been prioritized and the recently adopted EU Nature Restoration Regulation will further accelerate wetland restoration efforts. While technical guidance for wetland restoration is well developed, the monitoring and evaluation of restoration success remain limited.

The DarkDivWet project aims to reconceptualize the assessment of riparian wetland restoration success through the concept of dark diversity – species that are absent from a restored wetland but are present in the regional species pool and could potentially inhabit the site. The project investigates both taxonomic and functional dark diversity in plant and microbial communities in riparian wetlands in Estonia, Latvia, and Denmark. Furthermore, the project scales up the application of the dark diversity concept for evaluating ecosystem condition across the Atlantic, Boreal, and Continental biogeographic regions.

RESTORING RIVERS, SHIFTING COMMUNITIES: DIVERGENT MULTI-TAXA RESPONSES TO HYDROMORPHOLOGICAL MEASURES

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Key words: biodiversity, lateral connectivity, meta-ecosystem

Anthropogenic alterations to flow regimes and sediment dynamics have globally degraded riverine biodiversity, shifting assemblages from specialists to generalist species. To reverse these trends, river restoration measures may aim for a process-based approach to enhance fluvial dynamics and increased connectivity between different landscape elements. This study evaluates the Pilot Project Bad Deutsch-Altenburg (Austrian Danube), utilizing a meta-ecosystem framework to assess restoration measures spanning from the riverbanks to floodplain side-channels. Using a BACI design (2005–2023), we monitored multi-taxa responses to three key interventions: groyne optimization, bank restoration (riprap removal), and sidearm reconnection. The results demonstrate that while these measures successfully re-established hydromorphological dynamics, biological responses were highly taxon-specific across the river-floodplain gradient. At the river interface, bank restoration and groyne optimization reduced riparian plant cover and macrophyte abundance, specifically mosses, while water birds responded positively with significant compositional shifts. Analysis of local contribution to beta diversity (LCBD) and their components, indicates that community assembly changes in response to the implemented measures. The observed decrease in richness difference and increase in replacement are consistent with a reduced influence of neutral processes and a shift toward species sorting. Further into the floodplain, side channel reconnection triggered the most substantial transformation, shifting habitats from lentic to year-round lotic conditions. This lateral reconnection resulted in a decrease in terrestrial vegetation abundance and richness, alongside a fundamental restructuring of the food web where periphyton biomass replaced detritus as the primary energy source. This study underscores that while restoring the connectivity between the main stem and its side-channels effectively modulates ecosystem processes, the resulting community shifts are non-linear, highlighting the necessity of long-term, holistic management.

Acknowledgement
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SPECIFICS OF HYDROLOGICAL RESTORATION IN MOUNTAINOUS SPRING AREAS

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Key words: hydrological restoration, spring areas, wetlands

Šumava is an important headwater area with high proportion of mires. Wetlands have been affected here by drainage, intensive forestry and grazing. Some peatlands were disturbed by peat extraction. Šumava National Park is implementing hydrological restoration of wetlands and streams to improve their natural state since the 90ś of the last century.

Hydrological restoration in the sloping upper parts of the catchments has a number of specifics. It has to be comprehensive to cover entire mosaique of various small-scaled wetlands, springs and small streams which are hydrologically connected. Technological procedures must take into account the high and ubiquitous risk of vertical erosion. The restoration in Sumava National Park and adjacent areas is carried out according to three basic concepts: i) concept of micro-catchment restoration; ii) concept of “one-off” measures and iii) concept of a target water table. The lecture will present main technologies developed to restore the near-natural water regime of drained wetlands in mountainous spring areas.

The presentation will also include results of monitoring showing the response of various wetlands to the measures taken. After restoration, water table generally increased and the amplitude of their fluctuations decreased. Three different types of water table response were identified for different wetlands. The impact of restoration on water quality and runoff conditions within the restored micro-catchment will also be presented. The results will be commented on with regard to ongoing climate change in the mountainous environment.

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REFRAMING WETLAND VALORIZATION: A CONTEXT-SPECIFIC, HYDROLOGY-DRIVEN APPROACH FOR THE MONOSPITOVO WETLAND (NORTH MACEDONIA)

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Key words: conservation, natural values, management

Natural wetlands cover approximately 1.5% of the territory of North Macedonia. Wetlands in the lowlands represent the largest, but most degraded fraction due to historical drainage and ongoing agricultural intensification. This study presents an ongoing effort to develop a context-oriented valorization approach for the Monospitovo Wetland, a highly degraded lowland wetland of significant ecological and cultural importance. Historically covering approximately 5000 ha, the wetland has been reduced to less than 400 ha due to extensive drainage interventions initiated in the mid-20th century. Despite their ecological importance, wetland valorization studies are typically conducted within standardized frameworks defined by legislation, often emphasizing biodiversity inventories while providing limited insight into ecosystem processes and functioning. The proposed framework integrates hydrological, ecological and landscape-level analyses to better capture wetland functioning and conservation priorities. It integrates watershed-scale hydrological assessment, installation of piezometers for groundwater level monitoring, seasonal water chemistry and soil analyses and targeted biodiversity surveys. In addition, existing drainage channel networks have been digitized to support evaluation of hydrological connectivity and restoration potential. The approach rebalances existing valorization practices by prioritizing hydrological processes and landscape context as central determinants of wetland condition. Biodiversity data are thus interpreted in relation to environmental drivers, rather than treated as standalone indicators. Expected outcomes include improved understanding of groundwater dynamics, spatial identification of key hydrological pressures and a more function-oriented basis for conservation planning. This approach aims to support more context-specific wetland assessments and contribute to ongoing efforts to strengthen wetland conservation strategies in regions where these ecosystems are limited in extent yet exposed to significant anthropogenic pressures.

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PARTICIPATIVE MAPPING TO IMPROVE RESTORATION IN TÜRKIYE'S DELTAS

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Key words: coastal deltas, governance barriers, participatory mapping, wetland restoration

Deltas are sensitive ecosystems that are under continued threat and require new restoration initiatives. International strategies increasingly emphasize the importance of participatory knowledge sources in wetland restoration; however, this approach is quite limited in Türkiye. This study used participative mapping to identify threat perceptions, restoration activities and barriers to restoration. Interviews were conducted in 11 coastal deltas, with interviews (n=44) representing both governmental and non-governmental sectors using an open-ended questionnaire and a web-based participatory mapping tool. Responses were coded and thematically organized according to IUCN Threat Classification Scheme and SER definitions.

The results show that the main threats for the deltas were pollution, natural system modification, urbanisation, agriculture and overuse of natural resources. The majority of the restoration propositions included activities linked to promoting priority habitats, enhancing water provision, flood control and improving connectivity. These restoration propositions were at risk due to the current barriers identified, mostly focusing on governance limitations. The most cited barriers were unsuitable public policies, exacerbated by inadequate implementation and lack of coordination between sectors. The lack of scientific evaluations was also highlighted. Spatial assessments showed that areas with high threat perceptions and restoration proposals were largely within the borders of Key Biodiversity Areas, with this concentration distinctly apparent in open-water habitats. These conclusions indicate that wetland restoration planning in Türkiye should consider not only the types of threats, but also the areas where threats and restoration priorities are spatially concentrated. The study provides decision-makers with a stakeholder-based assessment framework for spatially prioritizing threat reduction, restoration needs, and intervention priorities. This methodology used in this study can be adapted and used in other wetlands around the world.

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HIDDEN PLANT DIVERSITY IN MEDITERRANEAN TEMPORARY LAGOONS: INSIGHTS FROM AN EX-SITU PROPAGULE BANK EXPERIMENT

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Key words: Mediterranean Temporary Lagoon, Mesocosm Experiment, Salinity, Propagule Banks, Submerged Macrophyte.

Experimental approaches are essential for understanding how environmental drivers shape plant communities. In temporary wetlands, soil propagule banks represent a hidden component of biodiversity that is not always detectable through conventional vegetation surveys. This reservoir of propagules contributes to wetland resilience by allowing species to persist through periods of environmental stress. In Mediterranean temporary lagoons, characterised by strong seasonal fluctuations in hydroperiod and salinity, soil propagule banks are therefore expected to play a key role in sustaining plant community persistence. This is particularly relevant in the context of ongoing climate change, which is projected to increase temperatures and reduce precipitation across the Mediterranean basin, potentially shortening hydroperiods and increasing salinity levels in temporary lagoons.

To investigate these dynamics, we collected soil samples from 40 temporary lagoons located along the French Mediterranean coast and in Corsica and transferred them to controlled mesocosms. Germination experiments were conducted to characterise the diversity of the soil propagule bank. In parallel, salinity treatments were applied to evaluate how plant communities respond to increasing salt concentrations, thereby simulating potential future environmental conditions.

The germination experiment revealed the presence of rare and protected taxa not recorded during field surveys, including *Riella helicophylla* and *Althenia filiformis*. These results highlight the importance of soil propagule banks as reservoirs of biodiversity, where species remain dormant and germinate only when suitable environmental conditions occur. Species also showed contrasting responses to salinity levels, suggesting that future environmental changes may alter current plant communities by favoring certain taxa whilst limiting others. By improving our understanding of propagule bank, species ecology, and plant community resilience, this study provides new insights for the management and conservation of Mediterranean temporary lagoons and their characteristic flora under ongoing climate change.

TRAINING IN WETLAND RESTORATION – – A PATH TOWARDS A SUSTAINABLE FUTURE

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Key words: climate change, energy dissipation, sustainable management, training, water and matter cycles

Wetland restoration is a fast developing field as wetlands continue to be lost and degraded at an alarming rate. The vast experience gained during the implementation of wetland restoration projects has revealed that for any wetland restoration to be sustainable in the long-term, the restoration adopted requires an integrated catchment-wide approach. However, this is still rarely done.

We advocate that training should be transdisciplinary and made for a mixed audience of professionals, including, for example, nature conservationists, water resource managers, land-use planners and policy makers. Such courses need to emphasise that wetlands and natural vegetation play an essential role in water and matter cycling within the landscape: importantly keeping matter losses low. In contrast, the drainage and destruction of the natural vegetation cover leads to the opening of both water and matter cycles: bringing about high irreversible losses of matter. Wetlands also play a very important role in energy dissipation through their extensive evapotranspiration and hence contribute significantly to climate amelioration. The concept of such courses and some key messages will be presented.

RECONSTRUCTING PEATLAND CHANGE: HYDROLOGY, POLLUTION AND RESTORATION AT FENN'S, WHIXALL AND BETTISFIELD MOSS

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Key words: Peatlands, Restoration, Palaeoecology, Hydrology, Climate modelling

Peatlands are among the most important terrestrial carbon stores, yet many UK systems remain heavily modified by drainage, extraction, burning, and atmospheric pollution. Determining whether restored peatlands are recovering or shifting into new ecological states is critical. This study focuses on Fenn's, Whixall and Bettisfield Mosses, a formerly cut lowland raised bog on the English midlands and Wales border, with a well-documented restoration history and extensive hydrological monitoring.

A multi-proxy approach integrates palaeoecological reconstruction with contemporary monitoring to evaluate peatland condition and resilience. Testate amoebae are used to reconstruct past hydrological variability, with transfer functions providing quantitative estimates of water-table depth. These data are combined with geochemical indicators, spheroidal carbonaceous particle (SCP) chronologies, long-term vegetation monitoring, and national atmospheric deposition datasets, including ammonia and rainwater chemistry spanning several decades.

Results indicate that present-day peatland conditions are strongly influenced by legacy effects of industrial pollution, peat cutting, and fire. Elevated metals and nutrient concentrations, alongside SCP profiles, demonstrate sustained anthropogenic impact. Hydrological reconstructions and vegetation trends reveal spatially variable recovery, with some areas exhibiting drying despite restoration, while others show clear evidence of repeated burning. These findings suggest that restoration may not return peatlands to pre-disturbance states but instead produces heterogeneous and potentially novel ecohydrological conditions.

To assess future vulnerability, climate data (HadUK-Grid) and UKCP18 projections are combined with CHESS-PE evapotranspiration datasets to model climatic water balance (P − PET) under RCP4.5 and RCP8.5 scenarios, enabling scenario-based evaluation of peatland drying risk. This approach is being extended to contrasting upland blanket bogs, from the relatively remote Kielderhead (northern England) to the industrially impacted Dark Peak (located between Manchester and Sheffield), providing a broader approach to evaluating peatland response to past and future environmental change.

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NITROGEN AND PHOSPHORUS LOSSES AND RETENTION BEFORE AND AFTER REWETTING OF A PUMP-DRAINED AGRICULTURAL WETLAND

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Key words: Nitrogen removal, Phosphorus retention, Reestablishment

Lake Gammelgaard in Eastern Jutland with an area of 44 ha was pump drained from 1957 to July 2023, where the lake was reestablished. We started the monitoring program in autumn 2019 and it has continued until now. Thus, at present we have mass balances of N, P and TOC 4 years before and 2 years after reestablishment. In the years 2020, 2021, 2022 and 2023 before reestablishment the loss of TN pumped out amounted to 24, 48, 25 and 26 kg TN ha^{-1} $year^{-1}$. During the same period 1.0, 1.6, 1.4 and 1.8 kg TP ha^{-1} $year^{-1}$ was pumped out. The loss of TOC before rewetting varied between 159 og 283 kg TOC ha^{-1} $år^{-1}$. In August 2021, June and August 2022 and June 2023 harvesting of biomass took place, and 104.9, 93.5, 94.6 and 70.7 kg N ha^{-1} and 8.8, 9.3, 6.9, and 6.5 kg TP ha^{-1} was removed.

Re-establishment of Lake Gammelgaard resulted in retention of nitrogen, which was calculated to be 100 and 49 kg TN ha^{-1} $year^{-1}$ in the first and second year, respectively, and with an efficiency of 53% and 49% of the load. After re-establishment of the lake, there was still loss of phosphorus, but the loss decreased significantly to 0.74 and 0.01 kg TP ha^{-1} $year^{-1}$ in the first and second year, respectively. After rewetting the loss of TOC continued to be high with a loss 263 and 139 kg TOC ha^{-1} $year^{-1}$.

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LONG-TERM MOISTURE REGIMES IN A WOODED RAISED BOG IDENTIFIED FROM SENTINEL-1 SAR TIME SERIES

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Key words: Wooded peatland, Synthetic aperture radar (SAR), Sentinel-1 backscatter, Moisture regime, Unsupervised clustering

Wooded peatlands are increasingly widespread across northern Europe, yet their hydrological conditions remain difficult to monitor because dense vegetation, uneven surfaces, and limited accessibility constrain both field measurements and traditional remote sensing approaches. In these environments, direct relationships between SAR backscatter and hydrometeorological variables are often weak, limiting the applicability of conventional event-based moisture assessments.

This study investigates whether long-term moisture regimes in a wooded raised bog can be identified using Sentinel-1 C-band SAR time series. The analysis was conducted in the Raudonoji Bala raised bog in eastern Lithuania using Sentinel-1 data acquired during the growing seasons from 2015 to 2025. SAR backscatter metrics (VV, VH, VH/VV ratio) were integrated with meteorological variables and hydro-topographic descriptors derived from a LiDAR-based DEM within a 10 m analysis grid. Relationships among variables were explored using correlation analysis and principal component analysis, followed by unsupervised K-means clustering to detect recurring SAR-derived moisture regimes. The optimal solution identified five clusters, which were subsequently interpreted and grouped into three broader moisture regimes: dry, intermediate, and wet. The results were evaluated using independent in situ water-table depth measurements.

The results show that SAR backscatter in wooded peatlands reflects integrated hydro-topographic and vegetation-related conditions rather than short-term meteorological variability. The identified clusters form a persistent relative wetness gradient, while the three derived moisture regimes reveal a clear long-term spatial pattern: dry regimes dominate most of the peatland, intermediate regimes form transitional areas, and wet regimes occur only in small localized patches.

These findings demonstrate that a regime-based interpretation of Sentinel-1 SAR time series provides a practical framework for long-term moisture monitoring in wooded peatlands.

SCIENCE INTO ACTION: DIGITAL TOOLS FOR ENVIRONMENTAL EDUCATION AND CITIZEN SCIENCE IN FLOODPLAINS AND WETLANDS

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Key words: Citizen science, Digital tools, Environmental education, Floodplain restoration, Wetland ecosystems

The restoration of floodplains and wetlands is not only an ecological but also a societal challenge, requiring the involvement of stakeholders and the broader public. Long-term success depends on awareness, participation, and a shared understanding of ecosystem functions and services, with environmental education and citizen science fostering engagement, acceptance, and sustained commitment.

Within the EU Horizon project Restore4Life, innovative, freely accessible, ready-to-use tools have been developed. Central to this effort is the fully released “Living Floodplains Digital Toolbox”, an interactive platform combining digital learning resources, participatory formats, and monitoring tools: (1) illustrations that make complex ecological topics, such as water retention, habitat assessment, carbon sequestration, and recreation, accessible and engaging for young people aged 10–18; (2) the “Restore4Life 5E Teaching Materials”, providing lesson plans and worksheets for indoor and field activities based on the 5E learning model; (3) the “Wetland Education Repository”, a curated collection of educational activities and best practices from across Europe; (4) the online game “Blue-Green Space4All” on blue-green infrastructure and sustainable spatial planning; (5) the participatory workshop format “Wetland Fresk”, inspired by Climate Fresk, to explore wetland ecosystem relationships; and (6) the citizen science app “Wetland4Life” for mapping and assessing wetlands. Complementing these tools, the “Indicator Toolbox for Assessing Ecosystem Services of Wetlands” provides indicators and methods for assessing ecosystem services, including fact sheets and protocols for spatial and field analyses, suitable for experts and trained non-experts.

The presentation invites teachers, environmental educators, practitioners, researchers, and institutions to test, apply, and further develop these tools. All materials are freely accessible via the Restore4Life platform (https://education.restore4life.eu) and are available in several European languages.

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IMPACTS OF ERICOID SHRUBS ON PEAT PROCESSES IN FORESTED FEN AND BOG

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Key words: shrubs, peat, microbial growth, microbial necromass, tannins

Shrubification is driven across peatlands of Northern Hemisphere by climate change and forestry drainage but the impacts of shrubs on the peat carbon storage are not univocal. On one hand, the root exudates and drying effects of the shrubs can accelerate the decomposition processes, thus threatening the carbon stored in peat. On the other hand, shrubs can maintain or even support the accumulation of carbon in peat particularly through the production of secondary metabolites such as condensed tannins and through associations with ericoid mycorrhiza, both of which contribute to the formation of more persistent organic carbon compounds. Microbial carbon use efficiency (MCUE) – defined through carbon assimilation on microbial biomass and their respiration – provides an additional lens for evaluating carbon flow through peat soils. To better understand the shrub impacts on surface peat processes, we measured C mineralization rate, and bacterial and fungal biomass and growth, calculated microbial CUE, and determined concentration of condensed tannins in surface peat collected from homogeneous patches dominated by different shrub species or by *Sphagnum* moss (control). The shrub species included those typical of nutrient-poor peatlands (*Rhododendron tomentosum*, *Vaccinium uliginosum*) and those found across poor and rich peatlands as well as mineral soils (*V. vitis-idaea*, *V. myrtillus*). To account for site-level variation, sampling was conducted in two drained peatlands: a nutrient-rich spruce swamp and a nutrient-poor pine bog, both ditched for forestry in the 1960s – the golden decade of forest drainage in Finland. The outcomes suggest that in the nutrient poor site, the shrub effect on soil C processes is present, while in the rich site no differences between the moss- and shrub-covered patches were not detected.

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THE HYDROLOGICAL RESTORATION POTENTIAL OF SMALL LANDSCAPE DEPRESSIONS IN THE NETE CATCHMENT IN BELGIUM: AN ECOSYSTEM SERVICES-BASED APPROACH

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Key words: Ecosystem services, Landscape depressions, Land use change, Upstream depressional wetlands, Wetland restoration

Small depressional wetlands can deliver many essential ecosystem services and affect landscape hydrological regulation, carbon storage, and biodiversity. However, their limited size and spatial isolation often exclude them from wetland inventories. They are also vulnerable to human alterations, such as filling them or draining them to lower groundwater tables, which results in connecting both surface and subsurface flows to the river network by ditches and prevents their natural functioning. We investigated the restoration potential of small landscape depressions in the Nete catchment within the sandy Campine region in the north part of Belgium, and how this restoration affects the provisioning of ecosystem services (ES).

A topography-based delineation of 20,843 potentially restorable surface depressions, including 4600 upstream depressional wetlands was made. Depressions were classified in five levels based on their geomorphological properties such as lotic position, wetting duration, but also current land use within the depression. The ECOPLAN-SE tool was used to evaluate changes in provisioning and regulating ES before and after restoration. Our results show that restoration can strongly increase regulating services, particularly soil carbon storage and runoff storage capacity, while provisioning services such as food production and wood production often decline. A distinction was made between “no-regret” depressions, where no negative impact on any of the investigated ES was found and “high-regret“ depressions, where only a positive effect was found on water quantity related ES, but all other ES decreased.

The ES quantification highlights the importance of context-specific restoration planning. These small depressional wetlands can significantly enhance landscape-scale climate resilience by mitigating both floods and droughts. Although in many locations restoration comes with trade-offs and challenges, policymakers could use these results to identify “no-regret” depressions in their region to restore and preserve these important landscape elements.

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FUNCTIONAL ZOOPLANKTON INDICATORS OF TROPHIC STATUS AND ECOSYSTEM RESILIENCE IN SMALL AND SHALLOW WATER BODIES

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Key words: anthropogenic stress, bioindication, ecological assessment, functional traits, rotifers

Small and shallow water bodies play a crucial role in maintaining regional biodiversity, water retention, and landscape-scale ecosystem functioning, yet they remain insufficiently represented in ecological assessment frameworks. This study investigates how zooplankton communities respond to environmental gradients, habitat complexity, and anthropogenic pressures, and evaluates their applicability as bioindicators of trophic status and ecosystem resilience.

Field-based surveys conducted across water bodies representing contrasting catchment types were combined with functional trait analyses and community-based trophic indices. Zooplankton assemblages were examined in relation to macrophyte cover, nutrient enrichment, and key physicochemical parameters to assess structural and functional responses to environmental stress.

Results indicate that macrophyte-dominated systems support more diverse and functionally complex zooplankton communities and are generally associated with lower trophic states and greater ecological stability. In contrast, water bodies exposed to agricultural or urban influence tend to exhibit simplified community structures, increased dominance of nutrient-tolerant taxa, and higher trophic conditions. The degree of human impact in the immediate surroundings significantly shapes community composition. However, even under strong anthropogenic transformation, macrophyte-rich systems may function as refugia for diverse and ecologically valuable species, provided that habitat heterogeneity is maintained.

Community metrics and zooplankton-based trophic indices proved sensitive to environmental gradients and consistent with established trophic classifications, supporting their usefulness in ecological assessment. The results highlight the potential of functional zooplankton indicators as practical tools for monitoring and managing small aquatic ecosystems under ongoing environmental change.

ISSUES OF PEATLAND RESTORATION ACROSS SCALES: A REVIEW AND META-ANALYSIS

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Key words: wetlands, water level, mires, fen, bog

Although peatland restoration has been widely promoted as a strategy for reducing carbon emissions and restoring hydrological function, its effectiveness remains context-dependent and highly variable across regions and methods. This study presents a systematic review and meta-analysis of 52 peer-reviewed studies from 2014 to 2024, synthesizing the ecohydrological impacts of restoration across multiple spatial scales and implementation types. In tropical peatlands, restoration frequently reduced CO_2 emissions by more than 65,000 $kg \cdot ha^{-1} \cdot yr^{-1}$ and increased carbon sequestration up to 39,700 $kg \cdot ha^{-1} \cdot yr^{-1}$, with moderate CH_4 increases (~450 $kg \cdot ha^{-1} \cdot yr^{-1}$). In boreal sites, CO_2 reductions were generally below 25,000 $kg \cdot ha^{-1} \cdot yr^{-1}$, with long-term carbon accumulation reported in other studies, typically around 2–3 $tCO_2 \cdot ha^{-1} \cdot yr^{-1}$. Higher values in our dataset likely reflect the limited number of boreal studies and the influence of short-term measurements. Across all regions, restoration was also associated with an average rise in WTD up to 10 cm. These averages were derived from studies conducted across diverse climatic zones, showing high standard deviations, indicating substantial inter-site heterogeneity. These differences emphasize the need for region-specific assessments rather than global generalizations, highlighting the importance of adaptive restoration strategies that balance carbon dynamics with hydrological resilience in the face of climate change.

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LINKING MICROBIAL COMMUNITIES TO NUTRIENT AND METAL CYCLING IN EUROPEAN WETLANDS UNDER DIFFERENT MANAGEMENT REGIMES

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Key words: wetland; peatland; microbiome; methane; nitrous oxide

European wetlands have undergone extensive degradation, with an estimated 56–80% of their historical area lost over the past 75 years. Understanding how microbial communities involved in macronutrient and metal cycling respond to these changes can help reveal the key microbial drivers of wetland biogeochemical processes.

This study explores how different management practices shape soil microbial community composition and ecological functioning related to nutrient and metal cycling across European wetlands, based on data from wetlands in six European countries (Latvia, Finland, Estonia, France, Spain, and Belgium). The study includes 36 sites, representing eight ecosystem types: unmanaged wetlands, rewetted wetlands, former peat extraction areas, grazed peatlands, reforested peatlands, drained peatland forests, continuous cover forestry (CCF), and treatment wetlands. Soil samples were collected from three depths (0–10, 10–20, and 20–40 cm) in autumn 2023 and sequenced to characterize microbial communities and their associated functional potential. In addition, soil physicochemical properties and in-situ greenhouse gas (GHG) emissions were measured.

Bacteria, archaea, and fungi revealed shifts in community compositions between unmanaged and human-altered ecosystems, demonstrating that management alters both community composition and potential functional pathways. Rewetting promoted recovery of natural bacterial and archaeal communities, including methanogens and methanotrophs, resulting in rewetted sites that are microbiologically similar to unmanaged reference wetlands. Drained and managed sites harbour microbial communities that favour CO_2 and N_2O production. Analyses further indicate that variations in metal concentrations across sites contribute to differences in microbial community structure. Fungal alpha diversity remained stable across management types, whereas bacterial Chao richness index values were high in nutrient-rich alluvial soils. Unmanaged wetlands exhibited the highest archaeal Chao richness index values, with some sites exceeding 1000 taxa. Understanding microbial responses to different wetland management practices provides valuable insight for conservation and restoration efforts, supporting more informed ecosystem management decisions.

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TWO PARTIAL REVIVALS OF A DRAINED PANNONIAN SHALLOW LAKE

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Key words: lacustrine wetland, lake drainage, lake restoration, Pannonia, wetland vegetation

Until its drainage and conversion to arable land in the 1830-ies, the Lake of Kobylí (Kobylské jezero) belonged to the largest natural lakes (up to 10 km^2 during floods) of the present Czechia. It was situated in the Trkmanka rivulet alluvium, at the northern borderline of the Pannonian basin. Its water was slightly brackish, with small salt marshes occurring along its shores. Maintenance of the drainage system was interrupted in 1938 and then carried out only spuriously. In the precipitation-rich years of 1960-66, impeded drainage + increased soil erosion in the Trkmanka catchment resulted in silting of its bed and water seepage into the drained area. As a consequence, water-logged marshes and shallowly flooded sites (up to 1 m) got established on about 2/3 of the former average lake area (some 300 ha). In 1965–67, we investigated the microclimate, vegetation succession, biomass production and mineral nutrient uptake in the main plant communities. On the deepest-flooded sites, the replacement of monodominant *Typha latifolia* stands by those of *Phragmites australis* was facilitated by the preferential grazing on *T. latifolia* of muskrats (*Ondatra zibethica*, up to 57 individuals per 1 ha). This spontaneous partial lake revival ended in 1967, after deepening of the Trkmanka rivulet + drainage ditches. The entire thereby reclaimed area was then re-converted to arable land. The next partial lake revival, accomplished between 2003 and 2015, was intentional and gave rise to two wetland patches: one (16 ha) in the former lake´s southern part + one (about 6 ha) in its northern part. Apart from marshes to which halophytes are now returning, they comprise 5 excavated pools with littoral belts in which *Typha angustifolia* soon gave way to *Phragmites australis.* The coypu (*Myocastor coypus*) has become the locally most important aquatic mammal. Its feeding preferences remain to be investigated.

Acknowledgement

The presentation will pay tribute to its deceased co-authors, especially to Josef Svoboda, who turned our attention to the remarkable resilience of the Lake of Kobylí.

RETHINKING FORESTRY ON PEATLANDS: PALUDISILVICULTURE AS A NOVEL MANAGEMENT APPROACH

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Key words: peatland forestry, peatlands

Northern Europe is rich in peatlands, which play a major role in regional climate change mitigation and adaptation. Drained peatland forests cover altogether about ten million hectares, being especially common in Finland, Sweden, Estonia, and Latvia, but found also in, e.g., northern Germany, Poland, and the Czech Republic. These forests are regionally important forest resources, yet they are also the largest source of soil-based greenhouse gas emissions and of carbon and nutrient loading into watercourses within the forest sector.

Pristine peatlands often have high water-table levels (WTLs) near the soil surface and sparse or absent tree cover. This view has strongly shaped the concept of paludiculture, which focuses on crop cultivation under wet conditions and often perceives tree production as problematic because trees generally require lower WTLs. However, many northern peatlands naturally support trees, and their WTLs can fluctuate substantially throughout the year.

Our WTL monitoring data from forested, undrained peatlands show that during the growing season the mean WTL can drop by more than 25–30 cm – low enough to support tree growth – while the ecosystems continue to accumulate organic material (peat). Based on these insights, we propose a new concept: paludisilviculture, a forest management approach inspired by paludiculture but grounded in knowledge of both naturally forested undrained peatlands and drained peatland forests. Paludisilviculture emphasizes catchment-scale planning, with a particular focus on raising and regulating WTL as the key factor controlling soil greenhouse gas emissions, reducing peat loss, and improving the overall sustainability of peatland forestry.

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WETLANDS IN THE CROSSFIRE: IMPACTS OF ARMED CONFLICTS ON WETLAND ECOSYSTEMS

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Key words: Armed Conflicts, Conservation, Restoration, Wetlands

Wetlands are tremendous assets for humanity. The total median annual value of the ecosystem services that wetland ecosystems provide is estimated at ~$8–39 trillion, which is around 8–37% of global GDP; these ecosystems are ultimately important for national security as, for example, they protect communities from extreme events. However, wetlands do not receive the policy makers' and media's full attention they deserve and the impacts of armed conflicts on wetlands and other ecosystems are often overlooked. We examine the multiple effects of conflicts and consider both direct (e.g., spraying with Agent Orange) and indirect (e.g., destruction of infrastructure) pathways through which armed conflicts affect wetland ecosystems. At the same time, armed conflicts may produce temporary positive effects by limiting or eliminating other human pressures, such as drainage for agriculture or urbanisation. To explore these dynamics, we investigate case studies from Ukraine, Mesopotamia, Kuwait, Nicaragua-Costa Rica conflict, and the Mekong Delta amongst others, to identify drivers of conflicts and associated wetland impacts.

Our analysis highlights the need to better understand the complex relationships between armed conflicts, environmental degradation, and ecosystem governance. Our key recommendations are that: 1) governments significantly increase their spending for biodiversity conservation (from around 0.25% of global GDP—compared with military expenditures of approximately 2.4% of global GDP), including for wetlands; 2) funding is allocated (for example, by the Ramsar Convention on Wetlands) to evaluate the negative and positive effects of armed conflicts on wetlands and to initiate remedial responses; and 3) the impacts of armed conflicts on wetlands are addressed in global environmental assessments (e.g. by UN bodies). Protecting these critically important ecosystems in an equitable manner—including involving Indigenous Peoples and local communities and harnessing the potential of wetlands as Nature-based Solutions—can help reduce conflicts between wetland users while supporting biodiversity conservation and human wellbeing.

FROM RESISTANCE TO OWNERSHIP: BUILDING LASTING STAKEHOLDER SUPPORT FOR URBAN AND PERI-URBAN WETLAND RESTORATION

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Key words: functional wetlands, stakeholder co-creation, hydrological connectivity, urban wetland governance, social-ecological resilience

Wetland restoration in urban and peri-urban contexts often faces resistance rather than enthusiasm. While ecological benefits are clear, public perception, land-use conflicts, agricultural interests, economic concerns and governance fragmentation frequently slow down or block implementation.

The LIFE-*Wetlands4Cities* project demonstrates that long-term wetland functionality depends as much on social infrastructure as on hydrological design.

Aligned with the conference theme of functional wetlands as drivers of hydrological connectivity and resilience, this presentation explores how stakeholder co-creation strengthens ecological outcomes. Urban wetlands play critical roles in flood attenuation, nutrient retention, microclimate regulation, and biodiversity support. Yet climate pressures and competing land uses intensify conflicts around space, water allocation, and investment priorities. Moving from “resistance of restoration” toward “co-creation of restoration” can transform these tensions into shared ownership and collective stewardship.

Drawing on practical experience from multiple restoration sites, we present tested methods for building durable social and political support for wetland restoration, shifting from consultation to co-creation. We will focus on four stakeholder groups and share practical lessons on what works—and what doesn’t—when engaging them. The stakeholder groups are:

- Citizens: understanding resistance (and how to take it away), citizen science as entry point, participatory design trajectories and educational games, …
- Private landowners / farmers: incentives and compensation mechanisms, demonstration plots and peer learning, Long-term co-management and lease agreements, …
- Companies and private stakeholders: financing and sponsorship models that work, water stewardship approaches etc…
- Policy makers: framing wetlands as multifunctional systems (well-being, health, biodiversity…), cross-departmental collaboration, ‘sponge city label’ as enabler,…

Participants will leave inspired and equipped with actionable frameworks to embed social resilience into wetland restoration, strengthening not only landscape hydrological connectivity but also the human networks that sustain it.

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INFLUENCE OF SOLAR PANELS ON MICROCLIMATIC CONDITIONS AND PLANT GROWTH IN A REWETTED PEATLAND PV SITE

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Key words: biodiversity, biomass production, peatlands

Rewetted peatland PV has emerged in Germany as a way to rewet peatlands while generating renewable energy. This novel land use has the potential to reduce greenhouse gas emissions from drained peatlands, while generating green energy and providing alternative income sources for land owners. However, little is known about the effects this will have on the microclimate and plant growth. Research on solar parks on mineral soils suggests that moisture, light, and temperature differ when comparing the conditions under solar panels to between solar panel rows. These microclimatic differences shape species diversity, aboveground biomass production, and bloom time. However, no studies of this nature have been conducted on rewetted peatland PV sites. We assessed these factors in a rewetted peatland PV site in northern Germany, comparing under panels, panel rows, and areas with no panels to determine the differences in microclimate and the effects on plant growth. Our results indicate, contrary to findings from many other solar parks, that species diversity does not differ based on proximity to panels. However, it is not yet clear the role that solar panel hight, size, and set up has on this finding. This work provides first insights into the factors shaping plant growth in a rewetted peatland PV site, and highlights the opportunities for future research.

BIOCHEMICAL MODELING-GUIDED COLLABORATIVE GOVERNANCE FOR ADMISSIBLE NUTRIENT FLUXES IN EUTROPHIC MEDITERRANEAN LAGOONS

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Key words: Biogeochemical modeling, Coastal lagoon eutrophication, Hydrological connectivity

European coastal lagoons suffer extensive eutrophication, with nutrient accumulation impairing their hydrological connectivity and buffering functions across hundreds of systems. In French Mediterranean lagoons specifically – where 15 of 29 assessed water bodies show degradated ecological status due to excess nutrients – the *Flux Admissible* mission supports managers in quantifying incoming nutrient fluxes and their impacts on coastal lagoons.

Through the **GAMELag** biogeochemical model, it follows a structured approach: (1) representing internal lagoon dynamics through N-P fluxes in primary production compartments (plankton, macrophytes) and sedimentary processes including organic matter accumulation; (2) testing *ex-ante* management scenarios co-constructed with local stakeholders to identify beneficial vs. ineffective measures; and (3) defining admissible nutrient fluxes alongside targeted management actions required to restore good ecological status under variable hydrological regimes.

Applications across French Mediterranean systems demonstrate enhanced catchment-lagoon connectivity boosting nutrient buffering, stabilizing ecosystems, and enabling sustainable water storage while balancing ecosystem benefits with local community needs (e.g., fishers' livelihoods).

Flux Admissible fosters scientist-manager dialogue, delivering a transferable framework for Mediterranean wetland restoration that supports EU Water Framework Directive goals, SDG 6.6.1, and Ramsar Convention wetland resilience.

25 YEAR (2020–2025) DYNAMICS OF *SPHAGNUM* MOSS SPECIES AND FUNCTIONAL RESTORATION IN WORLDS FIRST PERCOLATION ISPANI 2 MIRE, GEORGIA (SAQARTVELO)

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Keywords: *Kolkheti, percolation mire, Sphagnum moss, restoration*

Over the past two decades (2002–2022), worlds first percolation Ispani 2 mire in Kolkheti lowland (Georgia), has undergone significant ecological transformation, particularly in *Sphagnum* moss composition. Historical stratigraphic analyses indicate that *Sphagnum austinii* was the primary peat-forming species in the 19th century. Subsequent anthropogenic pressures including forest clearing, drainage, and peat extraction disrupted the hydrological regime, leading to substantial declines in *Sphagnum* populations.

Recent field surveys and updated vegetation mapping show a marked recovery of peatland vegetation. *Sphagnum austinii* has regained dominance in the mire, while *Sphagnum palustre* has expanded to secondary meadows and reforested areas, forming near-monodominant patches. *Sphagnum papillosum* dominates transitional zones, with occasional presence of *S. rubellum*. Concurrently, invasive species and fire-affected areas have been substantially reduced, reflecting improved ecosystem resilience.

Functional assessment indicates that Sphagnum recovery has restored key peatland processes. The mosses' high water retention capacity has stabilized the water table, re-established anoxic conditions, and reactivated peat accumulation, enhancing carbon sequestration potential. Declines in competitive vascular plants such as *Carex* spp. and *Rhynchospora alba* further highlight a shift towards natural ombrotrophic conditions. These biotic and abiotic changes underscore the peat bog's transition from a degraded carbon source to a functional carbon sink, with improved biodiversity and hydrological regulation.

Our findings demonstrate the importance of long-term monitoring for assessing peatland restoration success and provide critical insights for conservation and management of subtropical Sphagnum ecosystems. This case study highlights how targeted restoration efforts and natural succession can recover both structural and functional aspects of degraded peatlands, supporting climate mitigation and biodiversity objectives.

MEASURING GHG EMISSIONS IN A REWETTED FORESTED PEATLAND AS PART OF THE GERMAN PEATLAND MONITORING

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Key words: chamber system, GHG emission, rewetting, forest peatland monitoring

Forested peatlands in Germany represent a significant carbon (C) reservoir, storing on average 1,242 t C ha^{-1}. The past drainage of these peatlands transforms them into substantial greenhouse gas (GHG) sources and triggers a significant loss of soil organic carbon (SOC). However, long-term data on greenhouse gas (GHG) emissions during the rewetting of forested peatlands are rare. To track changes in stored C and to derive emission factors for organic soils under forests, Germany maintains a peatland monitoring program with 50 monitoring sites located in forested peatlands. Such data are important for IPCC reporting and to analyse how GHG emissions respond to rewetting over the long term.

To investigate long term GHG emissions dynamics from a forested peatland undergoing rewetting, we established the intensive monitoring site “Großes Eisenstraßenmoor” in the Ore Mountains. CO_2, CH_4 and N_2O emissions are measured simultaneously using five automatic double-chambers towers. Each tower includes both a transparent and an opaque chamber, allowing for the sequential determination of the CO_2 flux components net ecosystem exchange (NEE) and ecosystem respiration (R_{eco}) from the same spot. To separate the tree root respiration from other respiration flux components, trenching was performed at two of the five chamber towers.

First results from summer 2025 show that the site is still a net source for CO_2 with an average flux of 3.20 µmol CO_2-C m^{-2} s^{-1}. This occurs at an annual average peat water level of −59 cm with fluctuations between −0,54 and −70 cm. Due to these fluctuations, the site remains also a small source of N_2O, with daily average values from up to 6.51 nmol N_2O-N m^{-2} s^{-1}. Tree root respiration accounts for 0.84 µmol CO_2-C m^{-2} s^{-1}. High CH_4 emissions of 20.95 nmol CH_4-C m^{-2} s^{-1} were measured in former ditches. To assess the long-term influence of rewetting on GHG emissions, measurements will be continued.

FRACTION MAPPING OF WETLAND VEGETATION WITH SENTINEL-2 USING SYNTHETIC SPECTRAL MIXTURES

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Key words: *Carex* spp, mapping, *Phragmites australis*, Sentinel-2, synthetic data

Seasonally flooded wetlands such as Lake Cerknica (Slovenia) pose challenges for landscape-scale vegetation data acquisition and monitoring. Remote sensing in such environments has become a widely adopted alternative to ground-based vegetation surveys, which are time-consuming and labour-intensive. Categorical supervised classification mapping, even when using high-resolution imagery, often oversimplifies vegetation patterns because vegetation in such systems is typically highly heterogeneous. We utilised synthetic mixtures of field-referenced training pixels derived from Sentinel-2 imagery to train a multi-output neural network regression model predicting the fractional cover of reeds and tall sedges during the 2024 growing season. In total, 30,000 synthetic mixtures were generated from 75 pure reference pixels sampled in the field. The resulting fractional cover map was validated against 334 plots interpreted from UAV-based high-spatial-resolution orthomosaics. The approach proved highly efficient and accurate, with reeds mapped most accurately (MAE = 7%, RMSE = 10%, R^2 = 0.88), followed by tall sedges (MAE = 10%, RMSE = 16%, R^2 = 0.81) and the background class (MAE = 10%, RMSE = 16%, R^2 = 0.66). The resulting fractional map was compared with historical habitat mapping conducted in 2009. The comparison revealed that reed-dominant (reed > 50%) and co-dominant (reed 25–50%) areas declined by 74% and 59%, respectively, and were largely replaced by tall sedge-dominated vegetation, which increased by 363%. Overlaying historical annual mowing extent maps showed that reeds remained stable in areas without mowing, whereas reeds were replaced by tall sedges in areas subjected to moderate or intensive mowing. These results demonstrate the accuracy and practicality of the proposed mapping approach in intermittent wetland systems and highlight how such maps can be combined with other spatial data to support ecosystem management decisions.

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RAISED BOG RESTORATION FOR CLIMATE CHANGE MITIGATION

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Key words: hydrology, ecological restoration, peatlands, mire vegetation

Peatland ecosystems play not only a major role in the mitigation of climate changes and carbon storage but are also extremely valuable for the conservation of the species and habitat diversity. Drained and damaged peatlands are a source of greenhouse gas emissions. Within the EC LIFE project LIFE PeatCarbon in Latvia hydrological regime is restored at two locations – Cenas Mire and Lielais Pelečāre Mire. Geology, hydrology and vegetation of each site were thoroughly examined to perform elaboration of Hydrology Restoration plans and benchmark the success of restoration. Hydrogeological model was elaborated for each site to assess the expected impact of restoration measures and finetune restoration plans. In addition vegetation and hydrological monitoring is implemetned in three previously restored sites: Cenas Mire (2006), Melnais Lake Mire (2012) and Sudas-Zvieru Mire (2017). Changes in vegetation cover and hydrological regime in the course of restoration activities in drainage-influenced areas along with near-natural control locations of raised bog was observed in permanent vegetation plots and hourly water level data.

Vegetation studies show that restoration results in the succession of plant communities towards the targeted active raised bog vegetation of wetter conditions. This was evident from the decreased abundance of species benefiting from drainage and the corresponding increase of species characteristic for wetter habitats. As there was a distinct rise of the water level, also the vegetation recovery was followed by re-appearance of moss species *Sphagnum cuspidatum* and decrease of the cover of heather *Calluna vulgaris*. Most important is the development of *Sphagnum* communities as they play a crucial role in raised bog carbon accumulation and hydrology sometimes referred to as ecosystem engineers or keystone species. The monitoring of peatland restoration shows progressive stabilization of hydrological regime after restoration activities, reappearance of wetland plant communities and increased rate of overgrowing of drainage diteches.

DRIVING MICROPOLLUTANT REMOVAL IN GREYWATER VIA MANGANESE- AND IRON- AMENDED CONSTRUCTED WETLANDS

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Key words: constructed wetlands, greywater, micropollutants, reactive materials

Reactive materials such as manganese oxides (MnOx; pyrolusite, ECOPOL Spółka z o.o) and granular ferric hydroxides (GFH; GEH Wasserchemie GmbH & Co. KG) are practical to enhance constructed wetlands (CWs) performance by influencing abiotic and biotic treatment processes through adsorption and redox-mediated transformations. Yet, information regarding their effectiveness in removing micropollutants with differing physicochemical properties, as well as the underlying abiotic and biotic mechanisms remains limited, particularly in greywater systems. To fill these gaps, three experimental series were performed using synthetic greywater spiked with selected micropollutants: 1) batch-mode CWs under various conditions (utilizing MnOx only), 2) a modified OECD 308 test to evaluate compounds' dissipation rates, and 3) pilot-scale vertical flow CWs operated during declining temperature conditions. Results showed that GFH and MnOx enhanced the removal of selected micropollutants in CWs relative to the control (sand). GFH outperformed MnOx for most of the target compounds in experiments 2 and 3, however, MnOx exhibited consistent, abiotic-driven high affinity for diclofenac. In experiment 1, MnOx achieved over 99% of diclofenac removal, a process that appeared to be temperature-independent abiotic oxidation. The superiority of GFH was further confirmed in experiment 3 despite declining temperature. Its performance was likely attributed to its higher surface area (enhanced abiotic adsorption), and greater abundance of prokaryotic and fungal communities, suggesting a synergistic contribution of abiotic and microbially-mediated processes. In experiment 2, dissipation of target compounds was predominantly driven by biotic processes, however, quantification of functional genes (Fe- and Mn-related genes and denitrifiers) suggested that the role of dissimilatory Fe/Mn reduction remained uncertain, potentially due to competition for shared electron donors. Meanwhile, plants' influence was largely overshadowed by media effects. Nevertheless, experiment 3 revealed that plant presence was more influential in MnOx- than GFH-amended CWs, particularly shown by consistent metoprolol removal (around 80%) observed in MnOx-planted treatment.

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PEATLANDS IN CENTRAL EUROPE – – THEIR DEGRADATION AND POSSIBLE RESTORATION

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Key words: Czech Republic, eutrophication, peat extraction, vegetation changes

Both ombrotrophic bogs and fens supplied by spring water are currently undergoing changes caused by a decrease in the water table, an increase in nutrient availability, and, in some cases, destruction by industrial peat extraction. We have studied changes in vegetation and some other biota following these environmental changes and have also observed spontaneous ecological succession after the direct disturbance of peatlands by peat harvesting. Ombrotrophic bogs, unless directly disturbed, are more or less stable, whereas fens are continuously deteriorating in their natural value and extent. Restoration after peat harvesting is possible only if the water table is raised close to the surface. Otherwise, woodland composed of common tree species develops, but it still has a higher natural value than any artificial tree plantation. Other groups of organisms usually follow the vegetation changes.

Acknowledgement

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THREAT TO SAVANNA LANDSCAPES OR ESSENTIAL PROTECTION AGAINST DESERTIFICATION? THE DUAL ROLE OF HYDROPERIOD IN DRYLAND WETLANDS

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Key words: Dryland, hydroperiod, landscape, remote sensing, savanna

In dryland ecosystems, the distribution of free water shapes animal distribution by concentrating them around the few locations where it is available. The few places able to retain the scarce water range from temporary to permanent wetlands, with highly variable hydroperiods. Wildlife gathers around these wetlands, leading to the emergence of a vegetation gradient due to foraging and trampling, called the piosphere. Although the existence of this type of landscape degradation is well described, the mechanisms underlying its size and intensity remain unknown. We hypothesize that high water reliability, i.e., longer hydroperiod duration, leads to greater animal concentration, resulting in a larger, more intense piosphere. While hydroperiod is known to enhance wetland vegetation resilience in temperate climates, little is known about its effects in drylands. Using a 36-year Landsat-based dataset of wetlands' hydroperiods in Hwange National Park, Zimbabwe, we calculated a proxy for piosphere size using a vegetation saturation model based on the Normalized Difference Vegetation Index and compared it across hydroperiod categories. Furthermore, the dynamics of vegetation, water, and bare soil surfaces around wetlands, depending on the hydroperiod, were studied using a linear unmixing model. We found that wetlands with longer hydroperiods exhibited wider, more degraded piospheres than those with shorter hydroperiods, while simultaneously maintaining larger, more stable water and vegetation surfaces. On the other hand, wetlands with shorter hydroperiods showed a decrease in water surface area, which was correlated with vegetation dynamics, suggesting that vegetation may be sensitive to hydrological changes. In ecosystems where wetlands are the only water source, the hydroperiod mediates a trade-off between woodland degradation and vulnerability to desertification. Across the landscape, spatial heterogeneity in hydroperiods may create a mosaic of hydrological resources for wildlife, shaping vegetation patterns at the ecosystem scale.

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INVENTORY OF THE STATE OF SPRINGS IN HORSKÝ POTOK BASIN (ŠUMAVA PLA, CZECH REPUBLIC)

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Key words: degradation, springs, vegetation, water regime

Springs are important sources of biodiversity and have a strong impact on the local climate, contributing to the overall stability of the landscape. Retaining water directly at the source contributes in a fundamental way not only to mitigating the impact of dry periods, but also the impacts of extreme precipitation by reducing the speed of runoff, retaining water in the soil profile, and in vegetation. This key function of springs has been disrupted on a large scale by their drainage in the past.

The inventory of the state of springs in Horský potok basin is part of the project, which aims to identify the main features of spring degradation caused by drainage, and the impact of restoration measures on the water regime. Recently, the current methodology for monitoring springs has been tested, and the state of the springs within the one basin has been evaluated.

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EXTREME WETLAND RESTORATION

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Key words: Construction, Design, Lessons, Wetland, Restoration

Restoring the River South Esk to a nature-rich and climate-resilient catchment is an ambitious project aimed at increasing the biodiversity value, climate resilience and ecological coherence of the upper River South Esk Catchment in the Angus Glens, Scotland.

As part of the project, the feasibilty, design and construction to restore wetland habitats at three different locations was undertaken. The vision of the project was to restore a network of wetlands in Glen Clova, increasing connectivity between the River South Esk and its floodplain to support Natural Flood Management and to enhance and improve the already important native flora and fauna of Glen Clova. Key wetland fauna includes Atlantic salmon, freshwater pearl mussel, curlew, redshank, lapwing, oystercatcher and snipe.

This paper will examine the design opportunities and constraints, and the construction challenges involved in wetland restoration on an actively farmed estate located in the Highlands of Scotland during a period where rainfall was double the annual average and the river was repeatedly in flood. It will present the lessons learnt and the compromises reached to deliver wetland restoration.

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THE INFLUENCE OF WATER TABLE LEVEL AND GRAZING ON CARBON ACCUMULATION IN SALT MARSHES

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Key words: Photosynthesis, *Phragmites*, Soil, *Spartina*, Tides

Vegetated coastal wetlands including salt marshes have a large carbon accumulation capacity. In Nordic salt marshes, livestock grazing is widely used in nature management. However, grazing could potentially alter the carbon dynamics in these ecosystems. As salt marshes are very dynamic ecosystems due to frequent tidal inundation, we hypothesized that the effect of grazing on the carbon stocks could be influenced by the magnitude of tidal inundation. Here we investigated the effect of grazing and tidal inundation on above and belowground biomass patterns, soil carbon stocks and a range of soil and plant trait parameters in five grazed and ungrazed Danish salt marshes. Grazing strongly reduced the aboveground biomass of salt marshes with low tidal influence, while grazing in sites with high tidal influence did not significantly affect the aboveground biomass. However, grazing reduced soil compaction, increased root depth, and stimulated belowground biomass allocation in these sites, likely as a compensatory response. This coincided with a higher organic matter content (LOI) for salt marshes with high tidal influence. Plant photosynthetic capacity was generally enhanced by grazing, however this did not drive higher soil organic matter content. More intense grazing and soil compaction (bulk density) seemed to be the limiting factor for belowground biomass production, as these parameters generally increased with lower tidal ranges. These results suggest that grazing can have a positive effect on carbon accumulation in low marshes more affected by tidal inundation, while grazing in high marshes with low tidal influence is more likely to have a negative effect on carbon accumulation. Therefore, high marshes should be considered restoration targets with restricted grazing to stabilize carbon losses.

ServiPeat – A TOOL FOR ASSESSING CO-BENEFITS OF PEATLAND REWETTING

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Key words: peatlands, rewetting, meta-model, decision support, restoration

Peatland degradation through drainage has led to widespread ecological, hydrological and climate-related impacts. ServiPeat is an online decision support system in peatland rewetting that addresses the need for an accessible, science-based tool to support restoration planning by providing estimates of expected outcomes under rewetting scenario through ditch-blocking. The tool is intended for use by land managers, restoration practitioners and other stakeholders engaged in peatland management.

The tool is based on a numerical groundwater flow model MODFLOW and incorporates empirical and physical algorithms. Parameters in the algorithm depend on the peatland type, ditch condition and other inputs provided by the user. The hydrological module calculates a number of ditch blocks necessary for successful rewetting, dam height and rewetting extent. The model quantifies water retention gains and estimates changes in CO_2 and CH_4 emissions, capturing the relationship between groundwater level and GHG fluxes post-rewetting. The biogeochemical module addresses concerns about potential water quality deterioration following rewetting, particularly from phosphorus and nitrate release. It uses empirical models using soil pH as a proxy. The biodiversity module, based on BioScore species distribution model, provides an estimate of relative species richness change for key taxonomic groups depending on water table depth. The economic module evaluates ecosystem services using indicative monetary values based on unit water storage costs and the average annual EU carbon permit price, reduced by estimated water remediation costs.

The tool does not provide exact engineering designs but offers insights that can support decision-making and guide further investigation or field assessment. It is particularly valuable in the early stages of planning, while exploring rewetting options or seeking to communicate potential outcomes.

Acknowledgement

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HYDROLOGICAL RESTORATION AND VEGETATION RECOVERY CONTROL GREENHOUSE GAS TRADE-OFFS IN REWETTED PEAT EXTRACTION AREAS

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Keywords: Greenhouse gases, Peatland restoration, Rewetting, Water table, Revegetation

Peatland restoration is an effective nature-based climate mitigation solution, yet its net benefit remains uncertain due to trade-offs among global warming potential (GWP)-based greenhouse gases (GHGs): carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Rewetting reduces aerobic peat decomposition and CO_2 emissions but can stimulate CH_4 production and episodic N_2O emissions, particularly during early restoration stages. Understanding how hydrology and ecosystem recovery control these fluxes is essential for improving GHG assessments and restoration strategies in hemi-boreal peatlands. This study investigates soil GHG dynamics across two Estonian peat extraction areas, Laiuse (rewetted 2019) and Ess-soo (2021), using the closed dynamic chamber technique during 2023–2025. Laiuse focuses on water level (WL) manipulation with natural regeneration, while Ess-soo combines rewetting with both natural and active revegetation. Key environmental parameters, including soil temperature, moisture, and groundwater table, were also monitored. Across both sites, clear hydrological and ecological controls on GHG fluxes were observed. At Laiuse, soil CO_2 fluxes including seasonal dynamics ranged from 3.9 to 164 mg C m^{-2} h^{-1}, highest under deeper WL, while CH_4 remained low and N_2O was seasonally variable, reflecting fluctuating oxidation conditions. These fluxes combinedly correspond to ~265 mg CO_2-eq m^{-2} h^{-1}. At Ess-soo, soil CO_2 fluxes were lower (18.6–80.0 mg C m^{-2} h^{-1}), CH_4 showed a wider range, and N_2O remained very low. The soil fluxes sum up to 180–210 mg CO_2-eq m^{-2} h^{-1}, with higher CH_4 contribution than CO_2 but negligible N_2O. Thus, rewetting reduces CO_2 but introduces CH_4 trade-offs, while revegetation stabilises fluxes and lowers net CO_2-equivalent emissions, highlighting the need to optimise both hydrology and ecological recovery for long-term climate benefits. Analysing hydrological measures alongside vegetation recovery and other key environmental parameters, this study advances process-based understanding of carbon–nitrogen trade-offs in restored peatlands, addressing a key gap in peatland restoration and greenhouse gas budgeting and supporting development of more efficient restoration methods and accurate long-term climate impact assessments.

A METHODOLOGICAL APPROACH TO SELECTING SUITABLE LOCATIONS FOR LANDSCAPE-SCALE WETLAND RESTORATION

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Key words: landscape adaptation, landscape analysis, spatial data, wetland restoration

Wetland-rich landscapes are more resilient and provide essential ecosystem services, including water retention, drought mitigation and climate change adaptation. Identifying suitable sites for wetland restoration is therefore a key step, particularly because many potential locations are spatially small and easily overlooked. Effective planning of wetland restoration requires understanding the drivers of wetland loss and evaluating factors that influence restoration success. This study introduces a methodological framework for selecting suitable sites for the restoration of extinct wetlands based on the analysis of spatially available environmental and land-use datasets. The approach evaluates 15 factors related to hydrology, soil conditions, landscape structure and human influence, classifying each location as suitable, neutral or unsuitable for restoration. We further assess spatial patterns of site suitability and test the relative importance of individual factors using GAM models to capture spatial effects and GLMMs to incorporate variability across landscape types. The proposed methodology supports systematic and evidence-based planning, helps identify data requirements and highlights limitations associated with heterogeneous environmental conditions. The framework is intended as a practical tool for local and regional stakeholders aiming to restore natural water regimes and strengthen climate adaptation measures in diverse landscape types.

PUTTING PLANS INTO PRACTICE: A PRACTICAL CASE STUDY ON WETLAND RESTORATION

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Key words: application, functional wetlands, best practices.

While scientific research on wetland ecology provides a robust understanding in wetland functioning and restoration, there is still a challenge in translating these scientific findings into tangible and impactful actions.

The ongoing LIFE-*Wetlands4Cities* project serves as an example of one of many projects aimed at restoring former wetlands, targeting the restoration of 360 hectares of degraded wetlands adjacent to the cities of Mechelen (BE) and Tilburg (NL). This project employs a multi-scalar approach: governmental partners focus on urban infiltration infrastructure and increasing the buffering capacity within city limits, while environmental practitioners implement large-scale restoration of waterways and their surrounding floodplains. The main goal of the project is focused around the climatic benefits of wetlands for cities, however, by restoring natural hydrological states in the nature reserves, the project is able to simultaneously achieve benefits for the local biodiversity. This combined approach results in an integrated solution that is well balanced and realized a synergistic “win-win” situation for both ecology and society and for all partners included.

The case study that will be presented here, focuses on the working area around Mechelen (BE) where the aim was to restore 320 hectares of wetlands. We present a comprehensive “road map” of the implementation process, detailing the practical aspect of such an undertaking: from initial literature review and site selection to securing diversified funding and identifying high-impact hydrological interventions. Finally, we evaluate the project’s realization and preliminary results. By sharing our experiences (both the good and the bad) and lessons learned from the field, this presentation offers helpful insights for practitioners and others looking to turn scientific research into effective nature conservation.

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NUTRIENT MOBILIZATION AND EXPORT FROM REWETTED FENS

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Key words: peatlands, rewetting, phosphorus, nitrogen, export

Nutrient mobilization and subsequent off-site export are a common concern and a potential hurdle to peatland rewetting. Numerous studies report phosphorus and nitrogen mobilization from peat soils following rewetting. These processes are strongly determined by, among others, biogeochemical iron and sulfur cycling and hydrological dynamics.

However, studies that quantify nutrient balances from rewetted peatlands at field-scale or landscape-scale remain scarce, as do direct comparisons of nutrient exports before and after rewetting. As a result, the key question of whether mobilized nutrients are actually exported to surrounding surface waters remains largely unresolved.

In this systematic review, we synthesize drivers of nitrogen and phosphorus mobilization and export from near-natural, drained, and rewetted temperate fens. We 1) summarize main processes that affect nutrient export, 2) evaluate existing empirical data on nutrient exports from rewetted fens, and 3) identify main uncertainties and knowledge gaps in predicting nutrient export.

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NITROGEN AND PHOSPHORUS COMPARTMENTALIZATION IN PHRAGMITES AUSTRALIS AND PHALARIS ARUNDINACEA IN CONSTRUCTED WETLANDS FOR WASTEWATER TREATMENT

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Key words: common reed, nutrients, reed canary grass, standing stock, wastewater

Phragmites australis (common reed) and *Phalaris arundinacea* (reed canary grass) are two most commonly used plants for constructed wetlands designed for wastewater treatment. It is generally agreed that constructed wetlands must contain macrophytes, however, during the evaluation of nutrient removal, macrophytes are often neglected. During the years 1993 and 2020 the aboveground and belowground biomass of *P. australis* and *P. arundinacea* was sampled and analysed for dry mass and nutrient content 33 and 12 times, respectively. For comparison, also natural stands were samples and broad literature survey was done as well.

The results revealed clear difference between the ratio of above- and belowground biomass. For *P. australis* the belowground/aboveground biomass ratios of 0.65 and 1.86 for constructed wetlands and natural stands were found. For *P. arundinacea* the respective ratios were 0.45 and 1.43. The very similar ratios can be drawn from the literature. Another substantial difference is higher production of leaves of *P. australis* in constructed wetlands as compared to natural stands. For *P. arundinacea* this difference was not found. Also, for *P. australis*, there is a big difference between root and rhizome ratio. While in constructed wetlands the roots comprise 13% of the belowground biomass, in natural wetlands this ratio is 22%. The combination of higher aboveground biomass and higher leaf production in constructed wetlands results in higher standing stocks of nitrogen and phosphorus available for harvesting and, thus removal. For phosphorus and nitrogen, this increase is about 25% and 40%, respectively for both *P. australis* and *P. arundinacea*. The study also confirmed the fact that the most important factor for standing stock amount is the biomass as the concentrations of nitrogen and phosphorus do not differ significantly among natural stands and constructed wetlands

AIRBORNE REMOTE SENSING FOR ASSESSING HYDROLOGICAL STRESS AND COOLING EFFECTS OF URBAN WETLANDS

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Key words: multisensor data, hyperspectral, LST, desiccation

Urban wetlands are increasingly recognized as key regulators of the urban microclimate. However, their cooling capacity depends on ecosystem condition, often degraded in cities due to anthropogenic pressure and climate change. Detecting wetland status at fine spatial scales remains challenging, particularly in fragmented urban landscapes where wetlands are small and disturbed. This study evaluates the potential of airborne remote sensing to characterize wetland hydrological stress and cooling effects.

Airborne thermal infrared (TIR) and hyperspectral (HS) data, supported by ground reference, were collected in August 2025 in Wrocław (SW Poland). Wetland condition was described using water presence and vegetation desiccation. Relationships between field data and remote sensing metrics (day/night land surface temperature (LST) and HS indices) were analysed using Spearman's rank correlation, moreover wetland LST was compared with other urban vegetation.

Results show that water presence is best captured by TIR data, particularly nighttime LST, while vegetation desiccation is better detected using HS indices (e.g. Photochemical Reflectance Index, Modified Red Edge Simple Ratio, Normalized Pigment Chlorophyll Index). These findings highlight the value of combining TIR and HS data for detecting hydrological stress and monitoring urban wetlands under climate change.

Acknowledgement

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IRON IS THE KEY IN REWETTED PEATLANDS BUT NOT THE ONLY ONE

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Key words: phosphorus, redox-processes, restoration, sorption

Peatlands store a substantial fraction of the global soil carbon pool. Widespread drainage and land use change have accelerated peat decomposition, while restoration efforts aim to reduce carbon losses and greenhouse gas emissions through rewetting. While the recovery of carbon sequestration remains a central objective, nutrient dynamics increasingly emerge as a main driver controlling ecosystem functioning in restored peatlands.

Among these controls, iron plays a particularly important role in linking redox processes, organic matter turnover, and phosphorus cycling. Reductive dissolution of iron(III) oxides under anoxic conditions can release previously bound phosphorus and increase its mobility within the peat profile and adjacent waters. However, iron minerals also can immobilize phosphorus under both oxic and anoxic conditions in form of adsorbed or precipitated phosphate minerals (like vivianite), thereby limiting nutrient availability. A plethory of interactions such as humic matter complexation of iron (II, III), iron(II) oxidation by nitrate and precipitation of iron(II) sulphides under strongly reducing conditions as well as concurrent phosphorus sorption and precipitation reactions eventually determine phosphorus pore water concentration and leaching.

In above processes iron functions as an electron acceptor in microbial respiration and thereby contributes to organic matter mineralization. Through this pathway, iron reduction can indirectly mobilize phosphorus bound within organic matter pools, linking carbon decomposition with nutrient release. These processes highlight the multifaceted role of iron as both a regulator of phosphorus retention and a driver of nutrient mobilization in rewetted peatlands. However, recent observations indicate that iron alone does not explain the emerging patterns of nutrient dynamics after rewetting. Additional controls related to hydrology, other peat properties, ground water quality and in particular pH appear to modulate phosphorus release and retention in rewetted peatlands.

EPIPELIC AND PLANKTONIC DIATOM COMMUNITIES IN THE LIMNOCRENE SPRING ZELENCI REVEAL AN INCREASE IN TROPHIC VALUES

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Key words: limnocrene spring; diatoms; wetland complex; underwater springs;

Zelenci is a limnocrene spring in the South-Eastern Alps, notable for its unique structure and, among researchers, for its high diatom diversity. The spring pool is surrounded by marshes and other types of wetlands, creating a picturesque landscape. Our aim was to assess how abiotic factors influence the structure of diatom communities in different habitats and to compare the trophic status over 10 years of investigation. Four sampling sites were chosen, two for tychoplankton and two for epipelon. *Achnanthidium minutissimum* was the most abundant species in both habitats, while *Navicula* was the most diverse genus (17 species). Planktonic diatoms dominated plankton samples, while motile ecological type dominated the epipelon. Of all diatom taxa, 23.5% had some endangerment status. Key factors influencing the Shannon-Wiener diversity index were water level, temperature, and concentration of NH_4^+. The most important abiotic factors for the tychoplankton community were temperature and NH_4^+, while the most important abiotic factors influencing the structure of epipelon communities were water level, NH_4^+, pH, and dissolved oxygen concentration. The trophic index revealed increasing inflow of nutrients to the spring; 10 years ago, they were oligotrophic to oligo-mesotrophic, whereas in the present, they are predominantly eu-mesotrophic to eutrophic, indicating human pressure from more remote parts of the catchment area.

Acknowledgement

We are grateful to Ajda Stare, Gea Anić, and Lan Glad Zidar for their assistance with fieldwork, including sample collection and in situ measurements.

COMPARISON OF TRADITIONAL AND MOLECULAR METHODS OF MACROINVERTEBRATE IDENTIFICATION FOR ECOSYSTEM QUALITY ASSESSMENT IN THE LITTORAL ZONE OF LAKE BOHINJ

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Key words: Benthic invertebrates, Ecological assessment, Littoral zone, Metabarcoding

The determination of benthic invertebrates based on morphological characteristics is still traditionally used in aquatic ecosystem assessment, but in recent years, molecular methods of identification have become more widely used. These methods enable the detection of taxa that are difficult to identify, such as juveniles or deformed individuals, and can contribute to a better assessment of species diversity in an area. To evaluate which method, or combination of methods, yields the most accurate and useful results with the lowest possible costs, we compared different approaches for identifying benthic invertebrates in the littoral zone of Lake Bohinj. These included metabarcoding of bulk samples of benthic invertebrates ("bulk"), metabarcoding of the preservative ethanol of the samples ("eDNA"), and traditional determination based on morphology ("morpho"). The samples were collected following the standard procedure used within the assessment of ecological status and split in half in the field. Each half was then treated separately according to the protocols for the specific method. There were no statistically significant differences in calculated Lake Biotic Indices (LBI) between the three methods. We detected more families using morphological methods, while DNA analyses of bulk samples and preservative ethanol provided higher taxonomic resolution at the species level. The most time-consuming method was "morpho," followed by "bulk," while the fastest was "eDNA." We reviewed the advantages and disadvantages of each method.

Acknowledgement

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Poster Presentations

SOCIETY of WETLAND SCIENTISTS
Europe Chapter

PEATLAND PHOTOSYNTHESIS UNDER HEATWAVE STRESS: VASCULAR ACCLIMATION AND BRYOPHYTE DECLINE

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Key words: peatland; heatwave; *Sphagnum*; chlorophyll a fluorescence; functional types

Heatwaves are intensifying across temperate Europe, posing increasing risks to peatland carbon budgets, which depend on photosynthesis by co-occurring vascular plants and *Sphagnum* mosses. How each functional type responds at the level of the photosynthetic apparatus under heat stress has been poorly studied by in-situ measurement.

We measured the fast chlorophyll a fluorescence transient (OJIP; JIP-test) in four functional types, the sedge *Carex* spp., the forb *Comarum palustre*, the dwarf shrub *Vaccinium oxycoccos* and *Sphagnum* spp., across nine plots at the Rzecin fen (NW Poland) spanning a joint water-table and nutrient gradient, on five occasions through the 2024 growing season including three warm episodes above 30°C (115 plot-by-campaign means). Chl content, meteorological variables and pore-water nutrients were recorded concurrently.

The three vascular types maintained high photosystem II (PSII) efficiency throughout: F_v/F_m ranged from 0.71 to 0.81 and the performance index (PI_{abs}) rose through the season in the forb and shrub (Spearman $\rho = 0.63$ and 0.56 versus day of year). Efficiency correlated positively with VPD in the sedge and shrub and with pore-water calcium in the forb and sedge, indicating photosynthetic acclimation to summer conditions rather than acute stress. *Sphagnum* spp. showed the opposite pattern: its quantum yield was lowest during the hottest campaign ($F_v/F_m = 0.34$) and it operated in a dissipation-dominated state, trapping only 43 percent of absorbed light and dissipating 57 percent as heat. The dissipated flux per reaction centre ($DI_O/RC = 7.8$) was twelve times that of the vascular types (0.5 to 0.9), and *Sphagnum* spp. was unresponsive to all measured drivers.

These findings reveal a fundamental divergence: vascular peatland plants acclimate photosynthetically under heat stress while *Sphagnum* spp. declines toward a dissipation-dominated state. Under continued warming and vascular expansion, community carbon uptake would shift toward a more responsive but less carbon-stable regime.

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ESTABLISHING EDDY COVARIANCE OBSERVATIONS OF CO2 EXCHANGE IN NATURAL AND EXTRACTED PEATLAND IN LATVIA

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Key words: CO_2 flux, Land-use change; Peat extraction.

Peatlands are key regulators of carbon storage and ecosystem functioning, yet large areas in Latvia have been drained and intensively used for peat extraction. While restoration efforts are increasingly implemented in abandoned extraction fields, ecosystem-scale CO_2 flux measurements remain scarce and are currently limited to chamber-based approaches. Continuous observations are particularly lacking for actively managed extraction sites, where emission dynamics remain insufficiently understood. In the context of Latvia's peat sector transitioning towards a climate-neutral economy, robust, science-based data are essential for informed decision-making.

To address this gap, we initiated eddy covariance measurements of CO_2 exchange in Latvian peatlands using Li-Cor Carbon Node systems. The first unit was deployed in August 2025 within an active peat extraction site (cutover bog), located centrally in a milled peat field. A second unit in a nearby natural raised bog (Natura 2000 site; < 5 km distance) enables comparative analysis under similar climatic conditions.

We present initial results focusing on system performance, data continuity, and the challenges of solar-powered operation. Early observations provide insights into CO_2 emission magnitude and temporal variability under active extraction. The ongoing multi-year monitoring will be complemented by hydrological and meteorological measurements to support integrated assessment of peatland processes.

Acknowledgement

The study is supported by a donation from the "Mikrotīkls", which is administered by the University of Latvia Foundation and by the project PeatTransform (No. 6.1.1.2/1/25/A/001).

SEASONAL DYNAMICS OF DISSOLVED ORGANIC MATTER IN RUNOFF FROM WETLANDS AND DRAINED PASTURES: INSIGHTS FROM SMALL EXPERIMENTAL CATCHMENTS

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Key words: experimental catchments, dissolved organic matter, drained pastures, seasonality, wetlands,

Headwater catchments play an important role in regulating dissolved organic matter (DOM) fluxes in mountain ecosystems. This study compared seasonal DOM dynamics in two nearby experimental catchments located in the Šumava Mountains, Czechia, characterised by contrasting land cover: the Horský catchment (a mosaic of wetlands, forests, and meadows) and the Mlýnský catchment (drained pastures). The local climate featured a mean annual air temperature of 5.5 °C and an annual precipitation of 1050 mm. While total precipitation remained stable, air temperature increased by 0.35 °C per decade, particularly in winter, with declining snow cover and longer snow-free periods. Recent UV–Vis optical characterization (2023–2025) was integrated with long-term hydrometeorological data (1998–2025) to assess dissolved organic carbon (DOC) concentrations, fluxes, and chromophoric dissolved organic matter (CDOM) optical properties ($SUVA_{254}$, $SUVA_{350}$, $S_{275–295}$, $S_{350–S400}$, E_2:E_3, S_R, %arom, CFOI) in surface runoff. Results revealed that seasonal hydrological cycles significantly dominated DOM dynamics. DOM composition exhibited limited spatial variability despite contrasting land cover. $SUVA_{254}$ and $SUVA_{350}$ peaked in summer, indicating increased aromaticity and microbial processing, while spring snowmelt was dominated by flushing of high-molecular-weight, humified DOM. Pronounced decoupling of DOC quantity and quality occurred during summer baseflow. DOC concentrations peaked in autumn (precipitation-driven mobilisation) and were lowest in summer baseflow. Spring and winter showed intermediate levels, modulated by snowmelt and site-specific hydrology. The drained pastures catchment (Mlýnský) exhibited markedly greater seasonal variability in DOC concentrations and fluxes, with the highest seasonal and annual carbon exports and strongest hydrological responses. In contrast, the Horský catchment showed higher average DOC concentrations but more subdued seasonal contrasts and less extreme export dynamics.These findings highlight the adverse effects of drainage in headwater mountain catchments on DOM export, documenting higher and more variable carbon losses from drained pastures than natural wetland-forest mosaics, with implications for montane landscape management.

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Research is supported by Department of Applied ecology, Faculty of Agriculture and Technology, University of South Bohemia in České Budějovice.

CLIMATIC DEPENDENCY OF WATER TABLE DYNAMICS AT HYDROLOGICALLY DISTURBED PEATLAND SITES IN THE WETLAND REGION "DIEPHOLZER MOORNIEDERUNG" (LOWER SAXONY, NW-GERMANY)

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Key words:

climatic water balance, peatland drainage, rewetting, water table

Water tables were recorded in two peatland areas (mainly raised bog) at twelve measuring points once per day for seven years (12/2018 – 11/2025). Four groups were assigned in three site classes: 1 wet open-land bog, 1 drier wooded bog, 2 peatland periphery / grassland.

Seasonal and interannual variability of water tables was assessed, with focus on the dependency on climatic water balance. Latter was approximated as the sum of precipitation and potential evaporation (grass, Haude) at the nearest weather stations. Further, multivariate interrelations were examined between climate-dependent water table dynamics and basic site characteristics.

The findings indicate substantial hydrological disturbance, which is in accordance to biotope-type-mapping data. Solely on the wettest sites in climatically very humid years, near-surface water tables were observed throughout the year. Regularly, water tables strongly declined during summer, also in rather humid years.

The observed differences in water table dynamics can theoretically be attributed to distinct site characteristics, mainly topography and drainage structures, soil stratigraphy and hydraulic blockage, vegetation cover and evaporation. Corresponding effects could partly be reproduced by multivariate statistics deploying simply deducible proxies: terrain relief, peat layer thickness, and tree stocking.

The peripheral areas under agricultural land use were particularly drying up during summers, which is due to ditch drainage, but also to soil-stratigraphic groundwater coupling, that is, caused by the lack or loss of soil layers with low hydraulic conductivity.

Under heavy drainage, water table changes appeared to be independent from climatic conditions. In such cases, the peat soil dried out not only in dry seasons, but water levels declined already under highly positive water balance.

The findings suggest that further measures of water retention are essential to ensure long-term conservation of the peat soils and the wetland ecosystems both on the unmanaged raised bog sites and the peripheral agricultural sites.

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THE HYDROLOGICAL RESPONSE OF WETLAND AND STREAM RESTORATION IN THE ŠUMAVA MTS., CZECHIA

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Key words: Restoration, groundwater level, streamflow, retention potential

The headwater area of the Šumava Mts. is characterized by a high proportion of different wetland habitats, especially peatlands and waterlogged forests. However, as in the rest of Europe, the wetlands in this region have been affected by various human activities in the past, including drainage, peat extraction and pipe drainage.

Rewetting wetlands is an effective way to restore a disturbed hydrological regime, increase water storage in the landscape and stop the degradation of these important ecosystems. The positive effect of restoration measures on groundwater level is well known and frequently discussed. As rewetting techniques have gradually developed, restoration now consists not only of damming drainage channels but it also includes the restoration of watercourses. The main objective is to restore the natural character of a stable stream bed with erosion and accumulation processes and re-establish the link between the stream and its floodplain. However, the impact of restoration on the runoff regime and on the individual components of runoff is ambiguous, particularly when the specific physical-geographic conditions of individual sites are taken into account.

The study from the Šumava Mts. confirms the positive effect of restoration on the groundwater level. It includes significant increase of groundwater level and reduction of its fluctuation. In case of rainfall-runoff episodes was observed that the duration of runoff episodes after restoration was significantly reduced, mainly due to an increase in water storage. An increase in baseflow (up to 20%) was also recorded, accompanied by reduction in runoff depth, runoff coefficient and direct runoff. This suggests a positive effect of stream restoration on hydrological regime. However, a comparison of two different ecosystems showed that each catchment must be studied individually, as significant differences were discovered between the observed sites, making any generalization of results difficult.

A SEVEN-YEAR ROLE OF PONDS ALONG A CREEK RECEIVING DRAINAGE DITCH INPUTS

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Keywords: ponds, creek, water quality, agricultural drainage, nutrient assessment.

Natural ponds receiving agricultural drainage remain insufficiently studied for nutrient removal, despite their potential to mitigate diffuse pollution. In the Czech Republic, the total number and condition of natural ponds are unknown, partly because of the country's long tradition of carp aquaculture, which left many ponds abandoned or repurposed for drainage. By 2023, 47% of the Czech Republic's watercourses were classified as polluted, another 23% and 10% as heavily and very heavily contaminated. Regulatory monitoring of drinking-water sources has focused primarily on nitrogen, phosphorus, and total carbon. Natural ponds have physical and biological constraints for nutrient removal. This study addresses this knowledge gap by evaluating nutrient and carbon dynamics in a series of five ponds connected along a creek receiving agricultural drainage and upland forest runoff.

A total of 83 water sampling campaigns were conducted monthly from 2019 to 2025 at 11 points along the five-pond cascade, fed by a small creek, a tributary of the Klíčava drinking water reservoir watershed, which is impacted by agricultural runoff. Monitored parameters included pH, conductivity, TN, TP, TC/TOC, anions, and NH_4^+, determined using Czech and EU standard methods. Various concentrations fell below detection limits, reflecting water quality typical of drinking-water sources. To ensure valid inference in the presence of censored data, heteroskedasticity, and temporal autocorrelation, a Tobit regression with robust HAC standard errors was applied, enabling unbiased estimation of spatial, seasonal, and interannual trends. Flow measurements, pond surface area ranges, and water volumes were used to derive areal removal rates.

Pond 2 (411 m²) exhibited the highest annual average nitrogen retention rate per area of 2.4 $gTN.m^{-2}.day^{-1}$, followed by Pond 3 (633 m²), achieving 1.6 $gTN.m^{-2}.day^{-1}$, while Pond 4 (1550 m²) achieved the highest annual average phosphorus retention of 0.043 $gTP.m^{-2}.day^{-1}$. Overall, the study shows that ponds contribute to nutrient retention, though site-specific factors and seasonal shifts strongly influence their performance.

WHO'S THE ECOSYSTEM ENGINEER HERE? *CAREX ACUTA* FORMS MICROTOPOGRAPHY IN A TEMPERATE SEDGE–GRASS MARSH

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Key words: Ecosystem engineer, LiDAR, Sedges, Terrestrial laser scanning

Surface microtopography in temperate marshes is strongly influenced by the growth forms of dominant wetland plants. In many sedge–grass marshes, the formation of tussocks by certain *Carex* species represents an adaptive growth strategy through which these plants function as ecosystem engineers, modifying habitat structure and facilitating the persistence of other wetland species. The decline of such ecosystem engineers may therefore lead to long-term changes in plant diversity and wetland microtopography.

This study examined tussock characteristics in five vegetation stands typical of a temperate sedge–grass marsh to evaluate potential microtopographic changes related to altered water regimes. Tussock morphology and spatial distribution were analysed using in situ terrestrial laser scanning, which allowed for detailed measurements of two-dimensional area, perimeter, height, roundness, and distances between neighbouring tussocks.

Tussocks of *Carex acuta* differed among vegetation stands in area, perimeter, height, and roundness, indicating that plant community composition influences tussock morphology. However, distances between tussocks were relatively similar and evenly distributed across stands. The tallest tussocks occurred in stands dominated by *Carex acuta* and in mixed stands with *Calamagrostis canescens*. Co-occurring species influenced tussock structure differently: *Glyceria maxima* and *Acorus calamus* significantly altered tussock height and shape, while *Calamagrostis canescens* had a weaker effect and primarily used tussocks as habitat.

The results suggest that frequent, shallow, short-term flooding is important for maintaining marsh microtopography by supporting tussock-forming ecosystem engineers and preventing the establishment of ruderal or invasive terrestrial species.

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WHAT CAN WE LEARN ABOUT SPRINGS ON AGRICULTURAL LAND?

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Key words: agriculture; archival maps; drainage; landscape changes; land-use; wetlands

This paper outlines procedures, methods and relevant data for identifying and potentially restoring springs on existing agricultural land in the Czech Republic. Using five different locations as examples, it presents a step-by-step analysis of historical and current data related to these locations, and how this data could be processed and synthesised in GIS. The analysis uses stable cadastral maps, or more precisely, Imperial Imprints of the Stable Cadastre from the 19th century (often available online in high resolution), online historical aerial survey images (1953–2025), archived project documentation of land drainage, remote sensing and field surveys. In the Czech Republic, more than 1.1 million hectares of farmland (almost 30% of the total agricultural area) have been systematically drained; therefore, springs or wet areas on agricultural land in Czechia are often associated with failure of surface and prevailingly subsurface drainage, which was both justified as well as unjustified, as seen by today´s eye. Therefore, it is necessary to identify the actual location and condition of drainage in relation to historical land use, soil and geomorphological characteristics, in order to ensure that any restoration work is spatially targeted and effective in supporting the water regime and biodiversity, while the proposed intervention also being negotiable with farmers, landowners and other stakeholders.

These procedures, together with the biological aspects and parameters not mentioned here, form part of comprehensive assessment of the identified sites. They are intended to be subsequently employed for the systematic evaluation of areas with the potential for the restoration of former spring areas at farmland that have often been drained or otherwise degraded.

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REMOTE SENSING OF WATER-TABLE DYNAMICS IN NATURAL BOGS: EVALUATING VNIR-SWIR SENSITIVITY TO WATER-TABLE VARIATION UNDER DIFFERENT TREE CANOPY CONDITIONS

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Key words: Hydrology, Raised Bog, Remote Sensing, Sentinel-2, Vegetation Indices

Monitoring the temporal variability of the water table in bogs using satellite observations is crucial because water table dynamics strongly control peatland carbon balance, vegetation patterns, and fire risk. Satellite data enable consistent, large scale, and repeatable measurements that capture seasonal and interannual fluctuations. However, a major limitation for using optical satellite data in peatland hydrology is cloud cover because sensors cannot observe the surface through clouds. This leads to large temporal gaps in the data record, especially in northern regions where cloudy conditions are frequent. As a result, monitoring short term water table fluctuations becomes challenging. Optical satellite sensors do not provide direct measurements of bog water table depth, as they record only surface reflectance properties that are modulated by vegetation structure, surface moisture, and illumination geometry rather than subsurface hydrological conditions. Consequently, water table dynamics must be inferred indirectly from spectral responses that correlate with changes in water table. The presence of tree canopy further complicates this relationship by obscuring the surface, altering spectral signals through absorption and scattering, and thereby reducing the sensitivity and reliability of optical satellite data for detecting hydrological variability beneath forested bog environments.

Sentinel-2 MSI provides high-resolution optical imagery across 13 spectral bands spanning the VNIR and SWIR regions. Its 5-day revisit time (with the full constellation) could enable detailed monitoring of vegetation, surface moisture, and peatland conditions - when cloud-free data are available. Pilot study was conducted in Endla bog (Estonia) equipped with permanent long-term monitoring wells for water table measurements to assess the challenges posed by vegetation and cloud cover.

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ENHANCING CLIMATE RESILIENCE IN AGRICULTURAL CATCHMENTS THROUGH NATURE-BASED SOLUTIONS: INSIGHTS FROM THE LUBOCZ RIVER BASIN

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Key words: catchment resilience, climate change, Nature-based Solution, wetland

This research is conducted in the demonstration catchment of the Lubocz River (Pilica River basin, central Poland) as part of the LIFE Pilica project. The main objective is to develop a model river basin that demonstrates good practices for systems affected by anthropogenic pressure and climate change.

The Lubocz catchment includes natural wetlands in its upper part, which are increasingly affected by seasonal droughts observed in central Poland. The central part of the basin contains areas with wetland potential that could be restored using Nature-based Solutions (NbS), thereby enhancing catchment resilience to climate change.

The study focuses on the characterization of hydrological conditions and water quality in the Lubocz River and associated wetlands. In particular, the research aims to identify seasonal patterns and the influence of wetlands on surrounding areas and water quality in the river.

The monitoring program includes physicochemical analyses of water (suspended solids, nutrients, carbon fractions, and major ions), supported by to wetland-focused measurements such as iron dynamics, phosphorus fractionation, and surface-groundwater interactions.

Preliminary results indicate higher average concentrations of testing parameters in the upper and lower reaches of the river, suggesting spatial variability linked to both natural conditions and anthropogenic impacts.

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APPROACHES TO QUANTIFY ABOVEGROUND CARBON STOCKS AND SEQUESTRATION: A CASE STUDY FROM THE LEIPZIG FLOODPLAIN FOREST

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Floodplain hardwood forests play a key role in the global carbon cycle due to their high carbon storage capacity in vegetation and soils and their considerable carbon sink potential. This study compares different approaches to quantify carbon stocks and carbon sequestration, using the Leipzig floodplain forest as a case study, with a focus on aboveground carbon dynamics.

Within the Lebendige Luppe project, repeated forest inventories were conducted on 60 permanent plots, including tree, shrub, and deadwood assessments. In total, more than 8,000 individual trees from over 30 species were measured. These data were complemented by regeneration surveys, dendrometer measurements on approximately 290 trees since 2017, and increment core analyses. Aboveground biomass, carbon stocks, and sequestration rates were estimated using allometric models and expansion factors, and results from different methodological approaches were compared.

The results indicate that aboveground carbon stocks in the Leipzig floodplain forest are relatively high compared to national averages. However, substantial changes in vegetation biomass between inventory periods were observed, primarily driven by climate-induced stress and tree diseases. Increasing tree mortality has led to a significant rise in deadwood, affecting carbon pool dynamics.

Estimates of aboveground carbon sequestration vary depending on the method applied but consistently show high sequestration rates, in some cases exceeding values from national forest inventories. Extreme drought years had a pronounced impact on growth dynamics and are clearly reflected in sequestration estimates.

Overall, the findings highlight both the high climate mitigation potential of floodplain forests and the sensitivity of aboveground carbon dynamics to environmental change, emphasizing the need for long-term monitoring.

Acknowledgement

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CHANGES IN THE SPECIES COMPOSITION AND GROWTH ENVIRONMENT OF MOSS BALLS IN LAKE KUSSHARO

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Key words: caldera lake, *Fontinalis antipyretica* Hedw., *Drepanocladus fluitans* (Hedw.) Warnst.

Lake Kussharo, located in eastern Hokkaido, is home to marimo-like moss balls known as Marigoke. Moss balls are formed when fragments of moss growing on the lake bottom are detached by wave action and roll around in the water, eventually taking on a ball shape. The formation of moss balls requires multiple factors, including wave conditions, substrates, and the presence of mosses with structures that are prone to forming balls. Therefore, their occurrence is geographically limited, making it a rare phenomenon. However, there are few studies have been conducted in Japan. At Lake Kussharo, no continuous surveys have been conducted for approximately 20 years since the preliminary survey was conducted in 2003. In recent years, a decline in moss balls and the moss species that comprise them has been observed. Furthermore, *Drepanocladus fluitans* (Hedw.) Warnst., which previously constituted moss balls is now rarely observed, and *Fontinalis antipyretica* Hedw. currently dominates. This study aimed to clarify the causes of these changes by examining the structure of moss balls, its constituent species, and pH conditions. Four study sites were established in the lake. The results of this investigation clearly indicate that two distinct types of moss balls, differing in their constituent species, exist in Lake Kussharo. Furthermore, differences in pH significantly influenced the distribution and dominant species of the mosses. We hope to continue provide further insights that will contribute to the conservation of the constituent species and the maintenance of rare ecosystems.

Acknowledgement

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GRASS CARP-DRIVEN HABITAT SHIFTS IN A SMALL FOREST WETLAND POND

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Key words: biological invasion, ecosystem restructuring, herbivory, littoral habitats, trophic dynamics

Small forest ponds and wetlands often support highly diverse biological communities structured by macrophyte vegetation and habitat heterogeneity. However, the introduction of herbivorous fish can substantially alter these relationships. This study investigated ecological changes in a small forest pond created in 2003 following the introduction of grass carp (*Ctenopharyngodon idella*), with particular attention to macrophyte assemblages and zooplankton communities.

Macrophyte and zooplankton surveys were conducted before and after fish introduction. Aquatic vegetation developed rapidly during the early years of succession, with the number of macrophyte species increasing from four in 2004 to twenty-three in 2008. After grass carp were introduced in 2009, submerged vegetation disappeared completely and the number of plant species declined to eighteen, with subsequent recolonization dominated mainly by emergent and meadow species.

In total, 117 zooplankton taxa were recorded, including 92 species before and 76 after fish introduction. Community changes were accompanied by an increased abundance of taxa typical of eutrophic environments, including *Brachionus calyciflorus*, *Keratella quadrata*, and *Trichocerca pusilla*. Multivariate analyses indicated that nutrient concentrations, organic matter content, and habitat structure associated with macrophyte cover were the main drivers of rotifer and crustacean distribution.

Our results show that grass carp introduction can profoundly alter habitat structure and biological communities in small wetland ponds. Vegetation loss led to shifts in zooplankton composition and a greater dominance of eutrophic indicator species, highlighting the sensitivity of small wetland ecosystems to biological interventions.

INLAND WATER RESERVOIRS WATER QUALITY MONITORING USING REMOTE SENSING

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Key words: inland waters, remote sensing, time series, water quality

Inland water reservoirs monitoring is crucial for understanding their ecological condition, detecting potential environmental risks etc.. Traditional in-situ sampling methods, offer only limited spatial and temporal coverage because they rely on point-based measurements and require significant logistical and financial resources. Remote sensing (RS) has become an increasingly valuable tool for aquatic ecosystem monitoring, as it allows repeated observations of some key water quality indicators across extensive areas and enables objective, spatially continuous assessment. Nevertheless, many existing RS-based applications focus primarily on spatial snapshots, with only limited support for complex temporal analyses or the spatial resolution is insufficient for smaller reservoirs.

To overcome these constraints, we developed **RWQForecast** (https://rwqforecast.com), a web-based application designed to provide flexible, global-scale assessment of water quality in inland reservoirs larger than 1 ha. The system integrates Sentinel-2 satellite data with advanced machine learning models to estimate key optical water quality indicators, including chlorophyll-a, phycocyanin, and total suspended solids concentration. A major advantage of RWQForecast lies in its ability to combine spatial analyses with detailed temporal evaluations. The application is intentionally designed to minimize user input requirements, making the platform accessible without specialized technical expertise.

The application is continuously expanding in terms of both supported parameters and analytical capabilities. By providing accessible, scalable, and globally applicable water quality monitoring, RWQForecast significantly advances the practical use of remote sensing in inland water management.

Acknowledgement

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HOW TO BEST ADDRESS NUTRIENT RICH SOILS WHEN TURNING AGRICULTURAL PEAT BACK INTO BOG.

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Key Words: Nutrients, Peatland, Restoration

The study takes place on Natural England's Moss Side Farm which is part of the Risley, Astley and Chatt Mosses National Nature Reserve. It is 154ha of former agricultural peat which was bought with the intention of transitioning it to more nature friendly bog and fen habitats. This is to link up existing wildlife sites that neighbour the land. One of the biggest obstacles which we have had to overcome on the site is how to tackle the nutrient rich topsoil which has been added to the site throughout its farming history. A few methods have been trialled across the site including a more novel techniques of inverting the peat to bury the nutrient rich soil and to bring better quality and nutrient poor peat to the surface. Preliminary studies have shown that this can be an effective way of reducing the nutrients available without having to remove carbon rich soil from the site. During the trial plots the cost of inverting the soil worked out as less than the cost of stripping the topsoil which is likely to make this an appealing option for other land managers. With the aid of bunding it has been possible to rewet these areas which allows for bog vegetation to be planted within them meaning that we now have sphagnum species and cotton sedges growing on site for the first time in over 200 years. More detailed studies are being carried out to more accurately assess the differences in nutrient mobilisation and Green House Gass emissions from the inverted areas when compared to soil removal or rewetting with the nutrient rich soil still in place.

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Paul Thomas (Natural England), Andrew Dean (Manchester Metropolitan University), Stephanie Evers (Liverpool John Moores), James O'Brien (Natural England)

40 YEARS OF RESEARCH, MANAGEMENT AND RESTORATION OF A VALUABLE WETLAND: THE KUTNAR POOL IN THE NEWLY DECLARED PLA SOUTOK

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Key words: pool, management, restoration, macrophytes, algae

The Kutnar Natural Monument is a remnant of old branches of the Dyje river formed from original riverbed. Its exceptional value lies in its isolation from the network of branches turned into chanalls. This water body is fed with ground water of the flooplain plus rainfalls. In the mid-1980, Kutnar was the last alluavial pool north of Lednice ponds with a surviving original population of *Nymphaea alba* (*Stratiotes aloides* had already disappeared).

The timing of the first sampling coincides with the current threat to the pool with progressing silting. Without targeted interventions, just like after other backwaters, only a depression overgrown with reeds would remain.

Not only protected macrophytes, bur also a number of rare cyanobacteria and algae. Over 40 years, several successional stages have alternated.

Based on the results of the algological research, proposals are provided annually to nature protection authorities for setting up management. At the same time, in the following seasons, the imact of the interventions include thorough dredging combined with water pumping, removal of the reed turf, and transporation of sediments., In following seasons, population of N. alba and also *Sagittaria sagottifolia* occurred, algae typical for the early stages of pools appeared and spontaneous succession followed. In less than two decades, the pool sis aging mainly ecause of a large population of *Ceratophylum demersum*.

Reseearch documented cmposition of cyanobacteria and algae spectrum in various phases of succession.

WINTERGREEN SPECIES IN WETLANDS: LEAF FUNCTIONAL TRAITS, FLOWERING PHENOLOGY AND RESPONSE TO GRASSLAND MANAGEMENT IN SOUTH BOHEMIA (CZECH REPUBLIC).

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Key words: abandoned wetland, botanical garden, Central Europe, plant diversity, wintergreen leaves.

Abstract:

Under continuing climate change, winters are becoming milder in many regions, such as Central Europe, enabling new carbon acquisition opportunities outside of the main growing season. Managed wetland grasslands in particular host many plants capable of maintaining green leaves in winter (i.e. wintergreen leaves) and remaining photosynthetically active during this season, because of regular aboveground biomass removal providing greater access to light during. To understand wintergreen leaf strategies and their relationship to flowering and wetland grassland management, we measured wintergreen species leaf traits, flowering phenology and diversity of wintergreen species in South Bohemian wetlands. For 30 species in a botanical garden collection, we compared traits of winter leaves to summer leaves, including specific leaf area (SLA), leaf dry matter content (LDMC), and leaf length. We also monitored flowering phenology and wintergreeness status of approximately 175 species for five years in this botanical garden. We used generalized linear mixed model (GLMM) to determine the effect of wintergreeness status on flowering onset date, flowering end date, and flowering duration. Finally, we assessed diversity of wintergreen species in managed and abandoned wetland grasslands across South Bohemia, combining taxonomical and functional approaches. Fully wintergreen species (i.e. without brown leaves) initiated flowering 15 days before summergreen species. Managed wetlands had significantly higher diversity of both wintergreen and summergreen species than abandoned wetlands. The wintergreen communities also differed functionally, with taller slow-growing species in abandoned wetlands compared to managed wetlands. Our results suggest that active management sustains functionally diverse wintergreen communities, linking land-use practices to ecosystem functioning and biodiversity conservation in a changing climate.

SEASONAL DROUGHTS IN BALTIC RAISED BOGS: HYDROMETEOROLOGICAL AND ANTHROPOGENIC DRIVERS

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Key words: precipitation, reference evapotranspiration, water table depth

The functioning of healthy raised bogs is based on the interaction of precipitation and evapotranspiration which ensure sufficient moisture supplies. High water table enables peat formation, carbon accumulation, and favourable conditions for raised bog habitats. When the water table remains below ~0,2 m, peat decomposition processes begin and the condition of vegetation degrades. The aim of this study is to analyse the occurrence of seasonal droughts (water table depth WTD<−0,2 m) in raised bogs, the hydrometeorological conditions and anthropogenic influences that cause them.

The study is based on daily WTD data from two Lithuanian raised bogs: 1) natural Čepkeliai bog – 2 measuring points, and 2) Rėkyva bog, affected by a nearby peat quarry – 7 measuring points. Water measurements were taken in 2011–2025, with a duration of 5 to 14 years at individual points. Precipitation (P) and air temperature (T) data from the nearest weather stations (Varėna and Šiauliai) were used. Daily reference evapotranspiration (ETR) was calculated by the Thornthwaite method.

The anthropogenic impact on drought occurrence in the raised bog is evident: at the Rėkyva bog measuring points located near the peat quarry, WTD did not rise above 0.2 m during almost the entire measurement period, while at points further away, the total number of drought days and their duration were proportionally lower. However, in natural Čepkeliai bog, long-term droughts (>20 days) also occur every one to two years due to hydroclimatic conditions.

Daily WTD has a weak correlation with aggregate precipitation, with a moderate correlation (R>0.4) only apparent for precipitation over ~180–300 days. Meanwhile, a moderate negative correlation (R=−0.47) was found between daily WTD and temperature, and a fairly strong correlation (R<−0.6) with the average temperature of the 45–100 days. The strongest positive correlation (R=0.6-0.8) was found between daily WTD and aggregated 15-day and longer-term P-ETR values.

STRENGTHENING WETLAND PROTECTION IN EUROPE THROUGH GOOD PRACTICE EXCHANGE: THE RIWET PROJECT

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Key words: Blue-green infrastructure; Knowledge exchange; Policy; River basin management; Wetland restoration.

Wetlands and rivers provide essential ecosystem services, including biodiversity support, flood mitigation, carbon storage and water purification. However, these ecosystems have significantly declined across Europe due to land-use change, drainage, urbanisation and climate change. Strengthening wetland protection requires improved management approaches and knowledge exchange between regions.

The Interreg Europe project RIWET “Public-Private Governance of Rivers and Wetlands Restoration and Conservation as Blue-Green Infrastructure” facilitates the exchange of good practices that support governance and policy instruments for river and wetland restoration. The project brings together regional authorities, research institutions and environmental organisations from the Netherlands, Spain, Latvia, Italy, Slovenia, Greece, Poland, Albania, Ukraine and Ireland. Within the project, partners identify, analyse and share practical examples of ecosystem management that contribute to the protection and restoration of blue-green infrastructure. Currently, more than twenty practices from across Europe have been documented, covering topics such as nature-based solutions, catchment-scale water management, ecological monitoring, stakeholder engagement and restoration of wetland ecosystems.

This study presents an overview of the RIWET good practice exchange framework and highlights approaches for wetland protection and river basin management, demonstrating how knowledge exchange can support ecosystem resilience and more effective water governance across Europe.

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CAN FTIR-DERIVED SOIL ORGANIC MATTER CHEMISTRY SERVE AS A PROXY FOR SOIL CO_2 FLUX VARIABILITY IN A BOREAL DRAINED FOREST PEATLAND?

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Key words: Soil organic matter decomposition; FTIR spectroscopy; Boreal peatlands; CO_2 fluxes

Drained boreal forest peatlands are important sources of CO_2 emissions, largely driven by microbial decomposition of soil organic matter (SOM). Spatial variation in SOM chemistry may contribute to variation in carbon turnover and soil CO_2 fluxes but remains difficult to quantify across heterogeneous peatland environments.

This study evaluates relationships between SOM chemistry and spatial variation in soil CO_2 fluxes using Fourier-transform infrared (FTIR) spectroscopy, a rapid, non-destructive method that provides a chemical fingerprint of organic matter based on its infrared absorption spectrum. Whole FTIR spectra were used to develop partial least squares regression models relating spectral variation to measured soil CO_2 fluxes, while spectral regions associated with aromatic, carboxyl, aliphatic, and polysaccharide functional groups supported interpretation of the resulting relationships.

Soil samples were collected from clear-cut and continuous cover forestry plots at 0–10 and 20–30 cm depths between 2021 and 2023 at the Ränskälänkorpi experimental site (Finland). Samples were analysed using FTIR spectroscopy (4000–400 cm^{-1}), and the resulting spectra were related to biweekly growing-season soil CO_2 flux measurements. Partial least squares regression models were evaluated using leave-plot-out cross-validation. Preliminary results indicate that FTIR-derived information on SOM chemistry is associated with spatial variability in soil CO_2 fluxes. Future analyses will integrate microbial activity and additional greenhouse gas fluxes to further explore links between SOM chemistry and ecosystem carbon cycling.

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FTIR SPECTROSCOPY FOR COLLABORATIVE WETLAND RESEARCH: LINKING ORGANIC MATTER CHEMISTRY WITH ECOSYSTEM FUNCTION

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Key words: FTIR, drainage, peatlands, organic matter quality, ecosystem restoration

Wetland research generates extensive collections of peat, soil, litter, and vegetation samples, many of which have the potential to provide new insights into organic matter composition and transformation.

Fourier Transform Infrared Spectroscopy (FTIR) offers a rapid, non-destructive approach for characterizing peat, soils, plant biomass, litter, and other organic materials. Our research applies FTIR to investigate decomposition, vegetation inputs, restoration, land-use change, and environmental gradients across a wide range of wetland ecosystems. Spectral analyses are combined with measurements of hydrology, greenhouse gas exchange, carbon cycling, and other ecological variables to improve interpretation of ecosystem processes and support process-based modelling.

Rather than presenting a single case study, this contribution introduces our current research activities and demonstrates how FTIR analyses can complement existing wetland studies. We offer collaborative FTIR analyses of newly collected and archived samples, support with spectral interpretation, and integration of chemical information into ecological, biogeochemical, and restoration research. The approach enables comparisons among sites, climates, vegetation types, and management histories while increasing the scientific value of existing sample collections and long-term monitoring programmes.

We welcome collaboration with researchers interested in incorporating FTIR into wetland research. We are particularly interested in studies of peatlands and other wetlands addressing carbon cycling, greenhouse gas dynamics, vegetation change, hydrology, restoration, and ecosystem responses to environmental change. Our long-term goal is to establish an international FTIR spectral database that supports cross-site comparisons, harmonizes spectral interpretation, and fosters collaborative wetland research.

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ON THE NATURAL HABITAT FACTORS AFFECTING THE UTILIZATION OF MEDICINAL PLANTS BY THE AINU, JAPAN'S INDIGENOUS PEOPLE

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Key words: indigenous people, ecosystem conservation, Kushiro River, soil moisture

The Ainu, Japan's indigenous people, have historically utilized local wild plants for food, house, clothing, and medicine by hunting or gathering them. Clarifying the natural habitats of these utilized plants and conserving them contributes to preserving the region's native ecosystem. This study aimed to identify environmental factors influencing the natural habitats of plants historically used by the Ainu for medicinal purposes, thereby providing valuable insights for conservation planning. The research site was a low-lying forest area within a farm owned by Tamagawa University in the upper reaches of the Kushiro Wetlands. Eight study sites were established along boardwalk 1, located farther from the Kushiro River. And five study sites along boardwalk 2, which was closer to the river. Vegetation surveys were conducted. At all study sites along boardwalk 1 and those closest to the farm on boardwalk 2, *Sasa nipponica* covered approximately 90% of sites. Sites of 2-C to 2-E along boardwalk 2 exhibited higher soil moisture and soil temperature, but all sites adjacent to boardwalk 1 showed smaller seasonal fluctuations. Regarding the growth characteristics of dominant species, *Lysichiton camtschatcense* preferred high soil moisture levels during its growing season, while *Aconitum sachalinense* subsp. *yezoense* naturally occurred within suitable moisture conditions in forested areas. study sites located near the farm area, showed similar moisture content, soil hardness, and EC values in June and August, resulting in comparable species compositions. Maintaining a minimum distance of 30 m between farm and conservation zones would be effective in mitigating the impacts of agricultural drainage. The tendency for sites with greater total species diversity to also contain more medicinal and food-producing plants suggests that preserving rich vegetation environments is crucial. Conservation measures must be tailored to individual species and should make the map of Ainu used plants habitat.

Acknowledgement

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ASSESSING THE RELATIONSHIPS BETWEEN HYDROMETEOROLOGICAL VARIABLES AND SATELLITE-DERIVED LAND SURFACE TEMPERATURE ACROSS RAISED BOGS UNDER DIFFERENT LAND-USE REGIMES

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Key words: burned peatland, drained peatland, raised bog, remote sensing, surface temperature

Northern peatlands, one of the main global sites of soil carbon storage, play a vital role in the climate change feedback mechanism. Biophysical processes (ex. CH4 emissions) in sensitive raised bog ecosystems are controlled mainly by water table, temperature, plant development, and disturbance regimes. The balance between anaerobic and aerobic processes in peatlands is accelerated by increasing temperatures. In combination with *in situ* measurements, remote sensing techniques offer a practical approach for assessing the thermal conditions of the raised bog. Therefore, the main aim of this research is to investigate relationships between ground-based hydrometeorological data and satellite-derived Land Surface Temperature (LST) observations. LANDSAT satellite data of the growing season were used for 40 years (1985–2025) to monitor the long-term vegetation (NDVI) and thermal conditions (LST) to identify temporal patterns in 5 different disturbance regimes: burned peatland, unburned peatland, drained transitional peatland, natural raised bog and peat quarry. The study was conducted in the Rėkyva raised bog complex, a peatland in western Lithuania.

This study reveals a statistically significant LST increase across three of five peatland disturbance regimes: burned peatland, drained transitional peatland, and natural raised bog. The drained peatland showed the strongest warming trend, attributed to its disturbed hydrological regime. In the burned peatland, where vegetation cover remains in early recovery stages, a sustained long-term LST increase is evident. The minimum growing-season LST (7°C) was observed in the natural raised bog, and the maximum (36.6°C) in the extracted peatland. Pearson correlation coefficients indicated a moderately strong positive relationship (r = 0.61–0.65), between remotely sensed LST and mean air temperature from Šiauliai WS. These findings highlight that disturbed peatlands are more sensitive to climate change, emphasizing the importance of conserving and restoring the raised bog ecosystem.

GLOBAL DRIVERS OF METHANE EMISSIONS FROM ANTHROPOGENIC FLOODED LAND

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Key words: methane flux, chamber method, wetland, ditch, pond

The scarcity of greenhouse gas (GHG) flux measurements has resulted in knowledge gaps in both general GHG flux understanding and national GHG inventories. Methane (CH_4) fluxes from wetlands show high spatial and temporal variability, the drivers of which are poorly understood, resulting in substantial uncertainty in annual emission estimations. A similar challenge exists for inland waters such as ponds and ditches, which contribute significantly to anthropogenic CH_4 emissions but are even more scarce in observational datasets.

In this study, we compiled a global database of CH_4 chamber flux measurements from anthropogenic flooded land to better understand CH_4 fluxes better and to support the development of biophysical models. The database comprises approximately 6,000 instantaneous diffusive CH_4 flux measurements obtained using portable gas analyzers, accompanied by key hydro-physical water parameters. Notably, 40% of the dataset consists of previously unpublished data. The data span 147 unique sites across 23 countries and U.S. states, representing 10 Köppen climate classes and a gradient of human influence, including ditches, ponds, and wetlands.

Our results bring out the relationships between CH_4 flux and temperature, water level, pH, dissolved oxygen and electrical conductivity, and reveal their optimal ranges for CH_4 emissions across the dataset. We argue that the same mechanisms can explain CH_4 flux variability across different climates and ecosystem types, thereby making it possible to produce more accurate estimates of CH_4 emissions in regions where direct measurements are limited.

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THE FUTURE OF PEATLAND LANDSCAPES IN SWITZERLAND GROUNDWATER CONTROLS OF PEATLAND RESILIENCE UNDER CLIMATE CHANGE

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Key words: peat soils, eco-hydrology, groundwater, restoration, transdisciplinarity

In Switzerland, about 90% of the former peatland surface area has been lost due to peat mining and conversion to agricultural land, and around 90% of the remaining peatlands are degraded. The situation is similar in Western European countries, but in Switzerland the protection of fens and bogs is anchored in the federal constitution after a public vote in 1987.

Nevertheless, biodiversity conservation in the remaining peatlands is threatened by drainage and nutrient input, which is reflected in a yearly loss of about 1% of bog vegetation in Switzerland. Restoration efforts have been locally successful, but they conflict with other activities in adjacent areas (agriculture, groundwater pumping, drainage, waste storage, industries, etc.) and are further complicated by ongoing climate change. Peat soils are used for vegetable production in the Swiss lowlands and for dairy production in the Alpine region. Peat soil cultivation is unsustainable because the use of machinery requires deep drainage, which alters hydrological functioning and oxygenates the peat, leading to degradation and carbon loss as DOC and CO_2 (ca. 1–3 cm of peat is lost per year in Switzerland). Rewetting these soils and converting them to paludiculture would prevent carbon loss, but the road to this transition is challenging.

The *FuturePeat* project combines natural science (biodiversity, ecosystem functioning, eco-hydrology) with socio-anthropological, economic and legal analyses through a transdisciplinary co-construction approach. It involves partners from academia, NGOs, policymakers, farmers and landowners. We will use selected pilot sites representative of the range of conditions across Switzerland, which will allow us to investigate the hydrological effects of drainage across restored and active agricultural peat soils. By integrating hydrogeological observations, ecological indicators, management and restoration data, the project aims to develop methodological approaches to support groundwater and soil management strategies that enhance peat soil conservation, reduce CO_2 emissions, and preserve biodiversity.

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RESPONSE OF PEAT BIOCHEMICAL PROPERTIES TO DRAINAGE AND RE-WETTING ACROSS THE EUROPEAN PEATLANDS

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A significant proportion of Europe's peatlands has been drained. Drainage accelerates peat decomposition, causing biochemical changes, carbon loss, and long-term depletion of carbon stocks. Peatland restoration through re-wetting aims to return disturbed sites to conditions close to their natural hydrological and ecological state.

We aimed to identify peat quality parameters that can serve as indicators of peatland recovery after re-wetting. This work is part of the MiDiPeat project (Biodiversa+) and contributes – together with vegetation composition, microbial diversity, microbial processes, and methane cycling – to a comprehensive analysis of ecosystem response to re-wetting.

We examined changes in peat biochemical properties caused by drainage and re-wetting in ombrotrophic and minerotrophic peatlands across Europe (Finland, Estonia, Germany, Czechia), including natural, drained, and restored sites. These were characterized by measuring total C, N, and P content, dissolved organic carbon concentration, microbial biomass, aerobic and anaerobic microbial respiration, methane production potential, and activities of key extracellular enzymes; FTIR spectroscopy was used to assess peat quality.

Drainage caused overall peat degradation, indicated by reduced decomposability, higher content of recalcitrant (aliphatic and aromatic) compounds, lower pH, and reduced microbial biomass and activity – effects more pronounced in minerotrophic than ombrotrophic peat. Re-wetted sites showed biochemical properties more similar to natural than drained sites. We propose that reduced pH and increased microbial biomass and anaerobic CO_2 and CH_4 production are universal early indicators of belowground recovery, reflecting stabilization of anaerobic conditions and inputs of labile plant-derived organic matter following the spread of typical peatland plants.

Acknowledgement

Biodiversa+"MiDiPeat" – Monitoring of peat microbial diversity through vegetation properties and its implication for carbon dynamics across European peatlands

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