Questions & Answers: Bringing Clarity on Peatland Rewetting and Restoration

This joint paper, drafted by the Greifswald Mire Centre and Wetlands International Europe, addresses key questions raised in the European Parliament and the EU Council with respect to peatland restoration, in the context of the negotiations for the Nature Restoration Law (NRL) and the Soil Health Law. The paper deals with the difference between rewetting and restoration, the costs and benefits of these activities, the availability of data on peatland distribution and condition, the compatibility of rewetting with productive land use and food security and the issue of methane emissions after rewetting.

1) Q: What is the difference between peatland rewetting and peatland restoration?

A: Rewetting is bringing the water table back to that of the original, peat-accumulating peatland. Peatland restoration is bringing a degraded peatland back to a (better) state as it existed before degradation.

Because drained peatlands formerly always have been wet, peatland restoration must always include rewetting. Without rewetting, drained peatlands eventually lose all their peat and will no longer be peatlands. Peatland restoration should thus as a minimum aim at and result in the conservation of the peat. Whereas rewetting of drained peatlands is necessary to stop their huge CO_2 emissions, rewetting does not necessarily bring the peatland back to the state as it was before human-induced degradation. This might be due to the nutrient legacy of long-term intensive agricultural use, or because of irreversibly changed hydraulic conditions (decrease in peat porosity, hydraulic conductivity and storage coefficient) because of long-term drainage.[1] The reason might also be that you do not *want* to restore the peatland to its former "natural/wild" condition, because you need it to produce commodities - in this case under peat conserving, wet conditions ("paludiculture").[2]

2) Q: Is rewetting and restoring peatlands technically difficult?

A: Generally, not: Rewetting is stopping artificial drainage, i.e. it is about doing *less*, not about doing *more.* Restoration often requires additional activities next to rewetting.

The presence of peat indicates that - before artificial drainage started - more than sufficient water was available for the accumulation and conservation of peat (and the carbon it contains). Peatland degradation is - in the vast majority of cases - the result of deliberate water extraction. As soon as this water extraction stops, the drained peatland will rewet. Many peatlands can be instantaneously rewetted, simply by turning off the pump that pumps them dry. In peatlands drained by gravity-drainage (letting the water run out via ditches and canals), rewetting starts spontaneously when the drainage infrastructure is no longer maintained. To guarantee rapid and total rewetting, it might be beneficial (and necessary) to support the rewetting by building dams, filling in ditches or erecting bunds and dikes.

Restoration often requires - additionally to rewetting - extra activities to facilitate and stimulate the establishment of 'ecosystem engineers', i.e. peat-forming plant species, which improve the water

---

[1] Kreyling, J. et al (2021): Rewetting does not return drained fen peatlands to their old selves. Nature Communications (2021) 12:5693, https://doi.org/10.1038/s41467-021-25619-y

[2] Wichtmann, W. et al. (eds.) (2016): Paludiculture – productive use of wet peatlands. Climate protection − biodiversity − regional economic benefits. Schweizerbart Science Publishers, Stuttgart, 272 p.
Ziegler, R. et al. 2021. Wet peatland utilisation for climate protection – An international survey of paludiculture innovation. Cleaner Engineering and Technology 5, December 2021, 100305. https://www.sciencedirect.com/science/article/pii/S2666790821002652/pdfft

conditions and enable the regeneration of the peatland ecosystem (e.g. selected peat moss and sedge species).

Sufficient information on the technical requirements and possibilities of peatland rewetting and restoration is available and has recently been summarised by the Ramsar Convention.[3]

3) Q: Is rewetting and restoring peatlands costly?

A: No: Eventually, rewetting is the most profitable thing to do, but might require some upfront investments. Rewetting peatlands is about avoided costs and long-term economic benefits.

Peatland rewetting and restoration is not only beneficial for climate change mitigation, but brings many co-benefits, including important climate change adaptation profits (water regulation, evapotranspiration cooling, flood control, groundwater retention), next to water purification, the improvement of wetland and peatland specific biodiversity and the avoided costs of further degradation.[4]

Overall costs from lost productivity on organic soils are small relative to these benefits. At EU level, agriculture on peatlands represents only 3 % of the total EU agricultural land, including 1 % of the cropland and 4 % of the grassland[5] (see question 4 for further details). Any economic loss on these 3 % could easily be compensated by increased productivity on the other 97 %. In some regions (e.g., in the Netherlands, Finland and Germany), peatlands represent a higher proportion of the agricultural land and rewetting may have a larger socio-economic impact. The Commission's Impact Assessment of the draft NRL concludes that peatland rewetting (under productive land use) is expected to deliver large benefits for climate, biodiversity and associated ecosystem services. Benefits of fully rewetting drained agricultural peatlands were estimated to outweigh the costs of restoration.[6]

Furthermore, rewetting does not necessarily imply abandonment of agricultural use. Promising 'paludiculture' systems allow continued productive use under wet conditions (see footnote 2).

The focus on peatlands under agricultural land-use only is, however, not sufficient to meet the EU climate targets[7]. Forestry and other land use contribute significantly to peatland degradation and emissions, and targets for these land-use types should also be included in the NRL.

Projects in various countries illustrate the feasibility of large scale peatland rewetting.[8]

4) Q: Do we know well enough where the peatlands are?

A: The data is available and on higher levels ready for policy making. On detailed, e.g. parcel levels, data is not fully available in appropriate formats in all Member States and additional mapping efforts are running.

Various institutions collect data on the distribution and condition of peatlands and organic soils and make these data available. The Global Peatland Database (GPD)[9] collates and integrates data on location, extent and drainage status of peatlands and organic soils worldwide and holds detailed data

---

[3] Convention on Wetlands (2021): Global guidelines for peatland rewetting and restoration. Ramsar Technical Report No. 11. Gland, Switzerland: Secretariat of the Convention on Wetlands. 77 p.
Convention on Wetlands. (2021): Practical peatland restoration. Briefing Note No. 11. Gland, Switzerland: Secretariat of the Convention on Wetlands. 12 p.

[4] Bonn, A. et al. (eds.) (2016): Peatland restoration and ecosystem services: Science, policy and practice. Cambridge University Press/ British Ecological Society, Cambridge, 493 p.

[5] European Commission 2022. Impact Assessment Accompanying the Proposal for a Regulation of the European Parliament and of the Council on nature restoration, SWD 167, Part 5, p.485 accessible via https://environment.ec.europa.eu/system/files/2022-06/Impact%20Assessment%20accompanying%20the%20proposal%20%28Part%205%29.pdf

[6] European Commission (2022): Impact Assessment Accompanying the Proposal for a Regulation of the European Parliament and of the Council on nature restoration, SWD, 167, Part 5, p.485 accessible via https://environment.ec.europa.eu/system/files/2022-06/Impact%20Assessment%20accompanying%20the%20proposal%20%28Part%205%29.pdf

[7] Greifswald Mire Centre & Wetlands International (2022): Policy Briefing - Higher Ambition for Peatlands in the EU Nature Restoration Law Proposal
https://waterlands.eu/results-and-resources/policy-briefing-higher-ambition-for-peatlands-in-the-eu-nature-restoration-law-proposal/

[8] See notably relevant EU funded projects for wetlands and peatlands restoration: on the LIFE webpage, or the Horizon Projects webpage

[9] A project of the International Mire Conservation Group (IMCG) located and maintained at the Greifswald Mire Centre

for Europe. The EU Soil Observatory Dashboard and the European Soil Data Centre (ESDAC) of the EU Joint Research Centre JRC[10] provides an assessment of the state of soil health in the EU, including that of peat soils, which is updated continuously and synchronised with the System for Earth Observation Data Access, Processing and Analysis for Land Monitoring (SEPAL) of FAO.

These data allow the identification of EU and national hotspots of peatland emissions. Parcel level identification of peatland occurrence and condition (which is very relevant for implementation of the EU common agricultural policy CAP) will in many regions require additional mapping.

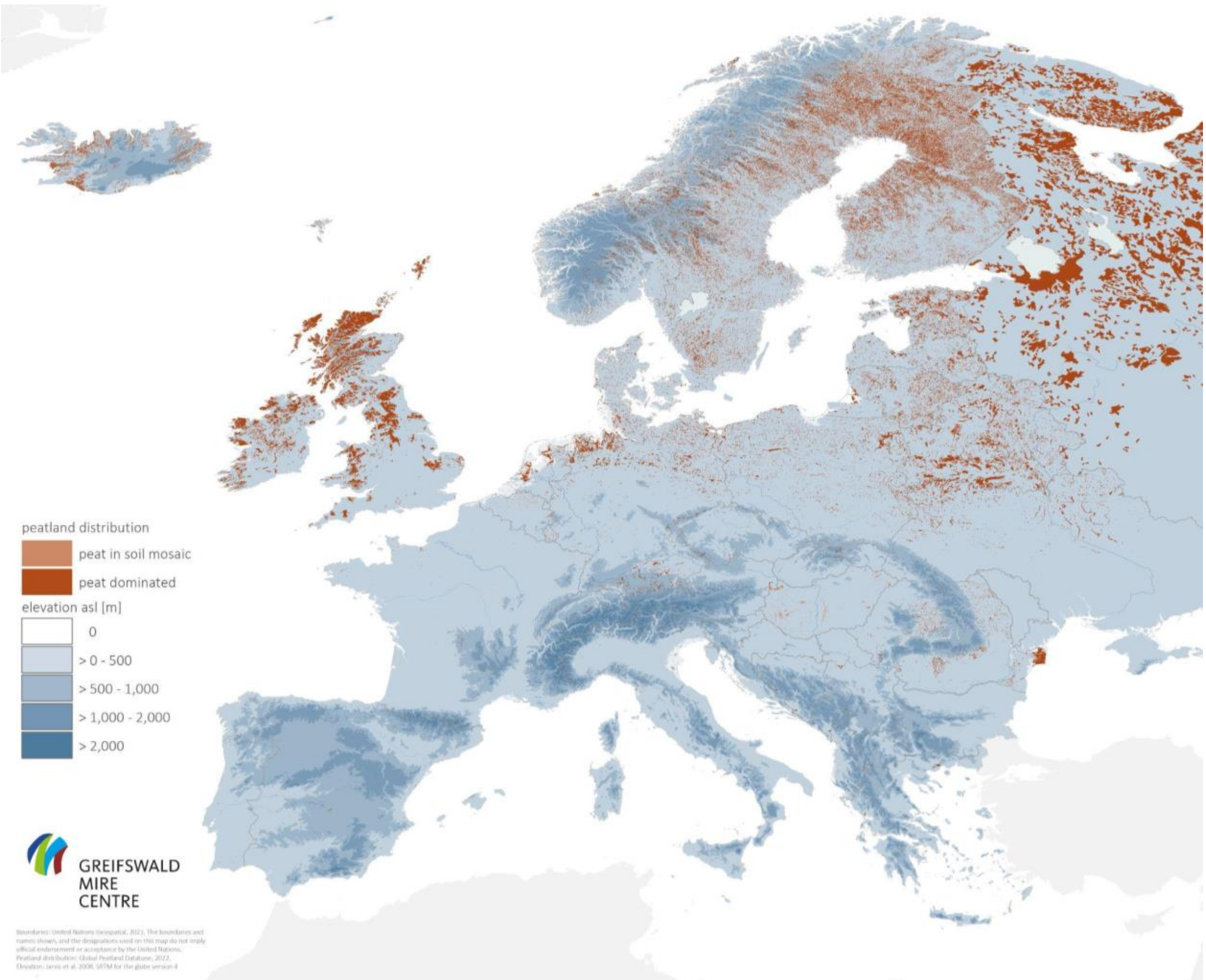

Figure 1: Peatland distribution in Europe. GPD 2022

In Europe, peatlands cover 59 million hectares, representing 12 % of global peatland extent. The distribution is uneven with a higher density in the northern lowlands, highlands and coastal areas, and more sparsely in steppe and broadleaved forest zones (see fig. 1)[11].

Currently, various EU-funded Horizon Europe projects (notably ALFAWetlands & WET HHORIZONS) aim at filling crucial knowledge gaps, improving the geospatial knowledge base and evaluating pathways of peatland restoration in Europe.

[10] See the JRC EU Soil Observatory Dashboard

[11] UNEP (2022): Global Peatlands Assessment – The State of the World's Peatlands: Evidence for action toward the conservation, restoration, and sustainable management of peatlands. Summary for Policy Makers. Global Peatlands Initiative. United Nations Environment Programme, Nairobi. peatland_assessment_SPM.pdf (unep.org)

5) **Q: Will rewetting make productive land-use impossible and lead to a loss of income?**

A: No, rewetting is a multi-purpose investment in long-term resilience allowing multiple forms of sustainable land use.

Paludiculture - the productive land use of wet and rewetted peatlands in a way that the peat soil is preserved and greenhouse gas emissions and subsidence is minimised[12] - allows the combination of agricultural production and peatland protection. Paludiculture involves a **paradigm shift from adapting site conditions to the requirements of specific crops to adapting crop selection and cultivation to the prevailing or required site conditions, i.e. permanently wet**. Biomass from paludiculture can be used as food, feed, fibre and fuel but also as raw material for industrial biochemistry or construction. Under the right conditions, peat accu-mulation may even resume, leading to a net se-ques-tration of carbon in the soil[13].

While rewetting benefits the entire society through the provision of ecosystem services, the costs of rewetting and restoration would directly be borne by landowners and managers, in the same way as landowners and managers take profit from drained peatland use through subsidies, while costs are externalized to society. This means that efforts to adapt and change agricultural practice after rewetting will have to be rewarded by dedicated support schemes.[14] But investing in restoration now will benefit macro-economy in the long-term.

Furthermore, **drained peatland use is associated with high energy and maintenance costs** (clearing of ditches, repair of sluices, management of dykes and energy for pumping of polders). Moreover, drainage-based agriculture causes continuous subsidence (height loss) through peat mineralization and often leads to a complete loss of soil fertility.[15] CO_2 emissions, soil organic carbon loss, soil degradation and soil erosion from peatlands are closely linked and should be addressed simultaneously. 13-36 % of the current soil carbon stock in European peatlands might be lost by the end of this century if drainage continues.[16]

The Dutch Council for the Environment and Infrastructure concluded that continuing with the *status quo* is "not an option", due to the ecological damage and loss of nature conservation areas, deterioration of safety, CO_2 emissions and financial consequences.[17]

6) **Q: Will rewetting drained peatlands used for agriculture create food security problems?**

A: No, rather the opposite: Continuing to degrade peatlands through drainage-based agriculture will lead to a loss of productive land, whereas rewetting allows to keep the land perpetually productive.

The EU is a net food exporter and top agri-food producer, and food availability is currently not at stake in the EU.[18] The peatland area of only 3 % of the agricultural land in the EU cannot seriously be claimed to be relevant for food security. On the contrary, the current drainage-based model leads to irreversible degradation of land and is unsustainable in the near-term. Developments towards agro-ecological practices,sustainable and healthy diets, particularly by reducing meat and dairy consumption will

[12] EU Peatlands & CAP Network (2021): Policy Briefing paper "Definition of Paludiculture in the CAP". https://www.greifswaldmoor.de/files/dokumente/Infopapiere_Briefings/202102_paludiculture_CAP_definition_final.pdf
[13] Greifswald Mire Centre (2023): Paludiculture. Paludikultur Hintergrund - Moorwissen en
[14] Nadeu, E. (2022): Nature Restoration as a driver for Resilient Food Systems. Policy Report, Institute for European Environmental Policy. Nature restoration as a driver for resilient food systems (ieep.eu)
[15] Joosten, H. et al. (eds.) (2012): Peatlands – guidance for climate change mitigation by conservation, rehabilitation and sustainable use. Mitigation of Climate Change in Agriculture Series 5. FAO, Rome, L + 96 p.
[16] Gobin, A. et al. (2011): Soil organic matter management across the EU best practices, constraints and trade-offs, accessible via https://op.europa.eu/en/publication-detail/-/publication/c4826475-ab97-4375-941a-19ea8e5c8ef6
[17] The Council for the Environment and Infrastructure (Rli) (2020): Stop land subsidence in peat meadow areas September. The 'green heart' area as an example. Stop Land Subsidence in Peat Meadow Areas: the 'Green Heart' Area as an Example (rli.nl)
[18] European Commission (2022), Safeguarding food security and reinforcing the resilience of food systems, COM(2022) 133 final, accessible via https://agriculture.ec.europa.eu/system/files/2022-03/safeguarding-food-security-reinforcing-resilience-food-systems_0.pdf

disproportionately affect drained peatlands, where an important share of these commodities are produced. Rewetting will indeed make peatlands unsuitable for the cultivation of various food crops (e.g. potatoes, carrots), but any necessary cultivation of such crops can be transferred to mineral sites[19,20], whereas the cultivation of energy and fibre crops can partly be moved from mineral soils to rewetted peatlands.

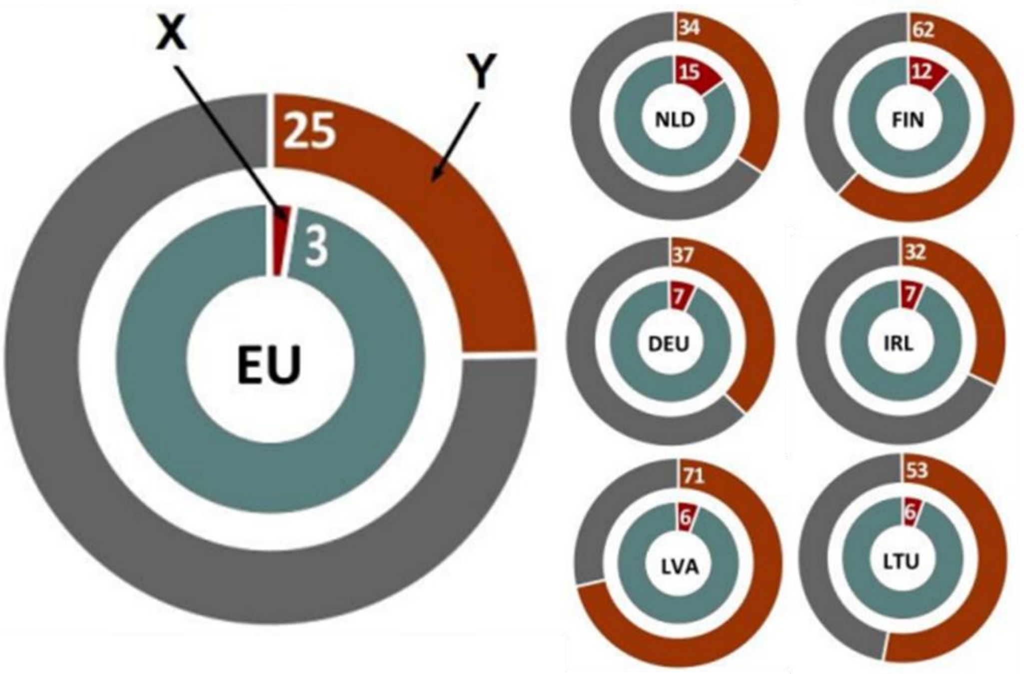

Figure 2: Relation between share of agricultural used peatlands under drainage in EU (inner circle) and the share of greenhouse gas emissions from these areas (outer circle). Rewetting X% of agricultural land will reduce agricultural greenhouse gas emissions by up to Y%. Small circles on the right show the top six EU Member States (Netherlands, Finland, Germany, Ireland, Latvia & Lithuania) sorted by area of agriculturally used peatlands under drainage and their associated greenhouse gas emissions [21]

Drained peatlands represent only 3 % of the EU's agricultural land and rewetting them would avoid up to 25 % of the greenhouse gas emissions from total EU agriculture. Except for the Netherlands and Finland, EU Member States only have a (low) single-digit percentage share of agricultural area on peatland (see fig. 2) - nevertheless there are different degrees to which the individual Member States will be affected.

A Finnish study on the impacts of rewetting and restoring agriculturally used peatlands revealed only minor impact on Finnish food production and national food security. However, municipalities rich in peatlands might encounter local challenges with regard to the prevailing way of farming[22].

---

[19] Searchinger, T. et al. (2022): Europe's Land Future? Opportunities to use Europe's land to fight climate change and improve biodiversity— and why proposed policies could undermine both. © Princeton University Microsoft Word - Searchinger, James, Dumas, Europe's Land Future (Princeton University, March 2022)_OJ March 29_unlinked.docx

[20] Poux, X. & Aubert, P.-M. (2018): An agroecological Europe in 2050: multifunctional agriculture for healthy eating. Findings from the Ten Years For Agroecology (TYFA) modelling exercise, Iddri-AScA, Study N°09/18, Paris, France. 201809-ST0918EN-tyfa.pdf (iddri.org)

[21] Greifswald Mire Centre (2021): Opportunities for Peatlands and Paludiculture in the EU Common Agricultural Policy (2023-2027) Opportunities for paludiculture in CAP (greifswaldmoor.de)

[22] Räsänen, A. et al. (2023): Euroopan unionin ennallistamisasetusehdotuksen luontotyyppi- ja turvemaatavoitteiden vaikutukset Suomessa. Luonnonvara- ja biotalouden tutkimus 1/2023. Luonnonvarakeskus. Helsinki. https://jukuri.luke.fi/handle/10024/552939

7) **Q: Is afforesting drained peatlands effective for climate change mitigation?**

A: No. This short-term approach violates sustainability, depletes the peat layer and causes net CO_2 emissions in the long run.

In the current political debate, several EU Member States argue that active afforestation of degraded peatlands should be recognized as a restoration measure under the Nature Restoration Law (NRL)[23].

Compared to taking no action, afforestation may in some cases (such as in some drained and cutaway peatlands) indeed provide short-term climate benefits, when the increase in biomass and litter carbon initially exceeds the loss of peat carbon. However, **this approach sacrifices the most space-effective resilient carbon store of the terrestrial biosphere, the long-term peat store**, for a shorter-term, less space-effective, and more vulnerable carbon store, namely vegetation and litter biomass.

For climate change adaptation, also the decreased groundwater recharge under coniferous forest and the dark and dense canopy of coniferous forests, which absorbs more heat than open peatlands[24] should be taken into account.

Summer droughts in Europe in the past 10 - 15 years led to higher fire vulnerability of boreal forest and to long-term smouldering peat fires[25]. In a future climate with higher probability of warmer winters and hotter and drier summers all across Europe[26], the risk for forest and peat fires in drained peatlands will increase even more.

8) **Q: Wouldn't methane emissions from rewetted peatlands damage the climate more than the emissions from drained peatlands?**

A: No. The methane emissions may initially increase climate warming, but soon the climate cooling effect of rewetting drained peatlands will prevail.

Methane emission is a collateral effect of carbon sequestration: Undrained peatlands release methane (CH_4) due to the water-saturated oxygen-free conditions, which enable the perpetual sequestration and storage of carbon in the first place. In natural peatlands the net uptake of CO_2 overcompensates the CH_4 emissions[23].

When peatlands are drained, the oxygen entering the soil leads to the decomposition of the peat resulting in high emissions of CO_2 and N_2O[27,28]. At the same time, CH_4 emissions stop, but persist in the drainage ditches[29,30]. Peatland rewetting peatlands again stops CO_2 and N_2O, but re-installs CH_4 emissions.

Rewetting of drained peatlands is therefore always a choice between continued emissions of CO_2 and N_2O in the drained situation, and of methane in the rewetted situation. In such a case, you must always choose the methane.

This is because CH_4 molecules indeed have a much stronger climate impact than CO_2 molecules but methane molecules remain in the atmosphere for only a short time - less than 12 years - before they are converted to CO_2. After some decades, a dynamic equilibrium of emission and removal of CH_4 establishes so that the methane concentration in the atmosphere as a result of the peatland emissions

[23] Jurasinski, G. et al. (2023): Active afforestation of drained peatlands is not a viable option under the EU Nature Restoration Law. Active afforestation of drained peatlands is not a viable option under the EU Nature Restoration Law | Zenodo

[24] Cerubini et al. (2012): Site-specific global warming potentials of biogenic CO2 for bioenergy: contributions from carbon fluxes and albedo dynamics. Environ. Res. Lett. 7 (2012) 045902 11 p. http://dx.doi.org/10.1088/1748-9326/7/4/045902

[25] Scholten et al. (2021): Overwintering fires in boreal forests. Nature, Vol 593, pp 399-404. https://doi.org/10.1038/s41586-021-03437-y

Lohila, A. et al. (2010): Forestation of boreal peatlands: Impacts of changing albedo and greenhouse gas fluxes on radiative forcing. Journal of Geophysical research 115: G04011. https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2010JG001327

[26] Ruosteenoja, K. et al. (2020): Thermal seasons in northern Europe in projected future climate. Int J Climatol. 2020;40:4444–4462. https://doi.org/10.1002/joc.6466

[27] Ojanen, P. et al. (2010) Soil–atmosphere CO2, CH4 and N2O fluxes in boreal forestry-drained peatlands. Forest Ecology and Management 260:411–421

[28] IPCC (2014): 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands. IPCC, Switzerland

[29] Minkkinen, K. et al. (1997): Importance of drainage ditches in emissions of methane from mires drained for forestry. Canadian Journal of Forest Research 27:949–952

[30] Köhn, D. et al. (2021): Drainage ditches contribute considerably to the CH4 budget of a drained and a rewetted temperate fen. Wetlands 41:71

does not increase further.[31] In contrast, CO_2 (a weak GHG) and N_2O (a very strong GHG) molecules are long-living and accumulate in the atmosphere.[23]

Rewetting therefore initially causes a slight warming impact because of increased CH_4 emissions, but in the longer term the result is cooling[32] (see fig. 4), in the same way as the treatment of acute appendicitis first makes things worse (the opening of the abdomen) before the inflamed vermiform appendix can be removed.

Rewetting is always better than maintaining the drained situation, despite the methane emissions involved. It is, therefore, opportune to i) rewet as fast as possible (i.e., before 2040) to prevent the methane emissions from amplifying peak global warming, and ii) limit methane emissions as far as possible, for which various management options are available (see the Ramsar Global Guidelines for Peatland Rewetting and Restoration[33]).

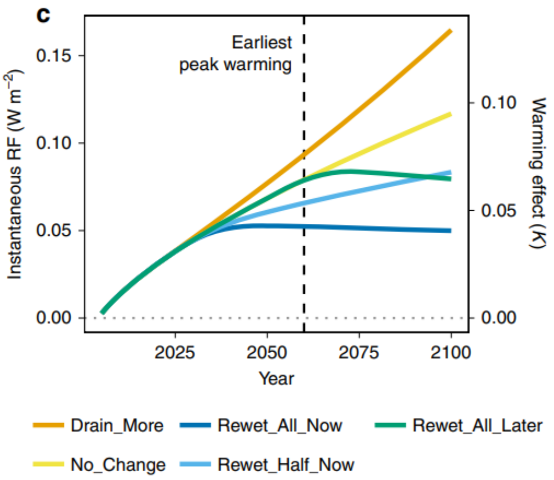

Table 1 Global scenarios of peatland management.

Scenario	Description
Drain_More	The area of drained peatland continues to increase from 2020 to 2100 at the same rate as between 1990 and 2017
No_Change	The area of drained peatland remains at the 2018 level
Rewet_All_Now	All drained peatlands are rewetted in the period 2020–2040
Rewet_Half_Now	Half of all drained peatlands are rewetted in the period 2020–2040
Rewet_All_Later	All drained peatlands are rewetted in the period 2050–2070

Figure 4: Radiative forcing and climate warming effect of different global scenarios of peatland management (Günther et al. 2020)

Summary

Rewetting and restoration of peatlands is efficient and cost-effective[34] in addressing the climate crisis and brings along many co-benefits.

[31] Frolking, S. & Roulet, NT (2007): Holocene radiative forcing impact of northern peatland carbon accumulation and methane emissions. Global Change Biology 13:1079–1088
[32] Günther, A. et al. (2020): Prompt rewetting of drained peatlands reduces climate warming despite methane emissions. Nat Commun 11, 1644 (2020). https://doi.org/10.1038/s41467-020-15499-z
[33] Convention on Wetlands. 2021. Global guidelines for peatland rewetting and restoration. Ramsar Technical Report No. 11. Gland, Switzerland: Secretariat of the Convention on Wetlands. 77 p.
[34] Dicks, J. et al. (2020: Economic costs and benefits of nature-based solutions to mitigate climate change. Cambridge Econometrics Cambridge, UK. Microsoft Word - The economic costs & benefits of nature-based solutions_final report_FINAL_V3.docx (camecon.com)

This Q&A briefing was jointly produced in May 2023 by:

Greifswald Mire Centre Ellernholzstr. 1/3 D-17489 Greifswald Germany URL: www.greifswaldmoor.de E-Mail: info@greifswaldmoor.de Twitter: @greifswaldmoor	**Wetlands International European Association** Rue de l'Industrie 10 B-1040 Brussels Belgium URL: https://europe.wetlands.org E-Mail: elise.vitali@wetlands.org Twitter: @WetlandsEurope