ADVANCED SUSTAINABLE SYSTEMS
www.advsustainsys.com

The Power of Nature-Based Solutions: How Peatlands Can Help Us to Achieve Key EU Sustainability Objectives

Franziska Tanneberger, Lea Appulo, Stefan Ewert, Sebastian Lakner, Niall Ó Brolcháin, Jan Peters, and Wendelin Wichtmann*

Peatlands are lands with a peat layer at the surface, containing a large proportion of organic carbon. Such lands cover ≈1 000 000 km² in Europe, which is almost 10% of the total surface area. In many countries, peatlands have been artificially drained over centuries, leading to not only enormous emissions of CO_2 but also soil subsidence, mobilization of nutrients, higher flood risks, and loss of biodiversity. These problems can largely be solved by stopping drainage and rewetting the land. Wet peatlands do not release CO_2, can potentially sequester carbon, help to improve water quality, provide habitat for rare and threatened biodiversity, and can still be used for production of biomass ("paludiculture"). Wisely adjusted land use on peatlands can substantially contribute to low-emission goals and further benefits for farmers, the economy, society, and the environment.

1. Introduction

In a widely accepted, globally applicable definition, a "peatland" is an area with a naturally accumulated layer of peat at the surface.[1,2] Peat is defined as sedentarily accumulated material of which at least 30% (dry mass basis) is dead organic matter. The presence or absence of vegetation is irrelevant to this definition of peatland. This "peatland" concept includes all "mires," i.e., peatlands where peat is being formed.[2] A wider concept for carbon-rich soils, including all peatlands, is "organic soil." This concept is used by the Intergovernmental Panel on Climate Change (IPCC) for soils with a high content of organic matter and used in national greenhouse gas inventories for reporting to the United Nations Framework Convention on Climate Change.[3,4]

Peatlands occur in all European countries except Malta, with a concentration in north-western, Nordic and eastern European countries. The overall area of peatland in Europe (with >0 cm of peat) is ≈1 000 000 km², which is almost 10% of the total surface area. Mires, i.e., currently peat-forming peatlands, cover more than 320 000 km². In the European Union (EU), peatlands cover 241 812 km².[5] In many peatland-rich EU countries, more than 50% of the peatlands are degraded, in some countries such as Germany even more than 95% (**Figure 1**). Peatland degradation is caused by artificial drainage, most often for agriculture, forestry or peat extraction.

In pristine, undrained peatlands peat accumulates because the decomposition of plants is slowed due to permanently water-logged conditions. Over thousands of years, a large store of carbon is accumulated in the soil.[6–8] Pristine peatlands also provide a unique habitat for specific biodiversity and numerous other ecosystem services to society, such as retention of pollutants and regulation of the local climate and the landscape water budget.[2,7,9,10]

Drainage allows oxygen to enter the soil, leading to microbial decomposition of the peat and thereby breakdown of the stored carbon leading to emission of substantial amounts of CO_2 and N_2O.[7,8,11] Further negative consequences of drainage are reduction in water quality through the discharge of nutrients

Dr. F. Tanneberger
Institute of Botany and Landscape Ecology
Greifswald University, Partner in the Greifswald Mire Centre
Soldmannstr. 15, 17489 Greifswald, Germany
E-mail: tanne@uni-greifswald.de

L. Appulo
Wetlands International European Association
Brussels 1040, Belgium

The ORCID identification number(s) for the author(s) of this article can be found under https://doi.org/10.1002/adsu.202000146.

DOI: 10.1002/adsu.202000146

Dr. S. Ewert
Institute of Geography and Geology
Interdisciplinary Centre for Baltic Sea Region Research (IFZO)
Greifswald University, Partner in the Greifswald Mire Centre
17489 Greifswald, Germany

Prof. S. Lakner
Rostock University, Agricultural and Environmental Faculty
18059 Rostock, Germany

N. Ó Brolcháin
National University of Ireland, Galway
Galway H91 TK33, Ireland

J. Peters
Michael Succow Foundation, Partner in the Greifswald Mire Centre
17489 Greifswald, Germany

Dr. W. Wichtmann
DUENE, Partner in the Greifswald Mire Centre
17489 Greifswald, Germany

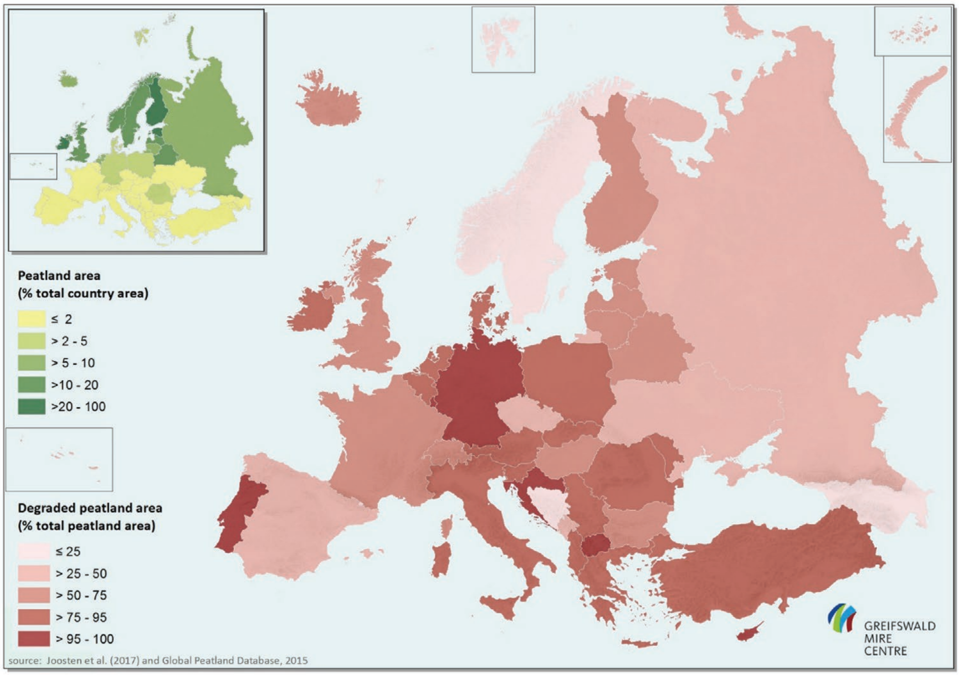

Figure 1. Proportion of degraded peatland area (large map) and proportion of peatland cover (small map) in Europe. The maps are based on the comprehensive book "Mires and peatlands of Europe" and have been prepared and made available by the Greifswald Mire Centre/Global Peatland Database (https://www.greifswaldmoor.de/global-peatland-database-en.html).[2]

to ground and surface water. Drainage of peatlands also leads to land subsidence (1–2 cm yearly) which results in increasing drainage costs, higher flooding risks, and—ultimately—to loss of productive land.[10,12]

Because of the multiple types of environmental damage caused by peatland drainage, these lands are today at the core of the EU's key environmental problems: greenhouse gas emissions, nitrogen pollution, and biodiversity loss. Drained peatlands in the EU emit ≈220 Mt CO_2eq per year (≈5% of total EU emissions), mainly from agriculture on drained peat soils. The latter make up only 2.5% of the total agricultural area but generate ≈25% of the total agricultural greenhouse gas emissions in the EU (incl. CH_4 from enteric fermentation and N_2O from fertilization), with an even larger contribution in peatland-rich countries, e.g., Finland (62%), Poland (42%), and Germany (37%, based on NIR 2019 data).[13] Drained, agriculturally used peatlands in the EU are—through peat mineralization—also an annual source of 1–5 Mt of NO_3 (own estimates based on NIR 2019), with substantial impact on ground and surface water quality, drinking water provision, and biodiversity. Nitrogen release correlates strongly with the drainage depth.[14–16] Last but not least, typical peatland biodiversity, in particular that of groundwater-fed fens in temperate Europe, has been devastated by drainage.[2,17]

Peatlands can play a vital role in addressing these challenges, in particular the twin climate and biodiversity crises. Consequently, an increasing number of EU policies start including improved management of drained peatlands as an essential ecosystem-based solution to avoid greenhouse gas emissions, reinstall carbon sequestration, reduce nitrogen mineralization, enhance nitrogen removal, and restore peatland-specific biodiversity. The aim of this article is to make a wider audience aware of the critical role of peatlands and to point at solutions and enabling policy frameworks, in particular with regard to the new Common Agricultural Policy (CAP) of the European Union, which will inform the European Green Deal.

2. The Solution: Peatland Rewetting

The negative environmental consequences of peatland drainage can be significantly reduced by raising water levels near to the surface (e.g., by ditch closing, stop pumping in polders). Greenhouse gas emissions from drained peatland can be curbed by restoring the water table to predrainage levels. Looking at the greenhouse gases individually and based on the 100 years global warming potential of each gas, it leads to: net annual removals of CO_2; an increase in annual methane (CH_4) emissions; a decrease in nitrous oxide (N_2O) and dissolved organic carbon (DOC) losses; and a lowering of net greenhouse gas (GHG) emissions.[4,18]

In European temperate peatlands, rewetting grassland on drained peat soils saves up to ≈20 t CO_2eq per hectare and year and even up to ≈30 t CO_2eq in case of cropland on drained peat soils.[4,18] Given the strong and not yet completely understood impact of CH_4 on global warming, the increase in CH_4 emissions associated with rewetting may seem like a problem.[19] But management must choose between CO_2 emissions from drained or CH_4 emissions from rewetted peatland. This choice must consider the radiative effects as well as the atmospheric lifetimes of both gases, with CO_2 being a weak but persistent and CH_4 a strong but short-lived greenhouse gas. As demonstrated by

Günther et al., CH_4 radiative forcing does not undermine the climate change mitigation potential of peatland rewetting as important climate change mitigation option in the land use and agriculture sectors.[20] Instead, postponing rewetting increases the long-term warming effect of continued CO_2 emissions.[21]

There is also strong scientific evidence underpinning ecosystem services from peatland rewetting.[10] For one rewetted peatland (54 ha) in Northeast-Germany, Joosten et al. quantified next to the annual greenhouse gas emission reduction (773 t CO_2eq) also the nitrogen release reduction (914 kg N), the increase in cooling effect (1 744 kW), and the increase in biotope value.[16] Recent studies from European fens, the peatland type most dramatically affected by drainage for agriculture, point at quick recovery of key microbial communities and plant functional types.[22,23]

Peatland rewetting has been demonstrated across Europe by governmental and private projects and programs.[24] Technical guidance is available.[25,26] Practical implementation often depends on the consent of all landowners in a hydrological unit as it is impractical, or even impossible, to keep stable high water levels in single plots surrounded by fields that continue to be drained.[27] It is therefore crucial to create social acceptance and support for land consolidation and rewetting.[28,29] Just like the drainage of peatland, the rewetting of peatlands must not be a matter for individual landowners, but for society as a whole. This should be started today in order to avoid major burdens for all actors due to rewetting of much larger areas only by the middle of the century and to allow for social and economic adjustment.[28] Prompt action is also needed as climate warming may make peatland restoration more difficult in the coming decades.[30]

There is growing awareness that "nature-based solutions" (NbS) can help to protect us from climate change impacts while slowing further warming, supporting biodiversity, and securing ecosystem services.[31,32] They are also increasingly seen as opportunities for sustainable investments. NbS are actions to protect, sustainably manage, and restore natural or modified ecosystems, which address societal challenges (e.g., climate change, food and water security or natural disasters) effectively and adaptively, while simultaneously providing human well-being and biodiversity benefits.[31] They play a vitally important role to mitigate and adapt to climate change, but are not a substitute for a rapid fossil fuel phase-out and must not delay urgent action to decarbonize our economies. NbS involve the protection and/or restoration of a wide range of naturally occurring ecosystems on land and in the sea. Clearly, peatland rewetting is a key nature-based solution. Soil carbon represents 25% of the potential of natural climate solutions (total potential, 23.8 Gt of CO_2eq per year), of which 40% is protection of existing soil carbon and 60% is rebuilding depleted stocks.[33] Currently, high level multilateral pledges focus on forests, and attention to other carbon-rich ecosystems such as peatlands is still limited.[32]

Protection of peat soils through conservation, rewetting and sustainable use is pivotal amongst the most effective measures to avoid significant GHG emissions.[34] Mitigation costs of 10–15 Euro per tonne CO_2, or less when combined with "wet" land use, have been demonstrated for Germany.[35] An analysis of the efficiency of three different land use based greenhouse gas abatement measures typical for Germany has shown that peatland rewetting is the most cost-efficient option compared to production of short rotation coppices and of feedstocks for biomethane production.[36] Peatland restoration is likely to be welfare enhancing, with benefits exceeding cost in appraisals of previous and future public investments into peatland restoration.[37] Costs, conditions, and attitudes across the EU differ, but a consistent pattern is that land use alternatives are mainly determined by economic variables and when the current value of land is low, willingness to change land use to rewetting and "wet" land use proved to be high.[29]

Carbon dioxide removal technologies become increasingly important and a sound understanding of the role of peatlands is crucial to integrate them appropriately in climate policy.[38,39] Often, reported potentials for sequestration of carbon in agricultural soils are overly optimistic.[40,41] Globally, rewetting peatlands is 3.4 times less nitrogen costly and involves a much smaller land area demand than mineral soil carbon sequestration.[11] Afforestation on drained peatlands is, in contrast to peatland rewetting, often providing little or no climate benefits (e.g., review for UK peatland afforestation) and not encouraged.[42,43] Although in temperate and boreal forestry-drained peatlands abandoning tree stands without rewetting may have short-term climate benefits compared to rewetting, it is clear that rewetting is the best option for safeguarding peat C storage in the long run. If drainage is maintained, a peatland with a thick layer of peat may gradually lose much more C than any tree stand can store and on dry peat the risk of releasing great amounts of C to the atmosphere in forest and peat fires increases.[44] Approaches such as carbon capture and storage and bioenergy with carbon capture and storage may remain technologically or economically unfeasible and their effects could easily be offset by losses due to land-use change.[20,45–48] The feasibility and efficiency of combinations with peatland rewetting should be assessed.

To reach the core goal of the Paris Agreement—zero net CO_2 emissions by 2050—in the long term, a complete cessation of peatland drainage and reversal of the effects of existing drainage is unavoidable. The EU and all its Member States have unanimously affirmed this goal, which has been reinforced by approving the European Green Deal in 2019.[49] With continued drainage, 12–41% of the GHG emission budget still allowable for keeping global warming below +1.5 to +2 °C will be exhausted by peatland emissions.[50]

However, current with conventional agricultural land use (**Figure 2**, left) is not easily combined with high water tables. Rewetted peatland may be set aside and included in "carbon farming" or "wilderness" schemes. To continue productive land use on peatlands, a paradigm shift is required involving new concepts, crops, and techniques such as paludiculture (Figure 2, right) as well as adjustments of the current agricultural policy framework.

3. Land Use Opportunities on Rewetted Peat Soils

A wide range of alternative, wet land use options have to be presented for European peatlands. To respond to the globally increasing competition for land, to maintain the production

Figure 2. Deep drained peatland used for conventional agriculture causing ≈29 t CO_2eq per hectare and year and currently fully eligible for CAP payments (left) and rewetted peatland used for paludiculture causing 0–7 t CO_2eq per hectare and year, currently not eligible for CAP payments (right), Germany (photos: H. Joosten & F. Tanneberger).[4]

function for rural livelihoods and to retain and restore wet grasslands as hotspots for biodiversity, in many peatlands a simple cessation of land use is no option. As a consequence, a fundamental transition to "wet" land use is inevitable. Land use options for rewetted peatlands in Europe can be broadly grouped into

- High-intensity paludiculture: the cultivation of deliberately established, selected wetland crops under intensive management with the goal to produce the highest quantity and/or quality of targeted biomass (i.e., cropping paludiculture with cattail *Typha*, sphagnum or sundew *Drosera*);
- Low-intensity paludiculture: the regular harvest from spontaneously established vegetation for biomass use (i.e., permanent grassland paludiculture with sedges or grasses under mowing or grazing);
- Wet wilderness: the absence of biomass harvesting and other on-site management with the focus on the provision of regulating services and wilderness biodiversity values (cf. "rewilding").[51,52]

Paludiculture is defined as productive land use of wet peatlands that stops subsidence and minimizes emissions.[35] In contrast to drainage-based agriculture, paludiculture cultivates crops that are adapted to high water tables, such as reed, cattail, alder trees, and peatmosses (**Figure 3**).[27,35] Using a variety of established techniques, the biomass can be processed to insulation and construction materials, growing media, and biorefinery products as well as to fodder and fuel. Innovative products, including medical and food products, are under development. Paludiculture pilots and demonstration sites on a farm-scale already exist in various countries.[53]

Carbon farming involves practices that improve the rate at which CO_2 is removed from the atmosphere and converted to plant material and/or soil organic matter. Carbon farming is successful when carbon gains resulting from enhanced land management and/or conservation practices exceed carbon losses.[54] Emerging funding options are, for example, "carbon credits." Basic considerations for generating carbon credits from peatland rewetting have been summarized already in 2011.[55] The first carbon credits from peatland rewetting have been sold in 2011 (from the German regional Moorfutures scheme),[16] a first national scheme followed in 2017 (the UK Peatland Code), and also in 2017 a methodology for rewetting drained temperate peatlands was launched under the Verified Carbon Standard.[56] Carbon farming includes peatland restoration and most forms of paludiculture, i.e., carbon farming on organic soils is, if combined with productive use of the plant biomass, paludiculture.

The diverse options for value adding manufacturing of biomass from paludiculture shows that the paludiculture system has great potential for the bioeconomy.[59,60] The five main objectives for bioeconomy set up by the European Commission

- ensuring food and nutrition security;
- managing natural resources sustainably;
- reducing dependence on nonrenewable, unsustainable resources whether sourced domestically or from abroad;
- mitigating and adapting to climate change;
- strengthening European competitiveness and creating jobs;

are largely or fully addressed by paludiculture. Only the first objective, ensuring food and nutrition security, remains critical.[59] But in any case, it is to be noted that on the one hand some food can be produced in paludiculture (meat, milk), possibly to a lesser extent than on drained peatlands, but with clear environmental advantages compared to drainage-based peatland management.[35] On the other hand, a new orientation toward paludiculture can relieve the pressure on mineral soils caused by the cultivation of renewable energy sources, by phasing out the cultivation of such renewables on mineral soils and using these soils again for food production.

The necessity of peatland rewetting is to be integrated also into other land-based climate protection measures—an integrative approach is necessary in which measures in the

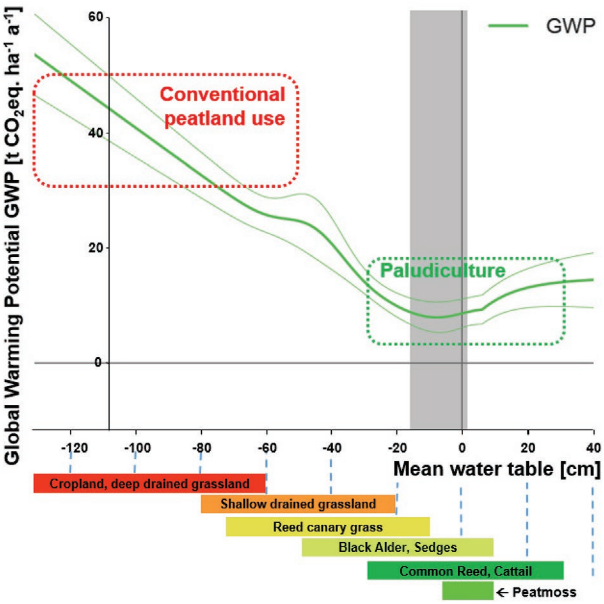

Figure 3. Results of a meta-analysis of greenhouse gas fluxes (CO_2, CH_4) in temperate peatlands and mean water table with typical water table ranges of conventional land use and paludiculture. This figure is based on and modified after recent publications.[35,57,58] Recent flux measurement results are continuously integrated into the Greifswald Mire Centre's (GMC's) emission database. Latest analyses show that emissions of drained peatland are even higher.

various sectors complement rather than hinder each other. For instance, the planning and the construction of wind power or solar energy plants on drained peatlands has to be combined with rewetting or at least a commitment to later rewetting of the peatland must be made.

4. Policy Opportunities and Challenges

Peatland rewetting together with carbon farming and/or paludiculture will provide win-win-options for various sectors of society:

- Agriculture: Alternative income streams on marginal organic soils, soil protection, better social image, climate adaptation (reduction of risks of crop failures after heavy rains, floods, or droughts);
- Society: Securing or creating additional employment in rural areas, regional recreation and tourism, identity, reduction of economic collateral damage caused by drainage;
- Economy: Substitution of fossil resources (energy sources, mineral oil-based construction material, peat in horticulture) by renewable biomass materials from wet peatlands, bioeconomy, sustainable food, and fodder production;
- Environment: Support of wide-ranging ecosystem services such as climate, water, and biodiversity protection.[10,35,52,53,61–63]

Peatland conservation and restoration cuts across most United Nations Sustainable Development Goals (SDGs). Wetlands, including wet peatlands, contribute directly to

- SDG 1 (no poverty): Wetlands offer a clean and reliable source of water and can help to generate economic benefits and reduce exposure and vulnerability to disasters, more than a billion people depend on wetlands for a living;
- SDG 2 (zero hunger): Wetlands combine rice and fish production; using wet peatlands for producing renewable energy can free mineral soils for food production; peatland rewetting reduces loss of productive land due to subsidence especially in coastal areas; improved ecosystem function and water regulation through restoration can increase yields and ensure resilient and sustainable food production;
- SDG 3 (good health and well-being): Half of international tourists seek relaxation in wetland areas, especially coastal zones;
- SDG 6 (clean water and sanitation): Almost all of the world's freshwater consumption is drawn either directly or indirectly from wetlands; wetlands are the integrating ecosystems in the landscape that store and regulate water flows;
- SDG 7 (affordable and clean energy): Renewable biomass from wet peatlands can be used for generating heat at a local and regional scale;
- SDG 9 (industry, innovation, and infrastructure): Paludiculture offers a wide range of innovation, e.g., for building and packaging materials; healthy wetlands form a natural buffer against the increasing number of natural disasters;
- SDG 11 (sustainable cities and communities): Floodplains and peatlands retain and detain floodwaters, reducing flood peaks reaching urban areas and communities;
- SDG 12 (responsible consumption and production): Sustainable management practices such as paludiculture can make wetlands engines of local communities; wet peatlands enhance water supply and quality;
- SDG 13 (climate action): Peatlands cover only 3% of global land but store twice as much carbon as the entire world's forest biomass; peatland rewetting cuts enormous amounts of CO_2 emissions released from drained peat soils and is a cost-efficient climate change mitigation measure;
- SDG 14 (life below water): Healthy and productive oceans rely on well-functioning coastal wetlands;
- SDG 15 (life on land): Some 40% of the world's species live and breed in wetlands.[11,64,65]

Global understanding and support for peatland rewetting is increasing. A true milestone was the United Nations Environment Assembly (UNEA) resolution on "Conservation and Sustainable Management of Peatlands," adopted by all UN member states in 2019. The resolution acknowledged the contribution of peatlands to the implementation of the 2030 Agenda for Sustainable Development.[66] Paludiculture has been applauded in recent reports published by the Food and Agriculture Organization of the United Nations and the Intergovernmental Panel on Climate Change as a GHG mitigation option and peat conserving action with emission factors similar to those of traditional wetland restoration.[4,12,18,67] An additional opportunity is the United Nations Decade on Ecosystem Restoration 2021–2030.

But despite increasing political support and clear scientific evidence for peatland rewetting as an important climate change mitigation option in the land use and agriculture sectors, millennia-old natural peatlands are still being drained for ephemeral use and abandoned after they have been destroyed and progress in peatland rewetting is very slow.[4,18,20] For example, in Germany ≈50 000 ha of drained peatland must be rewetted annually from 2020 onward to comply with a 1.5° pathway but to date only 70 000 ha have been rewetted in total since the 1980s.[28,38] One of the underlying reasons is (still) lack of awareness, the so-called "Cinderella syndrome." There is generally little understanding that peatlands are a crosscutting issue in cropland, grassland, forest land, and peat extraction. The undifferentiated presentation of the total land use sector, in which organic soil sources are obscured by forest biomass sinks, and the split reporting of agricultural emissions over the two sectors Agriculture and Land Use, Land Use Change and Forestry (LULUCF) in national greenhouse gas inventories conceal the fact that CO_2 emissions from organic soils (142 Mt), i.e., from a minor proportion of agricultural land, are of a similar size to CH_4 emissions from all animal husbandry and N_2O emissions from all fertilization across the EU.[68]

Paludiculture is a new, future-orientated concept for the sustainable use of peatlands. The large-scale implementation of paludiculture requires a consequent and consensually pursued paradigm change. This implies a major change in operational management and substantial investment in adapted machinery so that a change to paludiculture is virtually irreversible on the level of the individual enterprise. Because of the important ecosystem services generated for wider beneficiaries, it is reasonable that peatland rewetting and paludiculture projects are supported by central planning and public financing.[27] The solution of problems that originate from drainage-based peatland utilization will depend decisively on political will and successful best practice examples. Worldwide, wet cultivation of peatlands must become the norm whereas drainage-based cultivation must be an exception subject to licensing.[69] The importance of peatlands and the consequences of drainage have to be communicated as well as the possibilities of a sustainable land use to be demonstrated in pilot projects. Large-scale implementation, however, requires agricultural policies to set explicit incentives and stop counterproductive subsidies.[70] A study across Denmark, Finland, Norway, and Indonesia demonstrated that the same factors restrict the implementation of mitigation measures in all countries, the most important of these being lack of policy coherence, e.g., ignoring climate policies when planning land use or agricultural policies.[71] Mainly EU-level incentives for alternative land use are necessary, since climate and agricultural policies are predominately regulated at the EU level.[29] The key policy to become the "game changer" for peatlands in the EU is the CAP, as ≈51 000 km^2 of organic soils are used as cropland or grassland (more than 20% of the EU's total peatland area).[5,72]

5. The Time is Ripe—Improving the EU's Common Agricultural Policy (CAP) Now

The CAP framework is generally suitable for realizing an EU-wide realignment of peatland maintenance and supplying (co-)funding. In past CAP funding period 2014–2020, there were single examples of good funding practices supporting peatland, however, with a low share of funding: About 706 Mio Euro (4.4%) were spent within Rural Development for the climate objectives of priority 5 (own calculations based on European Commission 2016).[73] Note, that priority 5 comprises a bundle of climate measures, where peatland support plays only a minor role. At the same time, CAP payments heavily supported peatland drainage. For example, in Germany agriculture on 14 580 km^2 of drained organic soils received ≈410 Mio Euro direct payments and caused GHG emissions of ≈40 Mio t CO_2eq per year.[74]

In the new funding period after 2020, the CAP must enable land use (sectors Agriculture and LULUCF) to minimize peatland emissions.[34,71,75] As a guiding principle, no landowner in the EU should be economically or socially disadvantaged by maintaining or developing wet peatlands or rewetting peatlands. Deliberate degradation of the long-term carbon storage capacity of peatlands should always be penalized and should never result in increased payments from the EU. Policies should be rebalanced in order to safeguard European Union farmers to make a reasonable and sustainable living. A combination of the following actions and CAP instruments can pave the way toward low-emission peatland utilization:[70]

- Guaranteeing eligibility of farmed wet peatlands for 1st and 2nd CAP pillar payments and ending the systematic disincentive for farming wet peatlands (currently, rewetted peatlands used for paludiculture are not consistently eligible for direct payments);
- Phasing-out CAP funding for drained peatlands to achieve coherence between agricultural and climate policies and to underline the necessary paradigm shift for reaching the climate change mitigation goals under international law;
- Remunerating ecosystem services with results-based agricultural payment schemes to set attractive incentives for reducing greenhouse gas emissions and for supplying other ecosystem services (e.g., nutrient retention, water quality, and flood regulation);
- Implementing national peatland carbon credit schemes in the 16 EU Member States with significant peatland emissions to facilitate carbon retention and carbon capture;
- Establishing long-term programs (15–20 years) to ensure planning security and permanence of positive climate and environmental effects;
- Applying and refining existing instruments (e.g., European Agricultural Fund for Rural Development and European Regional Development Fund) to provide incentives for all implementation steps, including site preparation, establishment of suitable crops and techniques, raising the water level, selection and breeding, management and harvest with adapted agricultural equipment, processing, and marketing;
- Promoting knowledge transfer, consultation, and establishment of demonstration farms;
- Exchanging on experience between peatland-rich regions in Europe to develop regionally customized solutions, including participation and acceptance of all stakeholders, output orientation, and cost efficiency.

The new "Green Architecture" for the CAP 2021–2027 provides a number of suitable instruments to support rewetting and agriculture on rewetted peatlands, however, further policy design deems it necessary to implement a functioning support scheme.[75,76] **Table 1** displays key options within the CAP 2021–2027.

The table shows multiple options within the CAP, which can direct future agriculture on peatlands and support agriculture on wet peatlands. Not all proposed instruments are equally suitable for application in peatlands. One main unresolved issue is the short timeframe, with ecoschemes as yearly programs and even agri-environmental and climate measures (AECM) as programs of max. 7 years. Consolidation of land parcels, rewetting and adaptation to wet agriculture requires substantial investments and thus long-term security. Therefore, CAP programing has to provide funding options beyond the short-term horizon. And options both for short- and longer-term instruments should be used and further improved in the final CAP 2021–2027.

Table 1. Policy instruments within the CAP 2021–2027[76] and their potential to fund low-emission agriculture on peatlands.

Measure	Potential use for wet peatlands
Strategic plans	Indicators can be used to document progress and for policy management within future CAP. The proposed result-indicator 14 deals with "carbon storage in soils and biomass: Share of agricultural land under commitments to reducing emissions, maintaining and/or enhancing carbon storage (permanent grassland, agricultural land in peatland, forest, etc.)"
Direct payments and conditionality (including the "good agricultural and ecological condition (GAEC)")	Direct payments require the fulfilment of criteria. To support paludiculture, the EU should change the criteria of eligibility for direct payments and include the use of rewetted (wet) peatlands and paludiculture The Commission proposes in GAEC 2 a criterion supporting the protection of carbon-rich soils ("appropriate protection of wetland and peatland/protection of carbon-rich soils"), which should not be restricted to protected areas
Ecoschemes	These are agri-environmental programs, 100% funded by the EU in 1st pillar, which can be used as simple entry schemes. Ecoschemes are yearly, which is a main obstacle to applying this instrument in peatland rewetting
Agri-environmental and climate measures (AECM)	Agri-environmental programs cofunded by member states and EU over 5–7 years in the 2nd pillar. There are good-practice examples supporting wet peatlands, e.g., in the federal state of Brandenburg (Germany) aiming at support for peatlands with a mean annual water table not lower than 30 cm below soil surface. Other good examples can be found; however, up to now, there is no substantial upscaling of AECM funding for peatland rewetting and paludiculture
Agri-investment programs	These funding tools in the 2nd pillar could support investment into novel techniques for agriculture on wet/rewetted peatlands

The European Commission has declared environmental protection and the fight against climate change as the greatest challenge of the future CAP. Given the high climate change mitigation potential of paludicultures, EU institutions have expressed support for making agricultural land rewetted for paludiculture eligible for direct payments in the next CAP period.[77,78] The EU Commission's proposal for the coming CAP funding period defines a new standard for good agricultural and environmental condition as "appropriate protection of wetland and peatland" and the Directorate-General for Agriculture and Rural Development (DG Agri) explicitly takes paludiculture as an example to explain the new possibilities for the member states to protect peatlands within the new CAP framework.[79,80] Most recently, the European Parliament also called for gearing all European policy instruments, including CAP, to the climate targets of the Paris Agreement and stressed that agriculture has the potential to help the EU reduce its emissions through sustainable practices incl. those related to soil carbon.[49]

John Kingdon's famous *Multiple Streams Approach* (MSA) is one of the most cited references in order to explain policy change.[81,82] According to Kingdon, an idea's time comes when a problem stream, a policy stream, and a political stream are ripe, soften up, and merge due to the activities of policy entrepreneurs. As we have shown, the awareness of the problem of GHG emissions from drained peatlands raises on a global level. In the light of the MSA, initiatives like the UNEA resolution on "Conservation and Sustainable Management of Peatlands" indicate that the problem stream is ripe. The concept of paludiculture offers an alternative policy for a sustainable use of wet and rewetted peatlands. As we have shown in chapter 3, pilot projects demonstrate the technical feasibility of paludicultures which is a crucial criterion for a ripe policy stream. On the political level, scientists became policy entrepreneurs and took an active part in the current discussions on the CAP reforms in the EU.[13] In the light of the MSA, the reform discussions are the open policy window. It seems that the three streams are ripe and so paludiculture appeared on the agenda. But it is still open, as to what the decisions on the policy framework for agriculturally used peatlands in 2021–2027 will be. The new CAP regulations for peatlands will be the acid test as to whether the European Green Deal is just empty words or represents a real and lasting change.

Acknowledgements

The authors thank Emma Goodyer (International Union for Nature Conservation (IUCN) UK Peatland Programme), Wiktor Kotowski (Warsaw University, Poland), Kristiina Regina (Natural Resources Institute LUKE, Finland), Terry Morley (National University of Ireland, Galway), Chris Field (Manchester Metropolitan University), Valentina Sechi (Hogeschool Van Hall Larenstein (HVHL)) as well as Alexandra Barthelmes, John Couwenberg, Sabine Wichmann, Hans Joosten (all Greifswald Mire Centre) for their input and helpful comments to the policy brief “Peatlands in the EU—Common Agricultural Policy (CAP) after 2020” and to parts of this article. Parts of this study were funded by the European Social Fund (ESF) and the Ministry of Education, Science and Culture of Mecklenburg-Western Pomerania within the scope of the project WETSCAPES (ESF/14-BM-A55-0027/16 to ESF/14-BM-A55-0035/16), within the BMBF funded Interdisciplinary Centre for Baltic Sea Region Research IFZO (01UC1904), and within the Interreg North-West Europa Care-Peat project (NWE808 Care-Peat).

Open access funding enabled and organized by Projekt DEAL.

Conflict of Interest

The authors declare no conflict of interest.

Keywords

climate protection, ecosystem services, greenhouse gas emissions, paludiculture, rewetting

Received: June 21, 2020
Revised: August 14, 2020
Published online:

[1] H. Joosten, D. Clarke, *Wise Use of Mires and Peatlands – Background and Principles Including a Framework for Decision-Making*, International Mire Conservation Group and International Peat Society, Greifswald/Jyväskylä **2002**.
[2] H. Joosten, F. Tanneberger, A. Moen, *Mires and Peatlands of Europe. Status, Distribution and Conservation*, Schweizerbart, Stuttgart **2017**.
[3] 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Agriculture, Forestry and Other Land Use. National Greenhouse Gas Inventories Programme, http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html (accessed: August 2020).
[4] T. Hiraishi, T. Krug, K. Tanabe, N. Srivastava, J. Baasansuren, M. Fukuda, T. G. Troxler, *2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands*, Intergovernmental Panel on Climate Change, Switzerland **2014**.
[5] F. Tanneberger, C. Tegetmeyer, S. Busse, A. Barthelmes, S. Shumka, A. Moles Mariné, K. Jenderedjian, G. M. Steiner, F. Essl, J. Etzold, C. Mendes, A. Kozulin, P. Frankard, Đ. Milanović, A. Ganeva, I. Apostolova, A. Alegro, P. Delipetrou, J. Navrátilová, M. Risager, A. Leivits, A. M. Fosaa, S. Tuominen, F. Muller, T. Bakuradze, M. Sommer, K. Christanis, E. Szurdoki, H. Oskarsson, S. H. Brink, J. Connolly, L. Bragazza, G. Martinelli, O. Aleksāns, A. Priede, D. Sungaila, L. Melovski, T. Belous, D. Saveljić, F. de Vries, A. Moen, W. Dembek, J. Mateus, J. Hanganu, A. Sirin, A. Markina, M. Napreenko, P. Lazarević, V. Šefferová Stanová, P. Skoberne, P. Heras Pérez, X. Pontevedra-Pombal, J. Lonnstad, M. Küchler, C. Wüst-Galley, S. Kirca, O. Mykytiuk, R. Lindsay, H. Joosten, *Mires Peat* **2017**, *19*, 1.
[6] J. Limpens, F. Berendse1, C. Blodau, J. G. Canadell, C. Freeman, J. Holden, N. Roulet, H. Rydin, G. Schaepman-Strub, *Biogeosciences* **2008**, *5*, 1475.
[7] H. Rydin, J. K. Jeglum, *The Biology of Peatlands*, 2nd ed. Oxford University Press, Oxford **2013**.
[8] H. Joosten, A. Sirin, J. Couwenberg, J. Laine, P. Smith, in *Peatland Restoration and Ecosystem Services: Science, Policy and Practice* (Eds: A. Bonn, T. Allott, M. Evans, H. Joosten, R. Stoneman, Cambridge University Press, Cambridge **2016**, p. 63.
[9] F. Parish, A. Sirin, D. Charman, H. Joosten, T. Minayeva, M. Silvius, L. Stringer, *Assessment on Peatlands, Biodiversity and Climate Change: Main Report*, Global Environment Centre and Wetlands International, Kuala Lumpur/Wageningen **2008**.
[10] A. Bonn, T. Allott, M. Evans, H. Joosten, R. Stoneman, *Peatland Restoration and Ecosystem Services: Science, Policy and Practice*, Cambridge University Press, Cambridge **2016**, p. 493.
[11] J. Leifeld, L. Menichetti, *Nat. Commun.* **2018**, *9*, 1071.
[12] H. Joosten, M.-L. Tapio-Biström, S. Tol, *Peatlands – Guidance for Climate Change Mitigation through Conservation, Rehabilitation and Sustainable Use*, 2nd ed., Food and Agriculture Organization of the United Nations, Rome **2012**, p. 114.
[13] Greifswald Mire Centre (GMC), Wetlands International and National University of Ireland, Galway (NUI), Peatlands in the EU. Common Agricultural Policy (CAP) after 2020. Position Paper, https://www.greifswaldmoor.de/files/dokumente/Infopapiere_Briefings/202003_CAP%20Policy%20Brief%20Peatlands%20in%20the%20new%20EU%20Version%204.8.pdf (accessed: August 2020).
[14] C. L. van Beek, P. Droogers, H. A. van Hardeveld, G. A. P. H. van den Eertwegh, G. L. Velthof, O. Oenema, *Water, Air Soil Pollut.* **2007**, *182*, 291.
[15] B. Tiemeyer, P. Kahle, *Biogeosci. Discuss.* **2014**, *11*, 3023.
[16] H. Joosten, K. Brust, J. Couwenberg, A. Gerner, B. Holsten, T. Permien, A. Schäfer, F. Tanneberger, M. Trepel, A. Wahren, *MoorFutures® Integration of Additional Ecosystem Services (Including Biodiversity) into Carbon Credits – Standard, Methodology and Transferability to Other Regions*,Vol. *407*, BfN, Bonn-Bad Godesberg **2015**, p. 120.
[17] A. Sirin, T. Minayeva, H. Joosten, F. Tanneberger, in *IPBES: The IPBES Regional Assessment Report on Biodiversity and Ecosystem Services for Europe and Central Asia* (Eds: M. Rounsevell, M. Fischer, A. Torre-Marin Rando, A. Mader, Bonn, Germany **2018**, p. 217.
[18] D. Wilson, D. Blain, J. Couwenberg, C. D. Evans, D. Murdiyarso, S. E. Page, F. Renou-Wilson, J. O. Rieley, A. Sirin, M. Strack, E.-S. Tuittila, *Mires Peat* **2016**, *17*, 1.
[19] S. E. Mikaloff Fletcher, H. Schaefer, *Science* **2019**, *364*, 932.
[20] S. Roe, C. Streck, M. Obersteiner, S. Frank, B. Griscom, *Nat. Clim. Change* **2019**, *9*, 817.
[21] A. Günther, A. Barthelmes, V. Huth, H. Joosten, G. Jurasinski, F. Koebsch, J. Couwenberg, *Nat. Commun.* **2020**, *11*, 1644.
[22] W.-J. Emsens, R. van Diggelen, C. Aggenbach, T. Cajthaml, J. Frouz, A. Klimkowska, W. Kotowski, L. Kozub, Y. Liczner, E. Seeber, H. Silvennoinen, F. Tanneberger, J. Vicena, M. Wilk, E. Verbruggen, *ISME J.* **2020**, *14*, 1701.
[23] A. Klimkowska, K. Goldstein, T. Wyszomirski, Ł. Kozub, M. Wilk, C. Aggenbach, J. P. Bakker, H. Belting, B. Beltman, V. Blüml, Y. De Vries, B. Geiger-Udod, A. P. Grootjans, P. Hedberg, H. J. Jager, D. Kerkhof, J. Kollmann, P. Pawlikowski, E. Pleyl, W. Reinink, H. Rydin, J. Schrautzer, J. Sliva, R. Stańko, S. Sundberg, T. Timmermann, L. Wołejko, R. F. van der Burg, D. van der Hoek, J. M. H. van Diggelen, A. van Heerden, L. van Tweel, K. Vegelin, W. Kotowski, *PLoS One* **2019**, *14*, e0215645.
[24] R. Cris, S. Buckmaster, C. Bain, M. Reed, *Global Peatland Restoration Demonstrating SUCCESS*, IUCN UK National Committee Peatland Programme, Edinburgh **2014**.
[25] A. V. Kozulin, N. I. Tanovitskaya, I. N. Vershitskaya, *Methodical Recommendations for Ecological Rehabilitation of Damaged Mires and Prevention of Disturbances to the Hydrological Regime of Mire Ecosystems in the Process of Drainage*, National Academy of Sciences of the Republic of Belarus, Minsk **2010**, p. 40.
[26] T. Thom, A. Hanlon, R. Lindsay, J. Richards, R. Stoneman, S. Brooks, *Conserving Bogs. The Management Handbook*, 2nd ed., IUCN UK Peatland Programme, Edinburgh **2019**, p. 207.
[27] H. Joosten, G. Gaudig, F. Tanneberger, S. Wichmann, W. Wichtmann, in *Peatland Restoration and Ecosystem Services: Science, Practice, Policy* (Eds: A. Bonn, T. Allott, M. Evans, H. Joosten, R. Stoneman), Cambridge University Press, Cambridge **2016**, p. 339.

[28] S. Abel, A. Barthelmes, G. Gaudig, H. Joosten, A. Nordt, J. Peters, *Proc. Greifswald Mire Cent.*, Greifswald Mire Centre, Greifswald **2019**, p. 1, (in German).
[29] C. Buschmann, N. Röder, K. Berglund, Ö. Berglund, P. E. Lærke, M. Maddison, Ü. Mander, M. Myllyse, B. Osterburg, J. H. J. van den Akker, *Land Use Policy* **2020**, *90*, 104181.
[30] G. T. Swindles, P. J. Morris, D. J. Mullan, R. J. Payne, T. P. Roland, M. J. Amesbury, M. Lamentowicz, T. E. Turner, A. Gallego-Sala, T. Sim, I. D. Barr, M. Blaauw, A. Blundell, F. M. Chambers, D. J. Charman, A. Feurdean, J. M. Galloway, M. Gałka, S. M. Green, K. Kajukało, E. Karofeld, A. Korhola, Ł. Lamentowicz, P. Langdon, K. Marcisz, D. Mauquoy, Y. A. Mazei, M. M. McKeown, E. A. D. Mitchell, E. Novenko, G. Plunkett, H. M. Roe, K. Schoning, Ü. Sillasoo, A. N. Tsyganov, M. van der Linden, M. Väliranta, B. Warner, *Nat. Geosci.* **2019**, *12*, 922.
[31] E. Cohen-Shacham, G. Walters, C. Janzen, S. Maginnis, *Nature-Based Solutions to Address Global Societal Challenges*, Gland, Switzerland **2016**, p. 97.
[32] N. Seddon, A. Chausson, P. Berry, C. A. J. Girardin, A. Smith, B. Turner, *Philos. Trans. R. Soc., B* **2020**, *375*, 20190120.
[33] D. A. Bossio, S. C. Cook-Patton, P. W. Ellis, J. Fargione, J. Sanderman, P. Smith, S. Wood, R. J. Zomer, M. von Unger, I. M. Emmer, B. W. Griscom, *Nat. Sustainability* **2020**, *3*, 391.
[34] H. Wüstemann, A. Bonn, C. Albert, C. Bertram, L. Biber-Freudenberger, *Ecosyst. Serv.* **2017**, *24*, 187.
[35] W. Wichtmann, C. Schröder, H. Joosten, *Paludiculture – Productive Use of Wet Peatlands*, Schweizerbart Science Publishers, Stuttgart **2016**.
[36] N. Röder, M. Henler, H. Liebersbach, P. Kreins, B. Osterburg, *Ecol. Econ.* **2015**, *117*, 193.
[37] K. Glenk, J. Martin-Ortega, *J. Environ. Econ. Policy* **2018**, *7*, 345.
[38] An IPCC Special Report on the Impacts of Global Warming of 1.5 °C above Pre-Industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty, Geneva, https://www.ipcc.ch/sr15/ (accessed: August 2020).
[39] C. L. Fyson, S. Baur, M. Gidden, C.-F. Schleussner, *Nat. Clim. Change* **2020**, *10*, 836.
[40] N. Batjes, *Land Degrad. Dev.* **2019**, *30*, 25.
[41] W. H. Schlesinger, R. Amundson, *Global Change Biol.* **2019**, *25*, 386.
[42] T. J. Sloan, R. J. Payne, A. R. Anderson, C. Bain, S. Chapman, N. Cowie, P. Gilbert, R. Lindsay, D. Mauquoy, A. J. Newton, R. Andersen, *Mires Peat* **2018**, *23*, 1.
[43] IUCN UK Peatland Programme: Position Statement: Peatlands and Trees, https://www.iucn-uk-peatlandprogramme.org/sites/default/files/2020-04/IUCN%20UK%20PP%20Peatlands%20and%20trees%20position%20statement%202020.pdf (accessed: August 2020).
[44] P. Ojanen, K. Minkkinen, *Global Biogeochem. Cycles* **2020**, *34*, e2019GB006503.
[45] S. Fuss, J. G. Canadell, G. P. Peters, M. Tavoni, R. M. Andrew, P. Ciais, R. B. Jackson, C. D. Jones, F. Kraxner, N. Nakicenovic, C. Le Quéré, M. R. Raupach, A. Sharifi, P. Smith, Y. Yamagata, *Nat. Clim. Change* **2014**, *4*, 850.
[46] P. Smith, S. Davis, F. Creutzig, S. Fuss, J. Minx, *Nat. Clim. Change* **2016**, *6*, 42.
[47] K. Anderson, G. Peters, *Science* **2016**, *354*, 182.
[48] A. B. Harper, T. Powell, P. M. Cox, J. House, C. Huntingford, *Nat. Commun.* **2018**, *9*, 2938.
[49] European Parliament, The European Green Deal. European Parliament resolution of 15 January 2020 on the European Green Deal (2019/2956(RSP)), https://www.europarl.europa.eu/doceo/document/TA-9-2020-0005_EN.html (accessed: August 2020).
[50] J. Leifeld, C. Wüst-Galley, S. Page, *Nat. Clim. Change* **2019**, *9*, 945.
[51] F. Tanneberger, C. Schröder, M. Hohlbein, U. Lenschow, T. Permien, S. Wichmann, W. Wichtmann, *Wetlands* **2020**, https://doi.org/10.1007/s13157-020-01310-8.
[52] Ecological Restoration in the EU Post-2020 Biodiversity Strategy: The Opportunities of Rewilding European Landscapes for Nature and Climate, https://www.idiv.de/fileadmin/content/iDiv_Files/News_Files/2020/Ecological_restoration_in_the_EU_post-2020_biodiversity_strategy_-_The_opportunities_of_rewilding_European_landscapes_for_nature_and_climate.pdf (accessed: August 2020).
[53] J. J. M. Geurts, G.-J. A. van Duinen, J. van Belle, S. Wichmann, W. Wichtmann, C. Fritz, *J. Sustainable Org. Agric. Syst.* **2019**, *69*, 5.
[54] IPCC Climate Change: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Geneva, Switzerland, https://www.ipcc.ch/report/ar4/syr/ (accessed: August 2020).
[55] F. Tanneberger, W. Wichtmann, *Carbon Credits from Peatland Rewetting. Climate – Biodiversity – Land Use*, Schweizerbart, Stuttgart **2011**.
[56] VM0036 Methodology for Rewetting Drained Temperate Peatlands v1.0, https://verra.org/methodology/vm0036-methodology-for-rewetting-drained-temperate-peatlands-v1-0/ (accessed: August 2020).
[57] J. Couwenberg, A. Thiele, F. Tanneberger, J. Augustin, S. Bärisch, D. Dubovik, N. Liashchynskaya, D. Michaelis, M. Minke, A. Skuratovich, H. Joosten, *Hydrobiologia* **2011**, *674*, 67.
[58] G. Gaudig, F. Tanneberger, in *Current Trends in Landscape Research. Innovations in Landscape Research* (Eds: L. Mueller, F. Eulenstein, Springer, Cham **2019**.
[59] European Commission, *A Sustainable Bioeconomy for Europe: Strengthening the Connection between Economy, Society and the Environment Updated Bioeconomy Strategy*, European Commission, Brussels **2018**, p. 107.
[60] R. Beluhova-Uzunova, M. Shishkova, B. Trakia, *J. Sci.* **2019**, *17*, 227.
[61] H. Joosten, G. Gaudig, R. Krawczynski, F. Tanneberger, S. Wichmann, W. Wichtmann, in *Soil Carbon: Science, Management and Policy for Multiple Benefits, SCOPE Series*, Vol. *71* (Eds: S. A. Banwart, E. Noellemeyer, E. Milne, Wallingford, UK **2014**, p. 297.
[62] L. Ren, F. Eller, C. Lambertini, W.-Y. Guo, H. Brix, B. K. Sorrell, *Sci. Total Environ.* **2019**, *664*, 1150.
[63] R. Vroom, F. Xie, J. Geurts, A. Chojnowska, A. Smolders, L. Lamers, C. Fritz, *Ecol. Eng.* **2018**, *124*, 88.
[64] Ramsar Convention, Scaling up Wetland Conservation, Wise Use and Restoration to Achieve the Sustainable Development Goals, https://www.ramsar.org/sites/default/files/documents/library/wetlands_sdgs_e.pdf (accessed: August 2020).
[65] Wetlands International, Act Now on Wetlands for Agenda 2030. Policy Brief, https://www.wetlands.org/publications/act-now-on-wetlands-for-agenda-2030/ (accessed: August 2020).
[66] United Nations Environment Programme, Resolution Adopted by the United Nations Environment Assembly on 15 March 2019. 4/16. Conservation and Sustainable Management of Peatlands, https://wedocs.unep.org/bitstream/handle/20.500.11822/28480/English.pdf?sequence=3&isAllowed=y (accessed: August 2020).
[67] R. Biancalani, A. Avagyan, *Towards Climate-Responsible Peatlands Management*, FAO, Rome **2014**, p. 117.
[68] Proceedings of the Greifswald Mire Centre 02/2018, https://greifswaldmoor.de/files/dokumente/GMC%20Schriften/18-02_Barthelmes_GMC.pdf (accessed: August 2020).
[69] C. Schröder, H. Joosten, W. Wichtmann, in *Paludiculture – Productive Use of Wet Peatlands* (Eds: W. Wichtmann, C. Schröder, H. Joosten, Schweizerbart Science Publishers, Stuttgart **2016**, p. 229.
[70] Proceedings of the Greifswald Mire Centre 01/2018, https://greifswaldmoor.de/files/dokumente/GMC%20Schriften/Report_Economic%20incentives_Cinderella_GMC%20Proceedings_web.pdf (accessed: August 2020).

[71] K. Regina, A. Budiman, M. H. Greve, A. Grønlund, Å. Kasimir, H. Lehtonen, S. O. Petersen, P. Smith, H. Wösten, *Clim. Policy* **2016**, *16*, 522.

[72] NIS = National Inventory Submissions to the UNFCCC, https://unfccc.int/process-and-meetings/transparency-and-reporting/reporting-and-review-under-the-convention/greenhouse-gas-inventories-annex-i-parties/national-inventory-submissions-2019 (accessed: August 2020).

[73] European Commission, Rural Development Programmes by Country; Factsheets and Country Files for the Member States, Brussels, https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/rural-development/country_en (accessed: August 2020).

[74] Greifswald Mire Centre (GMC), Moorbodenschutz als naturbasierte Lösung im Klimaschutzprogramm 2030 – schnelle Einstellung von Moor-Entwässerung für wirkungsvollen Klimaschutz nötig! Faktenpapier bzgl. der "Eckpunkte für das Klimaschutzprogramm 2030", Greifswald, https://www.greifswaldmoor.de/files/dokumente/Infopapiere_Briefings/2019-09-Faktenpapier_MoorklimaschutzDE_4S.pdf (accessed: August 2020).

[75] G. Pe'er, Y. Zinngrebe, F. Moreira, C. Sirami, S. Schindler, R. Müller, V. Bontzorlos, D. Clough, P. Bezák, A. Bonn, B. Hansjürgens, A. Lomba, S. Möckel, G. Passoni, C. Schleyer, J. Schmidt, S. Lakner, *Science* **2019**, *365*, 449.

[76] European Commission, Proposal for a Regulation of the EU Parliament and of the Council Establishing Rules on Support for Strategic Plans to be Drawn up by Member States under the Common Agricultural Policy (CAP Strategic Plans) and Financed by the European Agricultural Guarantee Fund (EAGF) and by the European Agricultural Fund for Rural Development (EAFRD) and Repealing Regulation (EU) No 1305/2013 of the European Parliament and of the Council and Regulation (EU) No 1307/2013 of the European Parliament and of the Council, Brussels, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2018%3A392%3AFIN (accessed: August 2020).

[77] European Commission, *Commission Staff Working Document on the Review of the 2012 European Bioeconomy Strategy*, European Commission, Brussels **2017**, p. 74.

[78] European Parliament, Report on the proposal for a regulation of the European Parliament and of the Council establishing rules on support for strategic plans to be drawn up by Member States under the Common agricultural policy (CAP Strategic Plans) and financed by the European Agricultural Guarantee Fund (EAGF) and by the European Agricultural Fund for Rural Development (EAFRD) and repealing Regulation (EU) No 1305/2013 of the European Parliament and of the Council and Regulation (EU) No 1307/2013 of the European Parliament and of the Council (COM(2018)0392 – C8-0248/2018 – 2018/0216(COD)), Committee on Agriculture and Rural Development. A8-0200/2019, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2018%3A392%3AFIN (accessed: August 2020).

[79] European Commission, Annexes to the Proposal for a regulation of the European Parliament and of the Council establishing rules on support for strategic plans to be drawn up by Member States under the Common agricultural policy (CAP Strategic Plans) and financed by the European Agricultural Guarantee Fund (EAGF) and by the European Agricultural Fund for Rural Development (EAFRD) and repealing Regulation (EU) No1305/2013 of the European Parliament and of the Council and Regulation (EU) No 1307/2013 of the European Parliament and of the Council, https://eur-lex.europa.eu/resource.html?uri=cellar:aa85fa9a-65a0-11e8-ab9c-01aa75ed71a1.0003.02/DOC_2&format=PDF (accessed: August 2020).

[80] DG Agriculture and Rural Development (Agri), The Post-2020 Common Agricultural Policy: Environmental Benefits and Simplification, Brussels, https://ec.europa.eu/info/sites/info/files/food-farming-fisheries/key_policies/documents/cap-post-2020-environ-benefits-simplification_en.pdf (accessed: August 2020).

[81] J. W. Kingdon, *Agendas, Alternatives and Public Policies. Update Edition, with an Epilogue on Health Care*, 2nd ed., Pearson, Essex **2014**.

[82] M. D. Jones, J. J. Pierce, N. Herweg, A. Bernal, H. L. Raney, N. Zahariadis, *Policy Stud. J.* **2016**, *44*, 13.

Franziska Tanneberger is a researcher at the Institute of Botany and Landscape Ecology at Greifswald University and codirector of the Greifswald Mire Centre, Germany. She works on fen ecology and biodiversity, paludiculture, and peatland restoration, particularly within carbon schemes.