Peatlands, climate change mitigation and biodiversity conservation

An issue brief on the importance of peatlands for carbon and biodiversity conservation and the role of drained peatlands as greenhouse gas emission hotspots

/Policy brief

Peatlands, climate change mitigation and biodiversity conservation
An issue brief on the importance of peatlands for carbon and biodiversity conservation and the role of drained peatlands as greenhouse gas emission hotspots

ISBN 978-92-893-4168-4 (PRINT)
ISBN 978-92-893-4169-1 (PDF)
http://dx.doi.org/10.6027/ANP2015-727
ANP 2015:727

Author: Hans Joosten
Layout: Gitte Wejnold
Cover photo: Store Mosse, Sweden, Hans Joosten
All photos: Hans Joosten
Print: Rosendahls-Schultz Grafisk
Copies: 50
Typeface: Meta LF
Paper: Munken Polar

Printed in Denmark

www.norden.org/nordpub

Nordic co-operation
Nordic co-operation is one of the world's most extensive forms of regional collaboration, involving Denmark, Finland, Iceland, Norway, Sweden, and the Faroe Islands, Greenland, and Åland.

Nordic co-operation has firm traditions in politics, the economy, and culture. It plays an important role in European and international collaboration, and aims at creating a strong Nordic community in a strong Europe.

Nordic co-operation seeks to safeguard Nordic and regional interests and principles in the global community. Common Nordic values help the region solidify its position as one of the world's most innovative and competitive.

Nordic Council of Ministers
Ved Stranden 18
DK-1061 Copenhagen K
Telefon (+45) 3396 0200

www.norden.org

norden

Peatlands, climate change mitigation and biodiversity conservation

An issue brief on the importance of peatlands for carbon and biodiversity conservation and the role of drained peatlands as greenhouse gas emission hotspots

Policy brief

HANS JOOSTEN
Institute of Botany and Landscape Ecology
Ernst-Moritz-Arndt-University of Greifswald, Germany
Partner in the Greifswald Mire Centre

Funded by the Climate and Air Pollution Group (KOL) and the Terrestrial Ecosystem Group (TEG) under the Nordic Council of Ministers

This issue brief targets policy- and decision-makers in the Nordic Baltic countries and around the world dealing with climate change mitigation and wetland conservation as well as the interested general public. The brief is based on the report 'Peatlands and climate in a Ramsar context: a Nordic-Baltic perspective' in which all supporting figures and references can be found.

Ramsar NorBalWet Initiative

GREIFSWALD MIRE CENTRE

ERNST MORITZ ARNDT UNIVERSITÄT GREIFSWALD
Wissen lockt. Seit 1456

Key messages

- Peatlands (lands with peat at the surface) are highly space-effective carbon stocks: they cover only 3% of the land, but contain more carbon than the entire forest biomass of the world.
- When peatlands are drained, the hitherto well preserved carbon and nitrogen are released as greenhouse gases to the atmosphere and as nitrate to the surface water.
- Worldwide 15% of the peatlands have been drained, but these drained peatlands (on 0.4% of the land area) are responsible for 5% of the global anthropogenic CO_2 emissions.
- Further environmental problems associated with peatland drainage include loss of capacity for water purification, flood control and the provision of habitat for specialized biodiversity. One of the gravest – but least recognized – problems is subsidence, i.e. the loss of height. Subsidence leads all over the world to drainage problems, salt intrusion in coastal peatlands and eventually to the loss of productive land.
- The Nordic and Baltic States contain – also in global perspective - a large extent of peatland and a wide diversity of peat accumulating ecosystems (mires).
- Almost half (45%) of the peatland area in the Nordic and Baltic States have been drained and emit almost 80 megatons of CO_2 annually, i.e. 25% of the total CO_2 emissions of these countries.
- In Iceland and Latvia the peatland CO_2-emissions are twice as large as the total emissions from all other sources combined (excl. land use), in Estonia, Lithuania and Finland 50%, in Sweden and Norway 25 and 15% respectively. Only in Denmark (and Greenland) the peatland emissions lay below 10% of the total other CO_2-emissions. Peatlands may thus play a vital role in national climate change mitigation policies.
- A substantial reduction of emissions can be achieved by rewetting. The net greenhouse gas emissions from rewetted peatlands are low compared to the previous drained situation.
- Rewetting of drained peatlands is consistent with a wide variety of Nordic and Baltic policy agreements.

Recommendations

- Identify priorities for peatland rewetting by assessing peatland distribution, drainage status, actual emissions and identifying biodiversity conservation hotspots.
- Formulate success criteria and develop adequate indicators of successful peatland rewetting.
- Set up good practice demonstration projects, e.g. as Ramsar sites, to raise public awareness, share expertise and innovation, and develop management guidance.
- Strengthen links between science and policy to ensure that policy objectives are data based, clear and quantifiable.
- Increase commitments to conserving and rewetting peatlands.
- Develop and implement – where applicable – adequate support and direct funding mechanisms for changing drained peatland use to paludicultures (wet agriculture and forestry).
- Avoid and abolish perverse subsidies and regulations which drive peatland damage and destruction, and develop stronger regulatory mechanisms.
- Communicate the societal benefits of wet (both pristine and rewetted) peatlands in terms of ecosystem services and the costs arising from damaged peatlands.
- Promote the role of peatlands rewetting and restoration in reaching national and international policy targets, especially for climate regulation, water quality and biodiversity conservation.

Peatlands, climate change mitigation and biodiversity conservation

The purpose of this issue brief is to draw attention to greenhouse gas emissions from drained peatlands and to the opportunities for climate change mitigation by peatland rewetting.

Peatlands constitute – in the Nordic and Baltic States and beyond – an important part of the landscape, but their role in national greenhouse emissions is still insufficiently recognized.

Why bother about peatlands?

Peatlands are wetlands where permanently waterlogged conditions prevent the complete decomposition of dead plant material. In peatlands thick layers of carbon rich peat has accumulated over thousands of years. Peatlands contain thus disproportionally much carbon: in the boreal zone seven times, in the tropics even 10 times more per hectare than ecosystems on mineral soil. Peatlands are the most space-effective stocks of organic carbon on the planet: although they cover only 3% of the land, they contain more carbon than the entire forest biomass of the world.

SOME ETYMOLOGISTS RELATE ‘Suomi’, the native name of Finland (~fenland...), to ‘suo’, the Finnish word for ‘peaty wetland’ and link the word ‘Baltic’ to an old word for swamp (cf. Lithuanian ‘bala’, Russian ‘болото’). But these interpretations are contested. However, whatever the origin of these names may be, peatlands contribute substantially to the identity of the Nordic and Baltic countries.

When peatlands are drained, oxygen enters the peat, breaks it down, and the hitherto well-preserved carbon and nitrogen are released as greenhouse gases to the atmosphere and as nitrate to the surface water. Worldwide only 15% of the peatlands have been drained (= 0.4% of the land area), but these drained peatlands are responsible for 5% of all global anthropogenic CO_2 emissions.

Next to emissions, drainage disrupts other peatland ecosystem services, such as water purification, flood control and the provision of habitat for specialized biodiversity. One of the largest – but least recognized – problems is subsidence. Drained peatlands lose 1-2 cm of height per year, in the tropics even 5-7 cm. Subsidence leads all over the world to increasing drainage problems, salt intrusion in coastal peatlands and eventually to the loss of productive land. While the sea level is rising, the peatlands are being bogged down...

Northern peatland diversity and climate

As peat only accumulates in areas of excess moisture, the distribution of peatlands strongly depends on climate. In the (sub-) arctic zone, peat accumulation is restricted by low temperatures and the very short growing season. In the boreal zone, where temperatures are higher but evaporation is limited by the long winter cold, peat covers extensive areas. In the warmer temperate zone, peat is found in oceanic regions with more precipitation as well as in basins that attract groundwater from the surroundings. Climate thus governs where peat may occur, but rainfall and temperature and their seasonal variability determine the diversity of mires, i.e. of peat accumulating ecosystems.

Arctic polygon mires with their typical reticulate pattern of underlying ice wedges are restricted to areas of continuous permafrost with little precipitation. In Europe they only occur on Svalbard, Novaya Zemlya and in the Russian Nenets Autonomous Okrug.

In the Subarctic, peatlands induce the formation of permafrost and permafrost is largely confined to peatlands. Dry peatmoss vegetation and peat have excellent insulating properties, which delay the thawing of ice during summer. As a result, permafrost-underlain peat plateau mires develop, or on sites with plentiful water, also peat covered ice mounds of several meters height, the so called palsas.

In more continental parts of the boreal zone peatlands show a distinct striped surface patterning. In the north, string-flark (or aapa) mires dominate, whereas concentric and excentric raised bogs are restricted to more southern regions. The maritime parts of the boreal zone are characterised by mild winters, cool summers and plentiful precipitation, resulting in the formation of blanket bogs.

Further south the raised bogs of the temperate zone are found. With increasing summer evapotranspiration, only groundwater supply can guarantee the necessary water surplus and a wide variety of fen mires prevails.

Palsa mire in Dovrefell, Norway

Peatland drained for agriculture in Iceland

Land use in peatlands
Not only peatland occurrence and mire types are controlled by climate, but also land use. Human impact on (sub) arctic peatlands is restricted to hunting and gathering, reindeer grazing and infrastructure (roads, pipelines). Historically many boreal mires were mown and grazed for low-intensity agriculture; currently the peatlands are used for forestry and peat extraction. Large areas in the boreal zone, especially in the warmer parts, and in the temperate zone have been drained for arable and grassland agriculture and for peat mining.

Peatlands and climate regulation
Peatlands play an important role in global climate regulation. In all terrestrial ecosystems plants convert atmospheric CO_2 into plant biomass that after death rapidly decays. In peatlands, however, the dead biomass soon arrives in a permanently waterlogged, oxygen-poor environment, where decay is very slow and where the dead plants accumulate as peat.

Peat accumulation depends on the delicate balance between production and decay. The long-term carbon balance of natural peatlands is positive but carbon sequestration shows considerable year-to-year variability including short-term negative rates. In fact natural peatlands are rather close to the tipping point between carbon source and sink, making them sensitive to major climate change and human impact. Worldwide, undrained peatlands (>3 million km2) presently sequester up to 100 Megaton of carbon per year.

Since the onset of the Holocene, almost 12,000 years ago, peatlands have withdrawn enormous amounts of CO_2 from the atmosphere and stored it as peat. Some scientists consider carbon sequestration in peatlands as a major cause of decreasing atmospheric carbon dioxide (CO_2) concentrations and as an important contribution to the start of ice ages.

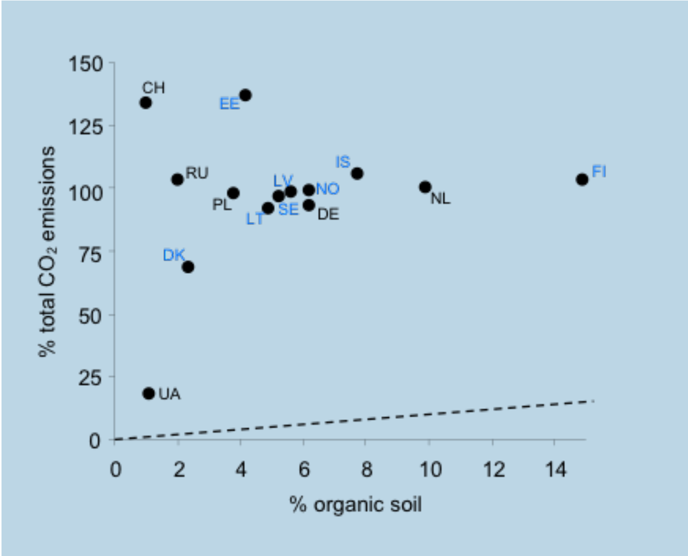
Under the wet conditions necessary for peat formation, part of the dead plant material is decomposed in the absence of oxygen, resulting in the emission of methane (CH_4). Natural peatlands are thus a major global source of CH_4. Methane is a much stronger greenhouse gas than CO_2 but has only a short atmospheric residence time (12 years).

When taking a short-term perspective, natural peatlands appear to have hardly any effect on the climate because the climate cooling of sequestered CO_2 is annihilated by the climate warming effect of emitted CH_4. As, however, the CH_4 is rapidly removed from the atmosphere by oxidation, whereas atmospheric CO_2 continues to be absorbed, the world's peatlands effectively cool the climate on the longer run.

Greenhouse gas fluxes from peatlands are influenced by a wide range of interrelated physical, chemical and biological processes, with water table being the single most important factor.

Climate impacts of peatland drainage
Conventional land use on peat soils involves drainage. Drainage leads to aeration which stops the emission of CH_4, but also results in emissions of CO_2 and the very strong greenhouse gas N_2O. These emissions continue as long as the peatland remains drained. In addition, large amounts of CH_4 are emitted from the drainage ditches, which also carry dissolved organic carbon (DOC) out of the peatland. The dissolved organic carbon is then largely decomposed off-site and emitted as CO_2. Emissions from peatlands generally increase with deeper drainage and warmer climates.

Currently 65 million ha of the global peatland area are degraded, largely as a result of drainage. Peat oxidation from this area is responsible for 1,150 Gigaton of CO_2 emissions per year. When peat fires are included, the global emissions from peatlands are likely twice as high, representing 5% of the total anthropogenic CO_2-emissions.



Net CO_2 emissions from organic soils (as a percentage of the total emissions from agricultural soils, X-axis) vs. area of organic soils under agriculture (as a percentage of the total area under agriculture, Y-axis) in selected European countries (In blue Nordic and Baltic states). The dashed line depicts the 1:1 ratio. Emission percentages can be above 100% because some countries claim to have (large) sinks in mineral soil croplands and particularly grasslands. CH: Switzerland, DE: Germany, DK: Denmark, EE: Estonia, FI: Finland, IS: Iceland, LT: Lithuania, LV: Latvia, NL: Netherlands, NO: Norway, PL: Poland, RU: Russia, SE: Sweden, UA: Ukraine

	peatland/organic soil (km²)			CO_2 emissions (Mt CO2 yr^{-1})		
	a. total	**b. drained**	**b/a (%)**	**c. total[1)]**	**d. peat**	**d/c (%)**
Estonia	9,150	6,619	72.3	17.08	8.04	47.1
Latvia	11,143	7,978	71.6	7.43	13.53	182.0
Lithuania	6,460	4,679	72.4	14.84	7.70	51.9
Finland	83,198	64,931	78.0	50.70	20.68	40.8
Sweden	85,023	15,458	18.2	45.71	10.58	23.1
Norway	46,211	8,438	18.3	52.70	8.00	15.2
Iceland	5,777	3,665	63.4	3.32	7.66	230.4
Denmark[2)]	1,428	1,365	95.6	38.30	3.17	8.3
Greenland	75	3	4.0	0.60	0.00	0.3
Total	248,467	113,692	45.8	230.42	77.79	33.8

[1)] without Land Use, Land Use Change and Forestry (LULUCF)
[2)] excl. Greenland

Peatland drainage and national emissions

The Nordic and Baltic States Denmark with Greenland, Finland, Norway, Sweden, Estonia, Latvia and Lithuania hold together almost 250,000 km² of peatland, i.e. 6% of the global extent.

In Europe, agriculture on drained peat soils is responsible for a large part of the total greenhouse gas emissions from agriculture. In fact in all European countries in which peat soils constitute more than 3% of the agricultural land area, these peat soils are responsible for the majority (>50%) of greenhouse gas emissions associated with agricultural land use. Almost half (45%) of the peatland area in the Nordic and Baltic countries have been drained. This value is high compared to the percentage of peatlands drained in the entire World (c. 16%), but lower than the total of Europe (almost 60%). The somewhat more positive picture compared to Europe is, however, attributable to only two countries, Norway and Sweden, in which less than 20% of the peatland area has been drained. All other countries (excl. Greenland where the total peatland area is too small to influence the statistics) have 2/3 or more of their peatlands area drained.

Together the degraded peatlands in the Nordic and Baltic States emit almost 80 megatons of CO_2 annually, i.e. 25% of the total CO_2 emissions of these countries.

Drained grasslands on peat in the temperate zone emit 29 t CO_2-eq ha^{-1}yr^{-1}, equivalent to driving 145,000 km in a middle-class car

In Iceland and Latvia the peatland CO_2-emissions are twice as large as the total CO_2-emissions from all other sources (excl. land use) combined, in Estonia, Lithuania and Finland 50%, in Sweden and Norway 25% and 15%, respectively. Only in Denmark (and Greenland) the peatland emissions lay below 10% of the total other CO_2-emissions. These figures show that peatlands should play an important role in national climate change mitigation policies.

Peatland rewetting as solution

If the water table is restored to pre-drainage levels, greenhouse gas fluxes become again similar to fluxes from undrained peatlands. In other words: CO_2 emissions decrease, stop or even become negative (peat accumulation), N_2O emissions stop and CH_4 emissions increase compared to the drained state.

It takes a while for the rewetted peatland to adapt to the new situation. During the first years after rewetting greenhouse gas fluxes tend to deviate from pristine sites, with rewetted nutrient poor sites usually showing lower and rewetted nutrient rich sites higher CH_4 emissions than pristine sites.

Because CH_4 has a 23 times stronger climate effect than CO_2 (the new IPCC Fifth Assessment Report even assumes 28 times), rewetted peatlands do not become ‘positive’ for the climate in an absolute sense (on the 100 year timescale). The immediate benefit of peatland rewetting is in the fact that the net greenhouse gas emissions from rewetted peatlands are significantly lower compared to the previous drained situation as is shown by the following table (based on the new IPCC tier 1 values for CO_2, CH_4, N_2O and DOC for drained and rewetted organic soils):

Initial drained land use	Emission reduction after rewetting ($t\ CO_2$-e $ha^{-1}\ yr^{-1}$)	
	Temperate zone	Boreal zone
Forest Land	6	2
Cropland	28	34
Grassland	20	25
Peat extraction	9	11

The Ramsar Convention on Wetlands has explicitly recognized the importance of peatlands for climate change mitigation and has called upon its member states ‘to minimize the degradation, as well as promote restoration, and improve management practices of those peatlands and other wetland types that are significant carbon stores, or have the ability to sequester carbon’.

Rewetting of peatlands also leads to a re-instalment of the other important ecosystem services. Several Nordic-Baltic countries have already practiced large-scale rewetting of peatlands for restoring biodiversity, whereas Denmark and Sweden have also implemented rewetting to reduce nutrient output to lakes, coastal areas and the Baltic Sea.

The policy framework for rewetting

Rewetting of peatlands is consistent with a wide variety of policy agreements to which the Nordic and Baltic countries (and – where applicable – most other countries) have committed. These include:

- the UN Framework Convention on Climate Change (UNFCCC) which allows rewetting of peatlands to be accounted under all land use activities of the Kyoto Protocol, including the new activity ‘Wetland Drainage and Rewetting’,
- the Convention on Biological Diversity (CBD) with its Aichi Target 15 to restore by 2020 ‘at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification’,
- the UNESCO World Heritage Convention and the Strategy for the Heritage Management of Wetlands of the European Archaeological Council,
- the climate initiatives of the UN Food and Agriculture Organisation (FAO),
- the European Union Habitats and Water Framework Directives, the EU Biodiversity Strategy and the EU domestic climate policy with respect to LULUCF,
- the Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention).

The ‘wise use’ concept of the Ramsar Convention provides an important bridge between these initiatives.

Designating Ramsar sites

As a worldwide instrument for the conservation of wetlands the Ramsar Convention plays an important role in highlighting the climate regulation function of the world’s peatlands and in stimulating their conservation and restoration.

The designation of peatlands as Wetlands of International Importance will contribute to the further recognition of the important role of peatlands for the world’s climate and biodiversity. Designating peatlands solely for climate change mitigation may, however, give the wrong impression that individual peatlands, even the largest ones, contribute decisively to climate change mitigation, therewith hampering the necessary comprehensive conservation of all peatlands as carbon sinks and stores.

From a climate perspective it is irrelevant where on Earth emissions or emission reductions take place, because gases in the atmosphere are dispersed across the globe within a few days.

The safeguarding of the climate regulation function of peatlands will benefit from an all-encompassing wise use approach for all peatlands worldwide. The Ramsar Convention could intensify its efforts in pursuing such comprehensive approach, especially in cooperation and in synergy with initiatives already being undertaken.

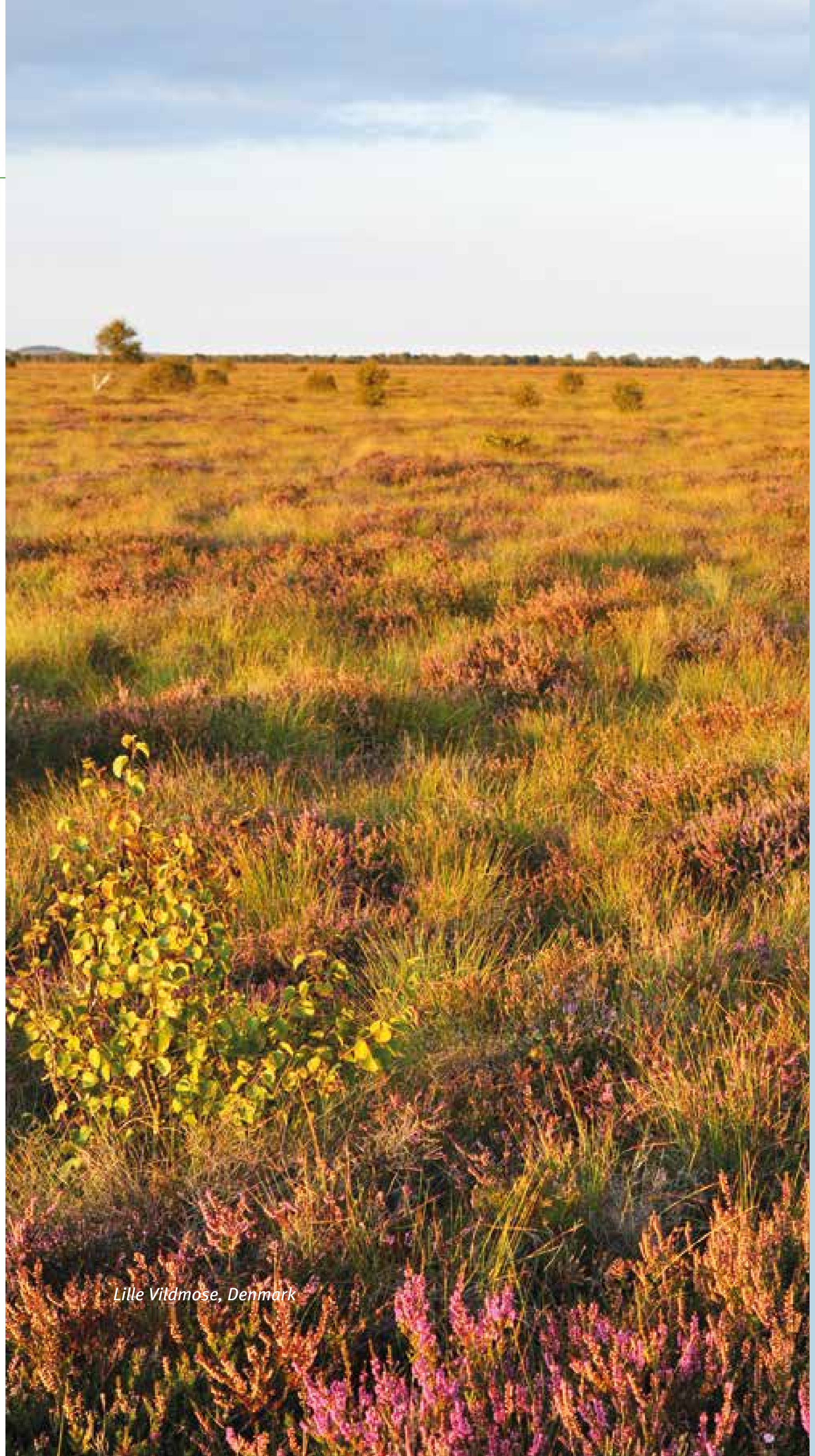
A crucial element of such strategy would be to use peatlands as centres for raising public awareness, i.e. by illustrating the important role of peatlands for global climate regulation and for many other locally, nationally and internationally relevant ecosystem services and by providing on-the-ground examples of peatlands management. Such centres will be specifically effective for sites where natural, degraded and restored peatlands can be contrasted, where drivers and effects of non-wise use can be made easily apparent, where ample opportunity exists for communication, education and public awareness, and where a relevant audience is easily available. These attributes can support the arguments for designating a peatland as a Wetland of International Importance (Ramsar Site) using climate regulation (criterion 1) as an additional criterion for designation.

The Nordic Baltic Wetlands Initiative (NorBalWet) is a Ramsar regional initiative with as participants Denmark, Greenland, Faroe Islands, Estonia, Finland, Iceland, Latvia, Lithuania, Norway, Sweden and Oblasts from Northwestern Russia. In 2013 Denmark designated the raised bog of Lille Vildmose as a Ramsar site using a Ramsar criterion on climate regulation. Sweden submitted nine new Ramsar sites using that criterion in the same year. Subsequently the NorBalWet Initiative initiated a project to assess the importance of Nordic Baltic peatlands for climate regulation.

Key challenges

An effective use of the opportunities of re-establishing the high water table in peatlands and thereby re-installing the provision of peatland ecosystem services including climate regulation comprises the following key challenges:

- Identification of priorities through mapping peatland distribution, drainage status, actual emissions and biodiversity conservation hotspots.
- Identification of success criteria and adequate indicators of successful peatland rewetting.
- Set up of good practice demonstration projects to raise awareness, share expertise and innovation, and develop guidance.
- Strengthening links between science and policy to ensure that policy objectives are based on science and are clear and quantifiable.
- Further commitments to conserving and rewetting peatlands.
- Development and implementation of adequate mechanisms and direct funding for – where applicable – changing drained peatland use to paludicultures (wet agriculture and forestry).
- Avoidance and abolition of subsidies and regulations which incentivise peatland damage, and development of stronger regulatory mechanisms and legislation.
- Communication of the societal benefits of wet peatlands in terms of ecosystem services and the costs arising from damaged peatlands.
- Promotion of the role of peatland rewetting and restoration in reaching national and international policy targets, especially for climate regulation, water quality and biodiversity conservation.



Lille Vildmose, Denmark

Designating peatland demonstration sites using the Ramsar Convention

Lille Vildmose in Denmark was designated as a Wetland of International Importance (Ramsar Site) in 2013 using for the first time an additional Ramsar criterion highlighting the important role of peatlands in climate regulation. The designation was also based on biodiversity criteria and the fact that the remaining raised bog habitat contains threatened and vulnerable ecological communities. An EU Life project supported by the European Commission, the private land owner Aage V. Jensen Naturfond, the Danish Nature Agency and Aalborg Municipality is currently rewetting large parts of the peatlands that were excavated and cultivated over the last three centuries and has started to reconnect isolated peatland habitats. Two out of four bog lakes have been re-established (plans exist for re-establishing a third lake in 2016). Raised water tables and restoration of former lakes and bogs have immediately resulted in an overwhelming increase in biodiversity. Within the last devades iconic species such as European Otter, Golden Eagle, White-tailed Eagle and Common Crane have (re)colonized Lille Vildmose and started to reproduce.
To catalyse peat formation, sphagnum mosses have been experimentally planted under various conditions. A visitor centre with wildlife exhibitions and films has been established and provides guided tours into the peatlands as well as special education programs for school classes. Funds to inform about climate regulation by peatlands have now been secured. Although the contribution of Lille Vildmose to global climate regulation may appear a tiny drop in the ocean, an impressive number of 50,000 interested local people and national and international tourists visited the centre in 2014.

Nordic Council of Ministers

Ved Stranden 18
DK-1061 København K
www.norden.org

ISBN 978-92-893-4168-4 (PRINT)
ISBN 978-92-893-4169-1 (PDF)
ANP 2015:727