Paludiculture

Sustainable productive utilisation of rewetted peatlands

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← Harvested wet peatlands in the Lower Peene Valley near Anklam, Germany (B. Herold) ↑ Harvested wet peatlands on Schadefähre island (Lower Peene Valley, Germany) with the Oderhaff in the background (G. Olsthoom)

UNEP Year Book 2012: "...a pioneering form of agriculture called 'paludiculture' that allows farmers to cultivate rather than degrade peatlands in ways that maintain their enormous carbon stocks while producing crops for sustainable biofuels."

Achim Steiner, United Nations Under-Secretary-General and Executive Director, United Nations Environment Programme, Nairobi, Kenia

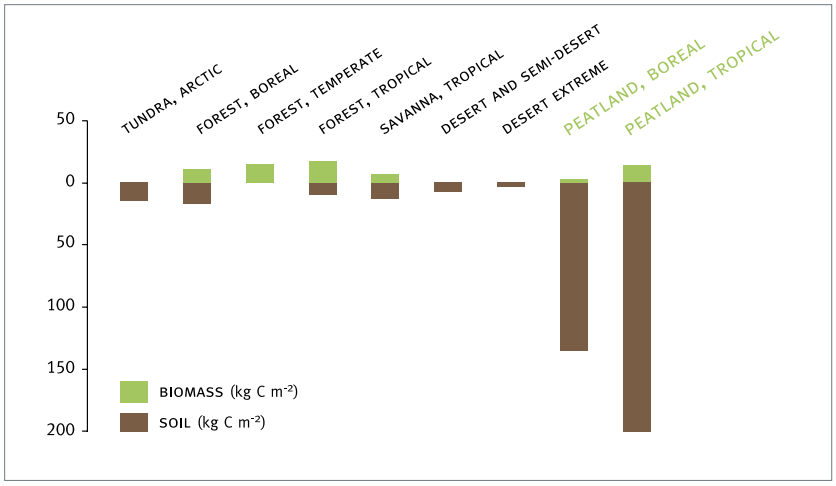
By 2030, the European Union aims to reduce its greenhouse gas emissions by 40% compared to 1990. The Energy Union initiative of the EU Commission helps to achieve this target by stimulating the use of renewable energy resources. Biomass from paludiculture, such as reed, can be used as an additional renewable source of energy. In addition, paludiculture systems can play a valuable role in enhancing biodiversity and protecting the large carbon stocks of wetlands, which have been identified as a significant hotspot of global emissions.

Dr. Peter Wehrheim, Head of Unit Climate Finance and Deforestation, Directorate-General for climate Action, European Commission

Global overview of peatlands

Facts:
- Peatlands hold globally twice as much carbon as all forest biomass
- Peatland drainage leads to disproportionally large greenhouse gas emissions

Peatlands are wetlands with a peat layer that largely consists of organic material with high carbon content. Peatlands have carbon stocks that greatly exceed those of other terrestrial ecosystems. Even the Giant Conifer Forest in the Pacific West of North America – with the highest trees in the world – reaches per ha only half of the carbon stock that peatlands hold on average. Peatlands constitute the largest and most concentrated reservoir of carbon (C) of all terrestrial ecosystems, worldwide storing an estimated 500 Gt (1 Gt = 1 Gigatonne or 10^9 metric tonnes) of C in their peat. This is equivalent to 75% of all atmospheric C, equal to all terrestrial biomass, and twice the carbon stock in the forest biomass of the world. These precious peatland ecosystems are being degraded and destroyed all over the world. Peat swamp forests in Southeast Asia are drained and logged; tundra peatlands are affected by global warming and mountain peatlands like in the Himalaya are subject to overgrazing and mining.
As a result of peatland drainage, carbon that under normal conditions would remain stored for infinite times is released at an alarming rate.



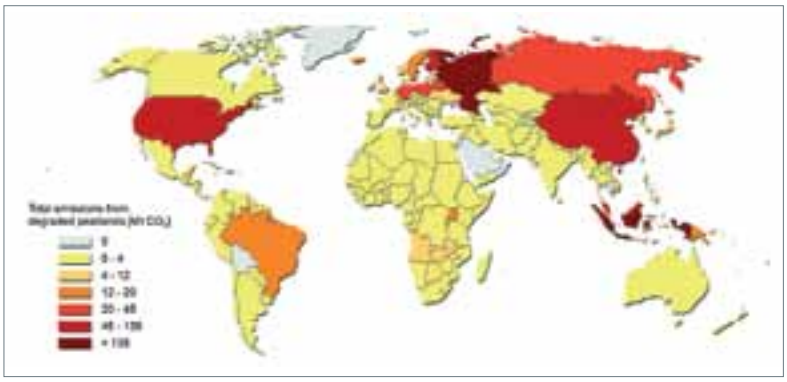
Compared with other formations, peatlands contain disproportionally much carbon (largely in their soil), UNEP Yearbook 2012 fig. 4, p. 24.

Keeping peatlands wet is important, especially in times of changing climate, declining water resources and diminishing ecosystem services. Managing our peatlands in a responsible way helps us support the livelihoods of local people, better adapt to climate change impacts as well as reduce greenhouse gas emissions.
Dr. Kaisa Karttunen, Senior Climate Change Officer Climate, Energy and Tenure Division (NRC) FAO

Hotspots of peatland carbon emissions

above: Peatland drained for *Acacia* plantations in Indonesia (R. Dommain)
below: Harvested Grey Sedge (*Lepironia articulata*) is used as braiding material in Indonesia (R. Dommain)

Peatlands cover only 3% of the world's land surface, but contain 500 gigatonnes of carbon in their peat soil – twice as much as all the forest biomass of the world. When peatlands are drained, the peat soil starts to decompose. This decomposition releases large amounts of carbon dioxide (CO_2) into the atmosphere. At present, the total CO_2 emissions from degraded peatlands amount to one third of the worldwide emissions from Land Use, Land Use Change and Forestry (LULUCF) and to 5% of the total global anthropogenic emissions. The annual CO_2 emissions from drained peatlands (excluding peat extraction and peat fires) have increased from 1.000 Mton in 1990 to 1.300 Mton at present. Since 1990 peatland emissions have increased in 45 countries; 40 of which are developing countries. In many countries emissions increased by more than 50%, including amongst others, Papua New Guinea, Malaysia, Burundi, Indonesia, Kenya, Gabon, Togo, Colombia, Ruanda, and Brunei.



Emissions from peatlands per country (in Mt. CO_2 per year) based on data from the IMCG Global Peatland Database , Joosten (2009), map: S. Busse

Productive use of peatlands is important for China and its huge population. But we must guarantee that peatland use is sustainable and avoids negative effects on the environment. Paludiculture is – also for China – a valuable option to explore.

Prof. Dr. Wang Shengzhong, Director of the Institute for Peat and Mire Research, Northeast Normal University, Changchun, China

The way out

Facts

– Drainage-based peatland utilisation causes peat oxidation, soil degradation, nitrate losses to surface waters, loss of flood control and water storage capacity, greenhouse gas emissions, peatland fires and haze.
– The lowering of the peatland surface necessitates a continuous deepening of drainage ditches, which again enhances peat oxidation and further lowers the surface.
– Ultimately, subsidence leads to the loss of productive land when the peatland can no longer be drained, is frequently inundated or becomes subject to salt intrusion.

Alternative peatland utilisation options

The most obvious option for preventing these problems is to refrain completely from drainage based peatland cultivation. Conservation of undrained peatlands keeps their valuable ecosystem services intact and avoids expensive investments in (often unsuccessful) repair.

Where peatlands have to be cultivated, the negative impacts of utilisation should be restricted by:

- minimising drainage
- choosing crops that are adapted to high soil moisture
- avoiding regular plowing, as tillage enhances peat oxidation
- cultivating permanent crops, which curb peat oxidation by reducing surface temperatures
- limiting nitrogen fertilisation, which increases peat oxidation and may result in large emissions of nitrous oxide.

Various options for site-adapted land use on wet and rewetted peatlands have recently been developed and tested. These 'paludicultures' revitalize traditional forms of land use through new utilisation schemes (e.g. reed cutting for insulation boards), or provide innovative products for growing market demands (e.g. biofuels).

above: Cultivation of reed in Western Poland (A. Schäfer)
below: Fen peatland managed for Aquatic Warbler in Ciacian, Eastern Poland (J. Peters)

We have to change our thinking: On the one hand, we have to preserve all wetlands that are still in their natural state. On the other hand we have to rewet drained peatlands and establish alternative land use practices to secure the diverse functions of wetlands for humankind and nature.
Prof. Dr. Michael Succow, Laureate of the Right Livelihood Award, University of Greifswald, Germany

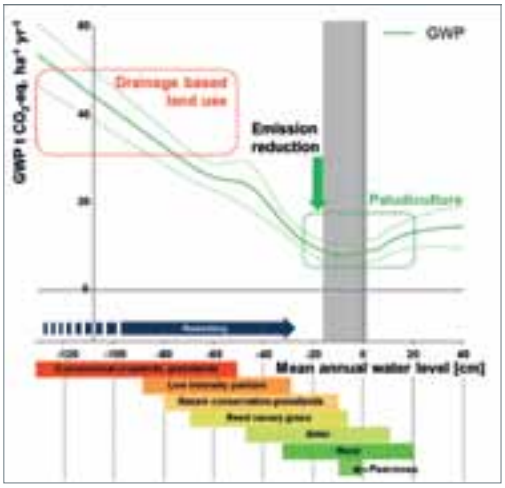
What is paludiculture?

Paludiculture ('palus'– latin for 'swamp') is the productive use of wet peatland in ways that preserve the peat body. Paludiculture includes traditional activities such as reed mowing for thatch or collecting litter for bedding, as well as new practices, such as the utilisation of biomass from wet peatlands for biofuel. In many cases even new peat is formed – the aboveground biomass is harvested and the belowground biomass forms new peat.

Biomass harvesting in Northeast Germany (C. Schröder)

Rewetting and paludiculture provide:

- Climate change mitigation by preventing CO_2 emissions and by evaporation cooling
- A halt to soil degradation and subsidence
- Habitats for rare species
- Recovery of the landscape water regime
- Decreased nutrient emissions to surface waters and seas
- Prevention of peatland fires
- Improved perspectives for (eco)tourism
- Raw materials for energy and industry
- Employment in rural areas



Global warming potential (GWP) of landuse on peatlands as a function of water table and landuse practice (Jurasinski et al. in Wichtmann, W., Schröder, C. & H. Joosten (eds.), 2016).

Only paludiculture enables us to combine the essential ecological functions of mires as carbon store, water regulator and champion of extraordinary biodiversity with the production of useful biomass. Drainage of peatlands can no longer be justified.

Prof. Dr. Hans Joosten, University of Greifswald, Germany

Paludiculture may help us combatting climate change as well as eutrophication of the Baltic Sea. Paludiculture offers a unique possibility to decrease carbon dioxide emissions from degrading organic soils while simultaneously providing landowners with an economically feasible and sustainable way of using the land. The production of biological raw material for energy and industry contributes to a decreased use of fossil fuels. An additional environmental benefit may be the decreased transport of nutrients to inland waters and coastal seas.

Prof. Dr. Stefan Weisner, Wetland Research Centre, Halmstad University, Sweden

Ecosystem services by paludiculture?

Paludiculture may offer new possibilities to restore wetlands that can deliver ecosystem services and vast amounts of biomass. But what price can be expected for the biomass? What is the value of the ecosystem services and who is going to pay for them? And finally, are these restored wetlands indeed sustainable in terms of greenhouse gas emissions? A full appreciation of paludiculture can only be given when all these items are taken into account and are valued against each other.
Dr. Adrie van der Werf, Agrosystems Research at Wageningen University, The Netherlands

Reduction of greenhouse gas emissions

Rewetting of degraded peatlands and subsequent paludiculture lead to a massive reduction in greenhouse gas emissions. Oxidation of peat and the associated release of greenhouse gases are stopped and carbon may even be sequestered again in newly accumulating peat. When the cultivated biomass is used for replacing fossil fuels and raw materials, further carbon emissions are avoided. The wet peatlands furthermore cool the local and regional climate through increased evapotranspiration.

Water is the most important element for the functioning of peatlands. Peatlands retain water surplus in winter and facilitate stable base flow in summer. These hydrological functions can be re-established by peatland rewetting for paludiculture.
Prof. Dr. A. P. Grootjans, Ecohydrology of Wetlands, Radboud University of Nijmegen and associate professor at the Center for Energy and Environmental Sciences (IVEM), University of Groningen, The Netherlands

Water regulation

Undrained peatlands have a stabilising effect on the water regime of the landscape. They mitigate floods by water retention and reduce water deficits in summer by water supply. They act as filters and transformers of harmful substances and in this way purify ground and surface waters. Rewetting of degraded peatlands prevents peat mineralisation, stops the consequent release of nitrates and reduces pollution of rivers and seas.

In Southeast Asia annual greenhouse gas emissions from peatland drainage often surpass the global reduction goals set in the Kyoto Protocol. In the long term we will only be able to stop these emissions while demonstrating that utilisation of wet peatlands is a 'win4all': in combating climate change, land degradation, extinction of species and poverty.
Marcel Silvius, Programme Head Climate Smart Land Use Wetlands International

Biodiversity

Pristine peatlands and peatlands in low intensity use (e.g. as hayfield or grazing land) are the habitat of numerous special plant and animal species. Habitat loss as a result of peatland drainage or abandonment threatens these species. Rewetting drained peatlands may restore a variety of rare habitats, depending on water regime, nutrient conditions, remaining species (seed bank) and degree of peat degradation.

In paludicultures, vegetation is allowed to develop spontaneously or certain species are intentionally promoted by seeding or planting. The management of the land determines its value for biodiversity and nature conservation. To increase this value, paludicultures can be implemented in a mosaic with wilderness areas. Especially in protected areas minimum standards of nature protection have to be respected (e.g. only harvesting outside of the breeding seasons of sensitive birds).

Abandoned and degraded peatlands become suitable only for generalist and pioneer species, thus losing their value for unique biodiversity. By stabilising the optimal water tables and using the upcoming biomass for energy and industry purposes they can be developed to valuable habitats for endangered species like the Aquatic Warbler and Greater Spotted Eagle.
Dr. Alexander Kozulin, State Research and Production Association „The Scientific and Practical Center for Bioresources", National Academy of Sciences of Belarus

The globally endangered Aquatic Warbler needs the mowing of wetland meadows in its breeding grounds (F. Tanneberger)

Prevention of peatland fires

Peatland fires are a major problem of drained peatlands. Once peat is burning it is nearly impossible to extinguish. The fire penetrates the subsurface and can smolder for months and even years. Peatland fires lead to substantial loss of peat, loss of standing biomass, air pollution with poisonous gases and huge greenhouse gas emissions. The remaining ashes cause eutrophication and contaminate the groundwater. In 1997, peat and forest fires in Indonesia released about 500 Mton of carbon, equivalent to 8% of the amount released by global fossil fuel burning in that year. The best way to prevent fire is to rewet the drained peatlands. Without economic use, little attention is paid to land and water management. A better way to prevent peatland fires is to combine rewetting with paludiculture, as the economic benefits from the use of biomass will encourage fire prevention.

Peatland fires smolder for long periods even in winter as for example in Bolsheorlovskoe, Russia (F. Edom)

Perspectives for agriculture and tourism in poorly developed rural areas

Areas rich in peatlands are often economically poorly developed and sparsely populated. Especially in such peripheral areas, paludicultures create environment-friendly jobs by offering alternative sources of income to farmers and manufacturing industry. By preserving and restoring attractive landscapes and by promoting regional market identities they provide incentives for tourism, contribute to sustainable growth, and counteract depopulation.

In Poland we developed agri-environmental schemes for wet grasslands to conserve habitats of endangered bird species. They give incentives for land users on peatland to install species-specific site management and support the utilisation of the biomass remaining from habitat management measures for pellets production or direct combustion.

Dr. Jaroslav Krogulec, OTOP/Birdlife Poland

(from top down)
Construction board made of cattail (www. typhatechnik.de);
Insulating boards made of reed (S. Wichmann);
Pellets made of biomass from fen peatland (lensescape.org);
Clay panel enforced with reed (N. Körner)

Products

Paludiculture biomass can substitute fossil raw materials, which leads to a further reduction of greenhouse gas emissions. Products range from pellets, briquettes and silage for energy, to furniture, mouldings, construction materials and horticultural substrates. Also foods like beef (e.g. from water buffalo) or medicinal plants e.g. marsh trefoil (*Menyanthes trifoliata*) can be produced in environment-friendly paludicultures.

The Neusiedler Lake area harbours the largest expanses of reed in Central Europe. Only a minor share of this reed is used. By using reed for energy purposes we can tap an important source of bioenergy – unused until now.
Prof. Dr. Arne Ragossnig, Geschäftsführer der UTC – UmweltTechnik und GeoConsulting ZT GmbH, Klagenfurt, Austria

In Manitoba, Canada, plants like cattails (*Typha*) soak up nutrients that would otherwise flow into waterways and cause eutrophication and large-scale algal blooms. Harvesting the biomass also provides raw materials for industry. The International Institute for Sustainable Development (IISD), the University of Manitoba and Ducks Unlimited Canada have demonstrated that the harvested material can be utilised for producing ethanol, heat, and energy, with nutrients from the ash being recycled. IISD's ongoing research continues to develop commercial scale harvesting opportunities in the Manitoba bioeconomy.
Dr. Richard Grosshans, University of Manitoba, Canada

VIP – Vorpommern Initiative Paludiculture

The VIP-project evaluated the effects of paludiculture on greenhouse gas emissions, biodiversity, the impact of harvest technology on the peat body, as well as the perspectives for regional development. Decentralised energy and heat supply is a particularly practical and cost-efficient option for paludiculture in the region. Local heating plants fuelled with biomass bales from wet fens can supply heat to private households, holiday resorts, greenhouses or animal farms. Biomass processed to pellets and briquettes can easily be transported to customers and combusted in automated ovens in public buildings.

Next to the traditional use of reed (*Phragmites australis*) for roofing, as it is common at the Baltic Sea coast, reed can be used for insulation and fire-resistant boards and plasters. Also water buffalo can be held on rewetted peatlands offering a highlight in the landscape. An adjusted grazing management with other robust breeds is possible as well.

The marketing of these regionally produced and refined products from peat conserving land use practices can help create a regional identity.

www.paludiculture.uni-greifswald.de/de/projekte/vip_projekt/projekt.php (German only)

Biomass harvesting with caterpillar in Northeast Germany (C. Schröder)

VIP

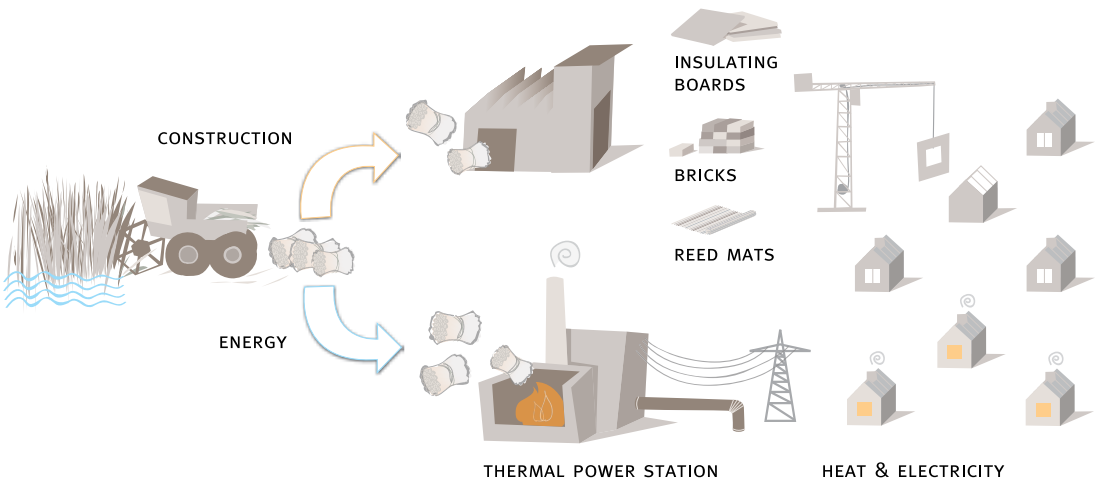
GEFÖRDERT VOM

Bundesministerium für Bildung und Forschung

NACHHALTIGES LANDMANAGEMENT

FONA Research for Sustainable Development BMBF

Processing biomass from wet peatlands



Wetland Energy – sustainable use of wet peatlands in Belarus

Adapted harvesting system for wet peatlands, based on snowcat (Ratrac) technology can be applied on very wet and soft peatland soils. It minimises mechanical impact on the vegetation and the peat soil surface. Vysokoe, Yaselda lowlands, Belarus (A. Haberl)

Rotating drying devices at the Mini-briquette factory Lidski near Dokudovskoe , Belarus (S.P.Kundas)

Biomass from reeds as a substitute for peat in energy production

In the framework of the 'Wetland Energy' project a peat briquette factory of the Beltopgaz group in Belarus was stimulated to use wetland biomass to produce renewable solid energy fuels. Additional goals of this project are the promotion of nature conservation, support of biodiversity, reduction of greenhouse gas emissions, and rural development.

The problem in Belarus: Peatlands cover 11.5% of the land surface but more than half of this area (1,534,000 ha) has been drained for agriculture, forestry or peat mining. Drained peatlands show considerable greenhouse gas emissions, they leak nutrients to ground and surface waters and are biodiversity deserts. Heavy soil degradation has made these sites unprofitable for agriculture which consequently has led to abandonment – but without restoration of the hydrological system. Frequent peat fires on drained and abandoned peatlands pose an increasingly significant risk for the environment and for human health.

Over the past fifteen years, more than 50.000 ha of drained peatlands in Belarus have been rewetted; an additional 500.000 ha may become available for re-wetting measures in the near future. The EU-funded 'Wetland Energy' project introduces a wet, sustainable land use system that keeps the land productive. In addition, regular mowing preserves breeding grounds for the Aquatic Warbler and hunting grounds for the Lesser Spotted Eagle.

www.succow-stiftung.de/wetland-energy-sustainable-use-of-wet-peatlands-in-belarus.html

European Commission
EuropeAid Development and Cooperation

Fossil resources are finite. Belarus does not have sufficient domestic energy resources and imports about 80% from abroad. All enterprises in our country have the social and economic obligation to explore domestic and renewable energy sources.

Prof. Semjon Kundas, Belarusian National Technical University, Minsk, Belarus

Production unit for manufacturing briquettes from paludiculture biomass. First tests with different mixtures of biomass and peat gave promising results. They showed that 100% biomass briquettes are feasible, make sense and are the only sustainable way to produce regional fuels so far (V.N.Potupchik)

Also peat factories and enterprises in Belarus must explore renewable energy sources to replace fossil peat. Utilisation of rewetted peatlands for biomass energy is a promising option for generating local welfare. Co-combustion of 5% biomass, as is occasionally done, is not enough. It will merely prolong the lifespan of peat factories. The only reasonable solution for Belarus is to develop technologies to process and combust pellets consisting of 100% biomass.

Dr. Aleh Rodzkin, Deputy Director for Science, Republican Research Unitary Enterprise „Bel NIC" Ecology under the Ministry of Nature conservation, Minsk, Belarus

Briquettes made of biomass from wetlands in Belarus (W. Wichtmann)

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ISEU

Biomass energy

(from top to bottom)
Baled biomass from paludiculture.(lensescape.org);
Combustion of fen biomass (lensescape.org);
Briquettes from reed (*Phragmites australis*) (N. Körner)

Innovative and sustainable land use options developed in Greifswald – energy generation from fen biomass

How to turn biomass from wet lands into a dry energy resource? How to make pellets and briquettes and how to use the biomass most efficiently is studied at the Institute of Botany and Landscape Ecology at Greifswald University.

The project 'Production of biofuels on rewetted fen peatlands' (ENIM) was the first to study the use of reed (*Phragmites australis*) and reed canary grass (*Phalaris arundinacia*) for energy generation. Combustion in a thermal power station proved that wet fen biomass is fully competitive with crop straw or miscanthus.
The 'Paludi-Pellets-Project' tested the compaction of the paludi-biomass and its combustion characteristics. An economic assessment is essential for interested entrepreneurs and farmers, and so the project developed a calculation tool.
The project 'MoorZukunft – Energy for West Pommerania' addressed the concrete implementation of paludiculture. It initiated cooperation between farmers and buyers in the construction and energy sector.

In a nutshell, the message is that 'fossil is finite – go local – welcome the wet!'

www.paludiculture.uni-greifswald.de/en/projekte/pellets_projekt/index.php
www.duene-greifswald.de/de/projekte.php_enim.php
(German only)
www.paludiculture.uni-greifswald.de/de/projekte/moorzukunft/
(German only)

Re-wetting versus agriculture?

Case study Malchin

In the federal state of Mecklenburg-West Pomerania (Germany) peatlands cover 12% (about 300.000 ha) of the land area. The majority is currently drained for agricultural purposes which cause 27% of all greenhouse gas emissions of the federal state. Rewetting would be the best option for climate and nature protection. However, local farmers are strongly opposed to rewetting, because they fear to lose productive land. Yet, ongoing subsidence will lead to a loss of this land on the long run anyhow.

Hans Voigt and Ludwig Bork show that the use of biomass from rewetted peatlands can be economically viable. Rewetting of their 400 ha grassland at Lake Kummerow (NE Germany) affected the composition and quality of the vegetation, making it unsuitable as fodder for cattle breeding. An alternative was found in the thermal utilisation of the biomass. With adapted machinery two to four tonnes of biomass per hectare are cut, swathed and baled in late summer. Approximately 6,000 bales, of about 250 kilograms each, are harvested per year.

In cooperation with Energicos GmbH and the city of Malchin the worldwide first heating plant for fen biomass now covers the demand of 1.000 households, a school and a kindergarten. In addition to the reduced emissions from the formerly drained peatland, the 4 GWh of biomass energy replaces 375.000 litres of fossil heating oil per year. This unique cooperation between land users, administration, district heating stations and energy users serves as an example for other communities.

(from top down)
Reedbed, Peene river valley (W. Wichtmann);
Big bailer with tandem axle and wide tyres (lensescape.org);
Heating plant for fen biomass, Malchin/Germany (lensescape.org)

After rewetting the adjacent Peene valley, we had to think in new directions, as our cattle would starve while having a full belly. The fodder wouldn't have the needed amount of digestible energy. It took us several years of planning and negotiating to finally get everyone's go for the thermal utilisation of the biomass.

Hans Voigt, farmer at Schwinkendorf / Mecklenburg-West Pomerania, Germany

(left column top down) Cattail (*Typha lattifolia*) in winter; Pellets made from reed; Harvesting biomass from wet peatlands near Lake Kummerow; Mowing and transport of reed for thatching in winter (all: lensescape.org); (right column top down) Peatmoss (*Sphagnum spp.*) in scientific experiment (lensescape.org); Haystacks of reed canary grass (*Phalaris arundinacea*) from wet meadows – in Belarus (W. Wichtmann); Reed (*Phragmites australis*) in summer (lensescape.org)

Construction and products
ALNUS – Cultivation of Black Alder

The wood of black alder (*Alnus glutinosa*) is a valuable material for carpentry, interior fittings, and furniture. Besides, tailings can be used as firewood. The ALNUS project developed a method for producing high grade alder wood on rewetted fen peatlands. The project showed that with the right management, wet (not very wet or dry) alder woods can provide profitable wood yields while simultaneously preventing peat oxidation or even allowing peat accumulation. Criteria and indicators for site selection and management were developed by integrating silvicultural, ecological and economic expertise. Convinced by the project's results the state forestry service of the German federal state Mecklenburg-West Pomerania started an ambitious programme to rewet drained peatland forests for alder cultivation.

www.uni-greifswald.de/~alnus

(from top down)
Kitchen made of black alder (*Alnus glutinosa*) (team7);
Alnus forest (J. Schröder);
Black alder swamp (lensescape.org)

ALNUS

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www.dbu.de

Sphagnum farming on degraded bogs for horticultural growing media

(from top down) Harvesting of peatmoss (*Sphagnum spp.*) with a special mowing basket (S. Wichmann); Experimental peatmoss cultivation in the greenhouse (D. Wellner); *Sphagnum* farming on former bog grassland at Rastede (Lower Saxony, Germany); Field experiment of 4 ha established in 2011, photo from 2014 (S. Wichmann)

Globally, about 30 million m^3 of slightly humified peatmoss peat ('white peat') are used each year as a raw material for horticultural growing media. As peat accumulates so slowly that it is practically non-renewable, an environment-friendly and sustainable alternative has to be developed.

This alternative is the cultivation of peatmoss on rewetted degraded bogs in paludiculture (*Sphagnum* farming). Fresh *Sphagnum* biomass can largely substitute white peat as it has similar physical and chemical properties.

After a first pilot on a cut-over bog in Ramsloh (NW Germany), a large-scale Sphagnum farming site was successfully established near Rastede (NW Germany).

Economic evaluation shows that peatmoss cultivation is already cost-covering with a yearly yield of 3.5 tonnes dry mass per hectare.

www.sphagnumfarming.com

Sundew farming

Sundew (*Drosera rotundifolia*) has a long history of use in the treatment of respiratory diseases including relieving wheezing and airway inflammation, whooping cough, bronchitis and asthma. Every year, millions of sundew plants are collected from their natural habitat for pharmaceutical purposes. However, in many European countries, sundew is legally protected. Yet, targeted cultivation has thus far not been attempted on a commercial scale. High costs are associated with the propagation and cultivation of sundew, which are moreover very time-consuming. In addition, the pharmaceutical industry requires high concentrations of the active ingredients plumbagin and 7-Methyljugon.

Sundew cultivation in combination with *Sphagnum* farming opens new perspectives. The nutrient-poor, wet, acidic and species-poor environment of peatmoss cultivation areas provides excellent living conditions for the round-leaved sundew. So far, the results of field and greenhouse cultivation experiments with round-leaved sundew are promising.

Round-leaved sundew as a paludiculture plant species could provide enough raw material of high quality at steady rates. In addition it would protect the sensitive wild sundew populations. Further research is needed on harvesting techniques at larger scales, as well as on economic aspects.

(from top down) Sundew on the *Sphagnum* farming pilot site in Hankhausen / Lower Saxony (B. Baranyai); Medicine products made from sundew (www.biover.be, www.healthpost.co.nz); *Drosera rotundifolia* (B. Baranyai)

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DPPP Database of Potential Paludiculture Plants

Cloudberry (*Rubus chamaemorus*). Utilisation: Food (Philipp Schroeder)

Papyrus (*Cyperus papyrus L.*)
Utilisation: Construction and energy (H. Joosten)

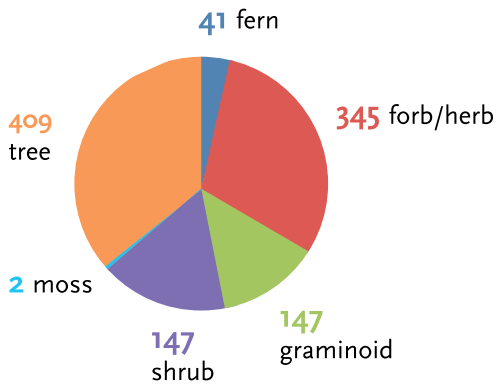
Marsh trefoil (*Menyanthes trifoliata L.*)
Utilisation: Medicine (A. Haberl)

Worldwide new sustainable management options for peatlands are needed. The identification of crops for wet peatlands is essential for the implementation of paludiculture.
The utilisation of wetland plants is very old and many species have already been used for centuries. Reed stands and wet meadows are traditionally used for thatching and fodder; medicinal plants and berries are gathered from mires; and logging of wetland trees is and was an important source of income in many countries.

With the progressive loss of traditional knowledge the usefulness of many species is no longer recognized, however. The Database of Potential Paludiculture Plants (DPPP) collects information on useful wetland plants in order to catalogue existing and identify new options for paludiculture.
Currently, over 1.100 species have been recorded and assessed for their paludiculture potential. More than 200 species seem promising for commercial paludiculture. They can be grown at high water levels, preserving the peat body, and there is a market demand for the products they provide.

An overview on potential paludiculture plants of the Holarctic (North America, Europe and Northern Asia) will soon be available to support further implementation of paludicultures.

Potential Paludiculture Plants
(1128 entries in the DPPP)



Distribution of life forms of the DPPP entries

The CINDERELLA project

In the climate change debate, peatlands are more or less neglected – like Cinderella in the fairy tale. The international project CINDERELLA aims to change this.

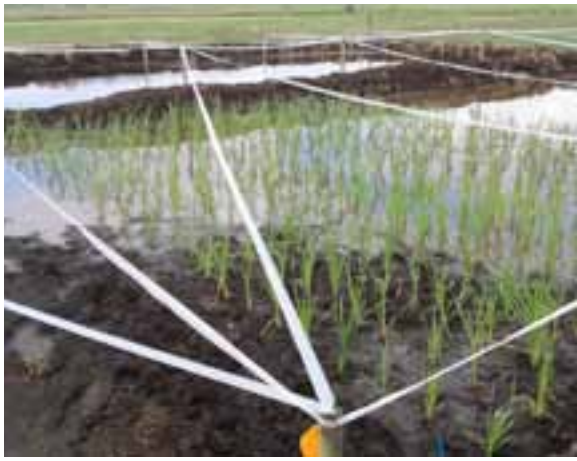
CINDERELLA is a cooperation between scientists and practitioners from Sweden, Denmark, The Netherlands and Germany to further explore climate smart agriculture on peatlands – in other words: paludiculture. The transdisciplinary research programme includes field and laboratory investigations as well as legal and economic studies to develop recommendations for site adapted management of wet peatlands, but also decision support for stakeholders and politicians.

CINDERELLA aims to identify paludicultures that maximise biomass production, minimise GHG emissions and nutrient release, and incorporate other ecosystem services. The project will develop management strategies and aims to disseminate paludiculture to Europe and the rest of the world.

CINDERELLA intends to promote paludiculture as an innovative strategy to adapt to climate change, with sustainable peatland utilisation becoming part of resilient agricultural regions.

www.paludiculture.uni-greifswald.de/en/projekte/cinderella/index.php

Reed (*Phragmites australis*) harvesting at Blauwe Stad, Netherlands (C. Fritz)



Zegveld field site with Cattail (*Typha sp.*) plantation in the Netherlands (C.Fritz)

PALUDI CULTURE
cinderella

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Greifswald Mire Centre

In 2015, Greifswald-based institutions working on peatlands joined forces and established a centre of excellence for peatland matters: the Greifswald Mire Centre (GMC). With more than 50 peatland experts of various disciplines concentrated in one place, the GMC functions as a science-policy interface. The GMC performs scientific research, implements conservation projects and provides advice to policy makers and society on an inter- and transdisciplinary basis.
The GMC offers science-based solutions for global challenges such as

- Climate change mitigation: Reduction of greenhouse gas emissions from peatlands and ecosystem-based adaptation
- Biodiversity: Conservation and restoration of peatlands worldwide
- Sustainable use: Paludiculture and innovative financing such as carbon credits

The Greifswald Mire Centre develops, communicates and implements science-based solutions for social challenges to support policies with respect to peatlands in industrialised and transformation as well as developing and emerging countries. A particular focus is on collecting and providing high resolution data on peatland distribution and status via the Global Peatland Database.
The comprehensive 'Peatlands and Nature Conservation International Library' (PeNCIL) is also part of the centre. It hosts more than 15,000 volumes on peatland science and nature conservation that are made available via the university library.

www.greifswaldmoor.de/home.html

Cultivation of peatlands has been in the past, and continues to be, a major threat to peatland health. Therefore the International Mire Conservation Group supports this initiative in utilising restored peatlands thereby supporting mire conservation globally.
Dr. Piet-Louis Grundling, International Mire Conservation Group, South Africa

For too long peatlands have only been valuable when turned into something else, through drainage for example. Now we understand the many benefits peatlands in their natural state can offer society. Land managers should be supported in delivering these benefits through sustainable peatland management.*Clifton Bain, Director IUCN UK Peatland Programme, United Kingdom*

GREIFSWALD MIRE CENTRE

ERNST MORITZ ARNDT UNIVERSITÄT GREIFSWALD

MICHAEL SUCCOW FOUNDATION for the Protection of Nature

DUENE e.V. at the Institute of Botany and Landscape Ecology

Peatland Management and the UNFCCC

Since its Conference of Parties in Durban 2011, the United Nations Framework Convention on Climate Change (UNFCCC) recognises peatlands and their potential for mitigation action under the Kyoto Protocol. The new land use activity 'Wetland Drainage and Rewetting' provides developed countries with a focused incentive to address emissions from drained peat soils. Parties to the Protocol may now use peatland rewetting to meet their emission reduction target. Fine-tuning of the flexible mechanisms under the Kyoto Protocol is still needed to allow trading in peatland credits.

Cover of the „2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands"

IPCC Peatlands Guidance

In 2014 the Intergovernmental Panel on Climate Change (IPCC) has issued guidelines on national reporting on emissions from drained and rewetted organic soils (peatlands) as well as guidance for accounting under the Kyoto Protocol. A number of countries have started work to adjust their reporting to the new IPCC guidelines.

Cover of the „2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol"

The Intergovernmental Panel on Climate Change prepared new guidelines for reporting and accounting rewetted peatlands under the Climate Convention. This makes paludicultures – that reduce peatland emissions and produce renewable biomass resources – an extra attractive land use option.
Dr. Thelma Krug, Vice Chair of the IPCC Brazil

Find more information about paludiculture in:

Wichtmann, W., Schröder, C. & H. Joosten (2016): *Paludiculture – cultivation of wet peatlands. Climate protection, biodiversity, regional economic benefits,* Schweizerbart Science Publishers, 300p.

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