STUDY TOUR - GUIDE
PALUDICULTURE

Succow Stiftung

Partner in the

GREIFSWALD MIRE CENTRE

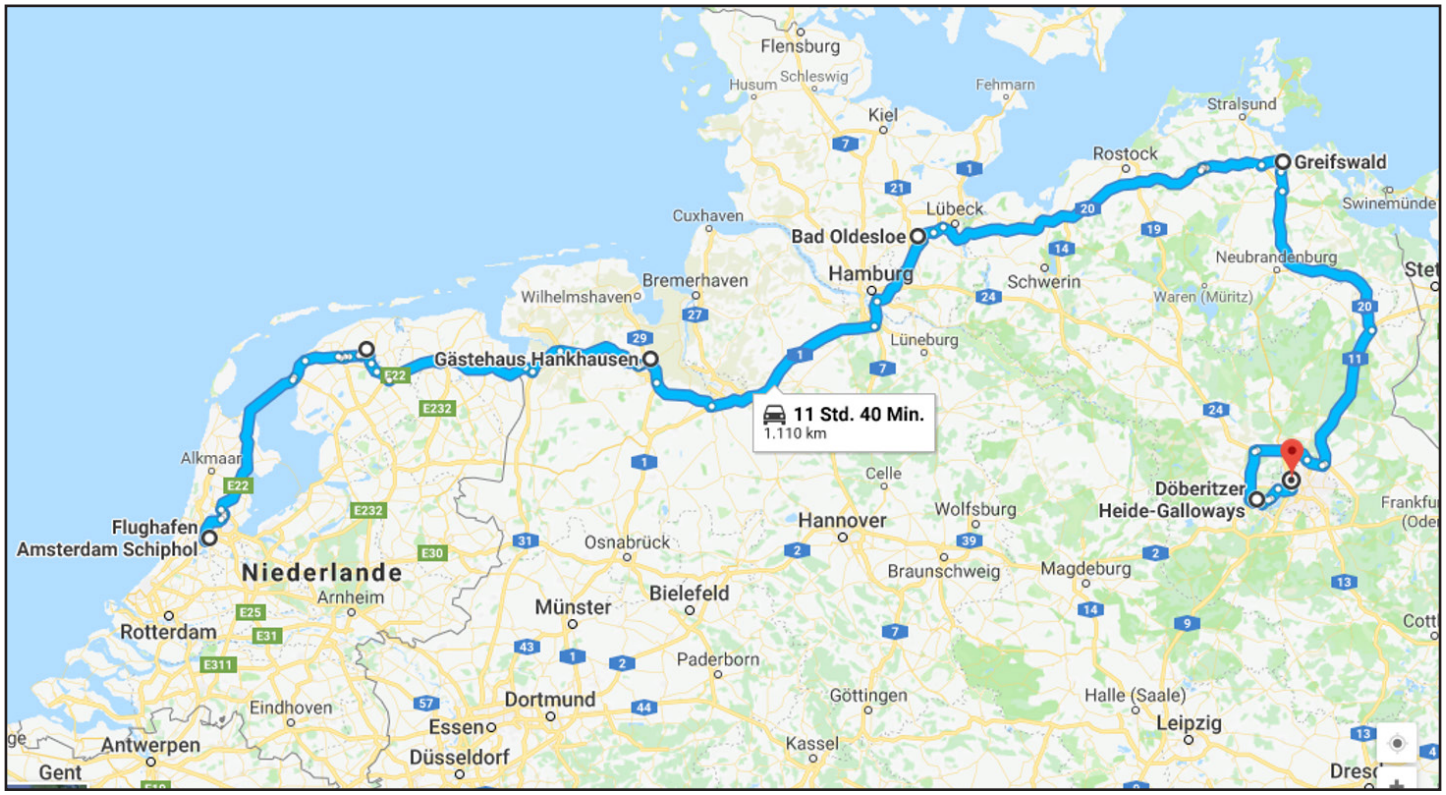
September 24th - 28th 2018

Contents

Overview

I EXCURSION OVERVIEW

Route



24.-28.09.2018 – Tour days (1-5)

Schedule

Monday, 24th September	Amsterdam & Noordoost Fryslân, The Netherlands
Tuesday, 25th September	Hankhausen, Bad Oldeslohe, Lower Saxony, Germany
Wednesday, 26th September	Schuenhagen, Greifswald, Mecklenburg Western-Pomerania, Germany
Thursday, 27th September	Polder Kamp, Neukalen & Malchin, Mecklenburg Western-Pomerania, Germany
Friday, 28th September	Potsdam, Brandenburg, Berlin, Germany

II The EUKI-Project

"Potential and Capacities for climate protection through productive use of rewetted peatlands"

Date:	January 2018
Countries:	Germany, Estonia, Latvia, Lithuania
Project duration:	10.2017-02.2020
Implem. Organisation:	Michael Succow Foundation (MSF)
Target Group:	Land users (on peatland); Land owners; Administration on national and regional levels; Agriculture and forestry agencies in nature conservation and agriculture; Ministries of environment and agriculture; Representatives of the Baltic states at the EU in Brussels
Project financing	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), is a project financing instrument by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMUB). It is the overarching goal of the EUKI to foster climate cooperation within the European Union in order to mitigate greenhouse gas emissions

On behalf of:
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
of the Federal Republic of Germany
European Climate Initiative EUKI
LITHUANIAN FUND FOR NATURE
Estonian Fund for Nature
EZERU UN PURVU IZPĒTES CENTRS
Succow Stiftung

The Baltic countries (Estonia, Latvia, and Lithuania) harbour 21,000 km² of peatlands of which more than 50% are drained and degraded. The project aims to tackle obstacles for implementing climate-friendly peatland management in the Baltic countries by assessing the feasibility to use drained peatlands in paludiculture after rewetting to substitute fossil resources e.g. peat mosses as horticultural substrates or reed as fuel on new evolved markets for products in the EU. In a multi stakeholder dialogue with workshops and field trips potential sites in each country will be identified and prioritized, planning for implementation will be analysed. To make the stakeholders ready for these innovative approaches, awareness and capacity on paludiculture practices will be built, including knowledge exchange within Europe. Within the project governmental partners in the Baltics shell be supported to adapt framework conditions for climate-friendly peatland management in national and EU policies to incentivise a shift to less drainage and more paludiculture among land users.

Box 1 What is paludiculture?

"Paludiculture is the agricultural or silvicultural use of wet and rewetted peatlands. Paludiculture uses spontaneously grown or cultivated biomass from wet peatlands under conditions in which the peat is conserved or even newly formed (Wichtmann & Joosten 2007). Paludiculture differs fundamentally from drainage based conventional peatland use, which leads to huge emissions of greenhouse gases and nutrients and eventually destroys its own production base through peat degradation (Joosten et al. 2012). Paludiculture allows the re-establishment and maintenance of ecosystem services of wet peatlands such as carbon sequestration and storage, water and nutrient retention, as well as local climate cooling and habitat provision for rare species (Chapter 5; Joosten et al. 2012, Wichtmann et al. 2010). Paludiculture implies an agricultural paradigm shift. Instead of draining them, peatlands are used under peat-conserving permanent wet conditions. Deeply drained and highly degraded peatlands have the greatest need for action from an environmental point of view, and provide the largest land potential. The implementation of paludiculture is the best choice for degraded peatlands. Paludiculture is a worldwide applicable land management system to continue land use on rewetted degraded peatlands. Various plants can be cultivated profitable under wet conditions. Paludiculture is also a land use alternative for natural peatlands particular for regions where the increasing demand for productive land drives the drainage. Because of their vulnerable ecosystem services, pristine peatlands should best be protected entirely. If land use on pristine mires is unavoidable, paludiculture should always be given preference over drainage-based land use (Joosten et al. 2012)" from Wichtmann et al. 2016 Utilisation of different paludiculture plants.

Box 2 Paludiculture Crops

Reed canary grass (*Phalaris arundinacea*)
is growing fast, the yields are high, and it burns well. Therefore, it is highly suitable to produce energy. Reed canary grass meadow can also be used as a wetland buffer zone for nutrients; water is directed from the drainage ditches of agricultural lands to re-vegetated peatlands. In this way, reed canary grass can be fertilised and nutrients removed. It is worth noting that the Estonian variety "Pedja" is cultivated as forage plant, and in Sweden, for example, paper is produced of reed canary grass.

Cattail (*Typha* spec.) can be used as fodder and energy plant, additionally it is often used as insulation material and for boards in the eco-construction sector. As a pioneering species of wet and muddy lands, it grows well in the restored peatlands and rapidly forms a dense plant cover.

Common reed (*Phragmites australis*)
can be used as a construction material e.g. for roof thatching or construction boards, in handicrafts, and as fuel in heating plants. Because the common reed can withstand brackish water, this plant can be collected also from coastal wetlands. It has good combustion properties e.g. calorific value comparable to wood, mineral contents in comparison to reed from peatlands is lower than e.g. in agricultural straw from mineral soils what means less ash during combustion, if harvested in winter low contents in problematic substances, see also Box 6.

Sedges (*Carex* spec.)
are used both as energy and forage plants, but also as a raw material for paper. Compared to the reed canary grass or the common reed, the sedges are more tolerant towards the nutrients found in soil.

Peat mosses (*Sphagnum* spec.)
are adapted to the nutrient poor and acid conditions in rainfed mires (bogs). The resulting slightly decomposed nutrient poor

Box 3 Current applications of Sphagnum fresh biomass

Sphagnum vegetation restoration
aims to re-establish Sphagnum dominated vegetation on degraded bogs (including sites where peat extraction has occurred) for nature conservation, erosion control or carbon sequestration with no intention to harvest the re-established mosses

Sphagnum gathering
is the collection of Sphagnum (e.g. for orchid cultivation) from wild populations which are not (or minimally) managed to maintain or increase yields.

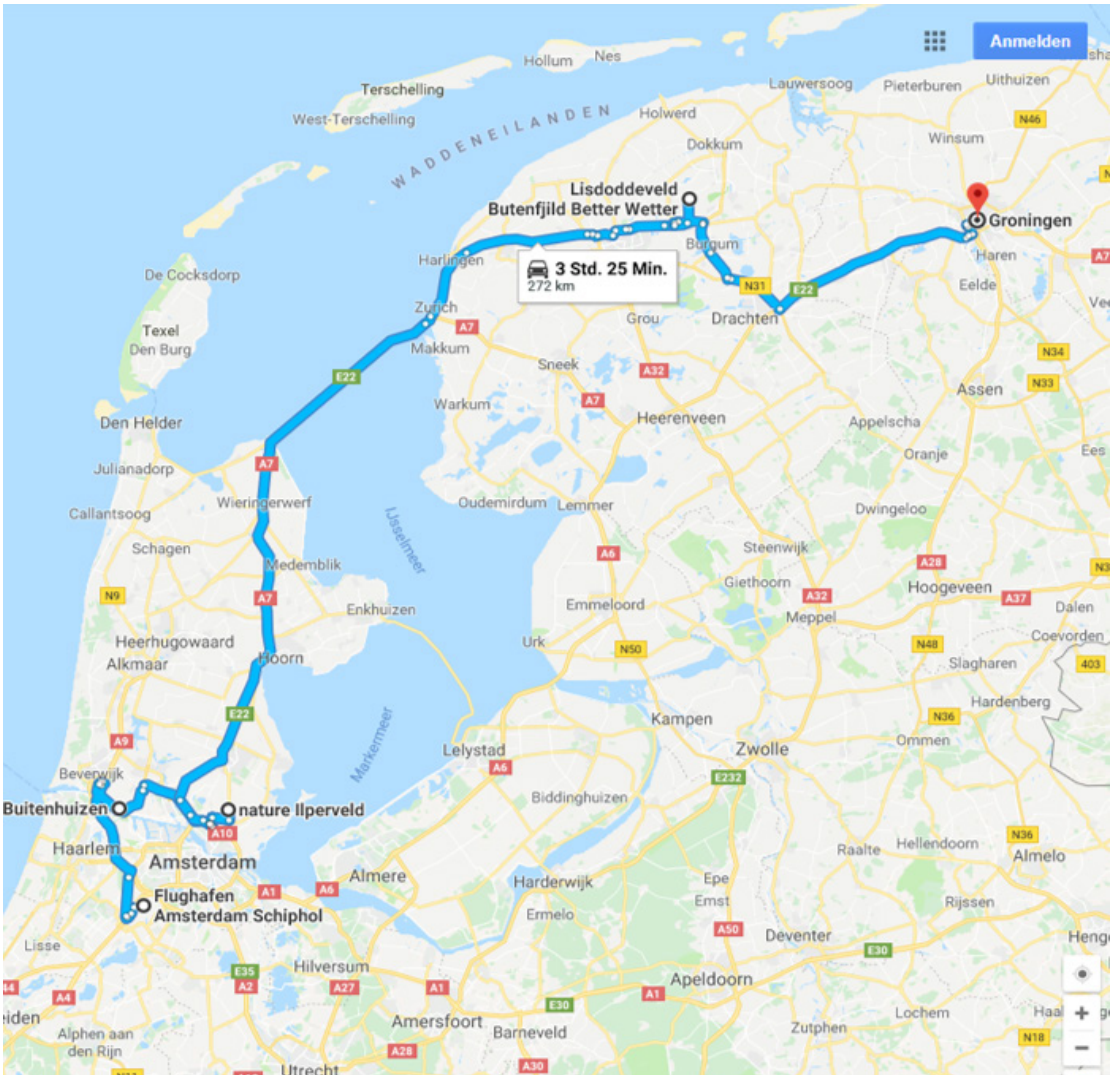
Sphagnum farming
aims to cultivate Sphagnum biomass for harvest, originally as founder material for restoration, but increasingly nowadays as an agricultural crop, e.g. as a raw material for agricultural growing. This new type of paludiculture includes the selection of highly productive species and active management to maximise yields, see also BoX 5 Sphagnum farming

NOTES:

Monday, 24th September

I EXCURSION DAY 1

Route



Schedule

Time	Location or event	Remarks
09:05	Arrival airBaltic in A. Schiphol from Riga	Departure Riga 07:40
09:20	Arrival airBaltic in A. Schiphol from Tallinn	Departure Tallinn 07:40
09:40	Arrival airBaltic in A. Schiphol from Vilnius	Departure Vilnius 08:10
11:00-13:00	Amsterdam Nauerna-Zuiderveen	Large scale establishment of Typha (cattail) cultivation.
14:00-15:00	Amsterdam Ilperveld	Successful restoration of an, for 600 years drained, peatland, with *sphagnum* farming method; Lunch; Presentation "Paludiculture research at Radebout University Nimegen" (PhD Jeroen Guerts).
17:00-18:00	Noordoost Fryslân	Better Wetter project, *Typha* cultivation test site and other Paludiculture options in the NL.
19:00	NH Groningen	Hotel check in; Dinner, afterwards optional guided walk through the old town.

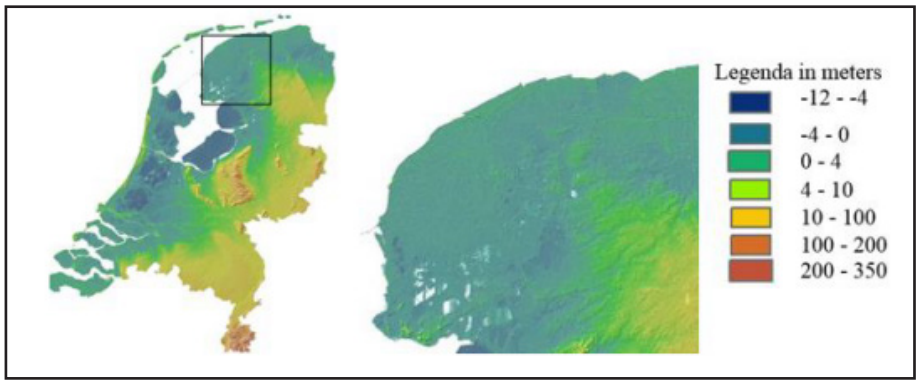
II INTRODUCTION

Landscape

With almost 25% at or below sea level main part, especially in the northwestern region of The Netherlands are dominated by coastal lowland areas and peatlands. The climate has a high maritime influence with relatively cool summers and mild winters.

Land use history

At the end of the last Ice Age the Netherlands were inhabited by scattered hunter-gather-groups. Over time different tribes and cultures settled in and began to use the land. Parts of the coastline were already densely settled in times of the early Roman Empire, while marshes further inland were not suited for settling. From the 14th century on hydrological engineering prospered in The Netherlands to make these wetlands accessible for agriculture and new settlements. The polder system was developed and refined, wet areas where diked, channels and pumping systems installed to control the water level inside the polder on a lower level then the surrounding groundwater level. The artificial lowering of the water tables led to degradation of the peatlands by oxidation and compaction of the peat what leads to subsidence of the polder surface. Consequently, hydro-engineers were forced to continue and deepen the drainage system to maintain the relative water level inside the polder at the wished level. This 600 year long tradition of wet and peatland management involved drainage of 98% of the originally flooded pasture areas and brought down the land surface in coastal parts of the Netherlands from 5 m above to up to 5 m below Sea water level. Nowadays more than 50% of The Netherlands land area would drown if the pumps stop their work. With a drastic increase of drained peatland area in the last decades, more and more water had to be pumped elsewhere, especially during wintertime. Environmentally these actions result in several problems through the intrusion of salt water in sweet groundwater and drinking water wells. Furthermore, high emissions of greenhouse gasses from the drained peatlands arise and high amounts of nutrients from the oxidation dry peat are released.



Elevation map of The Netherlands, and zoomed in part of Friesland, in meters

Nature Conservation

Main problems concerning nature conservation in The Netherlands are the strong fragmentation and loss of intact ecosystems. Therefore, big parts of the low land areas and wetlands of the region are protected under the Ramsar Convention and different directives concerning nature conservation (Birds Directive, Water Framework Directive, Habitats Directive). Today a technocratic approach with the “construction of natural ecosystems” is a widespreadtool to restore ecosystem functions and services in the Netherlands to takle the challenges . Main driving environmental body in The Netherlands is the Staatsbosbeheer, a governmental organization for forestry and the management of nature reserves that currently owns 250.000 hectares of land, aiming to strengthen the position of nature work to conserve and develop the Netherlands’ characteristic green heritage.

Research

The current water management strategy is unsustainable and insufficient to keep up with the effects of climate change, especially with the in future expected global sea level rise. A lotof research projects for adaptation to climate change scenarios and climate change mitigation where implemented in the last years – and are still going on - to study possibilities of land use under wet conditions. Peatland rewetting projects have just started or will start in the near future. With "Better Wetter" in Noordoost Friesland, Zuiverdeen, and "Omhoog met het veen" in Ilperveld, three of these projects will be visited during the excursion.

Box 4 Cinderella-Project

In the climate change debate, peatlands and their role for the global climate are more or less neglected – like Cinderella in the fairy tale The international, transdisciplinary research project CINDERELLA, funded by ERA-NET FACCE-JPI (The Joint Programming Initiative on Agriculture, Food Security and Climate Change) was started to change this. It is a cooperation between scientists and practitioners from Sweden, Denmark, The Netherlands, and Germany to further explore paludiculture. The transdisciplinary research program 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. The main objective was to extend the scientific base for a sustainable, productive land use of wet peatlands and to make alternative uses accessible to farmers and land authorities. Furthermore, the project aims to investigate the productive use of rewetted peatlands and the simultaneous restoration of ecosystem services, including reduction of greenhouse gas (GHG) emissions and land subsidence, water, and nutrient retention, and water purification.

Further Reading

FACCE-JPI:
https://www.faccejpi.com/content/location/96954
Cinderella: www.paludiculture.uni-greifswald.de/en/projekte/cinderella /index.php
Legal study paludiculture in Europe:
https://www.dropbox.com/s/ei2qipc5pczgvdk/Report_Laura_Koelsch_Iur_Cinderella_09062016.pdf?dl=0
Technical report Cinderella Nijmegen:
https://www.dropbox.com/s/774xec067awznt4/Final-Report-Cinderella-Nijmegen.pdf?dl=0

III EXCURSION SITES

1. Polder Zuiderveen

General Information

In the polder Zuiderveen (province of Noord-Holland) the largest dutch pilot study for paludiculture with *Typha* was conducted. It covers an area of about 12 hectare and is part of the Peat Innovation Program (IPV), commissioned by the Province of Noord-Holland, Gebiedscommissie Laag-Holland, and water authority HHNK. In the younger past this area has been drained and used as pasture meadows. Several years ago North-Holland planned to support rehabilitations works of houses with insulation materials from locally produced Typha. Ilperveld was selected for the implementation of a large scale Paludiculture crop cultivation pilot. Planning of the pilot was done in 2017 and in winter 2017/18 site preparation for the establishment of *Typha* and three other promising paludiculture crops (Azolla, Lemna, and *Sphagnum*) started.

Aerial view Polder Zuiderveen

Project progress

In the beginning, 28 basins with different sizes were created by excavating the top soil. *T. latifolia* and T. *angustifolia* and *Azolla* were planted. Different establishment compared with respect to practicability, plant development, and yields:

- Planting of rhizomes (in April),
- Planting young plants (in May), and
- Sowing (in June).

Harvest frequency is planned with 1 or 2 times per year. Small scale experiments with paludiculture crops will also be done. Water levels are adjustable up to 40 cm above the soil surface in all basins by using the natural incline. Accurate water level management shell prevent drying periods and development of weeds.

Schematic Drawing of pilot site Zuiderveen

Box 5 *Sphagnum* Farming

Sphagnum farming is the cultivation of peat moss (*Sphagnum*) aiming for the production and harvest of peat moss biomass. For this purpose the *Sphagnum* is cultivated in order to gain renewable raw material for the production of horticultural growing media. Blueprints for modern Technology and hydro-engineering date back to the early stage of the soviet union in the beginning 20th century where Lenin installed hords of engineers to develop schemes and technology to realise his vision of a modern and electrified Russian empire also with the exploitation of the huge Russian peatlands for energy and material utilisation. Nowadays almost all vegetable and decorative plants and flowers that are grown in professional horticulture are potted in substrates based on white peat. The Netherlands and Lower Saxony in Germany have largely depleted their white peat resources and continue to exploit the resource in the Baltics. We literally eat our way through the peatlands in a Northeast expansion. Paludiculture with Peat mosses cultivate *Sphagnum* as a renewable raw material in exploited peat mining areas drained agricultural peatland after rewetting. The Fresh *Sphagnum* biomass can be harvested in short rotations of ~5 years and can replace white peat in horticultural substrates and thus reduce the need for new peat extraction sites. Cultivation tests have shown its feasibility, but the initial production volumes are small and currently cannot provide enough raw material to substitute all horticultural peat. Further technological and economic research and development needs to be carried out to scale-up existing cultivations to provide future horticulture markets with high quality and affordable *Sphagnum* biomass that is able to compete with the well established productions schemes and markets for white peat.

2. Polder Ilperveld

General Information

The Polder Ilperveld is relatively small (8ha) and lies within the Nature Reserve Ilperveld, 5 km north of Amsterdam. Here, in order to restore ecosystem functions of drained peatlands, the technique of *Sphagnum* farming was applied within the research project "Omhoog met het Veen Ilperveld" ("Up with the peatland Ilperveld"). The area has been in agricultural use for 600 years. In the last decades the meadows were used for cattle grazing with summer groundwater tables of 80 cm below and a regular fertilisation with manure. Although, the available water was, due to the fertilisation, rather high (pH7-9), it is the first successful *Sphagnum* cultivation project in The Netherlands.

Aerial View of the polder Ilperveld

Amsterdam & Noordoost Fryslân, The Netherlands

Project progression

In order to create optimal conditions for the *Sphagnum* to grow, the grass vegetation and top 10 cm of the peat soil was removed. The water level was raised and kept stable to a few centimeters below surface level. After the planting phase, over time the vegetation showed a fast establishment of *Sphagnum* of 90% within the first two years. Fen species showed a steady increase, grassland and pioneer species disappeared from the vegetation. After 3.5 years the *Sphagnum* vegetation created a thick layer (8-12 cm) of recently formed 'white peat', consisting of largely undecomposed light brown peat mosses. Besides the *Sphagnum* farming there has been another experimental design developed to investigate the development of *Typha* under different abiotic conditions. The main aim of this experiment is to use paludiculture with *Typha* to stop soil subsidence.

Project results

Greenhouse gas emissions were strongly reduced compared to a drained peat grassland nearby. The change in land use reduced the net emissions from 300-620 g CO_2 –equivalents per m^2 and year (drained reference) into -86 (net sequestration) to 94 g CO_2 -equivalents per m^2 and year. After rewetting methane emissions remained very low, making CO_2 rather than methane dominant on the greenhouse gas balance. In general, the results of the pilot site showed that the technique of *Sphagnum* farming is suitable for restoration of a *Sphagnum*-dominated vegetation on former agriculturally peatlands. The development of *Sphagnum* covers from plant fragments (cuttings) is fast (< 1 year) and supports several ecosystem functions: It harbours characteristic fen plants and fungal species, it restores peatland hydrology by acting as a sponge and it sequesters carbon.

Additionally, results from the harvest in 2017 show that T. angustifolia developed much more shoots than *T. latifolia* in the wet plots which means that this species is more sensitive to water level drawdowns. However, *T. latifolia* generally produced more biomass, especially in the dry plots (red) and wet brackish plots (green), so this species seems less sensitive to changing water levels.

After 3.5 years the *Sphagnum* vegetation created a thick layer (8-12 cm) of recently formed 'white peat', consisting of largely undecomposed light brown peat mosses. It covers the former agricultural soil (nutrient-rich fossil peat), restores the hydrological properties and supports the establishment of typical fen species.

3. Northeast Friesland

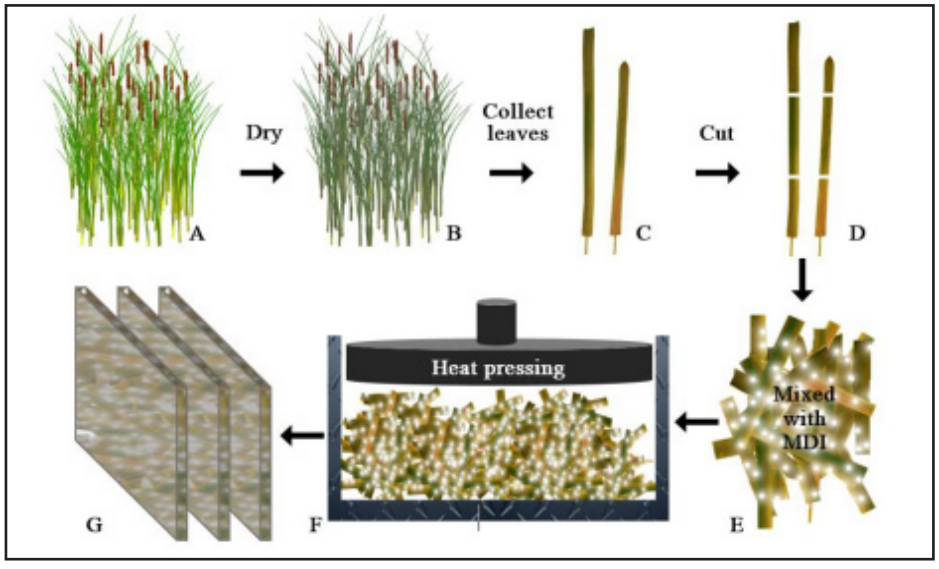
Typha field site

General Information

Within the program "Better Wetter", researchers of Kenniswerkplaats Noordoost Fryslân (an institution where Entrepreneurs, Government, Education, Research Institutions and Organizations in the region work together) and the consultancy office for ecology, "Altenburgh & Wymenga" analysed the problems of subsidence of peat soils and the flooding of areas during winter in low-lying areas. In order to look for sustainable solutions and to assess and optimise the whole production chain of Typha products, a pilot site has been implemented in northeast Friesland and farmers as key local stakeholders had been involved and asked for their willingness to implement wet forms of agricultural production of Typha.

Project progression

A solution for the problems of subsidence of peat soils and the flooding of areas during winter is to restore and/or maintain the wetlands in Friesland. Hence, specific parts of land are going to be flooded yearly. Most of the interesting areas for flooding are currently being used as grassland by dairy farmers When flooding their land, the farmers will earn significantly less money off their lands and are therefore probably not willing to participate in this project. Hence, some kind of compensation is required. With the conflicting interest of farmers and the program of Better Wetter, an interest has arisen in the possibilities to economize vegetation in wetland areas. Previous research, on different water tolerant species revealed *Typha* as the most promising species in The Netherlands for cultivation as paludiculture crop. Based on the *Typha* growing conditions, several locations for *Typha* cultivation were recommended and an artificial growing bed for a pilot project was built. Suitable harvesting methods were studied and compared in terms of costs, advantages and disadvantages. Concerning production of high quality products from *Typha* a focus was lain on bio-laminates and insulation material. Investigation of the processing as well as the applicability of the products were don. Additionally, product prices, market size, market demand and product advantages of the *Typha* products were analysed. A comparison to currently used conventional products and their markets was made.



Typha Production Chain

Project results

From the farmer´s perspective *T. angustifolia* was recommended as the most suitable species to cultivate in Northeast Friesland. Another promising candidate T. × *glauca*, which is the hybrid of *T. angustifolia* and *T. latifolia*, might produce more biomass and is more able to adapt to Dutch environmental conditions than both parents due to the heterosis. Based on Typha general determination of growing conditions, potential *Typha* growing locations were identified.

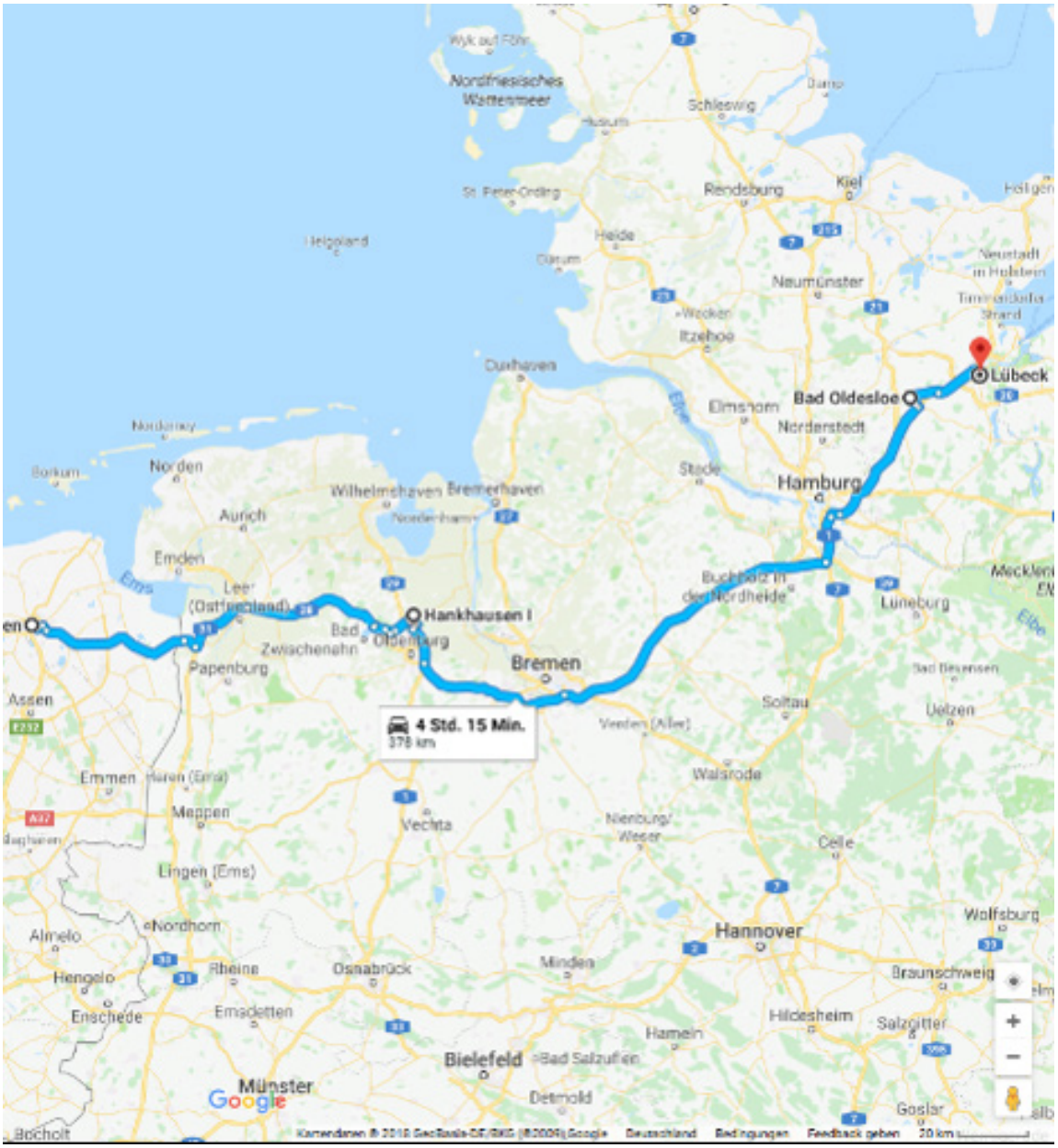
		T. latifolia	*T. angustifolia*	*T. × glauca*
Characteristics	Flower shape			
	Stem height	1-3 m (Grace and Harrison, 1986)	1.5-3 m (Grace and Harrison, 1986)	1-3 m (Grace and Harrison, 1986)
	Leaves shape	Broad and thin 15-25 mm (Weeda *et al.*, 1994)	Narrow and thick 4-14 mm (Weeda *et al.*, 1994)	Broad 5-19 mm (Kuehn *et al.*, 1999)
	Vegetative reproduction	Fast (Selbo *et al.*, 2004)	Faster than *T. latifolia* (Selbo *et al.*, 2004)	Fast (Smith, 1967)
Growing conditions	Soil type	Sandy, silty, clay (Gucker, 2008)	Peaty (Bolen, 1964)	Similar to its parents (Smith, 1967)
	Salt tolerance	Not very tolerant, especially when germinating (Choudhuri, 1968)	Not very tolerant, only slightly more than mildly brackish conditions are tolerated (Crain *et al.*, 2004).	Lack of data
	pH tolerance	5.5-8 (Weeda *et al.*, 1994)	6-8.5 (Weeda *et al.*, 1994)	Lack of data
	Wave tolerance	No (Weeda *et al.*, 1994)	Yes (Weeda *et al.*, 1994)	Yes (Smith, 1967)
	Water depth (above surface)	15-50 cm (Grace and Wetzel, 1982)	50-80 cm Peak density at 80cm (Grace and Wetzel, 1982)	Lack of data

3 *Typha* species suitable at pilot site

Tuesday 25th September

I EXCURSION DAY 2

Route



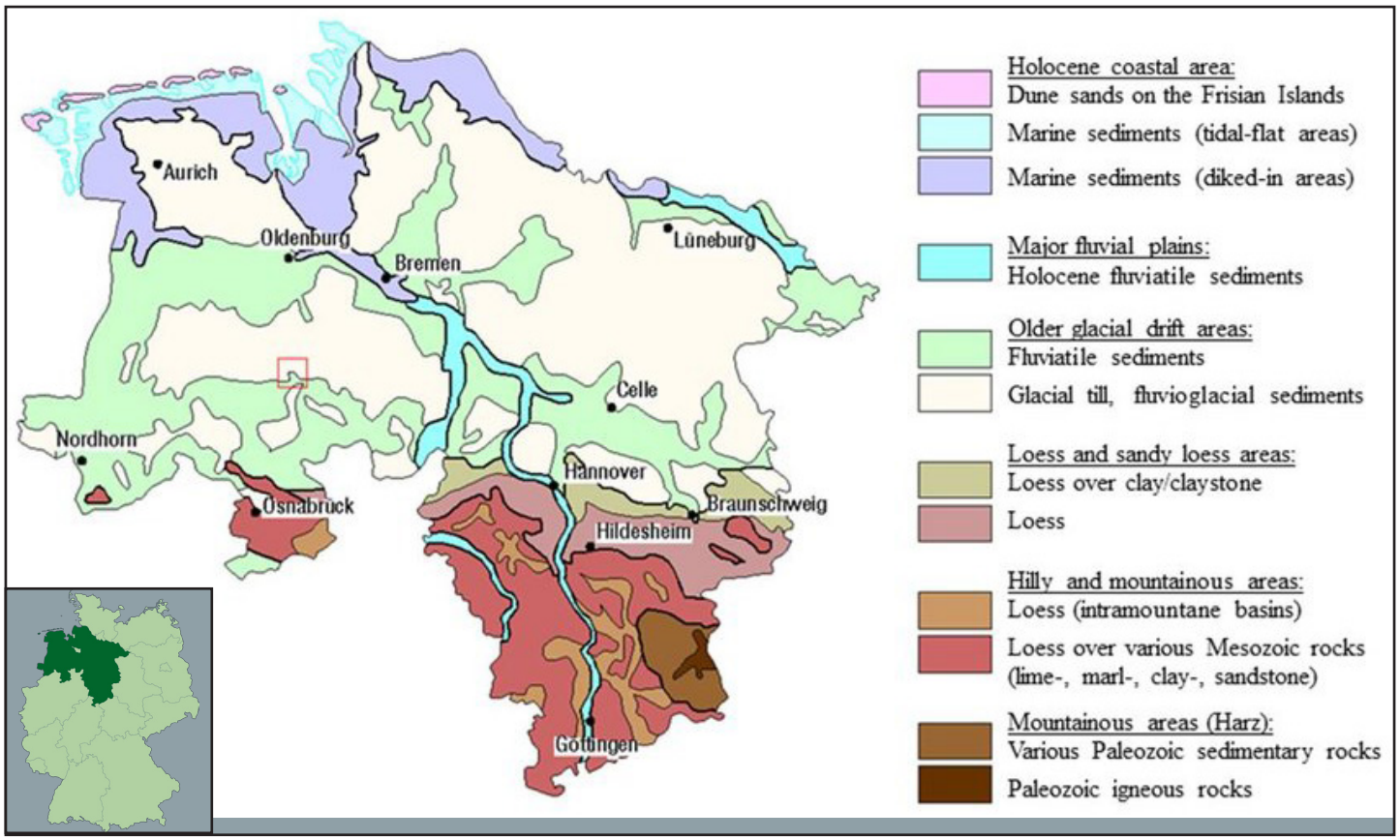
Schedule

Time	Location or event	Remarks
08:00	NH Groningen	Check out from Hotel.
10:00-13:00	Hankhausen	*Sphagnum* farming pilot site of Greifswald University / Moor Kultur Ramsloh (MoKuRa – peat substrate producer); Lunch.
16:00-18:00	Bad Oldeslohe	Hiss Reet - construction materials from reed.
19:00	Motel One Lübeck	Hotel check in.
20:00	Lübeck	Dinner - Presentation „Water management framework directive and peatlands in Schleswig-Holstein" (Dr. Michael Trepel – Ministry for energy transformation, agriculture and environment S-H)

II INTRODUCTION

Landscape

The excursion will take place in the northwestern part of Germany, Lower Saxony and Schleswig-Holstein. This region was shaped by the last glaciation and thus characterized by deposits of ground moraines, mainly sandy boulder clay or till, which were partly covered by drifting sand and river deposits. After the glaciation large areas paludified and fens and in particular, due to high precipitation rates, bogs developed. The northwest part is the main distribution area of bogs in Germany, and consequently the region with the main peat extraction activities. This region is also characterized by humid and oceanic (atlantic) climate.



Geologal units of Lower Saxony, and below its location in Germany

Land use history

In medieval times the bogs of this region were used for small-scale peat cutting. Slightly decomposed *Sphagnum* peat (white peat) was used as litter, while black peat was mainly used as fuel. At the end of the 17th century large bog cultivation started and land use on peat soils became more intensive. In the 19th and beginning of 20th century peat cutting increased in large mire complexes. Remarkable was the buck wheat fire cultivation on bogs, which caused substantially air pollution by smoke. In 1868 M.A.F. Prestel published a scientific paper „On the fire cultivation in peatlands in East Frisia“ in which he documented the peatland fires induced by the buck-wheat culture on drained peatlands and the distribution of haze plumes in central Europe. The environmental problems of this drainage based peatland utilisation led to the establishment of the Mire Experimental Station Bremen (in northwest Germany) in 1877, where peatlands and peatlands utilisation was investigated. In particular the ‘German raised bog cultivation’ was developed and studied. Bogs were mainly used as grassland and to a small extent as arable land. Before the Second World War peat cutting changed from manually to industrial extraction techniques. Under the NS-regime in the first halve of the 20th century prosecuted Jewish and political imprisoners and prisoners of the Second World War were forced to hard peatland reclamation and drainage works in 15 concentration camps of Emsland. Today the memorial site Esterwegen reminds of the fate of the forced labourers and the crimes of the NS-regime. After the Second World war the agricultural use was intensified with more effective drainage systems and heavy agricultural machinery of the Company Ottomeyer in particular during the 1950- 1970s.

Current land use

Peat extraction decreased over the last 30 years and will substantially decrease within the next years as the slightly decomposed peat ('white peat'), the most valuable raw substance for substrates in professional horticulture, is getting exhausted. Moreover, it becomes more difficult to get permits for extraction due to policy changes and refusal by local populations. The current licenses for white peat excavation are fading within the next years and new licenses are not issued. A sensitive issue is the cultivation of *Zea mais* as energy crop for production of "Biogas" on drained peatland a widespread practice, subsidised by bioenergy programmes in Germany, that causes up to 8-10 times more emissions of GHGs as the direct combustion of coal. Nowadays the total bog area in Lower Saxony is around 208,000 ha and only < 1 % is in a natural state. More than 50 % of the bog area is agriculturally used including 44 % bog grassland and around 8 % for peat extraction. To cover the growing demands from world-wide urbanisation, the cultivation of vegetables, fruits and flowers takes place in pre-prepared growing media, consisting mainly of slightly decomposed *Sphagnum* peat, which is mined from peatlands. Currently, peat provides 92 % of the German demand. In Germany, approximately 4 million cubic metres of white peat is used annually for professional horticulture and hobby gardening.

Nature conservation

The rapid loss of natural bog areas led to the 'Moorschutzprogramm' (program for peatland conservation; part 1- 1981 and part 2- 1986) of Lower Saxony, where priority areas for peat extraction and for nature conservation as well as the restoration by rewetting of cut-over bogs were specified. Major aims were to protect around 50,000 ha not extracted and 31,000 ha extracted bog areas as well as several small bogs as nature conservation sites.

Research

In the last years the use of *Sphagnum* biomass as a raw material for growing media in modern professional horticulture has been successfully tested and in some cases it demonstrates even better results than the peat-based substrates developed over many years.

Further reading

Couwenberg 2007: Biomass energy crops on peatlands: on emissions and perversions IMCG newsletter 03/2007
J. Köbbing & S. Wichmann 2015: Common reed for thatching—A first review of the European market, Industrial Crops and Products 77:1063-1073 (DOI: 10.1016/j.indcrop.2015.09.027)

Distribution of the peatland fires between 1848-1863:
http://reader.digitale-sammlungen.de/en/fs1/object/display/bsb10298347_00031.html

Monument Esterwegen: https://www.gedenkstaette-esterwegen.de/english/

Short Movie about peat extraction by Company Ottomeyer/Pyrmont 1970: https://www.youtube.com/watch?v=hk-ktzVIK9Y

III EXCURSION SITES

1. Peatland Hankhausen

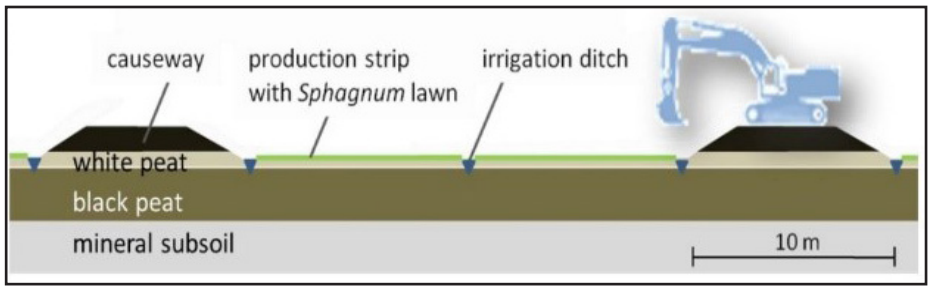
General Information

The peatland "Hankhauser Moor" is located near to the city Oldenburg in Lower Saxony. In 2011 there was a Sphagnum farming pilot site installed by the peat company Torfwerk Moorkultur Ramsloh GmbH & Co. KG (MoKuRa) in cooperation with the University of Greifswald. This area of former bog grassland was strongly degraded after decades of intensive use as grassland for dairy farming with deep drainage, leading to 1 m subsidence since 1958. Recently the region is situated 0.5 m below the sea level and drainage water has to be pumped out actively to the North Sea.

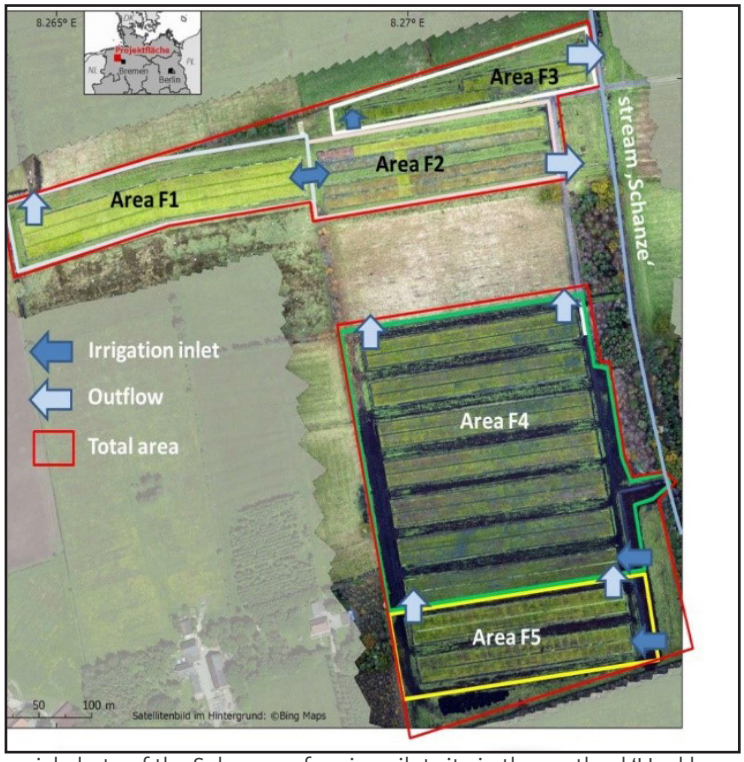
Aerial View of the peatland Hankausen

Project progress

For installation of the trials over 4 ha (10 acres) the upper highly mineralized peat layer (~30 cm) was removed and used for constructing dams resulting in 10 m wide production strips bordered by irrigation ditches. After site preparation *Sphagnum* fragments were spread on the bare peat and subsequently covered with straw. Afterwards the site was rewetted, irrigation water was pumped from the adjacent channelized 'Schanze' rivulet, east of the study site, which drains the entire surrounding territory. 1.5 years after initial establishment *Sphagnum palustre, S. papillosum* and *S. fallax* already covered 95% of the area with mean lawn height of 8.3 cm (maximum 22.4 cm, Figure 3). *Sphagnum* productivity is high with a dry mass of around 8.7 t ha^{-1} yr^{-1} after the lawn establishment. Five years after field installation first mechanical harvest of the *Sphagnum* mosses was conducted in 2016 the peat company Moorkultur Ramsloh GmbH & Co. KG. Harvest of the mosses was done by an excavator reaching into the cultivation site from the installed causeways with a long arm and mowing bucket. Two third of the upper *Sphagnum* mosses were cut as former experiences showed that residual *Sphagnum* stems left regenerate fast. The material was directly spread to newly prepared fields to enlarge the cultivation area to 14 ha.



Schematic cross section of the Sphagnum farming area consisting of causeway, ditch and production strip with Sphagnum lawn on white peat above black peat and the mineral subsoil



aerial photo of the Sphagnum farming pilot site in the peatland 'Hankhauser Moor' with the parts installed in 2011 (Area F1+F2) and in 2016 (Area F3-F5) and the irrigation system (stream 'Schanze' as origin of the water + inlets and outflows)

Project results

Up to now the experiments in the 'Hankhauser Moor' has convincingly proven the feasibility of large-scale Sphagnum farming already during the establishment phase, and also with the subsequent high *Sphagnum* biomass productivity. The pilot site now allows developing methodologies and testing machines for further upscaling of the cultivation and harvest of *Sphagnum* biomass.
Furthermore many sundew (*Drosera rotundifolia*) plants are spontaneously growing in the *Sphagnum* culture. Recently pharmaceuticals from *Drosera* sp. (dried above-ground plant parts) are used to medicate respiratory diseases. The plants are mainly collected from wild populations in intact peatlands, while all *Drosera* species are endangered now in Europe (Baranyai & Joosten 2016). Prospects of *Drosera* cultivation in combination with *Sphagnum* farming is investigated at the *Sphagnum* farming site in Hankhausen. Research on germination, survival, biomass growth and content of medicinal ingredients is done at the University of Greifswald.

Box 6 Utilisation of Common Reed (*Phragmites australis*)

Common reed (*Phragmites australis*) is a globally distributed emergent wetland plant. For thousands of years it has been traditionally used by people all over the world. Applications such as the manufacture of schnapps, coffee and boats are meanwhile less popular than they have been in the past. Reed as constructing has a long tradition in many cultureswhole buildings, garments, mats, boats, were and are made from reed especially in Europe still wide spread are reed-thatched roofs. Many of the traditional fishing villages in the Fischland-Darß-Zingst area (northeastern Germany) are still characterised by the typical architecture with reed-thatched roofs. Nowadays the touristic region is keen to maintain the traditional scenic appearance of the fisher villages. Traditional craftsmanship for the harvest of reed and the construction of thatch roofs is still present in enterprises and workshops in the region and finds also application in contemporary modern architecture. Local demand for thatch reed cannot be satisfied by local reed resources only. Land degradation and nature conservation restrictions limit the availability of suitable reed beds for the harvest of thatch reed and therefore imports from Eastern Europe and China are necessary.

Reed house

2. B – Company Hiss Reet

The family-owned company HISS REET (Schilfrohrhandel GmbH) was founded 1833 in Bad Oldesloe. It has been trading reed since the 1920s and has grown to become the biggest merchant for reed in Germany. Subsidiary companies in Turkey, Rumania and Hungary harvest the reed and are responsible for its processing. The reed products are directly distributed to Germany, Holland, England, Ireland, and Denmark via ship or truck. The company also trades complementary products of other manufacturers, for example dormer windows, wall heatings, fastening material. In addition to the traditional trade with thatch reed a growing focus is put on the trade with other reed products. Due to the constantly growing demand Hiss Reet founded the sector of natural building material in 2004. Clients also revealed a stronger interest for the sector of Hiss Reet Garden Products which hence was extended by new products.

Harvest prozedure of Company Hiss Reed

During the excursion there will be the chance to see construction materials of Hiss Reet applied in a in a small show pavilion.

Further reading

Blievernicht, A., Irrgang, S., Zander, M. & Ulrichs, C. 2013. *Sphagnum* biomass - the next generation of growing media. Peatlands International 1/ 2013: 32-35.

Emmel, M. 2008. Growing ornamental plants in *Sphagnum* biomass. Acta Horticulturae 779: 173-178.

Gaudig, G., Fengler, F., Krebs, M., Prager, A., Schulz, J., Wichmann, S. & Joosten, H. 2014. *Sphagnum* farming in Germany – a review of progress. Mires and Peat 13: Art. 8.

Muster, C., Gaudig, G., Krebs, M. & Joosten, H. 2015. *Sphagnum* farming: the promised land for peat bog species? Biodiversity and Conservation,

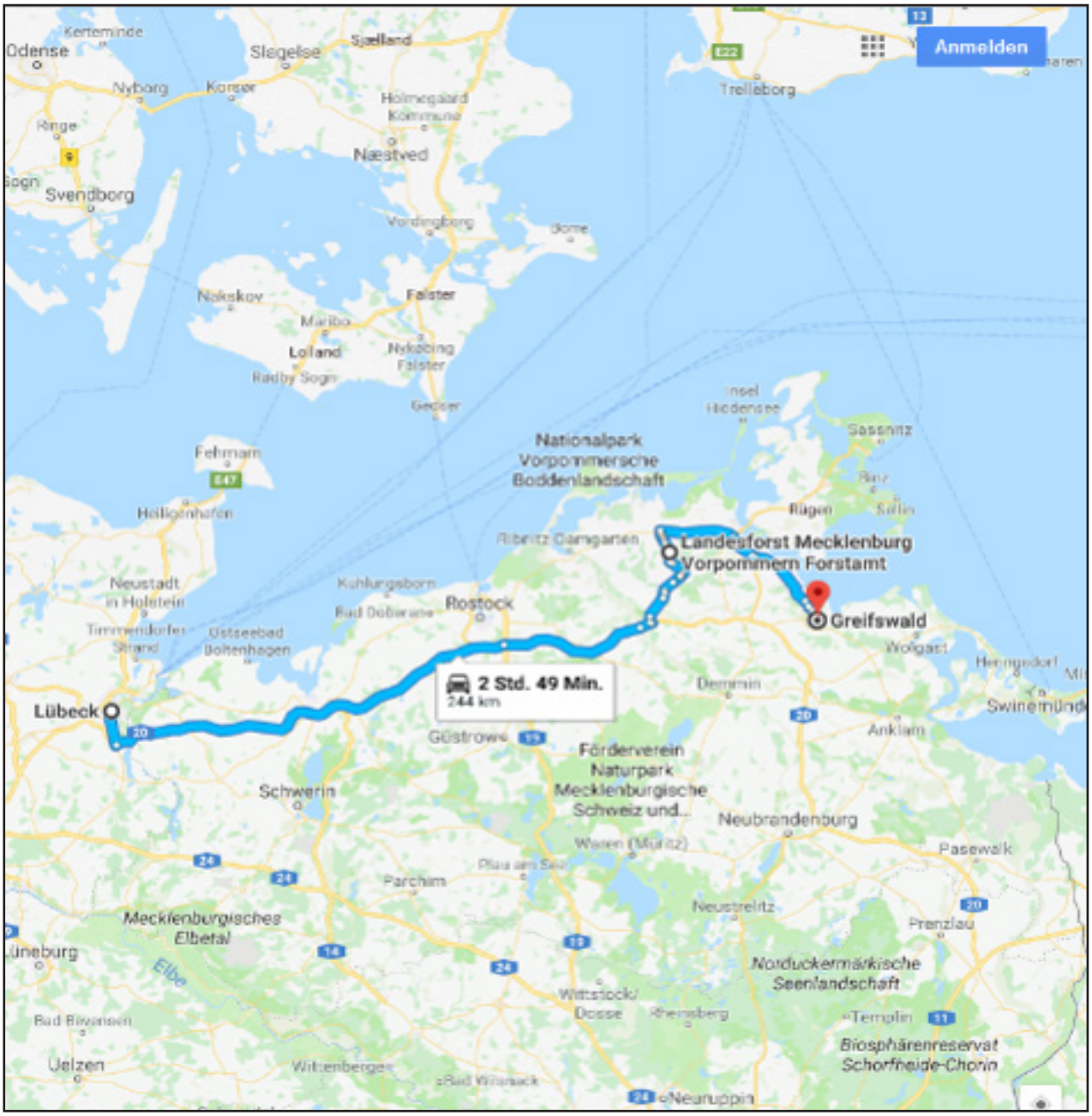
Wichmann, S., Prager, A. & Gaudig, G. 2017. Establishing *Sphagnum* cultures on bog grassland, cut-over bogs, and floating mats: procedures, costs and area potential in Germany. Mires & Peat 20, Art. 3.

www.moorkultur-ramsloh.de/

Wednesday, 26th September

I EXCURSION DAY 3

Route



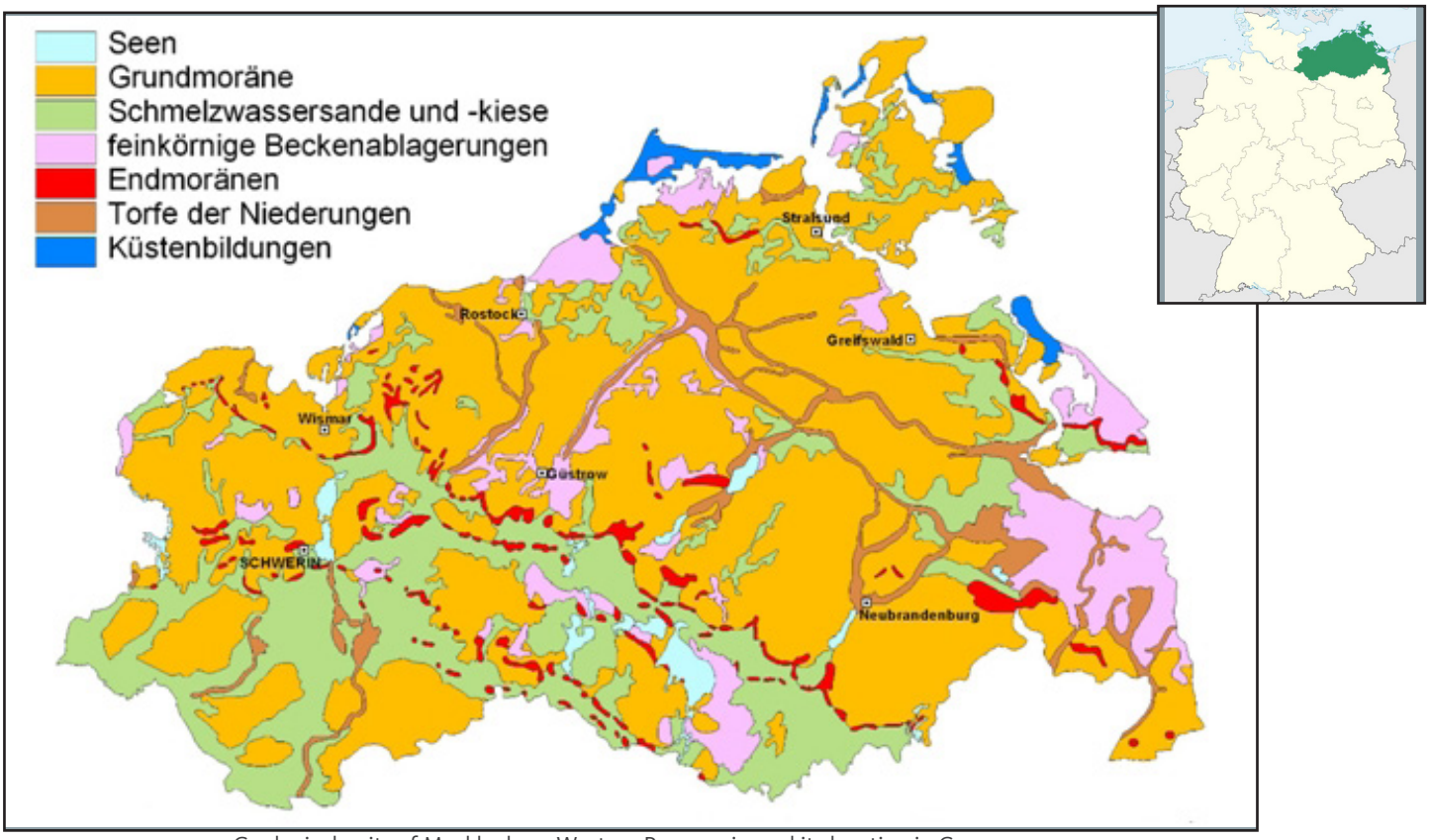
Schedule

Time	Location or event	Remarks
08:00	Motel One Lübeck	Check out from Hotel.
10:00-13:00	Schuenhagen	Wet Forest management of Federal state forestry M-W (visit of managed wet alder forest); Lunch.
14:00-18:30	Greifswald	Paludiculture Impulse presentations and workshop at Greifswald University.
19:00	VCH Greifswald	Hotel check in – free evening in Greifswald.

II INTRODUCTION

Landscape

The federal state Mecklenburg Western Pomerania extends along the Baltic Sea coastal plain and is situated within the North of Germany. Therefore, the moderate climate is primarily influenced by the Atlantic Ocean and Baltic Sea. The region's landscape was largely formed by glacial forces, which deposited materials and shaped the scenic hilly sites and lowlands that filled during the Holocene after the melting of the ice of the late glacial period of the Vistula ice age (since ~ 11.000 years before present) with wide peatlands, lakes, and meandering streams. The central part of Mecklenburg Western Pomerania is traversed from west to east by a hilly plateau with fertile clay soils covered by beech forests. The Southwest, between the plateau and the Elbe river, has poor sandy soils, pine forests, and marshy valleys. Along the coast, steep cliffs alternate with beaches and dunes. Within Germany it is the federal state with the largest peatland area, mainly fens, and the largest river valley mire, the Peene river valley in Mecklenburg Western Pomerania.



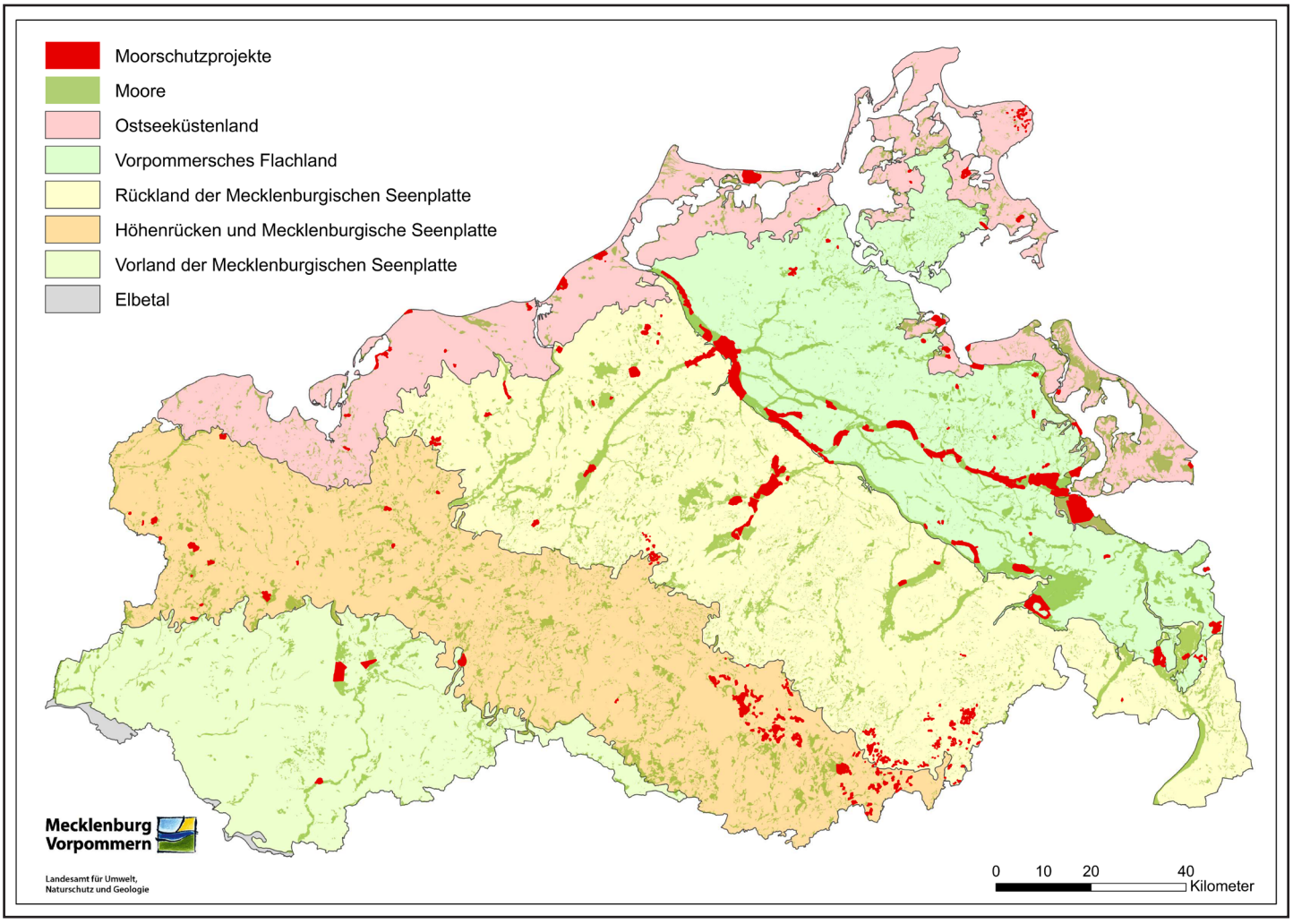
Geological units of Mecklenburg Western Pomerania, and its location in Germany

Land Use History

In the younger past agriculture was the main driving sector that shaped the landscape in the area. Especially during the Soviet era (1945–90) where the forced collectivation program merged small private farms into large state owned collective farms ("Landwirtschaftliche Produktionsgenossenschaften", LPG). After the German reunification (1990) and privatization of farms, these, for German and Western European standards relatively large-scale structures in agriculture, continued to prevail. This, on the one hand side, helped to maintain and develop the competitiveness and efficiency of agriculture as an important economic sector in the country, but on the other hand side also exacerbated environmental problems that were induced in the 1960s with a large-scale program for land reclamation and drainage of peatlands - the "Komplexmelioration". Peatland drainage measures of within this melioration were implemented till the early 1980s. But fertility and capillary water conductivity dramatically decreased under intensive agricultural use on drained peatlands, so that a peatland conservation movement started in the 1990s.

Current Land Use

At present nearly two-thirds of the state are covered by farmland and about one-fifths by forest. The main cultivated crops of the region are wheat, barley, sugar beets, potatoes, rye and hay. Corn (maize) and peas are also grown, and the state is among Germany's leading producers of rapeseed. The region's pastures, mainly on drained peatlands, support herds of cattle, sheep and horses. The majority of the peatland area is drained for agricultural purposes. These soils cause 27% of the total CO_2 emissions of the federal state. Less than 3% of the peatland area are under near natural or undrained conditions, another 59% are extremely or strongly degraded by drainage.



Peatland restoration projects in Mecklenburg Western pomerania

Nature Conservation

The conservation of peatlands found input in the federal program for peatland conservation of Mecklenburg Western Pomerania (Moorschutzprogramm MV) in 2000. Since then on 26,032 ha of peatlands (8.9 % from the total peatland area), measures for re-wetting and stabilisation of the hydraulic conditions have been implemented. Further re-wetting and conservation projects are intended. Currently, there are 283 nature reserves, 110 landscape reserves and three national parks, scattered all over the state, wide parts of these also covering peatlands. The National Park "Western Pomeranian Boddenlandschaft" is for example situated largely on the Darss Peninsula and its surrounding waters, and the National Park "Jasmund", on the northeastern coast of the island Rügen.

Box 7 Peatlands in Mecklenburg-Western Pomerania

Peatlands cover currently 12% (about 290,000 ha) of the land area of Mecklenburg Western Pomerania. Most widespread are river valley peatlands. Pristine river valley peatlands consist of three adjacent and functionally connected ground and surface water fed hydrogenetic mire types from the edge of the river valley to its center: surface flow mires (spring mires), in the valley plain percolation mires, and adjacent to the river flood mires.

Spring mires are fed by ground water and develop where aquifers are truncated and therefore artesian ground water continuously discharges to the surface. Spring mires are sloped sometimes even forming small cupolas and ridges. Where the artesian ground seeps out with high pressure Calcium is precipitated; the peat is highly decomposed and shows a high Calcium content. In the Peene valley, spring mires can be found e.g. near Loitz.

Percolation mires stretch across the sloped river plain adjacent to the spring mires. They are fed by the spring mire water discharge and continuously ground water inflow therefore the peat is only slightly decomposed and mineral and nutrient contents decrease to the center of the valley until the flood water regime of the river overrules the groundwater flow. The hydraulic conductivity of the peat body is high, and surface water levels are stable due to continuous water supply and the oscillation capacities of the slightly decomposed peat body. Percolation mires are the dominant peatland type of the North-Eastern German Plain, for example in the Peene catchment area.

Flood mires are under the influence of water from neighbouring water bodies. They are inundated periodically or episodically and can also fall dry. This mire type only occurs where inundations regularly occur. Inundation mires can be found in parts of the “Große Rosin” at the “Kummerow” lake and in the Lower Peene valley, downstream of Anklam. The periodically occurring dry periods provoke the development of highly decomposed peat and eutrophic nutrient conditions.

Locally bogs (ombrotrophic mires) can develop in river valley complexes where precipitation water forms rainwater lenses nesting in groundwater fed fen areas. The “Anklamer Stadtbruch” has 500 ha of such bog area nesting in a percolation mire. It is the biggest bog complex in Mecklenburg Western Pomerania but unfortunately widely destroyed by peat extraction.

III EXCURSION SITES

1. Schuenhagen

Wet Forest Management

Besides alternative utilisation of agricultural land also new ways of managing forests under wet conditions gained more importance in recent years. In contrast to the common forestry with tree species adapted to relatively dry conditions, now tree species tolerating high water level are cultivated under wet conditions. Common Alder (*Alnus glutinosa*), willows (*Salix* spec.) and birches (*Betula* spec.) are tree species, characteristic pioneers on mires, shifting river beds and moist soils in established woodlands that respond rapidly to natural environmental change and to changes in land use. However, these forests would need fertilisation for optimising growth rates and that needs carefully be adjusted not to threat paludiculture benefits of nutrient retention and peat preservation. High water levels allow to maintain the peat layer and create conditions for the development of mire vegetation. The biomass collected from the peatland afterwards can be burned in a heating plant to balance costs.

Box 8 Common Alnus (*Alnus glutinosa*) in Forestry

Life time	~120 years, fast growing
Adaptations (wet conditions)	High demand of nutrients Lenticells at trunk deliver tree with oxygen to roots In symbiosis with bacteria in root area to enable supply with nitrogen
Water level	0-20cm below surface
Establishment	Planting/Growth from the stump (high forest/low forest)
Harvest	High forest: 4-6 use cycle within 60-80 years, ca. 600-800m³ per ha Low forest: 1-3 use cycles within 20-40 years, ca. 200-500 m³ per ha
Application	Timber or fuel wood
Emissions	Reduction of ca. 18 t CO^2 per ha and year (compared to drained fen)

The Federal state forestry in Mecklenburg Western Pomerania

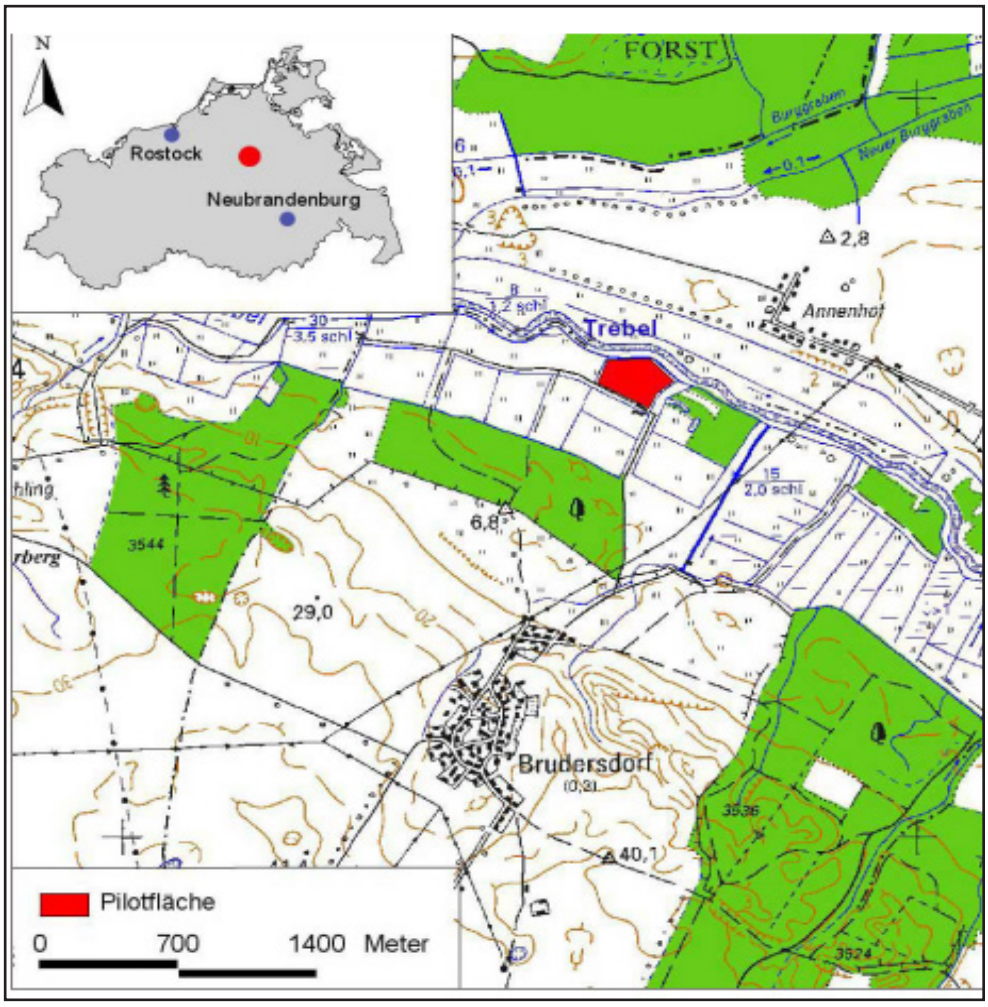
Especially in Mecklenburg Western Pomerania forestry under wet conditions is getting more and more important as 13% of the whole forest cover, which is around 300 000 hectares, are covered with peatlands. As the utilisation on these wet stands is often very limited, at least with conventional techniques, there was a project started by the University of Greifswald in 2005 to develop suitable methods to manage wet alder woods, see Box 8. In 2009, after positive outcome of this project, the Federal State Forestry started a big pilot site to test the utilisation of mobile cable cranes as a harvesting tool on wet ground. It was implemented within two forest offices in Mecklenburg Western Pomerania, one of them being Schuenhagen which will be visited during the excursion, located on old stands with *Alnus glutinosa* which is with 40 000 ha the second most common broadleaved tree species in the Federal State. During the project 3000 solid m³ of roundwood could be harvested within six weeks. The results showed that the proceeding is very soil protecting and allows the conservation requirements of the increasing demands of the timber harvest. Though, the technique needs a relatively high amount of money that can´t be covered by the income of the harvest.

The forestry office Schuenhagen

The forestry office in Schuenhagen lies in between the less fragmented broadleaved forests of northern Pomerania. It is a tradition-rich administration dating back into the 18th century when the region was under Swedish leadership. The office still is located in heritage-protected clinker building located on the river Barthe. The territory of the offices contains forests an forest area of ca. 20 000 hectares, located between the towns Stralsund, Richtenberg and Bad Sülze, also 600 hectare forest on the Darß and Zingst, next to the Nationalpark "Vorpommersche Boddenlandschaft" are included. The landscape is dominated by the lowhills of the ground morains of the glacial series. Soils are very nutrient-rich and moist, mean precipitation in the area around 600mm per year.

Cable crane

Schuenhagen, Greifswald, M. Western Pomerania



Map of the pilot site in Brudersdorf

Box 9 ALNUS-Project

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 carried out from 2002 to 2005 by the University of Greifswald developed a method for producing high grade alder timber on a small patch of 10 ha rewetted fen peat land. The project showed that with the right management, wet 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 program to rewet drained peatland forests for alder cultivation.

Further reading

Federal state forestry: https://www.forestry.gov.uk/PDF/fcpg008.pdf/$FILE/fcpg008.pdf

2. The city of Greifswald

In the Northeast of Germany, between the two largest islands of Rügen and Usedom, lies the University and Hanseatic city of Greifswald. The town belongs to Western Pomerania and is situated at a Lagoon of the Baltic sea Southeast. The Harbour of Greifswald is connected to the Lagoon by the River Ryckthat crosses the town and . The coastal part of Greifswald at the mouth of the Ryck, named Greifswald-Wieck, evolved from a fishing village. Today it provides a small beach, a marina, excellent fish restaurants, and fresh fish is bought at best in Wieck.

Important historic facts

1199	Founding of the Monastery of Hilda by Cistercians who had been expelled from Dargun
1250	Granting of the Lübeck Law and thus of independent self-government after the model of the city of Lübeck by the Pomeranian Duke Wartislaw III (14 May).
1456	Opening of Greifswald University at the initiative of the mayor of Greifswald, Dr Heinrich Rubenow
1310 – 1363	The heyday of Greifswald as a Hanseatic town
1535	Reformation in Pomerania, the Monastery of Eldena was transformed into a ducal office
1648	Peace of Westphalia, Western Pomerania together with Rügen falls to Sweden. The city will suffer for decades more from the effects of the Thirty Years' War.
1774	Caspar David Friedrich, the most important painter of German romanticism, is born in Greifswald.
1815	Transfer of Western Pomerania from Swedish to Prussian possession (Congress of Vienna)
1863	Connection of Greifswald to the Berlin-Szczecin railway line. Sailing experiences a final heyday right into the 1880s.
1903	Connection of the city to the electricity network.
1945	Peaceful surrender of the city of Greifswald to the Red Army, saving the city from destruction
1960s – 1980s	The expanding city of Greifswald becomes an economic and scientific centre in the otherwise underdeveloped region due to the arrival of large-scale industry (Lubmin nuclear power plant).
1990	The first free elections of a city parliament since 1933. As a result of structural social and economic changes after 1990, the importance of the university to the city increases.
2005	Opening of the Pomeranian State Museum.

History of the City

The Monastry Eldena

Hilda Abbey was founded in 1199 by the Cistercian monks, later called Eldena Abbey, south of the Ryck estuary. It is considered to be the birth-place of Greifswald city. The monastery crumbled into ruins after the Reformation in 1533. The stones were removed for municipal building projects during the Swedish era. Just a few fragments remained from the building complex of the once impressive monastery. These include the west wall and several columns from the centre nave. The huge lancet window juts out between the trees like a huge archway. The grounds were designed as a park based on plans by the landscape architect Peter Joseph Lenné (1789 – 1866). The ruin is a setting for theatre performances and concerts in the summer. The Eldena Jazz Evenings have taken place here in July for more than 30 years. The painter Caspar David Friedrich (1774 – 1840), born in Greifswald, made the Eldena Abbey ruins world famous with his paintings and at the same time turned them into a symbol for the entire Romantic period.

Hanseatic times

The Hanseatic League was a commercial and defensive confederation of merchant guilds and market towns in Northwestern and Central Europe. Growing from a few North German towns in the late 1100s, the league came to dominate Baltic maritime trade for three centuries along the coasts of Northern Europe. Due to a steady population increase, Greifswald became at the end of the 13th century one of the earliest members of the Hanseatic League. Through its membership the city experienced an economic boom.

University

From its founding to the present, the university has always provided important impetus for the development of the city throughout its more than 750-years history. In the process, the city and university have always benefited from each other. University studies, teaching and research have greatly contributed to the development of Greifswald as a scientific, medical and cultural centre in the Northeast of Mecklenburg Western Pomerania. For this reason, Greifswald is also one of the first university cities where the partnership between city and university is framed on the basis of a cooperation agreement. This is only logical since the city's mission statement emphasises the strengthening and expansion of the university as key goals of urban municipal policy. The importance of the university to the city is also shown by Greifswald bearing the name The University and Hanseatic City of Greifswald since 2005. The university owes its existence to a former mayor of Greifswald, Heinrich Rubenow, who founded the University of Greifswald in 1456 and was also its first rector. In July 2017, the exhibition on paludiculture plants was opened at the Botanical Garden of Greifswald University. For this the already existing `Paludarium` (exhibition of wetland plants) has been updated and extended by plant containers with additional important paludiculture plants and explanatory plaques.

Schuenhagen, Greifswald, M. Western Pomerania

Map of city Greifswald and its surrounding area

Mire Center Greifswald (GMC)

The Greifswald Mire Centre consolidates and strengthens already established Greifswald-based institutions in a new centre of excellence. This peatland science-policy interface performs interdisciplinary research, provides policy makers and society with substantiated knowledge and advice, and imparts theoretical and practical knowledge.

The main topics are

- Climate protection: 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 Mire Center in Greifswald is the science-policy-practice interface for all peatland related questions, locally and globally. There are 50 peatland experts of various disciplines working, concentrated in one place. Here, the **"Global Peatland Database",** the largest database of distribution and status of peatlands worldwide is coordinated. The extensive library **„Peatland and Nature Conservation International Library" (PeNCIL)** is also part of the GMC. Additionally, in Greifswald is the secretary of the International mire conservation group (Hans Joosten) situated, recently also Franziska Tanneberger was elected into the Main board of IMCG. This group actively brought in the peatland issue in the climate change debate on COP meetings since 2009 (starting with Hans Joosten who represented Belarus in the Climate negotioations).

In cooperation with its partner the center is doing or supporting projects regarding basic peatland research, applied conservation and restoration project work, Economic assessments of Restoration, sustainable management, paludiculture and ecosystemservices of peatlands.

These partners are

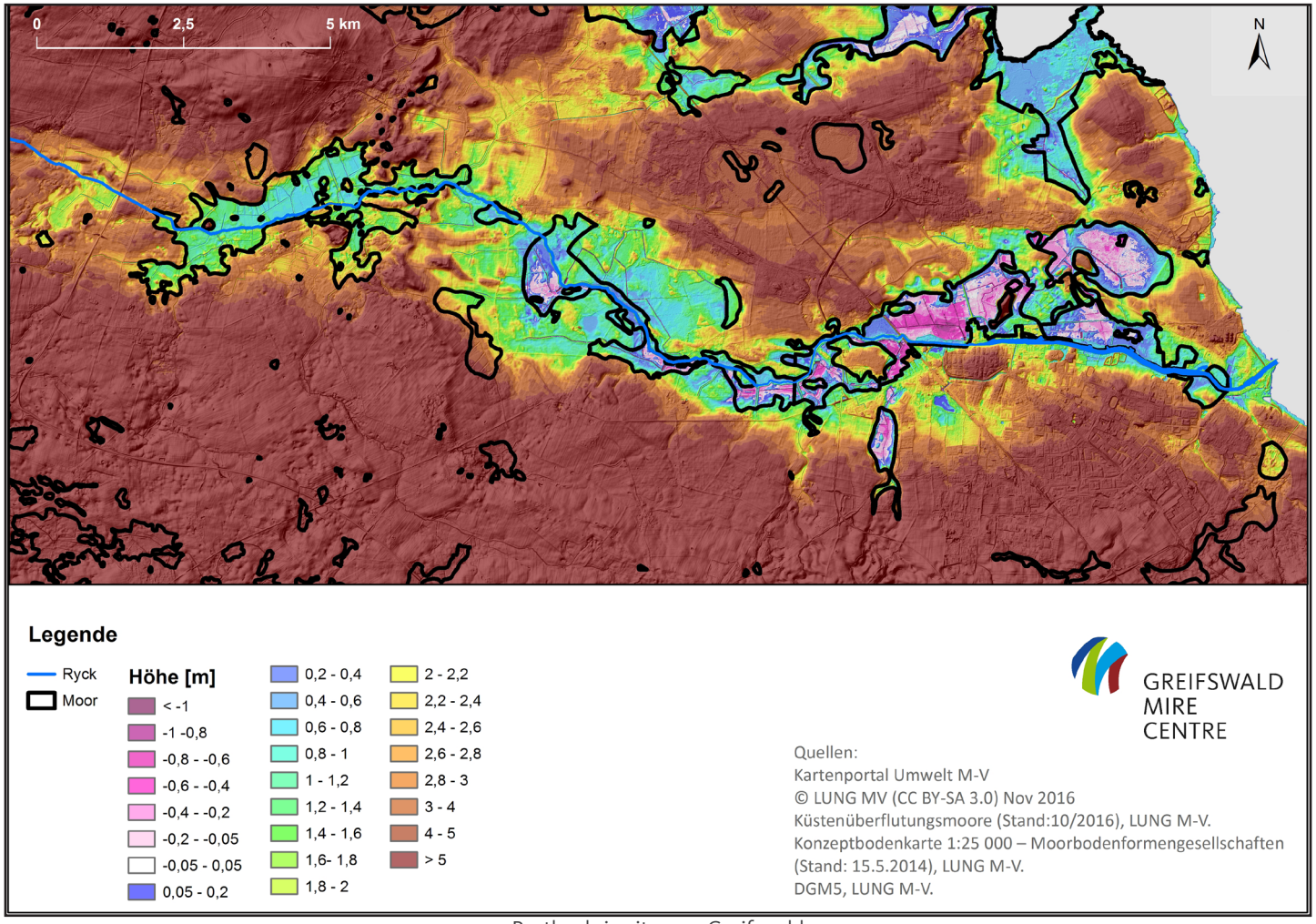
The Ernst Moritz Arndt University of Greifswald
was founded in 1456 and is among the oldest academic institutions in Europe. Over 12,000 students from all over the world study in Greifswald. Research related to peatlands is located at the Institute for Botany and Landscape Ecology. The institute is divided into eight working groups: General and special botany, Landscape Ecology and Ecosystem dynamics, Economics and Landscape economy, Peatland studies and Paleoecology, Experimental Plant Ecology, Plant physiology, Environmental ethics, and the social-ecological research group GETIDOS.

The Michael Succow Foundation
for the Protection of Nature, as one of the oldest foundations for nature conservation in Eastern Germany, is campaigning for sustainable land use and the active conservation of valuable landscapes. In national and international projects it contributes to climate protection, the conservation of biodiversity, the creation of wilderness areas and the education and further qualification of actors in nature and environmental conservation. The motto "Preserve and Sustain" is the kernel of the foundation's work, both in the implementation of practical nature protection plans as well as in the development of nature conservation and land use concepts for our and future generations

The Institute of Sustainable Development of Landscapes of the Earth
was founded 1999 at the Institute for Botany and Landscape Ecology of the University of Greifswald. The main objective of DUENE is the conservation of natural and cultivated landscapes and the support of sustainable development of landscapes. Current interdisciplinary research in landscape ecology and economics focuses on sustainable land use.

Peatlands in the city area

As the city of Greifswald was built in the flat Ryck valley, only some decimetres above mean sea level, there is even very close to the main city area peatlands existing. In a recent project at Greifswald University existing data on the peatlands in the city area had been updated and verified and a new map was issued (Figure 5) The area is very flat and dominated by fen meadows, also salty marshes due to the closeness to the coast and the backflow of the river Ryck. These areas are party used for grazing and/or being part of nature reserves and also part of research projects at the University of Greifswald.



Peatlands in city area Greifswald

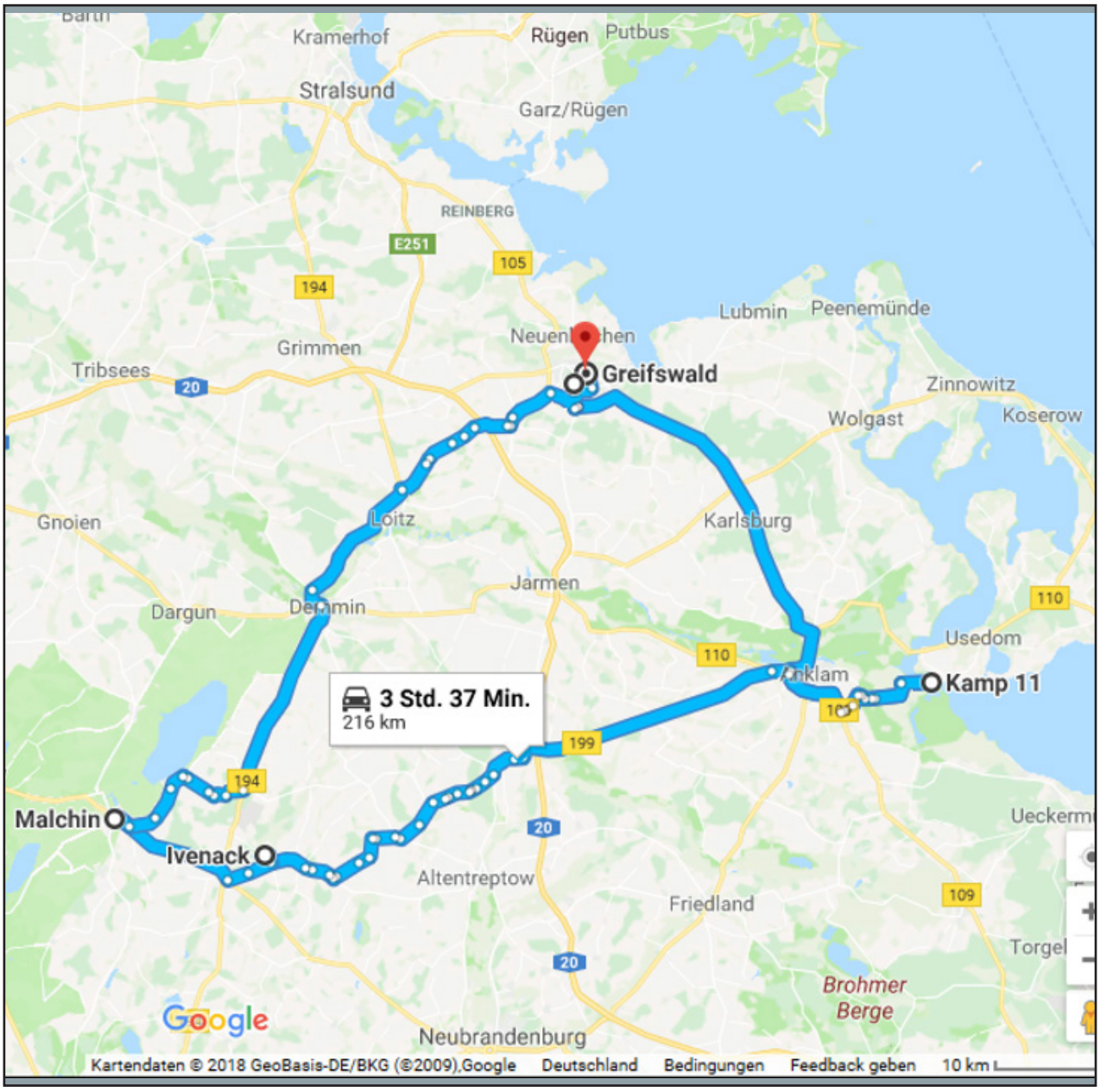
Further reading:

Mire Center Greifswald: https://www.greifswaldmoor.de/home.html
City Greifswald: https://www.greifswald.de/en/
University Greifswald: https://www.uni-greifswald.de/en/
Michael Succow Foundation: http://www.succow-stiftung.de/home.html
DUENE e.V.: http://www.duene-greifswald.de/en/index.php

Thursday, 27th September

I EXCURSION DAY 4

Route



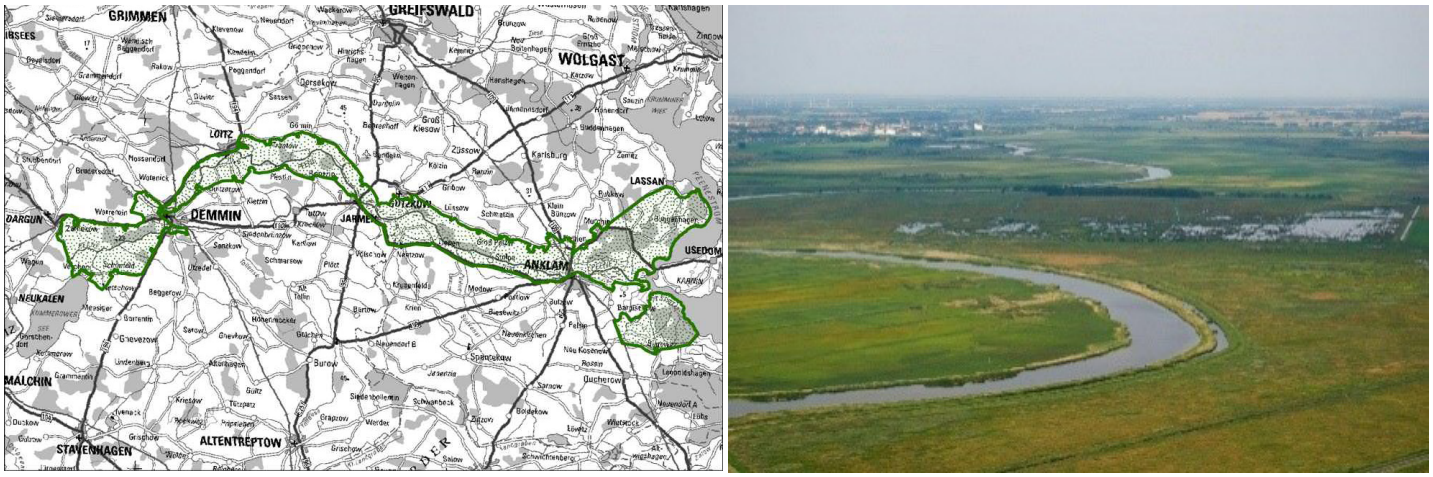
Schedule

Time	Location or event	Remarks
08:00	Greifswald	Departure from Hotel
09:00-11:30	Kamp, Bugewitz	*Typha* cultivation test site polder Kamp, *Typha* insulated House.
12:30	Ivenack	Lunch and visit of nature monument “Ivenacker Oaks”.
14:00-17:00	Neukalen & Malchin	Hay making in wet peatlands at Lake Kummerow and thermal utilisation of the hay bales in a Biomass Heating plant in Malchin.
19:00	VCH-Greifswald	Hay-making in wet peatlands at Lake Kummerow and thermal utilisation of the hay bales in a Biomass Heating plant in Malchin
20:00	Greifswald	Dinner with thematic paludiculture round table working group sessions

II INTRODUCTION

Landscape

The area is part of Peene river valley which is one of the largest fen areas in Germany, comprising 45,000 ha land. Due to its wild character it is known as the 'amazon of the north'. This landscape was formed by melting water during the Ice Age and shows landscape units of extended flat ground moraines of Mecklenburg Western Pomerania. It stretches over 85 km from Lake Kummerow (Kummerower See) in the west to the Oder Lagoon (Oderhaff) in the east. After the Elde River, the Peene River has the second largest catchment area and discharge of all rivers in this federal state. It has an extremely small hydraulic gradient of only 20 cm over 85 km. When water levels in the Baltic Sea are high or at strong Eastern winds blow, an unusual phenomenon can be observed: the Peene River flows upstream. The Peene river valley belongs to the system of the large river valleys of northeastern Germany that were formed during the last ice ages as glacial valleys. By autonomic peat growth extend percolating mires formed, with peat deposits of more than 9 m thick, fed by Calcium rich groundwater from the mineral ridges. Close to the Peene River a narrow area is covered by flood-plain fens, characterised by the special hydrological situation of the river.



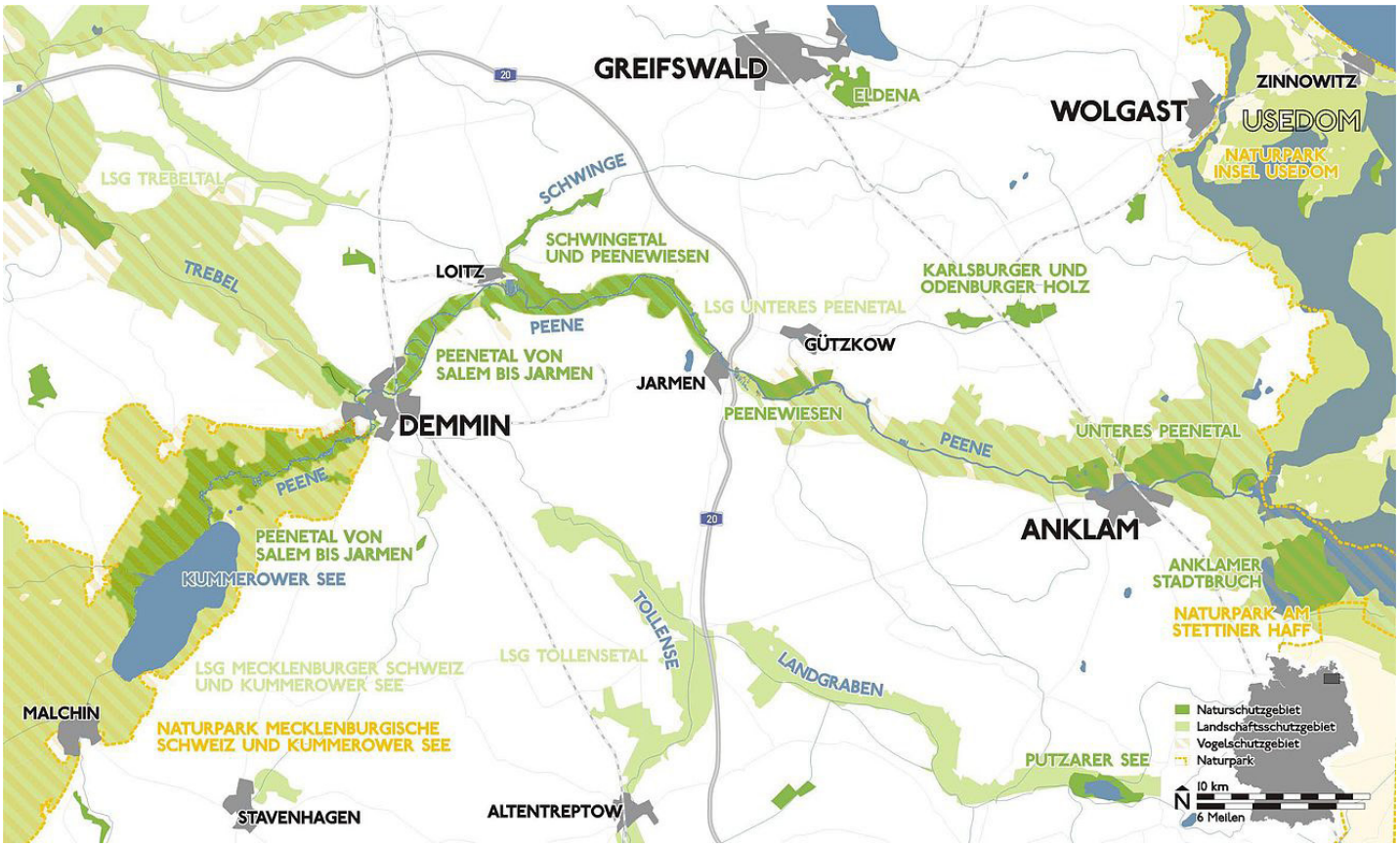
Location and Picture of the Peene River Valley

Land use history

Traditionally, the undrained or slightly drained peatlands at Peene river mouth were used for grazing, hay-making and locally also for peat cutting. Most parts of the mire have been under continuous use since medieval times. Its narrowness made it easily accessible and enabled an early use. During 1300-1800, the mire was part of the common land (German: Allmende) and land use was hardly differentiated, a general characteristic of agriculture at that time. The intensity of use varied with the difficulties of society and with population density. Meadows occupied 23 % of the mire. About one-half, located closer to the villages, was mown annually; the rest less frequently. The largest part of the mire was used as pasture, mainly for cattle – 22 % were grazed regularly and 55 % only sporadically. Both meadows and pastures were characterised by superficial drainage. The medieval tradition of common lands ceased and the now private land was parceled and more intensively used. Levelling and improved drainage allowed the exclusive use as meadows. Until the mid-19th century the spacius ans still wet common pastures were transformed into small patches of better drained meadows interrupted by peat pits - and the traditional paludiculture use ceased. In the 1920s, the state initiated and funded the formation of cooperatives responsible for largescale drainage if the mire. Until World War II large areas were poldered and used as high-intensity grassland after ploughing. After complex Melioration programs in times of DDR, agricultural use on half the peatland high intensity grassland monocultures after intensified drainage. After 1995 the polder system was abandoned and large parts of the peatlands were given back to nature. This initiated the transition towards a landscape dominated by wetlands and carrs.

Current land use

Today, while part of the peatlands is still used as high intensity grassland, the rewetted parts are either abandoned, used for conservation mowing or for reed cutting. Conservation mowing is implemented on c. 150 ha wet peatland at Peene river mouth by a local nature conservation NGO (Förderverein Naturschutz im Peenetal e.V.) in cooperation with local farmers and supported by the foundation OSTSEESTIFTUNG. Reed cutting for thatch is currently practiced on ca. 80 ha at Peene river mouth. In the region of Western Pomerania, in total 10 companies are active in reed cutting on a total area of ca. 550 ha. In 2017 the Federal state strategy for paludiculture was launched in order to find alternative ways to cultivate land under wet conditions.



Peene Valley with its reserves

Nature conservation

The Peene is the best-preserved river valley mire in Germany and a refuge for rare plant and animal species (see introduction above). Therefore, the Peene valley is a Special Protected Area (SPA, since 1990, 20,000 ha). The nature reserve 'Unteres Peenetal (Peenetal-moor)' is an important bird area (IBA, since 1988). Since 1992 the large-scale conservation and restoration project 'Peenetal/Peene-Haff-Moor' has been implemented to create a protection area of 45,000 ha covering the whole valley mire and including a core area of 20,000 ha of strict nature reserves. The nature park Peene valley was founded in 2011 and covers 33,400 ha. In 2017, an alliance of the Greifswald Mire Centre together with regional NGOs has proposed to designate the Peene valley as Ramsar site (decision at the level of the federal state of Mecklenburg-Vorpommern is still pending).From 1992 to 2008 large areas of fens in the Peene valley were rewetted, creating an outstanding nature conservation area.

Research

Several research-projects are taking action in the region. Since 2006, a local nature conservation NGO (Förderverein Naturschutz im Peenetal e.V.). studies the effects of summer conservation mowing at Peene river mouth. With the EU project REPEAT partners from Antwerp, Warsaw and Greifswald universities studied the effect of machine mowing on peat formation in fens in 2017/2018. Vegetation composition, soil and root properties as well as decomposition rates were compared at paired mown and unmown plots in Recknitz and Peene valleys.

Further reading

REPEAT project: www.repeat.paludiculture.com

III EXCURSION SITES

1. KAMP

The Polder Kamp

Within the EU project CINDERELLA partners from Aarhus, Halmstad, Nijmegen and Greifswald use a site near Kamp as a study site for transdisciplinary research on crop production with *Typha*. Research included soil, climate conditions and genetic characteristics, as well as nutrient removal and supply, biogeochemistry – of soil, water and carbon dynamics. Results show that the production of *Typha* on rewetted peatlands can, at optimal water table, combine high biomass productivity, high nutrient uptake and low emission of greenhouse gases.The project also includes sustainability as well as micro- and macro-economic assessments. In Kamp harvesting trials, biomass processing and use as building materials is monitored and integrated into a broader economic analysis and a life cycle assessment. Using a balloon-tyred “Seiga” machine, ca. 3 ha of Typha were harvested as bundles in winter 2016/17, yielding 7.5 t DM/ha.

Typha harvest in Kamp

Tourist house in Kamp

In 2014 the Dutchman Aldert van Weeren bought a 19 th century house in Kamp, which will also be visited during the excursion. His intention was to use it as guest house for nature tourists that are attracted by the beautiful landscape of Peene river mouth. Using local building material from rewetted peatlands was an obvious (but still rarely practiced) approach.

In cooperation with the University of Greifswald, a local farmer, local reed cutters and two factories in Prenzlau and Waren teamed up to produce 75 m³ blow-in insulation made from cattail and fire proof construction panels made from waste incurring during the production of thatching reed. These building materials were used for the renovation of the guest house. Cattail biomass is, due to its sponge-like tissue including a large amount of air-filled cells (aerenchyma), an outstanding natural insulation material.

The Wetland Products Foundation

Inspired by his findings, Aldert van Weeren founded the Wetland Products Foundation. The foundation's objective is to develop and promote building materials from wetland plants in Germany and The Netherlands.

Further Reading

Stiftung Wetland Products: www.wetlandproducts.com

2. IVENACK

The oaks of Ivenack are a monument that present an exceptional feature of cultural and natural history. They are evidence of the wide-spread way the land was used, which have survived in the deer park of Ivenack throughout centuries until present time.

Monument Oaks in Ivenack

At the end of the first millennium A.D. when these oaks had shot this area was already used by a Slavonic tribe named Wilzen. Forest pasturages (Hudewald) had been usual practice. Pigs, cattle, sheep, goats, and horses were driven into sparse forests to eat their fill there. The forests became sparse because of the grazing livestock bit off the young shoots thus allowing groth of only a few beeches and oaks with wide treetops the beechnuts und acorns of which gave additional food for it. Grazing livestock remained in the forest throughout a long time. Only its owners changed. Whereas Slavonic settlers were the first owners who had driven their livestock into the forest, so it were herdsmen of the monastery of the Cistercian Order in Ivenack who drove the livestock into the forest after 750 years. After the Reformation (in 1555) the oaks of Ivenack became proberty of the ducal authority in Ivenack. The deer park of Iveack was then founded in 1709 and existed until the world economic crisis in 1929. After the deer preserve had been cancelled, young trees could suddenly grow up and the character of a "Hudewald" got lost at last. In 1972 development of a new deer park with a preserve of smaller size was started up which was restocked with fallow deer. They were given space for growth by careful removal of growing young trees.

The largest oak (Quercus robur) has a diameter of 3.49 meters (chest height) and a height of 35.5 meters. That corresponds to a volume of wood of approximately 180 m³. It is impossible to determine the age of that oak in direct way. But following the results of measurement of the annual rings, an age of 1.000 years can be estimated. That oak is thus the largest and oldest living oak in Germany.

3. MALCHIN/NEUKALEN

Neukalener Seewiesen

The area of the Neukalener Seewiesen (ca. 400 ha) is characterized by peatland meadows and fens. It has been drained for agricultural use and is nowadays a re-wetted peatland with dominating sedge-meadows. Also some mosaics of Reed Canary Grass meadows occur, as well as Reed Mannagrass (Glyceria maxima) dominated patches. Small areas are covered by Common Sedge or Black Sedge. Red list species like Marsh stitchwort (Stellaria palustris), Ragged-Robin (Lychnis flos-coculi), Brown Sedges (e. g. *Carex disticha*) as well as Common Meadow-Rue (Thalictrum flavum) are remarkable.

The area of the wet meadow complexes notably increased after the pumping station was closed down. As, since that time, the groundwater tables are corresponding with the water tables of the Lake Kummerow, from time to time the peatland is fully inundated, depending on the wind and water table conditions of the lake. The change in water level affected the species composition of the sites, consequenting in a lowered fodder quality unsuitable for cattle feeding. The agricultural Enterprise of Hans Voigt was forced to switch to an alternative. Therefore, they pioneered in using sedge and reed biomass for powering a district heating unit. The hay that is meanwhile grown and harvested on the site, is used as a fuel in the biomass heating plant in Malchin (detailed information see below).

Picture of Neukalener Seewiesen

Thursday, 27th September

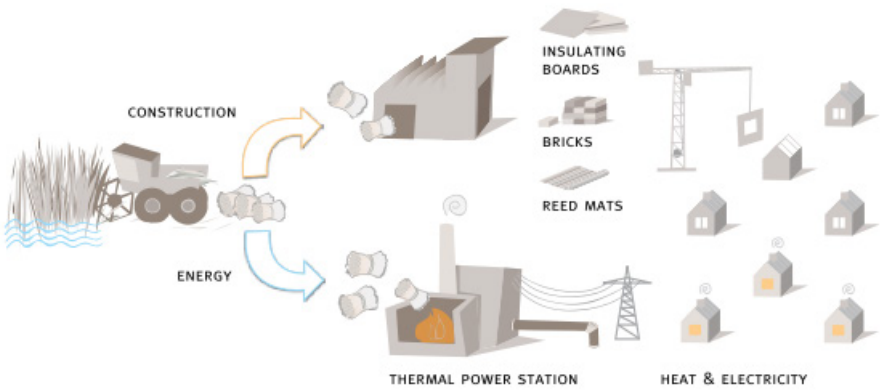
Biomass heating plant Agrotherm Ltd. Malchin

The decision to build up a heating plant to use the hay from wet meadows (Neukalener Seewiesen) as a fuel was motivated by several reasons. As the biomass quality was due to the re-wetting no longer good enough to feed cows, an alternative use for the biomass, now mainly sedges, reed and reed canary grass, was needed. Though, fertilization on rewetted fen peatlands is not allowed, after several years of planning, and working cooperation with on-going research projects at the University of Greifswald, the thermal utilisation of fen biomass was chosen as a promising alternative.

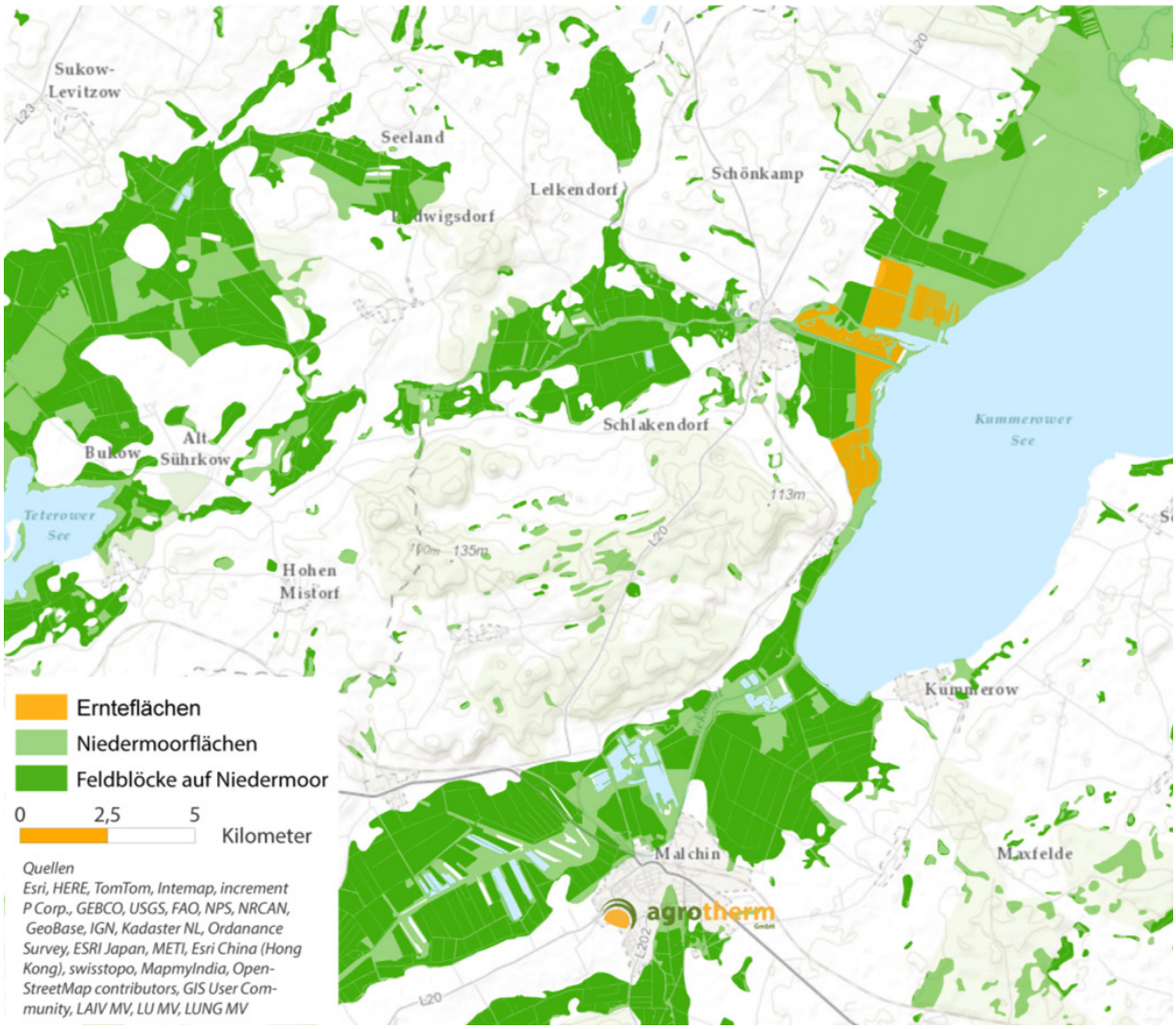
Withi this process an optimal scheme for harvesting hay as a fuel on 250 -350 ha could be elaborated, which provides the regular demand of a regional heating plant with biomass. The local energy provider could be convinced to cover the basic load for heat provision of about 500 households, a school and a kindergarten in the city of Malchin by using bioenergy. With side adapted machinery the 2-4 t of biomass per hectare can be cut, swathed and baled in summer during dry periods. Approximately 6,000 bales, each with a weight up to 250-300 kilograms, are harvested per year. In the exemptional summer 2018 sites which are normally not accessable could be reached for harvest and totally around 11000 Bales were processed. The heating plant has been constructed by Ludwig Bork to convert this fen biomass to heat. In addition to the reduction of the emissions from the formerly drained peatland, the 1,000 t of harvested fen biomass provide a total energy supply of 4 GWh and replaces 375.000 l of fossil heating oil. Adding value on rewetted peatland the thermal utilisation of the fen-biomass enables farmer Hans Voigt to continue the use of his land, keep his employees and preserve the nature heritage. The local production of sustainable biofuels increases regional collaboration and added value. However, to increase acceptance of peatland re-wetting and restoration for climate and regional development, it is vital to create local networks between land users, administration, district heating stations and energy user.

Main Features	
Location	Heat supply grid Malchin
Performance:	800 KW (thermal)
Biomass need:	800-1.000t/year
Biomass origin:	Rewetted fen peatland sites in the Peene river valley
Harvest area (yield):	400 ha (~ 4 - 5 t/ha)
Substitution effect:	290.000-380.000 l Oil

Processing biomass from wet peatlands



Kamp, Neukalen & Malchin, M. Western Pomerania

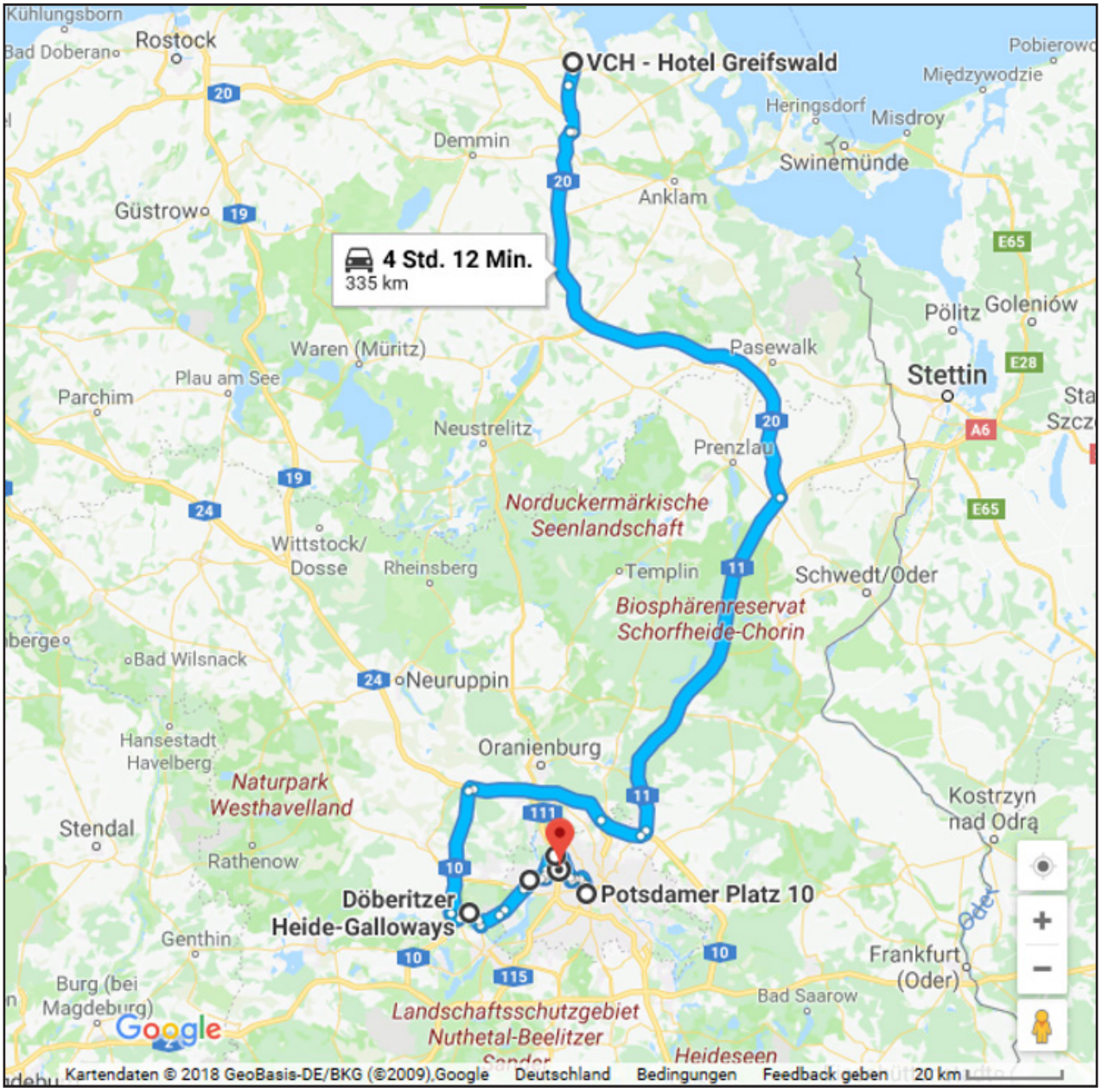


Location of Agrotherm and Meadows Neukalener Wiesen (orange) and peatland area (green)

Friday, 28th September

I EXCURSION DAY 5

Route



Schedule

08:00	Greifswald	Check out from Hotel.
11:30-15:00	Döberitzer Heide Potsdam / Berlin	Wet city site management with water buffaloes, production and marketing of waterbuffaloe meat for regional market; Lunch.
15:30-18:00	Berlin	Reception at the German Federal Ministry for Environment and Nuclear safety (BMU). Presentations of BMU staff “the EUKI programme” and of Project partners and Delegates on targets and first results of EUKI Paliduculture in the Baltics
19:35	Departure airBaltic from Berlin Tegel airport	Departure for all the same flight to Riga.
22:25	Arrival with airBaltic in Riga	Connection flights to Tallinn and Vilnius.
23:59	Arrival with airBaltic in Tallinn and Vilnius	

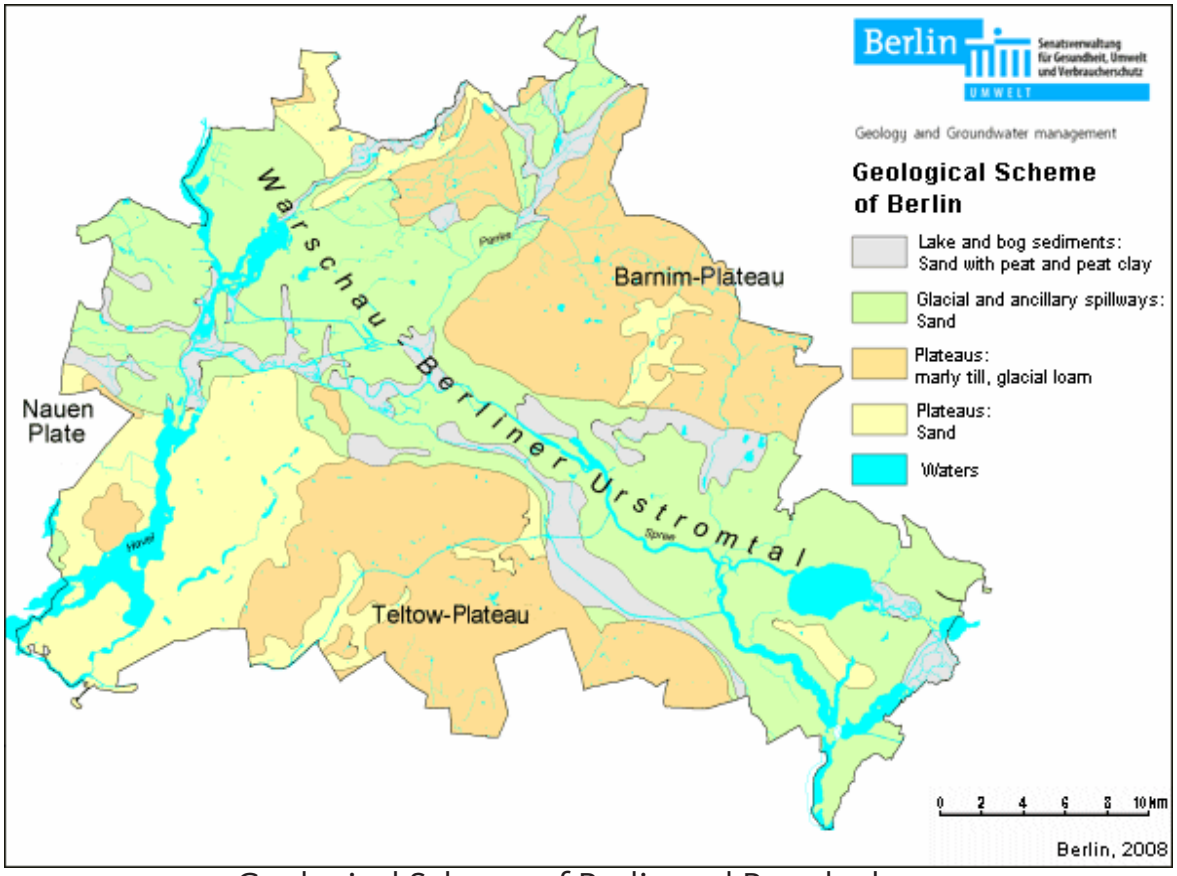
II INTRODUCTION

Landscape

Brandenburg is located in the northeast of Germany covering an area of 29,478 square kilometres, Brandenburg surrounds the national capital and city-state of Berlin, which together form the Berlin/Brandenburg Metropolitan Region, the third-largest metropolitan area in Germany. Brandenburg borders the states of Mecklenburg-Vorpommern, Lower Saxony, Saxony-Anhalt, and Saxony, and an international border with Poland. Its landscape is very divers, varying from fragrant pine and beech forests, extensive river valleys with large areas of grassland and wide fen areas.

The basic pattern of the surface formation of Berlin and Brandenburg is essentially determined by three major relief units which extend through the area from southeast to northwest. They owe their formation and emergence to the processes which occurred during the Quaternary Ice Age when a large-scale expansion of huge inland ice covered the northern part of central Europe. The Southern Ridge, including the Fläming region and the Lower Lusatian boundary wall. The broad, but very heterogeneous intermediate Plates and Lowlands Area, with a large number of greater and lesser, plateaus. The Northern or Baltic Ridge, which, in Brandenburg, includes the Uckermark district.

The „Döberitzer Heide" is a heath area of about 5000 hectare in Brandenburg, close to the city Podsdam, and not far from the city boundary of Berlin. Geologically seen, the region has been formed by glaciers and show a lot of landscape forms of moraines and ditches formed by melting waters from the young pleistocene. The main part of the region lies within the district Havelland. Geographically the Havelland refers to the land either side of the Havel river and the area surrounded by the large "U" bend in its course



Geological Scheme of Berlin and Brandenburg

between the city of Berlin and its confluence with the Elbe river, see pictures below.

Land use history

In the last 100 years the region of Döberitzer Heide has been depopulated and landuse and infrastructure partly abandoned.and is nowadays sparsely under agricultural and forestry use. Reason is the permanent utilisation as military training area, starting in 1713, which made the region for a long time inaccessible for the public. Until 1991 the area was used by the Red Army who characterized the land form intensely. Afterwards the German military took over 550ha of it. Until today some parts of the area are still used for military purposes and not open for public use. Other parts are more and more open for recreational acivities and nature conservation.

Nature conservation

In total eleven nature parks, three biosphere reserves and one national park preserve the valuable natural resources within Brandenburg, covering a third of the federal state territory. This includes two natural reserves, called „Döberitzer Heide" and „Ferbitzer Bruch" that cover an area of around 50 km2. Flora and fauna are well studied and besides its value in terms of nature conservation, it is since 1999, when some parts opened for the public, also an important recreation area for inhabitants of the metropole Berlin. To support and maintain the open landscapes of the heather Heck and Galloway cattle are used since 1992 by the association " För-

Picture of the heath in Döberitz

derverein Döberitzer Heide". Thanks to that the biodiversity of the area increased, currently being home for about 5.500 different species.

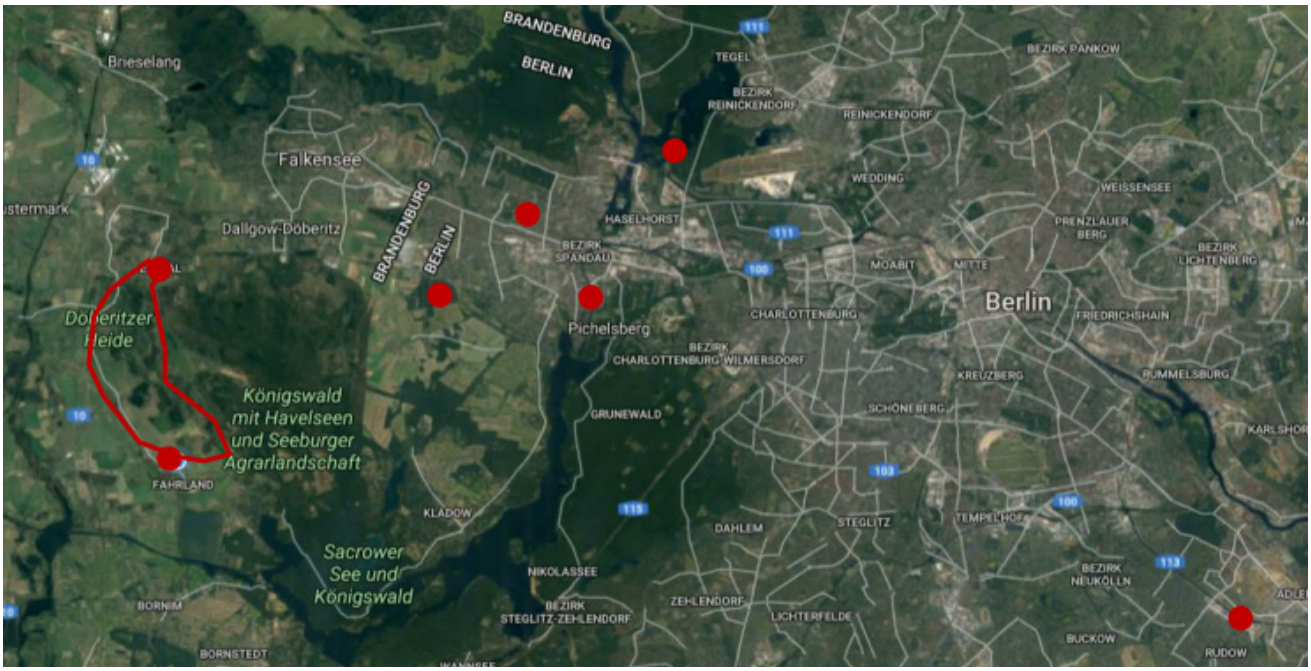
Box 10 Management of fen meadows with cattle

Since the "Wende" in 1989 the cattle population of northeastern Germany has decreased considerably. Consequently, the demand for grassland declined and large areas were abandoned. Revenues from fen grasslands failed to balance the costs, thus their utilisation relies on subsidies. Consequentlymany fen grasslands were abandoned and left to natural succession what made them attractive for re-wetting projects. Several research projects at Greifswald University addressed the sustainable use of rewetted fen peatlands, including cattle grazing. Results showed that extensive grazing with cattle is more effective than static proceeding of mowing. With their feeding behaviour cattle create a divers pasture landscape which creates refuges for other animals and therefore contribute to the biodiversity. In return, to finance this intensive and longterm nature conservation acti-

re marketed.

The animal farm “Döberitzer Heide Galloways”

In the heath area of Döberitz, the animal farm “Döberitzer Heide Galloways”is grazing with Galloway cattle and for wet sites also with Water buffaloe. The owner, Helmut Querhammer, started to graze with Galloway cattle in 1992. His motivation was the production of good quality products for regional markets in combination with gentle nature and landscape conservation. In the beginning he started with an area of 50 hectares on former military training areas and three Galloways. Meanwhile around 150 Galloways and 29 goats graze on an area of 150 hectares. Besides, he has a livestock of water buffaloes standing on the wet meadows of the area which are not suitable for cattle. Within the farm milk, meat and leather in high quality are produced and sold to regional markets and private households.It turned out that farming with water buffaloes is relatively convenient. The animals are very resilient and robust, being able to stand the harsh conditions in German winters, as well as the wet conditions of fen meadows due to their broad claws and preference of watery conditions. Also regarding fodder the buffaloes are very undemanding, even feeding on reed and other plants that are refused by other cattle. Required is an open stable, especially in winter times, with a mat of straw, eventually fencing,



Location of animal farm Döberitzer Heide Galloways

Water buffaloes in Brandenburg

and the availability of open water surfaces for drinking and bathing.

BOX 11 The water buffaloes

The water buffaloe was domesticated 6000 years ago and returned to Central Europe after extinction about 200 years ago. In Germany until 1998, buffaloes were exclusively hold in zoos whereas other European countries (Romania, Bulgaria, Hungary, Italy) used them already for milk production and working animal. The buffaloes reach a maximum age of 40 years, gain weights between 600 – 1000kg. Water buffaloes are very social animals, living in family groups and seem to like the contact with human.

Further Reading

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Links:

- Legal study paludiculture in Europe: https://www.dropbox.com/s/ei2qipc5pczgvdk/Report_Laura_Koelsch_Iur_Cinderella_09062016.pdf?dl=0
- Technical report Cinderella Nijmegen: https://www.dropbox.com/s/774xec067awznt4/Final-Report-Cinderella-Nijmegen.pdf?dl=0
- FACCE-JPI: https://www.faccejpi.com/content/location/96954
- Cinderella: www.paludiculture.uni-greifswald.de/en/projekte/cinderella /index.php
- EUKI Homepage: https://www.euki.de/
- Paludiculture in the Baltics: http://www.succow-stiftung.de/euki-paludiculture-in-the-baltics.html
- Sphagnum Farming: www.sphagnumfarming.com
- Mires and peat: www.mires-and-peat.net (Volume 20 - Special Volume: Growing *Sphagnum* 2017)

The project “Paludiculture in the Baltic states” is financed by the European Climate Initiative (EUKI). EUKI is a project financing instrument by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). It is the overarching goal of the EUKI to foster climate cooperation within the European Union in order to mitigate greenhouse gas emissions. It does so through strengthening cross-border dialogue and cooperation as well as exchange of knowledge and experience.).

On behalf of:

Federal Ministry
for the Environment, Nature Conservation
and Nuclear Safety

of the Federal Republic of Germany

European
Climate Initiative
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