CINDERELLA - Update X

December 2016, W. Wichtmann

"Comparative analysis, integration and exemplary implementation of climate smart land use practices on organic soils: progressing paludicultures after centuries of peatland destruction and neglect"

By irregular updates the CINDERELLA community and colleagues are informed about dates, news and other interesting issues within the scope of the CINDERELLA project, ref. paludiculture. All partners are kindly asked to provide current information which can be inserted here. The idea is to keep all project partners informed on the same level, to exchange information, to ask project related current questions, to arrange meetings and to make appointments as well as to prepare common activities (publications, new projects, etc.).

Reports on conferences and workshops

Short report on the Workshop on "Improving water quality in the Neman catchment area through rewetting, wise wetland and river basin management" 12th to 14th of December
(Wendelin Wichtmann)

This workshop, organized by the Michael Succow foundation and the Clean Baltic Network aimed at networking and first preparation of activities for the improvement of the Neman river water quality by implementing peatland rewetting and paludiculture as well as constructed wetlands within the whole Neman river catchment area. The Neman catchment comprises mainly areas in Belarus, Lithuania and Kaliningrad Voblast. Some small areas in northeastern Poland also contribute. About 60 participants from the four countries, but also from Sweden, Denmark, Germany and Netherlands attended. They came from NGO´s, municipalities, responsible governements and from science. The situation of the Neman river basin was analysed and first project ideas have been developed. Also the options to integrate peatland rewetting and water management in the river basin in new concepts for transboundary protected areas (Biosphere Reserves) were discussed. The workshop was followed by an excursion into the southern delta of the Neman river, about 120 km northeast from Kaliningrad, with it´s large floodplains and degraded peatland areas. We visited the "Haus im Moosbruch" run by the NGO antropos, a decrepituded pumping station and had a walk into the nature near bog "Großes Moosbruch".

Fig.: Large drained fen peatlands in the delta area of the Neman river lay abandoned (W. Wichtmann)

Fig.: Some small part of the "Großes Moosbruch" in Kaliningrad Voblast (W. Wichtmann)

Report on the IUCN UK peatland programme conference in Shrewsbury, 29.11.-1.12.2016
(Anke Nordt)

The conference took place in Shropshire, with one day of field trips to regional sites of restoration and conservation interests. More than 150 scientists, peatland and restoration managers and representatives of different authorities discussed and exchanged experiences around five workshop themes: Peatland benefits, monitoring, sustainable management, restoration, communication. Big issues where recurring thoughout the key notes, workshops and discussions: funding, monitoring and communication, underlaid by the overall question what will happen to land use and restoration of UK peatlands after the Brexit.

Key note speakers mentioned paludiculture as one promising option to improve peatlands in the UK as well as abroad. Some approaches towards paludiculture in research and implementation have started or will start in 2017, i.e. a PhD Student at the University of East London doing Laboratory experiments with different plant species and restoration managers in Cumbria and Cambridgeshire thinking about how to get paludiculture started in recently restored areas or areas with restoration measures taking place at the moment.

One recurring issue throughout the conference was on how to get funding for peatland work. Different Workshops looked deeper into market based mechanisms („peatland code“). One interesting example was given from Wales, where ecosystem services delivered from a specific farmland where prize tagged after restoration and payed to the landowner for 10 years. The costs where not related or combined with the restoration costs, which was undertaken before, nor with any compensation for the land owner due to reduced land use.

Figure: Fenn's, Whixall and Bettyfield Mosses at the English-Welsh border, one of the most southerly lowland raised bogs in the UK. For this densely used area, the size of this nature reserve is quite big. An EU-Life project just started in Oct. 2016, i.e. to buy land and raise water tables.

Upcoming: 2nd reed conference (rrr2017) in Greifswald: Reminder

The preparation of the rrr2017 conference in Greifswald to be held in September 2017 (http://www.paludiculture.uni-greifswald.de/en/projekte/rrr2017/index.php) is in progress. The second announcement to this international conference on reed as a renewable resource now is on the way. Please consider your participation and register soon. More information will be provided continously. Before the international conference, a national workshop will take place which highlights the restoration and paludiculture activities in the `peatland rich` federal states of Germany (25th of September, in German). Subsequently there will be field excursions (26th). The international conference (27th and 28th) will be completed by a sphagnum workshop (28th afternoon) including a field excursion to Lower Saxony the next day (29th of September).

Potential district heating plants for biomass from paludiculture in Mecklenburg-Vorpommern (Anke Nordt)

During 2016 Ludwig Bork (operator of the paludi-biomass heating plant in Malchin/MV) and me undertook efforts to set up a second district heating plant in Mecklenburg-Western Pomerania in the valley of the river Recknitz. Biomass from about 300 ha rewetted wet meadows is available and could be used for combustion. So we tried to find a suitable municiplaity with enough heating demand to build a heating plant similar to the size of Malchin (800 kW). With the experience of two years combustion of paludi-biomass Ludwig can give lots of figures and details to farmers, authorities and potential investors. The nearby town of Tribsees would be suitable regarding size and numbers of potential heat customers. Also an energy supply company from Berlin is interested in building and operating such a heating plant. There is no district heating grid until now in place: This would have to be built as well, raising investment costs quite significantly. There are different funding schemes in place for district heating with renewable energy and we are currently in discussion with the municipality as well as other private stakeholders in order to set up the heating grid. To provide long term renewable energy from rewetted peatlands could be one argument in rural areas to prevent residents from moving away or new people and companies to settle there.

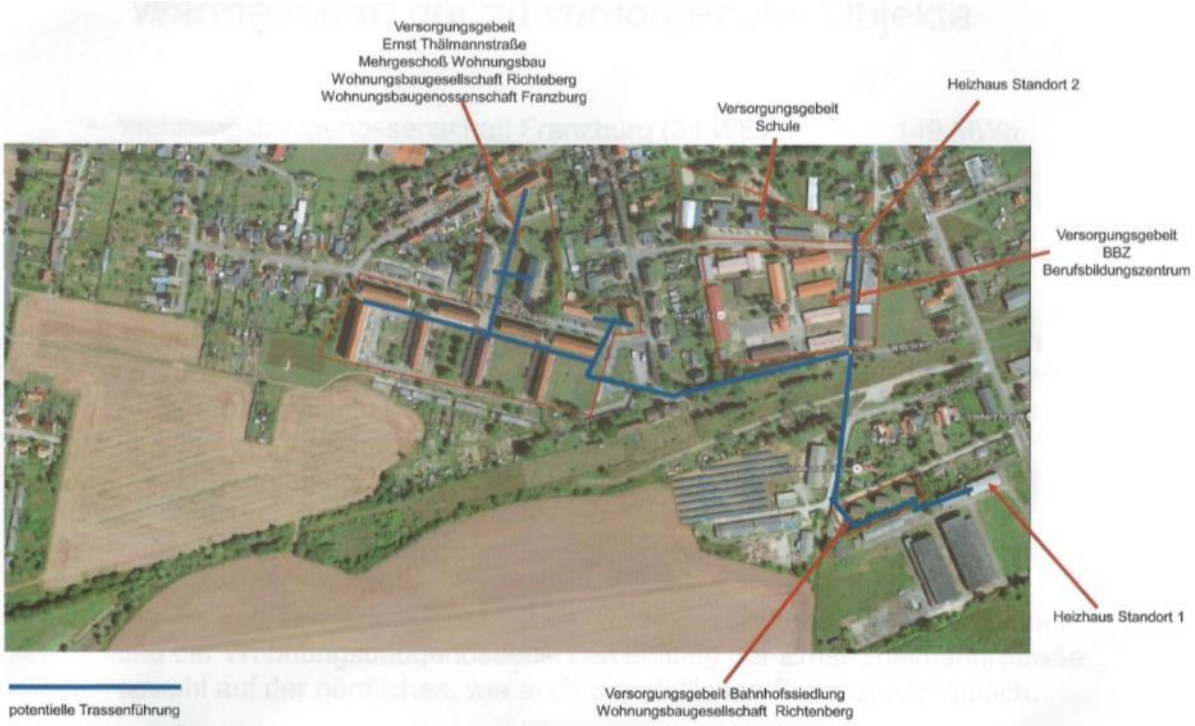

Figure: potential district heating grid and heat costumers in rural town of Tribsees

Field day, Typha breeding and other Greifswald activities (Claudia Oehmke)

A field day was organized by the CINDERELLA Team on 2nd of November 2016 including an excursion to the Biomass heating plant in Malchin, the wet grasslands in Neukalen and Core Sites of Cinderella in Aalbude, a rewetted peatland area. At the heating plant Ludwig Bork gave a brief introduction to the operation and efficiency of the heating plant. The excursion was given to Jasmin Karer from the University of Vienna and students of Greifswald University to strengthen the cooperation between the universities. Jasmin is doing her pre PhD studies on the potential for paludiculture in Austria at BOKU, Vienna.

Our Master student Nora Köhn harvested the Typha nutrient experiment in these days. Unfortunately the experiment went not as we expected. We had some problems after fixing the pH-value of the substrate (sphagnum peat), and the plants did not grow very well. However we could see some differences of plant growth in the different nutrient treatments. Nora will do lab analysis of soil and plant biomass (above and below) in Greifswald until January, and will continue with it in Nijmegen (with Jeroen Geurts and Christian Fritz) in February 2017.

We will collect single plants and biomass from 1 m² plots in the different harvesting treatments at the Core Sites in January/February. Lab works for all biomass of CINDERELLA collected in the core sites are still going on.

In January Franziska Eller (Aarhus University) will send biomass samples of the nutrient experiment of *Arundo donax, Typha latifolia, Typha angustifolia* and three different *Phragmites australis* clones, that will be analysed for combustibility and will therewith give additional information on the use options for all plant species. Samples will be analysed in cooperation in the CINDERELLA project of the partners Aarhus University, University of Nijmegen and Greifswald University.

Activities in Halmstad (Stefan Weisner)

Since the last update we have focused on measuring biogas production from plant biomass (shoots of *Phragmites, Typha, Glyceria* harvested in early summer and autumn) from our experimental wetlands outside Halmstad. Further we are measuring nitrogen and phosphorus removal in our experimental wetlands including the new wetlands with transplanted peat soil. After Christmas and New Year celebrations, we will start measuring biogas production from the plant biomass from Denmark (4 genotypes of *Phragmites australis*, and 1 genotype each of *Typha latifolia*, *Typha angustifolia, Arundo donax*, grown at 3 nutrient levels).

Testing UAV application for paludiculture and peatland science (Tobias Dahms)

The Peene River Valley, one of Germany's largest fen areas, is the cradle of aviation (Otto Lilienthal, born in Anklam 1848). Thus the most important ideas of aviation might be born in a peatland. That peatlands and aviation are a winning combination, applies to unmanned aerial vehicles (UAVs) too. UAV based mapping has a promising potential in contributing interesting new perspectives for peatland research.

With UAVs it is possible to provide ultra-high resolution ortho-photos (visible spectrum and near infrared) and ultra-high resolution digital elevation models (DEMs). The usefulness of aerial images with UAVs has been demonstrated before (Knoth 2013) and also methods used to process aerial images to derive DEMs have been successfully applied to ground captured images (Mercer 2016).

There are many interesting fields of application for aerial images collected by UAVs. It starts with the pure fact that having a current high resolution picture of the area where data has been collected adds a new perspective when transferring single points into an area by simple image interpretation. Remote sensing methods such as object based classification applied to such images can lead to a robust method of image interpretation.

Possible applications in peatland research are: vegetation structure, vegetation cover, vegetation classification, analysing fine scale patterns, etc. For paludiculture, UAVs provide also numerous possibilities: monitoring of vegetation health (e.g. Sphagnum farming), monitoring vegetation productivity (e.g. Sphagnum farming), high resolution digital elevation models for water management, vegetation classification for fuel management or quality biomass production, biomass productivity, measure area (harvesting, vegetation…), pre harvest reconnaissance for harmful objects and obstacles, etc.

Modern microelectronics and open source software allow the creation of UAVs being able to perform a fully autonomous mapping mission from take-off to landing for less than 400 €. Thus UAV image acquisition is possible with very low effort.

The NGO DUENE e.V., being partner in the Greifswald Mire Centre, has started in 2016 to explore the possibilities of UAV based mapping and provides its services to the University of Greifswald. Current development of the mapping UAVs are shown in the table below and some examples of images taken with the 2nd UAV are depicted in the following.

Table: development of UAV activities at DUENE - GMC Greifswald

1st first trial UAV	2nd development UAV	3rd final UAV
- cheap consumer UAV - quadcopter - 12 min flight time - point and shoot camera	- custom build UAV - quadcopter - 30 min flight time - camera stabilisation - point and shoot camera	- custom build UAV - hexacopter - >30 min flight time - camera stabilisation - APS-C camera - ir sensitive - RTK GPS (sub decimetre) - precise geo tagging

Knoth, C., Klein, B. , Prinz, T. & Kleinebecker, T. (2013) Unmanned aerial vehicles as innovative remote sensing platforms for high-resolution infrared imagery to support restoration monitoring in cut-over bogs. Applied Vegetation Science.
Mercer, J. J. & Westbrook, C. J. (2016) Ultrahigh resolution mapping of peatland microform using ground-based structure from motion with multi-view stereo. American Geophysical Union.

Fig.: First flight of our custom build mapping hexacopter (left), Cinderella site in Kamp, Mecklenburg-Vorpommern – after Typha harvesting (right)

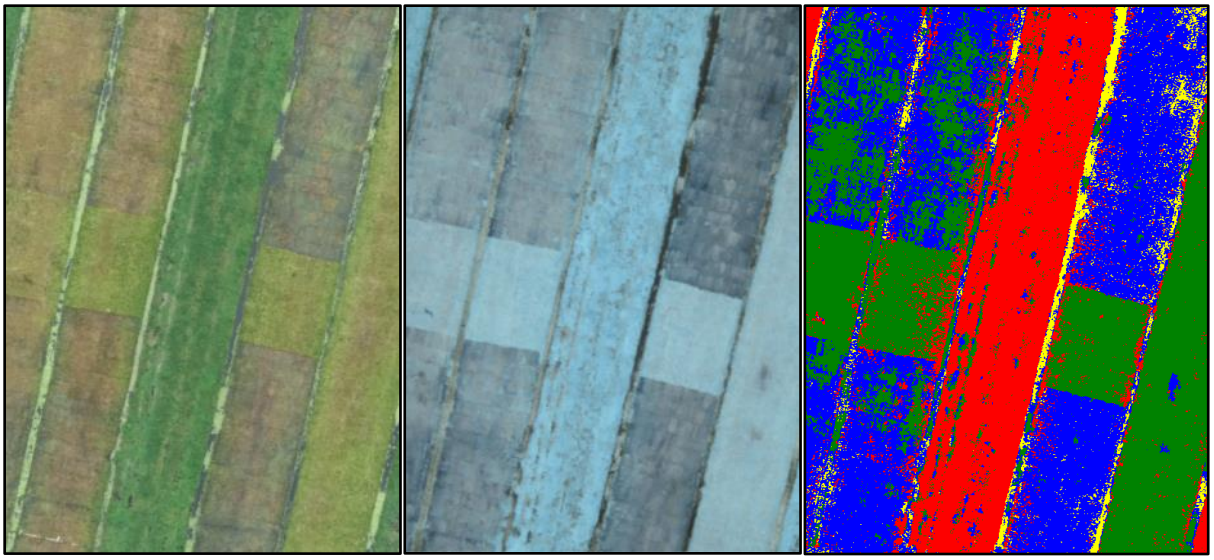

Fig.: Sphagnum farming site in Hankhausen, harvested and not harvested parts. RGB- and IR-image acquired with a point and shoot (IR with replaced hot mirror filter, blue channel = ir) and rough classification with ENVI (right).

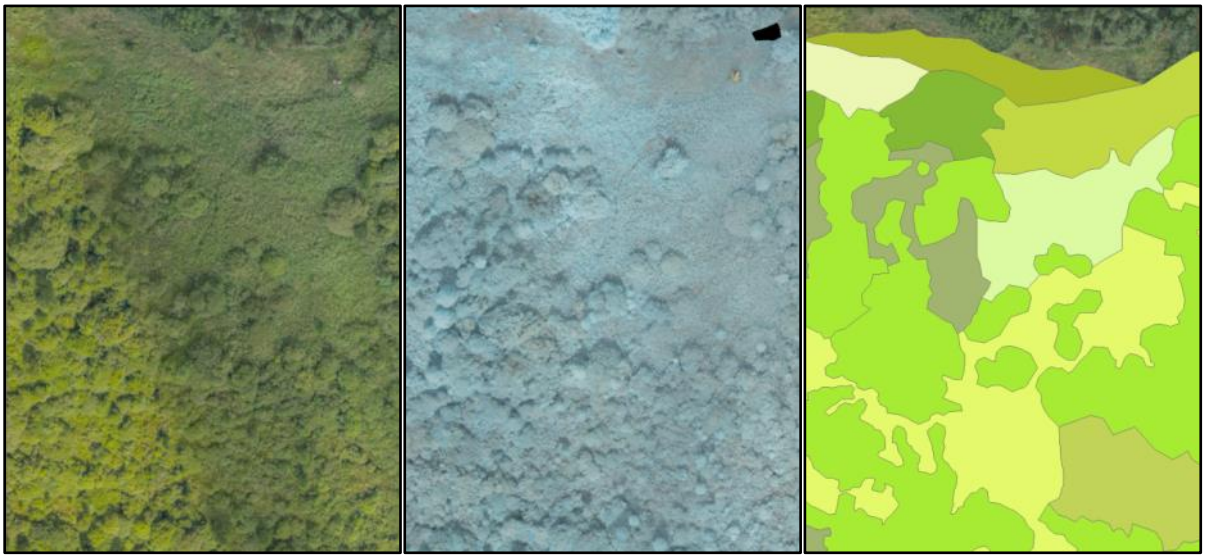

Fig.: Part of an overgrown peatland next to Warin, Mecklenburg-Vorpommern. RBG- and IR picture and vegetation classification based on image interpretation and ground based mapping (Barnik 2016).

Data collection on harvesting (Tobias Dahms)

Large-scale harvesting in paludiculture strongly differs from regular harvesting on dry soils and requires specific knowledge and techniques. Hanze Wetlands is one of the major companies involved in steadily improving the technology of wetland crop harvesting and has long-standing expertise. In October data collection during biomass harvest was repeated in the peatland area next to Assen, Netherlands. The analysis of the collected data is not yet finished. Results will be presented in a later update. In January a harvesting trial will be conducted on the *Typha* site next to Kamp, Mecklenburg-Vorpommern. The following figures give some impression of the harvest and a rough assessment of the impact on the soil/turf by using the frequency of crossing as a proxy (see also Schröder et al. 2015).

Schröder et al. (2015): Towards large-scale paludiculture: addressing the challenges of biomass harvesting in wet and rewetted peatlands. Mires and Peat 16: Art. 13.

Fig.: Peatland area next to Assen, Netherlands (left), Hanze Wetlands new tracked vehicle mowing (right)

Fig.: Hanze Wetlands new tracked vehicle chopping biomass

Fig.: Hanze Wetlands older tracked vehicle collecting biomass

Fig.: Overloading biomass for road transport (left), harvested biomass (left)

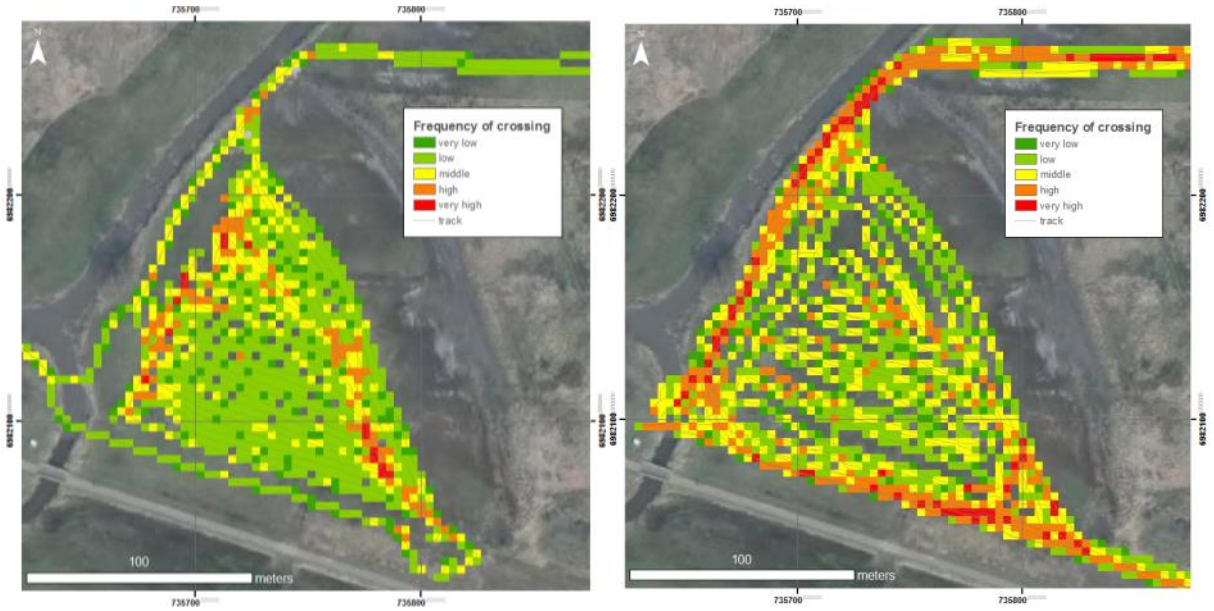

Fig.: frequency of crossing during mowing (left) and chopping (right)

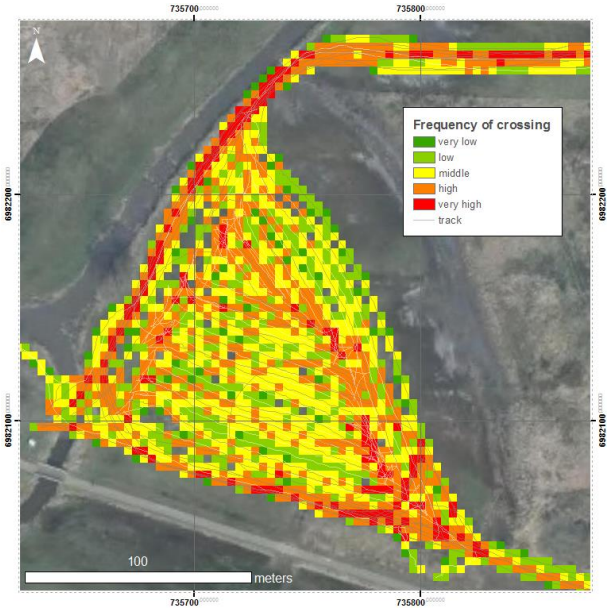

Fig.: frequency of crossing mowing and chopping combined

Nitrogen retention in wetlands (Felix Reichelt)

Last days I had a presentation in our working group at Greifswald University to show preliminary results from my literature study. Main question of the study: Are peatlands as effective as constructed wetlands in nutrients retention? And what are the driving factors in total nitrogen retention (TNret, syn.: TN removal) and total nitrogen removal efficiency (TNeff)? Here I give a short summary of my findings.

There is a very good systematic review by LAND et al. (2016) which shows main influencing factors for TNret and TNeff. The first is positively related to hydraulic loading rate (HLR), inlet concentration (TNin), TN loading rate (TNload) and mean annual air temperature (MAAT, Fig. 1). The latter (TNeff) shows also positive relation to MAAT, but negatively to HLR (Fig. 2), because higher HLR leads to a smaller probability to transform or remove a certain amount of nitrogen.

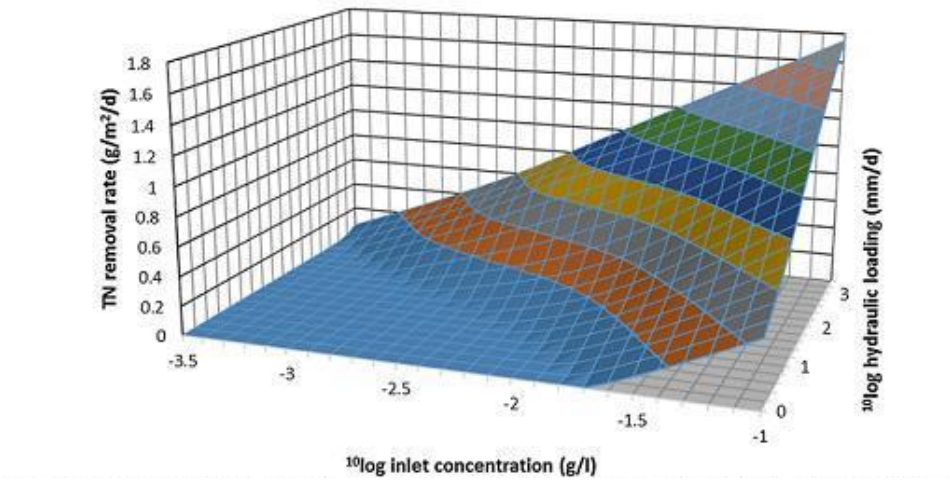

Fig. 1: Median removal rate of TN [g m^{-2} day^{-1}] as a function of inlet concentration [g l^{-1}] and hydraulic loading rate [mm d^{-1}]. The surface has been truncated at 0 g m^{-2} day^{-1} (LAND et al. 2016, Fig. 12)

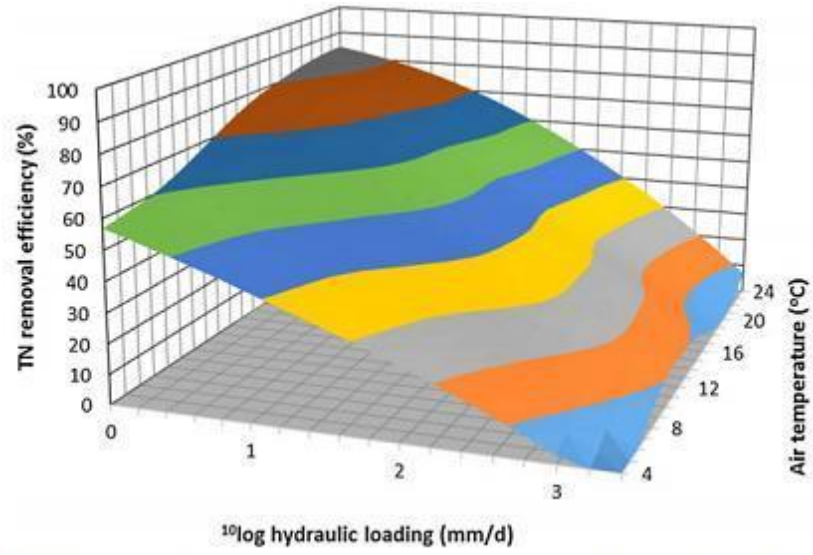

Fig. 2: Median removal efficiency of TN [% of load] as a function of hydraulic loading rate [mm day^{-1}] and air temperature [°C] (LAND et al. 2016, Fig. 11)

TNret data of LAND et al. 2016 was extracted and used as basis for further data collection. New data was only accepted, if following criteria were complied: TN balance given or calculable, full annual TN-balance observed (study period), measurement frequency at least once per month and study area at least 1 m².

At the moment my data base contains 211 datasets of 91 publications, with only 29 datasets from organic soils (Tab.1). Obviously TNret data for organic soils are under-represented. Therefore I still concentrate on searching TNret data from organic soils. Number of observations (n) in the following figures/tables can differ, because not every variable is reported in each publication.

Tab. 1: Overview of data basis concerning TN retention (as from: 23.11.2016)

Reference	Publication [n]	Datasets [n]	rate of org. soil [n]

Land et al. 2016	66	121	8 (6.6 %)
Additional data	25	90	21 (23.3 %)
∑	**91**	**211**	**29 (13.7 %)**

The whole TNret data (organic & mineral soils) show a quite broad distribution from under 5 % up to nearly 100 % TN removal efficiency (Fig. 3). But 24 % of the data (n = 54) is lacking in information on substrate type and must be discarded.

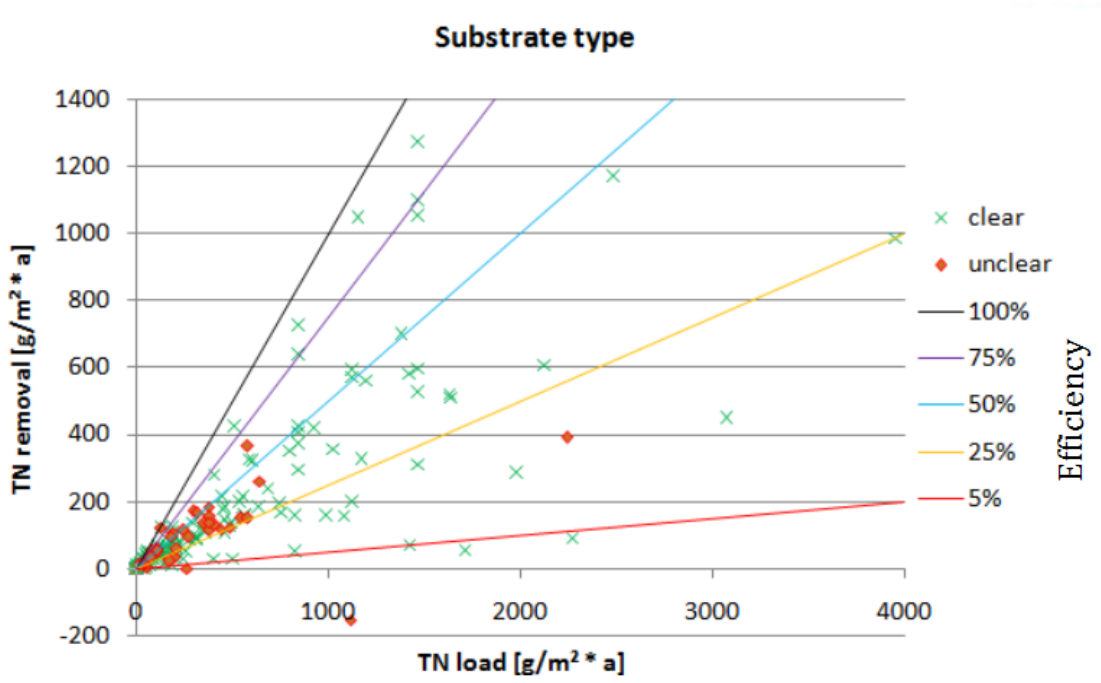

Fig. 3: TN removal efficiency [%] of the whole dataset with the information if substrate type is reported (clear, n = 134) or not (unclear, n = 39).

Comparing TNret of mineral and organic soils (Fig. 4) shows a much wider range of TNloads of mineral soils (one order of magnitude). This explains also the wider range of TN removal rate of mineral soils (cf. TNload is main influencing factor of TNret, LAND et al. 2016). Preliminary (simple) regressions (Fig. 5 & Fig. 6) indicate slight differences between mineral and organic soils, with R^2= 0.49 and R^2= 0.92 (linear reg.) and R^2= 0.55 and R^2= 0.93 (polynomial reg.), respectively. Mineral soils show slightly (Fig. 5) up to moderate (Fig. 6) higher TN removal rates with higher TNloads than organic soils. But the behavior of organic soils at high TNloads (> 460 g m² a^{-1}) is not clear due to lack of data.

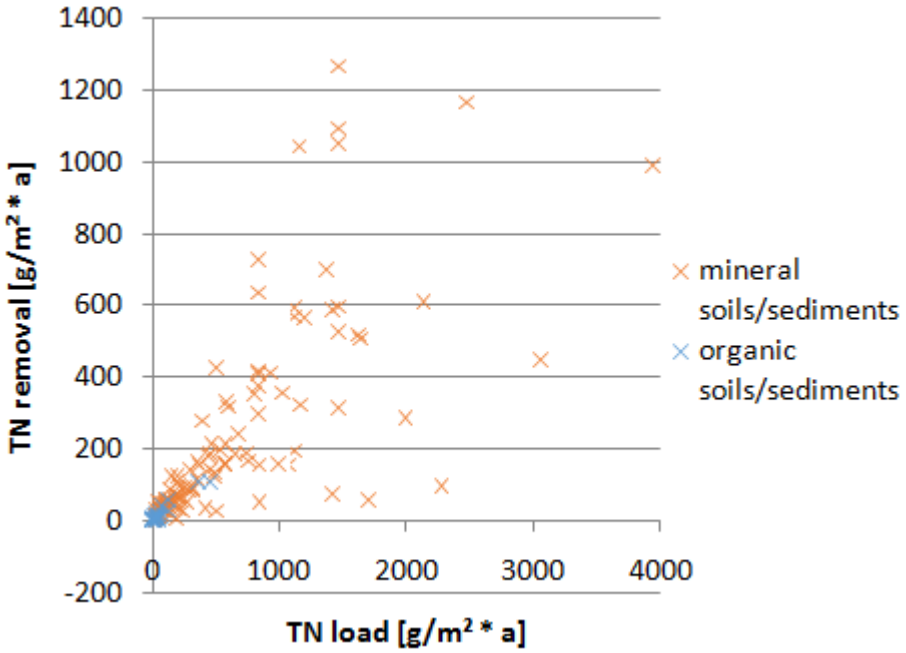

Fig. 4: Comparison of TN removal efficiency (TNeff) of wetlands on mineral (n = 111) and organic soils (n = 23).

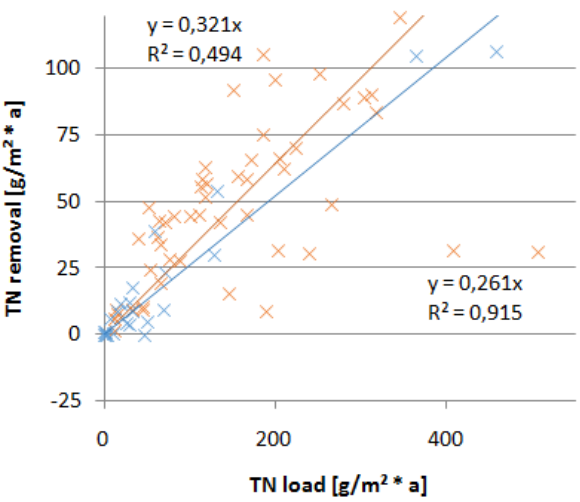

Fig. 5: Linear regression of the relation between TNret and TNload by mineral (orange) and organic soils (blue). Slope indicates TN removal efficiency (mineral: 32.1 %, organic: 26.1 %)

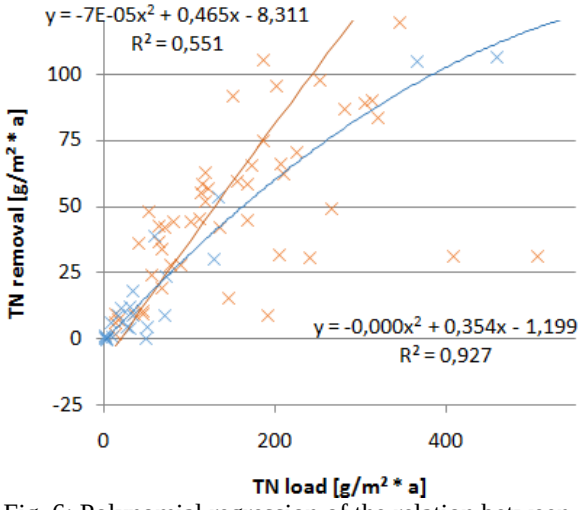

Fig. 6: Polynomial regression of the relation between TNret and TNload by mineral (orange) and organic soils (blue).

A clear relationship between vegetation and TNret or TNeff could not be found (not shown). Because most of the datasets originate from wetlands dominated by reeds (*Phragmites australis*, *Phalaris arundinacea*,…n = 138) other classes (algae (3), floating (1), submerged (3), mixed (25), trees (5)) are under-represented. Furthermore, sites of natural peatlands were difficult to be classified, because they are usually a mosaic of all these classes. Hence, they were often integrated in the mixed class.

Other influencing factors (geographical latitude, air temperature, quality of inflowing water, wetland type, …) will be considered and tested if necessary.

Activities in Nijmegen (Jeroen Geurts and Christian Fritz)

On the 24th of November we gave a workshop presentation on a Community of Practice meeting organized by the Platform “Slappe Bodem” (“soft soil”) and the Foundation for Applied Water Research STOWA. The main aim was to increase the co-operation between different stakeholders to counteract soil subsidence.

Figure: presentation on paludiculture by Christian Fritz during the workshop

In our workshop (see figure), we explained how paludiculture positively influences several ecosystem services (including peat preservation, CO_2 reduction, and water retention) and how this will lead to a more sustainable water management. We showed some examples of paludiculture pilot projects in the Netherlands where a combination is made between increasing ecosystem services, productivity, and economic perspectives. These pilot projects were or will be started in co-operation with provinces, water authorities, land users, and nature management organizations.

We received many positive reactions after our workshop and the Community of Practice meeting got a lot of media attention. Another workshop given by a landscape architect already incorporated paludiculture areas in his new landscape plan.

Wetlands International submitted 2 small proposals to get a feasibility study done in 2 provinces for starting up Paludiculture pilots and promoting the use of Paludiculture Biomass by companies. Radboud University is one of 3 core partners.

Currently we are analysing data from methane emissions from *Typha* and *Phragmites* under different N-treatments in mesocosms as well as data for fodder value of *Typha* and *Typha* sillage. A first feeding trial has been successful. Dry cows eat *Typha*. For horses it could be even more interesting. In a large floodplain the horses were grazing newly developed *Typha* in 2016 succesfully. In an associated project there will be time for a more detailed analysis of fodder intake next year.

Further news on peatlands protection and sustainable use

IMCG bulletin November 2016

The latest bulletin published by IMCG again provides several information on project related relevant issues and gives an overview on recently published papers on peatland protection: http://www.imcg.net/media/2016/imcg_bulletin_1611.pdf

Mires and Peat

Take a look at the latest volume (Vol. 19) of Mires and Peat: http://mires-and-peat.net/pages/volumes.php and use this online magazine to publish your newest results!