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EFFECTS OF LAND USE CHANGE ON FEN SOILS NUTRIENT DYNAMICS IN THE NATURE PARK OHRE-DRÖMLING

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SUMMARY

In the Nature Park Drömling a trade-off exists between the ban of deterioration of the FFH habitat type 6510 and rewetting to preserve typical fen soils. The study aimed of the development of optimized management strategies for this habitant type. It has to be ensured that the main receiving water course, the Ohre River (a tributary of the Elbe River) will not be burdened with additional nutrients, because a considerable part of the total runoff is used for groundwater recharge to ensure drinking water supply of Greater Magdeburg. An *in situ* experiment was established at two test fields' which comprises two differentiated fertilization and management levels. Soil, soil solution and plant biomass were analyzed for their contents of macronutrients. The results showed that the soil of the sites was good supplied with the nitrogen and phosphorus but potassium (K) is the limited yield factor. Another conclusion was that the different grassland management had no influence of soil, near surface groundwater and plant biomass nutritions. However the application of potash 60 showed impacts of the soil water regimes and also of the quality parameter of soil, plant biomass and the draining ditch.

KEYWORDS: fens, extensive grassland managements, nature park Drömling, rewetting

INTRODUCTION

The Nature Park Drömling, one of the largest fen districts in central Germany, is an important agricultural, recreational and drinking water supply area in the federal state of Saxony – Anhalt. At least two stakeholder conflicts are important:
(1) to safeguard the raw water quality and assuring the quality of raw water that is needed for a sustainable drinking water supply of the Magdeburg region and (2) to rewet fen sites in the Drömling area for ecosystem renewal and nature protection. The project focused on the rewetting of the specific site FFH habitat type (HT) 6510. A field trial was established to develop optimized management strategies for the habitat type 6510 to reflect specific effects of increasing groundwater tables. The hypothesis is that K, which is limiting factor, must be additionally fertilized to exploit available nutrients to produce a higher biomass yield and hence to prevent a nutrient burden of the Ohre River. Two different fertilizations and grassland management levels were established. The concentrations of macro-nutrients (nitrogen, phosphorus, potassium) in

soil, soil water and plant biomass were analyzed. First results of two year field experiments were presented.

The first goal of the project was to characterize the requirements regarding nutrients in soil and plant biomass for the HT 6510. Similarly, the optimal management model for the optimal preservation should be developed. Another objective was to investigate the effect of rewetting on nutrient parameters in the soil, near surface groundwater and plant biomass. These two goals were to prevent the degradation of peat lands, and are initiated by rewetting the peat. The results were a practical contribution to the preservation and development of both, the LRT 6510 and the fen.

MATERIAL AND METHODS

In the area of the Nature Park Drömling the average annual precipitation was around 572mm, although there are regional differences between the territory edge and core area. The core area is characterized by low rain and increased evaporation due to high groundwater level. Similarly, there is extreme temperature fluctuation between day and night caused by the high absorption capacity of the fen body and poor heat storage capacity of the soil. The average annual temperature is approximately 8.9 ° C and varies between 7.3 and 12.5°C. The selected test areas were fen sites, characterized by a 2 to 4 dm peat layer.
The following locations were selected:

Test field A-HT 6510 in a good state of preservation. It is a typical *Gleysol* (Altermann, M. & Rosche, O. 2009) in the area of Drömling. The humus horizon is clearly divided into two parts: the Aa-humus horizon is less filled with humus as the deeper Go-Aa horizon. The *Anmoorgley* was (more in the Aa-horizon than in the Go-Aa-horizon) degraded due to decomposition of a peat layer of > 4dmoriginally thickness. The peat degradation was caused by former drainage and intense agricultural land management attended by an aeration and microbial decomposition.

Test field B-rewetting of HT 6510 Site B is also classified as *Anmoorgley*, with a tendency to mineralization of the peat. The profile clearly was pronounced as a sandy sediment cover. The hydromorphic character of this test field was indicated by partially strong humus accumulation and excretion of iron. Presumably there was a flat peat layer which was indicated by humus spots which were now completely decomposed.

The ditch draining of the trial sites was sampled at regular intervals to study the nutrient dynamics . The groundwater level was recorded in *piezometer* tubes at each sampling.

Table1: Experimental design

options	**Test field A (good conservation status)**	**Test field B (rewetted since 2009)**
AMDS0	2 times mowing, no fertilization	
AMDS1	2 times mowing, withdrawal fertilization	
AMDS2	2 times mowing, fertilization to level B*	
ABDS0	mow, pasture, no fertilization	
ABDS1	mow, pasture, withdrawal fertilizion	
ABDS2	mow, pasture, fertilization to level B*	
BMDS0		2 times mowing, no fertilization
BMDS1		2 times mowing, withdrawal fertilization
BMDS2		2 times mowing, fertilization to level B*
BBDS0		mow, pasture, no fertilization
BBDS1		mow, pasture, withdrawal fertilizion
BBDS2		mow, pasture, fertilization to level B*

* according level B of VDLUFA

The demonstrated results just included the following options: AMBS0, ABDS0, BMDS0, BBDS0.

RESULTS/DISCUSSION

Soil

To assess the plant-available nitrogen we determined the inorganic, soluble nitrogen, called N_{min} (= sum of NO_3-N and NH_4-N). The N_{min} values indicated the current nitrogen supply of soil. The N_{min} values were presented in Table 2. The nutrient contents indicated high mineralization rates. The high N_{min} values from depths 60cm arising from the nitrate and ammonium concentrations (VDLUFA 1991). The increased N_{min} - values suggested optimum mineralization conditions at the time of sampling and were not unusual for a fen site (Rupp, H., Meissner, R., Müller, H., & Braumann, F. 1993). Temporal dynamics in the years showed increasing values in April due to mineralization. In contrast, falling levels were observed in June after harvest of plant biomass. The rewetting test field B showed higher levels for all three macronutrients.
The P_{cal} contents were shown in Table 2 Test field B was in contrast to test field A characterized with decreasing P_{cal} contents in the vegetation period. At the rewetted test field B, the levels increased in both soil layers to the same extent. Once again was test field B better supplied with phosphorus than test field A.

Table 2: Soil nutrients in the experimental period (depth 0-60cm, n=6)

	2009		**2010**		**2011**	
	Test field A	Test field B	Test field A	Test field B	Test field A	Test field B
N_{min} [mg/100g]	1,27	1,69	1,3	1,39	1,07	1,34
P [mg/100g]	4,65	4,44	2,16	3,91	0,71	2,48
K [mg/100g]	0,66	2,61	3,03	7,02	4,41	5,51
pH	4,54	6,55	4,44	6,31	5,1	6,1
C:N	14,7	13,6	15,01	14,27	14,8	14,4

The K concentrations for both test fields were low at the beginning of the trail (Class A level, according to VDLUFA), which can be explained with the characteristic fen deficiency of this nutrient. Kapfer (1994) demonstrated that peat soils usually have low-mineral sorption capacity for K which became therefore the limiting yield factor. Similarly to phosphorus, the values of available potassium in the soil decrease with the beginning of the vegetation period. A possible reason is the K-entry with precipitation and the ground water and surface water or the mobilization of fixed potassium from the minerals by the onset of vegetation (Rowell, D. L. 1994;Schachtschabel, P. & Scheffer, F. 2010).

In contrast to mineral soils adsorb the organic matter of peat soils K comparatively light what lead easily to a K-leaching in organic soils. At the same time the plants withdraw more K compared to soil storage, which can easily result in a K deficiency in fens with mow use (Kratz, R. & Pfadenhauer, J. 2001). A part of the K deprivation was attributed to animal excreta at pastured grassland, which had a positive effect on the K -balance. However, the returns of K by pasturing cattle cannot be proven in our experiment.

Plant Biomass

The nutrient concentrations in plant biomass at the two harvest dates in the summer and autumn of the years 2009-2011 were shown in Table 3. The first harvest date exhibit significantly higher biomass yields than the second date. This can be explained by the longer growing season and the more active spring growth of plants. However, the potential yield on the rewetted test field B is significantly higher, due to better hydrological conditions and the greater availability of soil nutrients (Table 2). K was at the beginning of the trial in soil and plant biomass significantly lower than after the fertilization of potash 60 (fertilizer with 60% K_2O). The K contents in the plant biomass showed a significant effect on the application (Table 3) and increased at both sites after fertilization. At the rewetted test field B, the contents were significantly higher than test field A

Table 3: Nutrition in plant biomass at harvest dates (2009-2011, n=6)

	2009		2010				2011			
	Test field A	Test field B	Test field A		Test field B		Test field A		Test field B	
	Okt.	Okt.	Juni	Okt.	Juni	Okt.	Juni	Okt	Juni	Okt.
Ertrag [dt/ha]	29,1	35,7	69,9	23,82	75,6	33,4	47,2	25,4	30,9	28,3
Kalium [g/kg TM]	3,30	4,90	4,30	8,00	5,30	9,80	4,80	7,3	6,00	8,6
Phosphor [g/kg TM]	2,60	3,90	2,68	2,96	2,51	2,75	1,90	2,7	2,34	2,54
Calcium [g/kg TM]	10,04	15,90	6,51	12,22	7,41	11,57	10,65	13,2	9,80	14,7
Magnesium [g/kg TM]	3,70	4,60	3,12	4,42	2,19	3,02	3,05	3,63	3,00	3,49

Near-surface groundwater

The results of the groundwater levels measurements were demonstrated in Table 4 and showed the success of the rewetting at Site B. The average of groundwater table at Site A was 44 cm below ground level (Table 4). In contrast the groundwater levels of Site B were significantly higher with 3 cm below ground surface.

Table 4: Groundwater table levels (cm below surface level, 2010-2011, n=3)

	average	**max**	**min**
Test field A	44,05	15	62
Test field B	3,25	0	16

Figure 1 showed the values of K from the draining ditch of the test fields throughout the experimental period. After the application of potash 60 (22.07.2010) the potassium values were continuously increased at site A but at the rewetted site B potassium values indicated a constant level. Due to the higher groundwater levels and the associated higher volumetric water content of the soil at site B we suppose a wet fixation of the applied K.

The K values in the draining ditch decreased with rising groundwater levels at site A from October 2010 , which is regarded as another indication of a wet soil fixation. The October sampling resulted in significantly increased K contents in soil (Table 2) . The so called "wet setting" is increasingly found on alluvial soils in river valleys and fens. These soils have most heavily expanded clay minerals and with long low fertilization of K they lost K from the interlayer (Galler, J. 2010;Schachtschabel, P. et al. 2010).

Grassland can in particular strongly reduce K supply of the soil because of intense rooting and high K withdrawal. For this reason prone alluvial soils, used as meadow or pasture, without K return in the form of economic or mineral fertilizers, tend to a strong fixation of K.(Galler, J. 2010).

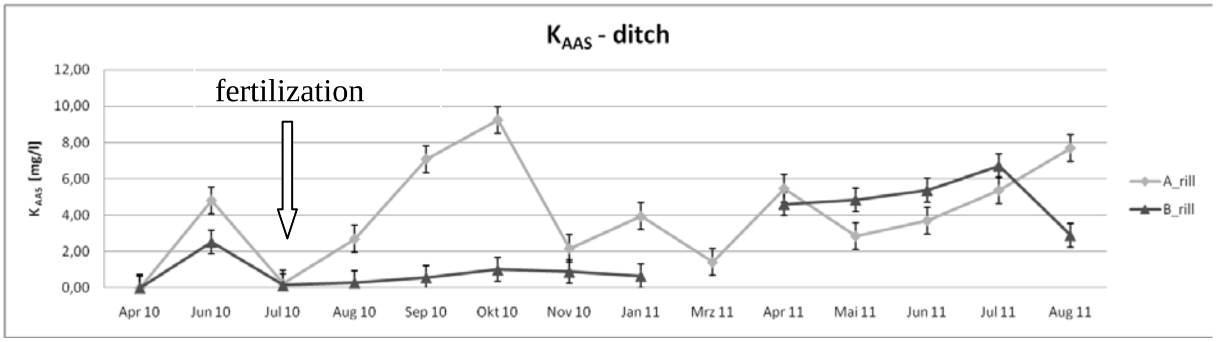

Fig. 1. Potassium concentration in the drainage ditch (2010-2011, n=3).

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REFERENCES

Altermann, M. and Rosche, O. wissenschaftlicher Report (unveröffentlicht). 2009.
Ref Type: Report

Galler, J. Bodenuntersuchungen. 2010. nachhaltigkeit.at/article/articleview/81640/1/4988.
Ref Type: Report

Kratz, R. and Pfadenhauer, J. Ökosystemmanagementfür Niedemoore. Strategien und Verfahren zur Renaturierung. 2001. Stuttgart (Eugen Ulmer).
Ref Type: Report

Meissner, R. 1995. Influence of Mineral Fertilizers and Different Soil Types on Nutrient Leaching - Results of Lysimeter Studies in East-Germany.

Rowell, D. L. Soil Science: Methods und Applications. 1994. Springer-Verlag Berlin Heidelberg New York.
Ref Type: Report

Rupp, H., Meissner, R., & Leinweber, P. 2004. Effects of extensive land use and re-wetting on diffuse phosphorus pollution in fen areas - results from a case study in the Dromling catchment, Germany. ***Journal of Plant Nutrition and Soil Science-Zeitschrift Fur Pflanzenernahrung Und Bodenkunde***, 167(4): 408-416.

Rupp, H., Meissner, R., Müller, H., and Braumann, F. Einfluss der Intensität der Landnutzung auf den anorganischen N-Gehalt im Boden und im oberflächennahen Grund und Oberflächenwasser von flachgründigen Niedermoorstandorten im Drömling. 1993.
Ref Type: Generic

Schachtschabel, P. and Scheffer, F. Lehrbuch der Bodenkunde. 2010. Spektrum.
Ref Type: Report

Schob, S., Meissner, R., Rupp, H., Bernsdorf, S., and Braumann, F. Effekte von Landnutzungsänderungen im Naturschutzgebiet Ohre Drömling auf die Nähstoffdynamik im Bodenwasser. 199-202. 2011. 14. Gumpensteiner Lysimetertagung 2011.
Ref Type: Report

VDLUFA. Methodenbuch 1**(Verband Deutscher Landwitschaftlicher Untersuchungs- und Forschunganstalten)**. 1991. VDLUFA-Verlag. Darmstadt.
Ref Type: Report