Reshaping agricultural peatland use climate friendly in selected German regions

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Abstract

About 30 percent of the world's soil carbon is stored in peat soils. Peatland's functional principle of carbon storage greatly depends on management strategies. Therefore agricultural peatland use becomes a focal point of interest in the current debate on climate protection. Agricultural management demands a drawdown of the water-level that causes aerobe degradation of the soils, as well as trace-gas emissions which have a negative impact on greenhouse-gas balance. Climate-friendly peatland management strategies, however, demand enhanced groundwater tables and decreased land-use intensity. Against this background we analyse ways of re-organising agricultural peatland use within a case study located in Germany, where intensive peatland use accounts for 2.3 – 4.5% of the country's overall greenhouse-gas emission. In order to cover all possible socio-economic and natural conditions, the study takes place in six representative regions. To analyse the micro-economic effects of re-organising peatland use, network analysis, stakeholder workshops and extensive farm surveys were carried out. First results indicate that a re-organisation of peatland use causes severe loss of agricultural income and necessitates financial compensation for farmers. However the results also show that the potential of rearrangement varies significantly according to regional conditions.

Key words

Agricultural peatland use, reduction of greenhouse gases, farm survey, economic consequences

1. Introduction

In the current debate on climate protection, agricultural production has become a focal point of interest. Increasingly under discussion are not only agriculture's contribution to reducing impact on the climate (e.g. through cultivation of energy crops and renewable resources (Smith et al., 2007), but also the negative effects of agricultural production on the global climate. In this respect especially high energy inputs and emissions from special branches of production, such as meat, the husbandry of ruminants or rice cultivation are central themes (Steinfeld et al., 2006, US-EPA, 2005, Smith et al., 2007). The present paper focuses, however, on the climate effectiveness of agricultural management on organic peat soils.

Peatlands are of the utmost importance for climate protection. Under natural, anaerobe conditions, peatlands are the only ecosystems that have the ability durably to absorb carbon dioxide (CO_2) while emissions of methane (CH4) take place simultaneously. As the amount of fixated CO_2 in natural peatlands corresponds approximately to the CO_2-equivalent of the emitted methane, the climate effectiveness of natural peatlands can be considered to be equal-zero-emission, whereas carbon is still stored in significant amounts (Succow & Joosten, 2001).

As the result of this functional principle, peat soils currently contain up to 30 percent of the overall carbon stored in global soils, despite the fact that they make up only 3 percent of the Earth's surface (Turunen et al., 2002, v. Post et al., 1982). Nevertheless, this climate-effective sink depends on the management carried out on the peatlands and can also transmute into a potential source of the emission of climate-relevant trace gases. This effect will be outlined using the example of German peatland management. In Germany emissions from peatland dependent upon management account for 2.3 – 4.5% of overall German greenhouse-gas (GHG) emission (Byrne et al., 2004). This is due to the fact that more than 80% of German peatlands is used agriculturally; agricultural cultivation changes the peatlands' function as carbon sinks. It demands a water-level drawdown that causes aerobe decomposition and that implicates emissions of CO_2 and nitrous oxide (N_2O). Although methane emissions are usually suppressed after draining, this effect is outweighed by the pronounced increases in N_2O and CO_2 (Kasimir-Klemedtsson et al., 1997). Despite the Kyoto Protocol's binding targets for (37) industrialized countries and the European Community to reduce greenhouse-gas emissions to an average of five percent against 1990 levels over the period 2008-2012 (21% in the case of Germany), this relatively important source is currently not considered and not credited to the corresponding Article of the Protocol (UFCCC, 1998).

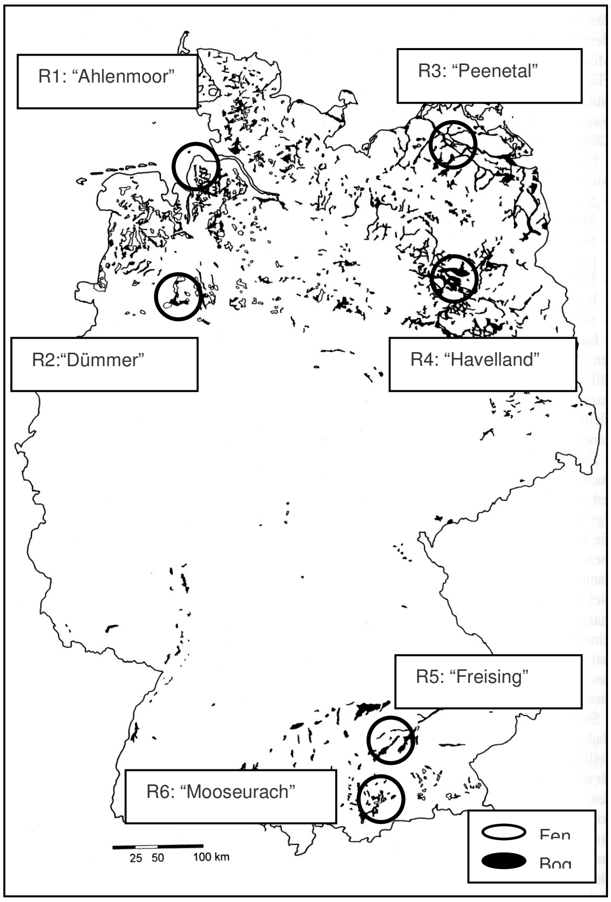
Climate-friendly peatland management requires a change to current land use that is predominantly carried out as arable land and intensive grassland on sites with low groundwater tables. Converting arable land to grassland, decreasing the land-use intensity and re-establishing the original groundwater table seem to meet the targets of climate protection (Freibauer et al., 2004, Droesler et al., 2008). However, a decrease in land-use intensity implicates a reduction in both agricultural yield and income. Severe consequences for the micro-economic situation of affected farms are to be expected. Depending on socio-economic as well as on natural specifics of different regions (e.g. peatland-type, degradation status, management strategy, etc.), the achievable positive effects (e.g. level of emission reduction, nature protection, etc.), as well as the negative effects (e.g. agricultural cost) will vary to a great extent and will influence the implementation of measures. New management strategies will further be determined significantly by the local stakeholders and their agreement on climate-friendly management strategies.

With this in mind our case study in particular (1) analyses socio-economic potentials of the implementation of more climate-friendly management on peat sites and (2) quantifies the effects of a climate-friendly reorganisation of agriculturally used peatland sites on the micro-economic situation of affected farmers. Since we assume that potentials as well as economic effects of climate-friendly peatland management depend fundamentally on local conditions (c.f. Vogel, 2002, Kantelhardt and Hoffmann, 2001), the study takes place in six German sample regions which are described in Chapter 2. To identify local site specifics, to incorporate the interests and expertise of relevant local stakeholders and to gather information about their interconnectedness, we apply the instruments "Network Analysis" and "Stakeholder Workshops". Furthermore, to allow the calculation of micro-economic effects and to introduce the voice of the farmers into the study, we compile extensive "Farm Surveys". The three instruments are described in Chapter 3. The preliminary results of our study are outlined in Chapter 4 and a conclusion is drawn in Chapter 5.

2. Regions of study

The study takes place in six German peatland regions (R) which are located in the north-west, north-east and south of Germany (figure 1, table 1). The sites cover the range of existing peatland types, as well as the range of management and cultivation types, and vary from very low up to very high degrees of agricultural land-use intensity. Within three regions, peatland is exclusively managed as grassland: Region R1 "Ahlenmoor" and Region R6 "Mooseurach" can be classified as distinct and intensive dairy-farming regions where peatland is used for forage production. In the region R3 "Peenetal" large scale re-wetting has been carried out. Agricultural peatland management has been changed to low-intensive grassland, used for suckler- or dairy-cow farming or managed under maintenance measures.

Figure 1: Location of the study regions (modified from Pfadenhauer & Droesler, 2005)



Within the regions "Dümmer", "Havelland" and "Freising" (R2, R4, R5 respectively) peatland is used as grass- as well as arable land. In this respect the "Dümmer" region represents a highly intensive region of tillage and animal production in terms of pig and cattle fattening. Here, efficiently drained arable- and intensive grassland is used for forage production while energy crops are gaining in importance.

In comparison, the two remaining regions are managed less intensively. Within R5 "Freising" agriculture is only partly carried out as arable land for cash-, forage- and energy crops. The main management strategy is still grassland, while a respectable amount of grass is used for the production of biogas. However, some farms practise niche production such as low-intensive animal husbandry or willow cultivation. Basically, due to the decline in dairy-cattle husbandry, agriculture withdraws in particular from the small-scale areas. Contrastingly the acreage of R4 "Havelland" is still used as low-intensive grassland for dairy- and suckler-cow husbandry. To a certain extent cash-, forage- and energy crops are also cultivated.

Table 1: Characteristic of the study regions

	R1 "Ahlenmoor"	R2 "Dümmer"	R3 "Peenetal"	R4 "Havelland"	R5 "Freising"	R6 "Mooseurach"
Location	Lower Saxony	Lower Saxony	Mecklenburg-Wester-pomerania	Brandenburg	Bavaria	Bavaria
Peatland Type	bog	fen	river valley fen	fen	fen	bog / fen
Predominant land-use	Grassland	Grassland / Tillage	Grassland	Grassland / Tillage	Grassland / Tillage	Grassland
Predominant agricultural production	Intensive Dairy cattle farming	Intensive pig and cattle fattening / energy crops	Dairy and suckler cattle farming	Dairy and suckler cattle farming / cash-, and energy crops	niche productions/ dairy cattle farming / Grass for Biogas	Intensive dairy cattle farming
Average farms' peatland area (%) [1)]	88	53	43	63	36	27

1) The given figure refers to the average peatland area percentage of the interviewed farms' total area.

3. Methodical approach

One should assume that the potentials to establish more climate-friendly peatland management depend on local site specifics as well as on variable local basic conditions such as economic and agro-political frameworks (c.f. Vogel, 2002; Kantelhardt & Hoffmann, 2001). We further suppose that the realisation of new management strategies will be influenced by the interests and requirements of different groups of "on-the-spot" stakeholders (Nutt, 2002, Byrons, 2003). With this in mind, our study follows a local approach that allows us to survey local basic conditions as well as to gather specific data for economic analysis. Our first objective was to explore which stakeholders should be considered relevant and how they are embedded into local networks. Therefore a Network Analysis was carried out. As a second step we aimed to pinpoint specific interests represented by players inside the identified networks and to discuss and analyse different interests concerning their retardant or promotional influence on climate-friendly peatland management. With this in mind local Stakeholder Workshops were arranged. To analyse the effects of different peatland management strategies on the stakeholders actually affected, on the third level we compiled extensive Farm Surveys.

- ***Network Analyses*** were run in three regions which represent the socio-economic conditions of southern (R5:"Freising"), north-western (R2:"Dümmer") and north-eastern (R4:"Havelland") Germany. The first objective of the analysis was to identify those stakeholders involved in land-use and to structure them according to their political or social entity. Secondly, a set of metadata on the stakeholders' views, risk perceptions, autonomies of decision and past activities should be cross-compared. Thirdly, the network structures concerning interconnections and intensity of interaction, as well as previous collaboration between actors, should be determined (Hübner et al., 2008). Based on an egocentric network (Jansen 2003) a list was generated of relevant actors who subsequently participated in a questionnaire. The questions covered the topics 1) information status, 2) different development goals, 3) protection interests and activities, and 4) specific network data (i.e. structural relationships). Though individuals were surveyed, most of the interviewees represented organisations, companies or institutions in general. The information collected was evaluated using the computer program VISONE, Version 2.2.10 (Brandes & Wagner 2004a; 2004b).

- ***Stakeholder Workshops*** were organised in all six study regions and were aimed, on the one hand, at incorporating the interests and expertise of local stakeholders, and on the other at identifying retardant and promotional factors of the implementation of climate-friendly strategies of peatland management. Furthermore, the workshops should highlight which actors are especially susceptible to climate-protective measures related to land-use issues, which actors show reservations and which actors are likely to become opponents. Based on the results of the prior Network Analysis, all local stakeholders of relevance were included. By the use of short presentations, we informed the stakeholders of the content and objectives of the study. On the part of the stakeholders, interests, the prospects of development and difficulties and requirements concerning local peatland management were all outlined. The concluding discussion focussed on the topics 1) local site conditions, 2) experiences with previous measures for peatland protection, 3) current peatland use and management, 4) competitive interests, and 5) the future development of local peatland management.
- In order to collect specific micro-economic data, we organised extensive ***Farm Surveys*****.** Of particular interest were data on (1) farm organisation and equipment, (2) livestock husbandry, (3) detailed crop and grassland cultivation processes on peat soils, (4) water management and site conditions, and (5) the effects and possible adaptation strategies of and towards sustainable use of farm peatland. In each region, up to 20 farms - 116 in total - were involved. The inquiry followed a structured questionnaire and was carried out in the form of personal interviews with the farmers. The recorded data serves as the basis for calculation and analysis of the current microeconomic situation of the farms, as well as for estimating the micro-economic effects of implementing climate-friendly peatland management.

4. Results

The results of the ***"Network Analysis"*** indicate that the potential for establishing a climate-friendly peatland management is influenced by a variety of stakeholders (see Table 2). Some of the stakeholders advance very specific and targeted interests (e.g. agriculturists, water managers, nature conservationists), while others represent more comprehensive objectives (e.g. regional development). The analysis furthermore reveals that density, strength and tightness of network structures vary throughout the study regions. Furthermore, the corresponding or contradictory character of the interconnectedness of stakeholders is locally differentiated to a great extent from area to area:

- For Region R5 "Freising", the analysis displays a tight and highly established network structure. The network extends across a wide range of stakeholders at different administrative levels. It shows a strong vertical integration of all key players and a distinct flow of information.
- In contrast, within Region R4 "Havelland", the identified network is characterized by a comparably low-network density and vertical connections are not pronounced. Instead, a strong horizontal separation is evident.
- Region R2 "Dümmer" lies between the first two regions and represents what can be seen as a region with average network structure (cf. Hübner et al., 2008).

As density and tightness of the network structures stands for the level of exchange and collaboration, potentials for the implementation of climate-friendly land-use strategies appear to be high in "networking regions", and to be low in "non-networking regions".

Table 2: Stakeholder Participation

(Number of persons participating at the workshops)

	R1 "Ahlenmoor"	**R2 "Dümmer"**	**R3 "Peenetal"**	**R4 "Havelland"**	**R5 "Freising"**	**R6 "Mooseurach"**
Agriculture	4	2	7	6	5	8
Water management	2	2	2		1	
Local authority / Regional development		7	2		2	1
Nature conservation	2	5	2	2	4	7
Other[1)]	1	3	1	3	3	5

1) Included fields: science, forestry, tourism, fishery, hunting, etc.

The ***"Stakeholder Workshops"*** verified the results from the "Network Analysis", with the addition of further findings:

- Within Region R5 "Freising", the wide range of participating stakeholders reflects the complex interests concerning the peatland area; stakeholders of agriculture, nature conservation, water management, regional development and tourism show clear interests in future peatland use. The manifold objectives are channelled by a local project group which tries to foster sustainable regional development. The workshop showed that the existing network structure promotes an intensive and solution-orientated discussion among stakeholders; the level of awareness concerning the value of peatlands for the conservation of water, biodiversity, climate, etc., and the degree of knowledge of degradation of agriculturally used peatland soils, are both remarkably high. Consequently, a climate-friendly change of peatland use can be considered as comparatively realistic.
- Within Region R4 "Havelland", mainly agricultural stakeholders participated in the workshop. The level of interconnection between stakeholders representing different fields of interests, as well as different administrative and institutional levels, is comparatively low. Regional strategies that could support climate-friendly management are currently neither explicitly pursued by regional development nor by nature conservation.
- In Region R2 "Dümmer" the participation of a wide range of stakeholders again reflects intensive and complex interest in the local peatland area. However, the prospects of changes in land use are to be considered rather slim, as the different interests pursue fundamentally opposite directions. Particularly in this region, the objectives of stakeholders who represent high-intensive agriculture and those representing conservation are mutually exclusive. Furthermore, the network lacks a central player channelling the different interests.

Across all the regions our workshops made clear that an implementation of climate-friendly land use would in fact require the increase of groundwater tables and low-intensive land-use strategies. However, from a technical point of view water logging is not possible in all regions. Furthermore, agricultural stakeholders and farmers, too, clearly reject those measures. The farmers justify the refusal primarily by reason of high costs of re-organisation and farm adaptation, which would have to be financially compensated.

The results of our ***"Farm Survey"*** show that even given the prospect of financial compensation, the acceptance of an implementation of climate-friendly management strategies is rather low (see table 3). In particular, low-intensive pasturing is met with disapproval by most farmers. Strategies to reduce the intensity of the current management strategy or to implement climate-friendly renewable-energy production are more appealing to the farmers. The latter strategy has even already been implemented in some cases (e.g. R5 “Freising”). Surprisingly, even a complete cessation of agricultural production appears conceivable for some farmers bearing in mind the necessity of financial compensation.

Table 3: Acceptance of climate friendly management strategies[1)]

		R1 „Ahlenmoor“	R2 „Dümmer“	R3 „Peenetal“	R4 „Havelland“	R5 „Freising“	R6 „Mooseurach“
Less Intensive Grassland Management	a) reduced intensity of fertilizer, reduced crop frequency	26	35	18	25	41	61
	b) implementation of low-intensive pasturing	11	20	12	15	21	14
Cultivation of adapted energy crops		21	35	22	40	53	35
Termination of Production / Restoration of natural conditions		32	25	35	30	32	19

[1)] Percentage of interviewed farmers who regard measures as conceivable with the prospect of financial compensation

Furthermore, the results of the farm survey differentiate to a great extent throughout the study regions. This can certainly be explained by different average amounts of affected area (see table 1) and to the local profitability of peatland cultivation.

5. Discussion / Conclusion

Peatlands are the only ecosystems which durably store carbon and are consequently of the utmost importance for climate protection. Agricultural land use, however, changes the function of peatland as a carbon sink and can cause high emissions of the climate-burdening trace gases CO_2 and N_2O. In order to lower these greenhouse-gas emissions, a reduction in land-use intensity is necessary. In our study we analyse the possibilities of implementing climate-friendly peatland management in Germany. The potentials seem to be very high, as more than 80% of the German peatlands are used agriculturally and resulting greenhouse-gas emissions account for up to 4.5% of overall national emissions.

The high anthropogenic emissions from peatlands require the development of alternative strategies of peatland management at a regional level. However, it becomes evident that such abatement strategies demand extensive re-organisation of land use which has substantial socio-economic consequences. Even though agriculture can clearly be seen as the main affected branch, such re-organisation will go much further: manifold fields of interest such as nature conservation, biodiversity, regional development will be involved. The results of our study show that strong socio-economic networks are needed to channel the interests of the various stakeholders and foster the implementation of climate-friendly land-use strategies.

From an agricultural perspective, intensive peatland use is fundamental for generating income. Consequently, agricultural stakeholders and farmers demand the maintenance of, or even an increase in, management intensity and they reject the implementation of climate-friendly land-use alternatives. However, farmers show a certain acceptance of re-organisation, if loss of income is compensated or the implementation of potential alternative strategies receives financial support from government. Certain openness is also shown towards the implementation of climate-friendly renewable-energy production as a long-term, market-based solution for peatland use. Our results show that farmers already test or even implement this strategy in some cases. However, with a long-lasting production commitment, the financial risks for farmers increase considerably and climatic consequences are not yet sufficiently known.

Finally it should be noted that a re-organisation of peatland use would provide fundamental benefits for society. However, farmers would have to bear the costs of adaptation and would not profit from such a solution. Against this background, the question arises how social benefits can be monetarised in order to finance climate-friendly peatland-cultivation strategies. Even if still at the theory stage, future solutions could be found at the level of global climate-protection initiatives. Continuing international negotiations on a future climate protocol could foster the integration of peatland management into international efforts to combat climate change.

However, in the light of the status of negotiations, it is still unlikely that emission reductions from land-management activities will form part of international or national emission trading schemes. Given the great uncertainty in greenhouse-gas emissions from managed "organic soils", it is still unlikely that peatland restoration will become part of internationally agreed mechanisms at a project level in the near future. However, financial support could originate from the proceeds of the international and national emission trading schemes.

The outcome of the international negotiations for a future climate regime in Copenhagen in December 2009 will determine whether land use and land management are to be more comprehensively included in the global climate-change mitigation after 2012. If more or ideally all types of land use become part of international commitments to reduce greenhouse-gas emissions, significant financial resources can be expected for implementing the climate-friendly use of peatlands.

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