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Prospects for climate friendly peatland management – Results of a socioeconomic case study in Germany

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Abstract: In the current debate on climate protection, agricultural production has become a focal point of interest. This study introduces the climate effectiveness of agricultural management of peat-soils. Agriculture on peatland demands a water-level drawdown that causes aerobe degradation of the soils. The resulting trace-gas emissions have a negative impact on the greenhouse-gas balance. In Germany more than 80% of peatland is used agriculturally; the resulting emissions account for 2.3 – 4.5% of Germany's overall emission. Climate-friendly peatland management strategies, however, demand enhanced groundwater tables and decreased land-use intensity. With regard to agricultural income, severe economic consequences are to be expected. Against this background we analyse opportunities to re-organise agricultural use of peatland. As it is assumed that the potential to reduce land-use intensity greatly depends on local socio-economic conditions which are likely to vary across different regions, six representative sample regions are surveyed. To analyse microeconomic effects with simultaneous consideration of local diversity, stakeholder workshops and extensive farm surveys were undertaken in all regions. 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.

Keywords: agricultural peatland use, reduction of greenhouse gases, farm survey, economic consequences

JEL Codes: Q24, Q54, R58

1. Introduction

In the current debate on climate protection, land-use strategies and, in this respect agricultural production has become a focal point of interest. Increasingly under discussion is 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, these ecosystems are characterized by the unique ability to absorb carbon dioxide (CO_2) continuously and durably. They function as carbon sinks by accumulating and storing dead organic matter from vegetation as peat. It may be true that simultaneously emissions of the climate gas methane (CH_4) take place, but 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).

Worldwide peatlands cover over 4 million km² and with this extent represent 3 percent of the land and freshwater surface of the planet. Despite this relatively small amount of area, one third of the world's soil carbon is found in these ecosystems. (Joosten and Clarke, 2002, Turunen et al., 2002, v. Post et al., 1982). Nevertheless, whether peatlands function as such a potent climate-effective sink significantly depends on the management carried out on them. Under certain conditions they can also transmute into a potential source of climate-relevant trace gas emissions. We want to outline this effect using the example of peatlands in Germany.

German peatlands have largely lost their ability to function as carbon sinks and actually have a negative effect on the climate. Management-dependent emissions from peatland actually account for 2.3 – 4.5% of overall German greenhouse-gas (GHG) emission (Byrne et al., 2004). The reason behind these high emissions is the fact that more than 80% of German peatlands is used agriculturally. Agricultural cultivation however changes the peatlands' function as carbon sinks. It demands a water-level drawdown that causes aerobe decomposition of the peat that implicates emissions of CO_2 and nitrous oxide (N_2O). Even if emissions of the greenhouse gas methane are usually suppressed after draining, this effect is outweighed by the pronounced increases in N_2O and CO_2 (Kasimir-Klemedtsson et al., 1997). For Germany the high greenhouse-gas emissions resulting from agricultural peatland management are already classified as a “main source” that cannot be ignored. Improved peatland management at the moment starts to be taken into account when considering strategies of climate protection. However, despite the Kyoto Protocol’s binding targets (for 37 industrialized countries plus 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), climate gas emissions from peatlands are not explicitly considered yet and climate friendly peatland management strategies are still not credited to the corresponding Article of the Protocol (UFCCC, 1998).

According to present scientific knowledge, however, management strategies like converting the arable land to grassland, decreasing the land-use intensity and re-establishing the original groundwater table would seem to meet the targets of climate protection and are increasingly suggested (Droesler et al., 2008).

In the case of Germany climate-friendly peatland management would require a significant change to current land-use that is predominantly carried out as arable land and intensive grassland on sites with low groundwater tables. A decrease in land-use intensity implies a reduction in both agricultural yield and income. Severe consequences for the micro-economic situation of affected farms are to be expected. What can also be assumed is that 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 re-organisation 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 put special emphasis on stakeholder participation applying the instrument “Stakeholder Workshops”. Furthermore, to allow the calculation of micro-economic effects and to introduce the voice of the farmers into the study, we compiled extensive “Farm Surveys”. The chosen instruments are described in Chapter 3. The preliminary results of our study are outlined in Chapter 4 and discussed in Chapter 5. A conclusion is drawn in Chapter 6.

2. Regions of study

To include the variety of economic and natural site conditions in Germany (Vogel, 2002), our research analyses conditions within six peatland regions (R) located in the north-west, north-east and south of Germany (see figure 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, Region R1 “Ahlenmoor”, Region R2 “Mooseurach” and R3 “Peenetal”, peatland is exclusively managed as grassland:

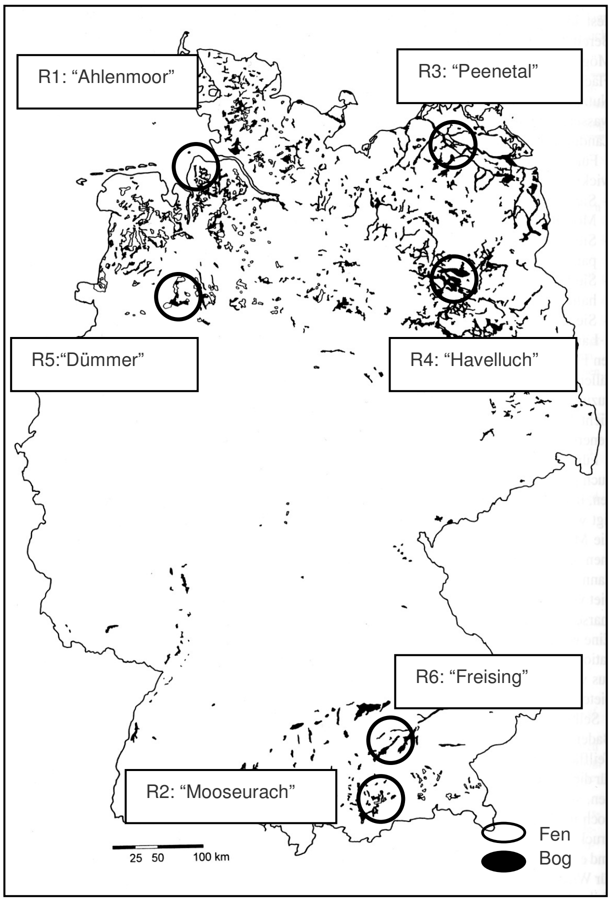

Figure 1: Location of the sample regions
(modified from Pfadenhauer and Droesler, 2005)

– Region R1 “***Ahlenmoor”*** is a bog site that covers about 4,000 ha. Only about 17 percent of the peatland is uncultivated, of which only 1 to 2 percent can be considered as “close to nature”. The conservation area is located at the edges of the bog.
– Region R2 “***Mooseurach”*** is situated close to the Alps covering bog as well as fen sites.
– Region R3 “***Peenetal”*** is a groundwater-fed fen site of high peat depth situated in a river valley. With a core region of 20,000 ha and an overall extent of 45,000 ha, the area is the largest interconnected peatland area in Central Europe.

Within Regions R4 “Havelluch”, R5 “Dümmer” and R6 “Freising“ peatland is used as grassland as well as arable land.

- Region R4 “***Havelluch”*** is located in the Berlin glacial valley and covers about 30,000 ha. It is mainly characterized by fen peat-soils that are, as a result of a strong drainage, mineralised in parts and degraded to a high degree.
- Region R5 “***Dümmer”*** contains fen and bog sites while in this case mainly fen sites, originating from aggradation, are surveyed. Parallel to the areas of intensive agricultural land-use a low intensive and in parts close-to-nature conservation area of about 5,000 ha exists that first and foremost functions as a habitat for bird life.
- Region R6 “***Freising”*** is a fen site fed by a continuous groundwater stream with an extension of about 3,000 ha. Within the core region ecologically valuable grasslands are maintained under conservation programs.

3. Methodical approach

One can assume that the potentials to establish more climate-friendly peatland management will depend on local site specifics such as the technical feasibility of water logging, the possibility of regeneration or the already given natural finiteness of the agricultural usability of the sites. Furthermore it is obvious that variable socio-economic conditions such as economic and agro-political frameworks will have a certain impact (c.f. Vogel, 2002). Lastly, one can suppose that the realisation of new management strategies will be influenced by the interests and requirements of different affected parties (Beierle and Cayford 2002).

Bearing in mind that these influencing factors will presumably vary from region to region, we decided to follow a local approach. The outcome should be a profound insight into the different peatland regions that would enable an adequate evaluation of local basic conditions. Furthermore our approach should deliver a comprehensive and locally specific database for economic analysis.

Literature reveals that participation of parties which have a stake in a special resource both increases the level of understanding and support for implementation measures and reduces potential conflicts and the need for heavy enforcement (MPA 2004; NRC Council 1996; Turaga, (no date); Webler et al., 2001). Furthermore it is pointed out that an early-stage incorporation of specific expertise and information held by key stakeholders supports successful planning and implementation of decisions and measures (Nutt, 2002; Byrons, 2003). Against this background we decided to organise ***Stakeholder Workshops*** in all six study regions. Consequently they were aimed at incorporating the expertise of the local, “on-the-spot" stakeholders. In addition we wanted to pinpoint specific interests and dispositions represented by players and evaluate, 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. Another objective of the workshops was to identify general factors that have retardant or promotional influence on the implementation of climate-friendly strategies of peatland management.

To identify all local stakeholders of relevance we were able to use the results of a prior Network Analysis by Hübner et al. (2008) which surveyed Stakeholder Network structures in the regions R1 "Ahlenmoor", R4 "Havelluch" and R6 "Freising". For regions "Mooseurach", "Peenetal" and "Dümmer" (R2, R3, and R5 respectively) we consulted local experts that were capable of making out relevant key actors.

In the course of the workshops we informed the stakeholders of the content and objectives of the study by the use of short presentations. On the part of the stakeholders, interests, the prospects of development as well as 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. The contents of the workshop were recorded, analysed and interpreted. Subsequently the main factors that influence the implementation of measures, either redundantly or promotionally, were identified.

In the second step of our study, we wanted to analyse what effects an implementation of climate-friendly management strategies would have on the stakeholders actually affected, namely farmers cultivating peatland sites. To this end we compiled extensive ***Farm Surveys*.**

To estimate which types of farms should be looked at, we initially viewed statistical data on the topics (1) structure and socio-economy of local agriculture, (2) local land use and (3) local change in agricultural structure at both administrative district and municipal level. Data was recorded using the official statistics of the Statistische Bundesamt Deutschland (German Federal Statistical Office). On the basis of our statistical research we defined three main selection criteria that farms had to meet. First of all, the farms had to cultivate peatland in the respective sample region. Secondly, the farm's organisation had to be considered either typical for the region concerning socio-economy, size and orientation or it had to be particularly adapted to the situation of peatland cultivation by specialisation ("niche production"). Thirdly, as a basic necessity, only farms could be selected whose manager expressed a willingness to cooperate and who agreed to participate in the interviews and provide farm management data.

In each region, up to 20 farms - 116 in total - were involved. To identify the potential farms local experts were consulted. Also the inquiry was arranged and conducted by local experts and carried out in the form of personal interviews with the farms' owners or managers. As we aimed to avoid falsification through the influence of different interviewers, the interviews followed a structured, pre-tested questionnaire, in which questions were kept in closed form, offering standardized answers. Information concerning the land-use of the farm's peatland was additionally described on the basis of detailed geographic maps. With the inquiry we particularly gathered 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.

Microeconomic data was merged within an Excel database. Also data processing was carried out in Excel-based calculation tools. Geographic data was entered into a Geodatabase and processed using the software ESRI ArcMap 9.2.

The recorded data serves as (1) the basis for calculating of the current microeconomic situation of farms that cultivate peat soils as well as (2) for modelling and evaluating the microeconomic effects of different scenarios of adapted peatland management. Further analysis of the data is done on the topics: (3) typical farm organisations representing peatland-cultivating farms, (4) typical peatland management strategies pursued within different regions, and (5) average percentage of the farms' peatland area on both individual and local levels.

4. Results

To outline the findings of our study our results will be divided into two parts. In the first section of this chapter we present the outcome of our quantitative analysis: classifying and comparing the study regions and gathering an overview over local variety. In the second section we go beyond the quantitative results by associating them with the qualitative outcome of our research. Here we will draw a comprehensive picture about the special conditions within the single regions and portray the regions' individual chances and limits of an implementation of climate-friendly peatland management.

QUANTITATIVE RESULTS

Agricultural usability of different types of peatland varies according to the differing soil-qualities. For this reason, in Table 1, we characterise the regions of study in regard to their ecological classification, differentiating between fen and bog sites (see row 1). Table 1 further outlines the kinds of land-use predominant within the regions and the related types of agricultural production (see rows 2 and 3). Significant differences between the regions also consist in average amount of farmed peatland. The share of peatland in proportion to the total agricultural area used for production is shown in row 4. The consequences being associated with this particular parameter will be outlined when describing the individual regions in the second section of this chapter.

Table 1: Characteristics of the study regions

	R1 "Ahlenmoor"	**R2 "Mooseurach"**	**R3 "Peenetal"**	**R4 "Havelluch"**	**R5 "Dümmer"**	**R6 "Freising"**
Peatland type	bog	bog / fen	river valley fen	fen	fen	fen
Predominant peatland-use	Grassland	Grassland	Grassland	Grassland / Tillage	Grassland / Tillage	Grassland / Tillage
Predominant production type	Intensive dairy cattle farming	Intensive dairy cattle farming	Dairy and suckler cattle farming	Dairy and suckler cattle farming / cash-, and energy crops	Intensive pig and cattle fattening / energy crops	niche productions/ dairy cattle farming / grass for Biogas
Average farms' peatland area (%) [1)]	89	27	43	63	53	36

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

The basis for parts of the above characterization was the preceding analysis of the structure of farms' individual agricultural area (see Figure 2). As shown in Figure 2, we distinguished between arable land and grassland, with simultaneous consideration of whether arable respectively grassland is situated on mineral soil or on peat soil. The parameters "predominant peatland use" and "average farms peatland area" (Table 1) were derived from the results of this analysis.

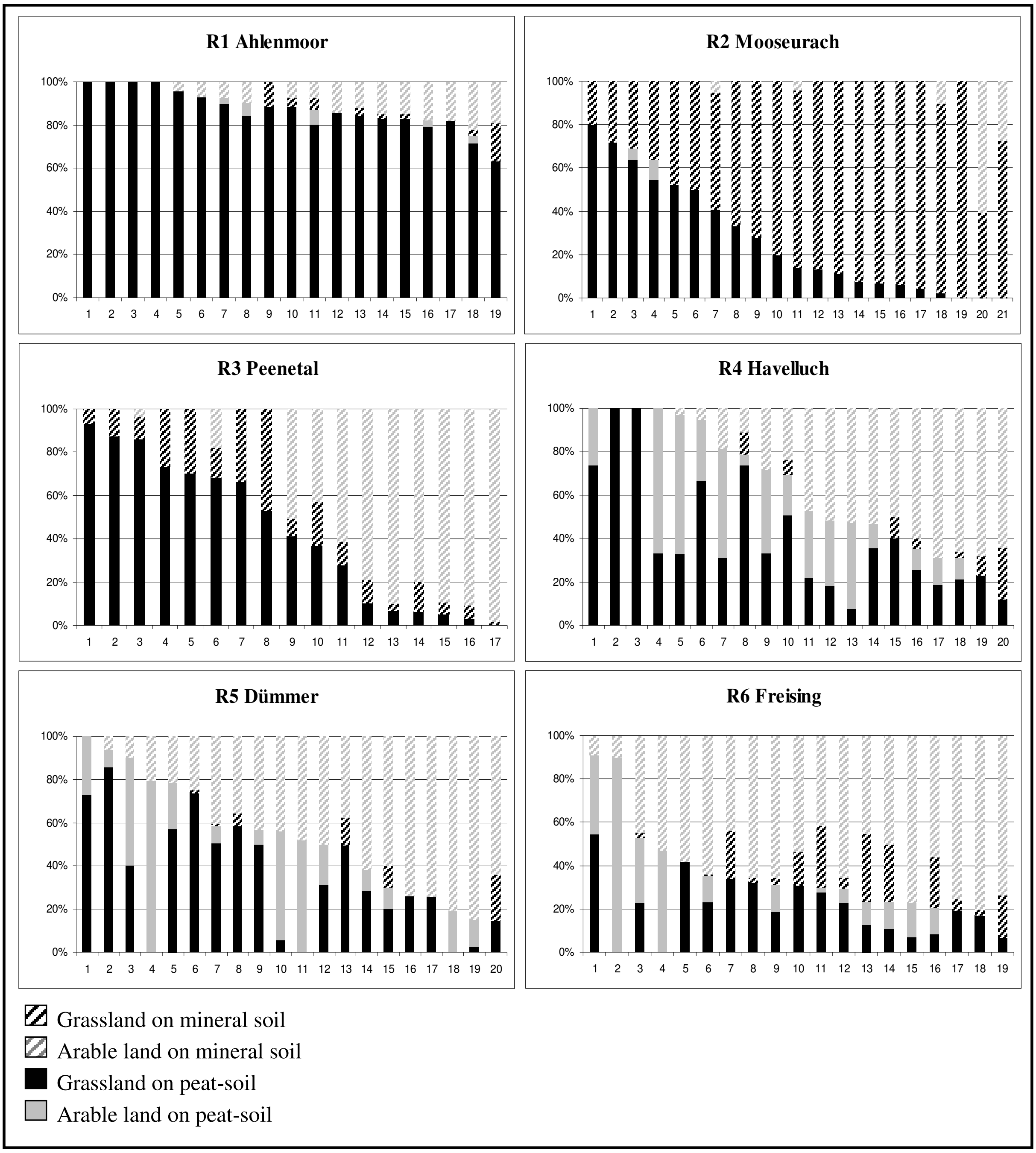

Figure 2: Structure of agricultural area of the interviewed farms

Additionally for agricultural area structure, the relevance and impact on the prospects for changes in peatland management will be demonstrated when describing the individual regions. We shall do the same with the findings derived from our analysis on "Acceptance of climate friendly management strategies" (see Table 2). Within the scope of this analysis we evaluated the attitude that interviewed farmers expressed towards defined strategies of alternative land-use management. Concerning this topic, we analysed the number of interviewed farmers supporting measures like less intensive grassland management, the cultivation of adapted energy crops or complete peatland restoration.

Table 2: Acceptance of climate-friendly management strategies[1)]

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

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

To illustrate, the views of which stakeholders were additionally involved in estimating the single regions' potential for climate-friendly peatland management, in Table 3 we give a short overview of the parties that participated in the workshops. Therefore we grouped the different players into five categories. Apart from the party of "Agriculture", the views of stakeholders from the areas of "Water Management", "Local authority and Regional development", "Nature conservation" and "Others" were incorporated, while "Others" includes parties like science, forestry, tourism, fishery, hunting, etc.

Table 3: Stakeholder Participation

(Number of persons participating at the workshops)

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

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

The quantitative results presented in this section already indicate the regions' variability. Basically they would allow drawing first conclusions about the locally different potentials of climate-friendly peatland management. However, to postulate conclusive estimations about the regions' flexibility towards adapted management strategies and about the consequences of implementation measures, they lack sufficiency. Therefore it appears necessary to combine them with qualitative results derived from the expert discussions and the statements made by the interviewed farmers. In the next section of this chapter –additional to the quantitative results- these qualitative results are incorporated. The outcome is a region-wise, comprehensive picture which describes the varying possibilities and barriers of alternative management strategies due to technical as well as socio- and microeconomic conditions.

PORTRAY OF THE STUDY REGIONS

According to the findings of our study, Region R1 ***"Ahlenmoor"*** can be classified as a highly productive grassland site exclusively used for the husbandry of dairy cattle. The surveyed farms turned out to be all family-run and to generate their relatively high income exclusively from dairy cattle management. As reported at the workshop, dairy cattle management was actively promoted and drawn into the region during the 1960s. The peatland area experienced a comprehensive reallocation of land. The technical potential of water management was optimized and laid out to meet the needs of agricultural use. As a consequence water tables can be controlled efficiently for the most part; management geared towards water logging and peatland regeneration is also feasible. However, workshop and farm surveys revealed that, despite the given technical opportunities, prospects of climate-friendly peat land management are restricted due to different other reasons: First of all, dairy cattle management still immigrates to the region, a fact that causes a high scarcity of acreage. Secondly, the characteristic of the pronounced grassland site (share of grassland >80%, see (Figure 2) and the high capital commitment of the investment-intensive dairy cattle husbandry (5000 €/dairy cattle) strongly limits the farmers' flexibility towards alternative, less intense land-use. Lastly, the percentage of farms' peatland area is extremely high and averages 89% while half of the farms are affected by more than 90% (see Table 1 resp. Figure 2). With that high amount of affected area, adaptation to and compensation of losses in yield and forage are virtually impossible. It becomes obvious that for this region perpetuation of dairy cattle husbandry under conditions of less intensive peatland management or abandoning of acreage is not possible; the economic consequences of farm re-organization would jeopardise farm profitability. It follows that the agricultural stakeholders` acceptance of climate-friendly peatland management is the lowest compared to the other regions (see Table 2). Farmers made it clear that they would rather terminate the entire production than to reduce intensity. However, this serious step was only taken into consideration under the condition of selling the farms as a whole and re-opening production on other adequate sites.

Also in Region R2 ***'Mooseurach'***, peatland area is mainly used for dairy cattle husbandry. Fen sites are intensively used for forage production. Valuable bog sites are in parts objects of nature-conservation programs and agriculturally managed with low intensity for the providing of animal stable litter. Our findings showed that current interests of nature conservation mainly aim to maintain and enlarge these bog sites. They shall either be managed by individual farmers or by farmers re-organizing their farms by specializing on maintenance ("Pflegehöfe"). Some farmers already implemented this branch of production within their operational concept. Yet excluded from measures, and apparently not in the focus of interest, are the extensive, intensively used fen areas in the region. For those sites again, the situation of the pronounced grassland region (share of grassland >93%, see Figure 2), which limits agricultural production on dairy cattle management, and the associated high level of capital investment constitute the main barrier for the acceptance of climate-friendly peat land management. However, compared to Region R1 there exists a significant difference: during the farm interviews it became apparent that the acceptance of reducing intensity as well as the consideration of a cultivation of adapted energy crops is remarkably higher in R2 than in R1 (see Table 2). This is obviously due to the fact that the farms' average percentage of peatland area in Region R2 (see Table 1), is with 27 % significantly lower than within Region R1. Farms can –to a certain amount- more easily compensate for forage losses through different adaptation measures on their remaining acreage.

The third region where peatland is mainly used as grassland, the river valley fen R3 ***"Peenetal"***, represents a specific situation. The region is part of a large-scale governmental conservation project which aims to protect the whole area of the river valley. Due to the project large-scale rewetting has been carried out. For our study this region portrays an area, where re-organisation of peatland management can be analysed retrospectively. In particular, the results of our stakeholder workshop showed that different basic conditions had been conducive to the implementation of alternative peatland management: peatland area located within the river valley was converted into acreage in the 1970s, first and foremost by surrounding agricultural area by dikes ("Polder-System"). As the ground surface -additionally strengthened by forthcoming degradation and shrinkage of the peat soil- falls below the natural water table, water has to actively be pumped out of the diked areas. Since German reunification, government-funded drainage has been phased out. Instead, farmers had to bear the high costs that tended to exceed the benefits generated on the marginal sites. As a consequence, taking the chance of financial compensation granted by the program, farmers voluntarily decided against keeping the sites under cultivation. Peatland acreage was either completely given up respectively kept under maintenance measures or the management had been changed to low-intensive grassland, used for suckler- or dairy-cow farming. Water logging and restoration of the sites also profited by the exceptional situation of the river valley. Water logging could easily be done by slitting the dikes. After implementation of the measures, further regulations to keep up the high water table were not necessary; hence further consequential costs appear to be low.

Subsequently stakeholders expressed different views on the restoration: Even if some farmers had to give up their farms completely, the majority of the affected farmers appreciated the measures as they were able to adapt to the re-organisations because of being compensated adequately. Local authority and regional development conform to the view of the agricultural stakeholders. From their perspective keeping up the costly drainage would not have been financially feasible in the long run, whereas the granted compensation benefited to the whole region. However, sceptical views were also expressed: nature conservationists as well as climate experts point out that measures could have been planned, controlled and monitored more carefully: the large-scale re-wetting went along with impacts on valuable low-intensive grasslands featuring endangered species and high biodiversity; furthermore, at the time of the implementation, effects on the climate could not been completely forecasted. In some sections of the local population a certain opposition arouse against the large-scale measures of re-wetting which now influences the implementation of further programs.

In contrast to R3, within Region R4 ***"Havelluch"***, regional strategies that could support peatland conservation programs or the implementation of climate-friendly management have not been and currently are not explicitly pursued; neither by regional development nor by nature conservation. In addition, within this region the technical implementation of water logging poses the most significant problem: prospects of peatland regeneration and water logging are highly limited by the low average rainfall and the resulting lack of water. Furthermore, a high number of ditches and channels pervade the acreage and the significant degradation of the peat-soils strongly affects their function for water storage. Even if calibration of the water tables could be managed properly, technical water logging is likely to turn out to be costly. At the moment, from an agricultural point of view, the water management appears to be suboptimal for agricultural use. Land-use is mostly carried out as low-intensive grassland for dairy- and suckler-cow husbandry. To a certain extent, cash-, forage- and energy crops are also cultivated. Many sites are controlled inefficiently and vary between extremely dry and wet conditions in the course of one year. Despite these unsatisfactory conditions, farmers refused to reduce intensity of production. They rather aim to push forward an improved water management to be able to optimize and intensify agricultural production. Beside the limitation of the unavailability of water and the farmers' attitude, the results of our workshop implied that another factor might limit the implementation of climate-friendly peatland management: the level of interconnection between stakeholders representing different fields of interests, as well as different administrative and institutional levels, appears to be comparatively low while no special interest is expressed to deepen interconnectedness and collaboration.

In Region R5 ***"Dümmer"***, by contrast, participation of a wide range of stakeholders at the workshop (see Table 3) reflected intensive and complex interest in the local peatland area.

Nevertheless, the different interests pursue fundamentally opposite directions; objectives of stakeholders who represent high-intensive agriculture and those representing conservation are mutually exclusive. R5 can be classified as a pronounced region of tillage and high-grade animal production in terms of pig and cattle fattening. The efficiently drained peatland is mainly used as arable and intensive grassland. Energy crops are also gaining in importance. The use of peatland area is essential for the generation of a high local agricultural income whereas maintenance of this income first and foremost depends on keeping up and even increasing the high number of animal units. From the point of view of agricultural stakeholders peatland area is indispensable on the one hand for the production of forage, on the other hand for compliance with the conditions of the German Community Scheme for Fertilisers ["Deutsche Düngemittelverordnung" (c.f. European Parliament, 2003; BMELV 2008)]. For this reason, although the technical potential to water logging and regeneration is to be considered as good, the prospects of climate-friendly peatland management are restricted.

Contrasting strongly with the rest of our study regions, our results for region R6 ***"Freising"*** draw a significantly different picture. From a technical point of view complete water logging and restoration as large scale measures seem to be limited. However, for different reasons particularly in this region stakeholders appear to be for changing the current peatland management: In contrast to Regions R1, R2 and R5 income aspects do not present a significant obstacle to alternative use of peatland. Current 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. Within the peatland's core region, ecologically valuable grasslands are maintained for the provision of animal stable litter. Generally, the region experiences a voluntary pullback of agricultural use, as local agriculture and especially the husbandry of dairy cattle diminish and the cultivation of the extremely small structured area is not profitable anymore. Therefore the area's future development is already the topic of lively discussion. At the workshop the wide range of participating stakeholders reflected the complex interests concerning the area (see table 3); stakeholders of agriculture, nature conservation, water management, regional development and tourism show clear interests in future use. Surprisingly in this region agriculture shows interests that go with the objectives of nature conservation. In the eyes of conservationists farmers are indispensable for the maintenance of the ecologically highly valuable grassland area especially if it should be enlarged under peatland conservation programs. Agricultural stakeholders are basically interested in keeping the peatland under cultivation. This interest is on the one hand explained in view of the possible future developments of agriculture that require keeping the area in good agricultural and environmental condition. Furthermore, personal and traditional motives tie the farmers to agricultural cultivation of the area. However, at the moment farmers do not insist on high-level production but are for keeping the area under low intensive, still reasonable agricultural maintenance, given the condition of adequate financial compensation. They, as well as the stakeholders of nature conservation, see the option of integrating climate protection into concepts of land use as a possible way towards reasonable use and fair compensation. Generally it became obvious that farmers within this region are mostly open-minded about changes of management strategies. Our interviews revealed that some farms already practise niche production such as low-intensive animal husbandry, husbandry of horses, willow cultivation or herb and grass breeding on the peatland sites. Furthermore, climate-friendly renewable-energy production has already been implemented in some cases. Besides the farmers personal attitude in this region, the comparatively low share of peatland per farm (36% average farms peatland area, see Table 1) as well as the good options of alternative income in the region foster the farmers' flexibility towards farm re-organisation. As mentioned above, beyond agriculture and nature conservation, there exist further groups of stakeholders showing interest in the peatland area: a huge impact comes from the nearby Munich Airport and the city of Freising. The area functions as water reservoir, recreation area and potential ecological compensation area; roles that appear compoundable with climate-friendly peatland management.

The manifold objectives are channelled by a local leader group which tries to foster sustainable regional development. The workshop clearly showed that the existing interconnection promotes an intensive and solution-orientated discussion among the different parties; 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.

6. Discussion

The current results of our study reveal that different variable basic conditions influence the implementation of climate-friendly peatland management. Among other factors, such as natural finiteness of agricultural usability of peat soils, options of adaptation, etc., three particular determinants seem to have the highest impact: first of all, the existing level of interconnection and cooperation between local stakeholders; secondly, the technical feasibility of restoration and water logging; and thirdly, the level of agricultural profitability of peatland cultivation concerning income, capital commitment and the share of affected peatland area. It is obvious that regional potentials for the development of climate-friendly peatland use strongly depend on the composition of the single parameters. In Table 4 we demonstrate the characteristic of these main factors for the different regions.

Table 4: Prospects of the implementation of climate-friendly peatland management [1)]

Prospects of implementation due to the…	**R1 Ahlenmoor**	**R2 Mooseurach**	**R3 Peenetal**	**R4 Havelluch**	**R5 Dümmer**	**R6 Freising**
…level of interconnection and cooperation between local stakeholders	→	↘	→	↘	→	↑
…technical feasibility of restoration and water logging	↗	→	↑	↓	↗	→
….level of agricultural profitability of current peatland cultivation	↓	↓	↑	↗	↓	↗

[1)] Characteristic of the main determinants for the implementation of climate-friendly peatland management within the different study regions (Based on workshop- and farm survey results)

Above all regions we detected that the potential for establishing climate-friendly peatland management is influenced by a variety of stakeholders. Some advance very specific and targeted interests (e.g. agriculturists, water managers, nature conservationists), while others represent more comprehensive objectives (e.g. regional development). The results reveal that interconnection and cooperation ("Networking") between local stakeholders represent major criteria for the implementation of conservation measures. Table 4 (see row 1) shows that the level of this inter-connection locally varies to a great extent. As character and strength of interconnectedness between different stakeholders corresponds with the level of exchange and collaboration, potentials for the implementation of climate-friendly land-use strategies appear to be high in "networking regions" (e.g. Region R5 "Freising"). The existence of networks that involve players providing scientific information can sharpen up the level of awareness concerning the peatlands' value for the conservation of water, biodiversity, climate etc. Further it enhances the standard of knowledge about the degradation of agriculturally used peat soils and the resulting finiteness of long-term peatland cultivation. It became apparent that the level of awareness of these scientific backgrounds was substantial for making allowances for conservational peatland management. Beside stakeholders providing scientific expertise, it seems essential that local players are incorporated who are capable of planning and implementing development concepts that involve the needs of all affected groups.

In contrast to "Networking regions", development, implementation and acceptance of measures in regions that lack existing interconnections between local key actors are likely to find low acceptance and can lead to subsequent conflicts that might complicate further regional development. To avoid such developments, from our point of view it is essential to involve all relevant players in the entire process of land-use planning. We also assume that this predication not only counts for our special study case, but for every kind of land-use change that affects broad fields of interests.

We outlined above that the implementation of climate-friendly land use requires the increase of groundwater tables and low-intensive land-use strategies (Pfadenhauer and Droesler, 2005). In analysing the situation for our different study regions, it became clear that technical feasibility and resulting costs differ from area to area. Complete water logging is not possible for all sites respectively associated with high costs. Therefore in some regions already technical feasibility will limit the implementation of climate-friendly peatland management (c.f. Table 4, row 2).

Regardless of whether technical feasibility of water logging and regeneration of close to nature conditions is given or not, our results show that agricultural stakeholders and farmers through all regions in a large part reject such measures. Also the implementation of new and low profitable, still "agricultural" strategies like suckler cow husbandry is met with disapproval. The refusal was primarily justified by reason of high costs of re-organisation and farm adaptation. Only suggestions like reducing the intensity of current management strategies or implementing climate-friendly renewable-energy production seem to be more appealing. We saw that renewable-energy production has even been implemented in some cases. The enhanced acceptance for reducing intensity we explain by reason of easier adaptation and the fact that comprehensive changes of production processes and technique are not necessary. Regarding the attitude towards cultivating energy crops, farmers stated that given the expectation of adequate prices they prefer market-orientated solutions to measures only feasible given the condition of financial subsidies.

Generally our study shows that particularly in regions, where current production on peatland sites is highly profitable or capital intensive, the attitude towards management changes is rather negative, even given the prospect of financial compensation (c.f. Table 4 row 3). Whenever intensive peatland use is fundamental for farm income, agricultural stakeholders consequently want to maintain or even increase management intensity. Especially for capital intensive branches of production - such as dairy farming - the economic consequences of farm re-organization are likely to jeopardise financial survival, a result that was also confirmed by our first economic calculations. Greatly determining peatland use's importance for farm profitability of course is the average amount of affected area. Potentials of adaptation to and compensation of losses in yield and forage decrease with increasing farms' peatland area. Therefore it is only consequent that in regions where the average percentage of farms' peatland is high, measures are far stronger refused than within regions where farms are affected only by a small amount of acreage.

As a resume we can state that prospects of the implementation of climate-friendly peatland management are influenced by a complex combination of different basic conditions which also go beyond the above described (e.g. traditional ties, uncertainty, personal unwillingness towards changes, etc.) Therefore, what we derive from the current results of our study is that developing implementation measures and programmes of climate-friendly peatland management individually and adapting them to regional conditions seems unavoidable.

At this moment the results we have shown are based on the outcomes of the workshops and farm interviews and mainly mirror the qualitative perceptions of affected stakeholders and farmers.

This is work in progress. The future stage is to assess the farms' technical efficiency in implementing strategies of climate-friendly peatland management, estimating the resulting costs and quantifying and contrasting the effects and profitability of the potential for climate change mitigation resulting from a change in agricultural peatland management.

6. Conclusion and Outlook

Peatlands are the only ecosystems which durably store carbon and consequently are of the utmost importance for climate protection. Agricultural land-use, however, changes the peatlands' function as carbon sinks 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 and this has substantial socio-economic consequences. Even though agriculture can clearly be seen as branch most affected, such re-organisation will go much further: manifold fields of interest such as nature conservation, biodiversity, regional development, etc. 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 even if a re-organisation of peatland use could provide fundamental benefits for society, farmers would have to bear the costs of adaptation and would not profit from such a solution. Against this background, the question arises how either social benefits can be monetarised in order to finance climate-friendly peatland-cultivation strategies or common instruments of agricultural politic can be used to subsidise the farmers' losses. 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.

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. Equally, 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, intensive international negotiations for a future climate regime take place at the moment. The outcomes 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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