

Climate change mitigation via peatland management – Challenges for rural areas

Lena Schaller^a, Rico Hübner^a and Jochen Kantelhardt^b

^a*Institute of Agricultural Economics and Farm Management, Technische Universität München, Alte Akademie 14, 85354 Freising, Germany; lena.schaller@wzw.tum.de, rico.huebner@tum.de*

^b*Institute of Agricultural and Forestry Economics, University of Natural Resources and Applied Life Sciences Vienna, Feistmantelstr. 4, 1180 Vienna, Austria; jochen.kantelhardt@boku.ac.at*

Abstract: *Our study introduces the prospects of climate change mitigation via adapted peatland management. Natural peatlands are the only ecosystems that durably absorb carbon dioxide. Because of this functional principle they store about 30 percent of the world's soil carbon. Therefore, particularly on peatland sites, intensive agricultural use and the related soil degradation cause high emissions of trace gases and have significant negative effects on the greenhouse-gas balance. For this reason, intensive management strategies should be called into question and developed towards less intensive, climate-friendly alternatives. To analyze which prospects exist to implement new management strategies, our study aims to answer the following questions: Are there common factors that foster or repress changes of peatland management? What are the microeconomic consequences affected farms will have to suffer? What is the influence of social networks on the implementation of climate change mitigation strategies? To approach our questions, stakeholder workshops, network analysis and extensive farm surveys were carried out in representative German peatland regions. The results show that a re-organisation of peatland use causes severe loss of agricultural income and necessitates financial compensation for farmers. Furthermore, besides agriculture, changes of peatland management involve manifold fields of interest. Strong socio-economic networks are needed to channel these interests and to facilitate implementations. The results also show that regional conditions vary to a high extent. As a consequence, potentials of rearrangement also are regionally variable and require implementation measures and programmes that are adapted to local conditions.*

Keywords: *Agricultural peatland use, climate change mitigation strategies in rural areas, microeconomic consequences, social network analysis*

Introduction

In the current debate on climate protection, emissions of greenhouse gases originating from agricultural production have become a focal point of interest. The present paper focuses on the climate effectiveness of agricultural management for 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 (CO₂) while emissions of methane (CH₄) take place simultaneously. As the amount of fixated CO₂ in natural peatlands corresponds approximately to the CO₂-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 (Joosten & Clarke, 2002). 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 (Joosten & Clarke, 2002; Turunen et al., 2002, v. Post et al., 1982). Nevertheless, this climate-effective sink depends on the management carried out on the soils and can also transmute into a potential source of the emission of climate-relevant trace gases (Augustin, 2001).

This effect will be outlined using the example of German peatland management. In Germany the function of the peatlands as carbon sinks is nearly lost. This is due to the fact that more than 80% of German peatland is used agriculturally. To enable agricultural cultivation, peatlands have been extensively drained. The related water-level drawdown causes aerobic decomposition and implicates

emissions of CO₂ and nitrous oxide (N₂O). Although methane emissions are usually suppressed after draining, this effect is outweighed by the pronounced increases in N₂O and CO₂ (Kasimir-Klemedtsson et al., 1997). Byrne et al. (2004) demonstrate that emission factors (fluxes) vary significantly for bogs (nutrient poor, ombrotrophic and oligotrophic peatlands) and fens (nutrient rich, minerotrophic, mesotrophic and eutrophic peatlands) and for different management practices. For intensive grassland sites Global Warming Potentials (GWP) (100yr) were numbered as 2367 for bog and 4794 CO₂-C Equivalent kg ha⁻¹yr⁻¹ for fen sites. The carbon losses of intensive grassland are even exceeded by the losses observable for arable land use due to enhanced aeration and related mineralization via ploughing. Arable management shows GWPs with 4400 (bog) respectively 5634 (fen) CO₂-C equiv. kg ha⁻¹yr⁻¹. In contrast, restoration of the sites via rewetting – dependent on the water level – limits or stops aerobic mineralization as well as carbon losses. Here GWPs make up 192 resp. 736 CO₂-C equiv. kg ha⁻¹yr⁻¹ for bogs and 559 resp. 179 CO₂-C equiv. kg ha⁻¹yr⁻¹ for fens (Byrne et al., 2004). In Germany, emissions from peatland which are dependent upon management account for 2.3 – 4.5% of overall German greenhouse-gas (GHG) emission (Byrne et al., 2004). Consequently it appears clear that Germany has great potential for reducing GHG emissions by implementing peatland protection measures.

Climate-friendly management strategies however require a significant change to current land use. In Germany land use on peatland sites is predominantly carried out as arable land and intensive grassland. In contrast, targets of climate protection could only be met by converting the arable land to grassland, decreasing the land-use intensity and re-establishing the original groundwater table (Freibauer et al., 2004, Byrne et al., 2004). Such measures can result in mitigation potentials which lie within a maximum range of about 30 t CO₂-C equiv. ha⁻¹a⁻¹ (Drösler et al, in prep.) but naturally implicate 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 (eg. peatland-type, degradation status, management strategy, etc.), the negative effects (eg. agricultural cost), as well as the achievable positive effects (eg. level of emission reduction, nature protection, etc.) will vary to a great extent and will influence the implementation of measures. Furthermore, new management strategies will be determined significantly by the local stakeholders and their agreement on climate-friendly management strategies.

With this in mind, our study in particular analyses (1) common factors that foster or repress changes in peatland management, (2) consequences and adaptation potentials and (3) the influence of social networks on the implementation of climate change mitigation strategies. Since we assume that potentials as well as effects of climate-friendly peatland management depend fundamentally on local conditions (c.f. Vogel, 2002, Kantelhardt and Hoffmann, 2001), the study focuses on two different German sample regions which are presented 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 applied the instruments “Stakeholder Workshops” and “Network Analysis”. Furthermore, we compiled extensive “Farm Surveys”. The three instruments are described in Chapter 3. The findings of our study will be outlined in Chapter 4 and discussed in Chapter 5. A conclusion is drawn in Chapter 6.

Regions of study

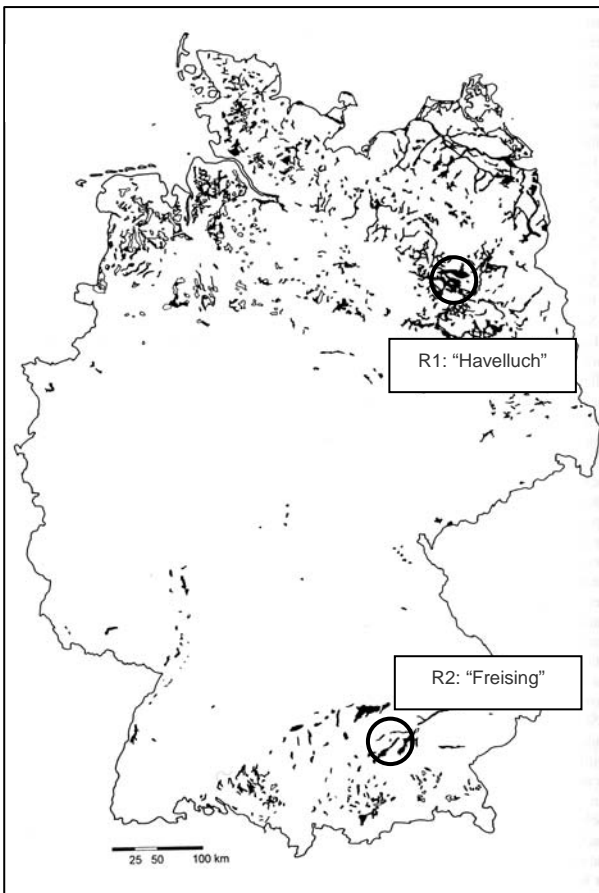


Figure 1. Location of the sample regions (modified from Pfadenhauer and Droesler, 2005)

The two study regions R1 “Havelluch” and R2 “Freising” represent typical natural and agro-economic conditions in the north-east and south of Germany. R1 is located in the Berlin glacial valley and covers about 30,000 ha. It is characterized by fen peat soils which are, as a result of strong drainage, degraded to a high degree. R2 is a fen site fed by a continuous groundwater stream with an extension of about 3,000 ha. Within the core region ecologically valuable litter meadows are maintained under conservation programmes. In both regions peatland is used as grass- as well as arable land for cash- and energy crop, as well as for forage-production. While grassland use in R1 is mainly focused on forage production, within R2 a respectable amount of grass is used for the production of biogas. Basically, due to the decline in dairy-cattle husbandry, within R2 conventional agriculture withdraws from the small-scale areas, some farms practise niche production such as low-intensive animal husbandry or willow cultivation. Comparing the share of peatland area in proportion to the farms’ total agricultural production area, farms in R1, with 63% of peatland area on average, are remarkably higher affected than farms in R2, where the share averages 36%.

Methodical approach

It is assumed that potentials to establish climate-friendly peatland management depend on local site specifics as well as on variable local basic conditions such as economic and agro-political frameworks (cf. Vogel, 2002; Kantelhardt & Hoffmann, 2001). Furthermore, the realisation of new management strategies is influenced by the interests and requirements of different groups of “on-the-spot” stakeholders (Bryson, 2003; Nutt, 2002; Byrons, 2003). Bearing in mind that these factors will presumably vary from region to region, we decided to follow a local approach which allows us to survey local basic conditions as well as to gather specific data for economic analysis.

Our first aim was to find out if there are common retardant and promotional factors of the implementation of climate-friendly strategies of peatland management. Therefore, we had to analyse which specific interests concerning local peatland use are represented by relevant local players and which influence these different interests will have on implementation. Furthermore, we wanted to explore which actors are especially susceptible, which actors show reservations and which actors are likely to become opponents of climate-protective measures related to land-use issues. At this, we organised *Stakeholder Workshops* in both of the study regions. The workshop discussion focused 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. Apart from the party of “Agriculture”, stakeholders from the areas of “Water Management”, “Local Authority and Regional Development”, “Nature

Conservation” and further parties such as science, forestry, tourism, fishery and hunting were included.

For the second step of the study we wanted to identify how the stakeholders are embedded into local networks. Therefore *Network Analyses* were run. Basically we aimed to structure the stakeholders involved in land use according to their political or social entity. Furthermore, a set of metadata on the stakeholders’ views, risk perceptions, autonomies of decision and past activities should be cross-compared. The last objective was to determine the network structures concerning interconnections and intensity of interaction, as well as previous collaboration between actors (Hübner et al., 2008). For the collection of the necessary data a written survey was carried out, using a mail questionnaire that was provided to the stakeholders. 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 VISIONE, Version 2.2.10 (Brandes & Wagner 2004a; 2004b)

To analyse the effects of alternative peatland management strategies on the stakeholders actually affected – namely the farmers – specific micro-economic data had to be collected. Therefore, for the third stage we compiled 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 of and possible adaptation strategies for 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.

Results

Comparing the two sample regions, the results of the Stakeholder Workshops illustrate a significant variability in respect of the stakeholders’ interest in and view on climate friendly peatland management and their estimations about the prospects of implementation. Table 1 gives a short overview of the parties that participated in the workshops.

Table 1. Stakeholder Participation (Number of persons participating at the workshops).

	R1 Havelluch	R2 Freising
Agriculture	6	5
Water management		1
Local authority / Regional development		2
Nature conservation	2	4
Other ¹⁾	3	3

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

During the workshop in R2 “Freising”, a wide range of stakeholders showed complex interests concerning the peatland area. In the course of the discussion on the area’s future development it became obvious that agricultural interests mainly correspond to the objectives of nature conservation. Basically agricultural stakeholders – in view of the possible future developments in agriculture and due to personal and traditional motives – are interested in keeping the peatland under cultivation. However, as the region experiences a voluntary pullback of agricultural use – because local agriculture and especially the husbandry of dairy cattle diminish and the cultivation of the extremely small structured area is no longer profitable – they do not insist on high-level production but are in favour of keeping the area under low intensive, still reasonable agricultural maintenance. The objective of the agricultural stakeholders obliges the interests of the stakeholders of nature conservation; from their point of view the farmers are indispensable in maintaining potential conservation areas. In addition to the interests of agriculture and nature conservation, huge impact comes from nearby Munich Airport and the city of Freising. For these stakeholders the

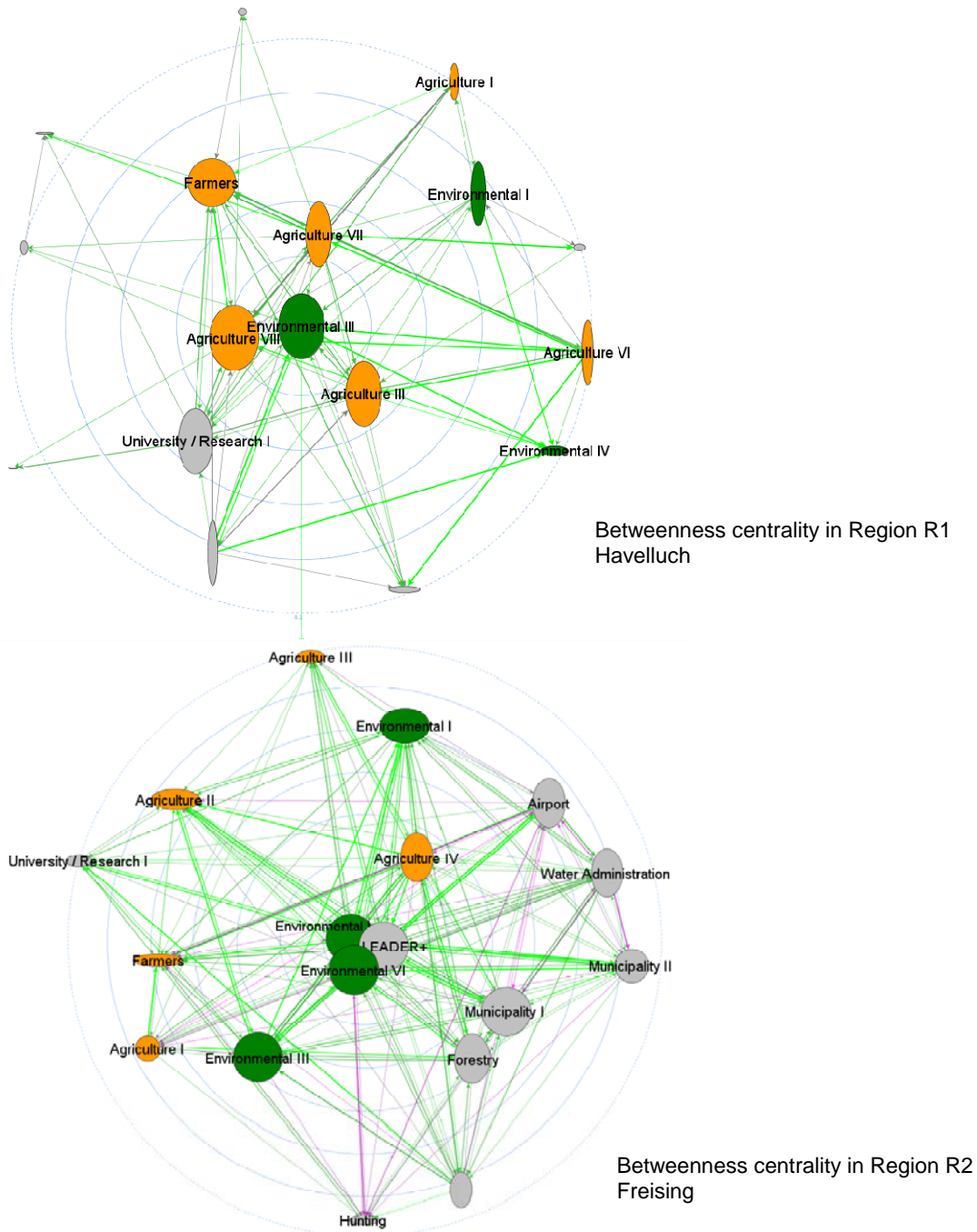
area functions as water reservoir, recreation area and potential ecological compensation area. The manifold interests within R2 are channelled by an efficiently performing local leader group which tries to foster sustainable regional development. The workshop showed that the existing interconnection promotes 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. Due to this situation, a climate-friendly change of peatland use can be considered as comparatively realistic for this region – even though from workshop discussion it also emerged that, from a technical point of view, large-scale water logging and restoration seem to be limited.

Within R1 “*Havelluch*”, mainly agricultural stakeholders showed interest to participate in the workshop. Furthermore, the level of interconnection between participating stakeholders representing different fields of interests, as well as different administrative and institutional levels, appeared to be comparatively low while no special interest was expressed to deepen interconnectedness and collaboration. Regional strategies that could support climate-friendly management are currently neither explicitly pursued by regional development nor by nature conservation. Apart from the limited exchange of ideas between different groups of stakeholders, within R2 another problem became obvious during the workshop: prospects for the technical implementation of water logging are highly limited by low average rainfall and the resulting lack of water. Additionally, according to the statements of water-management experts, 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 would probably turn out to be costly.

Our workshop results showed the high importance of well-established interconnections between the different groups of stakeholders. This result was verified by a Network Analysis. The two sample regions show significant variability in regard to density, strength and tightness of network structures. In Figure 2 the “betweenness centrality” of all relevant stakeholders for the two regions is visualised in a radial layout. This index is expressing whether a player functions as a link between other actors of the network (Real & Hasanagas, 2005).

In R1, the identified network is characterised by a comparably low-network density. Vertical connections are not pronounced. Instead, a strong horizontal separation is evident. Although a high number of actors are present, few communication processes seem to occur. However, four actors are identified to be a relevant authority according to their high betweenness. Three of these actors belong to the agricultural group and one to the environmental group.

In contrast to this, within R2 the analysis displays a tight and highly established network structure. The network extends across a wide range of stakeholders at different administrative levels and shows a strong vertical integration of all key players and a distinct flow of information. Analysing the betweenness centrality in this region, it is evident that three stakeholders occupy a strong central position. Two of them are representatives of the environmental field. What is remarkable is the position of the aforementioned leader group. With its intensive efforts to foster regional development, this actor succeeded in achieving a central position within the network and playing the most significant role as regards channelling and mediating communication between the local actors.



Legend

The colour of links indicates the “degree in commonality in goals”.
The thickness of the links indicates the “intensity of contact”.

- »dominantly contradicting goals«
- »partly contradicting goals«
- »neither common nor contradicting goals«
- »partly common goals«
- »dominantly common goals«

Classification

- agricultural organisation / administration
- environmental organisation / administration
- others

Source: own graphic made with VISONE

Figure 2. Betweenness centrality of relevant stakeholders in the study regions.

Based on the data collected during our *Farm Surveys*, we studied the local farmers’ acceptance and the specific effects and adaptation potentials for the farms. Within R1 the acreage is used as low/middle intensive grassland for dairy- and suckler-cow husbandry, as well as for the cultivation of

cash-, forage- and energy crops. From the farmers' point of view, the current water management appears to be suboptimal for agricultural use. Many sites are controlled inefficiently and vary between extremely dry and wet conditions in the course of one year. Despite these unsatisfactory conditions, the farmers' acceptance of changes in management strategies is low: in particular the reduction of production intensity or the introduction of measures which demand a substantial change in farm organisation (eg. the implementation of a low-intensive pasturing, see Table 2) are clearly rejected. As the farms' average share of peatland is comparatively high at 63%, and consequently farm income is first and foremost created on peatland area, farmers aim rather to push forward an improved water management to be able to optimise and intensify agricultural production in order to increase farm income.

Table 2. Acceptance of climate-friendly management strategies¹⁾

		R1 "Havelluch"	R2 "Freising"
Less Intensive Grassland Management	a) reduced intensity of fertilizer, reduced crop frequency	25 %	41 %
	b) low- intensive pasturing, suckler cows	15 %	21 %
Cultivation of adapted energy crops		40 %	53 %
Termination of production / Restoration of natural conditions		30 %	32 %

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

For R2 potentials appear in a different light. First of all, income aspects do not present a significant obstacle to alternative peatland use. R2 is characterised by a comparatively low share of peatland per farm (36%) as well as by good options of alternative income. Furthermore, as mentioned above, local agriculture and in particular the husbandry of dairy cattle diminishes. Against this background – as the farmers are not extremely dependent on forage produced on the sites – in particular peatland area managed as grassland loses its agricultural usability and the cultivation of the small structured peatland area is not competitive anymore. Consequently, farmers in R2 show higher acceptance of decreasing intensity or of implementing new and reasonable management strategies (eg. cultivation of adapted energy crops, see Table 2). To a certain extent, farmers have already implemented such strategies as an alternative to conventional agricultural (eg. grass for biogas production, willow cultivation, production of flower-seed). Generally, for farmers in R2 adaptation to changes of peatland use appears possible, if fair compensation is paid.

Discussion

The results produced in our study show that potentials for the development of agricultural land use vary throughout different regions. Different and locally specific basic conditions significantly influence the perspectives of climate-friendly peatland management. When we analyse the results of our *Network Analysis*, *Stakeholder Workshops* and *Farm Surveys* we find various factors having remarkable impact (eg. natural finiteness of agricultural usability of peat soils, options of adaptation, required compensations, standard of knowledge, etc.) However, cross-comparing the regions we could observe that there exist three main factors which determine the potential to implement measures for peatland conservation.

Firstly, the existing level of interconnection and cooperation between local stakeholders: The results of *Network Analysis* and *Stakeholder Workshops* indicate that the potential for establishing a climate-friendly peatland management is influenced by a variety of players. Some of the stakeholders advance very specific and targeted interests (eg. agriculturists, water managers, nature conservationists), while others represent more comprehensive objectives (eg. regional development). Furthermore, the corresponding or contradictory character of the interconnectedness of stakeholders is locally differentiated to a great extent. As density and tightness of the network structures stand 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”.

The second important factor which we were able to identify is the technical feasibility of restoration and water logging. Stakeholders representing the field of water-management at our workshops made it clear that an implementation of climate-friendly land use – requiring the increase of groundwater tables – is, from a technical point of view, not possible in all regions or technically complicated and brings with it high implementation costs. Consequently, in some regions the positive effects of climate protection will be outweighed by unreasonable mitigation costs.

Lastly, as the third factor, implementation is strongly influenced by the level of agricultural profitability of peatland cultivation concerning income and capital commitment. The results of our *Farm Surveys* show that, even allowing for the prospect of financial compensation, the acceptance of climate-friendly management strategies in the regions is rather low. The farmers justify their refusal primarily by reason of high costs of re-organisation and farm adaptation, which would have to be financially compensated. In particular, measures which demand a substantial change in farm organisation (eg. the implementation of low-intensive pasturing) are rejected while strategies to reduce the intensity of the current management strategy or to implement climate-friendly renewable-energy production are more appealing to the farmers. However, we concluded that agriculture’s acceptance of changes in management diminishes whenever the current production on peatland sites is fundamental for farm income, highly profitable or capital intensive. In particular for capital intensive production – like dairy farming – and for farms with high shares of peatland area, the economic consequences of farm re-organisation are likely to jeopardise financial survival, a result also confirmed by our economic calculations.

Discussing our results we must draw attention to the system boundaries within which our study is conducted. At the moment we analyse regionally specific and farm-individual potentials of land-use changes on agricultural sites within single peatland areas. By doing so, the effects of management changes which emerge beyond these system boundaries are not considered. Production limitations on peatland sites can cause production-“exports” or an intensification of production on alternative area. Naturally such adaptation measures can also show negative climate effects (eg. intensified fertilisation, enhanced transport, land-use changes for the creation of alternative UAA, etc.). Therefore, for the derivation of macroeconomic and even global cost-benefit relations of a climate-friendly peatland management, profound scenarios involving effects within much broader system-boundaries would have to be analysed.

Conclusion

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. A 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.

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.

Finally it should be noted that our results were created within narrow system boundaries which do not allow for consideration of further relevant macro-economic cost and benefit positions taken to have a significant influence on abatement costs. In order to fill these gaps, future research is planned.

Acknowledgements: Work has been granted by the Federal Ministry of Education and Research (FKZ 01LS05047)

References

- Augustin, J. (2001) Emission, Aufnahme und Klimarelevanz von Spurengasen. In: M. Succow and H. Joosten (ed.) *Landschaftsökologische Moorkunde*, 2nd ed., Schweizerbarth, Stuttgart: 28-37.
- Brandes, U. and D. Wagner (2004a) Netzwerkvisualisierung, *Information Technology* 46(3): 129-134.
- Brandes, U. and D. Wagner (2004b) Visone - Analysis and Visualization of Social Networks. In: Jünger, M. and P. Mutzel (ed) *Graph Drawing Software*. Berlin: Springer, pp. 321–340.
- Bryson, J. M. (2003) What To Do When Stakeholders Matter: A Guide to Stakeholder Identification and Analysis Techniques. *Public Management Review* 6(1): 21-53.
- Byrne, K.A., Chojnicki, B., Christensen, T.R., Drösler, M. and A. Freibauer (2004) EU peatlands: Current carbon stocks and trace gas fluxes. *CarboEurope-GHG Concerted Action – Synthesis of the European Greenhouse Gas Budget, Report 4/2004*, Specific Study, Tipo-Lito Recchioni, Viterbo.
- Drösler, M., Freibauer, A., Höper, H., Augustin, J., Sommer, M., Kantelhardt, J., Schaller, L. and U. Petschow, (in prep.). *Klimaschutz durch Moorschutz*
- Freibauer, A., Rounsevell, M., Smith, P. and A. Verhagen (2004) Carbon sequestration in the agricultural soils of Europe. *Geoderma* 122(1): 1-23.
- Hübner, R., Kantelhardt, J. and L. Schaller (2008) *Climate protection - land use in peat-land areas: Network analysis as a method for actors and systems analysis*. In Daub, C.-H., P. Burger and Y. Scherrer (ed.) *Creating Values for Sustainable Development - Proceedings of the 2nd International Sustainability Conference*. Basel, Schweiz, 21-22 Aug. 2008.
- Joosten, H. and D. Clarke (2002) Wise Use of Mires and Peatlands – Background and Principles including a Framework for Decision Making. *International Mire Conservation Group and International Peat Society*, Finland
- Kantelhardt, J. and H. Hoffmann (2001) Ökonomische Beurteilung landschaftsökologischer Auflagen für die Landwirtschaft - dargestellt am Beispiel Donauried. *Berichte über Landwirtschaft* 3: 415-436.
- Kasimir-Klemetsson, A., Klemetsson, L., Berglund, K., Martikainen, P., Silvola, J. and O. Oenema (1997) Greenhouse gas emissions from farmed organic soils: a review. *Soil Use and Management* 13: 245-250.
- Nutt, P. (2002) *Why Decisions Fail: Avoiding the Blunders and Traps That Lead to Debacles*. Berrett-Koehler Publishers Inc., San Francisco, USA.

- Pfadenhauer, J. and M. Driesler (2005) *Climate change mitigation via peatland conservation*. Project submission, unpublished.
- Post, W., Emanuel, W., Zinke, P. and A. Stangenberger (1982) Soil carbon pools and world life zones. *Nature* 298: 156-159.
- Real, A.T. and N.D. Hasanagas (2005) Complete Network Analysis in Research of Organized Interests and Policy Analysis: Indicators, Methodical Aspects and Challenges. *Connections* 26(2): 89-106.
- Turunen, J., Tomppo, E., Tolonen, K. and A. Reinikainen (2002) Estimating carbon accumulation rates of undrained mires in Finland – application to boreal and subarctic regions. *The Holocene* 12(1): 69-80.
- Vogel, T. (2002) *Nutzung und Schutz von Niedermooren: empirische Untersuchung und ökonomische Bewertung für Brandenburg und Mecklenburg-Vorpommern*. Der Andere Verlag, Osnabrück.