Reducing GHG emissions by abandoning agricultural land use on organic soils

- A cost assessment -

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ABSTRACT

Roughly 4.9% of the German utilized agricultural area is located on organic soils (fens and bogs). Nevertheless, the drainage of these areas in order to allow their agricultural utilization causes roughly a third of the greenhouse gas emissions (GHG) of the German agricultural sector, being equivalent to 2.3% of the total German GHG emissions. Obviously, German policies trying to reduce the GHG emissions successfully must tackle this issue. The abandonment of the cultivation of organic soils would be an effective policy to reduce the GHG emissions however the question remains whether it is an efficient measure compared with the other options?

In the paper we assess the mitigation costs on the basis of the standard gross margin and tenure of the agriculturally used peatlands and with the sector model RAUMIS. Without engineering and transaction costs the mitigation costs are below 50 € per Mg CO_{2eq}. This makes rewetting of peatlands at least in the medium and long run a fairly efficient options for reducing GHG emissions, especially as the implications on the sector due to reallocation affects are fairly small.

Keywords: GHG-Mitigation, Landuse, peatland

1 Introduction

Undrained peatlands accumulate plant remains in waterlogged and usually acidic conditions over thousands of years. However, if these areas are drained the oxidation of the organic material starts and the peatland turn from being a net sink of Greenhouse gases (GHG) into a net emitter.

Around the world, peatlands cover roughly $3.8 * 10^8$ ha (JOOSTEN, 2009). JOOSTEN (2009) estimates that the agricultural use of peatlands induces global GHG emissions in the magnitude of 1.09 * Pg $CO_{2eq.}$ a^{-1}. This is equivalent to roughly 13%-17% of the non-CO_2-emmisions of global agriculture (USEPA, 2006). However, agricultural used peatlands cover only 0.8% to 1.7% of the global agricultural area. The estimate is based on the data provided by JOOSTEN (2009) and OLESZCZUK et al. (2008) regarding the extent of agriculturally used peatlands and the extent of the global agricultural land of $5.0 * 10^9$ ha (FAOSTAT, 2010).

In contrast to other agricultural emissions, like N_2O emissions from fertilization, the emissions from peatland are not necessarily correlated to the volume of production. The by far largest emitter is Indonesia, followed by Russia, and China, Mongolia, USA, Germany and Malaysia (JOOSTEN, 2009). The Top Ten emitters are accountable for more than 80% of the global GHG emissions from peatlands in 2008. Especially in South-Asia the emissions literally skyrocketed in the recent decade. Emissions from drained peatlands used for agriculture are an important source of agricultural GHG emissions primarily in Asia and Europe.

For Germany, the annual THG emissions of drained peatland are in the magnitude of 16-30 Mg $CO_{2eq.}$ ha^{-1} a^{-1} for grassland and30-42 Mg $CO_{2eq.}$ ha^{-1} a^{-1} for arable land (HÖPER, 2007, DRÖSLER et al., 2011). The current GHG inventory estimates the emissions from peatlands in the magnitude of roughly 5% of the total German GHG emissions or 40% of GHG emissions related to agricultural sector in 2009 (UBA, 2011). Even if the size of peatland is estimated more conservatively the emission from peatland are still in the magnitude of 2.3% of the total German GHG emissions (ROEDER & OSTERBURG, submitted). Obviously, German policies trying to reduce the GHG emissions successfully must tackle this issue. In most cases the GHG emissions from the cultivation of peatlands can only be markedly reduced if the water table is altered implying an abandonment of agriculture or at least a significant reduction of the land use intensity. The abandonment of the cultivation of peatlands would be an effective policy to reduce the GHG emissions however the question remains whether it is an efficient measure compared to other options.

Up to now the economic implications of a rewetting of agriculturally used peatlands were mainly analyzed at farm level (e.g. KANTELHARDT & HOFFMANN, 2001; SCHALLER & KANTELHARDT, 2009, SCHALLER et al., 2011). To our knowledge the only regional study, that discusses this option as a mitigation strategy is conducted for Swiss agriculture (HARTMANN *et al.*, 2005). However, the authors exclude this effective option from their cost calculation as in Switzerland wetland restoration would primarily affect horticulturally used areas, making this option rather expensive.

Forage cropping and in particular dairy farming play an important role in the agricultural utilization of German peatlands (ROEDER & OSTERBURG, submitted). This fact complicates the derivation of a reliable cost estimate, as especially dairy farming is characterized by a significant share of sunk costs, as most of the capital is fixed in immobile and inalienable assets as stables and milking facilities. Therefore we use the standard gross margin (SGM), the tenure and the gross value added (GVA) to obtain the short, medium and long term costs of abandoning the agricultural use of peatland. While the SGM and tenure are derived from the farm structure survey the GVA is calculated with agricultural sector model RAUMIS.

In particular we are interested in three questions: How do the SGM and tenure respond to change in the share of peatland on the municipality level? Do the distributions of the SGM and tenure for peatland differ between the different parts of Germany? How high are the CO_2-abatement costs for the abandonment of peatlands?

The paper is structured as follows. First, we will outline the used data. Second, we briefly explain the applied method for the statistical analyses and modelling. The result section is bisected. After we describe the agricultural use of peatland, we present the assessments regarding the mitigation costs. The paper closes with a brief discussion and outlook.

2 Material

To assess the land use on German peatlands, we disaggregate the information in the available data sources up to the municipality level. For the calculation of the area of agriculturally used peatlands we use an algorithm comparable to the one implemented in the German GHG inventory (HAENEL, 2010, p. 351). In contrast to HAENEL (2010), we delimit the extent and distribution of peatland with the help of the Geological Map of Germany at scale 1:200,000 (GUEK 200) (BGR, 2003) and not the Soil Map of Germany at a scale of 1:1,000,000 (BGR, 2010). For each municipality we calculate the share of grassland and arable land on peatland, using the Digital Landscape Model (Basis-DLM) for Germany (BKG, 2008). The BASIS-DLM maps the distribution of different land uses at the scale of 1:2,500. We supplement this data with information on agricultural land use provided by the farm structural survey ((ASE): FDZ, 2010). This data is based on the full sample of the German farm population and is available for the years 1999, 2003 and 2007. The highest spatial resolution of the ASE is the municipality. However, one must bear in mind that the ASE does not map the farms' activities according to the location of the plots but of the farms' headquarters. This might especially induce some bias in

Eastern Germany and Schleswig Holstein, where the farms are comparably large, measured in ha, compared to the size of the municipalities.

3 Methods

The GHG emissions of the different land uses are derived from DRÖSLER et al. (2011). The assumed emission reduction is equivalent to the difference between the emission factor of the current land use and the one for the category „naturnah/renaturiert (natural/restored)“ Forage cropping is of outstanding relevance in the agricultural utilization of German peatland. Furthermore, the GHG emissions from grassland are strongly linked to the drainage level. As intensively managed grassland requires well drained soils, we attribute grassland to the category “Grünland intensiv mittel (intensive grassland with average drainage status)” if the farm’s average stocking density of grazing livestock per ha main forage area exceeds 1 livestock unit (LU) per ha and to the category „Grünland extensiv trocken (extensive grassland well drained“ if the stocking density is below 0.5 LU per ha. Between these thresholds the emission factor for grassland is linearly interpolated.

We calculate the opportunity costs of abandoning peatland in three different ways (SGM, tenure and gross value added) to reflect different time horizons and therefore degrees of flexibility by the land manager. The SGM is a measure for the short term opportunity costs as it assumes that all production factors (e.g. land, labour, building, machinery) are fixed and can not be alienated, that the intensity of farming is fixed, and that the relative shares of the activities remain constant. This means a mixed cash cropping dairy farm will proportionally cut back its cash cropping activities and dairy herd in case it looses land. However, in reality in such a farm the extent of cash cropping will be over proportionally reduced.

The tenure is more a measure of the mid-term opportunity costs as some of the farmers’ fixed costs are incorporated in their willingness to pay for additional land. However, it has several drawbacks. First, as an empirical measure, it can not take into account shifts in the supply of land implied by a certain scenario. Second, the German land market is characterized by long lasting tenure contracts (MÖLLER et al, 2010). Therefore the tenure depends more strongly on the average profitability in the past than the current one. Third 1999 was the last year when tenure was recorded for all farms in the ASE. However, from

1999 till 2007 the average tenure for a representative subsample of farms rose by 21 and 13 € per ha for arable and grassland, respectively.

For the calculation of SGM per ha the German average SGM (without 1. pillar subsidies) for the years between 2000/01 and 2006/07 of a given activity is weighted with the respective activity level and divided by the agricultural area.

SGM and tenure are derived from the ASE and reflect observed values. In order to get a better picture of the intra- and interregional heterogeneity of the costs we calculated both indicators on farm and county level.

The GVA is a measure of the long term opportunity costs as all fixed factors must be paid. In contrast to the previous indicators it is not derived directly from empirical data but calculated by a model, the German agricultural sector model RAUMIS (regionalised agricultural and environmental information system for Germany) (WEINGARTEN, 1996; ROEDENBECK, 2004). RAUMIS has an activity based non-linear programming approach. The partial supply model covers the entire German agricultural sector and depicts agricultural production activities in consistency with the economic accounts for the sector. We differentiate 77 crop activities (including set-aside programmes and less intensive production systems) and 16 activities for animal production. From a regional point of view the model covers 326 model regions at county-level (comparable to NUTS 3). These model regions are equivalent to the smallest optimising unit for the programming approach.

For the simulation of abandonment of peatland use, we implement an incremental tax of 300 to 1200 € for UAA on peatland. We perform simulations for the target year 2019, using a baseline projection of the current agricultural policy (OFFERMANN et al., 2010). Full decoupling of direct payments and regional flat rate payments for both arable and grassland are considered as well as the abolishment of the milk quota.

In tendency our approach will underestimate both the intensity and the SGM of farming on peatland, due to a peculiarity of German agriculture. In 2007, already on 17% of the silage maize was used as substrate for the production of biogas (FDZ 2010). Unfortunately, neither the SGM for silage maize for biogas is available nor exists reliable, high resolution data on its distribution for Germany as a whole. Our approach treats all areas cultivated with silage maize as main forage area, therefore underestimating the "real" stocking density and we apply the reported SGM for silage maize used as feedstock.

In order to account for the regional difference in German agriculture, we divide our sample into four study areas reflecting regions, which differ in their contribution to the area of agriculturally used peatlands and in their farm structure (Tab.1). The study areas are selected on the basis of the German *Laender*. Especially the two study areas **NW** and **NE** are characterised by high shares of UAA on peatland. While only 38% of the German UAA is located in these areas, more than 85% of the agricultural used peatland can be found in these two regions.

Table 1: Definition of the study areas for the regionalized analyses

	Laender	**Share of national UAA on peatland**	**Share of national UAA**	**General farm structure**
NW	Schleswig-Holstein, Lower Saxony, (Bremen, Hamburg)	48%	22%	large family farms
NE	Mecklenburg-Western Pomerania, Brandenburg, (Berlin)	37%	16%	large commercial farms
SO	Baden-Wurttemberg, Bavaria	9%	27%	small family farms
CE	All others	7%	35%	

Source: Own calculation based on FDZ (2010), BKG (2008) and BGR (2003)

We use POSTGRES®8.213 and POSTGIS®1.3.3. to handle the geographical data and SAS®9.1 for the statistical analysis.

4 Results

4.1 Extent and distribution of agriculturally used peatland in Germany

High shares of utilized agricultural area (UAA) on peatland can especially be found in North-western part of Lower Saxony, the central part of Schleswig-Holstein, Mecklenburg-Western Pomerania, Brandenburg and the Southern part of Bavaria (Fig. 1). While peatlands cover large contiguous areas in the North and East of Germany, their distribution is more locally concentrated in the South and more or less restricted to the area south of the Danube. Based on the GUEK 200 we estimate 980 000 ha UAA are located on peatland (~4.9% of Germanys UAA).

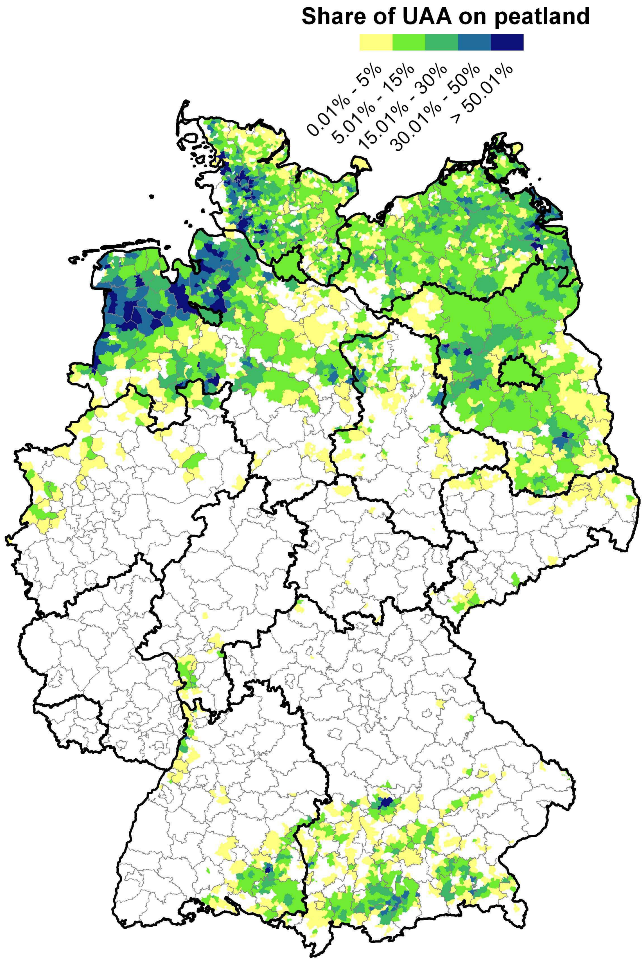
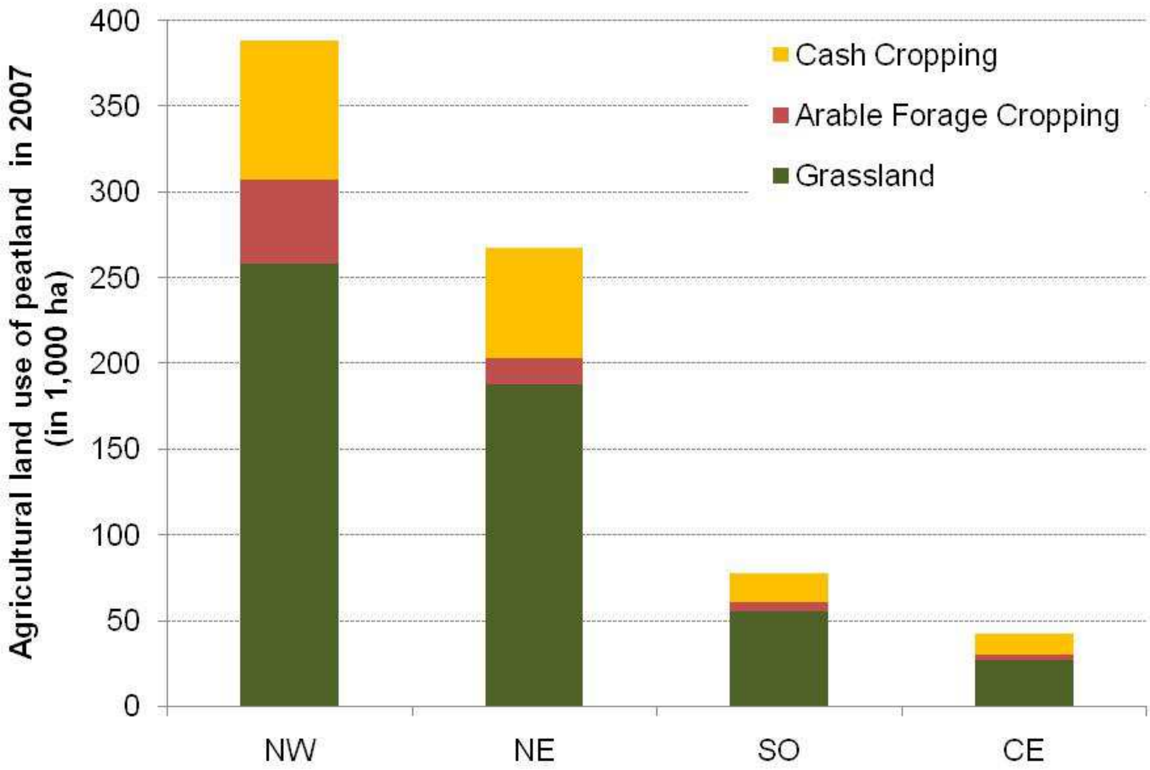


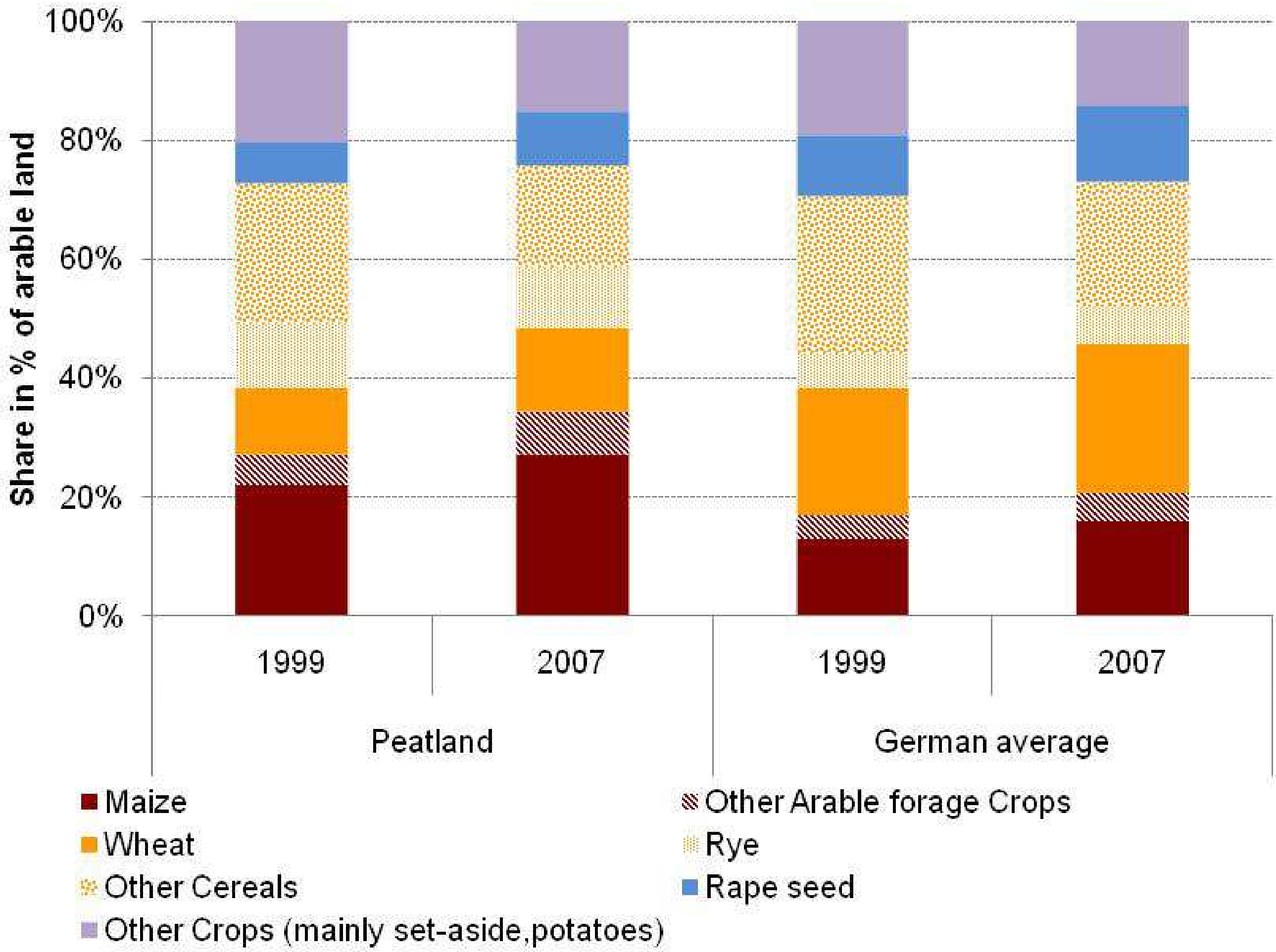
Figure 1: Distribution of the utilized agricultural area (UAA) on peatland in Germany
Source: Own presentation based on BKG (2008) and BGR (2003)

Fig. 2 depicts the utilization of UAA on peatland for the four study areas. In all areas roughly a third of the peatland is used as arable land. Roughly 77% of the UAA is devoted to forage cropping. Most of the forage is used to feed the local dairy herds. In **NW** arable forage cropping (mainly silage maize) is conducted on 12% of the UAA on peatland or 37% of the arable land on peatland. These are twice the shares of the other study areas. Between 1999 and 2007, the share of arable land on UAA rose by 7% in **NW**, while it remained constant in the other areas.



Source: Own presentation based on FDZ (2010), BKG (2008) and BGR (2003)

Compared to the national average maize and rye are more widespread on peatland (Fig. 3). This goes at the the expense of wheat and rape seed. This difference between the use of organic and mineral soils is particularly pronounced in the western German peatland areas. In eastern Germany the difference in the utilization of organic and mineral soils is much smaller. These smaller differences do not necessarily indicate a similar use of organic and mineral, but may be due to the large farming structures prevalent in eastern Germany. Due to these large structures it is fairly likely that in particular the impact of smaller peatlands is levelled within a single farm. The cropping pattern is fairly stable between the different regions. The only exemptions are the high importance of potatoes in Bavaria and Lower Saxony (more than 10% of the arable land) and silage maize in **NW**. Between 1999 and 2007 similar changes in the crop rotation could be observed on organic and mineral soils. In this period the share of maize, winter wheat and rape seed expanded on the expense of other cereals, in particular summer cereals.



average between 1999 and 2007

Source: Own presentation based on FDZ (2010), BKG (2008) and BGR (2003)

Fig. 4 depicts for the different study areas the accumulated share of main forage area as a function of the stocking density. **NE** is characterized by low intensities whereas high densities are prevalent in particular in **SO** and **NW**. In **NE** 70% of the main forage area on peatland is stocked with densities below one grazing LU per ha. This share is below 10% both in **SO** and **NW**.

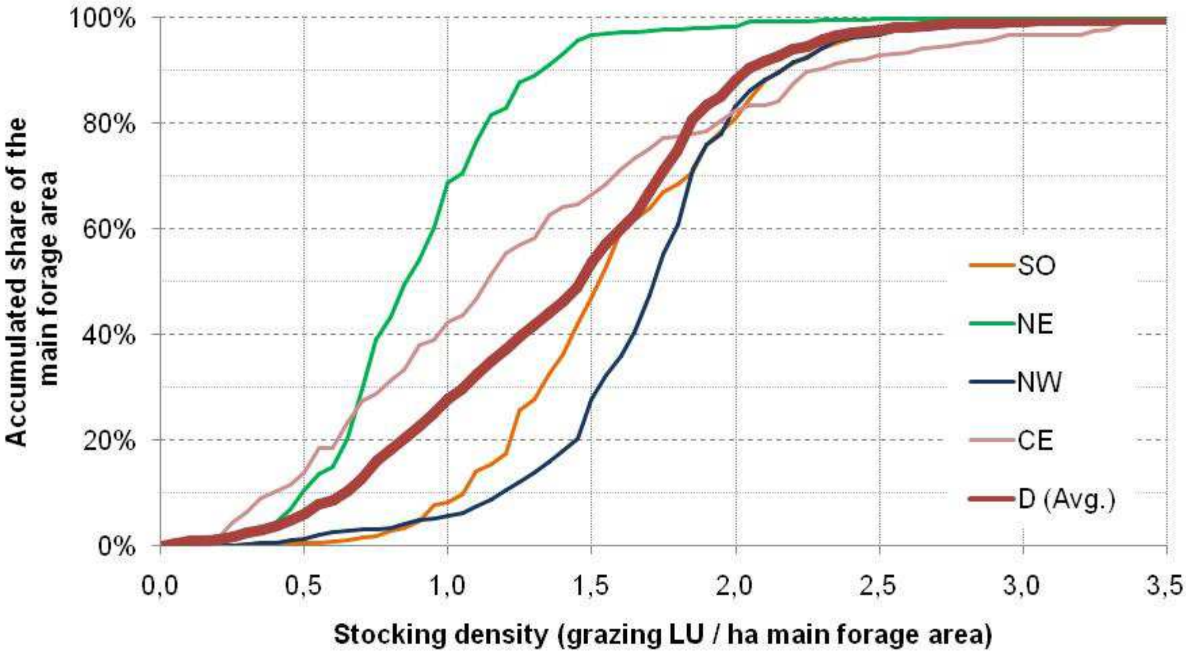


Figure 4: Intensity gradients for the use of main forage area on peatland in the study areas (2007)
Source: Own presentation based on FDZ (2010), BKG (2008) and BGR (2003)

The effect of abandoning and rewetting of agricultural used soils depends crucially on the current emissions. These emissions are basically a function of the drainage level and the peat type. However, no German wide information on the drainage level of peatland is available. Therefore we model the emissions based on the assumption that intensively managed areas are well drained. This assumption is pretty plausible for intensive land uses. However, it is harder to establish a connection between land use intensity and drainage level for the lower end of the intensity gradient, as areas could have been well drained in past and the drainage is still operating while livestock numbers dropped in the recent years due to economic reasons. Therefore we estimate the total GHG emissions by choosing different threshold values to delimit grassland of different intensity and drainage status (Table 2). Irrespective of the chosen threshold values the emissions are in the magnitude of roughly 20 Pg CO_{2eq} per year.

Table 2: Mitgation potential by a rewetting of agricultural used peatland (Pg CO_{2eq} per year)

	Optimistic assumptions (0.5 / 1 / 1.5)[1]	**Intermediate assumptions (0 / 0.5 / 1)**	**Pessimistic assumptions (0 / 0.2 / 0.5)**
Arable land	7.7	7.7	7.7
Grassland	11.8	13.8	14.5
Total	***19.5***	***21.5***	***22.2***

Source: Own calculation based BKG (2008) and BGR (2003) and DRÖSLER et al. (2011)
1) Threshold values (grazing LU per ha of main forage area) used to delimit wet extensively used grassland, dry extensively used grassland and intensively used grassland

4.2 Response of SGM and tenure to the share of peatland

The higher share of grassland in areas with higher shares of peatland does not mean that the utilization of peatland is in economic terms less intensive compared to mineral soils. This is indicated by the positive correlation between the SGM and the share of UAA on peatland (Figure 5). The increasing SGMs per ha is due to the general positive correlation between the stocking density and the share of peatland (ROEDER & OSTERBURG, submitted). The increasing stocking densities in peatland rich areas can mainly be attributed to a concentration of dairy farming in these areas.

While the SGM shows a clear response to the share of peatland, the increasing SGM are not mirrored by a similar trend in the tenure for grassland. The tenure for arable land is not shown as the sample in particular for areas with higher shares of peatland is too small.

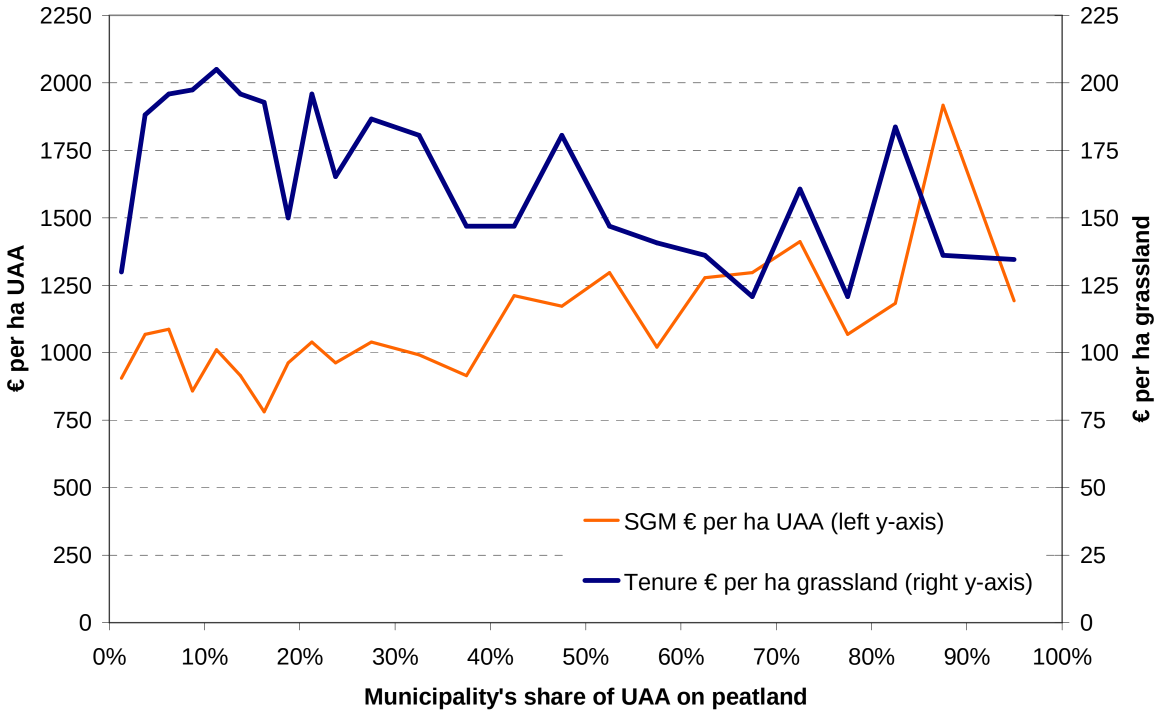


Figure 5: Localization index for the Standard gross margin (SGM) in 2007 and tenure for grassland (1999) as a function of the share of UAA on peatland

Source: Own calculation based on FDZ (2010), BKG (2008) and BGR (2003)

4.3 Distribution of SGM and tenure in the different regions

In the following section we present the results of the analysis of the cumulative density distribution (CDD) to describe the intensity gradient in the use of peatland. We present mainly results for the year 2007 as the differences between the years are generally negligible. The data for the study area **CE** are not shown as this study region summarizes *Laender* with a completely divergent farm structure in West and East Germany. Regarding the interpretation of the graphs one should keep in mind that the steeper the depicted curve is the smaller is the observed gradient.

An analysis on farm and county level based on the SGM as indicator for the short term opportunity costs of abandoning the utilization of peatland shows great differences between the study areas (Figure 6). On farm level, the lowest median values are found in **NE** (570 € per ha) while the median reaches 1,700 € per ha in **NW**. In **NE** the differences in the productivity at farm level are comparatively small. This is indicated by the steep form of the function and the narrow inter quantile range (IQR) of roughly 420 € ha. In contrast the IQR in **SO** is nearly three times as wide. In **NW** the CDD of the county averages follows the distribution of the data at farm level, at least for the top-left part of the graph. This implies that here farms with a high SGM per ha are frequently located in areas where the regional average is also high. In contrast the form of the function is very steep in **SO** and **NE** implying that at county level high SGMs of single farms are levelled out by low SGM of other farms.

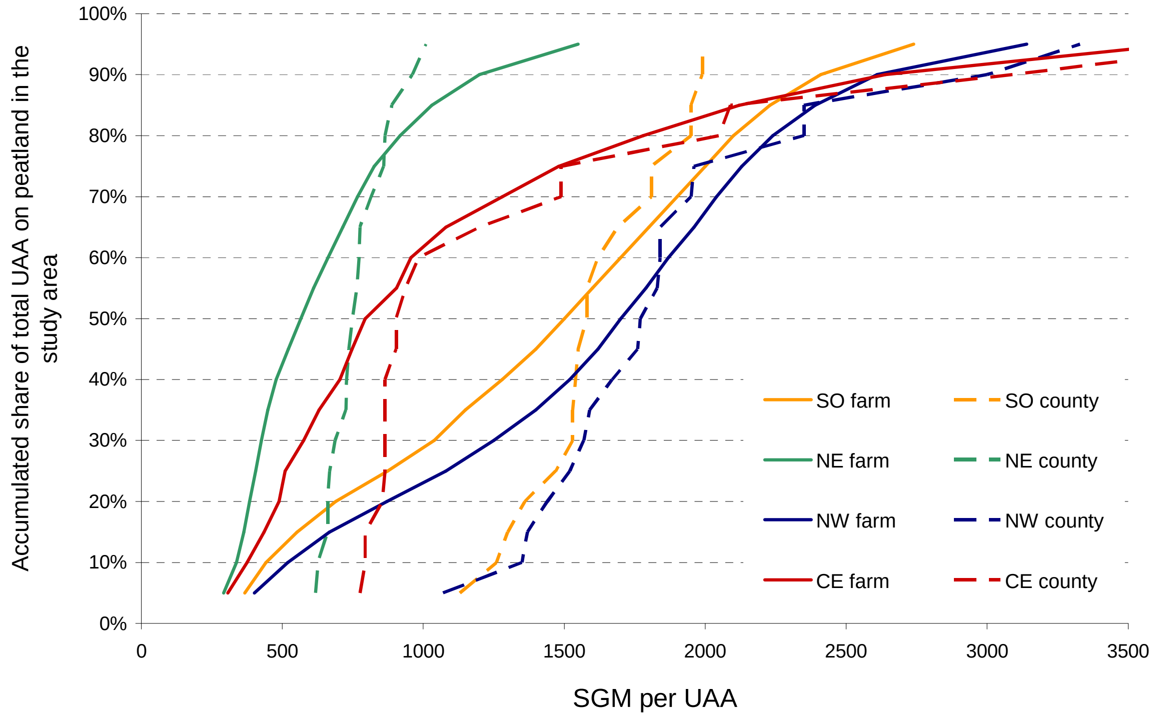


Figure 6: **Cumulative density distribution of UAA on peatland as a function of the standard gross margin (SGM) (€ per UAA ha) in the four study areas in 2007 at farm and county level**

Source: Own calculation based on FDZ (2010), BKG (2008) and BGR (2003)

In contrast to the SGM presented in Figure 6 the land rental payment per hectare (tenure) is an indicator for the mid term opportunity costs. Unfortunately data on tenure are only available for the full sample of German farms for 1999. Only data on the farms' average tenure could be used as the information on recent contracts is rather sporadic. We assume that the presented figures underestimate in tendency the current tenure.

With respect to the tenure the differences between the study areas are much smaller than for the SGM (Figure 7). This can be explained by the fact that dairy farming, which is of particular importance in **NW** and **SO**, is associated not only with a high SGM but also with high fixed costs and labour demands per ha. The median tenure lies between 50 € in **NE** and 165 in **NW** and **SO**. Also the tenure varies much less in the **NE** (IQR of 70 €) compared to the **SO** and **NW** (IQR of 235 €). Interestingly, in all study areas a quarter of the UAA on peatland is used by farms who did not state any tenure or a tenure of zero. Especially in **NE** and **SO** the differences in the tenure on county level are rather small (IRQ of 20 and 55 €)

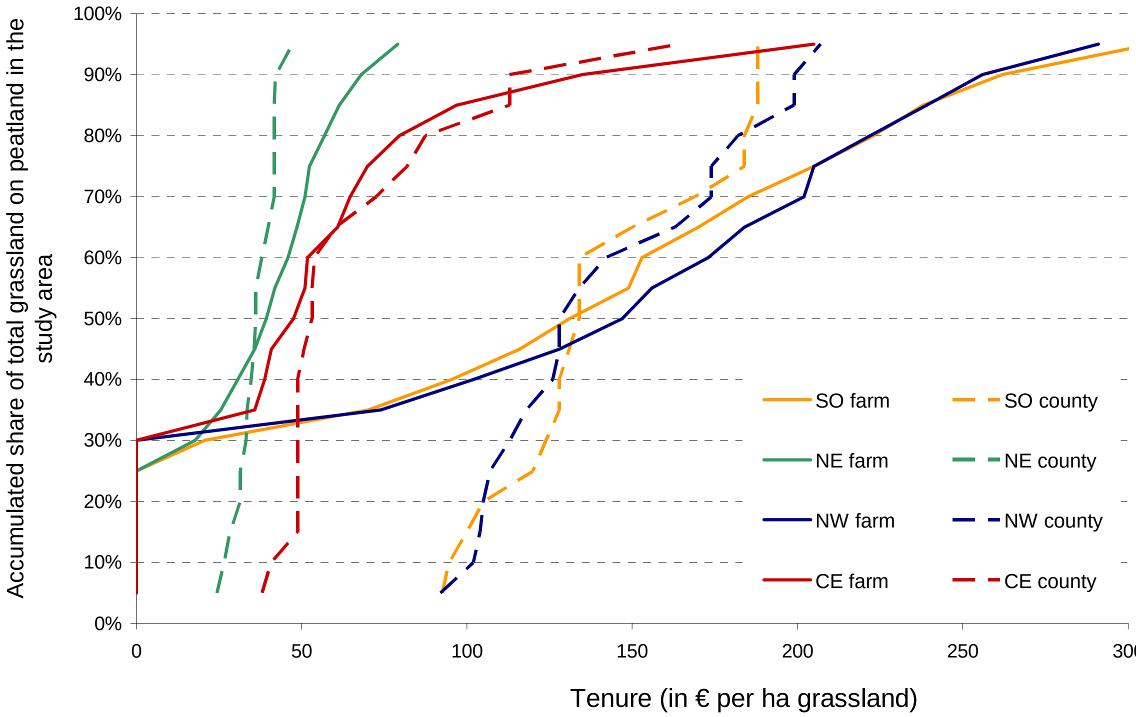


Figure 7: Cumulative density distribution of UAA on peatland as a function of the average tenure in the four study areas in 1999 at farm and county level

Source: Own calculation based on FDZ (2010), BKG (2008) and BGR (2003)

4.4 Results of model simulations with RAUMIS

We assume that restored wetlands are not eligible for direct payments related to agricultural land. The tax implemented on peatland has thus to exceed the returns on arable or grassland use, including direct payments. If the tax would be in the magnitude of the direct payments (300 € per ha (= net tax of 0 € per ha) about a third of the agriculturally used peatland would be abandoned (Figure 8). The introduction of a land use tax leads to reduction of marginal land uses, such as grassland at very low stocking densities, set-aside and coarse grain. In case of these activities, part of the direct payments covers the production cost, so that areas are abandoned more easily. In parallel, temporary grassland is increased on remaining arable land as a substitute for lost permanent grassland. Up to a net tax of 400 € per ha the area of marginal arable crops and especially grassland is increasingly reduced, and almost 80 % of all peatland under agricultural use is abandoned. At higher tax rates less additional area is abandoned, because more competitive land uses have to be reduced. For example, green maize a comparatively competitive crop, used e.g. for subsidized biogas production, is significantly reduced only at higher tax rates.

Impacts on agricultural output are limited compared to the reduction of 2 % of total arable land and 10 % of grassland. In case of dairy production, output drops by less than 1 %, while wheat and beef are reduced by 3% to 4 %. Furthermore, the employment effects are relatively small.

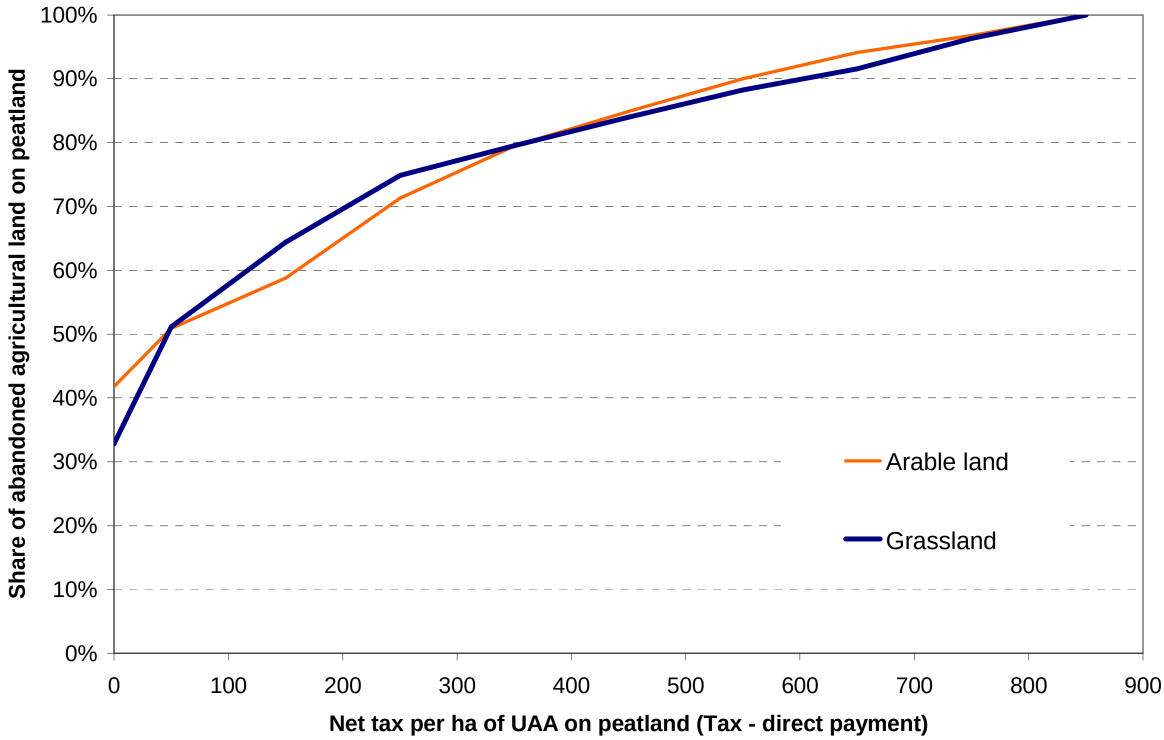


Figure 8: Share of abandoned agricultural land in dependence of a tax on the utilization of peatland

Source: Own calculation based on RAUMIS.

4.5 Mitigation costs

In a final step we calculate the mitigation costs based on the potential saving of GHG emissions and the different assessments of opportunity costs. With exemption of the cost assessments based on the SGM the mitigation costs are below 10 € per Mg CO2eq per year. Generally the abatement costs are lower for arable land since the greater potential saving of GHG emissions outweigh the higher costs per ha.

Table 3: Mitgation costs per Mg CO_{2eq} per year of abandonment and rewetting of agricultural used peatland in dependence of the calculation method

Calculation Method	Q25	Arable land Median (Avg.)	Q75	Q25	Grassland Median (Avg.)	Q75
SGM	19	33 (36)	50	27	42 (42)	54
Tenure	0	4 (6)	10	0	3 (6)	9
GVA	0	2 (7)	10	0	3 (10)	13

Source: Own calculation

5 Discussion and Outlook

In the following discussion we will first have a look on the mitigation cost estimates produced by the different approaches. Then we will put the results in the context of other studies on mitigation costs in agriculture. We close with a brief comment on methodological problems of the presented approach. The stated mitigation effects include only the effect of abandoning the agricultural use of peatland and the rewetting of these areas. Effects induced by reduced CH_4, e.g. due to reduced cattle stock, or N_2O emissions, caused by ceasing fertilization on the affected areas, are not considered.

The simulation results match fairly well the results derived from the analysis of tenure. If we assume that the tenure for new contracts will be in the magnitude of the 75% quantile, this will result in mitigation costs of 10 € per Mg CO_{2eq} on arable land and 9 € per Mg CO_{2eq} on grassland. The use of the 75% quantile is motivated by two reasons. First, the tenure in new contracts is generally higher compared to old ones. Second, as rewetting needs larger contingent areas, farmers are in a strategic advantage and it will hardly be feasible to determine precisely the differences in the opportunity costs between plots and farms. In contrast to the simulation results the empirical SGM provides an upper bound for the mitigation costs. Determining the mitigations costs based on the SGM of the UAA on peatland overestimates the mitigation costs as adaption and reallocation of profitable activities and labour costs are not accounted for. However, even if the SGM is used, a complete abandonment of agriculturally used peatlands would imply mitigation costs of 845 million € or 40 € per Mg CO_{2eq}.

If one compares these results with the meta-analysis of VERMONT & DECARA (2010) or the extensive assessments in MORAN *et. al* (2008) and USEPA (2006) one can conclude that rewetting peatland is for Germany at least in the medium to long run a very cost-efficient option to significantly reduce agricultural GHG-emissions. In these studies agriculture can reduce its GHG emissions by 10% to 20% for mitigation costs of up to 100 € per ton of CO_{2eq}. However, the mitigation potential for some of the most cost efficient and relevant options in these studies is currently challenged (e.g. minimum tillage) in the scientific community (BAKER *et al.* 2007) or the implementation is legally prohibited in the EU (e.g. use of ionosphores).

The results represent a first estimate of the mitigation costs. One should keep in mind that the results might be biased in one or the other direction. A sector approach, like RAUMIS, overestimates the factor mobility within a county as the resources of all farms in a county are aggregated into one "county farm". However, the empirical analysis of the land use shows that the differences between the farms are quite substantial and already observable within a given municipality. Especially dairy farming and biogas production are two activities currently concentrated on peatland whose economic performance is sensitive to transportation distances. Consequently, the reallocation of forage cropping to mineral soils will induce additional costs, not considered in RAUMIS, either for the transport of the forage crops or the relocation of production facilities not covered in the model.

Furthermore, RAUMIS assumes homogenous conditions for agricultural production, this contradicts the empirical results, where we see some marked differences in the use of land on peatland compared to mineral soils (e.g. concentration of arable forage cropping). Whether the yields of the activities relocated from organic to mineral soils are comparable remains open. Consequently, the impact of this bias on the cost estimate is unknown.

Neither the simulation nor the empirical results include some additional costs as the engineering costs for rewetting the peatlands and transaction costs. Furthermore, potential effects of indirect land use change are not considered.

Given constant GHG emissions on a per ha base it is advisable to abandon and rewet the agriculturally used peatland with the lowest production value first. Such a strategy would minimize the negative offsets per ha induced by indirect land use changes. Additionally, from an economic point of view, a strategy of exploiting these differences in intensity and compensating each farmer only on the magnitude of his personal opportunity costs is optimal. However, abandoning and rewetting peatland requires larger contingent areas, implying that every singly affected land user (owner) must accept the rewetting. As to whether the intensity differences at the local level can be exploited for the efficient design of a nationwide mitigation strategy or whether the payments must be set at a level that is acceptable for the vast majority of farmers in an area remains a debate. While in southern and northwestern Germany, these differences in land use intensity among farms are widely already balanced at the municipality level. In northeastern Germany, the intensity of a farm is positively correlated with the land use intensity in the wider area, increasing the likelihood for the implementation of a differentiated compensation scheme.

Estimating the mitigation costs of abandoning agricultural use on peatland is associated with some uncertainties regarding the underlying data. The various data sources delimiting peatlands in Germany differ substantially in the mapped size and distribution. This has obvious implications on the attribution of land uses to organic and mineral soils. The utilization of the different data sources for determining the peatland area and distribution will improve the confidence in the results and allows an assessment of the potential error. Furthermore, the assumption that within one municipality the land use of arable land on mineral and organic soils is identical is challenged by the empirical result that certain cultures are more frequent in municipalities with higher shares of arable land on peatland. The utilization of plot specific IACS (Integrated accounting and control system) data would allow investigating the interaction between soil type and culture on a level below the municipality.

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