Is peatland restoration a cost-effective measure for climate protection? An ecologically extended cost-benefit-analysis

Jan Philipp Schägner[1] and Lena Schaller[2]

[1] Institute for Ecological Economy Research Potsdamer Str. 105 D-10785 Berlin Germany
Phone: +49 (0) 30 88459427 Fax: +49 (0) 30 8825439 E-Mail: Philipp.Schaegner@ioew.de

[2] Lehrstuhl für Wirtschaftslehre des Landbaues Alte Akademie 14 85350 Freising-Weihenstephan Germany
Phone: +49 (0) 8161 71 3193 Fax: +49 (0) 8161 71 4426 E-Mail: Lena.Schaller@wzw.tum.de

Summary

Alternative uses or restoration of drained peatland can diminish their greenhouse gas emissions substantially. In our project, we estimate if such measures are cost-effective strategies for global climate protection. Therefore we conduct an ecologically extended cost-benefit-analysis on alternative peatland managements, taking into account the economic impacts on the farming sector, benefits of other uses that must be foregone (e.g. streets and housing), implementation costs of technical measures, and ecological impacts such as GHG emissions, nutrient eluviation, biodiversity and landscape aesthetics. To make this multidimensional set of impacts comparable to alternative scenarios by putting them on the same basis, we valuate each single impact monetarily as far as possible.

Key index words: climate protection, peatland, cost-benefit-analysis, monetary valuation, CO_2-abatement costs

Introduction

About 99% of German peatland has lost its ability to accumulate peat, mainly in consequence of drainage for agricultural use (Vogel, 2002). This results in a degradation of the peat body which is responsible for about 2,54% of German CO_2-emissions (Byrne *et al.*, 2004). In the light of global warming most industrialized countries undertake great efforts for mitigation of global warming. Therefore, it seems worthwhile to investigate if alternative forms of peatland management may be a cost-effective measure for global climate protection. In our research project 'GHG-exchange and economic effects of climate friendly peatland management in Germany', we estimate CO_2-abatement costs resulting from alternative forms of peatland management. Therefore, we investigate the multidimensional impacts resulting from changes in peatland management and integrate them into an ecologically extended cost-benefit-analysis (CBA).

The total economic effects of alternative peatland management are manifold. Besides GHG emissions, changes in the use of peatlands affect farming income, employed labour and various ecosystem goods and services such as tourism and recreational values, biodiversity, landscape aesthetics and water and nutrient retention. All those effects influence social welfare, either negatively or positively. To make all such different effects comparable for decision-makers, monetary valuation of each single impact is necessary. Within our research project we are going to conduct monetary valuations of at least the most predominant effects of peatland management changes. We thereby try to identify possibilities for climate protection via peatland protection that are less costly as compared to other measures which are currently processed in others sectors.

Preliminary estimates show that CO_2-abatement costs, resulting from peatland protection measures, may differ widely. Regional and local circumstances have a strong influence on the costs and benefits of peatland protection. Whereas some local peatland protection measures are even characterized by negative CO_2-abatement costs, others are extremely costly. However, peatland protection can be a very cheap measure for climate protection, which shall be demonstrated by a case study in this paper. By way of identifying the circumstances which determine the costs and the benefits of peatland protection, we are going to give some important support for decision-making on optimal policies towards local peatland use.

Materials and methods

Within welfare economics, cost-benefit-analysis (CBA) is a method for aggregating individual preferences regarding some kind of alternative measures. The result represents the change in the so-called total economic value (TEV) which reflects every impact on human utility or well-being. Thereby, a CBA supplies a rational and systematic procedure for decision-makers to consider all costs and benefits of all affected individuals. The goal is to increase the quality of political decision-making by avoiding decisions which are based only on one impact dimension, only on effects for one generation or only on effects for a certain group of individuals. Unfortunately, political decision-making is usually far behind the optimal

Table 1. Costs and benefits of peatland restoration.

direct benefits	direct costs
• climate protection • reduced costs of drainage	• decreasing agricultural profit • planning costs • technical measures of water logging • possible costs for resettlement of vegetation • maintenance costs
indirect benefits	**indirect costs**
• flood protection • retention of pollutants • regulation of microclimate • recreational value • aesthetical value of landscapes	• costs for the regional economy • possible damage as a result of changed groundwater levels
Non-use-benefits	
• existence and bequest value of the increased biodiversity	

theoretical framework of CBA. It is common practice in German political decision-making, to conduct cost-effectiveness analysis, instead. This usually comprise only a single goal and therefore, they integrates only so-called direct costs and benefits (see Table 1).

The difficulty in integrating further impacts results from their multidimensional character. Environmental impacts are usually manifold. For example, peatland protection measures may affect GHG emissions, farming income, employed labor, tourism and various ecosystem goods and services such as recreational values, biodiversity, landscape aesthetics and water and nutrient retention. If alternative measures of peatland protection are to be compared, it is necessary to describe the magnitude of each impact by a uniform indicator. As many effects such as implementation costs, prices for land and farming income loss are already expressed in monetary terms, economists usually aim to express the environmental impacts in monetary terms too. Thus, the final result represents a monetary value which allows an easy comparison of various alternatives (see Fig. 1)

However, monetary valuation is a cost and time consuming procedure and therefore, a gap between the requirements of the theoretical framework and the common practice of ecologically extended CBA remains. In our research project, we are going to conduct monetary valuations in our six test regions for at least the most predominant impacts of alternative peatland managements. Further impacts, which cannot be valued in monetary terms, will be integrated qualitatively by experts' appraisals.

Preliminary results

As our project has not yet reached the half-way stage, it is still too early to present final results for all impacts of alternative peatland management. However, in this paper we present some anecdotal evidence based on a case study in one of our test regions. It shows the great potential for climate protecting which peatland protection can have.

The most predominant determinants of the costs and benefits of peatland protection measures as a strategy for climate protection are the impacts: (1) on GHG emissions, (2) on farming income, (3) on drainage costs, (4) the implementation costs and (5) the effects on non-agricultural uses such as housing, industry or transport. The emission factors for GHG depend on water levels and land-use. Whereas drained mires emit CO_2, natural mires emit methane but also accumulate carbon. Emissions from drained grassland and forestry are moderate while emissions from tillage and peat excavation are very high. Nitrous oxide is emitted in fens depending on water saturation of the soil (Höper, 2007).

Changes in farming income are determined by the quality of the agricultural soils, the farms' structures and the change in land use which results from the peatland protection measure. Peatland which is of low soil quality create only low farming incomes. Thus, less intensive agricultural use or restoration can lead only to less farming income forgone. The farms' structure determines income loss by the existence of so-called sunk-costs. If farms have undertaken high investments in assets which are attached to a certain place such as barns for animal husbandry, a loss of farming land would lead to insufficient utilization of these assets and thus, to a high loss of farming income. In contrast, farms which have undertaken only low investments or investments in assets which can be sold for utilization in other regions (e.g. tractors) can react with more flexibility to the loss of farming land resulting from peatland protection measures.

Implementation costs depend on technical measures which are necessary for restoration. Water availability is the primary determining factor. Whereas some peatlands easily

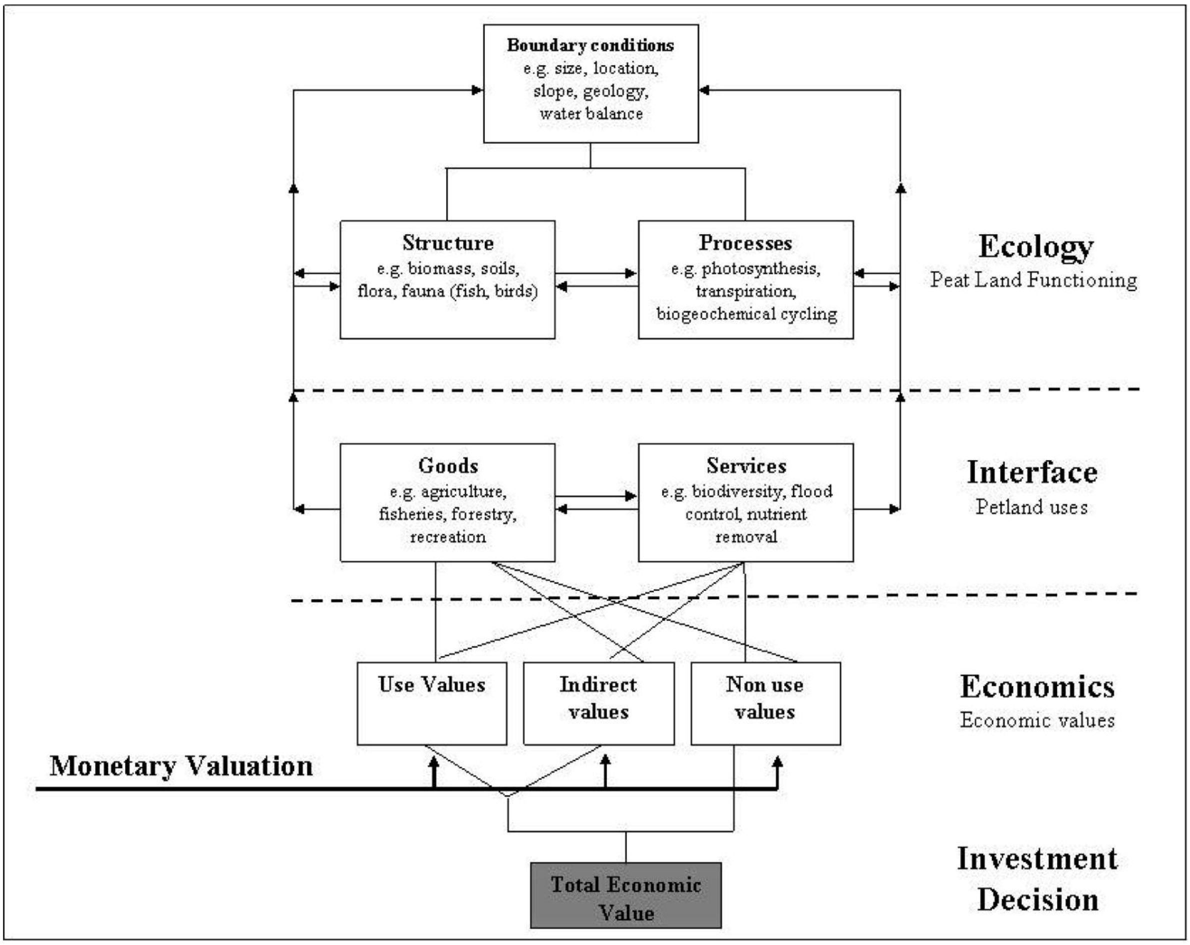

Figure 1. Ecological goods and services and their monetary valuation. Source: Turner, 2001.

allow for waterlogging by simply destroying some drainage tubes, others may require the shifting of dikes or the diversion of water streams. On the other hand, restoration may save costs for drains which are not necessary anymore. Such costs can be very high, especially when new investments in dikes and pump stations are necessary in the near future. Another important cost-determining factor is the effect on non-agricultural land uses. For example, street courses may have to be changed, communities may have to be surrounded by new dikes and pumping could be necessary to reduce ground water levels.

In our research project, we investigate these impacts of alternative forms of peatland management in six test regions, which represent typical examples of German peatland. The test region we want to outline in more detail here is the Peenetal, which is a fen located in the Bundesland Mecklenburg-Vorpommern in the north east of Germany. The Peenetal is characterized by one of the biggest German peatland restoration projects. Within the last ten years 20 000 hectares have been subject to restoration. Before restoration, peatland in the Peenetal has mainly been used for agriculture, especially intensively used grassland, and some forestry.

In the following, the effects on the total economic value of this restoration project will be demonstrated by some preliminary data on one single 509 hectare polder of the upper Peenetal, the polder Zarnekow-Upost. It should be noted that the results are not expected to be representative for peatlands in Germany in general. The polder is rather expected to be an extremely positive example of climate protection via peatland protection. In the Polder Zarnekow-Upost, about 272 ha of intensively used grassland have been subject to waterlogging and about 50 ha have been transferred from intensively used grassland into less intensively used grassland.

According to Höper (2008), the GHG emissions for intensively used grassland are about 20.6 t CO_2-equivalent per year and ha (CO_2-E/y ha). Changing intensively to less intensively used grassland will lower the emission to 16.2 t CO_2-E/y ha and waterlogging will decrease the emission to 0.4 t CO_2-E/y ha. Thus, the total GHG emission reductions in the Polder Zarnekow-Upost are expected to amount to about 5,700 t CO_2-equivalent per year.[1] A common method for monetary valuation of GHG emission reductions is to consider CO_2-abatement costs which are spend for climate protection measures in other sectors. The current certificate price of 21.30 € per ton of CO_2 at the EU Emissions Trading Scheme reflects such costs for the regulated industries (EU Carbon Futures, February 27, 2008). Thus, since waterlogging, the Polder Zarnekow-Upost produces a value of about 122,000 Euros each year.[2] By discounting this series of payment for the next 30 years with a discount rate of 3%, the present value amounts to about 2,513,000 €.

In addition, costs for the drainage and the maintenance of the dike will be saved in the future. Due to ramshackle drainages, dikes and pumping station, high investments would have been necessary in the following years, if no restoration were to have taken place. Thus, these costs can be assumed to be saved as a result of the restoration. The present value of the investment costs which were estimated by the local water and land authority for the following 10 years, amount to about 747,000 €. Furthermore, the present value of the saved annual costs for drainage and maintenance of the dike amount to about 198,000 €.

On the other hand, restoration causes farming income loss, which will be estimated within our research project by a farmers survey. For the moment, we consider the compensations that farmers received for their lost income as an indicator of their forgone farming profits.[3] In total, farmers and land owners in the Polder Zarnekow-Upost received about 489,000 €.

By summing up the estimated costs and benefits, we perceive an overall net benefit of the restoration measure in the polder Zarnekow-Upost of about 2,969,000 €. Abatement costs for one ton CO_2-equivalent amount to about minus 4 €. This basically means that in the polder Zarnekow-Upost, reducing GHG emissions by one ton CO_2 equivalent saves about 4 €. If the GHG emissions saved could be sold in the EU-Emissions Trading Scheme, additional 21.30 € could be gained per ton CO_2-equivalent.

The results presented here are only based on preliminary data and not all impacts of the restoration measure are integrated in our CBA yet. In our further research we try to integrate additional monetary values for impacts such as recreational values, landscape beauty and biodiversity. However, these estimates represent a realistic approximate value of possible results for some polders in the Peenetal based on data of the most predominant restoration impacts (see acknowledgements for explanations of data used). Nevertheless, it should be noted that the results may differ widely across the single polders in the Peenetal and peatlands in other regions. Other polders may show entirely different cost structures. Future investments which are necessary to maintain the drainage system may be far lower. In some polders, streets and houses are located. In such cases, waterlogging would cause extensive costs. In other regions, peatland yields far more farming income, due to higher soil quality. Thus, compensations for restoration measures would have to be higher. Furthermore, the costs for drainage are far lower in other peatland regions.

Therefore, the results are only valid for the case study presented here and cannot be transferred to other applications. However, they demonstrate the potential that peatland restoration can have.

Conclusion

The results presented here demonstrate that alternative peatland management can be an extremely cheap strategy for climate protection, as compared to other measures which are currently processed, as for example in the energy sector. Some peatland sites even show negative CO_2-abatement costs, which basically means that money can be saved by saving the climate. It seems to be promising to conduct further research on the cost-effectiveness of peatland protection for climate protection. Therefore, the cost determining circumstances have to be identified on a local and regional level. Moreover, it is necessary to integrate further impacts of peatland protection measures into CBA. Especially, impacts on local employment, farming income and landscape beauty are essential factors in the political decision-making process, because they determine the local populations´ acceptance of such measures.

Therefore, it is important to investigate the distribution effects of the costs and benefits of peatland protection measures across different social groups. Compensations for the disadvantaged groups may increase the political enforceability of restoration measures.

However, it is difficult to generate representative results for CO_2-abatement costs by peatland protection, which can be transferred easily to other applications. Political decision-makers need a rational procedure at hand, which supports them by deciding on the advantageousness of alternative peatland management at a certain site. Therefore, it is necessary to develop a pragmatic CBA guideline, which can help to estimate the site-specific costs and benefits of peatland protection measures within reasonable efforts.

Acknowledgements

Due to the fact that the responsibilities for waterlogging in the Peenetal are located at various governmental agencies and departments, the collection of data on the peat restoration project is a time-consuming process and is not yet completed. Therefore, some data for the calculations presented here were from other polders in the region or had to be extrapolated.

The data on the compensations for farmers and landowners affected by the waterlogging were delivered by the responsible agencies (Zweckverband Peenetal, in e-mail to author, February 20, 2008; Landgesellschaft MV, in e-mail to author, February 18, 2008). The data on the drainage and the dike maintenance in the polder Zarnekow-Upost are costs which are accounted for in the year 2002. This year is supposed to be a representative year (Water and Land Authority, Upper Peene, in conversation with the author, February 21, 2008). Therefore, it is assumed that these costs represent the average costs for the following years. The data on the land use in the polder are based on

[1] These estimates do not taken into account that waterlogging of fens usually leads to increased methane emissions in the first years. Therefore, in the first years, GHG emission reductions will be not as high as calculated. The values used for the calculation are mean values so that there can be differences for each fen.

[2] The author is aware of the fact that currently, it is not possible to gain EU-Allowance for peatland restoration in the EU Emissions Trading Scheme. Nevertheless, this is a widely accepted method for valuing GHG emission reductions.

[3] Due to the fact that there was a wide acceptance of the restoration measures among the farming community, it is expected that famers got higher compensations than their forgone profits. Thus, forgone farming income is rather overestimated in these calculations.

statements made by a farming enterprise, which had farmed about 70% of the land affected by waterlogging. Its land use pattern is expected to be representative for the polder (Agrargenossenschaft Zarnekow, in conservation with the author, February 25, 2008). The expected investment costs are costs that had been estimated for another polder in the Peenetal (polder Görmin). This polder is only 71% of the size of the polder Zarnekow-Upost. The conditions of pumping stations and dikes are expected to be similar. To avoid overestimations, the estimated investment costs are transferred to the polder Zarnekow-Upost at a rate of one. The investments were expected to be necessary within the next 10 years (Water and Land Authority, Demmin, e-mail message to author, February 15, 2008). Therefore, they are assumed to accrue linearly over time and the resulting payment stream is discounted at a rate of three percent. All annual values are discounted for 30 years, also at a rate of three percent.

References

Byrne, K.A., Chojnicki, B., Christensen, T.R., Drösler, M., Freibauer, A. *et al.* (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, October 2004.

Höper, H. (2007). Freisetzung von Treibhausgasen aus deutschen Mooren (Emission of greenhouse gases from German peatlands). *Telma: Berichte der deutschen Gesellschaft für Moor- und Torfkunde* **37**. Deutsche Gesellschaft für Moor und Torfkunde, Hannover.

Pearce, D., Atkinson, G. and Mourato, S. (2006). *Cost-Benefit Analysis and the Environment: Recent Developments*. OECD, Paris.

Turner, R.K., Brouwer, R., Georgiou, S. *et al.* (2000). *Ecosystem functions and services: an integrated framework and case study for environmental evaluation*. GEC 2000–21.

Vogel, T. (2002). *Nutzung und Schutz von Niedermooren: Empirische Untersuchung und ökonomische Bewertung für Brandenburg und Mecklenburg-Vorpommern* (Use and protection of fens: Empirical investigation and economic valuation in Brandenburg and Mecklenburg-Vorpommern).