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# ESTIMATING THE VULNERABILITY OF MIRES AND PEATLANDS TO CLIMATE CHANGE IN NORTH-EAST GERMANY

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## SUMMARY

The federal state of Brandenburg in NE-Germany will be significantly affected by climate change with an effect on biodiversity. Because of having one of the largest shares of peatlands of all German states, an index was designed to estimate the vulnerability of mires and peatlands to climate change. As vulnerability results from the interaction of change in exposure, particular sensitivity as well as adaptive capacity, several parameters were identified and considered differently following this concept. The outputs could be used to priority setting in nature conservation but contribute also to a better understanding about the essentially various influences that control the basic characteristics of peatlands.

## INTRODUCTION

The anthropogenic caused climate change has become one of the main global change drivers. Not only climate change mitigation but also the adaptation to its unpreventable consequences is one of the biggest challenges of humankind.
The "German strategy for climate change adaptation" (Bundesregierung 2008) sets a framework for climate change adaptation in the Federal Republic of Germany. The long-term aim is to minimize the risk from climate change for biological, geophysical as well as socio-economic systems by reducing their vulnerability or rather by protecting and strengthening their adaptation capacity. A major element in the "German climate change adaptation strategy" is the conservation of biological diversity. There are many indications that changes of climatic parameters already have a considerable influence on all levels of biodiversity (Leuschner and Schipka 2004, Parmesan 2006, Badeck *et al.* 2007, Haggenmüller and Luthardt 2009). It is assumed that the effects of climate change in combination with other stresses like pollution, landscape fragmentation or land use change will lead to a much higher stress on biodiversity in the future. However, how fast changes will emerge is regionally different depending on the resilience, respectively the vulnerability of ecosystems and their compartments (IPCC 2007). Detailed information about the effects of climate change in Germany and its regions should enable stakeholders to provide adequate against its risks (Bundesregierung 2008). The University of Applied Science Eberswalde (Germany) works within several research projects in the Federal state of Brandenburg to contribute to that issue.

## Special conditions in Brandenburg

Brandenburg, situated in NE-Germany (see Fig. 1), is significantly affected by climate change. Projections of regional climate models predict a continuing increase of average daytime temperature, especially in winter. Longer periods of drought and more frequent extreme weather events are set to occur (Linke *et al.* 2010). Even now the region is characterised as a relatively dry region with a low annual precipitation and mainly sandy soils. The status of the landscape water budget is critical (Holsten 2009). The predicted changes will increase the stress on biodiversity in the region. However, some elements of biodiversity will be more affected than others. For this reason, our working group is developing a method to identify areas of equal reactions towards climate change. The method is based on a spatial analysis of regional climate change projections and potentially effective system parameters (e.g. soil, relief, hydrological parameters) in landscape units. The estimation of changes of the abiotic elements in the system serves as basis for the risk evaluation of its biotic components. For the differences of ecosystems sensitivity and adaptive capacity concerning these changes, we need to figure out:

1. Which structures are particularly sensitive and in which extend are system functions and -services affected?
2. How reacts the system and which structures exists to buffer the disturbance by sustain its functions?

Especially the basic characteristics of peatlands (see Joosten and Clarke 2002) are likely to change under future climates (Zhaojun *et al.* 2011). Since mires are considerably vulnerable to changes in their water supply, it is widely accepted that changes of meteorological elements will have an increasing effect especially on peatland eco-hydrology (Charman 2002, Breeuwer *et al.* 2008, Acreman *et al.* 2009, Dise 2009). However, Brandenburg still offers a high amount of peatlands in a wide hydro-ecological range. The federal state has one of the largest shares of peatlands of all German states (Landesumweltamt Brandenburg 2006). Due to that fact, Brandenburg has a supranational responsibility to protect these ecosystems.

## A METHOD TO ESTIMATE THE VULNERABILITY OF MIRES AND PEATLANDS TO CLIMATE CHANGE

To evaluate the risks for mires and peatlands from climate change, the working group developed a method to estimate their vulnerability in northeast-Germany. By hypothesizing that the future condition of mires strongly depends on several parameters, which needed to be considered differently, we designed a vulnerability index.

Of great interest was to what extent the hydro-ecological conditions of peatlands will be affected in upcoming decades. Here, we propose an easy to handle index to carry out an area-wide analysis of geogenous (groundwater-fed) peatlands vulnerability to climate change with case studies from Brandenburg. The index is based upon the following principles: simple, universal and comprehensive. In this case *simple* stands for criteria that are easy to determine and to assess, but based on scientific information best available. In order to determine the current hydro-ecological characteristics of peatlands we use the Brandenburger biotope mapping as basis of assessment. *Universal* stands for a method that can be applied in many regions and for all uncultivated peatland types, which are influenced by geogenous water. Finally, *comprehensive* means that all important aspects of peatlands response to climate change are evaluated from different perspectives.


Fig. 1. The Federal State of Brandenburg and its location in the Federal Republic of Germany.

Vulnerability results from the interaction of any change in exposure (e.g. temperature), particular sensitivity (=impact) as well as specific adaptive capacity (IPCC 2007, Gitay *et al.* 2011). In addition to this framework we define the specific vulnerability of peatlands as follows: Peatlands are vulnerable to climate change, if they lose their current specific habitat and regulation functions. For example, a peatland may shift from one state to another, e. g. from a *Sphagnum*-mire to a rich mire type. Hence, vulnerability cannot be equated with damaging, rather by a loss of ecosystem diversity.
Based on a literature review and expert judgment we identified fourteen relevant criteria for the analysis of vulnerability (see Fig. 2).

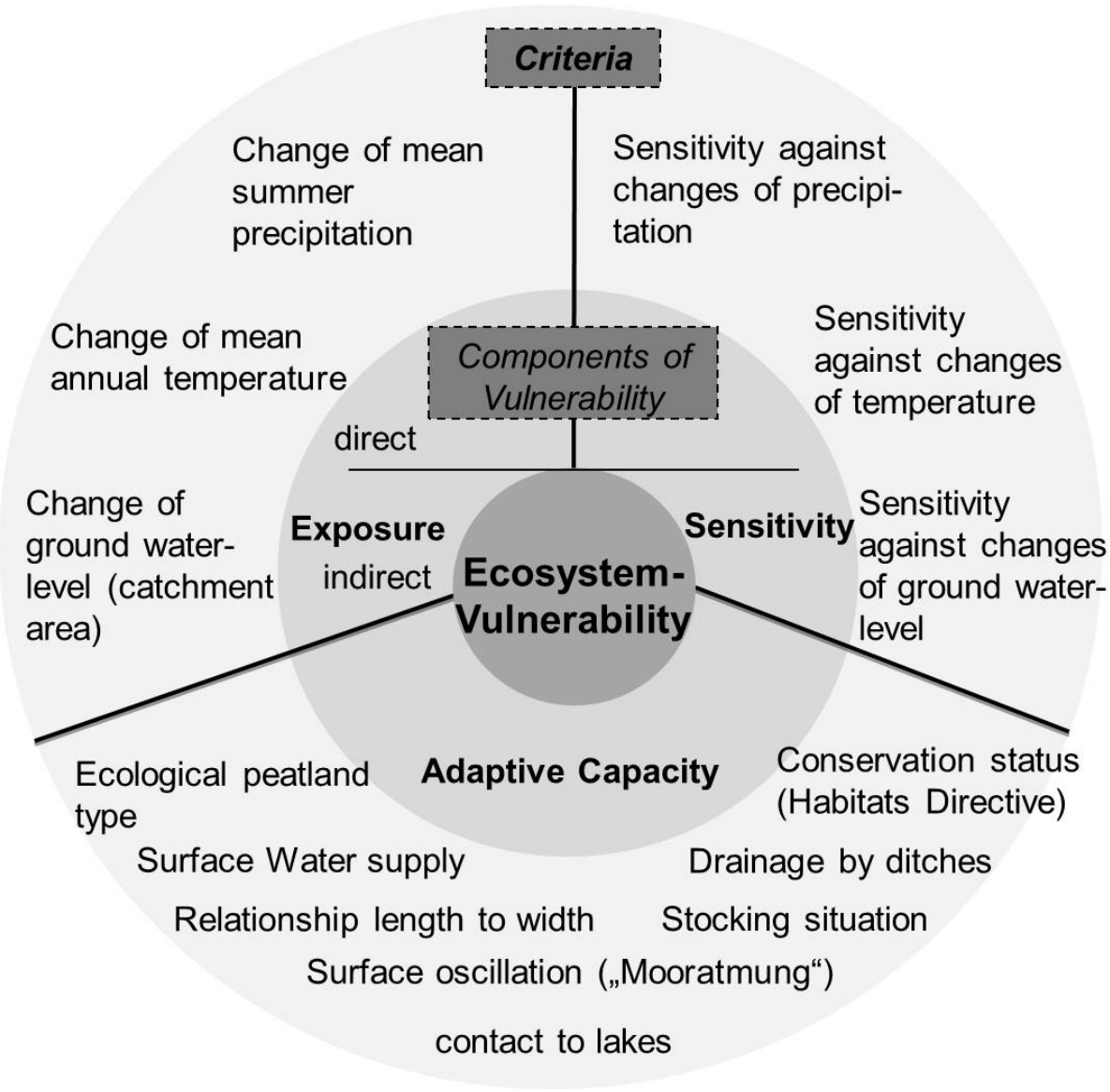


Fig. 2. relevant criteria for analysing the vulnerability of mires and peatlands to climate change.

In order to assess the impact on peatlands, we use four regional climate change scenarios for Brandenburg (= direct exposure) provided by State Office of Environment (Landesumweltamt 2010) combined with the development of regional groundwater levels over the past years (= indirect exposure) as well as corresponding indicators for the sensitivity. For example: Climate change can be expected to lead to decreasing summer precipitation (exposure) and associated lower water tables in peatlands. Thus, especially plant communities with a need of high and balanced water levels are most sensitive (like *Sphagnum*-laws). For this reason, we assess the sensitivity to a change in amount of summer precipitation by means of the demand of peatland biotopes to water levels and fluctuations. To assess the vulnerability, the ability or potential of peatlands to adapt the adverse impacts must be considered (IPCC 2007). However, adaptive capacity of peatlands is highly dependent on the present local conditions, such as direct damage by humans, type or shape of a peatland as well as for example the phenomenon peatland surface oscillation (Winter 2000, Fritz *et al.* 2007, Parish *et al*. 2008, Zhaojun *et al.* 2011). As figure 2 shows, we selected eight criteria to assess the specific

adaptive capacity of a peatland for this purpose. All respective indicators of the fourteen criteria are scored on a five-point scale from 1 (very low impact/adaptive capacity) to 5 (very high). In order to calculate an overall vulnerability score (V), the index combines all information on exposure (E), sensitivity (I) as well as adaptive capacity (A) in an algorithm, based on Ellner (2011). Finally, the calculated vulnerability score for each peatland assorted into five vulnerability classes from not vulnerable to very high vulnerable. The classes are graded logarithmically in order to achieve a more appropriate and balanced weighting of impact and adaptive capacity factors. Additionally, a threshold value was integrated that comes into play, when a very high indirect exposure of a peatland corresponds with a very high associated sensitivity and the adaptive capacity criteria contact to lakes is higher than very low. In this case the ecosystem will be ranked in the highest vulnerability class, independent from actual calculated vulnerability score.

## RESULTS

In order to test the index, twenty different peatlands in the federal state were selected to verify the methodology. First results show a differentiated vulnerability from very low to very high, but no peatland was assessed to be not vulnerable at all.

## CONCLUSION

The results such as the selected criteria are a contribution for a better understanding about the essential various influences that control the basic characteristics of peatlands.
The outputs of this method could be used for priority setting in nature conservation to counter on-going losses of these ecosystems.

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