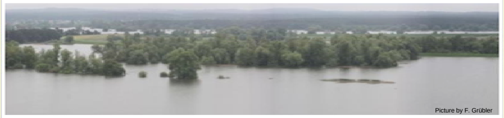
Global change vulnerability assessment of conservation targets and its implications for nature conservation management

– a case study from eastern Germany –

Jantje Blatt, Björn Ellner, Stefan Kreft, Lena Strixner, Vera Luthardt, Pierre Ibisch
Eberswalde University for Sustainable Development (University of Applied Sciences), Germany

Kooperatives Promotionsprogramm Klimaplastischer Naturschutz

Introduction



Climate change, as the most important element of global change, is increasingly exposing conservation targets to a diversity of stresses, both directly and in interaction with other anthropogenic stresses. Therefore any proactive and strategic nature conservation management should be based on a thorough vulnerability assessment of its targets. Here, we propose an **index of ecosystem vulnerability to climate change.** It is designed to facilitate the identification of adaptive conservation strategies and thus support managers who have to deal with the increasing non-knowledge. Our vulnerability index may be used in target prioritization exercises in the context of climate change-adaptive management.

The method was applied to forest ecosystems in the National Park "Lower Odra Valley" in the region Brandenburg in eastern Germany (see Fig. 1). Typical forest types are floodplain forests with *Salix alba* and *S. x rubens, Alnus glutinosa* and *Populus nigra*, elm-oak-forests on hillsides with *Ulmus laevis* and *Quercus robur*, old beech forests with *Fagus sylvatica* and different coniferous plantations, that still remain from former silvicultural land use in the National Park area.

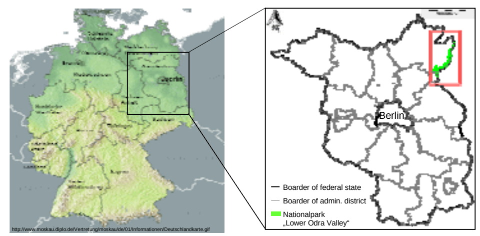


Figure 1: Lower Odra Valley National Park, Brandenburg state, in eastern Germany.

Figure 2: Dynamically changing forest ecosystems in the Lower Odra Valley National Park. (Pictures by P. Ibisch).

Method

Based on a literature review of vulnerability assessments and a sound classification of stresses for ecosystems caused by global climate change (Geyer et al., in prep.) we identified relevant criteria for the analysis of exposure and corresponding sensitivity (= impact) as well as adaptive capacity of forest ecosystems (see Fig. 3). Subsequently, we drafted a list of 18 semi-quantitative indicators built on valid (empirical) data from literature.

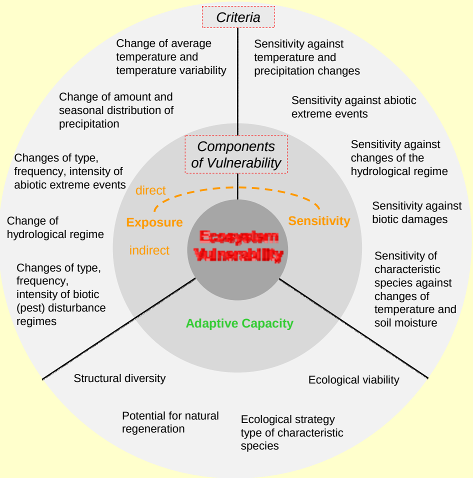


Figure 3. Conceptual framework of vulnerability (based on IPCC Fourth Assessment Report, cf. Parry et al. 2007) and criteria of forest ecosystem vulnerability against climate change (adopted from Polsky et al. 2003).

The indicators are scored on a scale from 1 (very low impact/ adaptive capacity) to 5 (very high). To calculate an overall vulnerability score (V), the index combines all information on exposure and corresponding sensitivity (I) as well as adaptive capacity (A) in the following algorithm:

$$V = \frac{I}{A} \qquad \left(I = \frac{\sum_{i=1}^{n}(E_{Di} * S_{Di}) + \sum_{i=1}^{n}(E_{Ii} * S_{Ii})}{I_Z} \qquad A = \frac{\sum_{i=1}^{n} A_i}{A_Z} \right)$$

E_D / S_D = Indicators of direct exposure and corresponding sensitivity.
E_I / S_I = Indicators of indirect exposure and corresponding sensitivity.

The vulnerability scores are assigned to five vulnerability categories form very low vulnerable to very high vulnerable. The scores are graded logarithmically in order to achieve a more appropriate and balanced weighting of impact and adaptive capacity factors.

Additionally, we integrated two threshold values that come into play, when one (two) high exposure factor(s) correspond(s) with one (two) high sensitivity factor(s). In this case the ecosystem type will be ranked in the second highest (highest) vulnerability class, independent from calculated vulnerability scores (see Fig. 4/ 5).

Results

First results show that the most vulnerable forest ecosystems in the Lower Odra Valley National Park are plantations (of different species, i.a. *Fraxinus excelsior, Robinia pseudoacacia, Larix decidua, Pinus sylvestris*). They are classified as highly sensitive against increasing temperatures, precipitation decline and biotic/ abiotic extreme events while their adaptive capacity is rather low (see Fig. 4/5), amongst other due to their structural uniformity. In general, all plantations show a higher vulnerability against climate change compared to natural forest ecosystems. Beech forests of *Fagus sylvatica* will probably be the most affected natural forests. They are sensitive against increasing temperatures and decreasing precipitation with only little adaptive capacity and thus rank in the moderate vulnerability class. Floodplain forests are less vulnerable. Their hydrological regime depends to a greater extend both on the river water level and on water management than on precipitation. Forests of *Pinus sylvestris or Quercus robur* that grow on warm and dry sites appear to be relatively well adapted to probable changes of climate variables, which is reflected in the smallest vulnerability score.

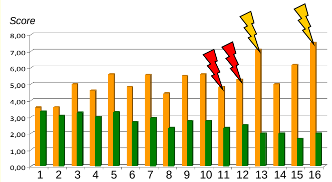


Figure 4. Impact/ Adaptive Capacity scores (with threshold values) of forest ecosystems in the National Park "Lower Odra Valley".

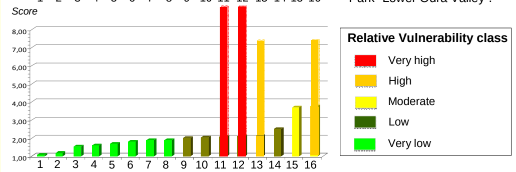


Figure 5. Vulnerability scores of forest ecosystems in the National Park "Lower Odra Valley".

Additional Legend (for Fig. 4 and 5)

1 Pinetalia
2 Carpinion betuli on dry and warm sites
3 Tilio -Acerion pseudoplatani (Adoxo-Aceretum)
4 Carpinion betuli on fresh sites
5 Salicetalia purpurae with Salix alba and Populus nigra
6 Querco-Ulmetum on hillsides
7 Salicetalia purpurae with Salix x rubens and Alnus glutinosa
8 Plantations of Populus nigra
9 Alnion glutinosae
10 Fagion sylvaticae
11 Plantations of Robinia pseudoacacia
12 Plantations of Fraxinus excelsior
13 Plantations of Pinus sylvestris
14 Other plantations
15 Plantations of Pseudotsuga menziesii
16 Plantations of Larix decidua

Conclusion

The index offers a differentiated, comprehensive and easily accessible picture of the vulnerability of forest ecosystems and corroborates results of other vulnerability assessments through e.g. modeling (cf. Lindner et al. 2010). Yet the set of indicators is still to be verified as sufficiently reflecting the real vulnerability of the observed systems. As a key tool for adaptive conservation strategies and a new prioritization of targets it should be of additional value for nature conservation managers. Therefore we also have to validate its applicability by practitioners.

Literature cited

Geyer, J., Kiefer, I., Kreft, S., Chavez, V., Jeltsch, F., Salafsky, N., Ibisch P.L. (2010) in prep.
Lindner, M., Maroschek, M., Netherer, S., Kremer, A., Barbati, A., Garcia-Gonzalo, J., Seidl, R., Delzon, S., Corona, P., Kolström, M., Lexer, M.J., Marchetti, M. (2009): Climate change impacts, adaptive capacity, and vulnerability of European forest ecosystems. In: *Forest Ecology and Management.* 698-709.
Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden, J.P., Hanson, P.E. (eds) (2007): Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, UK/USA.
Polsky, C., Schröter, D., Patt, A., Gaffin, S., Martello, M.L., Neff, R., Pulsipher, A., Selin, H. (2003): Assessing vulnerabilities to the effects of global change: An Eight-Step Approach. Belfer Center for Science and International Affairs, Harvard University, John F. Kennedy School of Government.