Predicting climatic change effects on riparian softwood vegetation - a modelling approach combining ecological and hydrological information

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Introduction:

Softwood forest species (willows and poplars) are adapted to particular hydrological conditions, which makes them the dominant vegetation type in riparian areas with flood durations between 90 and 200 days per year.

In our study area (Fig. 1), the Elbe River, riparian softwood forests have nearly vanished due to river regulation and deforestation. Climate change is believed to increase the loss of suitable habitats for softwood forest species due to changes in hydrological conditions (e.g. lower ground water levels and flood durations, higher fluctuations). Besides further decrease of natural regeneration of softwood forest species, established vegetation might also suffer as a consequence.

In a habitat modelling approach, species occurrence was linked with hydrological parameters. Possible effects of climate change scenarios on the current vegetation state are demonstrated.

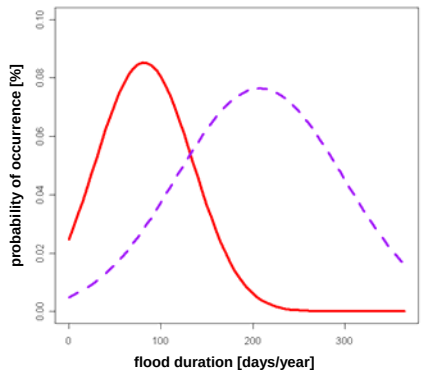

Fig. 3: Probability of occurrence for old (solid) and adult (dashed) *Salix viminalis* in relation to flood duration with optima at 82 days/year (old) and 208 days/year (adult)

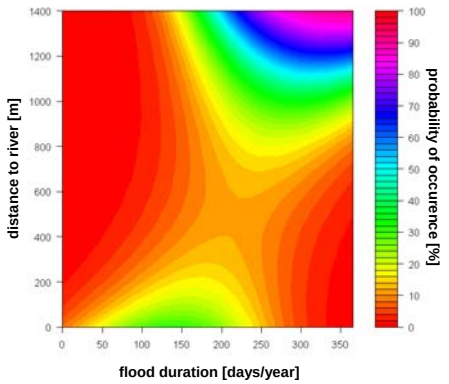

Fig. 4: Probability of occurrence for adult *Salix triandra* in relation to flood duration and distance to river

Methods:

Presence/ absence data of softwood forest species (e.g. *Salix alba*, tree; *S. viminalis*, shrub) were sampled in a stratified random design with respect to differences in ground level as well as distance to the river. Moreover, age of the target vegetation was recorded, differentiating between juvenile, adult and old life stages. Hydrological and geographical data (flood duration and distance to river, respectively) were extracted from a high resolution Digital Elevation Model including hydrological information. Distance to river was used as a synonym for variation in average water level, which decreases with increasing distance to the river. Species occurrence in relation to flood duration and distance to the river was tested by means of logistic regression using a forward stepwise selection procedure of variables. Significance of chosen models was tested using $\chi 2$.

Results:

Significant effects of flood duration (e.g. *Salix viminalis*, Fig. 3), distance to river as well as interaction effects (e.g. *Salix viminalis,* Fig. 4) could be detected for the typical riparian softwood forest species. Moreover, significant differences in optima considering flood duration between age classes within species were identified (e.g. *S. viminalis*, Wilcoxon rang-sum test: W= 8198, $p \leq 0.001$, Fig. 3).

Highly significant logistic regression models predicted great amounts of suitable habitats in terms of flooding conditions for softwood forest species (Fig. 5a, *S. alba*). Climate change scenarios, where for instance average discharge per year is reduced (Jacob & Bülow 2005), led to a dramatic decrease in occurrences of softwood forest species compared to the status-quo scenario (Fig. 5b).

Conclusion:

The *Salix* species surveyed in this study exhibited significant responses to hydrological parameters. Every change in hydrological patterns by both climate change and river regulation measures has severe impacts on the remaining softwood forests at the Elbe River and hinders the restoration of these vegetation types belonging to the most threatened worldwide.

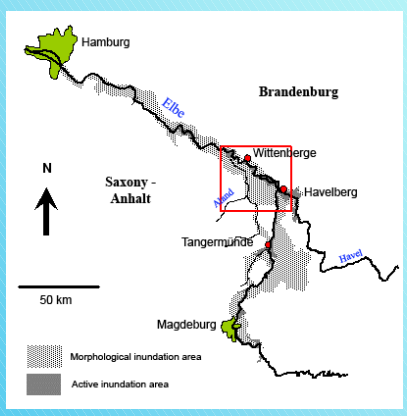

Fig. 1: Elbe River floodplain with the study area (red rectangle)

Fig. 2: Softwood forest vegetation at the riverbank of the Elbe River

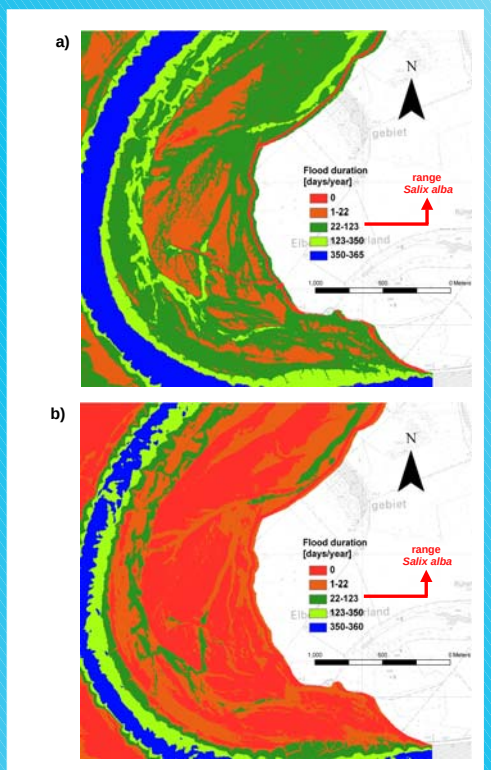

Fig. 5: Spatial distribution of predicted occurrence of *Salix alba* (range) depending on flood duration : **(a)** range according to current average discharge of 706 m^3/s and resultant flood duration (status quo), **(b)** range according to reduced average discharge of 288 m^3/s and resultant flood duration (climate change scenario)

Jacob, D. & Bülow, K. (2005) Klimaszenarien für den deutschen Teil des Elbeeinzugsgebietes. In : Auswirkungen des globalen Wandels auf Wasser, Umwelt und Gesellschaft im Elbegebiet (Wechsung, F., Becker, A., Gräfe, P. eds.), pp. 85-118

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