„Species Distribution Modelling of Beech - Silver Fir Mixed Commercial Forests“ as part of the project „BuTaKli“

Background

As climate change will be accompanied by changing temperature conditions and a redistribution of precipitation, the natural distribution of tree species will also shift (Bonan 2008). In Europe beech will be strongly affected by this development and may be successively replaced by more drought stress tolerant oak species in the long term (Hanewinkel et al. 2012). Through effective forest management strategies, however, beech forests may be preserved.

The BMUB and BMEL funded project “BuTaKli – Beech - Silver Fir Mixed Forests as an Adaptation of Commercial Forests to Climate Change Extreme Events” addresses this topic by investigating the viability of Beech - Silver Fir Mixed Forests as an adaptation strategy of beech forests to the challenges of climate change. This approach grounds on the hypothesis, that the mixing of beech forests with silver fir results in positive complementary effects, which increase the water use efficiency and drought stress tolerance of both species.

Section “ALU 4 – Influence of Silver Fir Admixture on the Economic Performance of Beech Stands under Changing Environmental Conditions” of the project focuses on the simulation of tree species distribution under different climate scenarios. The here described master thesis will be embedded in this work.

Aim

The aim of this thesis is to model the potential spatial distribution of beech, silver fir and beech – silver fir mixed forests for Germany. The modelling will be conducted both for the present situation as well as for different climate scenarios, which may also be understood as different levels of drought stress intensity. Finally, based on the resulting modelled forest area, the economic viability of this mix of tree species shall be evaluated and compared to the results for the pure beech forests.

Data and Methods

Occurrence data of beech and silver fir will be collected on a continental/national (e.g. from the GBIF database, ICP Level 1 Plots) and local scale (field data). Additionally, a range of environmental and geographic parameters will be collected on the continental/national (e.g. from the WorldClim database) and local scale (e.g. DWD data), which may serve as explanatory variables.

In the first part of the thesis, the collected data shall be used to shed light on the relationship between the distribution of beech and silver fir and the selected environmental explanatory variables. As means to this, an ensemble of Species Distribution Models (SDM) will be trained with the continental/national occurrence and environmental/geographic data to filter only the significant from the pool of variables. The result will then be cross-validated and downscaled to a local scale to compare to the previously obtained local occurrence data. The same SDM training procedure will be

applied to the local data and its result will also be cross-validated and verified with the actual occurrence data.

The second part of the thesis will focus on the projected tree species distribution under different climate scenarios. Therefore, scenario data will be collected (e.g. from the WorldClim database) and fed into the SDM created in part one.

The results will be visualized in the form of maps with ArcGIS.

Expected Results

The results will comprise the following elements:

- A set of explanatory variables, which have significant effects on the distribution of beech and silver fir
- Species Distribution Models for modelling beech, silver fir and beech - silver fir mixed forests
- Maps for the potential current distribution of beech - silver fir mixed forests as well as for the future distribution under diverse climate scenarios
- Economic implications on the creation of beech - silver fir mixed forests

Schedule

1.	Data collection and preparation:	2 weeks
2.	Preparation of the SDM:	1 week
3.	Training and validation of the national and local models:	4 weeks
4.	Scenario modelling:	3 weeks
5.	Mapping:	2 weeks
Total:		12 weeks
Thesis writing:		(another) 12 weeks

References

Bonan, G.B. (2008) Forests and climate change: Forcings, feedbacks, and the climate benefits of forests. *Science*, 320, 1444-1449.

Hanewinkel, M., Cullmann, D.A., Schelhaas, M.-J., Nabuurs, G.-J. & Zimmermann, N.E. (2012) Climate change may cause severe loss in the economic value of European forest land. Nature Climate Change, 3 (3): 203-207.