JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

Project unit: A

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Analyzing *Betula litwinowii* encroachment and reforestation in the Kazbegi region, Greater Caucasus, Georgia

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1. Background

The **encroachment of trees and shrubs** in high mountains is an increasing worldwide phenomenon, which is expected to dramatically alter the **high mountain ecosystem and its functioning**. It further indicates a starting reforestation process.

Encroachment of ***Betula litwinowii* (birch)** shrubs, an endemic species of the subalpine belt in the Greater Caucasus, has been observed in the Kazbegi district in the last decades.

Aims and objectives of the study:

- Analysis of the floristic composition at *B. litwinowii* stands
- Quantification of the spatial extent of *B. litwinowii* forests and the relation to topographical site conditions
- Map different *B. litwinowii* encroachment stages by means of modeling

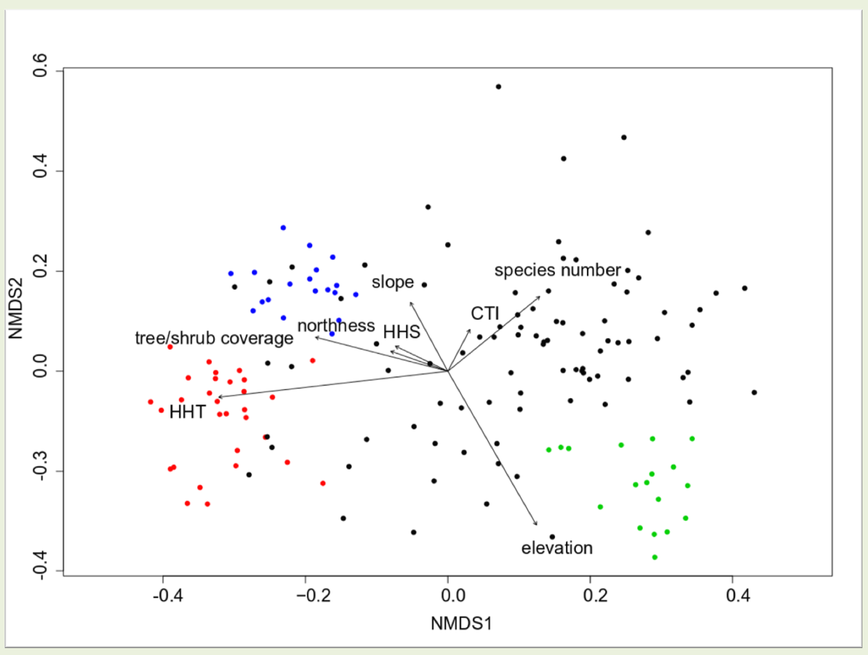
2. Methods

- Analysis of 155 vegetation relevés sampled in 2009, 2011 and 2015 to define different *B. litwinowii* vegetation groups by cluster analysis, non-metric multidimensional scaling (nmds) and an indicator species analysis.
- Assessment of *B. litwinowii* forest growth by digitizing forest outlines in aerial and space borne imagery of 1987, 2005 and 2010.
- Modeling of tree and shrub coverage using the Random Forest Algorithm as an indicator for different *B. litwinowii* encroachment stages.

3. Results

3.1 Vegetation analysis

- **Four types** of *B. litwinowii* stands characterized by a **gradient in tree and shrub coverage** and differing topographic positions were identified.
- Main encroachment sites: **former meadows and pastures** (initial *Bromus variegatus-B. litwinowii* encroachment), **tree line** (*Rhododendron caucasicum-B. litwinowii* tree line scrubs



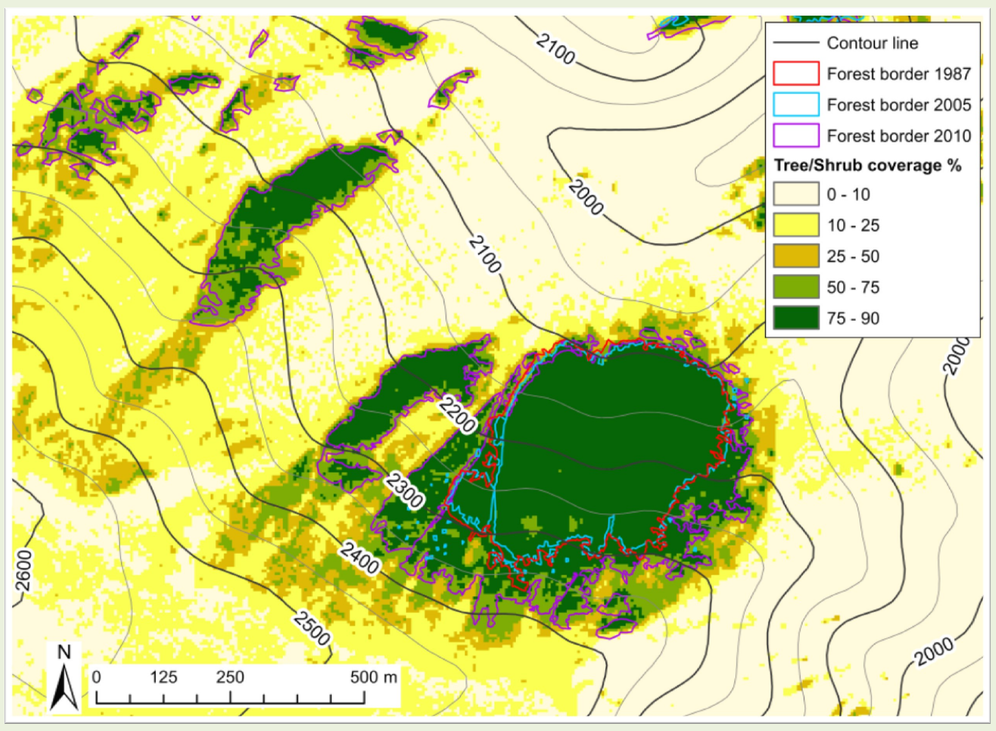
NMDS ordinaiton of the vegetation groups: *Aconitum nasutum-B.litwinowii* forest (red), *Rubus idaeus-B.litwinowii* forest (blue), initial *Bromus variegatus-B. litwinowii* encorachment (black), *Rhododendron caucasicum-B.litwinowii* tree line scrubs (green). HHS = Height highest shrubs, HHT = Height highest trees, CTI = Compound topographic index

3.2 Forest outline digitization

- The forest increased by **25% between 1987 and 2010** mainly in uphill direction.
- Most of the area was gained between 2005 and 2010.

3.3 Modeling process

- Different encorachment stages of *B. litwinowii* could be depicted very accuratly with the Random Forest algorithm (**R^2=0.69**).
- *B. litwinowii* initial succession occurs on south exposed slopes.
- Most important predictors during modeling process: the distance between the relevés and adjacent B. litwinowii stands as well as the red and green satellite bands.



Digitized forest outlines of 1987, 2005 and 2010 and underlying tree and shrub coverage model

4. Conclusions

- The four vegetation groups showed a relation to the modeled encroachment stages.
- A **substantial increase** in forest and shrub growth in the Kazbegi region was found, triggered by reduced grazing pressure.
- An advancement of the tree line in higher elevations was observed.
- Further encroachment of shrubs is expected to greatly **alter the high mountain ecosystem.**
- **Future studies** that monitor shrub encroachment and forest regeneration and capture the underlying drivers are needed for a **sustainable land-use management**.

***B. litwinowii shrubs* in the Kazbegi valley**

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