



amies II - Scenario development
for sustainable land use
in the Greater Caucasus, Georgia



AMIES II – Workshop 2017

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Project Unit C

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



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Center for international
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- Encroachment of shrubs is an increasing worldwide phenomenon
- Possible reforestation:

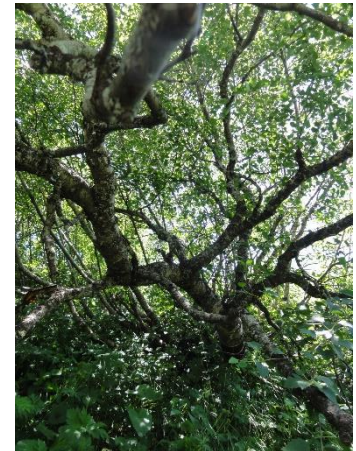
Alteration of the landscape structure and ecosystem functions

- Reduction of agricultural land
- Reduction of floristic diversity

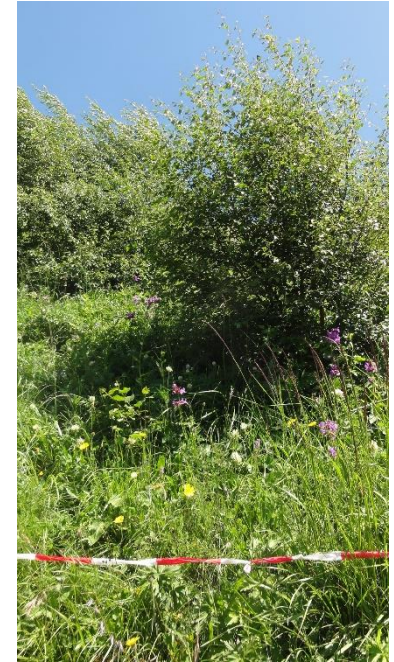


Mountain forests provide important ecosystem services

- Protection against avalanches and landslides
- Touristic development



- *Betula litwinowii* (birch): endemic species, dominates timberline, forms the tree line
- Severely damaged during Soviet period
- Recent studies: recovery of forest vegetation
- Objectives:
 - 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







```
graph LR; A([Vegetation analysis]) --> B[Information on floristic composition, vegetation structure, site conditions]
```

Vegetation analysis

Information on floristic composition,
vegetation structure, site conditions

- 155 vegetation relevés from 2009, 2011 and 2015
- Cluster analysis: define vegetation groups
- Ordination: which are the main underlying gradients for vegetation structure
- Indicator Species Analysis: what are typical species for the groups



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graph LR; A([Forest outline digitization]) --> B[Assessment of forest growth]
```

Forest outline digitization

Assessment of forest growth

- Digitization of aerial and space borne imagery of 1987, 2005, 2010
- Area calculation
- Area comparison between the different years

Modeling *B. litwinowii* coverage



Identify different encroachment stages

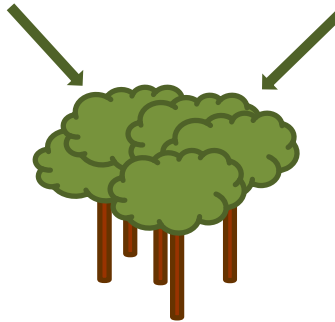
Vegetation
relevés

Predictor variables:

- Multispectral imagery
- Vegetation Indices
- Topographic parameters

Response variable:

- Tree and Shrub coverage [%]



Tree and Shrub coverage map

Results

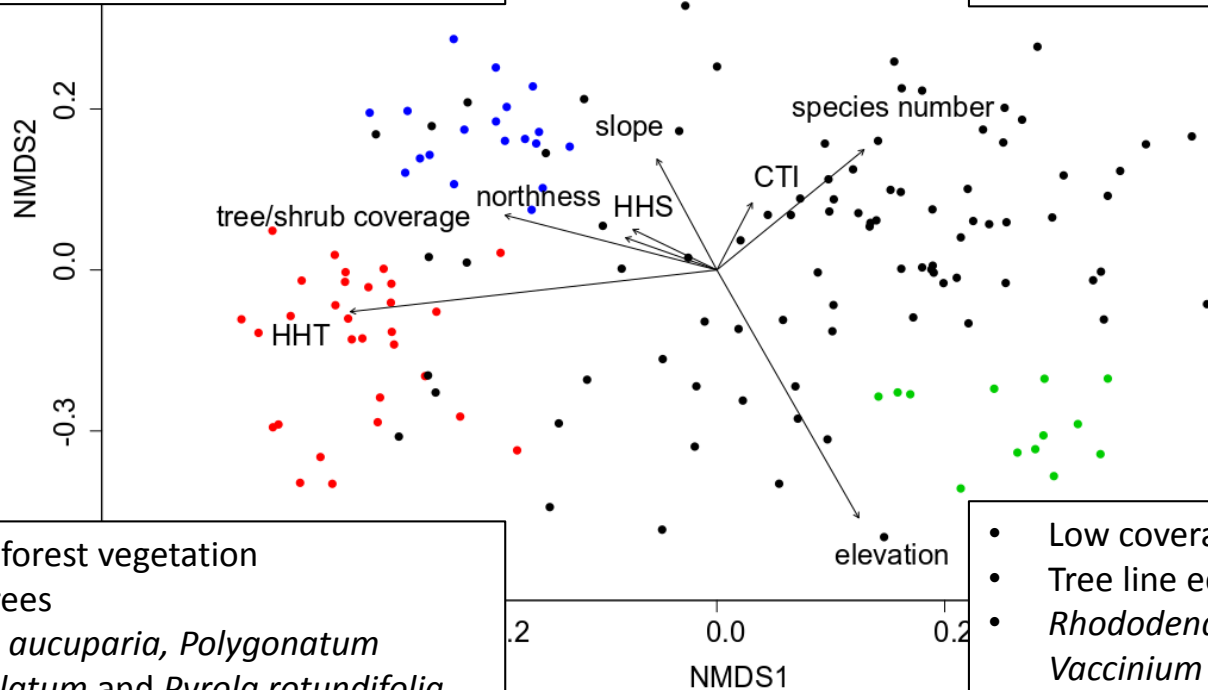
Vegetation Analysis

Rubus idaeus-*B. litwinowii* forest

- High coverage
- Low elevation, steep slope
- Lower trees and shrubs
- *Heracleum roseum*, *Viola caucasica* and *Polygonum carneum*

Initial *Bromus variegatus*-*B. litwinowii* encroachment

- Loose shrub stands, low coverage
- Former meadows and pastures
- South exposed slopes
- *Lotus corniculatus*, *Ranunculus oreophilus* and *Rhinanthus minor*



- Dense forest vegetation
- High trees
- *Sorbus aucuparia*, *Polygonatum verticillatum* and *Pyrola rotundifolia*

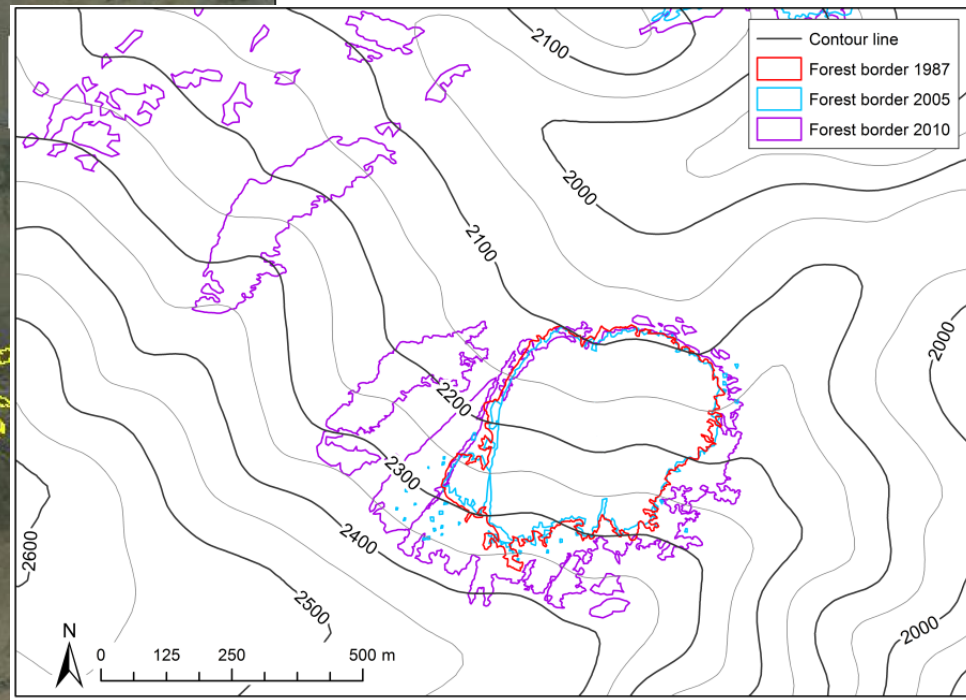
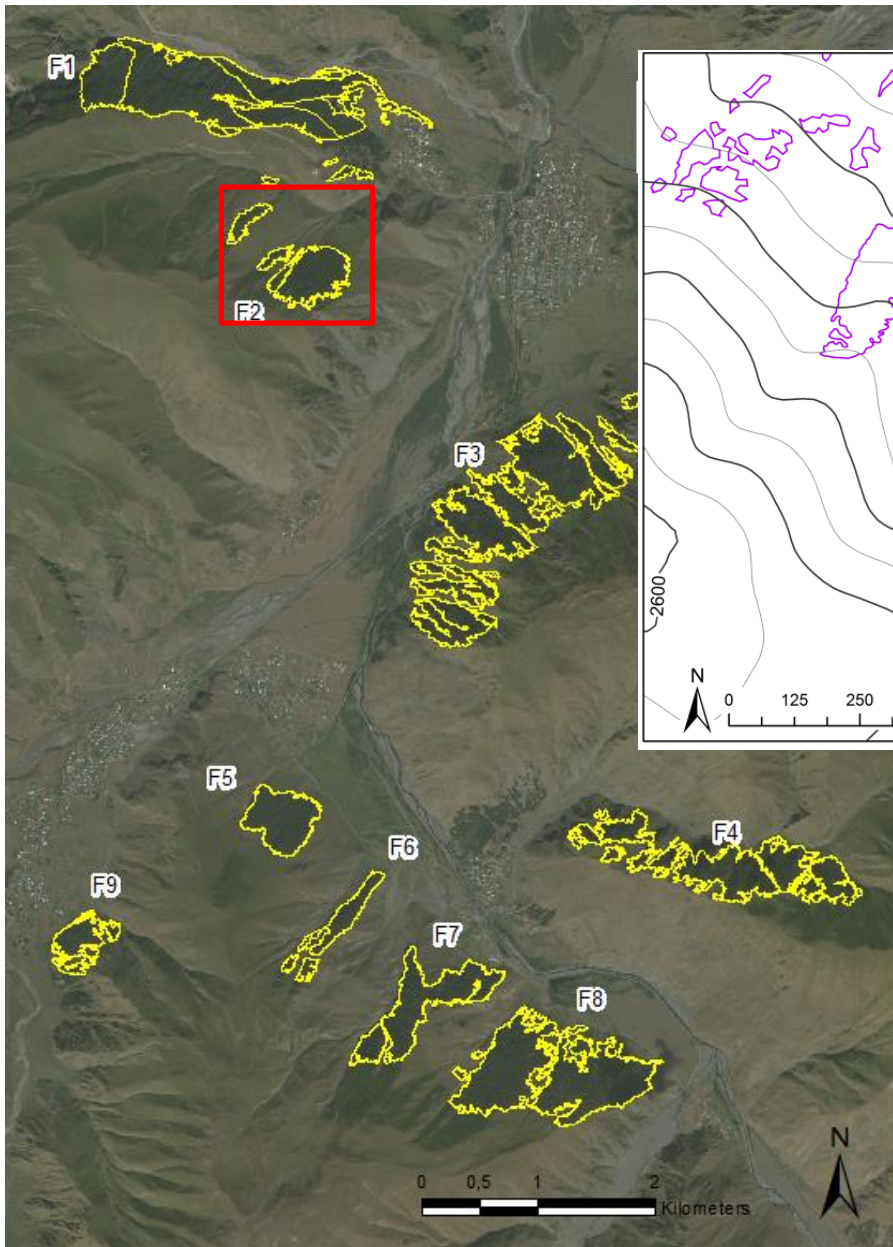
- Low coverage
- Tree line ecotone
- *Rhododendron caucasicum*, *Vaccinium myrtillus*

Aconitum nasutum-*B. litwinowii* forest

Rhododendron caucasicum-*B. litwinowii* tree line scrubs

Results

Forest outline digitization



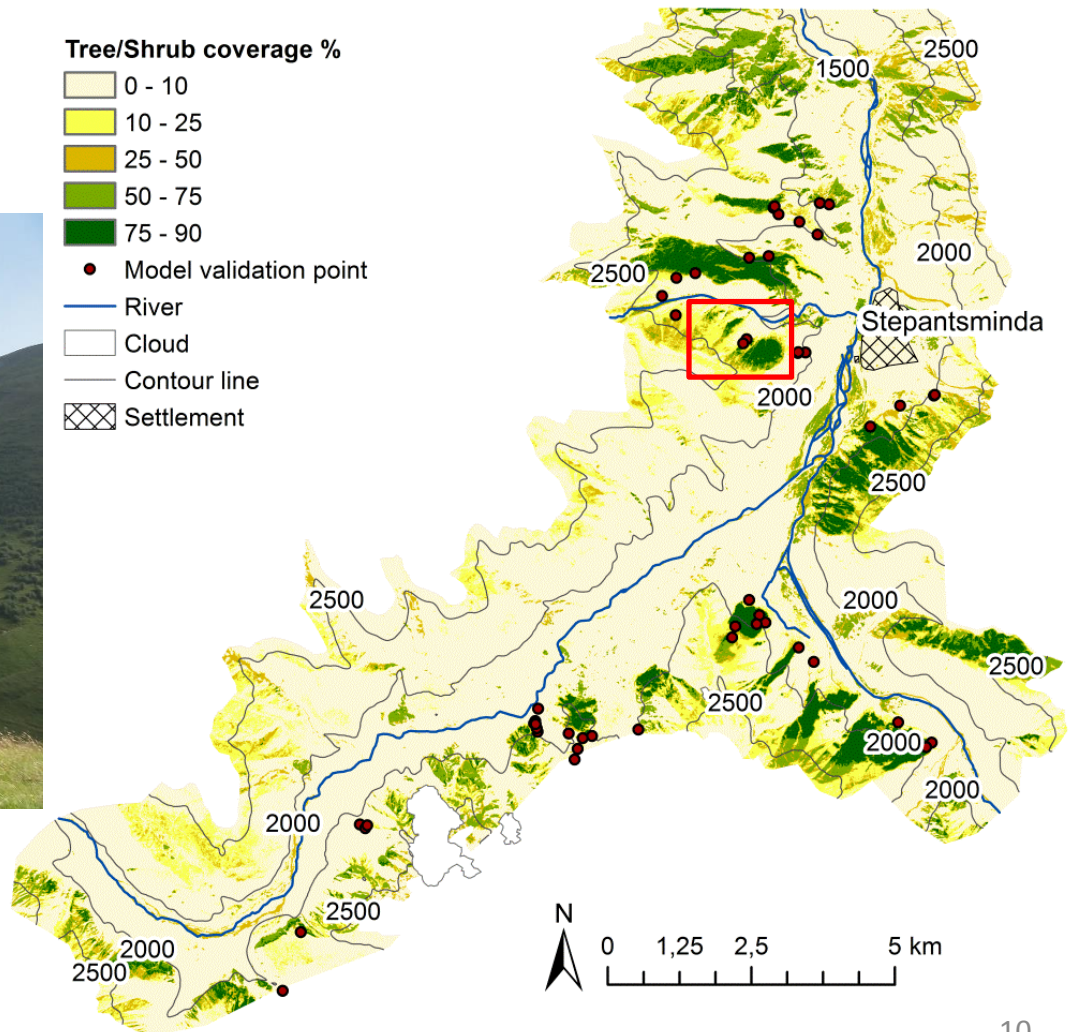
- 25 % increase in forested areas
- Increase mainly in uphill direction

Results

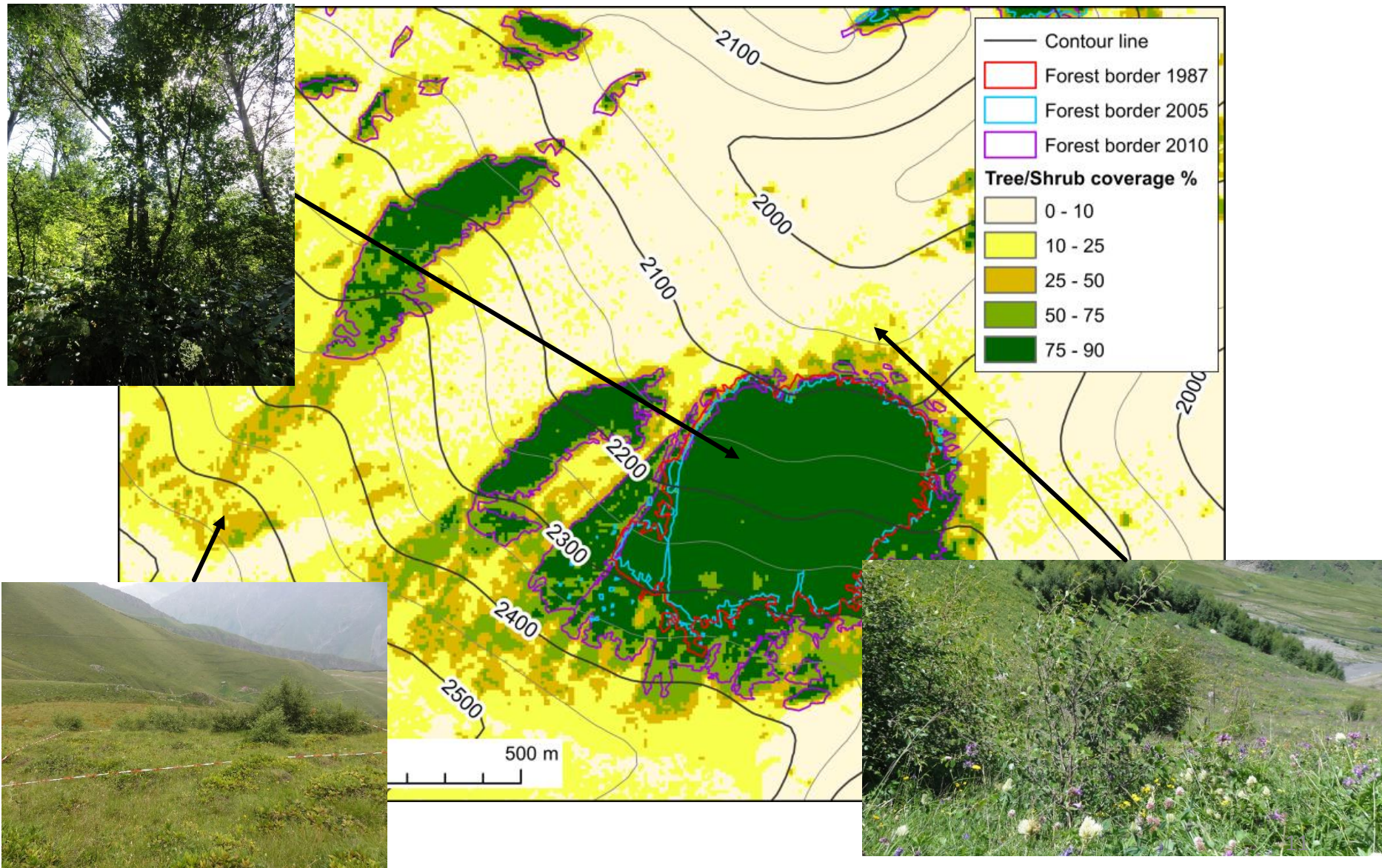
Modeling process

- Dense forests at north-east exposed slopes

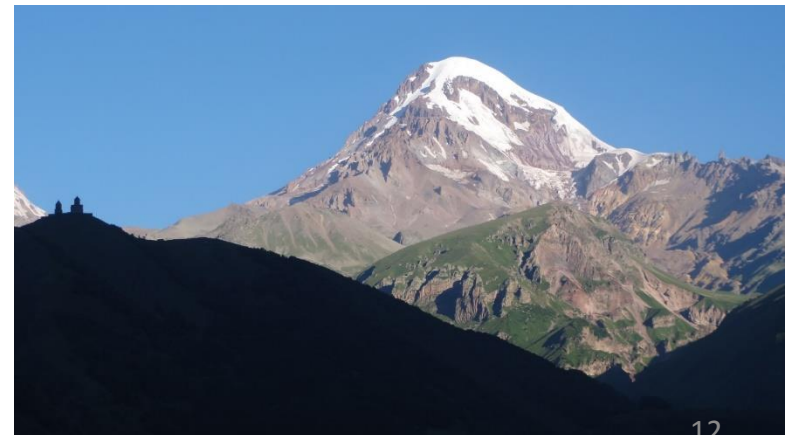
- 50 validation points: $R^2 = 0.69$



Relation between identified vegetation groups and modeled coverage classes



- Distinct and structurally defined floristic composition in *B. litwinowii* stands
 - closely related to site conditions, as well as tree and shrub coverage.
- Substantial increase in forest and shrub growth in the Kazbegi region,
 - Most possibly triggered by reduced grazing pressure and climate change.
- *B. litwinowii* on south exposed slopes
- Since 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 urgently needed for a sustainable land-use management.

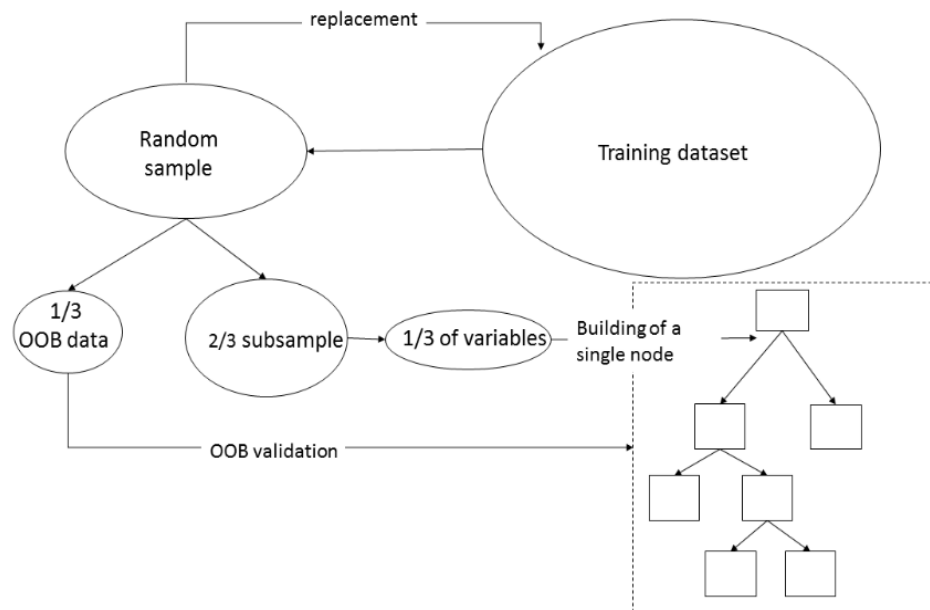




Conclusions

Thank you for your attention





Vegetation analysis



Information on floristic composition, structure, site conditions

Forest outline digitization



Assessment of forest growth

Modeling *B. litwinowii* coverage



Identify different encroachment stages