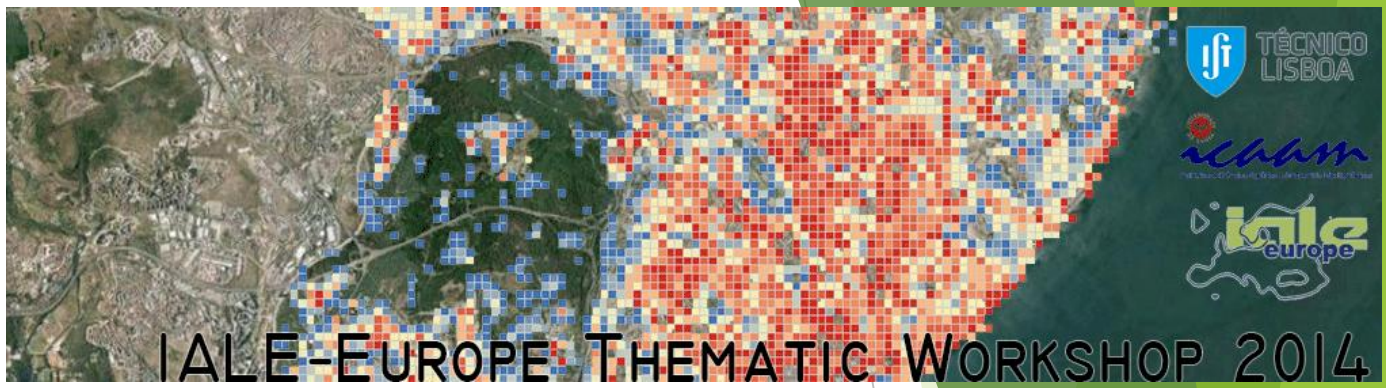
[1]Stoicescu, I., [2]Tudor, A.C., [1]Năpăruș, M.,
[1,3]Stupariu, M.S., [3]Cioacă, T.,
[1]Pătru-Stupariu, I., [4]Buttler, A., [4]Peringer, A.



Patterns and Processes in South-Carpathian Wood-Pastures: An approach to analyse land-use driven landscape change in complex mountain landscapes

[1]Department of Regional Geography and Environment, Transdisciplinary Research Centre Landscape - Territory - Information Systems (CeLTIS), Faculty of Geography, University of Bucharest, Romania
[2]Centre for Environmental Research and Impact Studies, University of Bucharest, Romania
[3]Faculty of Mathematics and Computer Science, University of Bucharest, Romania
[4]Laboratory of ecological systems (EPFL-ENAC-ECOS) and Swiss Federal Institute for Forest, Snow and Landscape Research (WSL) , Lausanne, Suisse

General context: SNF-WindLand-project

- **WindLand: Improved wind energy assessment based on coupled wind, terrain and vegetation modeling**
- 2 study regions: RO and CH
- Landscape-change influences wind energy potential (terrain roughness)
- Track no.3: Landscape models and vegetation patterns
- Vegetation Change following dramatic land use changes in the post-com period.

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

ECOS ECOLOGICAL SYSTEMS LABORATORY

ÉCOLE POLYTECHNIQUE FEDERALE DE LAUSANNE
LABORATOIRE DE SYSTEMES D'INFORMATION GEOGRAPHIQUE
LaSIG

WIRE Wind Engineering & Renewable Energy Laboratory

CelTIS

FNSNF Swiss National Science Foundation

UNIVERSITATEA DIN BUCUREŞTI

ueefiscdi

Swiss Contribution

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

sciex.ch

Specific context

To present approach and early results of my PhD-project “Simulating landscape dynamics in pasture-woodlands of the Southern Carpathians following land use and climate change.”

Local scale approach (pasture-woodlands):

- Transfer of the WoodPaM model from the Jura Mts. to the Carpathians
- Calibration and initialization with very high resolution LiDAR-data (extent: several kilometers square).
- Analysis of model output with landscape metrics and link to LES (Large Eddy Simulations).

Research questions

In order to understand ongoing landscape change, we address the following research questions:

- **What are the spatial patterns of forest encroachment in the Carpathian wood-pastures?**
- **What processes, driving factors and constraints can be deduced?**

Structure of the talk

First steps of my PhD study here presented:

- Inspection of the study area,
- Interviews for understanding drivers of land use change,
- LiDAR-analysis,
- Ecological data,
- Synthesis from land-use and vegetation patterns: deduction of hypotheses on processes of long-term landscape dynamics from patterns

Methods

LiDAR data analysis

- Geomorphology. Goal: Identification of rock outcrops (safe sites for tree establishment)
- Potential identification of shrub and tree encroachment. Goal: reconstruction of processes from patterns at landscape scale

ArcGIS, MatLab

Landscape history analysis

- Old forest/ grassland as hot-spots of historical continuity

Method: *time-depth analysis*

(Van Eetvelde et al. 2009, Pătru-Stupariu et al. 2013)

Field observations

- Geomorphology
- Land-use structure
- Forest community
- Encroachment patterns

Ecological data compilation

- Traits of dominant woody plant species

Interviews for understanding drivers of land use change

- Current land use
- Past land use

Synthesis of results

- Relating vegetation to land use change
- Formulating hypothesis on mechanisms of forest encroachment

Landscape change simulations

- Calibration, initialization, formulation of land use and climate change scenarios

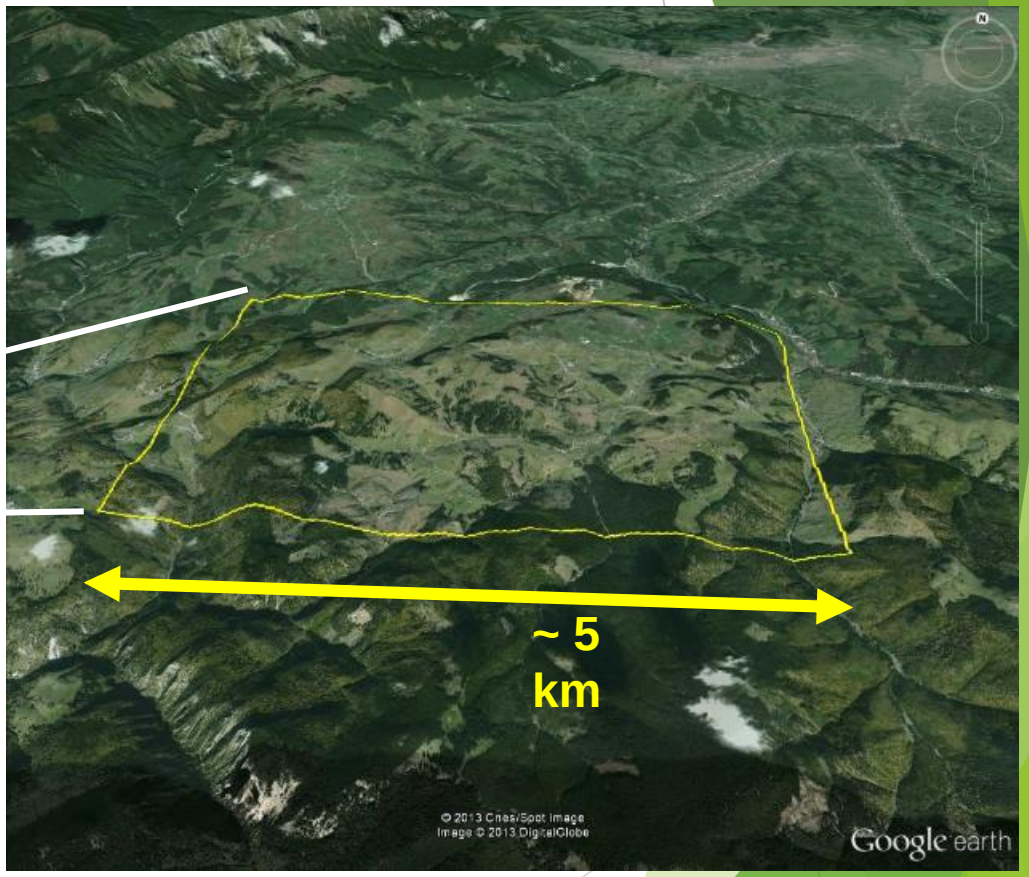
WoodPaM-simulation model of wood-pasture ecosystem dynamics *(Gillet 2008, Peringer et al. 2013)*

Study area: FUNDATA, Romania (Southern Carpathians, Rucăr- Bran Passageway)

- Altitude: 1160-1360 masl
- Geomorphology: karstic bedrock - limestone outcrops
- Climate: 4-6^{o}C annual mean temperature; 915 mm average yearly precipitations sum (1961-2000); dry summers
- Dominant woody species : European beech *Fagus sylvatica*, Norway spruce *Picea abies*, Juniper *Juniperus communis*.
- Land-use: pastures (sheep and cattle) since XIVth Century
- Land-use change: abandonment in the post-communist period

Study area: FUNDATA, Romania (Southern Carpathians, Rucăr-Bran Passageway)

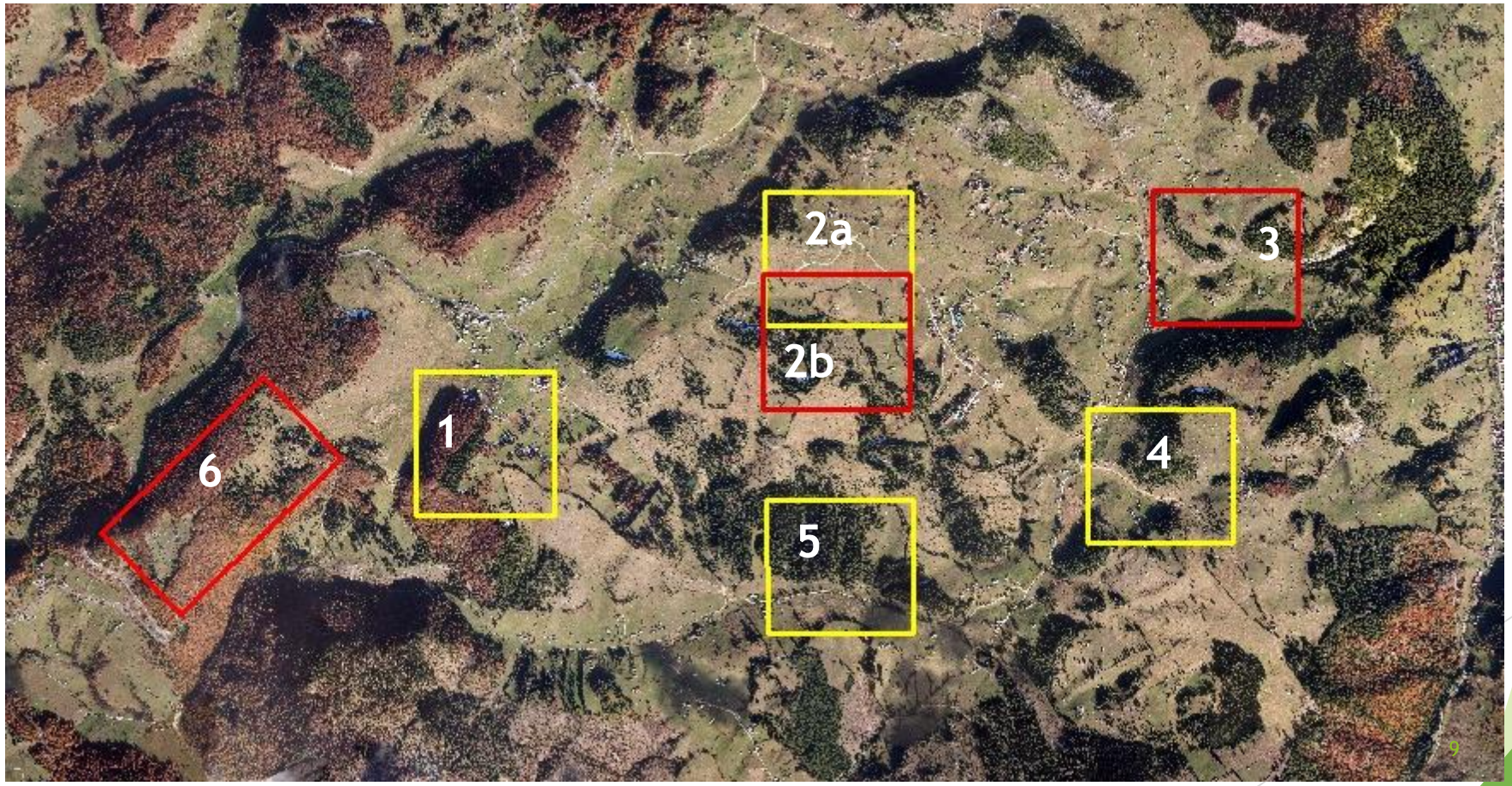
Google Earth View



Shape area: 22 km^2

Study sites selection

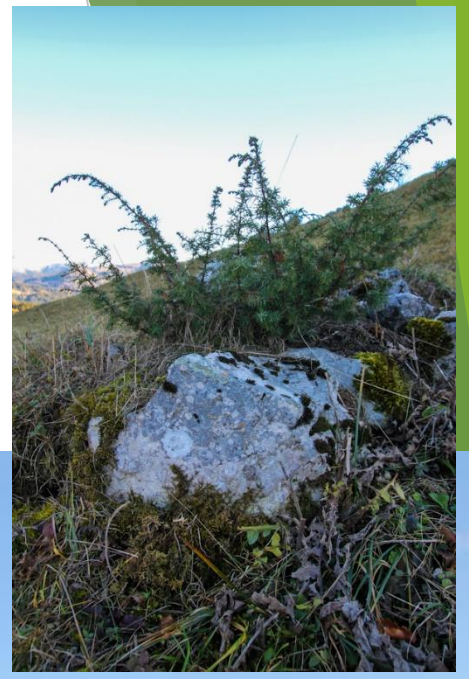
- 7 Study sites, which represent characteristic patterns of vegetation (shrub encroachment, forest communities) and land use (pasture size).
- Focus sites: 3, 2b, 6

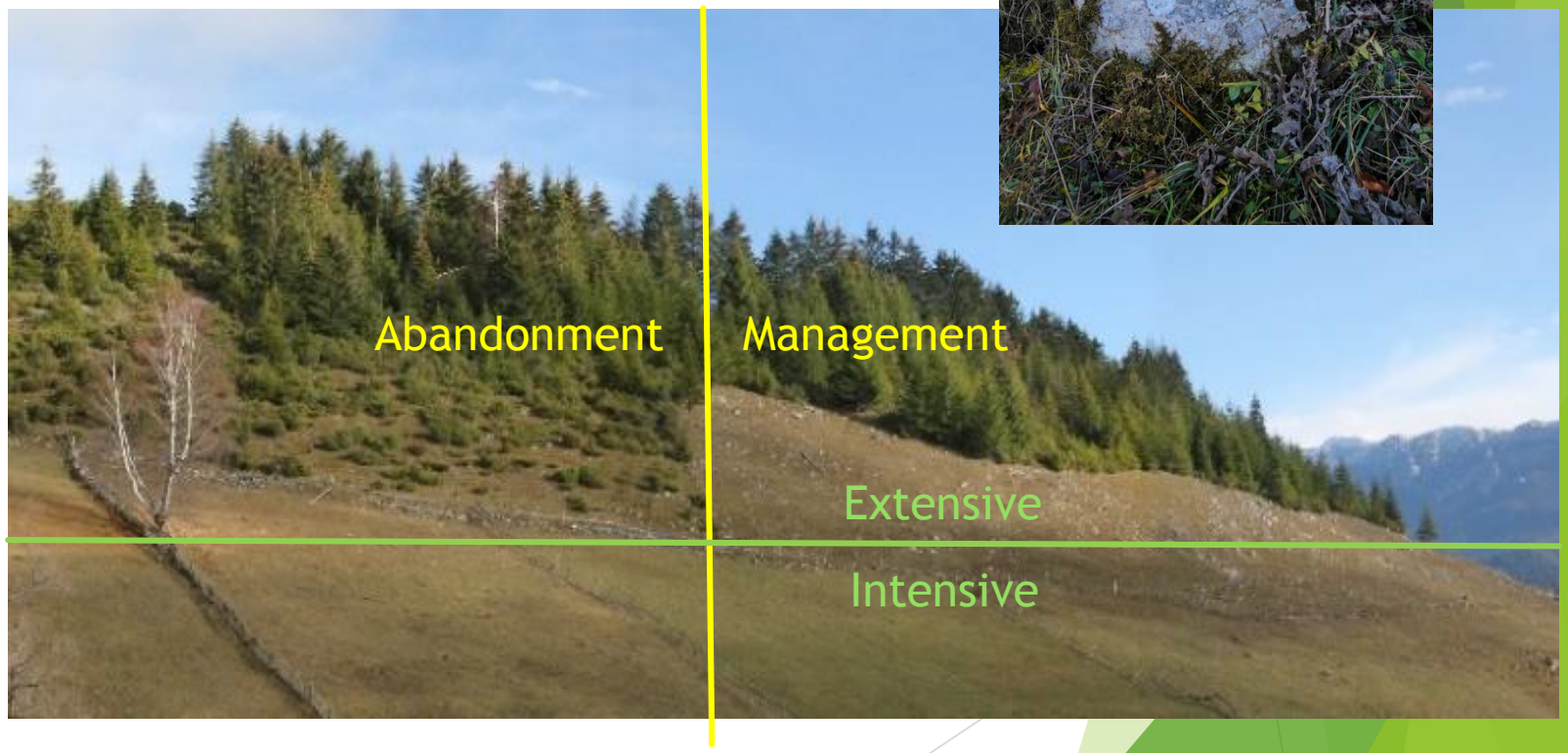


Aerial photograph view

Field obs. results
Site 3

- Steep slope, shallow soil with limestone outcrops on the hilltop, deep soil with no rocks at the foothill.
- Small scale fencing: Partly abandoned paddocks upslope, smaller paddocks intensely used downslope.
- Forest community dominated by spruce.
- Dense juniper and spruce encroachment uphill, no woody plants when management.





Field obs. results

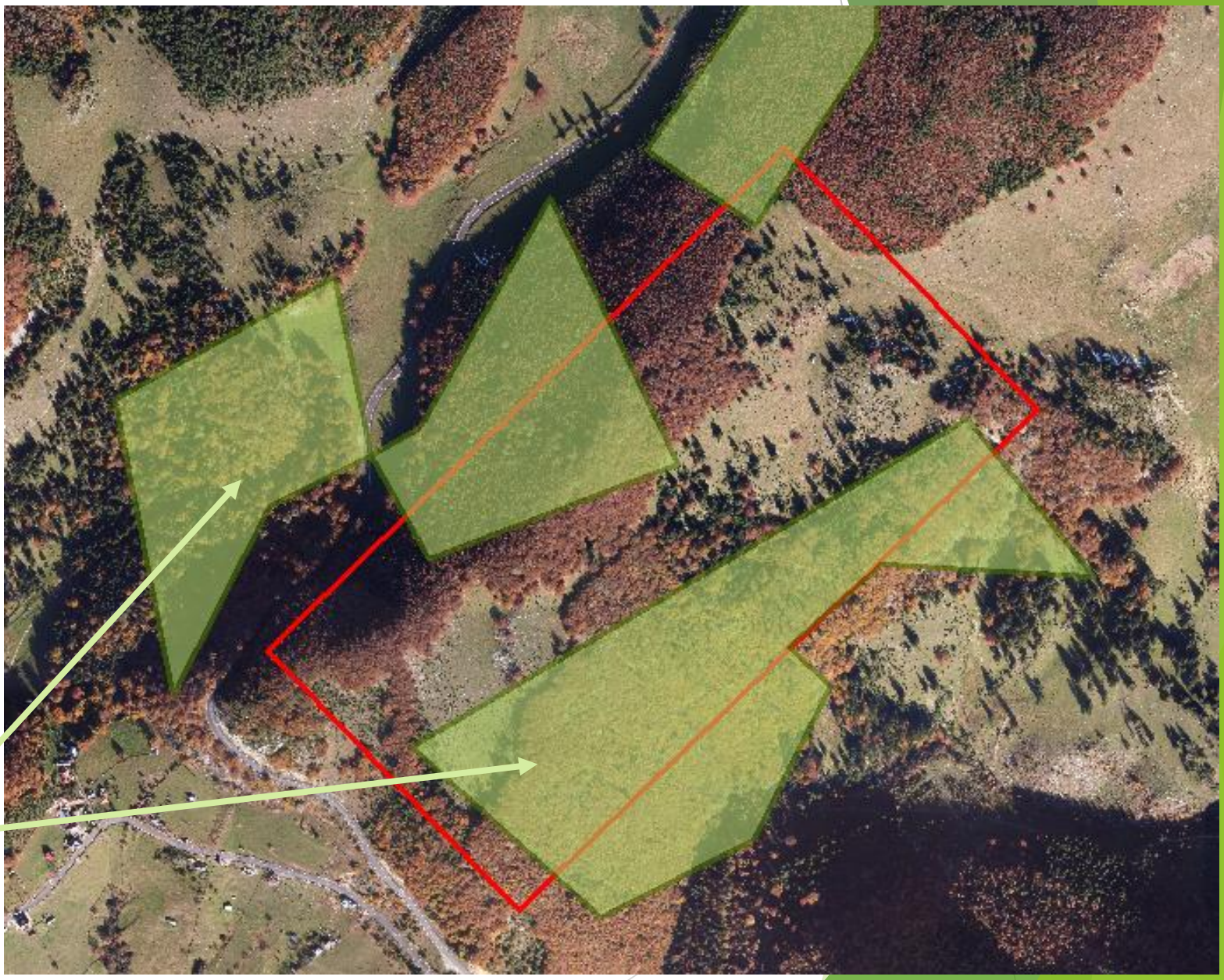
Site 2b

- Medium declivity, more rock outcrops in the hilltop, less in the foothill.
- Large commonage pasture - no fences present.
- Forest community dominated by spruce.
- Scattered encroachment of juniper and spruce all over.

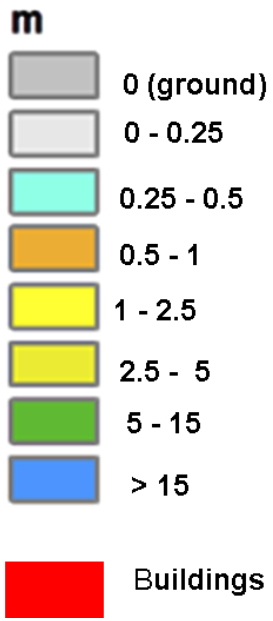
Field obs. results
Site 6

- Low declivity, few rock outcrops.
- Large commonage pasture - no fences present.
- Old forest*: beech dominance.
- Encroachment performed by spruce.

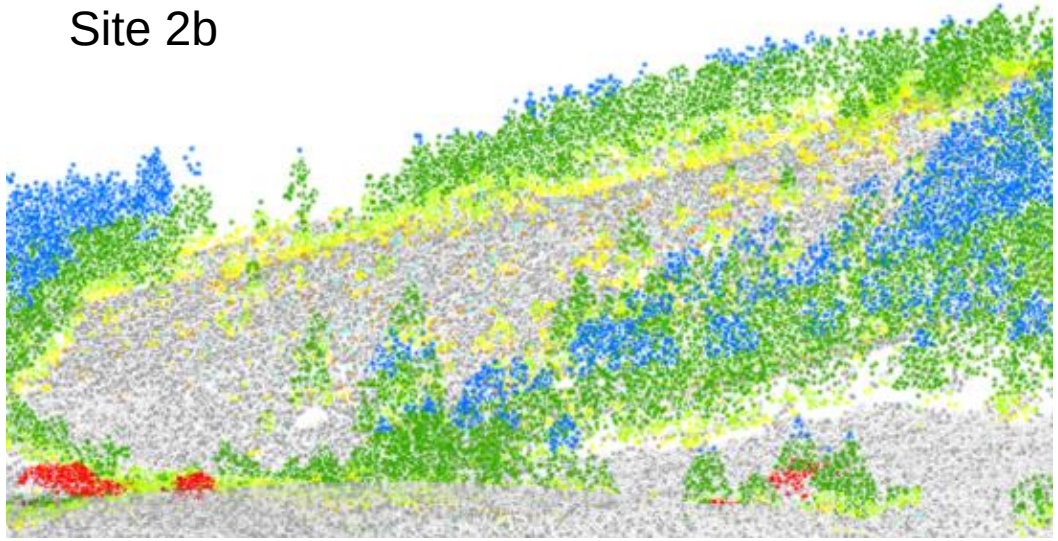
*Old forest (1912-2009), according to *time-depth* analysis



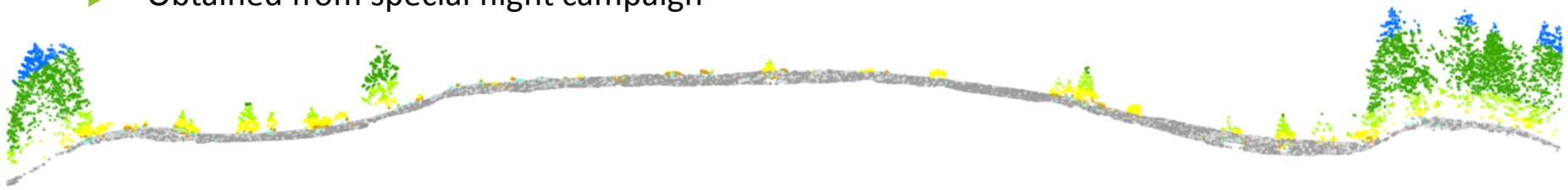
LiDAR data inspection- Results



Site 2b



- 20- 22 points per m^2
- Classification with focus on lower vegetation (shrubs and young trees)
  (Korpela, I. 2010)
- High accuracy, low noise
- Obtained from special flight campaign



Interview results

- After the communist period, the migration of young population towards urban areas triggered land abandonment. This confirms the phenomenon pointed out by Kuemmerle et al. 2009, Munteanu et al. 2014.
- Recent changes in ownership structure: inefficient management of the common pastureland.
- Poor allocation of subsidies for wood-pasture maintenance.

Ecological behavior of dominant woody species- Data compilation results

	Growth speed	Maximum age	Tolerance to shade	Browsing resistance	Distance of seed dispersal
Beech (*F. silvatica*)	moderate	430 years	high	low	Low (low density long-distance zoochory)
Spruce (*P. abies*)	high	700 years	high	moderate	high
Juniper (*J.communis*)	high	150 years	low	high	Low (low density long-distance zoochory)

Data source: Various. Classified excerpt from the database on ecological behavior of tree species of the wood-pasture simulation model WoodPaM (Gillet 2008, Peringer et al. 2013).

Synthesis: Patterns and processes

Aim: deduction of hypotheses on **processes** of long-term landscape dynamics **from patterns**:

- Land use structural shift (abandonment of large commonage pastures to the favor of small scale paddocks in rotational grazing systems) drives landscape segregation into intensive grassland and closed forest (see Western Europe). *(Landscape scale)*
- Beech dominates in natural/old forest, whereas spruce dominates in secondary succession (forest development in abandoned pastureland).
  -> *WoodPaM- simulation studies. (Community scale)*
- Ecological traits of spruce suggest fast and widespread encroachment, but upcoming summer droughts might inhibit establishment.
  -> *WoodPaM- simulation studies. (Population scale)*
- Rock outcrops play a crucial role for tree establishment, their presence accelerates encroachment and influences woody plant density.
  -> *LiDAR analysis. (Life process scale)*
- Subsidies need the definition of maintenance goals for wood-pasture management. -> *WoodPaM- simulation studies. (Landscape scale)*

Outlook

- LiDAR data analysis:
  - Identification of shrub and young tree, classification of encroachment patterns based on neighborhood analysis.
  - Accurate estimate of height and crown diameter for age estimate from an allometric growth function (dendrochronological field study following *Peringer 2008 Diss.)*
  - Reconstruct encroachment dynamics from patterns: *Peringer & Rosenthal 2009.*
- WoodPaM simulations:
  - Parameterize WoodPaM simulation model with processes data, then validate and calibrate model against patterns: *Gillet 2008 and Peringer et al. 2013.*

References

[1] Korpela, I., Ørka, H.O., Maltamo, M., et al. (2010). Tree species classification using airborne LiDAR – effects of stand and tree parameters, downsizing of training set, intensity normalization, and sensor type. Silva Fennica 44(2): 319–339.

[2] Kuemmerle, T., Muller, D., Griffiths, P. and Rusu, M. (2009) Land use change in Southern Romania after the collapse of socialism, Regional Environmental Change, 9, 1–12.

[3] Munteanu, C., Kuemmerle, T., Boltiziar, M. et al. (2014). Forest and agricultural land change in the Carpathian region- A meta-analysis of long-term patterns and drivers of change. Land Use Policy 38 (2014) 685–697

[4] Pătru-Stupariu I., Angelstam P., Elbakidze M., Huzui A., Andersson K., (2013). Using forest history and spatial patterns to identify potential high conservation value forests in Romania. Biodiversity and Conservation [22:2023–2039]

[5] Peringer, A. and G. Rosenthal (2009). Temporal and spatial patterns of woody plant succession in pre-alpine calcareous fens-effects for the management of low-intensity grazing systems in Upper Bavaria. Raum-Zeitmuster der Gehölzsukzession in Kalkflachmooren: Konsequenzen für das Management von extensiven Viehweiden in Oberbayern. In: Naturschutz und Landschaftsplanung 41 (6), S. 173–180.

[6] Peringer, A. (2008): Analyse von Mechanismen der sekundären progressiven Sukzession von voralpinem Niedermoorgrünland zu Erlenbruchwald. / Mechanisms of woody plant succession in extensively grazed prealpine fens. PhD-Thesis. University of Stuttgart.

[7] Van Eetvelde, V. and Kayhko, N. (2009) The applicability of quantitative techniques for assessing spatio-temporal patterns of landscape changes, In Breuste, J., Kozova, M. and Finka, M., (eds.) Proceedings of the European IALE Conference 2009, pp. 379–382.

Thank you for listening!

Acknowledgement
This work was supported by the Swiss Enlargement Contribution in the framework of the Romanian-Swiss Research Programme, project WindLand, project code: IZERZO_142168/1 and 22 RO-CH/RSRP.

Contact: Ioana Stoicescu, ioana.stoicescu@yahoo.com
Department of Regional Geography and Environment, Transdisciplinary Research Centre Landscape - Territory - Information Systems (CeLTIS), Faculty of Geography, University of Bucharest, Romania