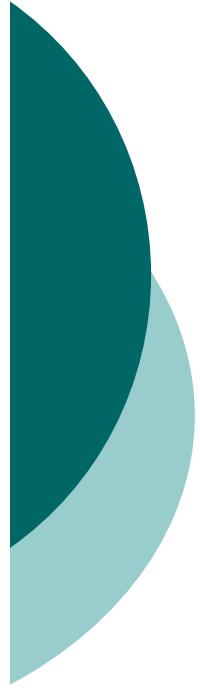


Relationship between species richness and landscape heterogeneity

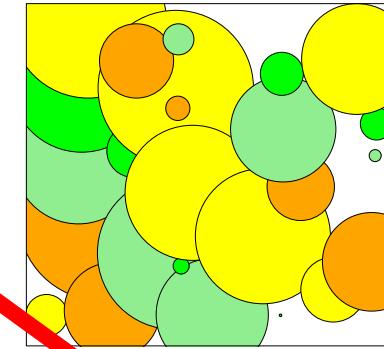
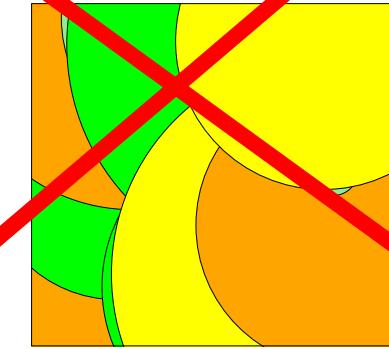
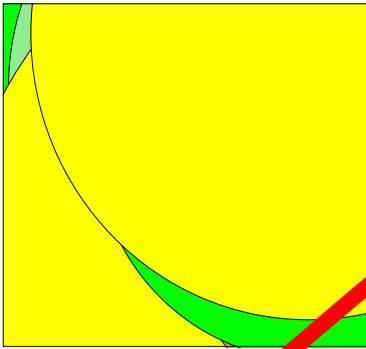
David Zelený, Ching-Feng Li, Irena Veselá & Milan Chytry





~~Diversity – heterogeneity relationship~~

Effect of landscape heterogeneity on **gamma** diversity:

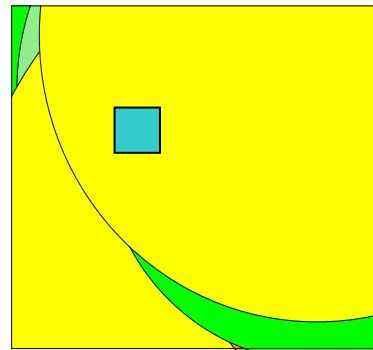


→ higher landscape heterogeneity

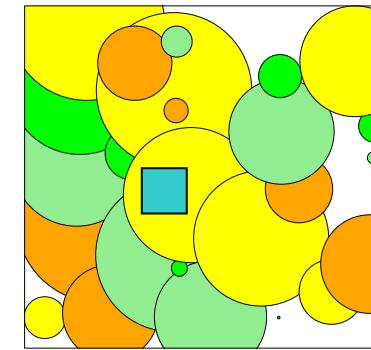
more habitat types

higher overall (gamma) diversity

Diversity – heterogeneity relationship



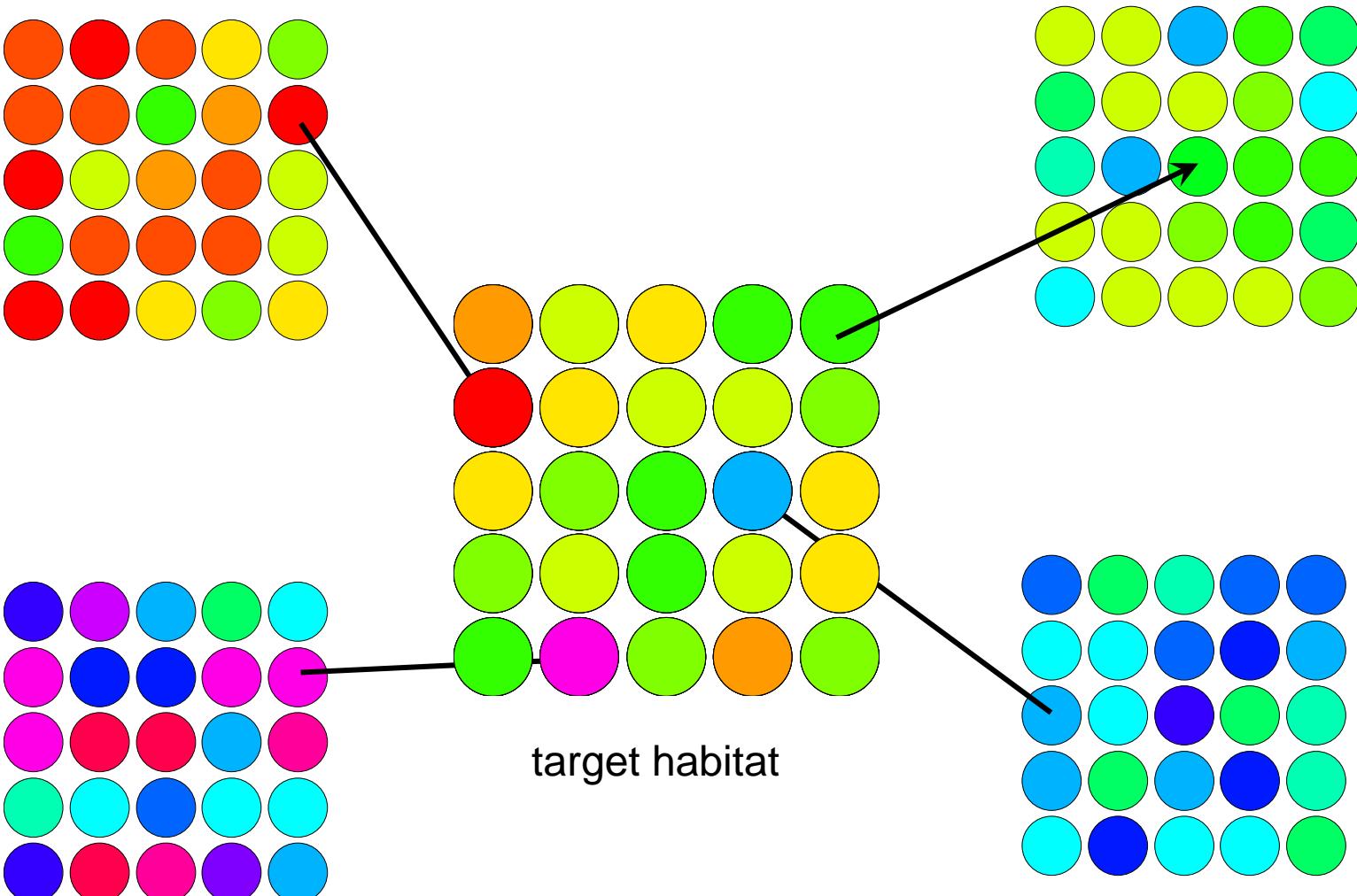
homogeneous
landscape



heterogeneous
landscape

Question: will be the number of species within the plot influenced by the heterogeneity of the surrounding landscape?

Spatial mass effect (vicinism): why is it good to have various neighbors?

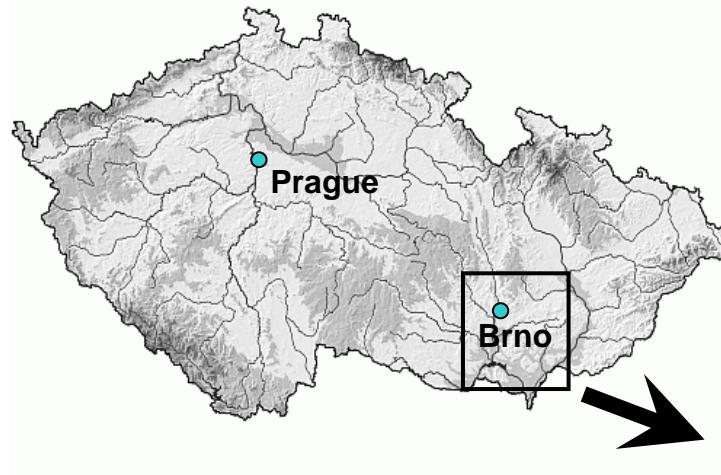




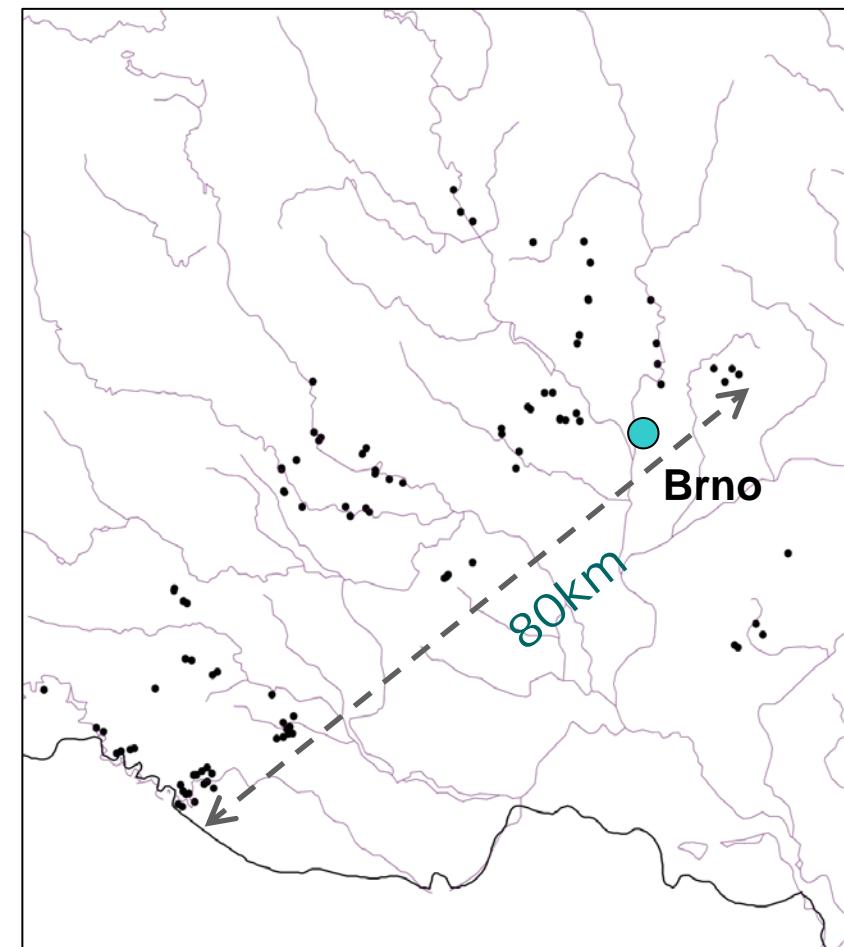
Methods

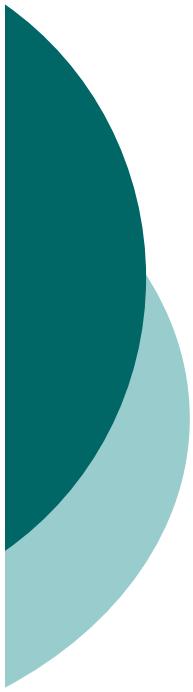
Study area:
eastern part of the Czech Republic

Study area & plot distribution



100 plots distributed
across southern
Moravia





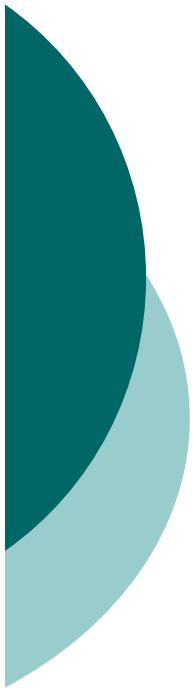
Methods

Study area:
eastern part of the Czech Republic

Studied vegetation type:
forest vegetation dominated with oak

Oak dominated forest ...





Methods

Study area:

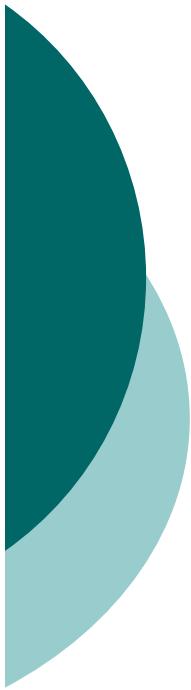
eastern part of the Czech Republic

Studied vegetation type:

forest vegetation dominated with **oak**

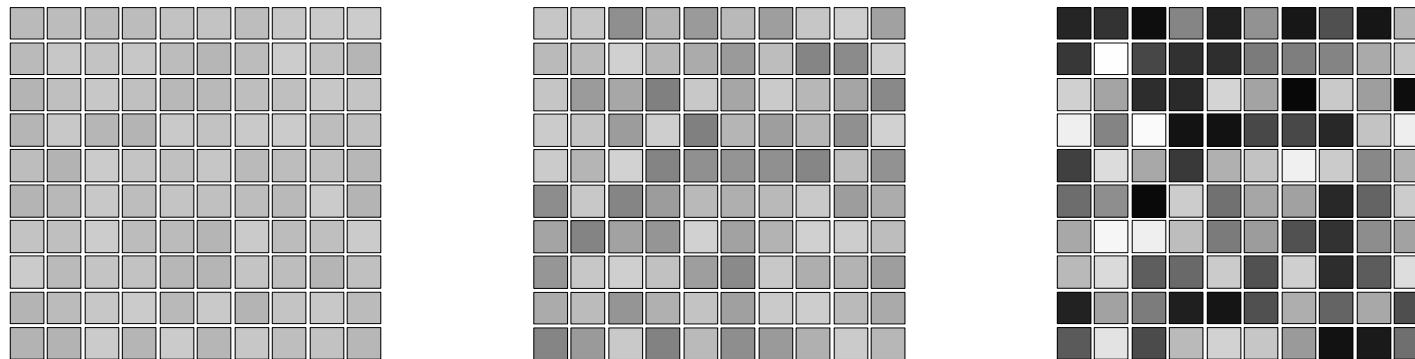
Sampling design:

sampling stratified along the gradient of **habitat productivity** and **landscape heterogeneity**



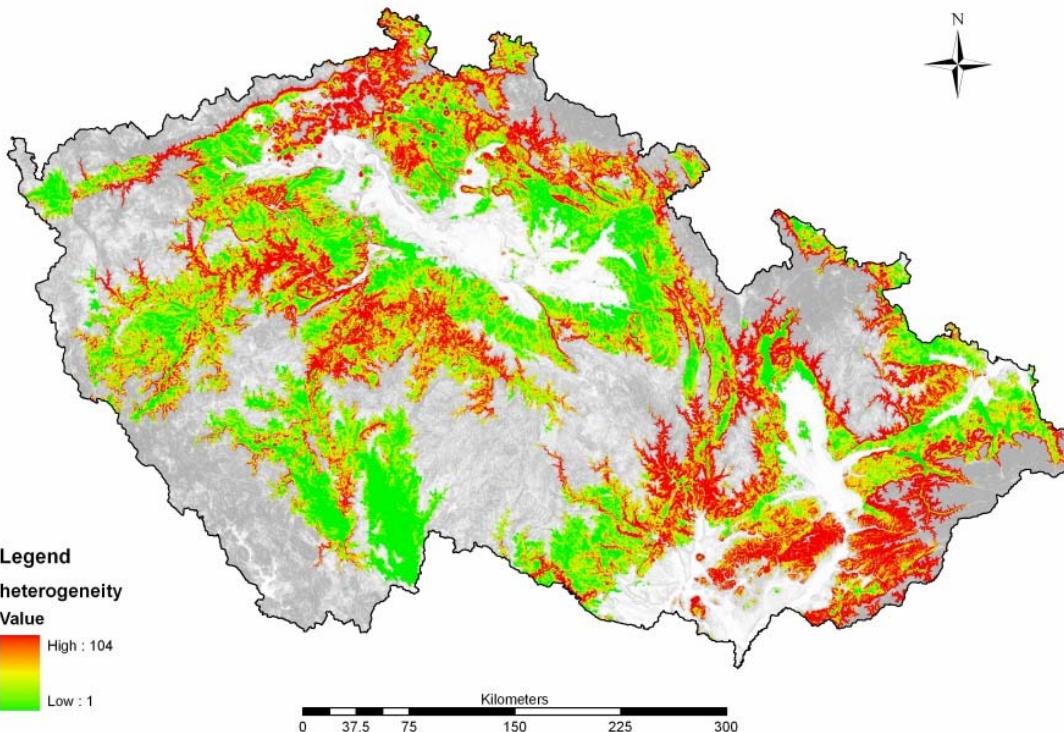
Landscape heterogeneity

= topographical heterogeneity

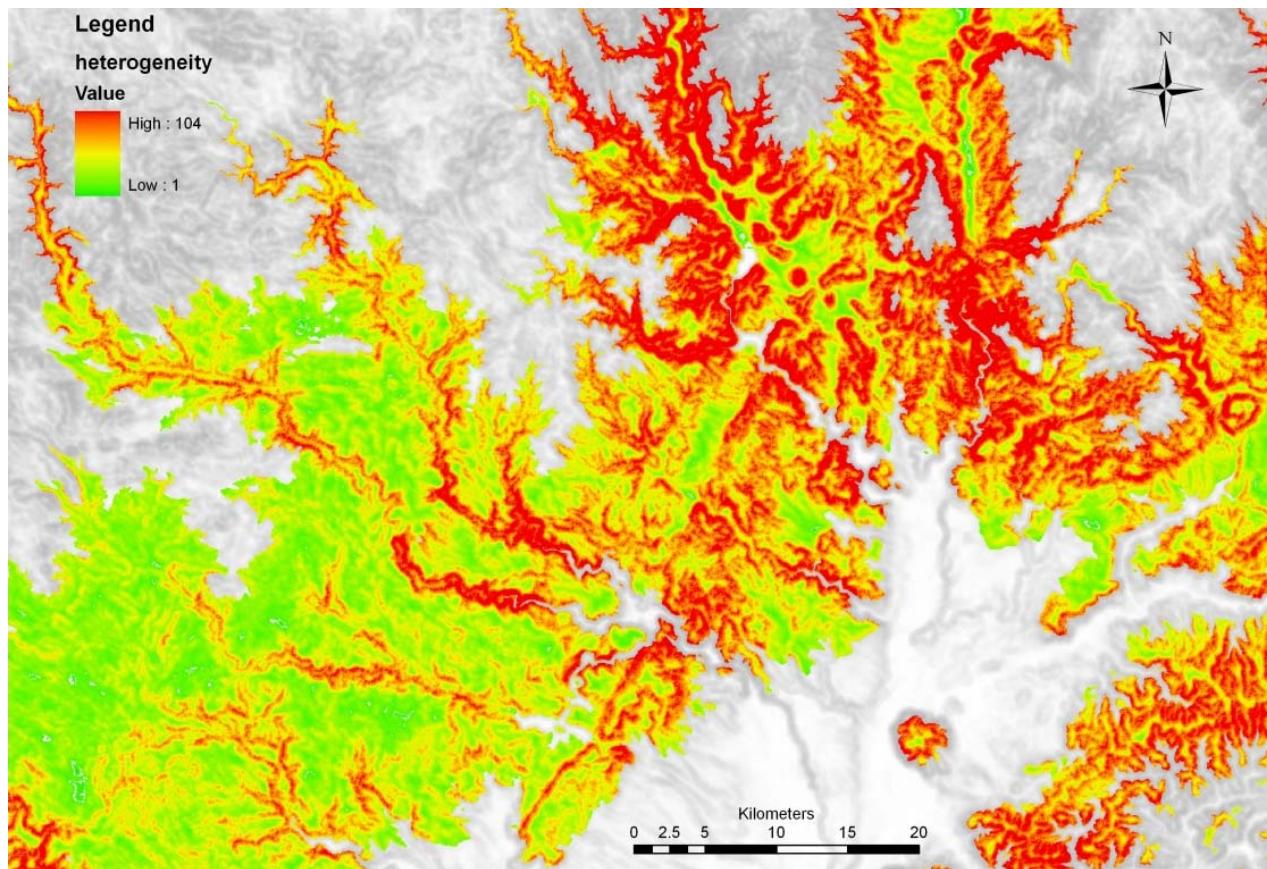


increasing topographical
heterogeneity of the landscape

Landscape heterogeneity



Landscape heterogeneity





Sampling procedure

- generate localities for sampling (based on stratification)
- go to the field with GPS and search for the locality
- if locality fits to our criteria, set up a permanent plot and make a relevé
- sampling involves: recording all vascular plant species, estimate environmental characteristics of the plot, measure canopy cover and take soil sample
- in the end of the season, moisture measuring on selected localities was conducted



Measuring canopy openness





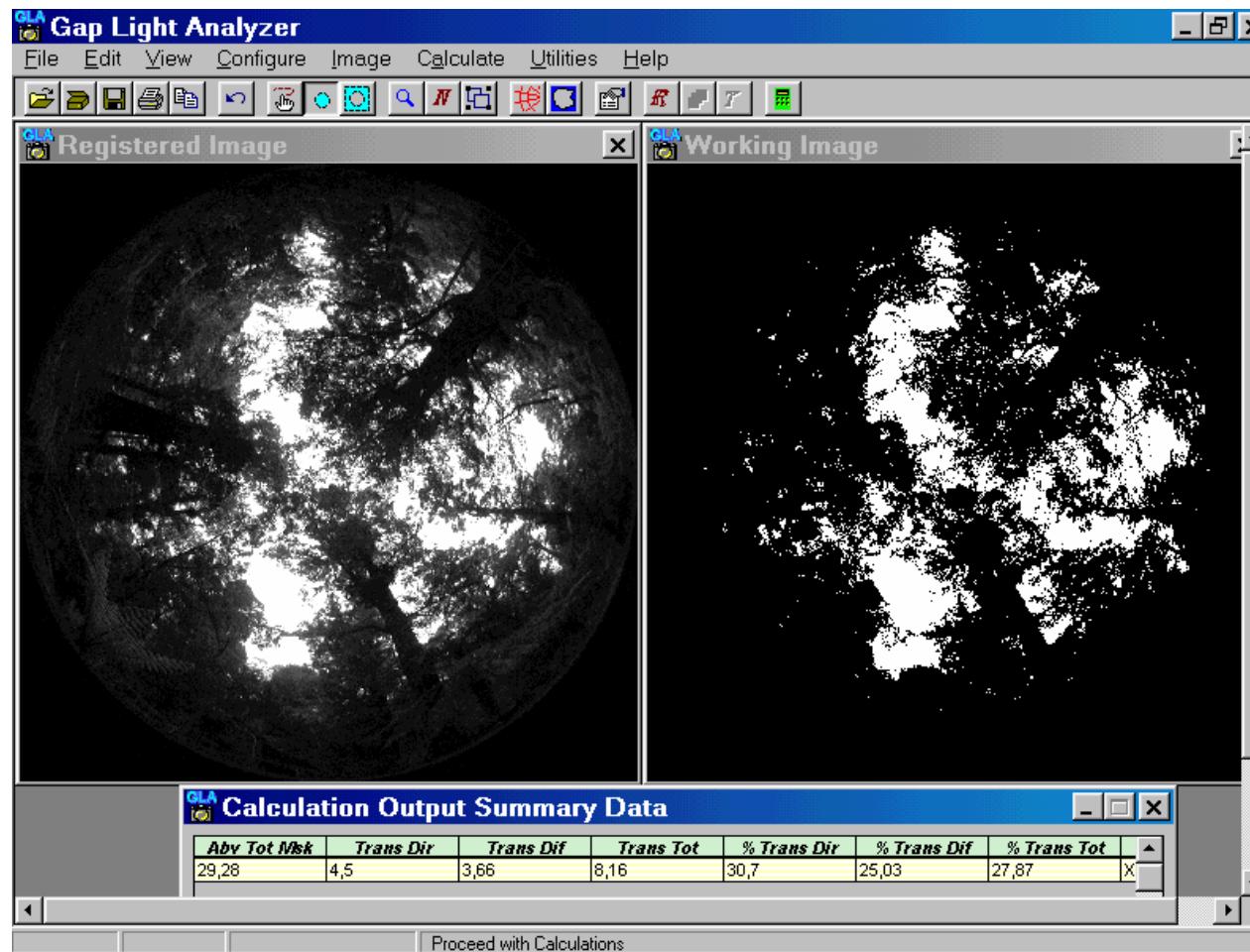




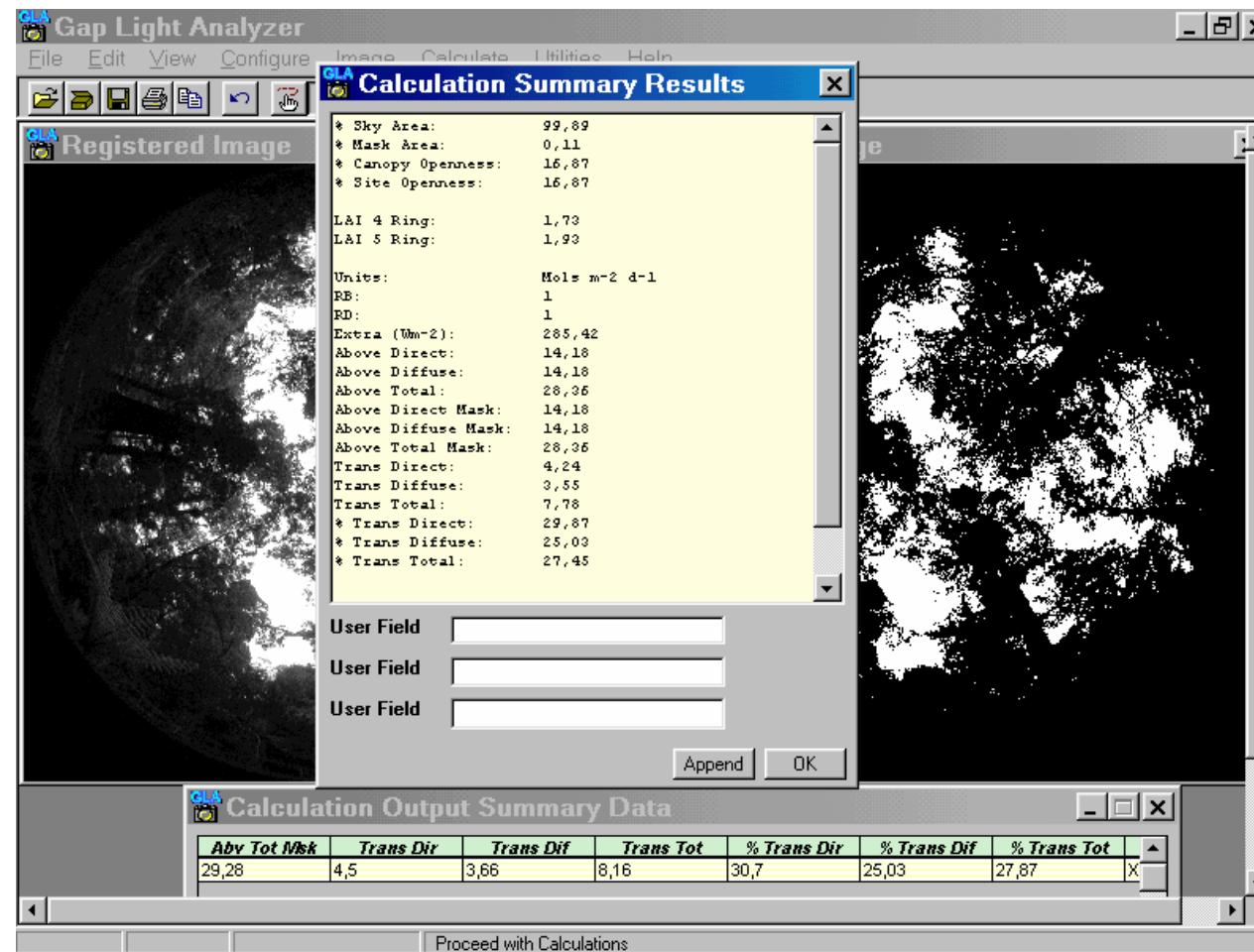
Measuring canopy openness

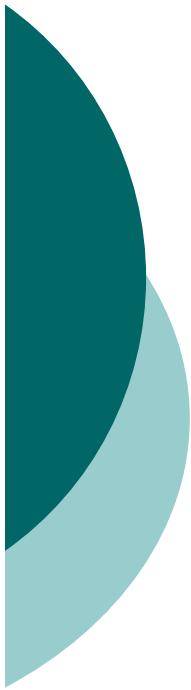


Measuring canopy openness



Measuring canopy openness





How to measure the productivity of habitat?

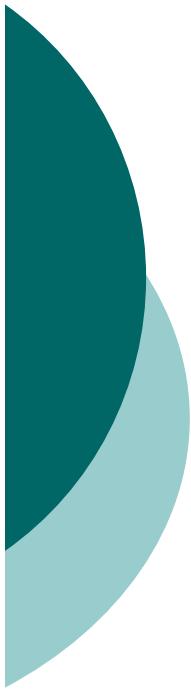
1) chemical analysis of the soil sample for nutrient content

Advantage:

- fast and easy

Disadvantage:

- not all nutrients present in the soil may be reached and used by plants



How to measure the productivity of habitat?

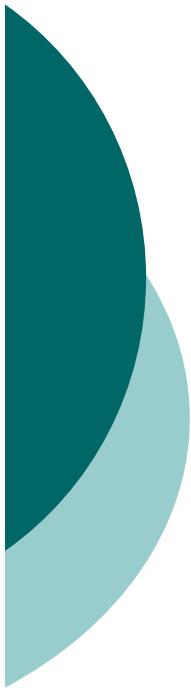
2) measuring the real biomass production
(cut – dry – weight)

Advantage:

- not so fast, but still quite easy

Disadvantage:

- depends on species composition of the biomass
(presence of large species)
- will be influenced by number of other factors (in forest mainly by light)



How to measure the productivity of habitat?

3) bioassay greenhouse experiment

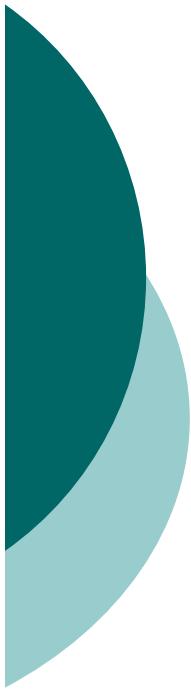
How does it work:

- take the soil sample from each plot
- put it into the greenhouse and treat with unlimited water conditions
- grow selected bioassay species
- harvest, weight and analyze biomass for nutrient content

Bioassay experiment



© I. Veselá



How to measure the productivity of habitat?

3) bioassay greenhouse experiment

Advantage:

- measure the potential habitat productivity, not influenced by the differences in the species composition, water availability etc.

Disadvantage:

- time, money and work demanding

Bioassay experiment for productivity assessment

Journal of Vegetation Science 18: 665-674, 2007
© IAVS; Opulus Press Uppsala.

665

Habitat engineering under dry conditions: The impact of pikas (*Ochotona pallasi*) on vegetation and site conditions in southern Mongolian steppes

Wesche, Karsten^{1*}; Nadrowski, Karin² & Retzer, Vroni³

¹Institute of Biology - Geobotany and Botanical Garden, Martin-Luther-University Halle-Wittenberg, 06099 Halle, Germany;

²Department of Animal Ecology, Justus-Liebig-University, 35392 Giessen, Germany, E-mail nadrowski@bio.uni-giessen.de;

³Chair of Biogeography, University of Bayreuth, 95440 Bayreuth, Germany, E-mail vroni.retzer@uni-bayreuth.de

*Corresponding author. E-mail karsten.wesche@botanik.uni-halle.de; Fax +49 345 55 27228

Abstract

Question: Does ecosystem engineering by small mammals have a significant influence on vegetation patterns in the arid steppe vegetation of southern Mongolia?

Location: Gobi Altay Mountains, southern Mongolia.

Methods: We assessed the impact of the small lagomorph *Ochotona pallasi* on plant community composition, nutrient levels and biomass production in montane desert steppes. Data were derived from vegetation relevés, harvests of above-ground standing crop and a bioassay, followed by analyses of soil and plant nutrient contents.

Results: Although the local climate is arid with <150 mm annual precipitation, clear evidence of allogeic ecosystem engineering was found. Plant communities on burrows differed



Bioassay experiment for assessment of site productivity in oak forests

Veselá I.*¹, Zelený D., Li C.-F. & Chytrý M.

Department of Botany and Zoology, Faculty of Science, Masaryk University, Kotlářská 2, 611 37 Brno, Czech Republic

* presenting author (iriska@mail.muni.cz, www.sci.muni.cz/~vesela)



Bioassay experiment for assessment of site productivity in oak forests
Veselá I.^{*}, Zelený D., Li C.-F. & Chytrý M.
Department of Botany and Zoology, Faculty of Science, Masaryk University, Kotlářská 2, 611 37 Brno, Czech Republic
* presenting author (iriska@mail.muni.cz, www.sci.muni.cz/~vesela)

Introduction
Site productivity of forest stands can be estimated by soil analysis or by analysis of herb layer biomass. However, both approaches have some disadvantages:
- soil chemical analysis is time consuming and expensive;
- soil productivity is often measured in the topsoil;
- in contrast, the earliest contact in herb biomass can be highly influenced by light availability and other abiotic factors and by species interactions.
In addition, biomass production depends on light and nutrient availability.

Methods
The dataset was recorded by selection of 100 randomly distributed plots with diameter of胸幹 (DBH) > 10 cm in the forest. The plots were divided into two groups:
- **herb layer biomass**: the total amount of above-ground biomass of all species in the herb layer was measured;
- **bioassay experiment**: the total amount of above-ground biomass of radish (*Raphanus sativus* L.) was measured in each plot. The radish was chosen because it is a photophyte, which has the same range and modes of nutrient utilization as the forest herbs. The radish was sown in pots with soil collected from the forest floor. The pots were placed in the forest under different light regimes: full sunlight, partial shade and deep shade. The pots were randomly distributed in the forest. The radish plants were harvested after 10 weeks and their biomass was measured. The radish plants were then analyzed for nutrient content (N, P, K and Ca).

Bioassay experiment
After removing the upper 10 cm of soil, we had four types of soil material: plain soil, soil with added NPK fertilizer, soil with added Ca and plain soil with Ca (soil with Ca). These soil mixtures were mixed together and sown (radish seeds) in pots (10 cm diameter).
After 10 weeks, the total amount of radish biomass was measured in the pots and seedlings were harvested. In the beginning of experiment, 12 seeds of radish were sown in each pot. After 10 weeks, the radish plants were separated into four groups of three. After successful seedling recruitment, one seedling from three was left, resulting in four seedlings of radish separated by sufficient distance to ensure no competition between them.

The first year: After the first year in half of the experiment, the radish biomass was measured again. The radish plants were harvested after 10 weeks and their biomass was measured. The radish plants were then analyzed for nutrient content (N, P, K and Ca).

The next three years: The radish plants were harvested after 10 weeks and their biomass was measured. The radish plants were then analyzed for nutrient content (N, P, K and Ca).

Control pots with Pots: The control pots with radish plants were harvested after 10 weeks and their biomass was measured. The radish plants were then analyzed for nutrient content (N, P, K and Ca).

Control pots without radish: The control pots without radish plants were harvested after 10 weeks and their biomass was measured. The radish plants were then analyzed for nutrient content (N, P, K and Ca).

Results
The correlation coefficients between nutrient contents and productivity were calculated.

	NPK	NPK + Ca	NPK + Ca + light	Ca	Ca + light	NPK + light	NPK + Ca + light + P
NPK	0.61**	0.6	0.6	0.6	0.61**	0.58*	0.59*
NPK + Ca	0.61**	0.6	0.6	0.6	0.61**	0.58*	0.59*
Ca + NPK	0.29**	0.30**	0.6	0.6	0.36**	0.35**	0.42**
Ca	0.29**	0.30**	0.6	0.6	0.36**	0.35**	0.42**
Ca + light	0.31**	0.32**	0.6	0.6	0.38**	0.37**	0.43**
light	0.31**	0.32**	0.6	0.6	0.38**	0.37**	0.43**
P	0.6	0.6	0.6	0.6	0.6	0.6	0.6

In contrast to the forest herb-layer biomass, the radish biomass better reflects soil productivity. The radish biomass is significantly correlated with soil nutrient content. While radish, the total amount of forest biomass and its Ca content does not reflect soil pH, the radish biomass is significantly correlated with pH (see also the scatterplot).

As an example, in our study, known as available phosphorus, the availability of phosphorus decreased. The radish biomass decreased. The decrease in radish biomass could be therefore caused by its relationship with phosphorus content. Our results show that the radish biomass decreased but there was no significant correlation except for the NPK pots, which has even the same range and modes of nutrient utilization as the forest herbs.

We created multivariate regression models, separately for forest and radish biomass, using all characteristics and (if used) soil nutrient content, light availability as explanatory variables.

Indicator regression models (NPK + Ca + light + P):

Indicator	Forest biomass	Radish biomass
Forest biomass	0.0000	0.0000
Radish biomass	0.0000	0.0000
Indicator <th>Forest biomass</th> <th>Radish biomass</th>	Forest biomass	Radish biomass
Forest biomass	0.0000	0.0000
Radish biomass	0.0000	0.0000

For the forest herb-layer biomass, the cover of tree canopy was more important than the soil factors. Compared to the model of radish biomass, where transpired variables explained over 70% of variation, the model of forest herb biomass explained only slightly more than 20%. Individual indicator variables were significant only for the radish biomass, while what was not transpired, transpiration estimated by Silvastek indicator values was added as an auxiliary variable. In the model of forest biomass, the explained variability increased to 31.1% (not shown).

Conclusions
The bioassay experiment showed, that radish as a photophyte plant can be successfully used for the assessment of soil productivity in forest sites indicated by the results of control pots.

Both forest herb-layer biomass and radish biomass are significantly correlated with soil nutrient content, with one significant difference – while the radish biomass is highly correlated with soil pH, the forest herb-layer biomass is not.

Results of multivariate regression models revealed that the radish biomass is more sensitive to soil nutrient content than the forest herb-layer biomass. The radish biomass is significantly influenced by light and nutrient content, while the forest herb-layer biomass is influenced by soil nutrient potential rather than related productivity in dominated site by significant correlation with forestry productivity maps.

This study was supported by the Argon project MSM 0021620837 and its results are part of PhD study of these authors.

poster presented by **Irena Veselá** at the 17th International Workshop of European Vegetation Survey in Brno (May 2008)

Bioassay experiment for productivity assessment



The first week



After the third week – half of the experiment



Before harvesting



The most obvious differences



Control pot with Perlite
– the lowest concentration of fertilizer



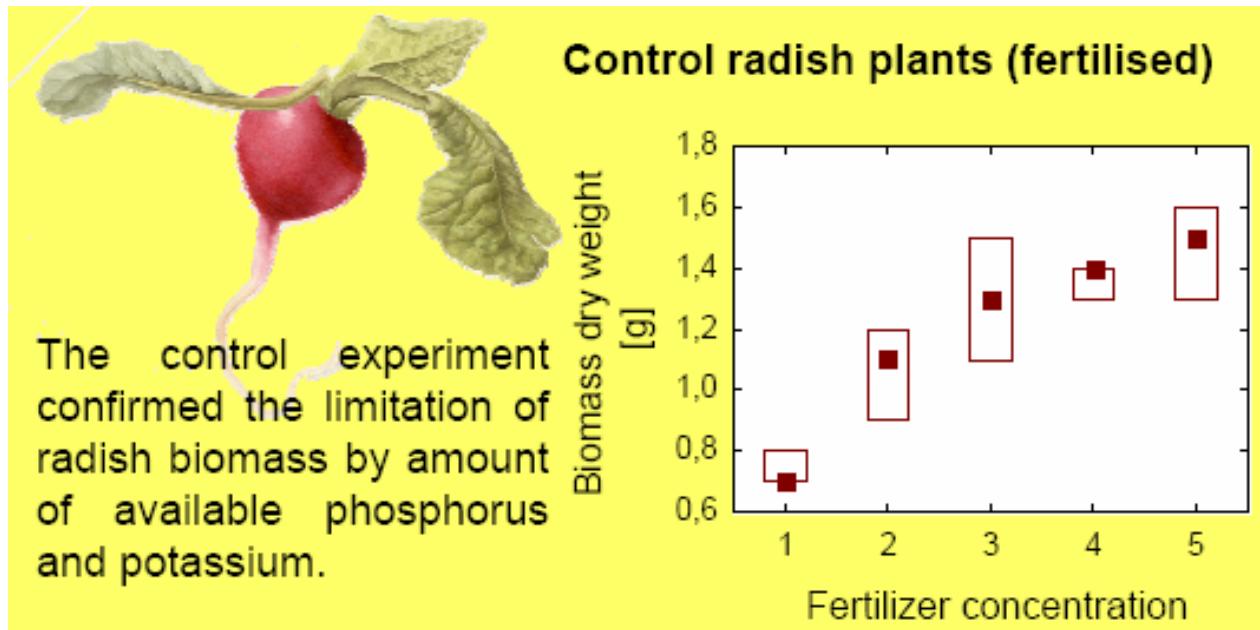
Control pot with Perlite
– the highest concentration of fertilizer



Veselá et. al (2008): Bioassay experiment for assessment of site productivity in oak forests. - 17th International Workshop European Vegetation Survey, Brno, Czech Republic, 1-4. 5. 2008.



Bioassay experiment for productivity assessment





Bioassay experiment for productivity assessment

Results

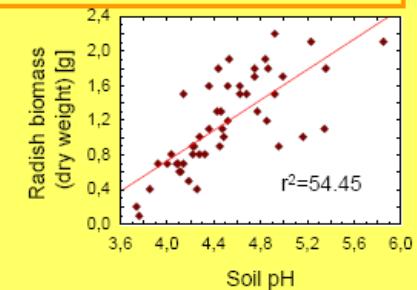
Spearman correlations: significant correlations are marked with asterisks ($p = 0.01^{**}$, $p = 0.05^*$). Corresponding pairs of nutrient ratios are coloured.

		FOREST BIOMASS (herb layer)					RADISH BIOMASS				
		N/P	N/K	K/P	Ca_total	dry weight	N/P	N/K	K/P	Ca_total	dry weight
SOIL		0.426**	n.s.	n.s.	n.s.	n.s.	0.524**	0.336*	0.296*	-0.458**	-0.530**
	N/K	n.s.	0.312*	n.s.	n.s.	n.s.	n.s.	0.596**	-0.317*	-0.455**	-0.462**
	K/P	0.391**	n.s.	n.s.	-0.315*	-0.289*	0.506**	n.s.	0.395**	-0.355*	-0.427**
	Ca_total	-0.291*	-0.381**	n.s.	n.s.	n.s.	-0.550**	-0.429**	n.s.	0.495**	0.476**
	pH_H2O	-0.437**	-0.539**	n.s.	n.s.	n.s.	-0.562**	-0.527*	n.s.	0.833*	0.792*
	C/N	n.s.	0.388**	-0.467**	n.s.	n.s.	n.s.	n.s.	-0.349*	n.s.	

In contrast to the forest herb-layer biomass, the radish biomass better reflects soil characteristics (significant correlations between corresponding nutrient ratios). While neither the total amount of forest biomass nor its Ca content does not reflect soil pH, the radish biomass is significantly correlated with pH (see also the scatter plot).

As our sampling covered mostly forests on acidic soils, the availability of phosphorus increases with pH. The positive correlation of radish biomass with soil pH could be therefore caused by its relationship with phosphorus content.

Comparison of forest herb-layer biomass data and radish biomass data revealed that there is no significant correlation except for the N/P ratio, which has even the same range and median of attained values.





Soil moisture measuring

Why to measure soil moisture?

Productivity of the habitat reflects not only amount of nutrients, which can be used by plants, but also water availability – soil may have high nutrient status, but due to dry conditions, the actual productivity of the stand is low.

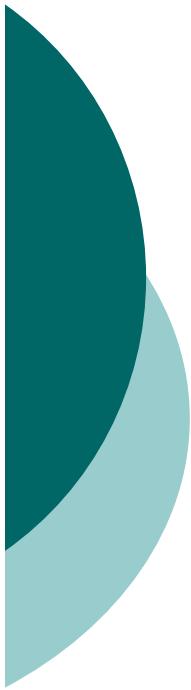
But: soil moisture measuring, especially at larger scale, is technically rather complicated ...

Soil moisture measuring



Theta Probe ML2x
sensor and reader
(Delta-T, United
Kingdom)





Soil moisture measuring

Methods:

- select half of the permanent plots (technically it's not possible to visit all 100 plots during a short period)
- after the period of long lasting drought (5 days without rain) visit all these plots (took 4 days)
- within each plot, 10 measurements were taken from random positions



Soil moisture measuring

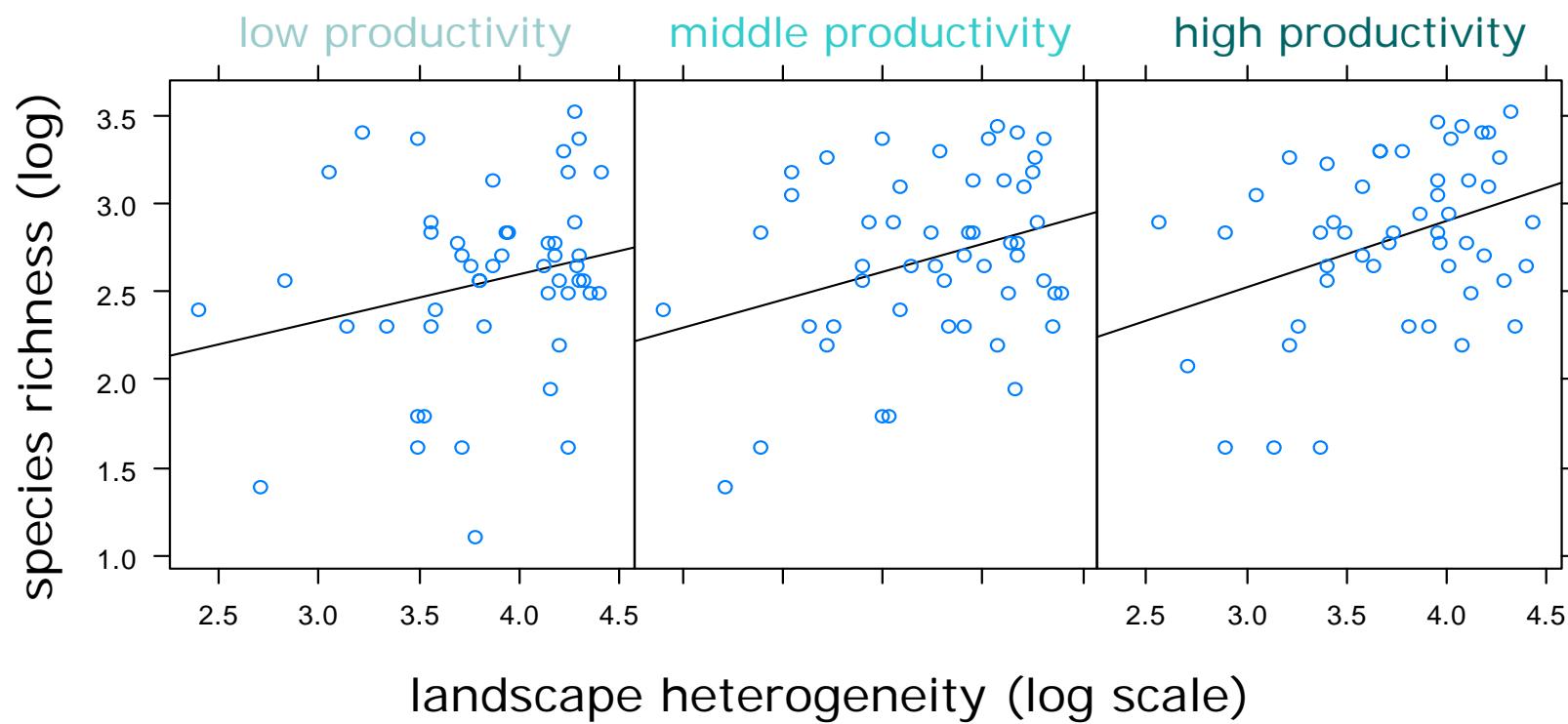
Question: which environmental factors does measured soil moisture reflect?

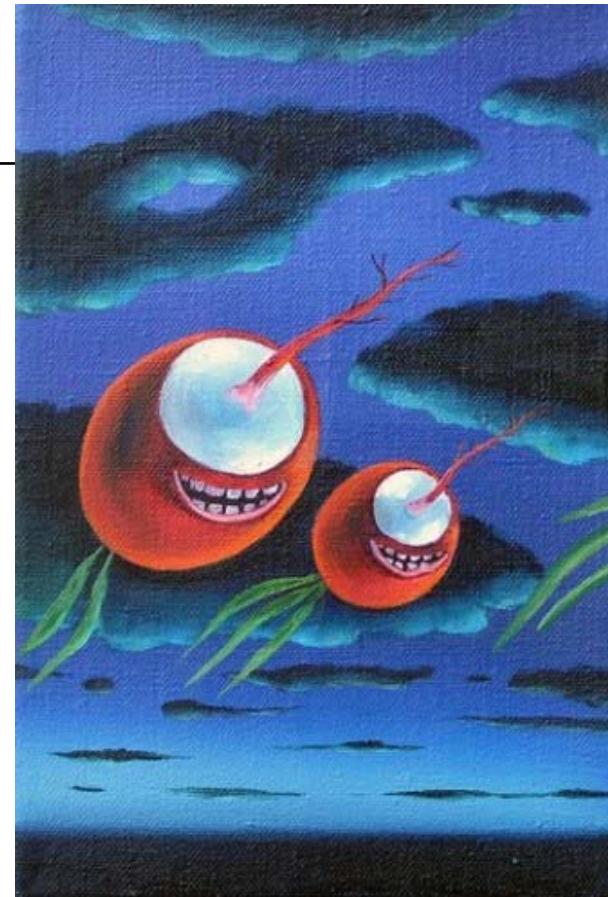
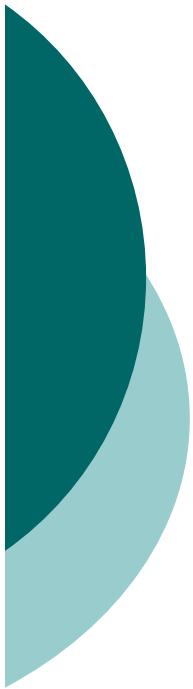
Analysis: Generalized Linear Models

Result: the most important factors are **slope**, **cover of tree layer** and **soil type**



Results





Thank you for your attention!

The research was supported by long term research plan MSM 0021622416 (Masaryk University, Brno).