Natural Backround of Landscape Management

Tomáš Koutecký
Mendel University in Brno

The Main Principles of Landscape Ecology

(with examples from the Czech Republic)

Content of the Lecture:

- **Landscape in general**

(landscape structure, history, perception…)

- **Landscape Ecology Backround**

- Ecological niche concept
- Metapopulation concept
- Island biogeography
- Landscape fragmentation
- Ecological succession
- Human impact and Ecosystem changes

Landscape

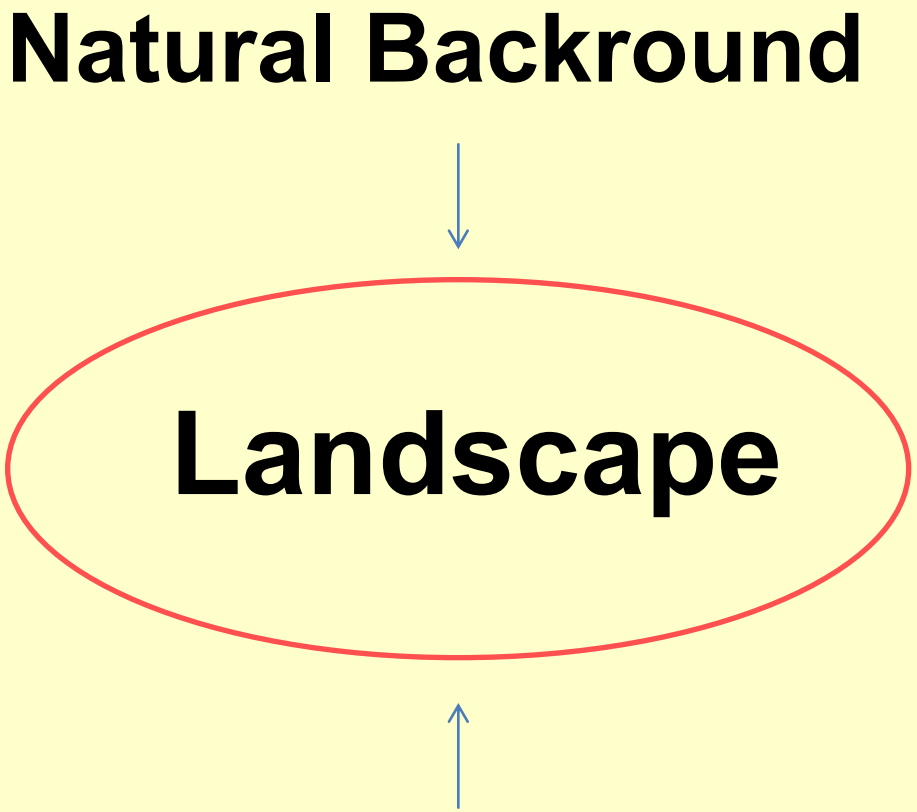
Wikipedia Definition:

A landscape is the visible features of an area of land (…)

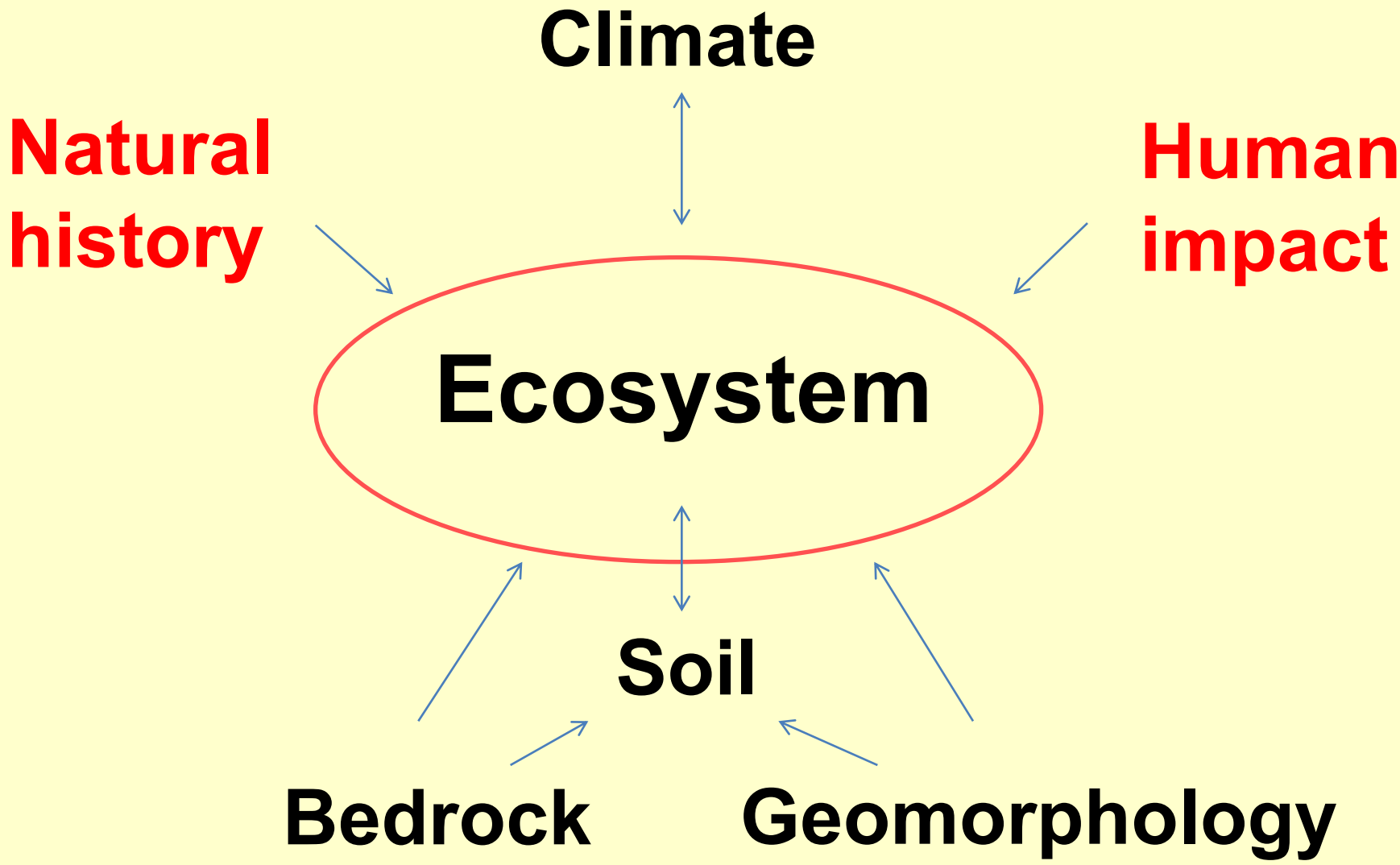
The Features:

hills, valleys, plains, rivers, lakes, forests, meadows, fields, settlement, transport infrastructure, industrial facilities…

1. **Geophysically defined features**
2. **Biotic landscape cover (ecosystems)**
3. **Features connected with human society**


Natural Backround
Landscape
Human Utilization

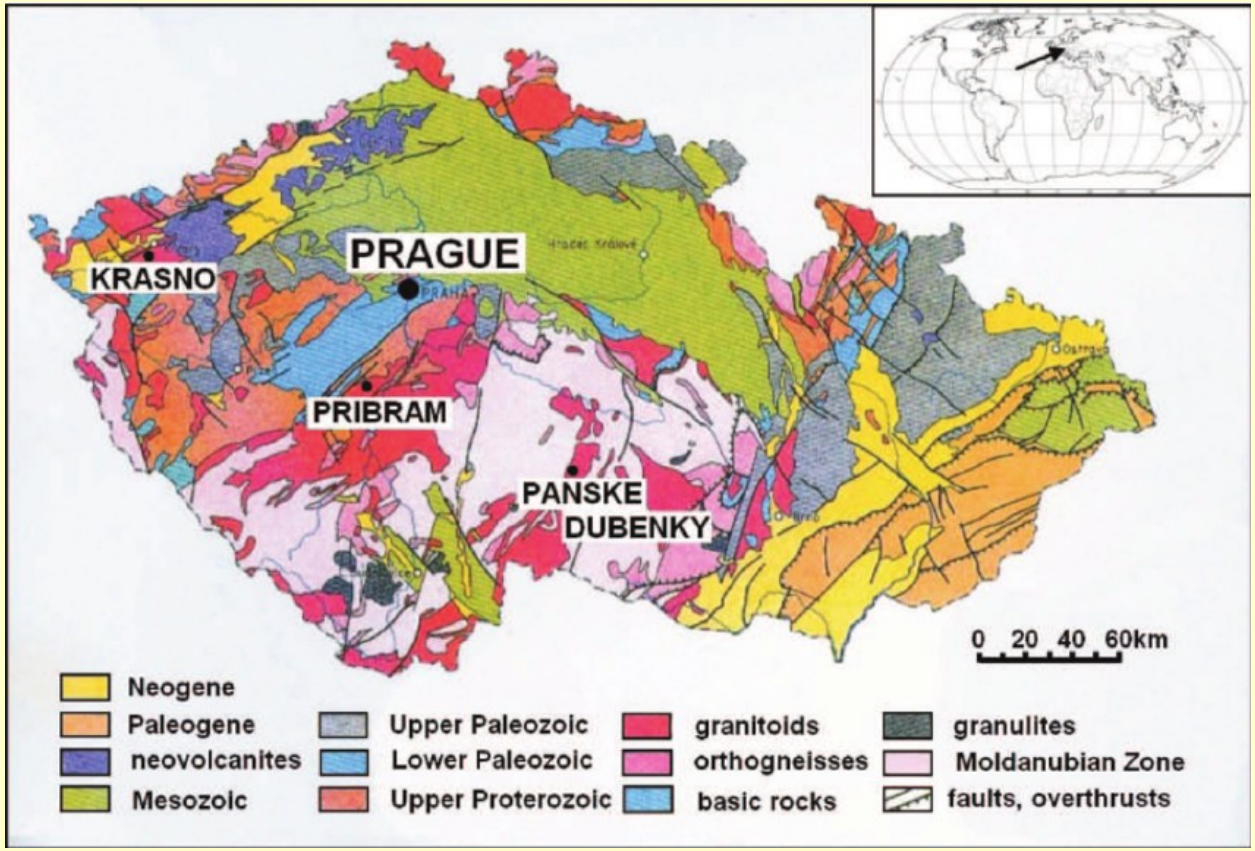
Biological view:
Landscape is a mosaic of ecosystems…



Natural backround of Czech landscape

1. Geological bedrock, relief, soils

- Landscape utilization should be consistent with environmental conditions
- Bedrock, relief and soils are one of the key factors detemining vegetation
- Czech geological structure is complicated. Prevailing Hercynic bedrock covers whole Bohemia and western part of Moravia, the eastern part was formed by Alpine orogenesion.



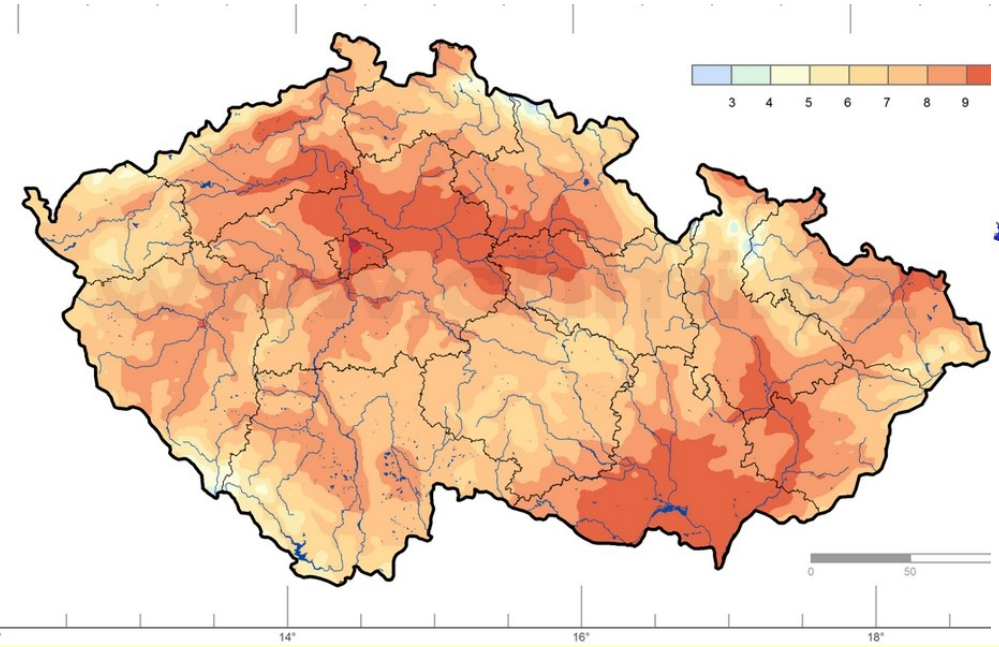
https://www.researchgate.net/profile/Lucie_Novakova3

Natural background of Czech landscape

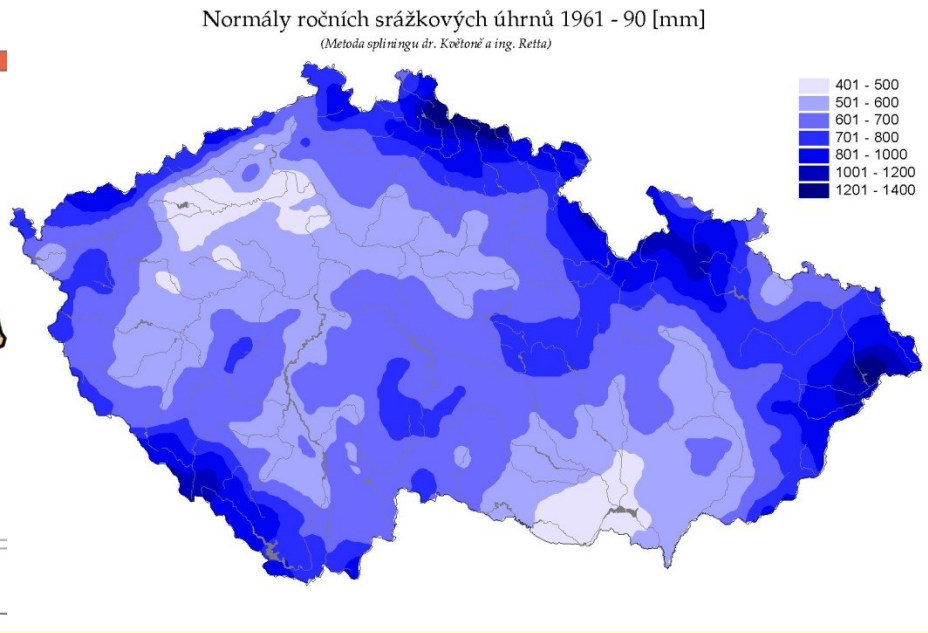
2. Climate

- Czech climate is transitional between oceanic and continental

Mean annual temperature (°C)

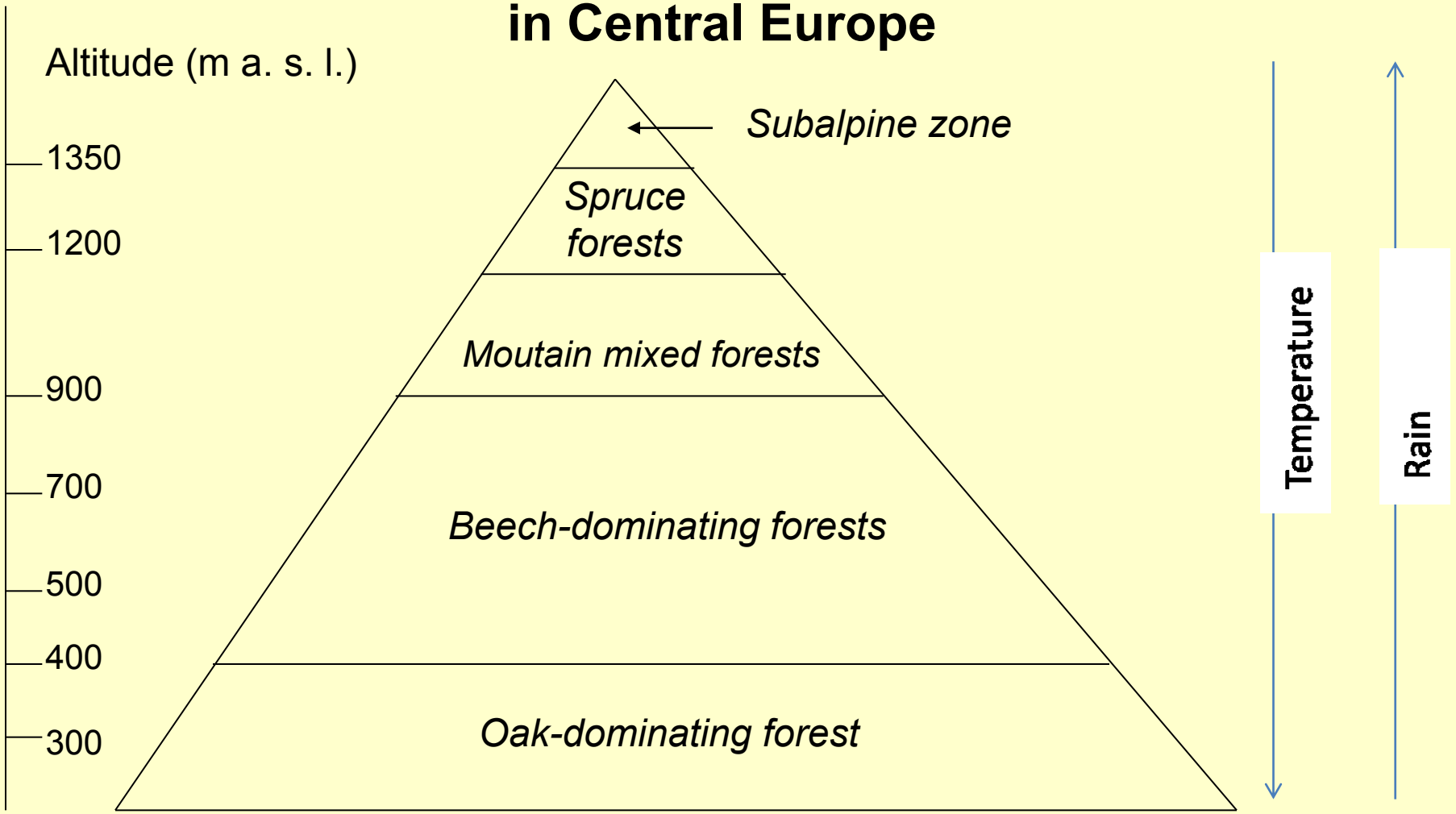


Mean annual precipitation (mm)



www.chmu.cz

Altitudinal Zonality of Natural Vegetation in Central Europe



After excluding of human impact the strong majority of Central Europe would be covered by forest

Oak-dominating Forest (lower altitudes)

picasaweb.google.com/lh/photo/mKagfLANYYYYfh4JWU7kgQ

Oak-hornbeam Forest (lower altitudes)

Beech Forest (middle altitudes)

Fir-beech forest (lower mountains)

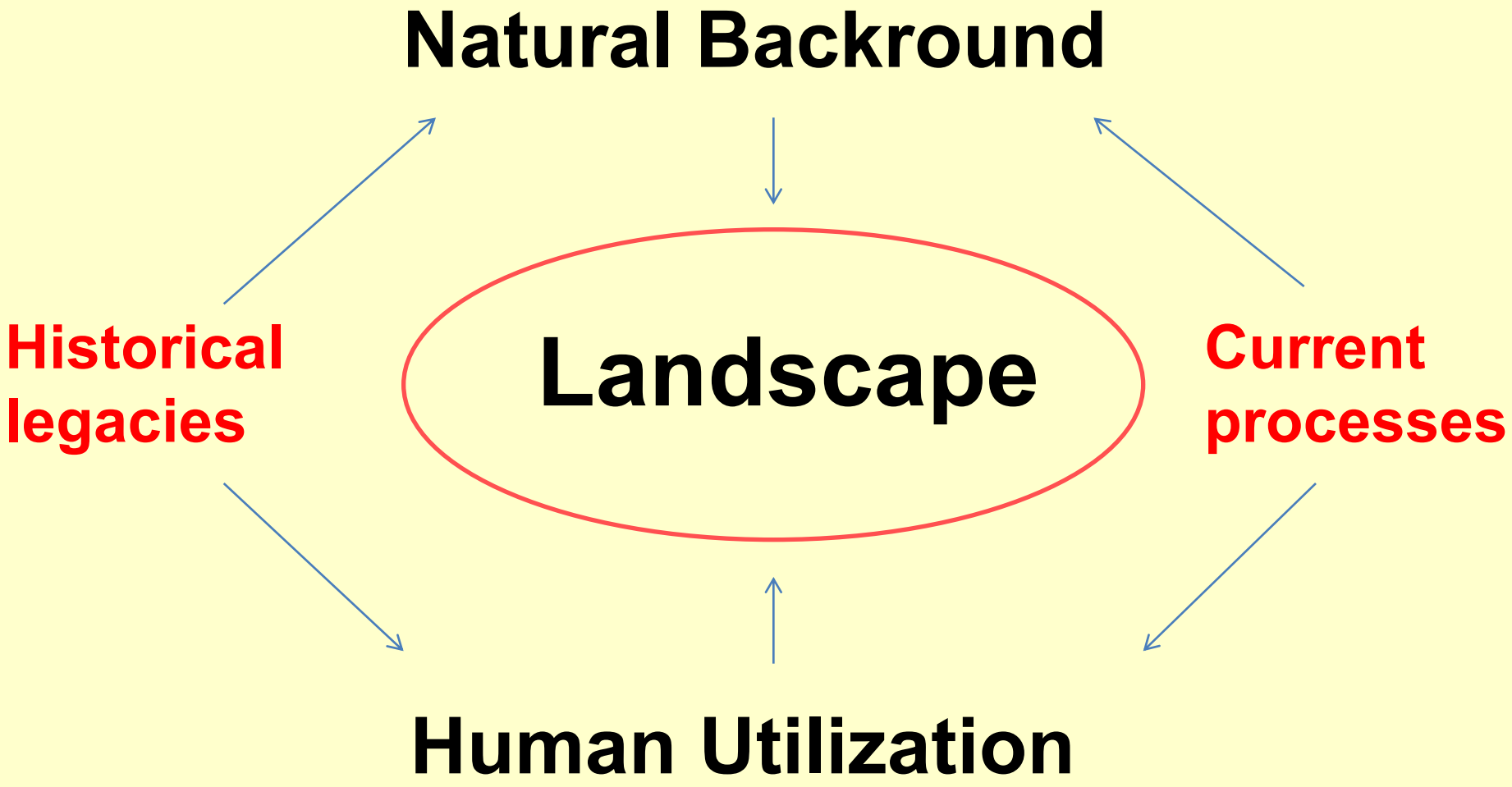
Mountain mixed forest (mountains)

Mountain spruce forest (mountains)

Subalpine zone (above tree line)

Studniční Peak, Krkonoše Mts.

turistika.cz


Natural Backround
Historical legacies
Landscape
Current processes
Human Utilization

Prague – Architectural mosaic of the last 1000 years

https://www.idnes.cz/zpravy/domaci/kolik-vezi-ma-stovezata-praha-nadsenci-jich-napocitali-pres-pet-set.A100805_115917_praha-zpravy_sfo

In all landscapes you can find simillar patern…

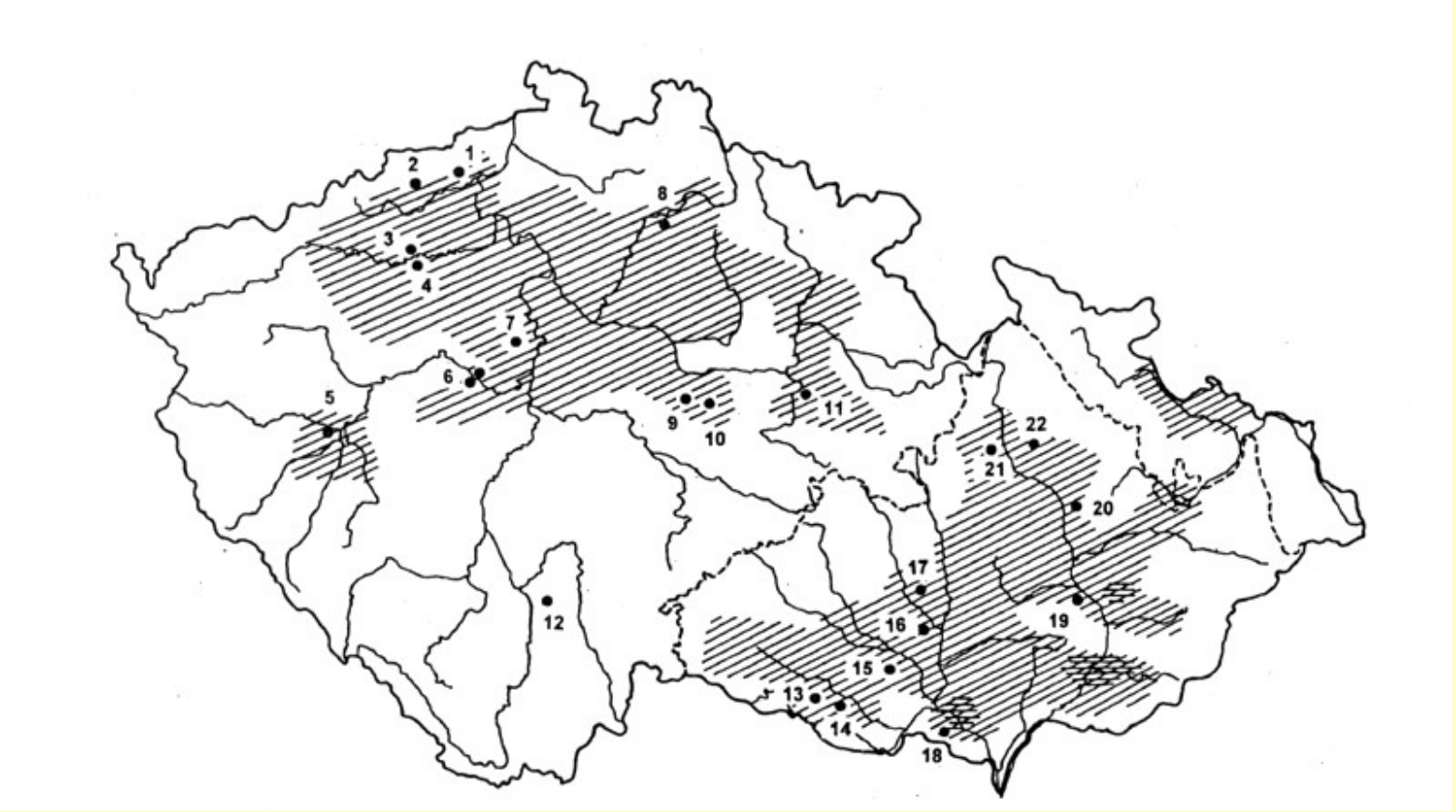
Example 1: South-Moravian landscape with natural protected areas

Far landscape history

May be the landscape of Central Europe in Ice Age

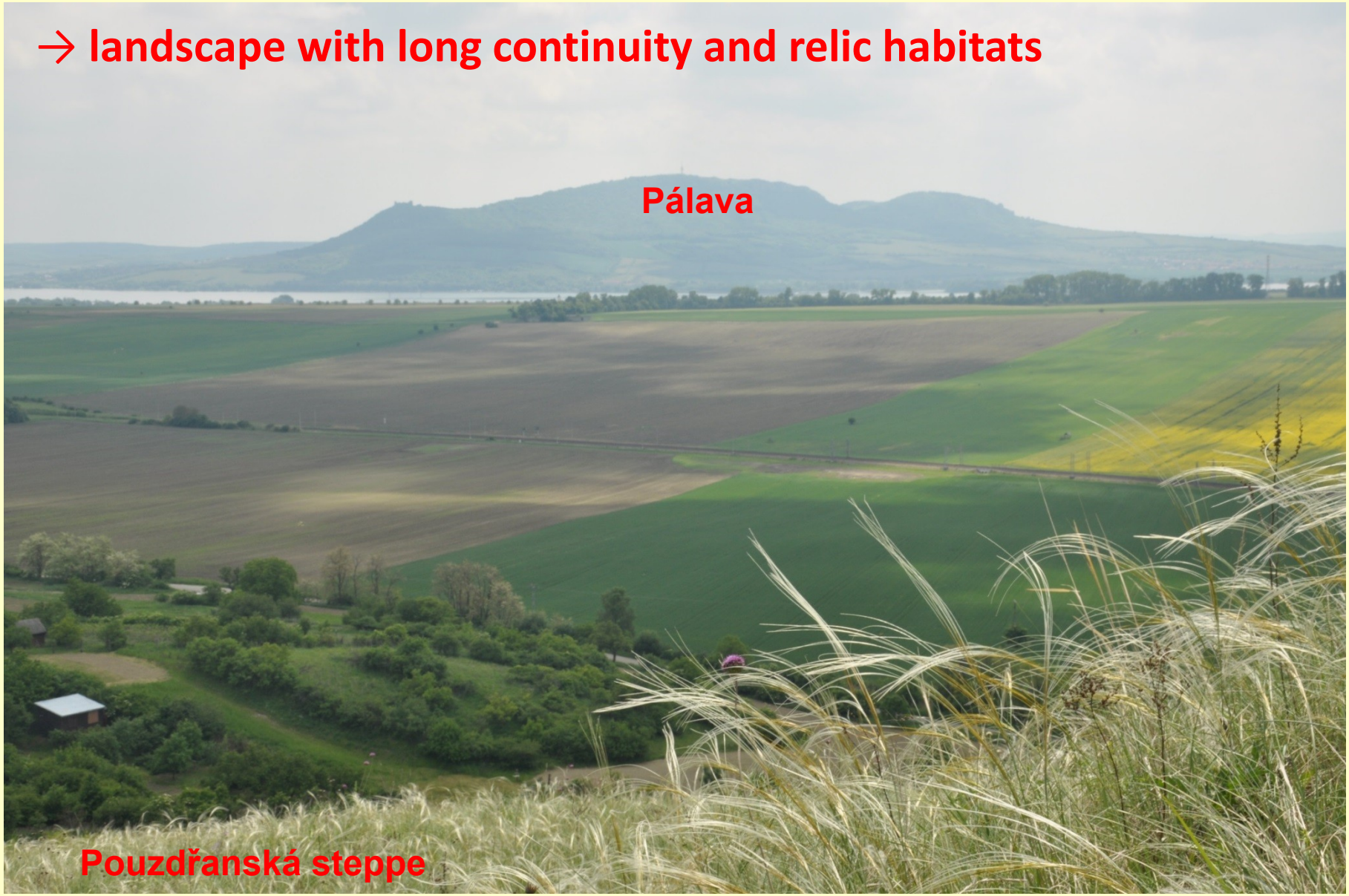
Altay, Kuray steppe, Southern Russia

Neolithic (agricultural) Settlement 7000 BP



→ People due to landscape utilization stopped forest expansion. Especially in lowland, localities with relic species from Ice age and early Holocene were preserved.

Example 1: South-Moravian landscape with nature protected areas



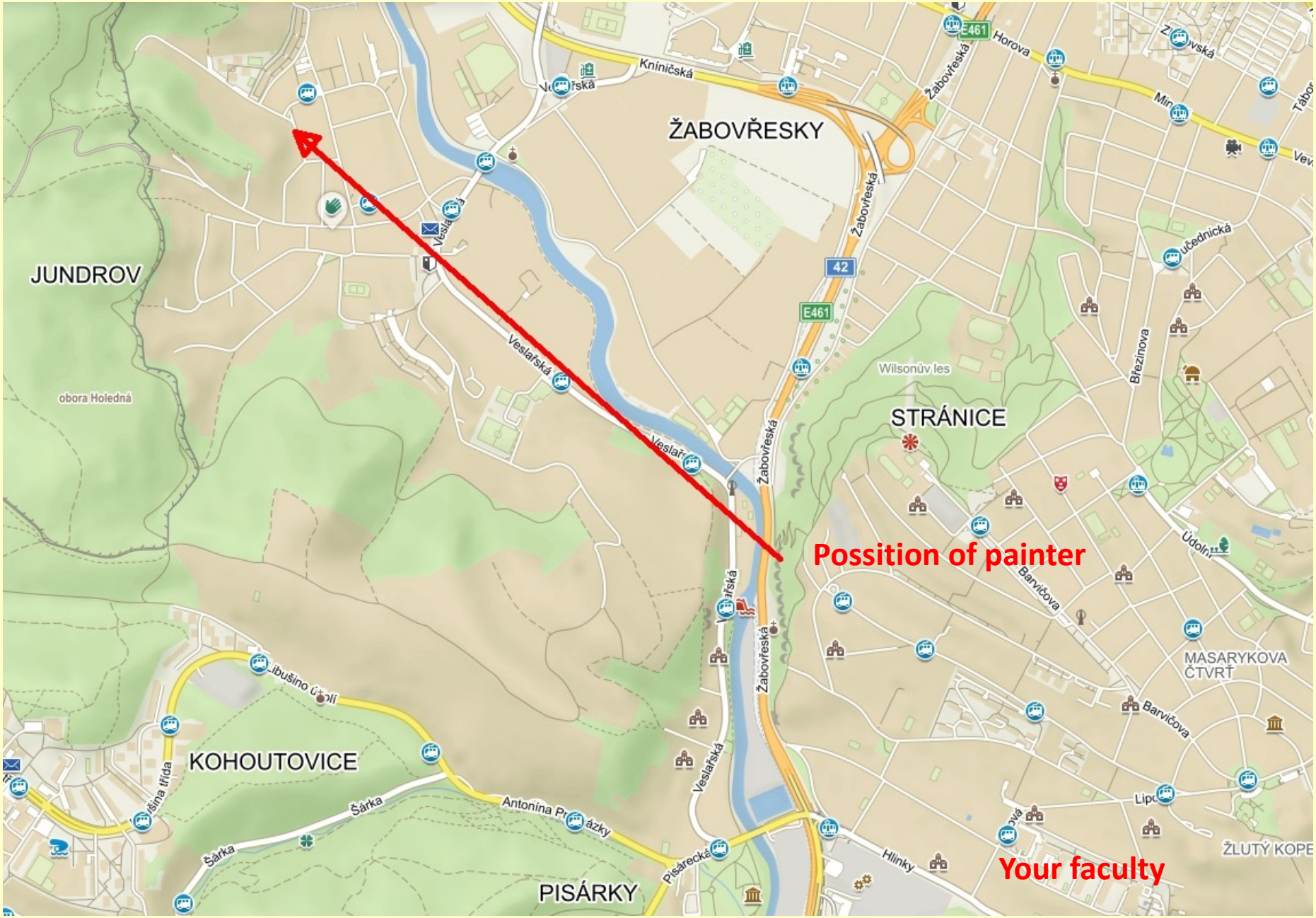
Example 2:
Legacies of historical developtment of settlement

Landsacape as a mirror of different law in landscape planning…

Try to think about landscape of your home on this way…

(you will find many examples like this)

Landscape History: Testimony of Old Paintings and Photography



Landscape History: Testimony of Old Paintings and Photography

- Aerial images and old maps are the most powerful tools in landscape analyses.
- However, old paintings and photography provide real form of landscape with many details.

…180 years later, photo: Josef Ptáček (2012)

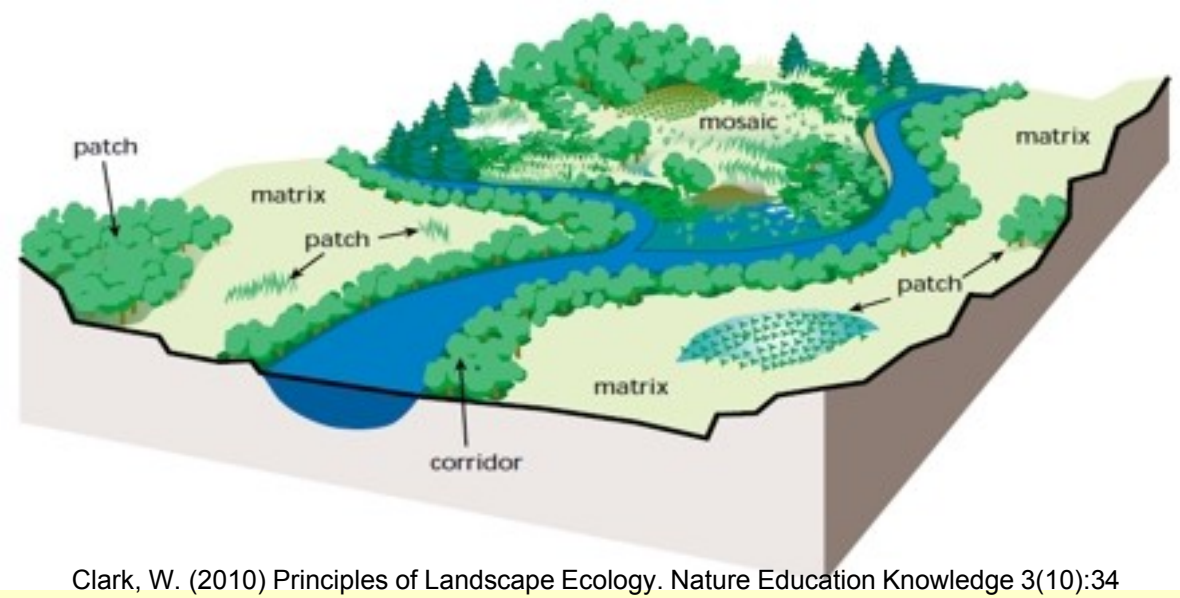
Landscape History: Testimony of Old Paintings and Photography

Bohumír Kristýn (1972): Rudý říjen Coal Mine in Ostrava

In less than 50 years, there is comletely different landscape. Changes could be surprisingly fast.

Actual view (2019)

Landscape Structure



Clark, W. (2010) Principles of Landscape Ecology. Nature Education Knowledge 3(10):34

The main landscape components:

1. Pathes
2. Corridors
3. Matrix

South-Moravian agricultural landscape

Forested landscape of Beskydy Mountains

stromy.cea.cz

- Forest cover of the Czech Republic: 34%
- Natural or near-natural forests: less than 1%

Perception of the landscape

1. **Sensory perception**

visual experience, sounds, tactical peception (heat, could, wind, wetness), smells…

…not only visual contact is important

For example, the smell could be an integral part of some place…

The Smell of Starobrno Brewery on Mendel Square

www.encyklopedie.brna.cz

Soubor Úpravy Zobrazit Historie Záložky Nástroje Nápověda

Čichová mapa Brna | Překladač Google | ruduit se souches - Hledat Goo

www.brnosmrdi.cz/#detail-334

souches

Brnosmrdí

Brno Map of Smells

O projektu

Lipová

Neumannova

Vinařská

Hlinky

Google

× zavřít

bnosti o místě

adu z pivovaru

Typ: Jídlo

Poll about Starobrno Brewery

Hlasování

Smells

Necítím (0)

Voní (50)

místo sdílet místo

Malt with specific smell

CS 21:34 7.10.2020

https://brnensky.denik.cz/galerie/brno-pivo-pivovar-starobrno-kometa-pivnice-exkurze-suroviny.html?photo=4

Perception of the landscape

1. **Sensory perception**

visual experience, sounds, tactical peception (heat, could, wind, wetness), smells…

2. Knowledge

3. Memories and experiences

Both are important layers of our landscape perception.

Brno

Compared to Ostrava, Brno is usually more attractive for visitors. But the streets of Ostrava are my childhood sceneries. It makes this town very important for me…

→ Perception of the landscape is strongly individual

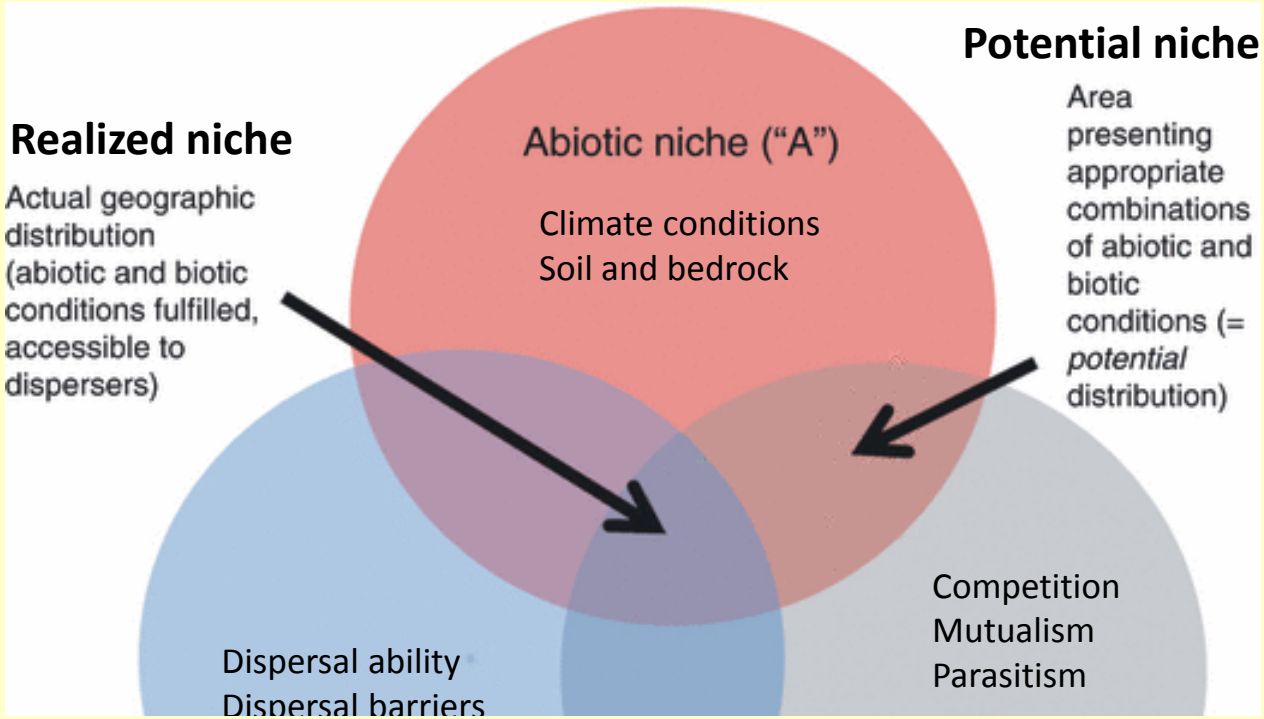
Ostrava

https://d34-a.sdn.cz/d_34/c_C_D/L9eB9eu.jpeg?fl=res,667,500,1

Landscape Ecology Backround

Ecological Niche Concept

…a set of conditions that allow the existence of a population of a particular species.



In Europe there are many species with potential niche in America. But because of barrier of Athlantic Ocean they are not able to reach this area.

→ **Species pool**: all species avaliable to colonize focal site.

Peterson, A.T. (2011) *Ecological niche conservatism: a time-structured review of evidence*. Journal of Biogeography, 38, 817-827.

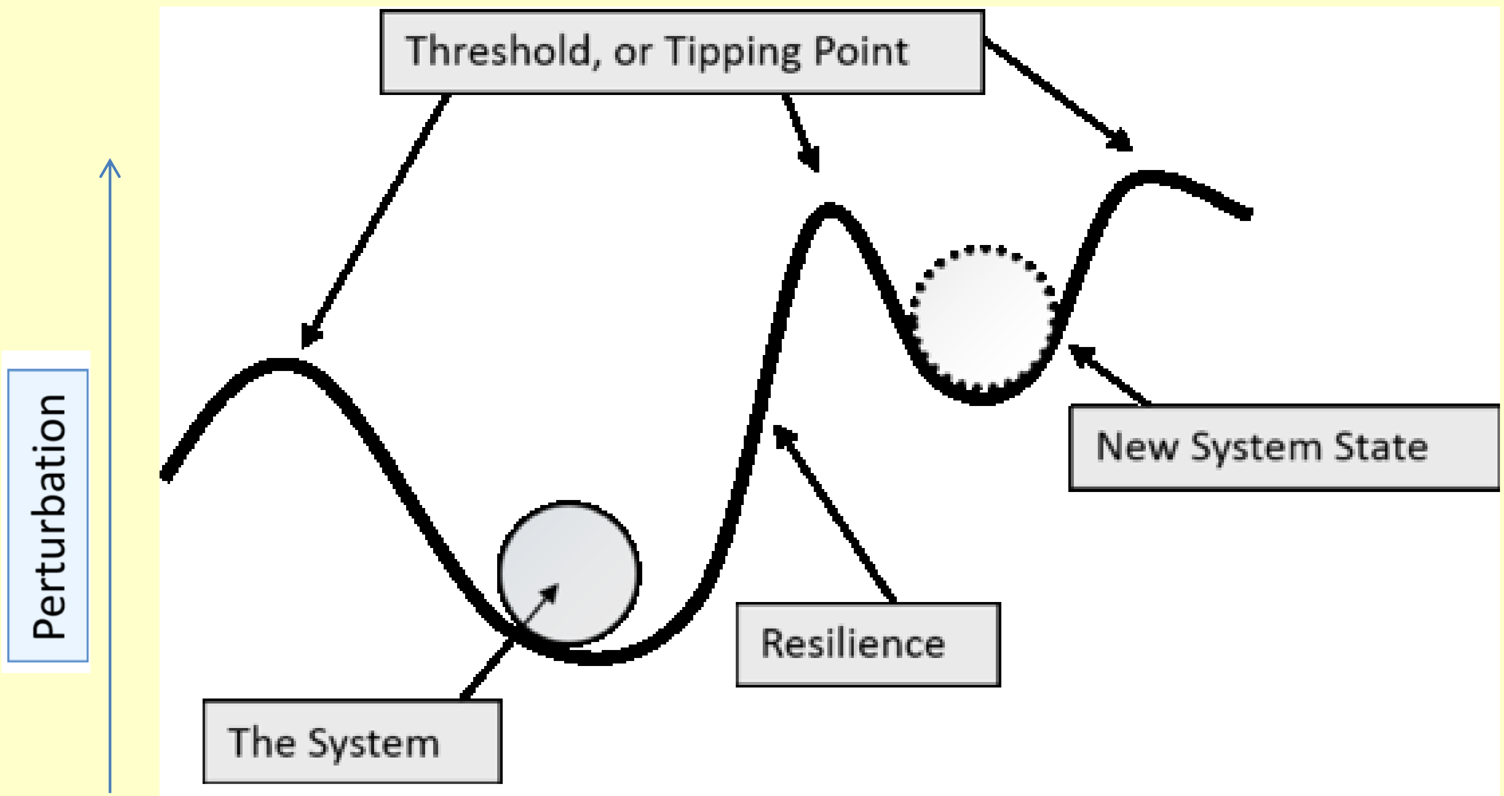
Ecological Stability Concept

Ecosystem *is the complex of living organisms, their physical environment, and all their interrelationships in a particular unit of space* (britannica.com).

Changes of particular components due to the internal or external influences could caused ecosystem change.

Ecosystem is like a ball in the hole…

- Removing of the ball from the hole implies an irreversible ecosystem change
- Ecosystems with higher resilience (in deeper hole) are more stable



https://ieampodcast.com/2018/10/11/finding-balance-resilience-in-era-with-marco-vighi-and-andreu-rico/

Example of ecosystem change:
The loss of former Mediterranean forests along coast

Due to timber logging, pasture and intensive soil erosion during Antiquity a new secondary shrubby vegetation of macchia and garrique developed. The change is irreversible.

Metapopulation / Metacommunity Concept

Levins, R. (1969), "Some demographic and genetic consequences of environmental heterogeneity for biological control", Bulletin of the Entomological Society of America, ***15*** *(3): 237–240.*

Metapopulation/metacommunity is described as a group of spatially separated populations of the same species/communities which interact at some level.

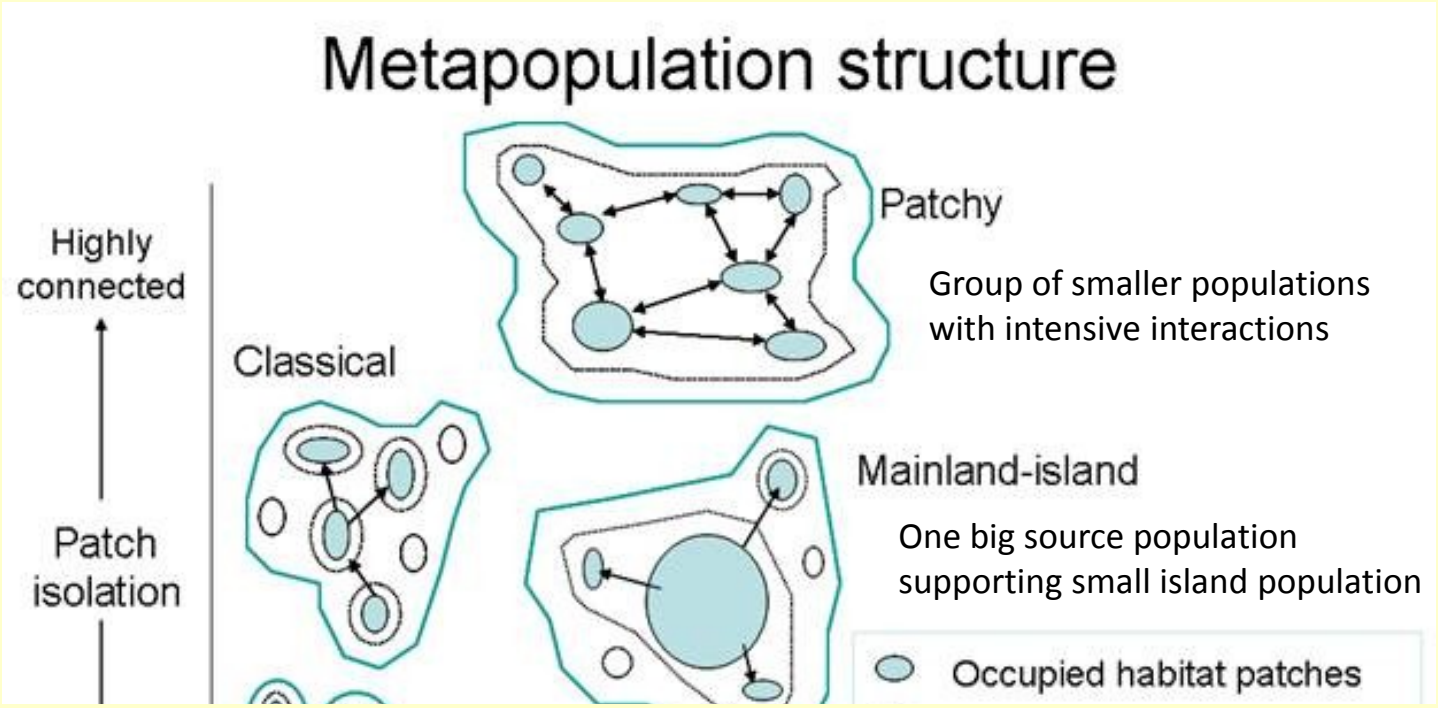
- Also unoccupied suitable (potential) habitats could be involved.

- Size of population/community and intensity of interactions are crutial for population/community developtment.

- Small populations without interaction are more vulnerable to disturbances or inbreeding potentially causing extinction.

Metapopulation / Metacommunity Concept

Levins, R. (1969), "Some demographic and genetic consequences of environmental heterogeneity for biological control", Bulletin of the Entomological Society of America, ***15*** *(3): 237–240.*



NOTES

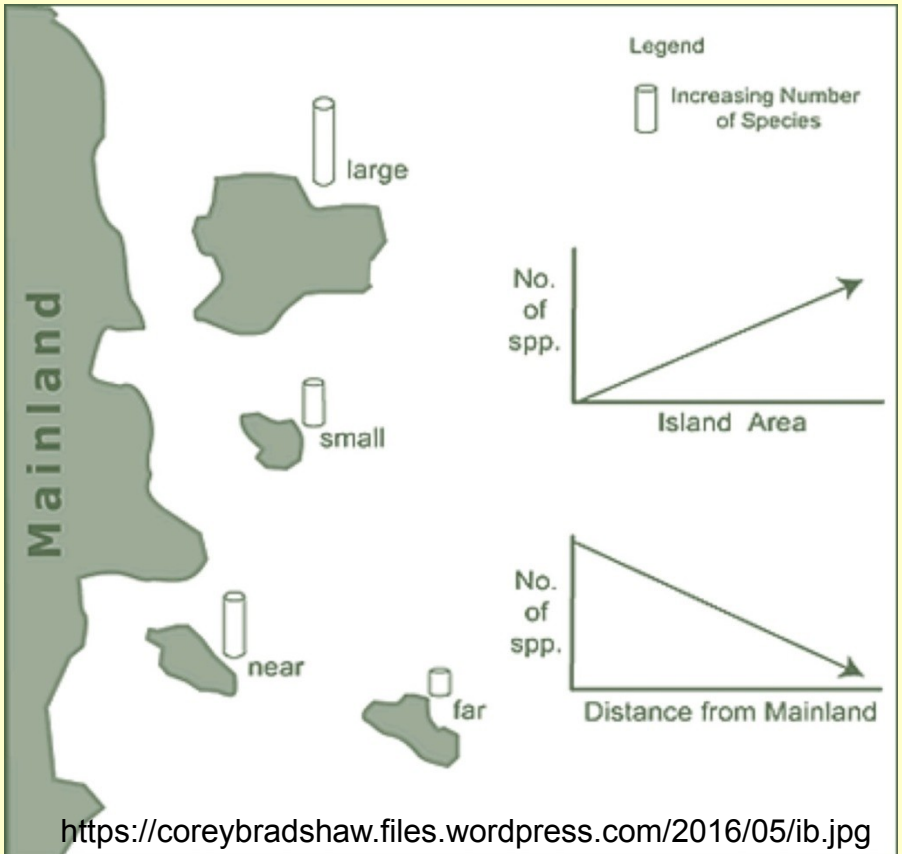
1. The concept was derived from the butterfly communities …It better fit to the animals than to the plants
2. In plant kingdom a real migration is missing. „Migration“ is possible almost only via reproduction (propagules).
3. To capture a responce of plant communities to the changes a longterm observation is needed.

The Theory of Island Biogeography

MacArthur, R. H., Wilson, E. O. (1967) The Theory of Island Biogeography. Princeton, N.J.: Princeton University Press, 203 p.

The number of species on the island reflects balance between rate of colonisation and extinction.

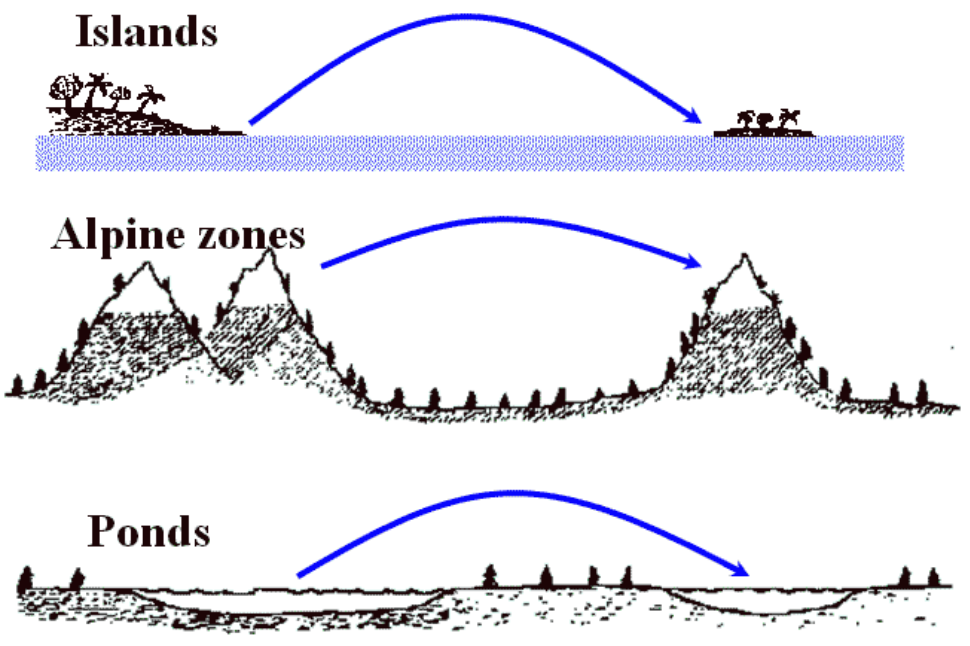
1. Small islands have restricted resources compared to the larger ones, leading to lower species diversity.
2. Increasing distance from the mainland reduce colonisation intensity. The far islands therefore have less species.



https://coreybradshaw.files.wordpress.com/2016/05/ib.jpg

Islands are not only in the sea…

…Landscape Islands



NOTE:

The theory was derived from the newly formed volcanic islands. The general application to the terrestical ecosystems has its limits due to the complex interactions between „islands“ and surrounding landscapes. The history of „islands“ also plays an important role.

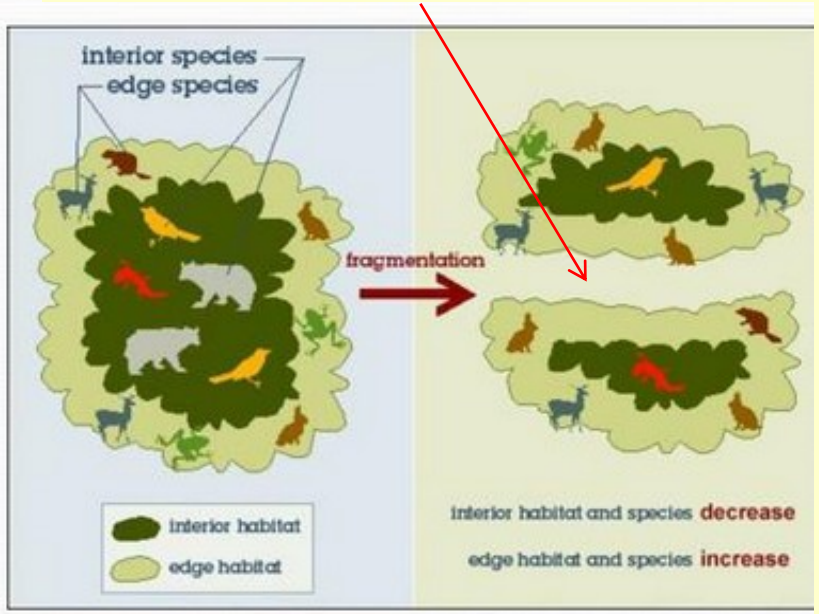
Landscape Fragmentation

Process of dividing of habitat (or vegetation type) to the smaller sections. Fragmentation is accompained by the edge effects (forming the ecotones along margins reducing original habitats).

Edge Effects

- High perimeter length to area ratio
- Greatest effects occur in small remnant areas and those with complex shapes

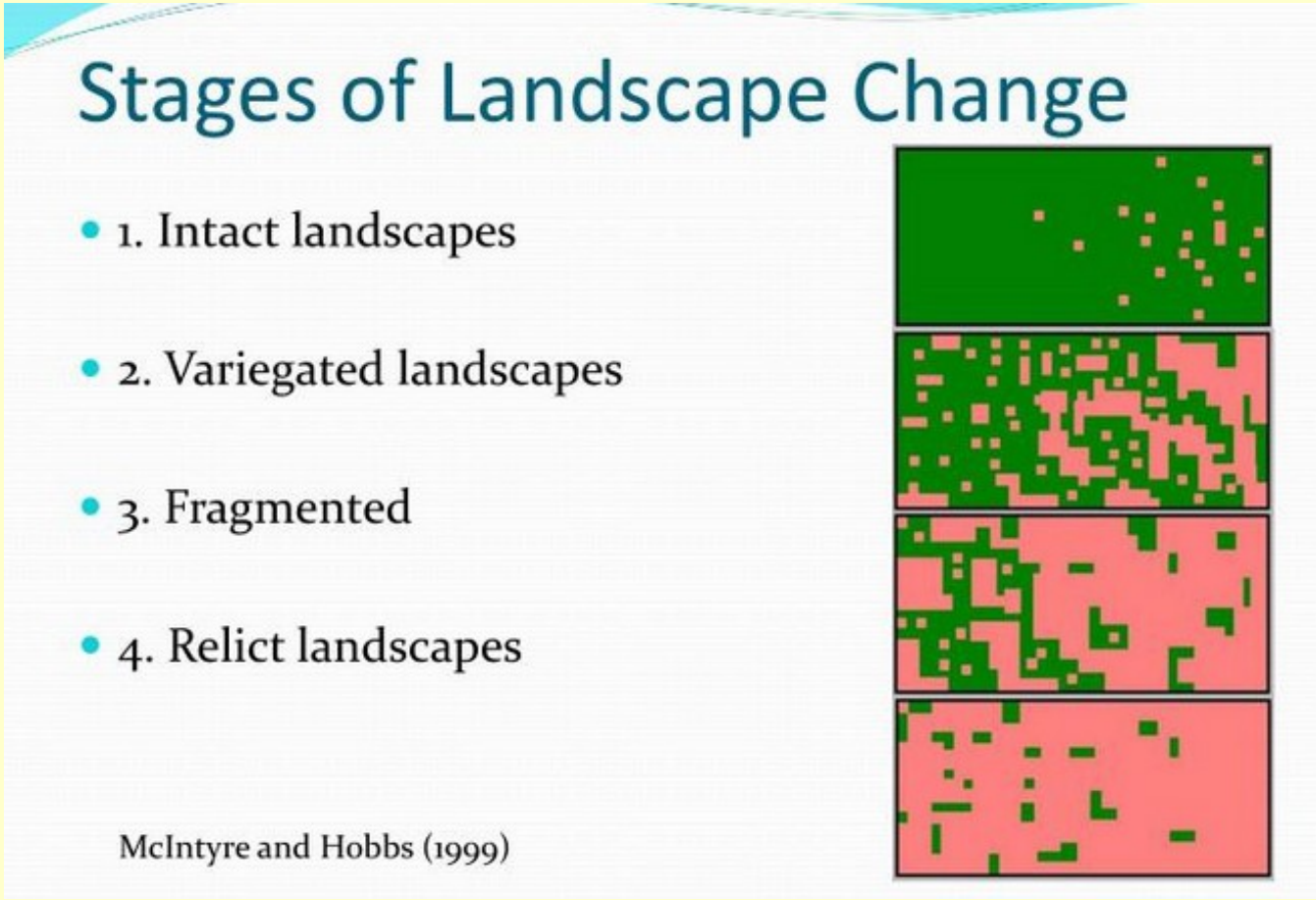
Construction of the road through forest affects a much larger area than we would expect.



- Fragmentation causes extinction of species requiring larger interior habitats (brown bear on the picture)

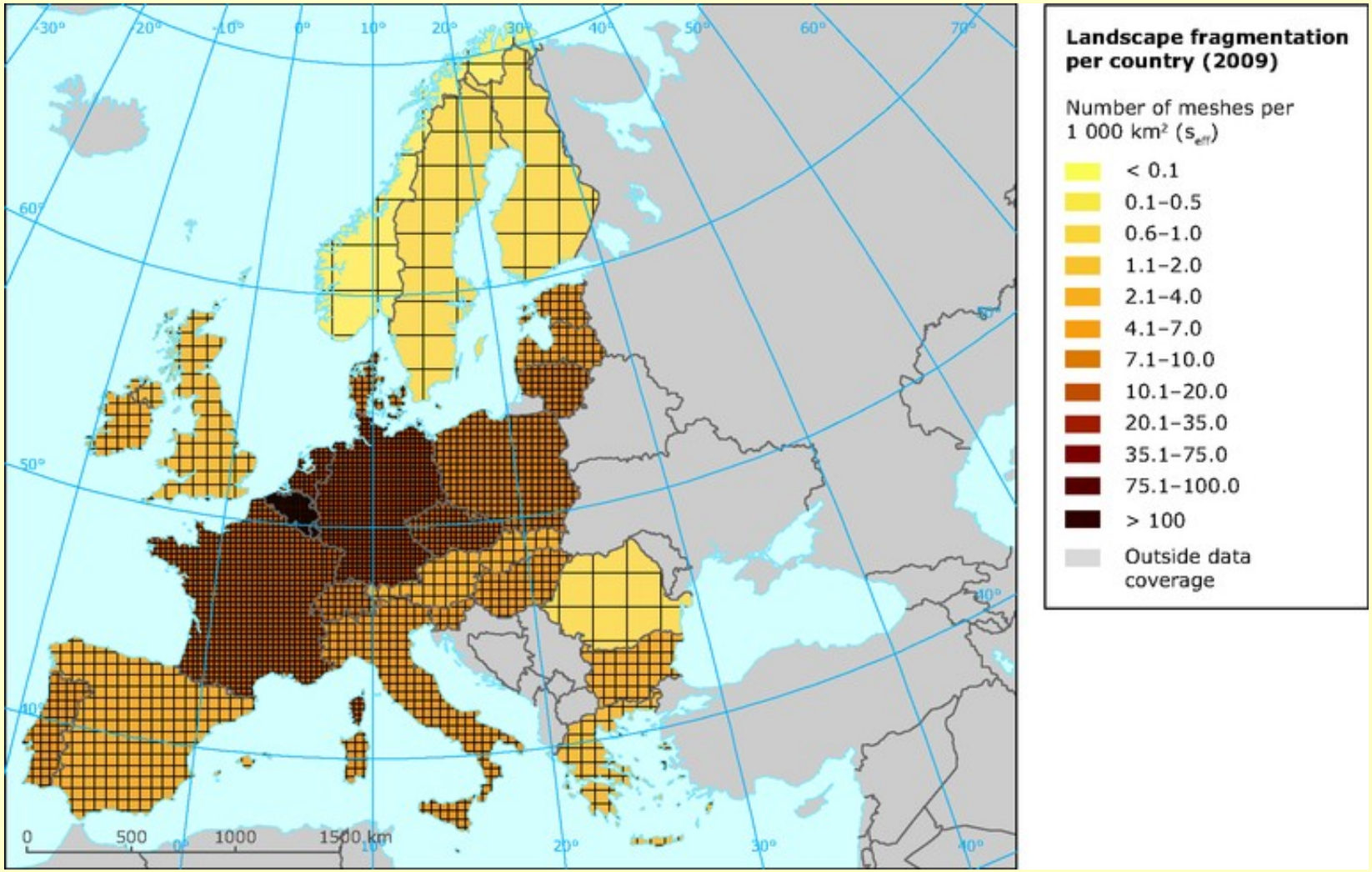
https://www.slideserve.com/jovan/habitat-fragmentation-and-loss

Landscape Fragmentation



Options 3 and 4: There are no interior habitats in the small remnats of former natural landscape → only edge species can be found here and repatriation of extinct interior species is problematic (common in European landscape).

Landscape fragmentation in EU



https://www.eea.europa.eu/data-and-maps/figures/illustration-of-the-level-of/illustration-of-the-level-of/image_large

Ecological Succession

Wikipedia definition:

…is the process of change in the species structure of an ecological community over time due to internal or external factors

- **Internal:** Competition, facilitation, parasitism…
- **External:** Disturbance (natural or manmade)

Succession is accompained by increasing complexity of the community (establishing of self-perpetuating processes).

Primary succession

- Colonisation of area non occupated by organisms before

(Volcanos, mining areas, areas after deglaciation…)

Secondary succession

- Developtment of community after severe disturbance or removal of a pre-existing community
- Areas after fire, insect outbreak, forest decline, abandoned agricutural land…

Primary succession on spoil heaps (Ostrava-Karviná Coal District)

1. The starting point: bare stone

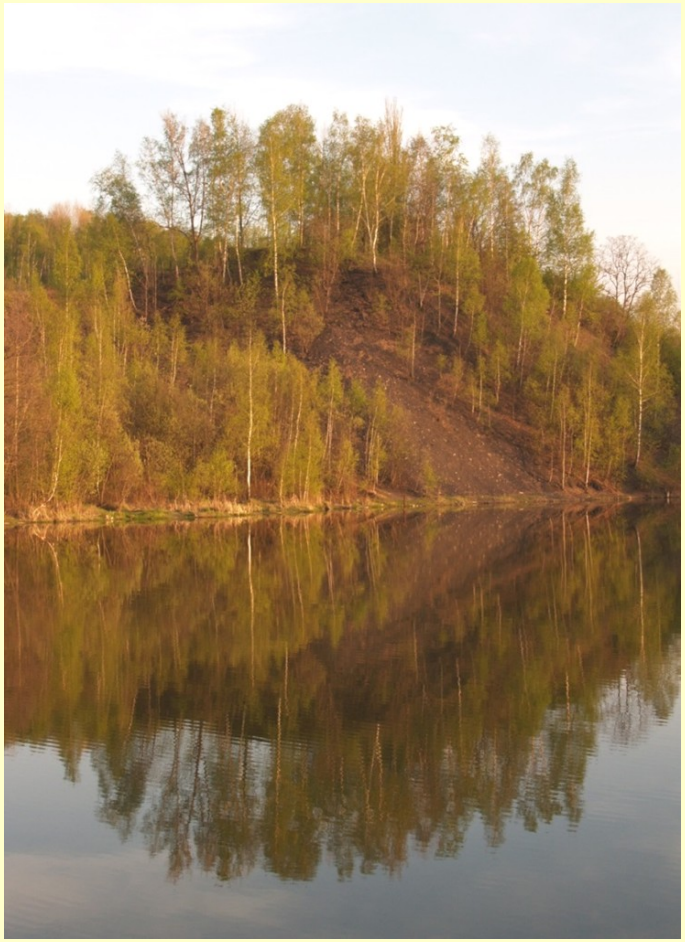
…it was digged 1000 m below surface

2. Initial stage of succesion and the first communites (1-10 years)

- Prevail the ruderal and stress-tolerant species
- Low level of competition at the biginning
- Non-woody species dominate
- High abundance of non-native plant species

3. The first forest generation (…15 years)

- Pioneer woody species
- Common light demanding species in the understorey
- Later the first forest species appear



4. Regeneration of late successional tree species (…30 years)

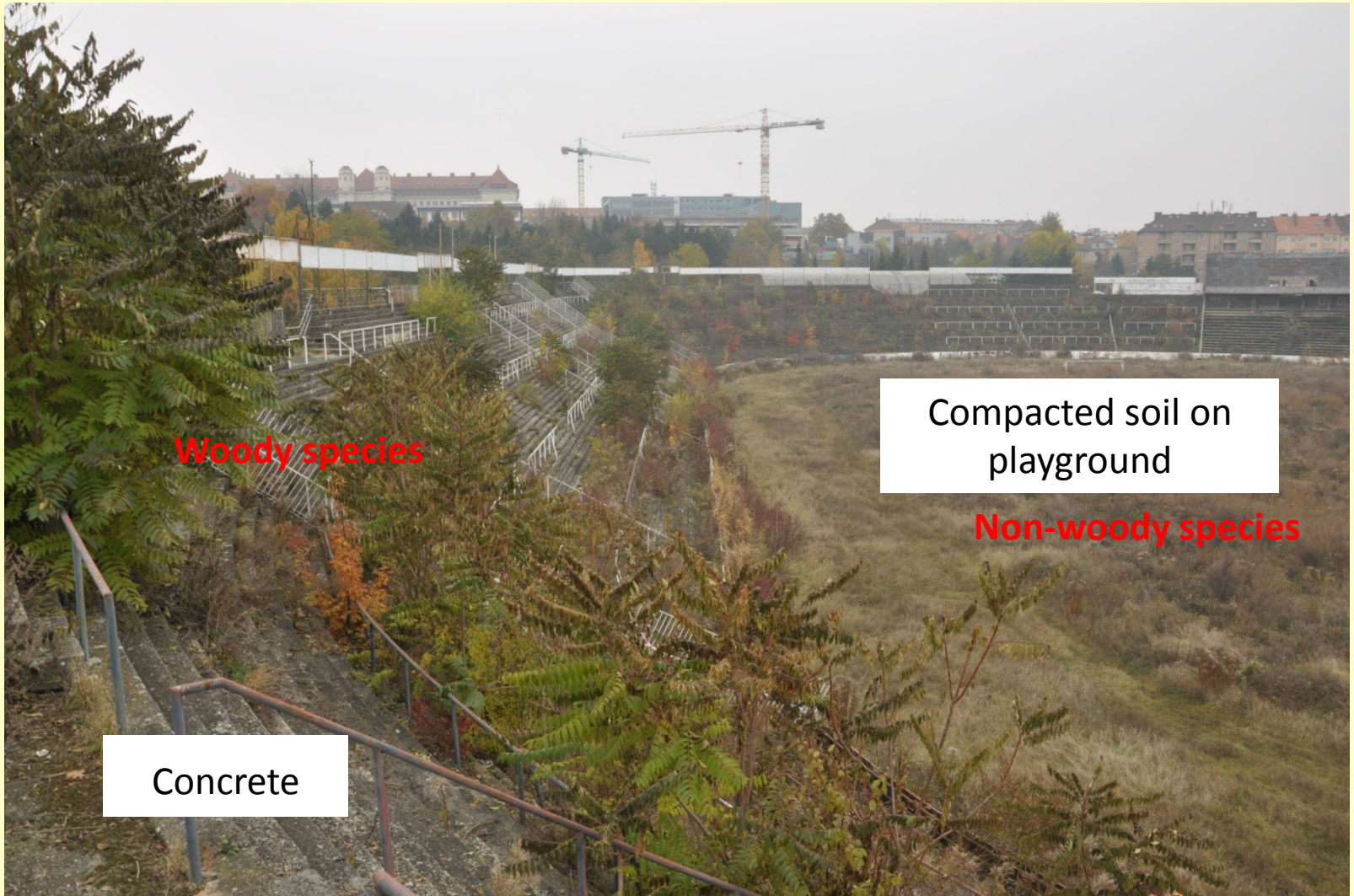
Odval jámy Hlubina v Karviné - Dolech

Odval Dolu Michal

5. The second forest generation (50 – 70 years)

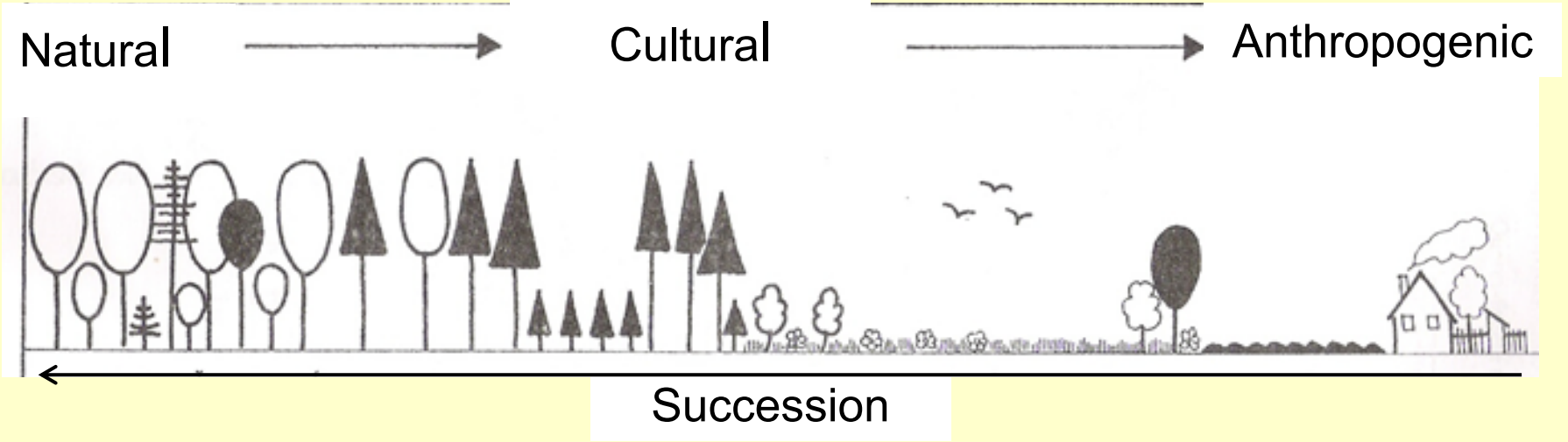
Successional Trajectories

- **In the same place, the succession could run in different ways.**
- **Example from the old Lužánky Arena in Brno, where the succession trajectory depends on „soil“ properties.**



Ecosystem changes due to the human impact

Model of Central-European non-aquatic ecosytem



Natural forest

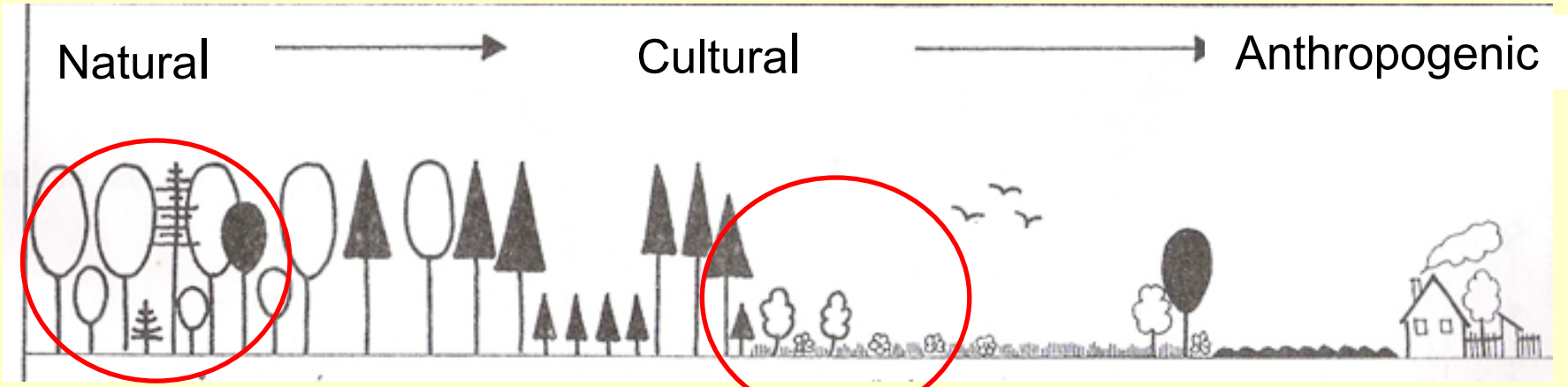
Artificial forest

Arable land

Settlement

Ecosystem changes due to human impact

Where you can find the most ecologicaly stable parts of landscape?



Natural forest **Artificial forest** **Arable land** **Settlement**

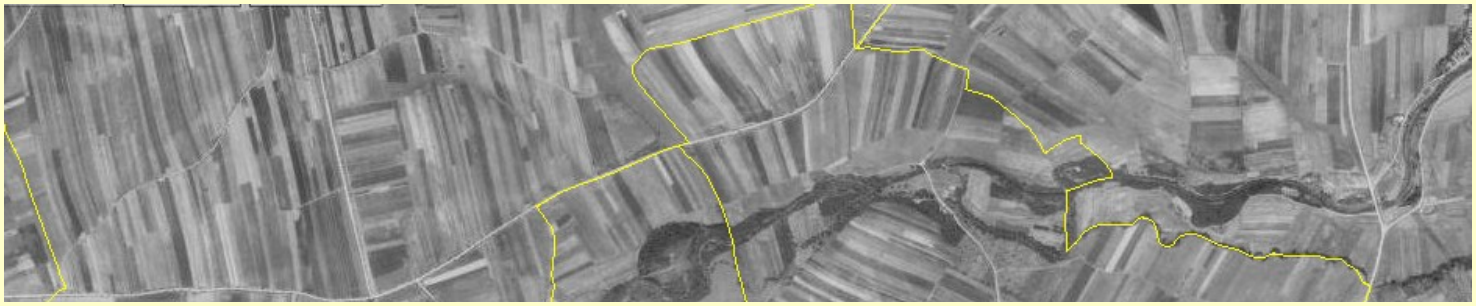
The most ecologicaly stable landscape segments

= segments with long natural continuity

- **natural and semi natural forests**
- **mires and wetlands**
- **relic habitats (remnants od steppes, rocks…)**
- **ecotones, extensive meadows and pastures**

Landscape history:

Czech landscape in 1950 and today



- Landscape 70 years ago was more stable and with higher biodiversity value due to fine landscape structure.
- Diversity loss was also caused by intensification of agriculture (soil consolidation, pesticides, mineral fertilisers).
- Today crop production causes soil structure destruction and soil contamination.
- Present landscape structure is vulnerable to extreme weather events.
- Landscape needs great structural changes connected with utilization change
- It will be very expensive, but without appropriate measures we will pay much more

  (loss of soil fertility, food and ground water contamination, floods…).

Ecological Stability Framework

- **Landscape segments with higher ecological value than the landscape matrix**
- **In Central Europe usually forests take part in the framework**

  …but not only (meadows, wetlands, open relic habitats…)
- **Ecological stability of the segments differ according to landscape type**

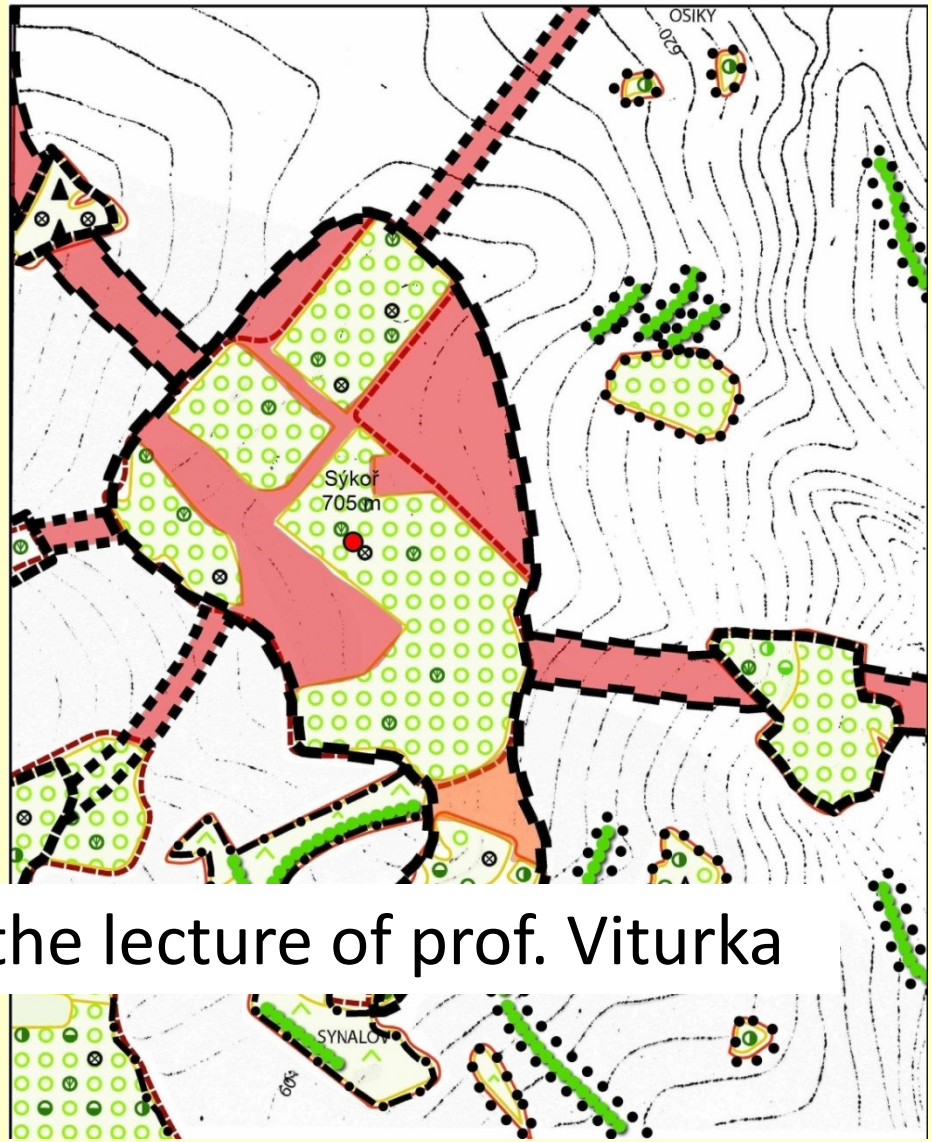
(in national park ESF is consisted from the more stable segments than in intensively utilizated agricultural landscape)

Demarcation of the ecological stability framework is a starting point for better landscape management.

Sýkoř Model Area

Ecological Stability Framework

Territorial System of Ecological Stability



…to be continued within the lecture of prof. Viturka