

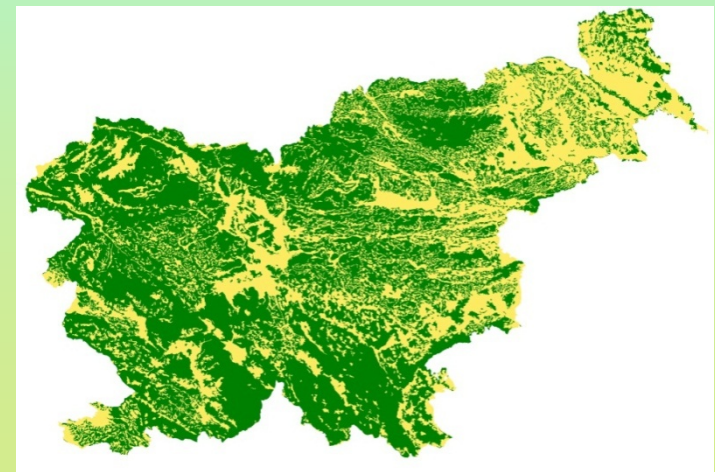
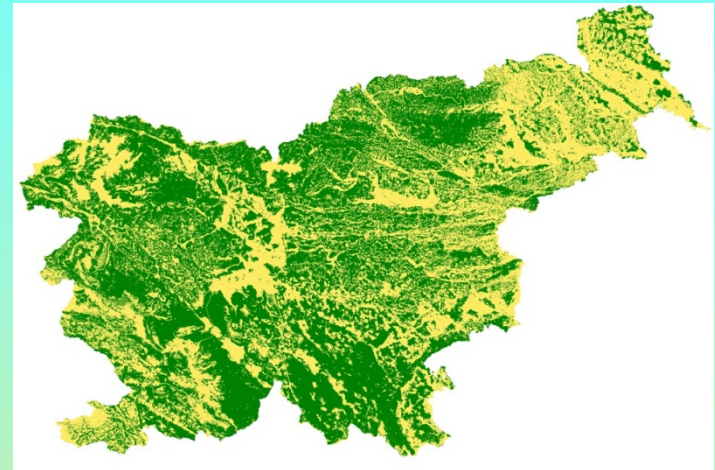
Detecting forest cover changes of Slovene landsCapes by means of historic maps – why?

(dr. Janez Pirnat - SLOVENIJA)

- **Assistant Professor** for Landscape Ecology, Urban Forestry. University of Ljubljana
- **Member:** IALE, EFUF, COST, PERISCAPE
- **Professional interest:** spatial and temporal changes in a land use pattern, old and modern land-use maps, history, remote sensing, GIS

Change in forest cover in last 135 years in Slovenia with spatial distribution for years 1975 (top) and 2000 (bottom)

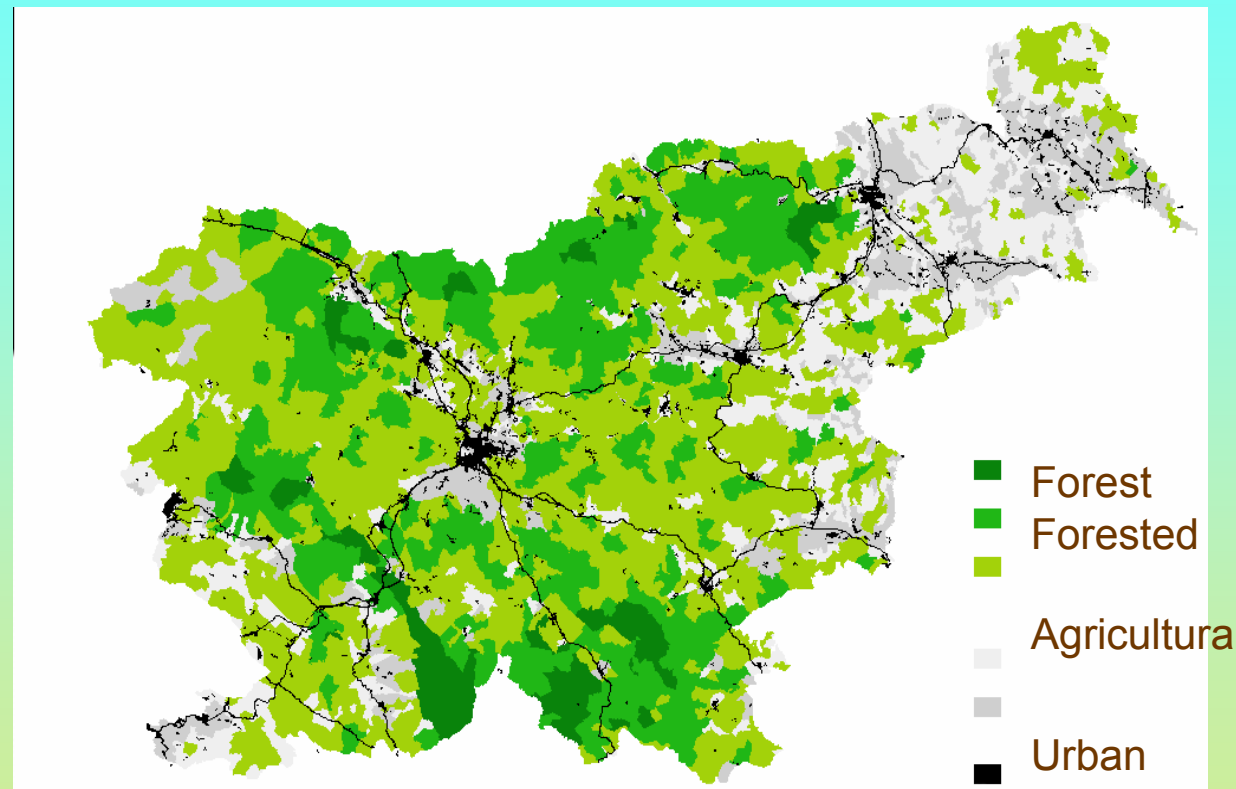
- Forests in year 1875: 36 %
- Forests in year 1947: 43 %
- Forests in year 1961: 48 %
- Forests in year 1981: 52 %
- Forests in year 2001: 57 %
- Forests in year 2011: 60 %



From forestry to landscape forestry - Landscape structure (after Forman 1995)

MATRIX	PATCHES & CORRIDORS	ARTIFACTS
1. Total area	1. Remnant	1. Original
2. Highly connected	2. Regenerated	2. Changed
3. Control over dynamics	3. Introduced	3. Historic
	4. Environmental	
	5. Disturbance	

Landscape types in Slovenia in 2002



0 50 km

Main landscape types in Slovenia (Hladnik 2002)

Type no.	Forest cover	Forest & natural vegetation spatial attribute	% of Slo.
1	>85	primary core forests	4.6
2	63-85	larger depth of IE	24.0
3	40-62	smaller depth of IE	42.6
4	20-39	more natural remnants	14.9
5	<20	less natural remnants	11.1
6		area of settlements	2.8

Forest landscape (forest cover > 85%)

Matrix: forest

Patches: agriculture, small settlements

Corridors: rivers



- Close to nature ecosystems prevail,
- Biodiversity
- Few human settlements

Forested landscape (forest cover 40 - 85%)

Matrix: forest or agriculture.

Patches: forests or agriculture, small settlements

Corridors: rivers, roads

Artifacts: trees, noosferic



Human influence has long tradition. Forest is usually left on low quality soils, agriculture on the best. Mixture of close to nature ecosystems and changed ecosystems

Agricultural landscape (forest cover 20 – 39%)

Matrix: agriculture

Patches: forests, settlements.

Corridors: trees, roads, rivers

Remnants: trees, noosferic



Human influence
longlasting. Forest
(remnants) only on
worst soils (too wet,
dry or stony) not
suitable for
agriculture.

Urban landscape (forest cover < 20 %)

Matrix: urban

Patches: forest, agriculture,

Corridors: noosferic

Artifacts: trees, noosferic



Artificial ecosystems prevail.

Forests and trees are often fighting to survive.

Noospheric landscape (remnant) elements - artifacts

- Original - still performing original function
- Changed - original function was gradually changed into new role
- Historic - original function was lost, new was never developed



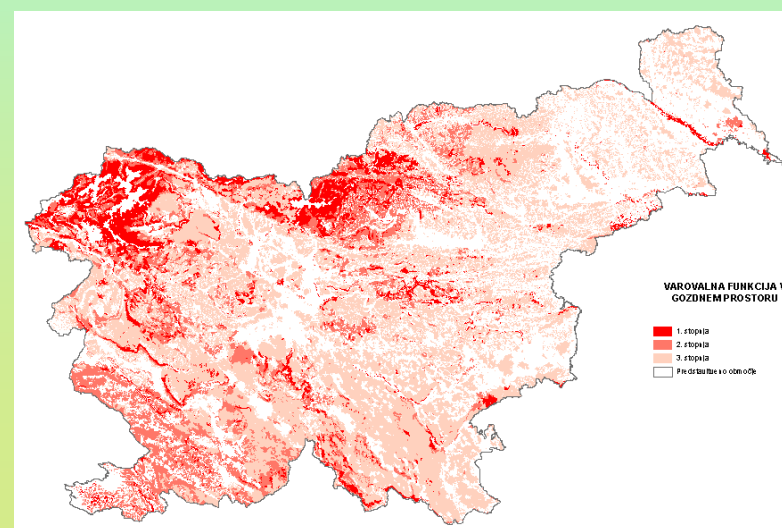
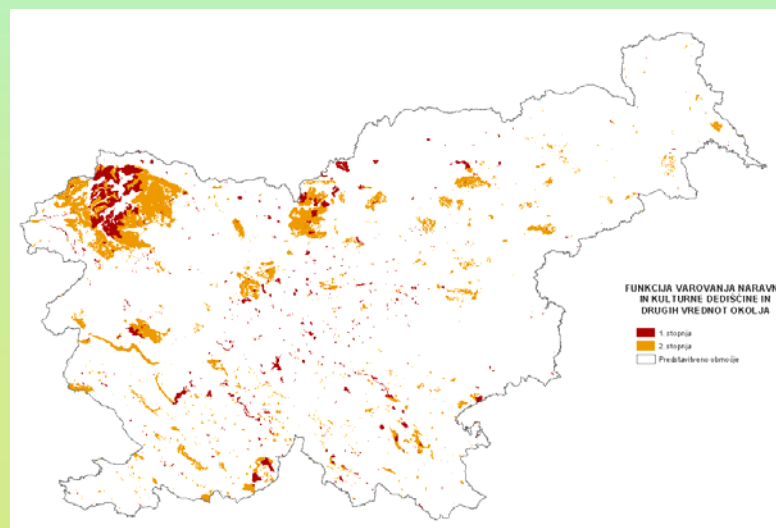
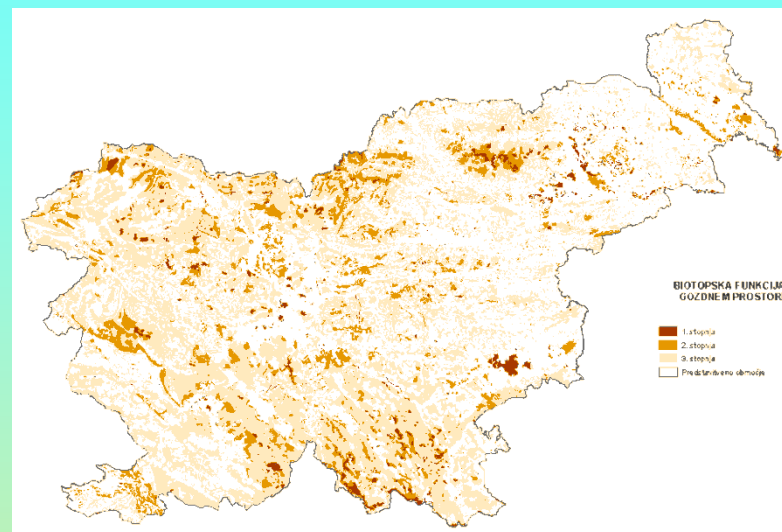
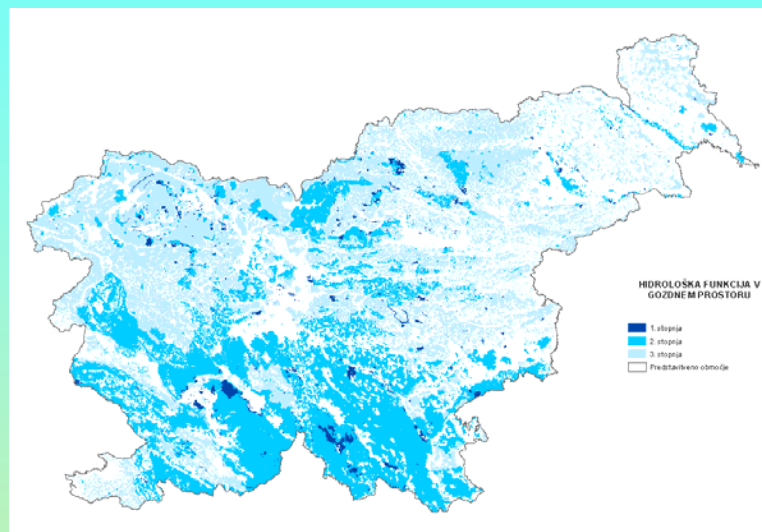
Ecosystem services (after de Groot et al., 2010)

PROVISIONING	REGULATING	HABITAT	CULTURAL
Food	Air quality	Nursery habitat	Aesthetic
Water	Climate	Genpool protect.	Recreational
Fiber&Fuel	Natural hazards		Inspiration
Geneic Materials	Water regulation		Cultural heritage
Biochem. prod.	Waste treatment		Spiritual
Ornamental	Erosion protect.		Education
	Soil formation		Science
	Pollination		
	Biolog. regulat.		

Forest functions according to Slovenian Forest Act

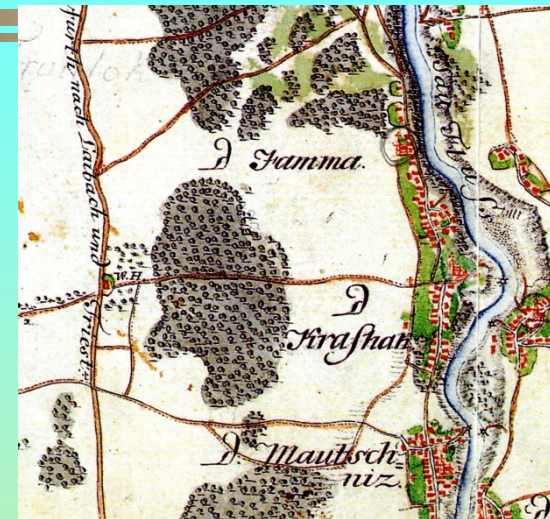
ECOLOGICAL:	SOCIAL:	PRODUCTIVE:
(soil) Protection	Protect of infrastr.	Timber
Hydrological	Recreational	Other for. resour
Biotopic	Tourist	Game manage.
Climatic	Educational	
	Research	
	Health	
	Natural heritage	
	Cultural heritage	
	Aesthetic	
	Defence	

Forests with **hidrological** function (top-left), with high **biodiversity** (top right). Forests with **heritage** (bottom-left) and forests with **protection** function (bottom-right)



Historic maps and forest remnant patches at Sorško polje, Slovenia

- 18th century (1763-1787)
military map



- 19th century (1826)
Franziscan cadastre



- 2009 arial photo



18th century (1763-1787) military map of the Emperor Joseph

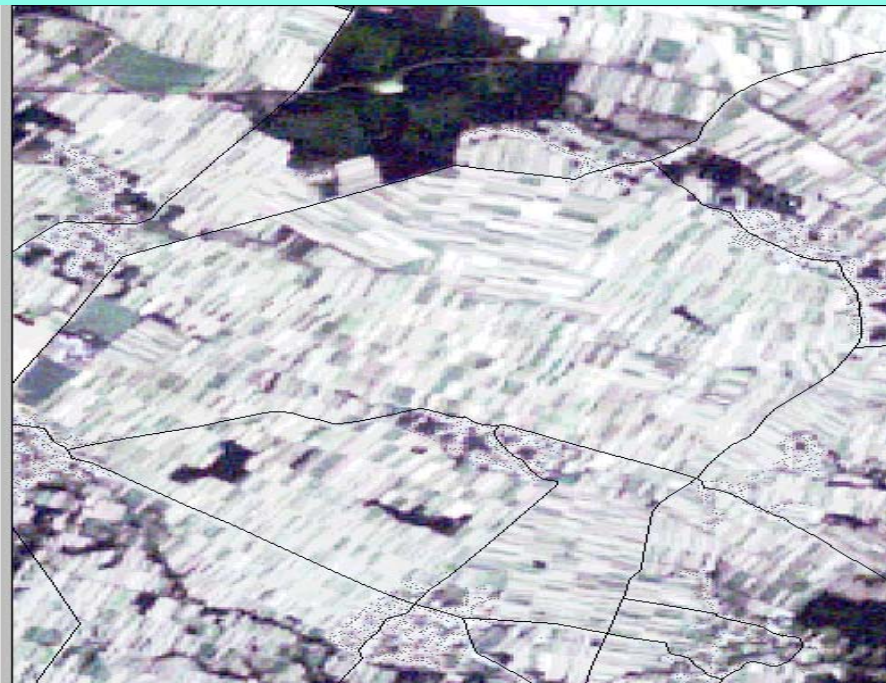
- Scale: 1:28.800
- Very good position of important buildings, churches , bridges (good for the control points when using „resample“ in GIS tools)
- Generalised distribution of major land uses
- Forests (patches) represented, borders sometimes rather vague.

Temporal land-use change and development of tools

Military map: 1763

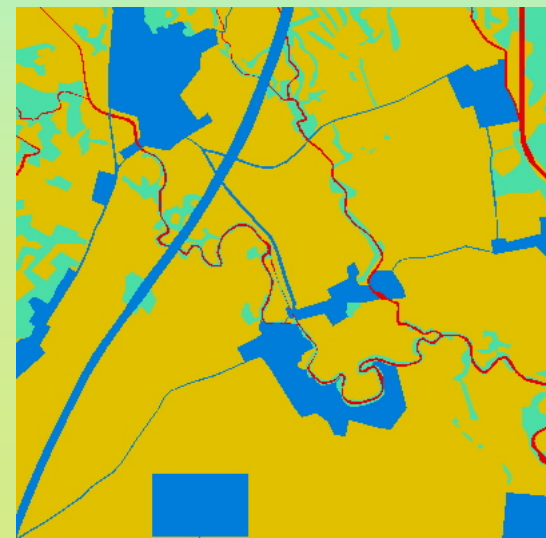
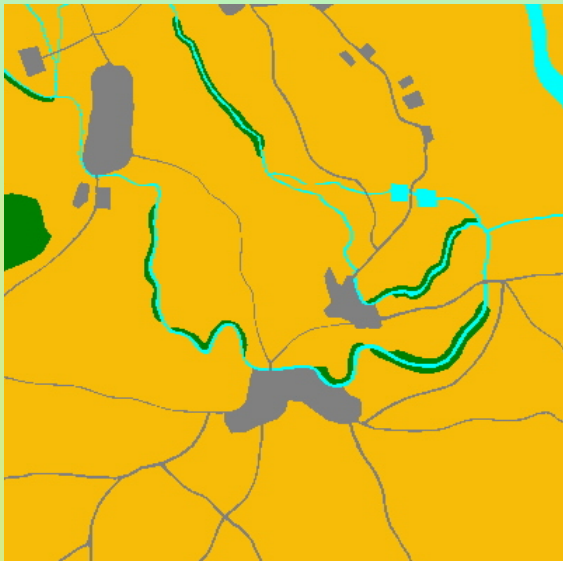


Landsat TM: 2001



Landscape structure as indicator
for sustainable land use

Examples: 18th century map and raster image (left) 21st century arial photo and raster image (right)

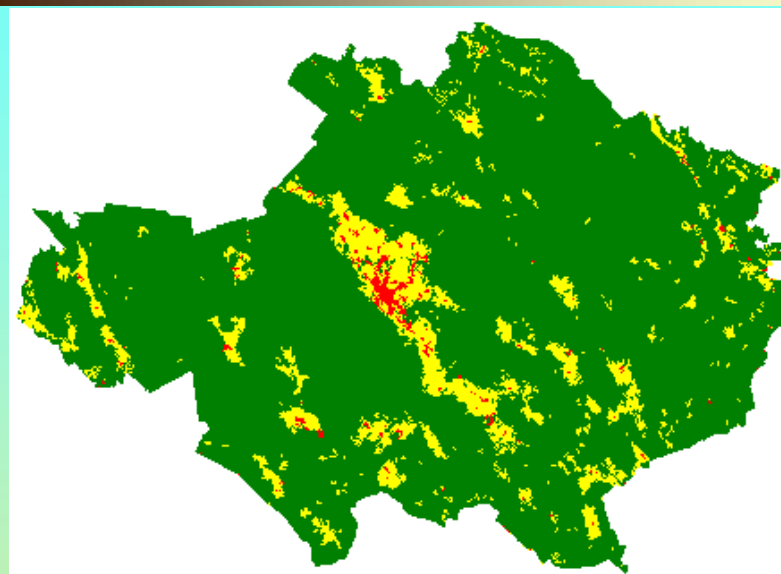
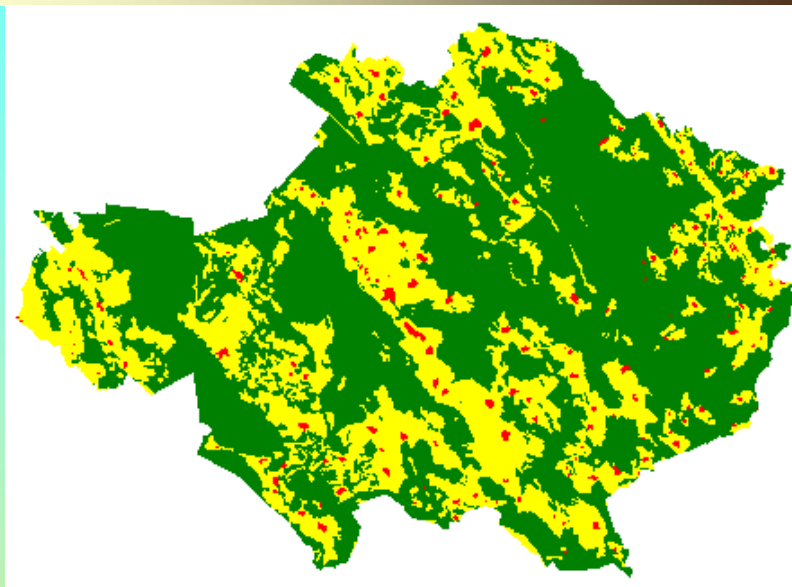


Kočevsko (Gottschee) 1340 - 1941

- A former Kočevsko is a territory of 787km² in the south of Slovenia. It was settled in the first half of the 14th century with German speaking inhabitants from Western Carinthia and Eastern Tyrol. According to an Austrian military map from period 1763 - 1787 forests covered 64 % of the land. The decline of the region started as early as in the late 19th century due to an economic emigration, but most of the damage resulted from World War II and was caused by war devastation and by the change of political system immediately after the war as well as by systematic destruction of the cultural heritage of Gottscheer Germans in favour of ideological and nationalistic reasons

Gottschee 1763 (left) - Kočevsko 2010 (right)

Forests (F), Agriculture (A), Settlements (S)



S	1317 ha	1.7 %
A	26917 ha	34.2 %
F	50468 ha	64.1 %

S	755 ha	1.0 %
A	8291 ha	10.5 %
F	69669 ha	88.5 %

Franziscean cadastre (1826)

- Fields – light brown
- Meadows – dark green
- Pastures – light green
- Gardens – succulent green
- Forests - grey
- Settlements



Franziscean cadastre – basic highlights

- Scale 1: 2880 (1:1440)
- Maps illustrate natural and cultural objects: waters, roads, buildings and some demarcation features (stone walls, trees and tree rows.)
- The most important topographical elements of these maps are the dividing lines between individual parcels. (control points for GIS)
- Maps of previous land use helps us to understand the social situation of pre-industrial agriculture period
- It is possible to establish whether specific patterns or elements, are old or recent.
- By comparison of maps with modern aerial photos, we can show spatial differences of individual elements between early 19th century and today.

Franziscean cadastre and forestry

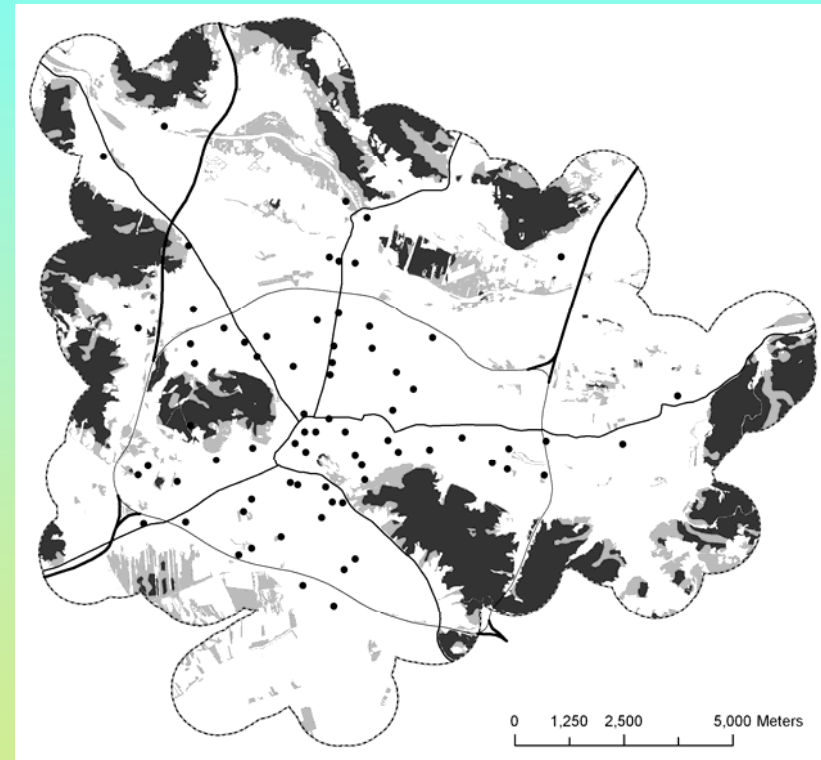
- Maps are showing forest continuum
 - in term of matix
 - in term of patches / corridors
 - in term of artifacts
- Maps are showing resilience of forest structure (biodiversity)
- Maps of historic vs. modern landscape types

Resilience

- Temporal changes of land use pattern are result of different driving forces and landscape „resilience“.
- European landscapes are undergoing fundamental changes
- Resilience in forest ecosystem spatial patch distribution is important indicator of biodiversity function or habitat supporting services.
- Historic maps (and documents) are important tools for studying landscapes as a palimpsest.

Combining historic and modern analysis in landscape ecology (Hladnik and Pirnat, 2011)

- Evaluation of spatial forests close to naturalness based on their tree structure and forest continuum in space (black)



Major components of the spatial solution (according to Forman 1995)

- **Indispensable patterns.** Top-priority patterns for protection with no known substitute for their ecological benefits (large natural vegetation patches, wide vegetated corridors protecting water courses, connectivity for movement of key species among large patches and small patches and corridors providing heterogeneous bits of nature)
 - **Aggregate-with-outliers pattern.** The pattern aggregate land use, yet maintains corridors and small patches of nature throughout developed areas, as well as outliers of human activity spatially arranged along major boundaries.
 - **Strategic points** (locations whose ecological importance is exceptional in long term)
- All three are a spatial understanding of forest biodiversity role

Thank you for attention!

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