Vegetation structure of oxbow lakes along an urban-rural gradient – Case study of Warsaw (Poland)

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Introduction

Introduction

DOM DEVELOPMENT S.A.

ZESPÓŁ MIESZKANIOWY Z GARAŻEM PODZIEMNYM I USŁUGAMI
"JEZIORKO"

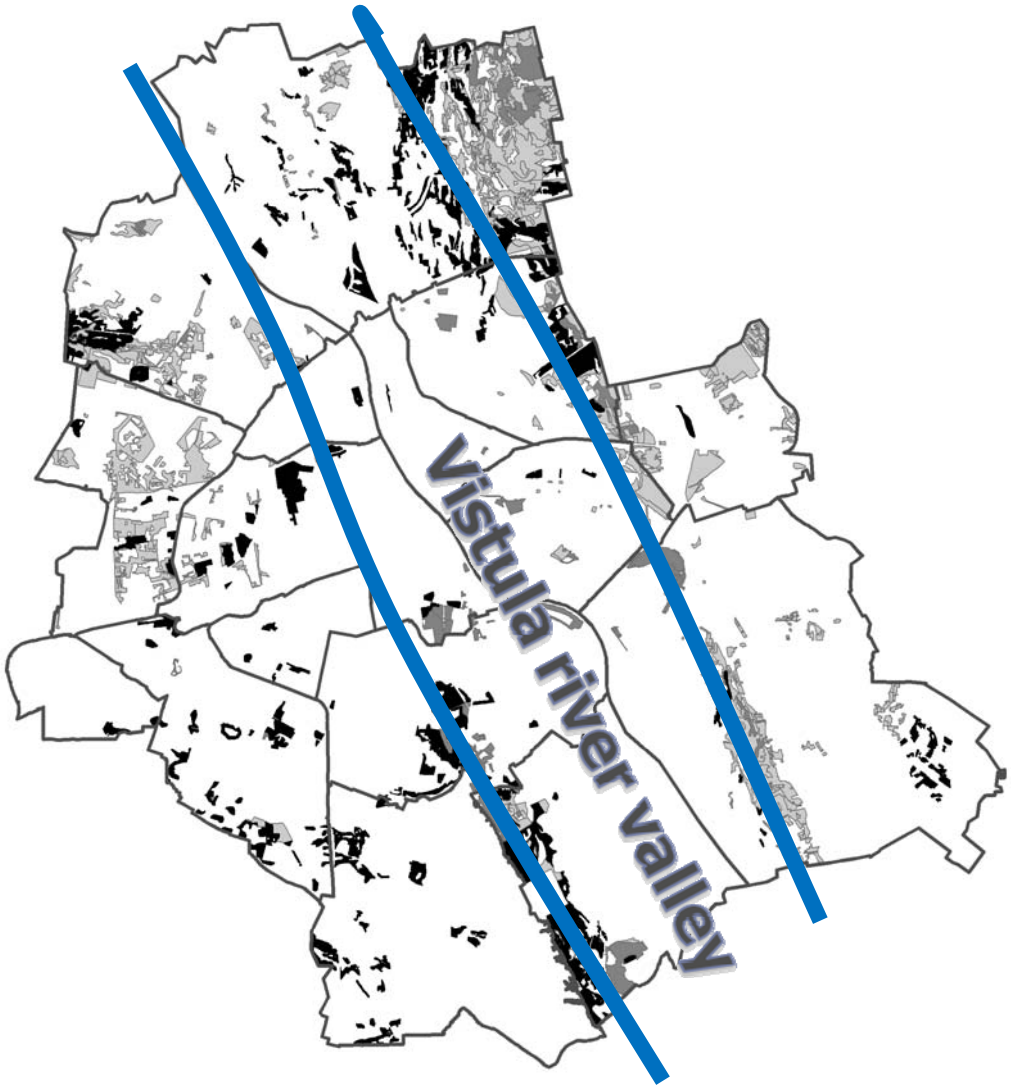
HERMANOWICZ REWSKI ARCHITEKCI

Environmental Impact Assesement procedures do not take into account changes in landscape structure.

It is included in the law, but there are no clear measures

Introduction

2. In the Vistula River Valley pressure increases along an urban-suburban-rural gradient



(Sikorska, Sikorski 2002)

Introduction

The effect of population density on the structure of water dependent ecosystems

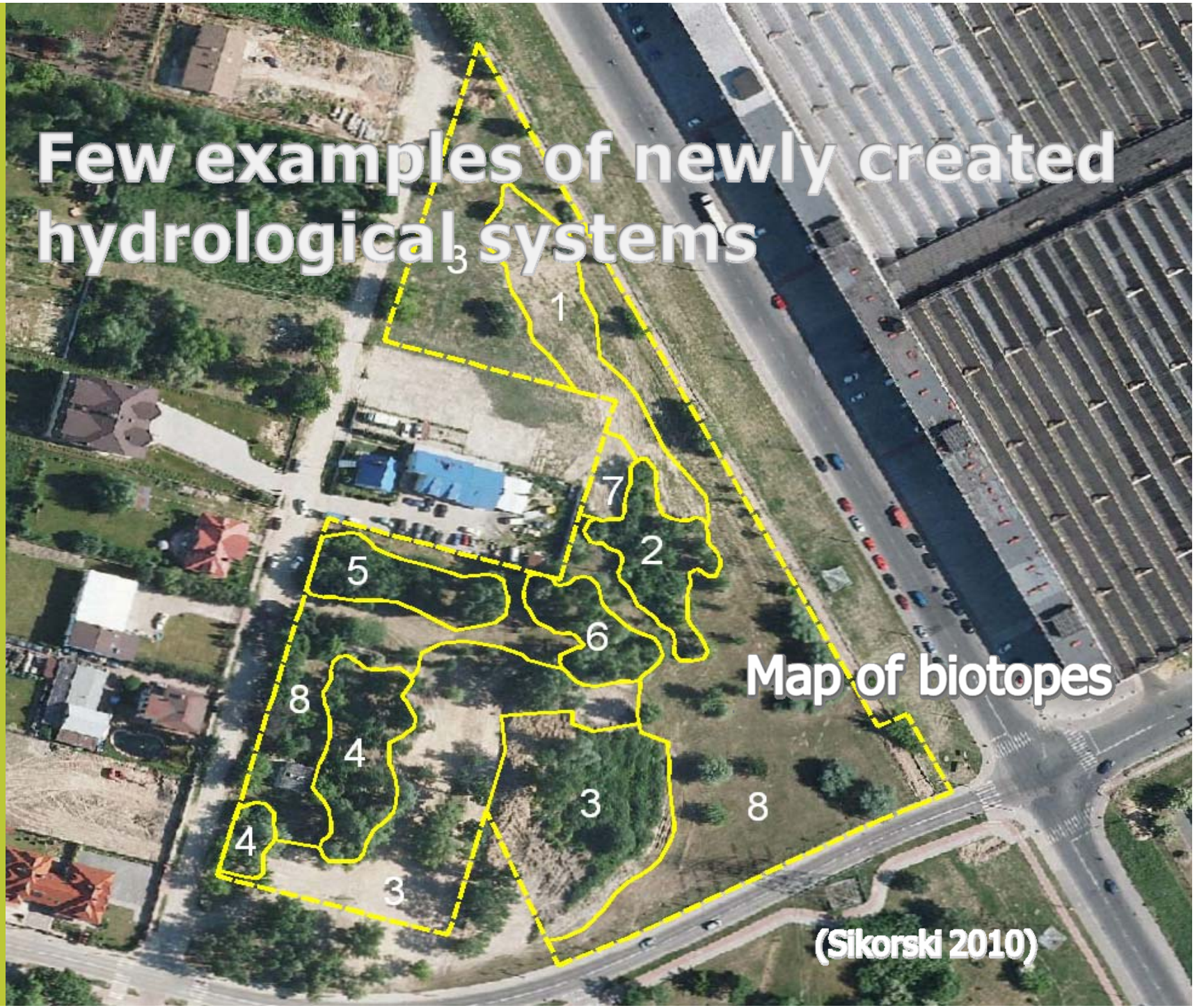
Landscape structure indicator	Mean	r^2
NumP – Number of Patches	70,5	**-0,591***
CA – Class Area [ha]	397,7	**-0,597***
MPS – Mean Patch Size [ha]	5,4	-0,184
TE – Total Edge Lenght [km]	102652,2	**-0,582***
ED – Edge Density [km/ha]	15,2	**-0,581***

(Sikorski, Sikorska, Dobrzańska 2010)

- **Water dependent ecosystems within urban areas are getting more and more rare and their area is getting smaller**
- **Their presence is negatively correlated with population density per hectare**

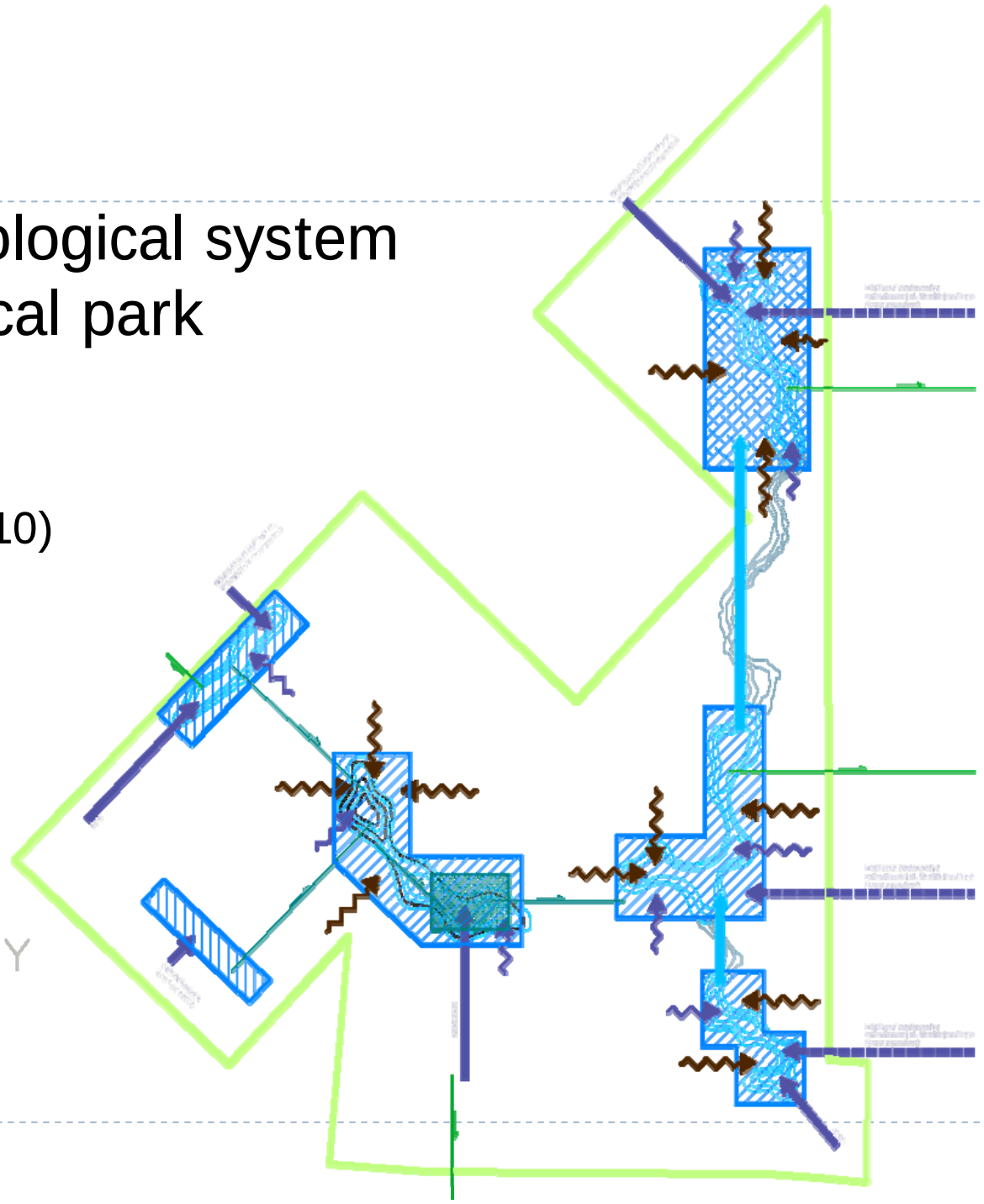
Introduction

Few examples of newly created hydrological systems

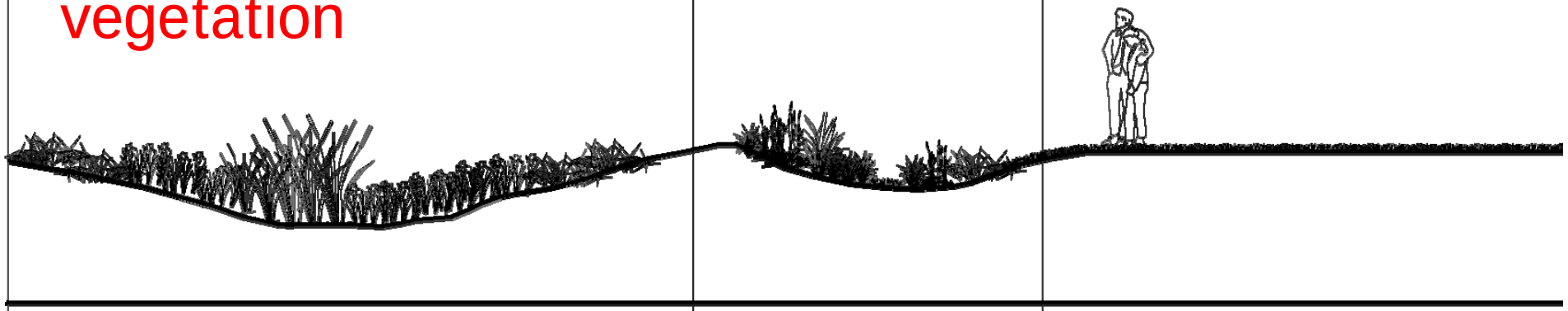


Concept of hydrological system in a new ecological park (Ursus, Warsaw)

(Mroczkowski at all. 2010)



Project of new hydrogenic (water dependent) vegetation



BIOTOP 1
Roślinność niecki biretencyjnej stale wilgotnej (podmokłej) - np.: kosaćce - możliwość penetracji bezpośredniej nie wskazana, należy ograniczyć do minimum lub wyeliminować całkowicie

BIOTOP 2
Roślinność niecki bioretencyjnej czasowo zalewanej (czasowo wilgotnej) jako zbiór roślin odpornych na takie warunki - możliwość penetracji bezpośredniej z ograniczeniami.

BIOTOP 3
Trawnik niski koszenie częste wg. potrzeb utrzymania na odpowiedniej wysokości i niedopuszczenie do wkroczenia sukcesji roślin wysokich i z łąk kwietnych) - możliwość swobodnej i bezpośredniej penetracji, umożliwić dostęp.

Introduction

Examples of compensation – - Irrigation system, sustaining constant water level


Restoration of ecosystems (few new concepts in progress) and creating new ecosystems are still uncommon

Aim of the study

The aim of this study was to assess the effect of anthropopressure associated with the increase of built-up areas on vegetation diversity of oxbow lakes

Research area

Methods

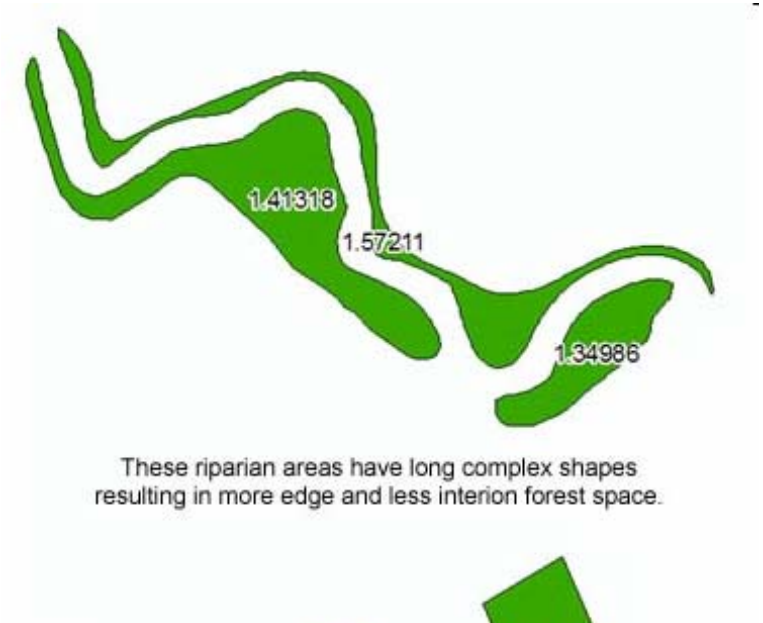
Examination of vegetation diversity

- Water dependent vegetation of the lake
  - Phytosociological inventory (Braun-Blanquet)
    - representative transects in each of the lakes (phytosociological relevés)
  - Assesement of vegetation naturalness
    - Synantrophization indices (apophytes, spontaneophytes, antropophytes percentage)
    - diversity indices (Shannon's, Simpson's diversity indices, domination index)
  - Classification - multivariate analysis DCA (CANOCO)
- Vegetation structure of the neighboring areas (0,5 km)
  - Real vegetation maps 1:1000 (aerial photograps, field research)
  - Assesement of landscape fragmentation and urbanization pressure – LANDSCAPE METRICS (FRAGSTAT)
- Correlations between vegetation naturalness and the landscape metrics (STATISTICA)

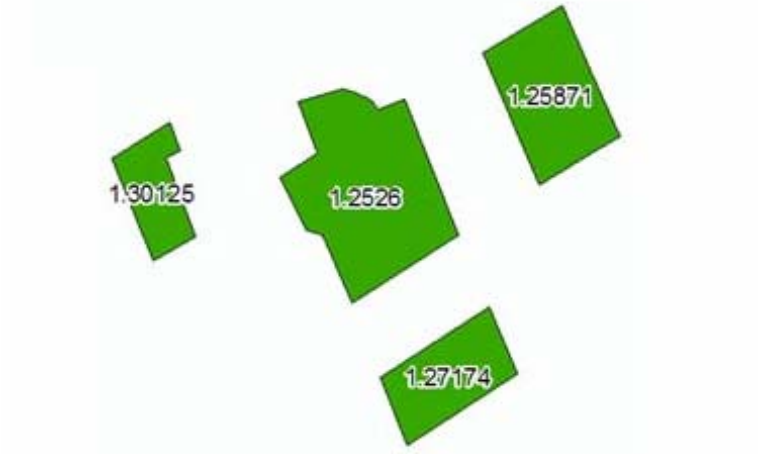
landscape metrics

- SDI – Shannon Diveristy Index
- SEI – Shannon Eveness Index
- MSI – Mean shape index
- MPAR – Mean Perimeter/Area ratio
- MPFD – Mean Patch fractal dimension
- TE – total edge
- ED – total edge density
- MPS – Mean Patch size
- NumP – Number of Patches
- CA – class area

Application of landscape metrics



These riparian areas have long complex shapes resulting in more edge and less interion forest space.



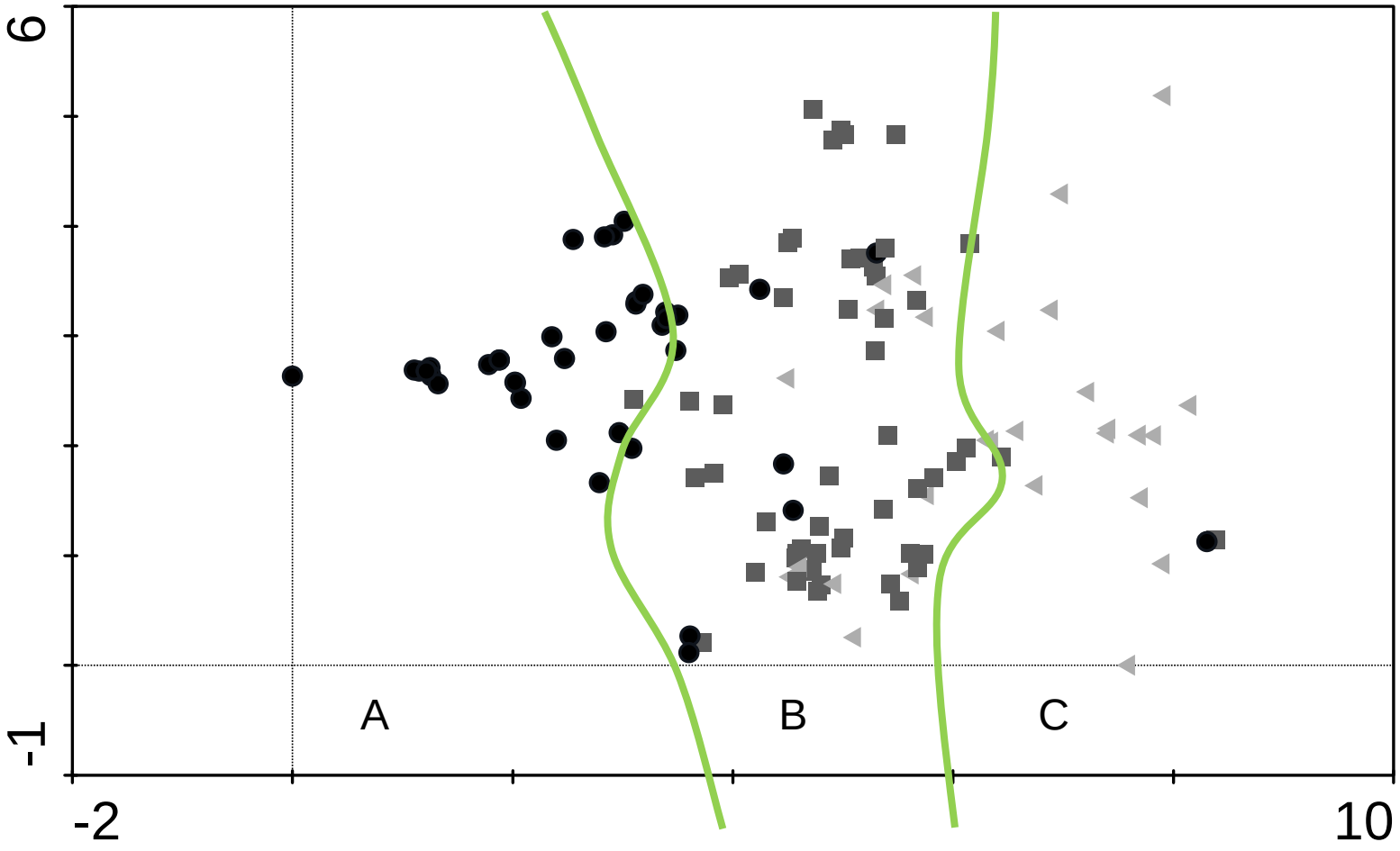
Woodlots in agricultural areas tend to be rectangular. They posess less complex shapes with greater forest interior space.

Please notice the indicators connected with water dependent areas which have **simplified shapes** and **less complicated borders** as the urbanization pressure **increases**

Results

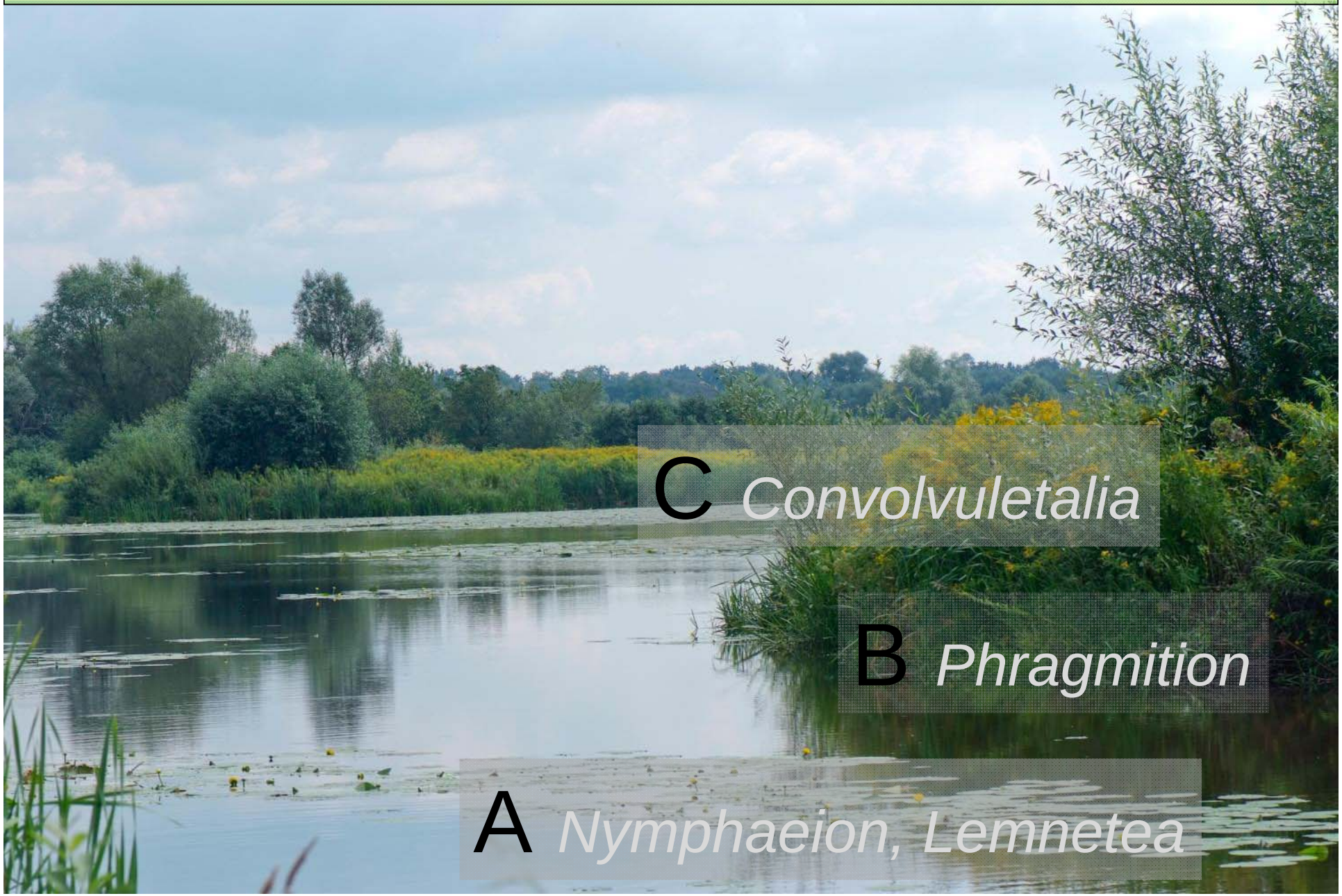
Diversity of water-related vegetation

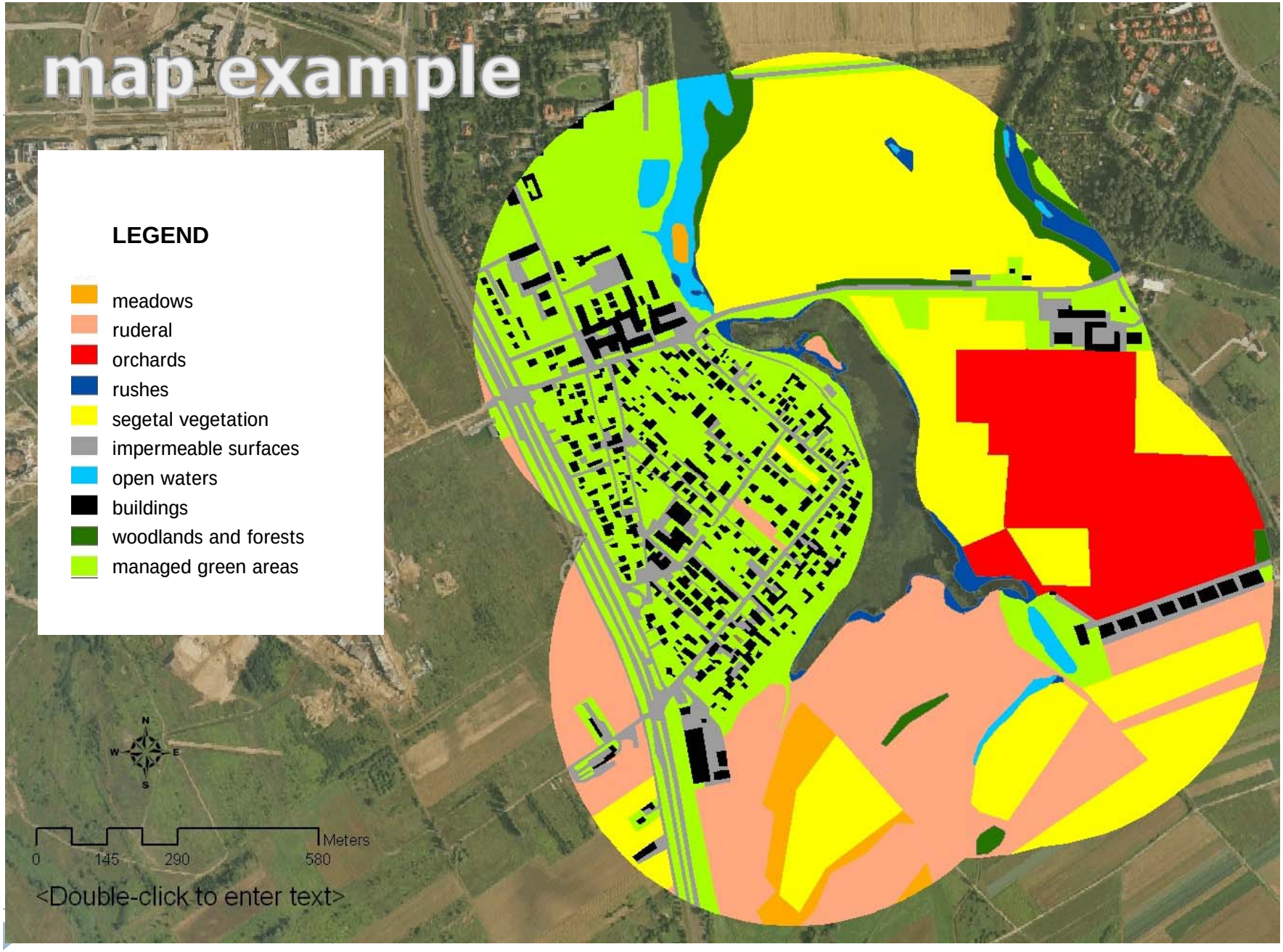
Vegetation differentiates into 3 zones

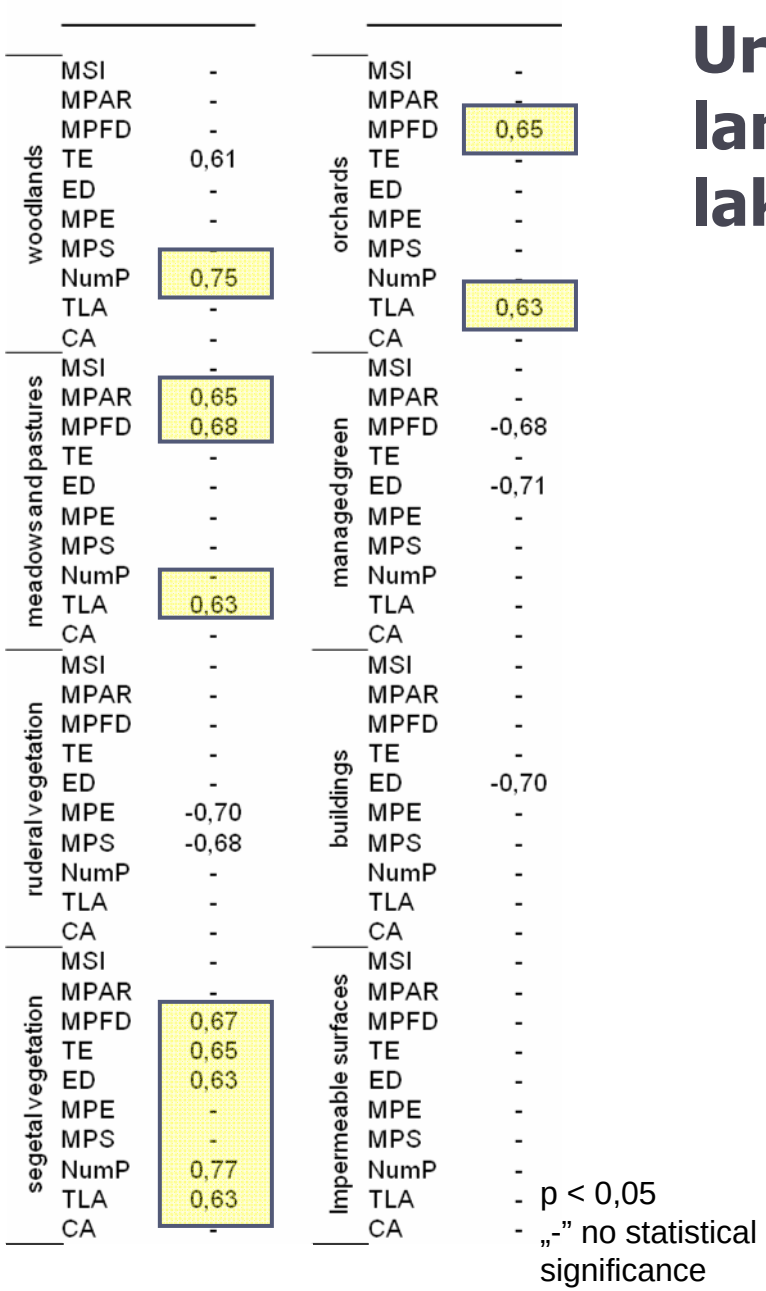


DCA diagam for 126 samples indicates that distinguished zones (A,B,C) show little resemblance and form homogenous plant communities

Diversity of water-related vegetation



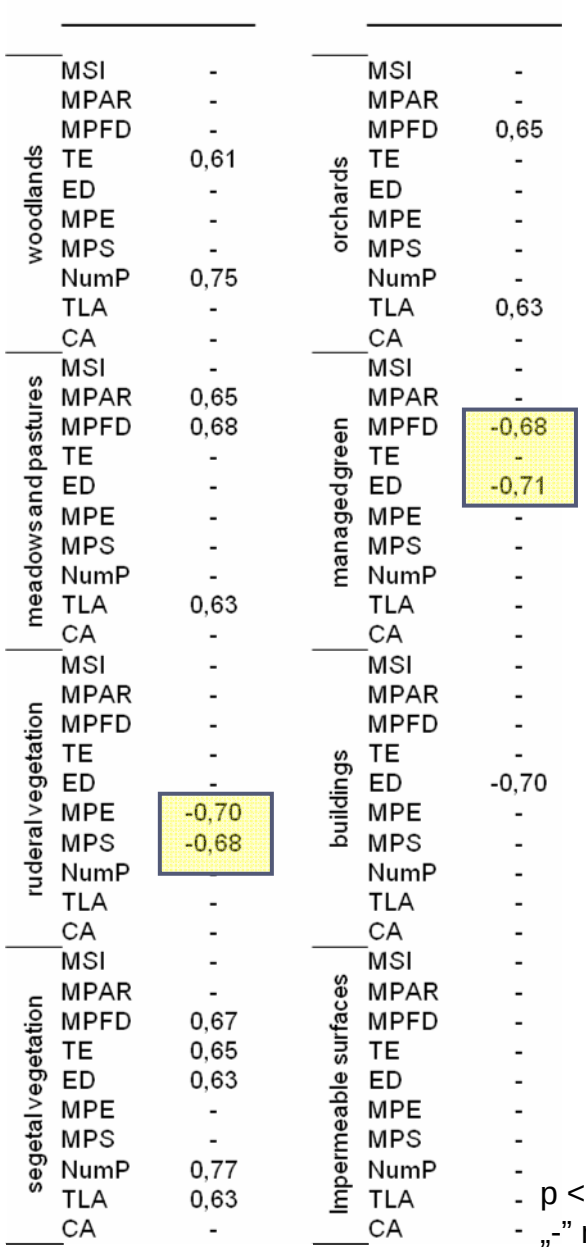

map example
LEGEND
meadows
ruderal
orchards
rushes
segetal vegetation
impermeable surfaces
open waters
buildings
woodlands and forests
managed green areas
N
W
E
S
0
145
290
580
Meters
<Double-click to enter text>



p < 0,05
„-" no statistical significance

Urban–rural gradient and the landscape structure of oxbow lakes neighbourhood

- The further from the city center:
  - the more patches of elements characteristic for rural landscape (forests, meadows, agricultural land, orchards)
  - the more complex are the patches (their shapes are more complicated)
  - Within the city these areas are more fragmented and their borders are artificially simplified
- The closer to the city center :
  - the more managed green areas of complicated shapes
  - the larger the areas covered by ruderal vegetation (Rudbeckio-Solidaginetum)



woodlands	MSI	-
	MPAR	-
	MPFD	-
	TE	0,61
	ED	-
	MPE	-
	MPS	-
	NumP	0,75
	TLA	-
	CA	-
meadows and pastures	MSI	-
	MPAR	0,65
	MPFD	0,68
	TE	-
	ED	-
	MPE	-
	MPS	-
	NumP	-
	TLA	0,63
	CA	-
ruderal vegetation	MSI	-
	MPAR	-
	MPFD	-
	TE	-
	ED	-
	MPE	-0,70
	MPS	-0,68
	NumP	-
	TLA	-
	CA	-
segetal vegetation	MSI	-
	MPAR	-
	MPFD	0,67
	TE	0,65
	ED	0,63
	MPE	-
	MPS	-
	NumP	0,77
	TLA	0,63
	CA	-

orchards	MSI	-
	MPAR	-
	MPFD	0,65
	TE	-
	ED	-
	MPE	-
	MPS	-
	NumP	-
	TLA	0,63
	CA	-
managed green	MSI	-
	MPAR	-
	MPFD	-0,68
	TE	-
	ED	-0,71
	MPE	-
	MPS	-
	NumP	-
	TLA	-
	CA	-
buildings	MSI	-
	MPAR	-
	MPFD	-
	TE	-
	ED	-0,70
	MPE	-
	MPS	-
	NumP	-
	TLA	-
	CA	-
Impermeable surfaces	MSI	-
	MPAR	-
	MPFD	-
	TE	-
	ED	-
	MPE	-
	MPS	-
	NumP	-
	TLA	-
	CA	-

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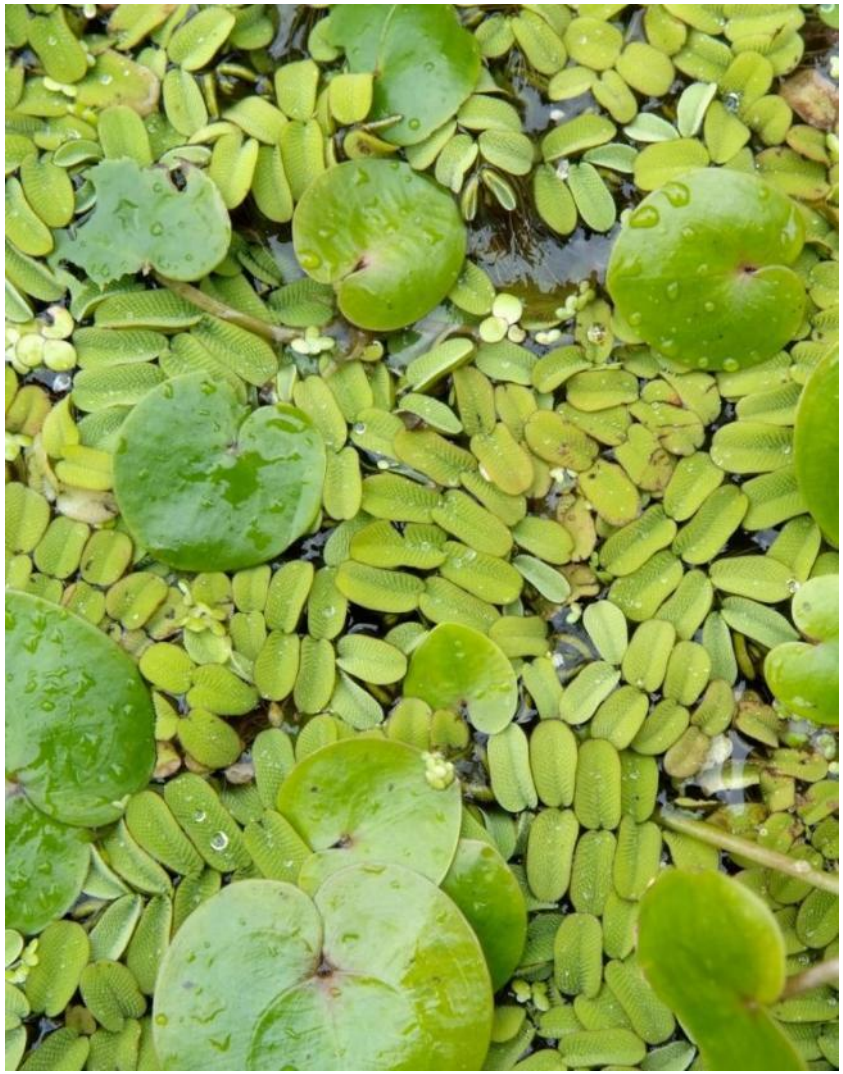
Diversity of water vegetation (*Nymphaeion* and *Lemnetea*) and the landscape structure of neigbhoring areas (A)



- The condition of water vegetation seems to be **independent** from the most structure of the landscape in the neighbouring areas (no land use type affects significantly the quality of vegetation)

- The biggest impact is caused by the **size of impermeable surfaces** patches (probably due to increased surface runoff) and **the number of woodland** patches and their **border length** (shading by trees is a limiting factor for aquatic vegetation to develop)

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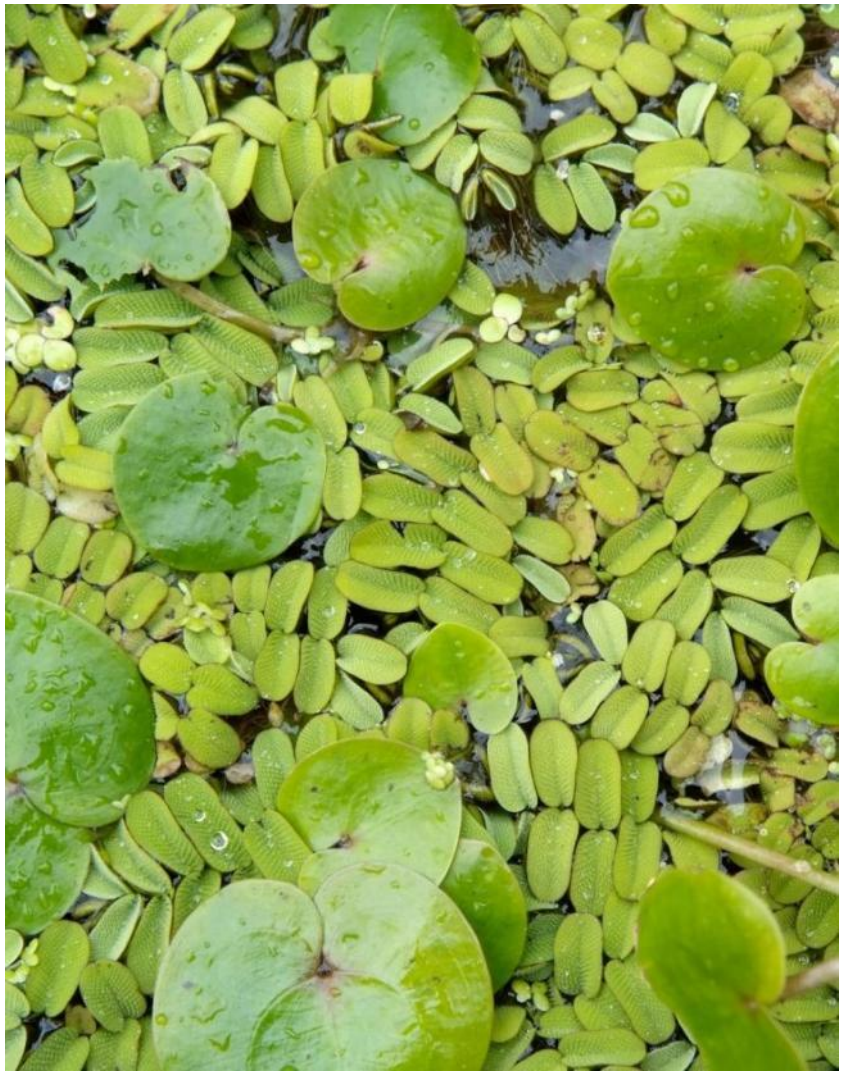

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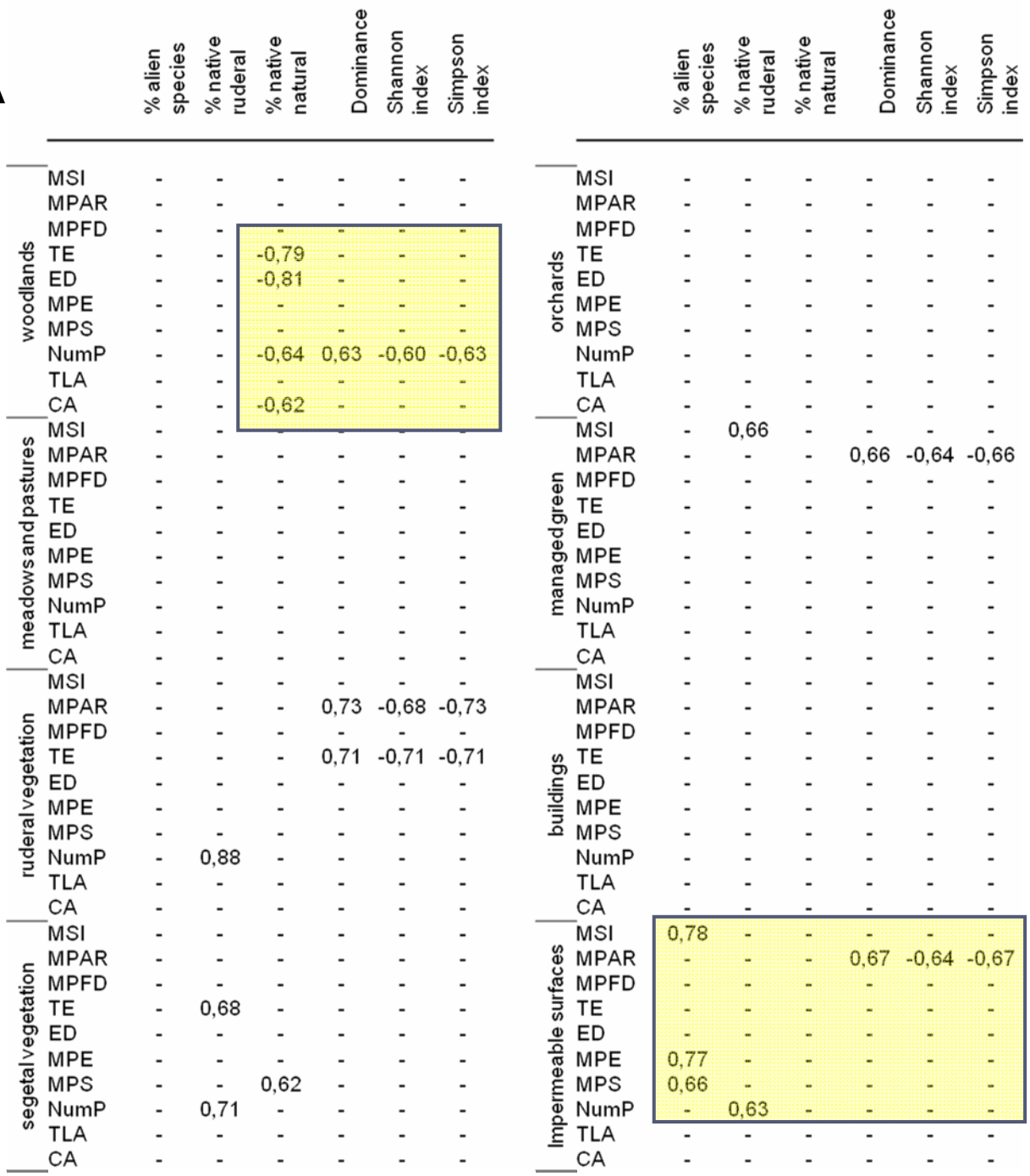
A



		% alien species	% native ruderal	% native natural	Dominance	Shannon index	Simpson index
woodlands	MSI	-	-	-	-	-	-
	MPAR	-	-	-	-	-	-
	MPFD	-	-	-	-	-	-
	TE	-	-	-0,79	-	-	-
	ED	-	-	-0,81	-	-	-
	MPE	-	-	-	-	-	-
	MPS	-	-	-	-	-	-
	NumP	-	-	-0,64	0,63	-0,60	-0,63
	TLA	-	-	-	-	-	-
	CA	-	-	-0,62	-	-	-
meadows and pastures	MSI	-	-	-	-	-	-
	MPAR	-	-	-	-	-	-
	MPFD	-	-	-	-	-	-
	TE	-	-	-	-	-	-
	ED	-	-	-	-	-	-
	MPE	-	-	-	-	-	-
	MPS	-	-	-	-	-	-
	NumP	-	-	-	-	-	-
	TLA	-	-	-	-	-	-
	CA	-	-	-	-	-	-
ruderal vegetation	MSI	-	-	-	-	-	-
	MPAR	-	-	-	0,73	-0,68	-0,73
	MPFD	-	-	-	-	-	-
	TE	-	-	-	0,71	-0,71	-0,71
	ED	-	-	-	-	-	-
	MPE	-	-	-	-	-	-
	MPS	-	-	-	-	-	-
	NumP	-	0,88	-	-	-	-
	TLA	-	-	-	-	-	-
	CA	-	-	-	-	-	-
segetal vegetation	MSI	-	-	-	-	-	-
	MPAR	-	-	-	-	-	-
	MPFD	-	-	-	-	-	-
	TE	-	0,68	-	-	-	-
	ED	-	-	-	-	-	-
	MPE	-	-	-	-	-	-
	MPS	-	-	0,62	-	-	-
	NumP	-	0,71	-	-	-	-
	TLA	-	-	-	-	-	-
	CA	-	-	-	-	-	-
orchards	MSI	-	-	-	-	-	-
	MPAR	-	-	-	-	-	-
	MPFD	-	-	-	-	-	-
	TE	-	-	-	-	-	-
	ED	-	-	-	-	-	-
	MPE	-	-	-	-	-	-
	MPS	-	-	-	-	-	-
	NumP	-	-	-	-	-	-
	TLA	-	-	-	-	-	-
	CA	-	-	-	-	-	-
managed green	MSI	-	0,66	-	-	-	-
	MPAR	-	-	-	0,66	-0,64	-0,66
	MPFD	-	-	-	-	-	-
	TE	-	-	-	-	-	-
	ED	-	-	-	-	-	-
	MPE	-	-	-	-	-	-
	MPS	-	-	-	-	-	-
	NumP	-	-	-	-	-	-
	TLA	-	-	-	-	-	-
	CA	-	-	-	-	-	-
buildings	MSI	-	-	-	-	-	-
	MPAR	-	-	-	-	-	-
	MPFD	-	-	-	-	-	-
	TE	-	-	-	-	-	-
	ED	-	-	-	-	-	-
	MPE	-	-	-	-	-	-
	MPS	-	-	-	-	-	-
	NumP	-	-	-	-	-	-
	TLA	-	-	-	-	-	-
	CA	-	-	-	-	-	-
impermeable surfaces	MSI	0,78	-	-	-	-	-
	MPAR	-	-	-	0,67	-0,64	-0,67
	MPFD	-	-	-	-	-	-
	TE	-	-	-	-	-	-
	ED	-	-	-	-	-	-
	MPE	0,77	-	-	-	-	-
	MPS	0,66	-	-	-	-	-
	NumP	-	0,63	-	-	-	-
	TLA	-	-	-	-	-	-
	CA	-	-	-	-	-	-

$p < 0,05$
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Diversity of vegetation of rushes (*Phragmition*) and the landscape structure (B)

- Condition of rushes seems to be dependent on the structure of the vegetation in surrounding areas
- Presence of woodlands of complicated shape, affects positively biodiversity and naturalness of the rushes in oxbow lakes
- Negative affect is caused by the presence of agricultural lands and high number of areas with ruderal vegetation

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B

		% alien species	% native ruderal	% native natural	Dominance	Shannon index	Simpson index
woodlands	MSI	-	-	-	-	-	-
	MPAR	-	-	0,63	-	-	-
	MPFD	-	-	0,72	-0,73	0,74	0,73
	TE	-	-	-	-	-	-
	ED	-	-	-	-	-	-
	MPE	-	-	-	-	-	-
	MPS	-	-	-	-	-	-
	NumP	-	-	-	-	-	-
	TLA	-	-	-	-	-	-
	CA	-	-	-	-	-	-
meadows and pastures	MSI	-	-	0,61	-	-	-
	MPAR	-	-	-	-	-	-
	MPFD	-	-	-	-	-	-
	TE	-	-	-	-	-	-
	ED	-	-	-	-	-	-
	MPE	-	-	-	-	-	-
	MPS	-	-	-	-	-	-
	NumP	-	-	-	-	-	-
	TLA	-	-	-	-	-	-
	CA	-	-	-	-	-	-
ruderal vegetation	MSI	-	-	-	0,67	-0,64	-0,67
	MPAR	-	-	-	-	-	-
	MPFD	-	-	-	-	-	-
	TE	-	-	-	0,63	-0,61	-0,63
	ED	-	-	-0,72	0,77	-0,75	-0,77
	MPE	-	-	-	-	-	-
	MPS	-	-	-0,61	0,65	-0,64	-0,65
	NumP	-	-	-	-	-	-
	TLA	-	-	-	-	-	-
	CA	-	-	-	0,65	-0,64	-0,65
segetal vegetation	MSI	-	-	-	-	-	-
	MPAR	-	-	-	-	-	-
	MPFD	-	-	-	-	-	-
	TE	-	-	-	-	-	-
	ED	-	-	-	-	-	-
	MPE	0,77	-	-	-	-	-
	MPS	0,76	-	-	-	-	-
	NumP	-	-	-	-	-	-
	TLA	-	-	-	-	-	-
	CA	-	-	-	-	-	-

		% alien species	% native ruderal	% native natural	Dominance	Shannon index	Simpson index
orchards	MSI	-	-	0,64	-	-	-
	MPAR	-	-	-	-	-	-
	MPFD	-	-	-	-	-	-
	TE	-	-	-	-	-	-
	ED	-	-	-	-	-	-
	MPE	-	-	-	-	-	-
	MPS	-	-	-	-	-	-
	NumP	-	-	-	-	-	-
	TLA	-	-	-	-	-	-
	CA	-	-	-	-	-	-
managed green	MSI	-	0,67	-	-	-	-
	MPAR	-	-	-	-	-	-
	MPFD	-	-	-	-	-	-
	TE	-	-	-	-	-	-
	ED	-	-	-	-	-	-
	MPE	-	0,67	-	-	-	-
	MPS	-	-	-	-	-	-
	NumP	-	-	-	-	-	-
	TLA	-	-	-	-	-	-
	CA	-	-	-	-	-	-
buildings	MSI	-	-	-	-	-	-
	MPAR	-	0,67	-	-	-	-
	MPFD	-	-	-	-	-	-
	TE	-	-	-	-	-	-
	ED	-	-	-	0,67	-0,66	-0,67
	MPE	-	-	-	-	-	-
	MPS	-	-	-	-	-	-
	NumP	-	-	-	-	-	-
	TLA	-	-	-	-	-	-
	CA	-	-	-	-	-	-
Impermeable surfaces	MSI	-	-	-	-	-	-
	MPAR	-	-	-	-	-	-
	MPFD	-	-	-	-	-	-
	TE	-	-	-	-	-	-
	ED	-	-	-	-	-	-
	MPE	-	-	-	-	-	-
	MPS	-	-	-	-	-	-
	NumP	-	-	-	0,61	-0,61	-0,61
	TLA	-	-	-	-	-	-
	CA	-	-	-	-	-	-

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B

		% alien species	% native ruderal	% native natural	Dominance	Shannon index	Simpson index
woodlands	MSI	-	-	-	-	-	-
	MPAR	-	-	0,63	-	-	-
	MPFD	-	-	0,72	-0,73	0,74	0,73
	TE	-	-	-	-	-	-
	ED	-	-	-	-	-	-
	MPE	-	-	-	-	-	-
	MPS	-	-	-	-	-	-
	NumP	-	-	-	-	-	-
	TLA	-	-	-	-	-	-
	CA	-	-	-	-	-	-
meadows and pastures	MSI	-	-	0,61	-	-	-
	MPAR	-	-	-	-	-	-
	MPFD	-	-	-	-	-	-
	TE	-	-	-	-	-	-
	ED	-	-	-	-	-	-
	MPE	-	-	-	-	-	-
	MPS	-	-	-	-	-	-
	NumP	-	-	-	-	-	-
	TLA	-	-	-	-	-	-
	CA	-	-	-	-	-	-
ruderal vegetation	MSI	-	-	-	0,67	-0,64	-0,67
	MPAR	-	-	-	-	-	-
	MPFD	-	-	-	-	-	-
	TE	-	-	-	0,63	-0,61	-0,63
	ED	-	-	-0,72	0,77	-0,75	-0,77
	MPE	-	-	-	-	-	-
	MPS	-	-	-0,61	0,65	-0,64	-0,65
	NumP	-	-	-	-	-	-
	TLA	-	-	-	-	-	-
	CA	-	-	-	0,65	-0,64	-0,65
segetal vegetation	MSI	-	-	-	-	-	-
	MPAR	-	-	-	-	-	-
	MPFD	-	-	-	-	-	-
	TE	-	-	-	-	-	-
	ED	-	-	-	-	-	-
	MPE	0,77	-	-	-	-	-
	MPS	0,76	-	-	-	-	-
	NumP	-	-	-	-	-	-
	TLA	-	-	-	-	-	-
	CA	-	-	-	-	-	-

		% alien species	% native ruderal	% native natural	Dominance	Shannon index	Simpson index
orchards	MSI	-	-	0,64	-	-	-
	MPAR	-	-	-	-	-	-
	MPFD	-	-	-	-	-	-
	TE	-	-	-	-	-	-
	ED	-	-	-	-	-	-
	MPE	-	-	-	-	-	-
	MPS	-	-	-	-	-	-
	NumP	-	-	-	-	-	-
	TLA	-	-	-	-	-	-
	CA	-	-	-	-	-	-
managed green	MSI	-	0,67	-	-	-	-
	MPAR	-	-	-	-	-	-
	MPFD	-	-	-	-	-	-
	TE	-	-	-	-	-	-
	ED	-	-	-	-	-	-
	MPE	-	0,67	-	-	-	-
	MPS	-	-	-	-	-	-
	NumP	-	-	-	-	-	-
	TLA	-	-	-	-	-	-
	CA	-	-	-	-	-	-
buildings	MSI	-	-	-	-	-	-
	MPAR	-	0,67	-	-	-	-
	MPFD	-	-	-	-	-	-
	TE	-	-	-	-	-	-
	ED	-	-	-	0,67	-0,66	-0,67
	MPE	-	-	-	-	-	-
	MPS	-	-	-	-	-	-
	NumP	-	-	-	-	-	-
	TLA	-	-	-	-	-	-
	CA	-	-	-	-	-	-
Impermeable surfaces	MSI	-	-	-	-	-	-
	MPAR	-	-	-	-	-	-
	MPFD	-	-	-	-	-	-
	TE	-	-	-	-	-	-
	ED	-	-	-	-	-	-
	MPE	-	-	-	-	-	-
	MPS	-	-	-	-	-	-
	NumP	-	-	-	0,61	-0,61	-0,61
	TLA	-	-	-	-	-	-
	CA	-	-	-	-	-	-

$p < 0,05$
„-" no statistical significance

Nitrofilous herbaceous vegetation of the banks (*Convolvuletalia*) and the landscape structure (C)

- Herbaceous vegetation of the banks seems to be under strongest influence of the neighbourhood structure
- Plant communities associated with edges (*Convolvuletalia*) consisting mostly of ruderal plants and suffering from antropopressure, become a a place of alien species penetration
- Neighobourhood of agricultural land or meadows favors antropopressure when complicated shapes of woodlands promote stability

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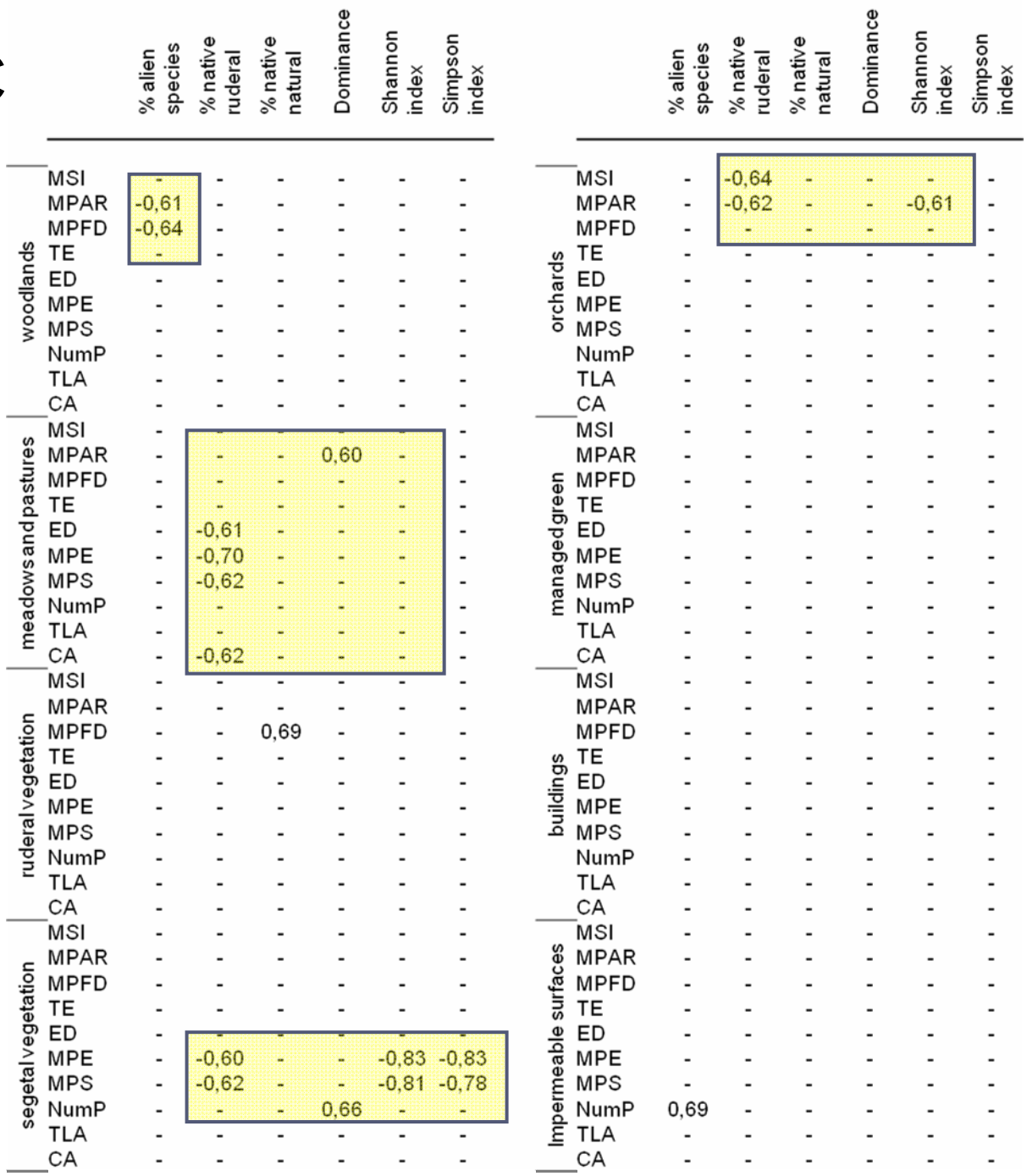
C



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Conclusions

- Along the urban-rural gradient the spatial pattern of the landscape associated with oxbow lakes changes. This concerns the shapes and size of the patches connected with agricultural landscape then more then the presence of built-up areas. In urban areas only the mean size of ruderal areas significantly increases.
- No statisticaly significant correlation was found between the percentage of built-up areas and vegetation naturalness, which makes it impossible to state any parameters usuful in spatial planning which could limit the size of new buil-up areas. Higher pressure on the areas in the river valles has been observed during recent years.
- 3 different zones of vegetation were distinguished which react differently to the landsue od neighoboring areas
- Aquatic vegetation growth is limited by the presence of big patches of impermeable surfaces and woodlands shading the shores. In case of other zones – the more large patches of low naturalness and simplified shapes, the greater is the pressure of alien plants.


Thank You for Your attention ...