

**ANALYSIS AND EVALUATION OF NATURE SPACE POTENTIAL  
IN PERI-URBAN SPACES  
USING  
REMOTE SENSING DATA  
AND GIS**

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## **What do we want?**

analyse and evaluate the nature space potential for the suburban space

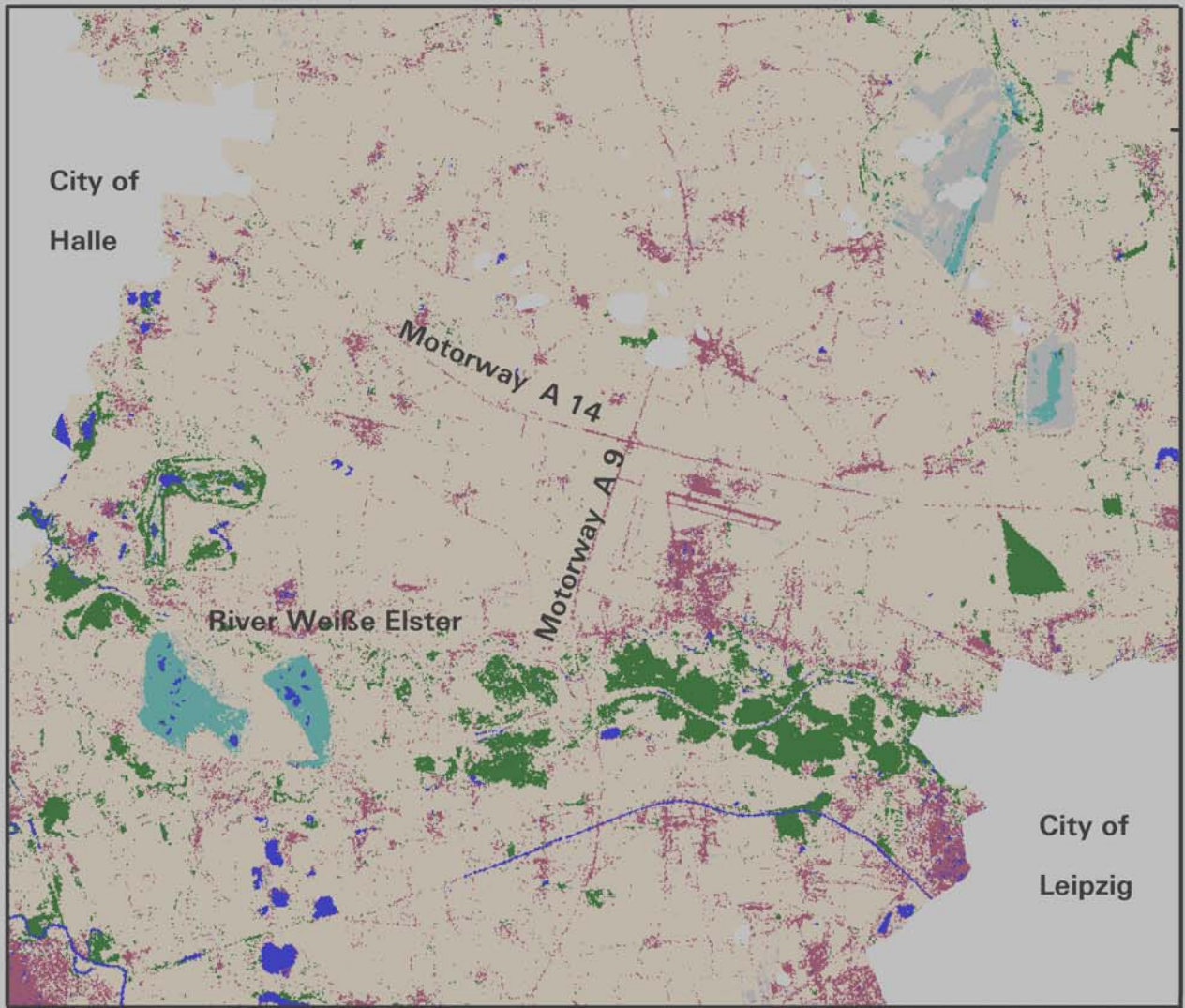
## **Which techniques do we apply?**

remote sensing methods and include geographical information systems (GIS)

## **Where is our area of investigation**

The conurbation between Leipzig and Halle (East Germany)

# Land Use in the Agglomeration between the City of Halle and the City of Leipzig 1989



## Class Names

-  Sealed area
-  Unsealed area
-  Agriculturally used area including allotments
-  Woodland
-  Water
-  Open pit mining with various moisture levels
-  Clouds in the satellite image

## **The area of investigation is the conurbation between Leipzig (federal state Saxony) and Halle (federal state Saxony-Anhalt) in East Germany.**

### **Why is this an interesting area of investigation?**

it has been an agricultural region for a long time,  
this area has undergone competitive economic and ecological constraints.  
since the reunification took place in 1990 it underlies high dynamics with

respect to land-use development,  
it shows a strong growth of peri-urban settlements, and

it is regarded as a region formerly polluted by industrial plants and mining industries, and presently

as a region put pressure on by traffic, commercial sites, new settlements.

The configuration of its nature space potential presently shows a deficit in comparison to other

regions, and it offers relatively little recovery potential.

With respect to heterogeneity it has suffered from a high loss over centuries compared to the former grown culture landscape.

### **Why investigating the suburban space?**

The degree of urban influence increases in the suburban region compared to almost natural

and agricultural landscapes with the growth of overdevelopment.

With respect to the immensely expanding suburbanisation and settlement dispersion in German (and other European) urban-suburban regions the importance moves from the centre to the

suburbs of towns.

### **Specific administrative problem for planning authorities**

Halle belongs to Saxony-Anhalt and Leipzig is part of Saxony,  
so in-between this multipurposely used region the state's border cuts through the responsibilities of each particular planning authority.

Thus we have a lack of regional planning.

This is where analysed satellite data offer a very useful instrument

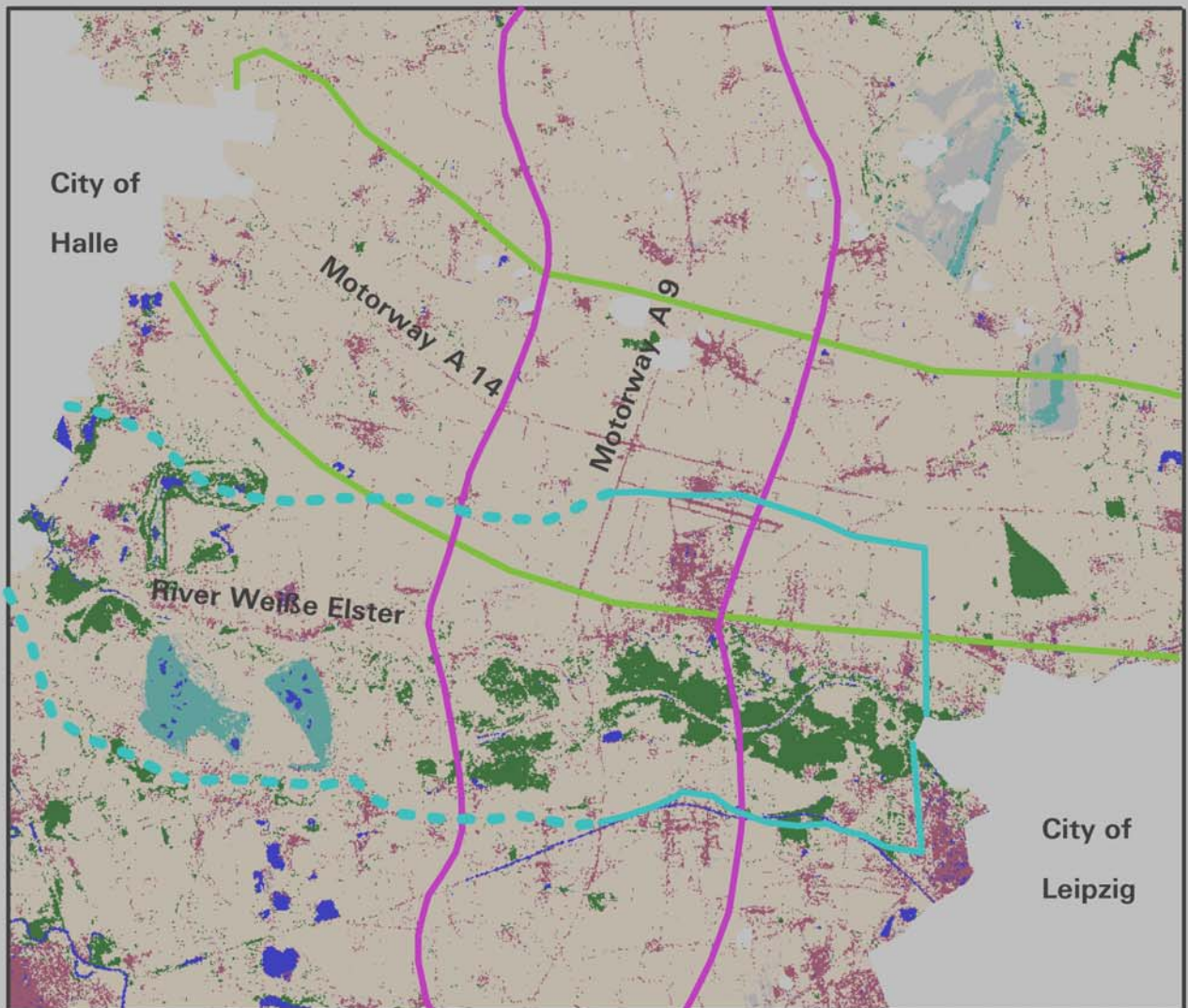
They can show both federal states the necessity of concerted actions in order to recognize the state in which this region is in and to be able to regulate the process.

Furthermore, this highly dynamic region with competitive land use types offers a splendid possibility to test the suitability of landscape structure indicators for landscape monitoring.












Monitoring by means of remote sensing data and methods plus GIS techniques

Date of Acquisition	Sensor	Approach
07.07. 1989	Landsat-TM 5	First approach Using buffer zones along development axes
13.09.1999	Landsat-TM 7	
08.08.1998	IRS – 1C / LISS III	Second and third approach (combined) Using a ring and sector model and testing landscape metrics
21.06.1998	Spot - XS	

# Land Use in the Agglomeration between the City of Halle und the City of Leipzig 1989



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|--|---|--|---------------|
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|  | Agriculturally used area including allotments                             |  | Woodland      |
|  | Water   |  |               |
|  | Open pit mining with various moisture levels                              |  |               |
|  | Clouds in the satellite image   |  |               |
|  | 3 km buffer zone north and south of the Motorway A 14                     |  |               |
|  | 3 km buffer zone east and west of the Motorway A 9                        |  |               |
|  | 3 km buffer zone north and south of the River Weiße Elster in Saxony only |  |               |
|  | 3 km buffer zone north and south of the River Weiße Elster                |  |               |

## **First approach**

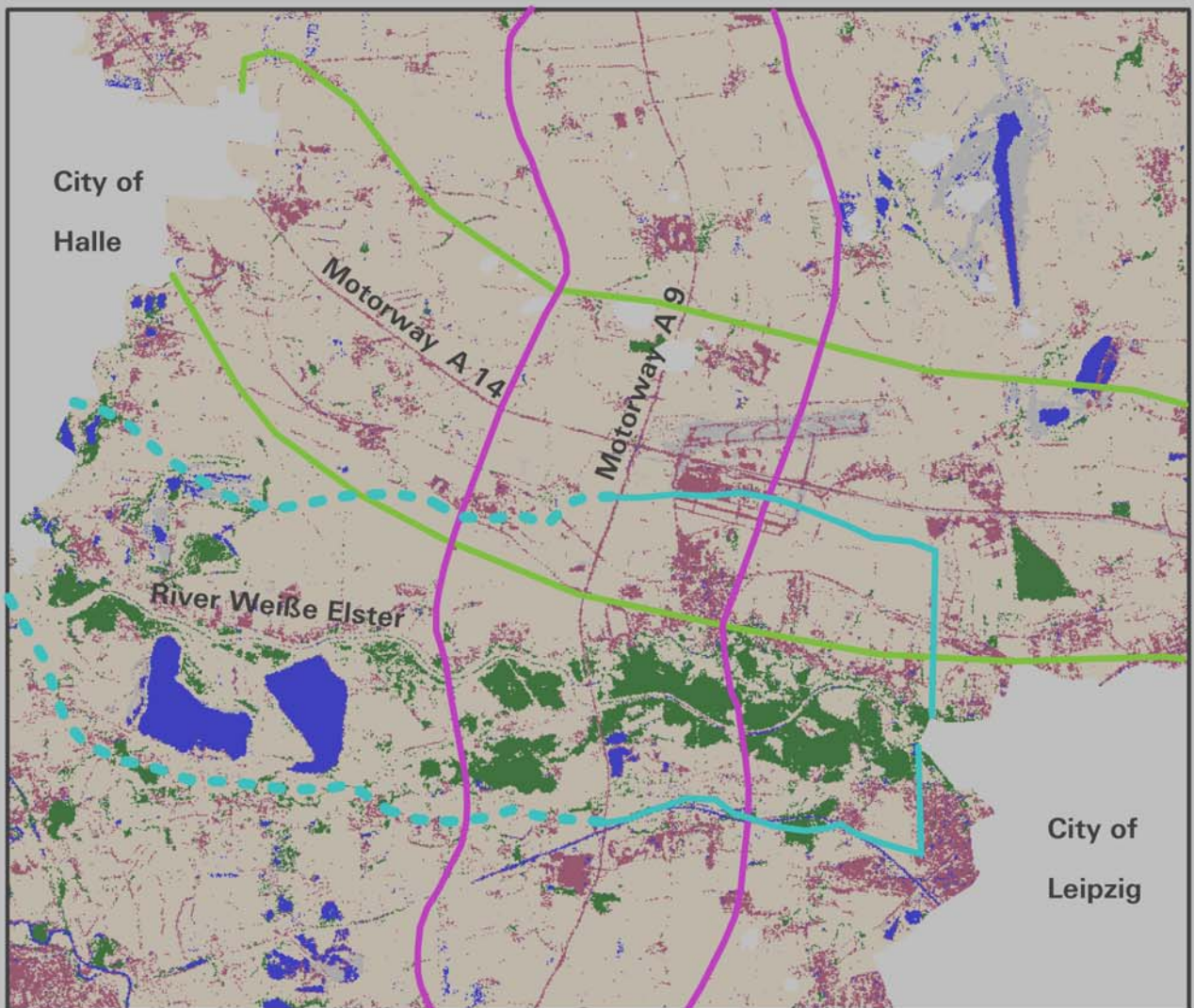
### **Remote sensing data and methods**

Both classifications, 1989 and 1999, are calculated using the maximum likelihood classifier with the non-parametric rule of the parallelepiped optimization put first. A hierarchical classification needs to be generated as different settlement densities and open pit mining are spectrally very similar, as well as fields without crops and unsealed ground (e.g. airport) are difficult to be separated.











### **GIS method**

3 km wide buffers each of them subdivided into 100 m distanced zones are created on both sides of important development axes, such as the motorways A 14 and A9, but also for the river Weiße Elster with its floodplain landscape as a recreational axis in-between the two conurbations.

# Land Use in the Agglomeration between the City of Halle und the City of Leipzig 1999



## Class Names

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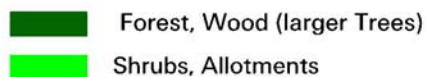
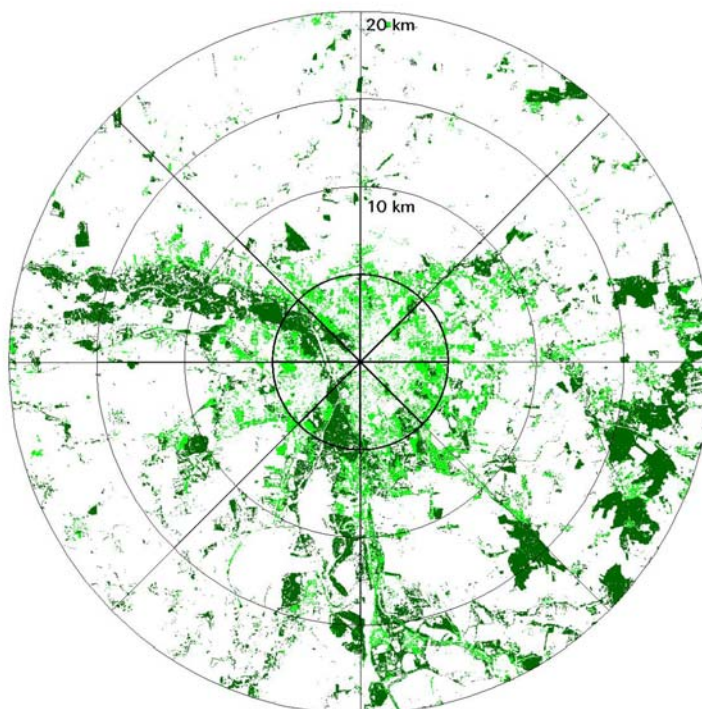
## **Results**

On both sides along the motorway A 14 sealed areas have almost tripled within the first 500 meters. Along the A 9 these areas have doubled in the same zones. Especially large areas have been sealed such as business parks, a new air strip for the airport, a new central market for Leipzig, and further commercial sites with direct access to the motorways.

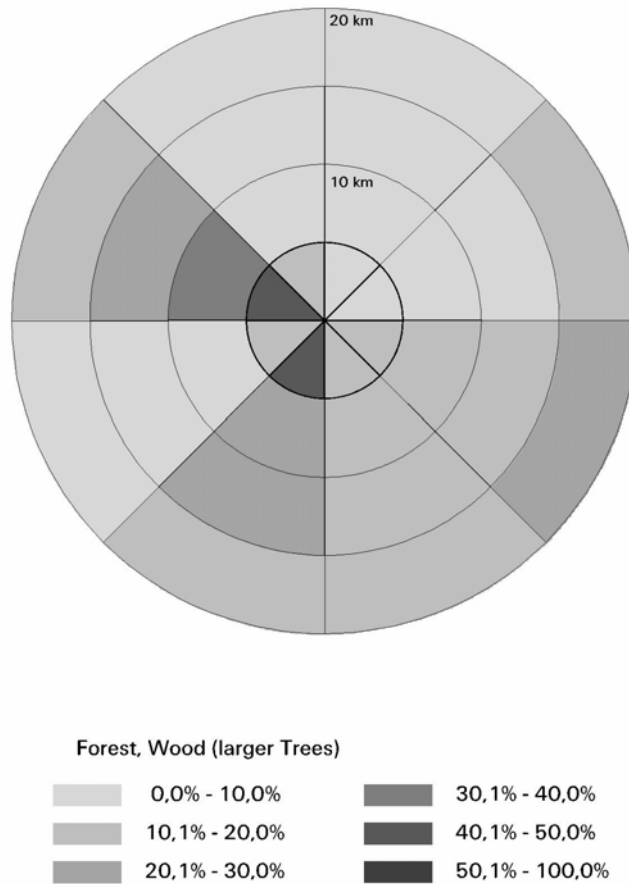
Further away from the motorways new districts play an important role. These are either new apartment or single family houses, or new built commercial sites including shopping centres.

The increase of sealed areas is at expense of agricultural land use in first place. Between buffer zones 300 m up to 500 m agriculture decreases by 20 % to 10 %.

# Multispectral Classification of Green Structures - IRS-1C Data 1998



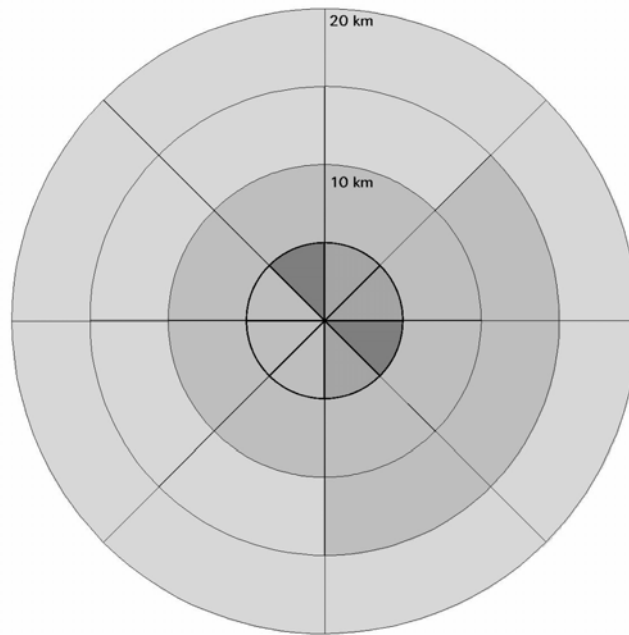
Relative Vegetation Cover (Forest, larger Trees) Calculated from IRS-1C Data



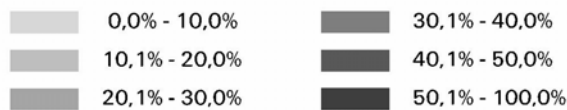
- emphasis on forest and large tree vegetation is in the northwest and south/southwest of the City of Leipzig (area of floodplain forest)
- the internal ring (5 km) is best equipped with large vegetation
- large deficits exist in the northern peri-urban area
- the eastern to southern environment has a higher stand of large vegetation

## Relative Vegetation Cover (Allotments, smaller Trees)

Calculated from IRS-1C Data

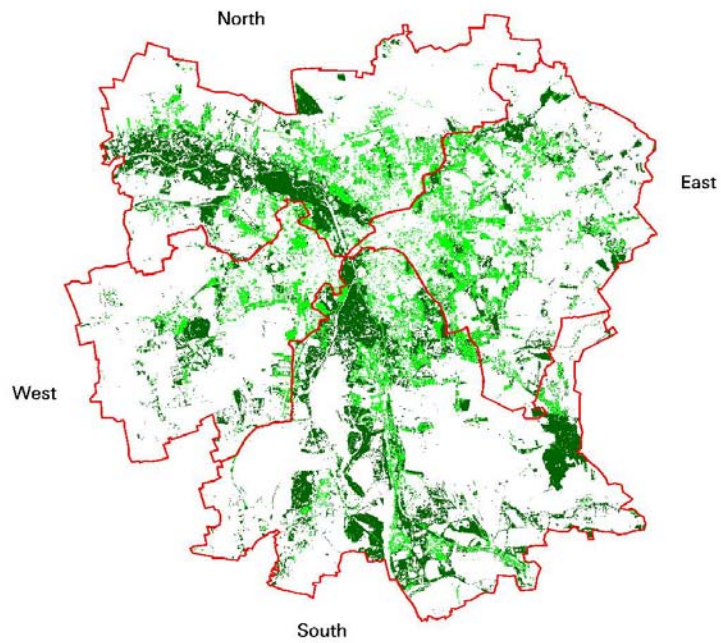




### Shrubs, Allotments



- the suburban landscape in total is poorly supplied with small trees and bushes
- these small trees and bushes are distributed relatively regular around the city
- an emphasis on small trees and bushes is detectable in the eastern surroundings
- towards the city centre the highest values appear

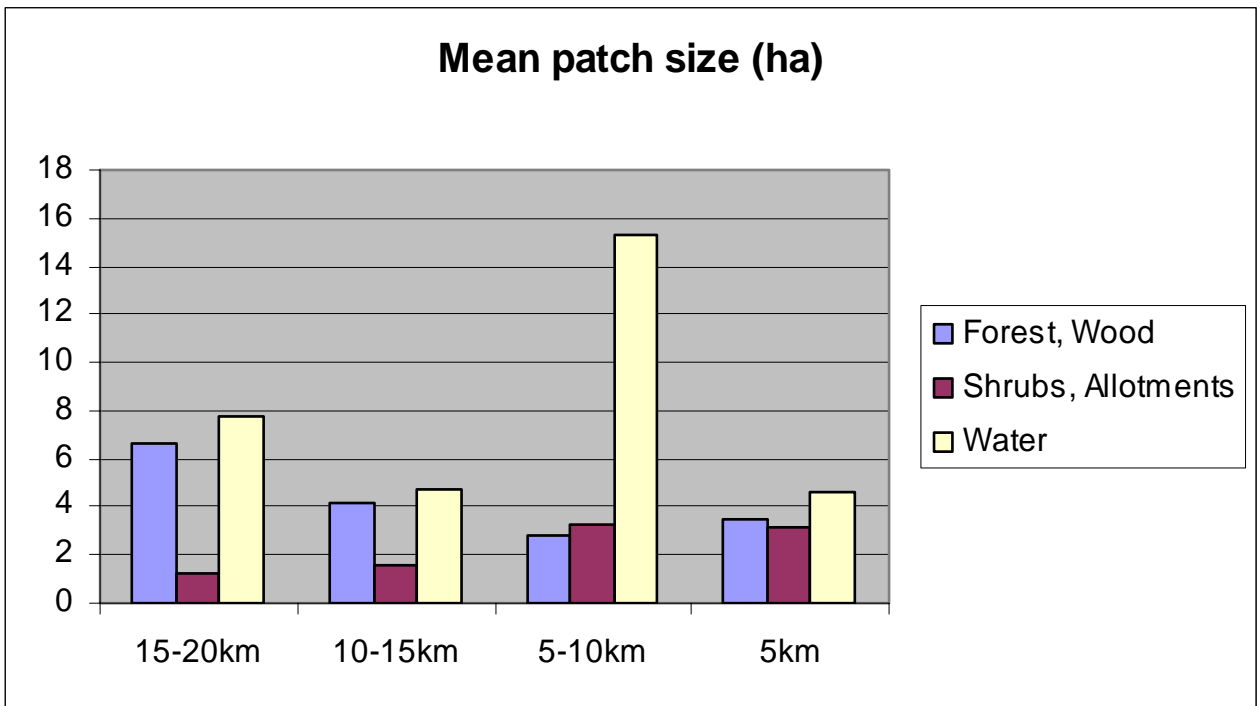
## 'Green Ring' Leipzig - Working Areas



-  Forest, Wood (larger Trees)
-  Shrubs, Allotments

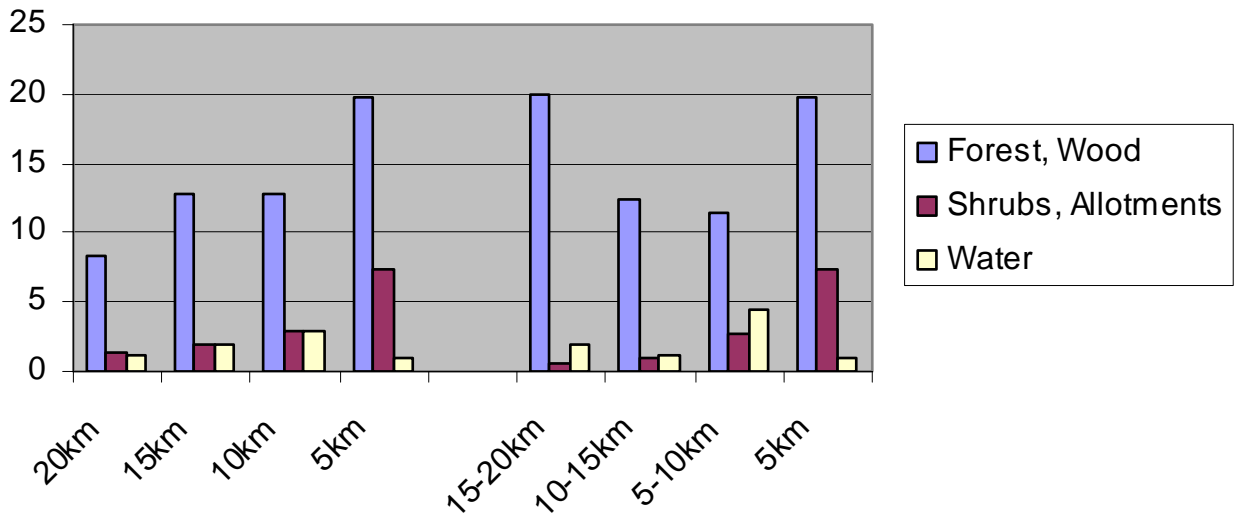
# Landscape Structure Metrics

- Landscape ecology
  - involves the study of landscape patterns, the interactions among patches within a landscape mosaic, and how these patterns and interactions change over time.
  - involves the application of these principles in the formulation and solving of real-world problems.
  - is founded on the notion that the pattern of landscape elements (patches) strongly influences ecological characteristics, including vertebrate populations.
- The ability to quantify landscape structure is prerequisite to the study of landscape function and change.
- For this reason, much emphasis has been placed on developing methods to quantify the landscape's structure.



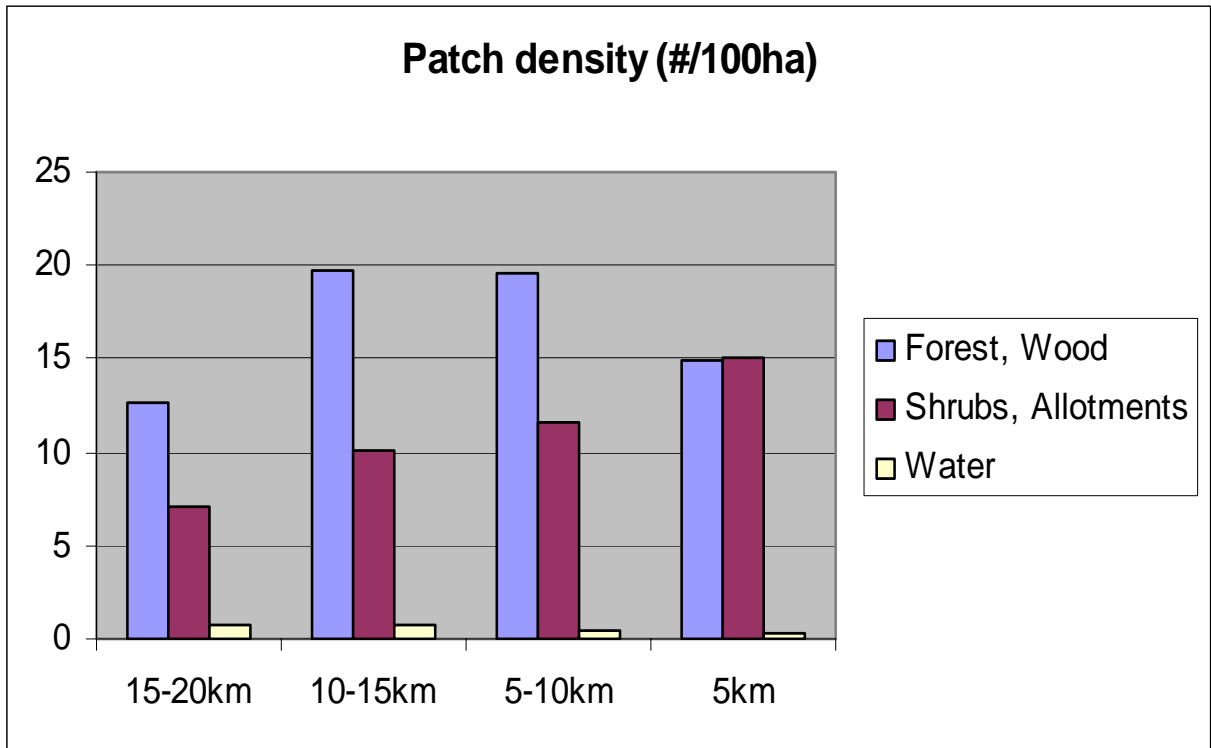
- MPS indicates the medium size of the patches and is a function of the total area of the landscape and the number of patches
- smaller values are a hint for a higher fragmented landscape

### Largest patch index (%)



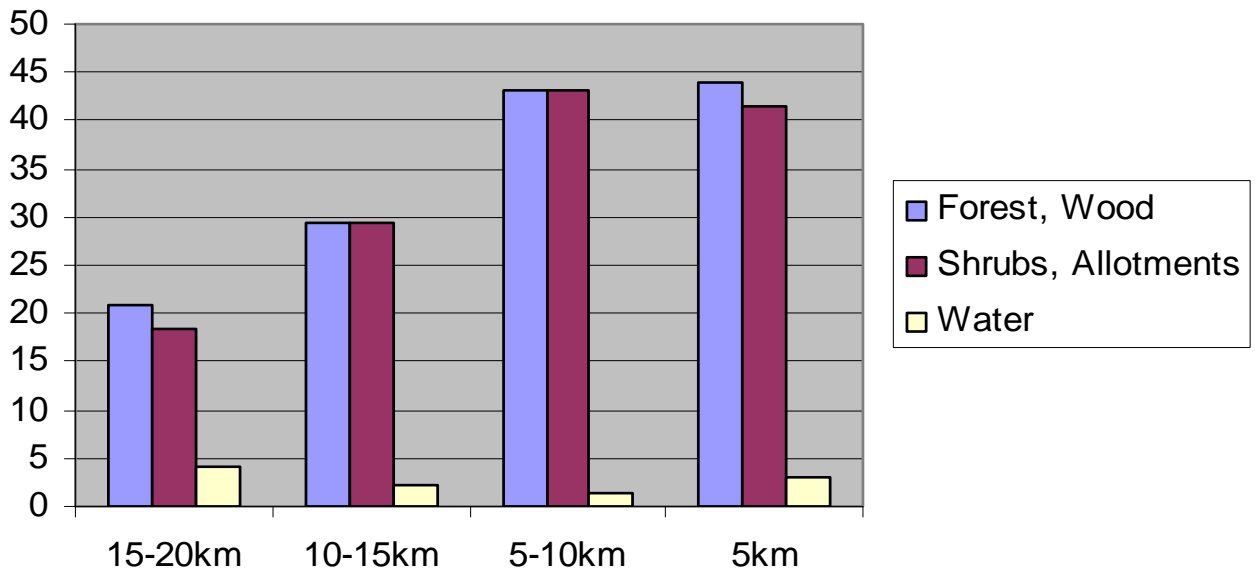
- LPI equals the percentage of the landscape comprised by the largest patch.
- LPI approaches 0 when the largest patch of the corresponding patch type is increasingly small. LPI = 100 when the entire landscape consists of a single patch of the corresponding patch type; that is, when the largest patch comprises 100% of the landscape.
- measure for the heterogeneity of the landscape





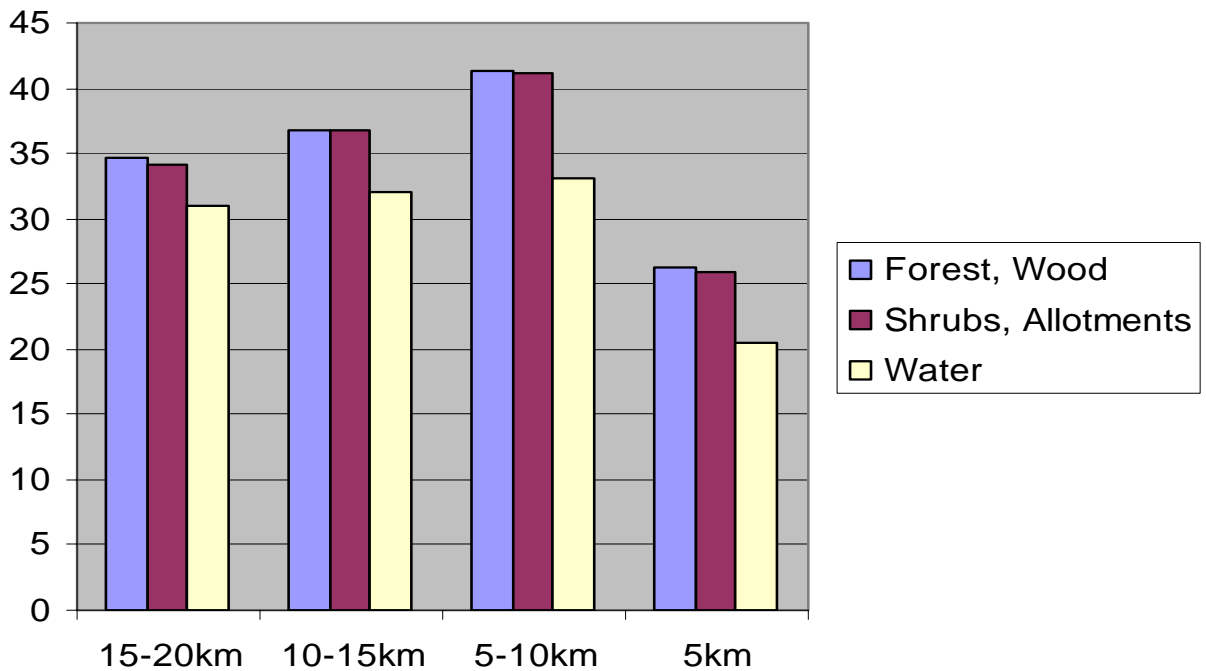
- PD equals the number of patches of the corresponding patch type (NP) divided by total landscape area, multiplied by 10,000 and 100 (to convert to 100 hectares).
- facilitates the comparison of landscapes with different sizes

## Edge density (m/ha) of selected features



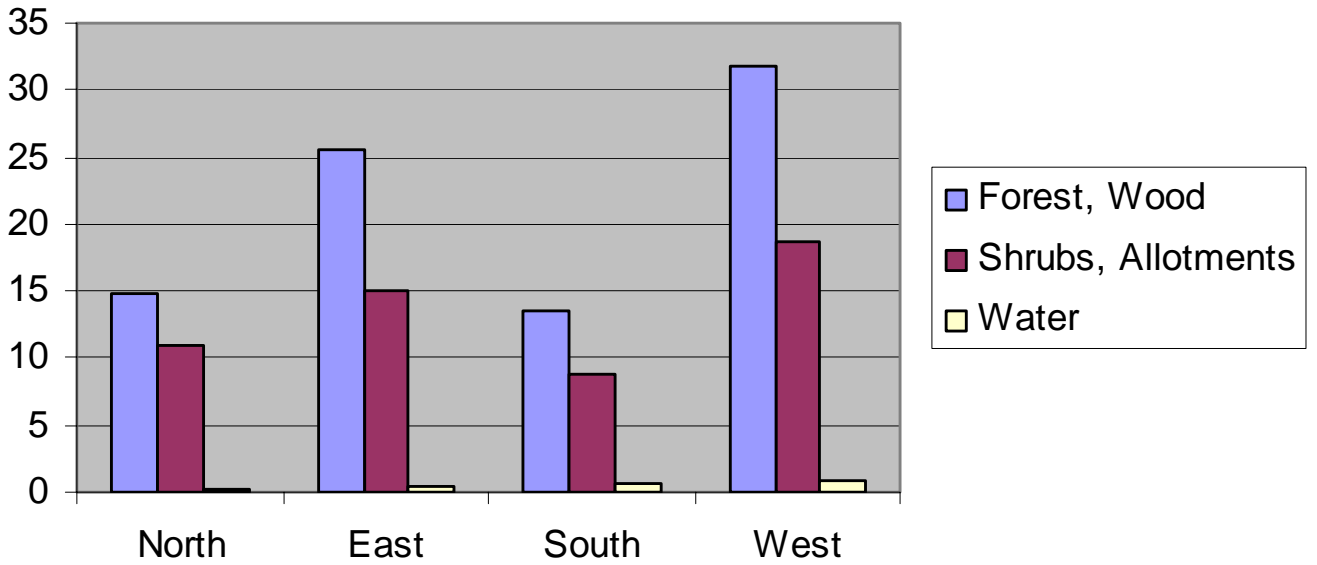
- ED equals the sum of the lengths of all edge segments involving the corresponding patch type, divided by the total landscape area, converted to hectares.
- strong increase of the edge lengths from the peri-urban area to the city centre

## Landscape shape index calculated using TE

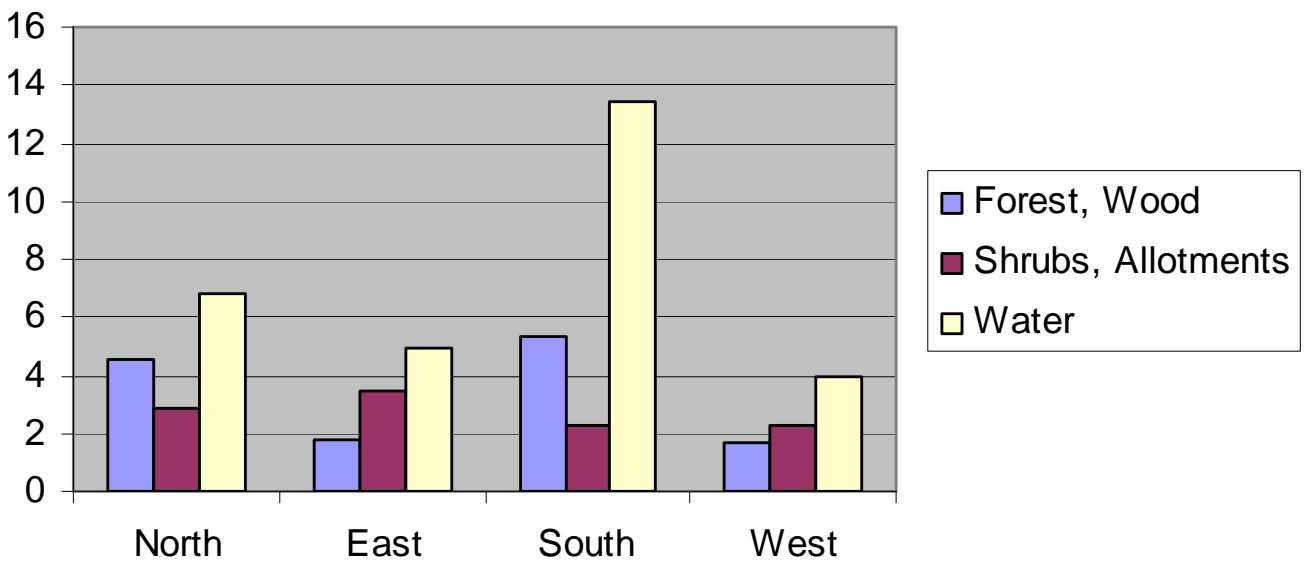


- $LSI = 1$  when the landscape consists of a single patch of the corresponding type and is circular (vector) or square (raster);
- LSI increases without limit as landscape shape becomes more irregular and/or as the length of an edge increases within the landscape of the corresponding patch type.
- highest values are in the city fringe

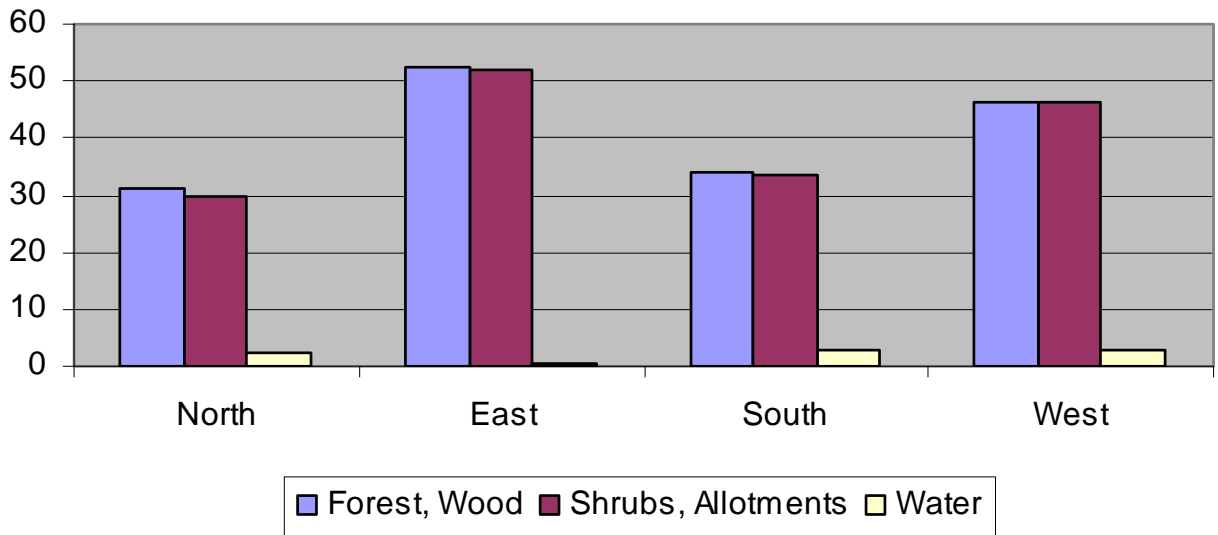
**Patch density (#/100ha)**



**Mean patch size (ha)**



### Edge density (m/ha)



### Mean nearest-neighbor distance(m)

