Landscape Metrics

Landscape metrics can quantify landscape composition or configuration and can be applied on three levels:

- *patch-level*: these metrics describe spatial properties of individual patches and their context;
- *class-level*: metrics describing properties of all patches belonging to the same category;
- *landscape-level*: metrics describing spatial properties of the pattern in the whole studied area.

Some metrics can be applied on different levels and refer to the whole study, which defines the landscape. Typical landscape metrics to describe the composition, are:

Haines-Young and Chopping (1996) proposed the following grouping of landscape metrics:

Areal indices: describe the proportion of different patches of landscape types, as well as the shape characteristics and core-edge ratio.
Linear indices: describe the borders, shapes and network properties of linear structures at a landscape level, such as connectivity.
Topological indices: describe spatial relations between landscape elements and spatial units regardless size and shape. They express spatial distribution and association, isolation, heterogeneity and diversity.

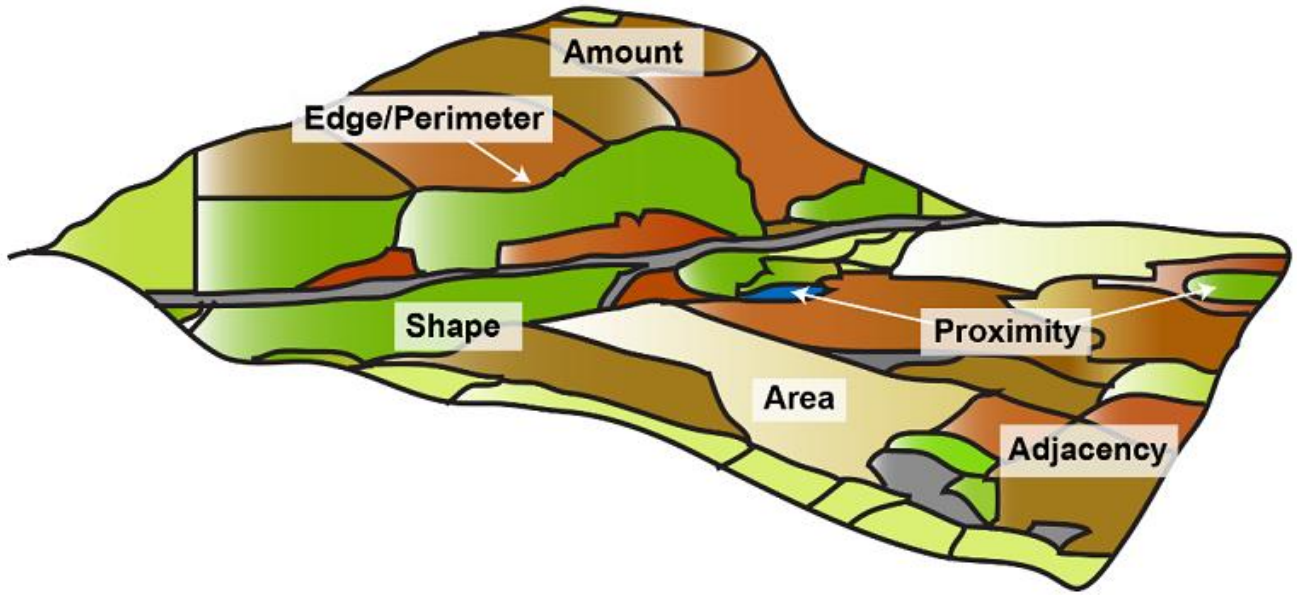


Table 1 List of the 10 landscape metrics evaluated in this study.

Metric	Variable	Category	Measure
Area	Area	Area/Density/Edge	Landscape Composition
Number of Patches	NP		Fragmentation
Largest Patch Index	LPI		Dominance
Landscape Shape Index	LSI		Aggregation
Normalized LSI	NLSI		Aggregation
Total Core Area	TCA	Core Area	Landscape Composition
Number of Disjunct Core Areas	NDCA		Spatial Contiguity
Percentage of Like Adjacencies	PLADJ	Contagion/Interspersion	Aggregation
Interspersion & Juxtaposition Index	IJI		Intermixing of classes
Clumpiness	CLUMP		Adjacency
Landscape Division	DIV		Diversity
Splitting Index	SPLIT		Fragmentation
Effective Mesh Size	MESH		Homogeneity
Perimeter-Area Fractal Dimension	PAFRAC	Shape	Shape Complexity
Patch Cohesion Index	COHE	Connectivity	Connectedness

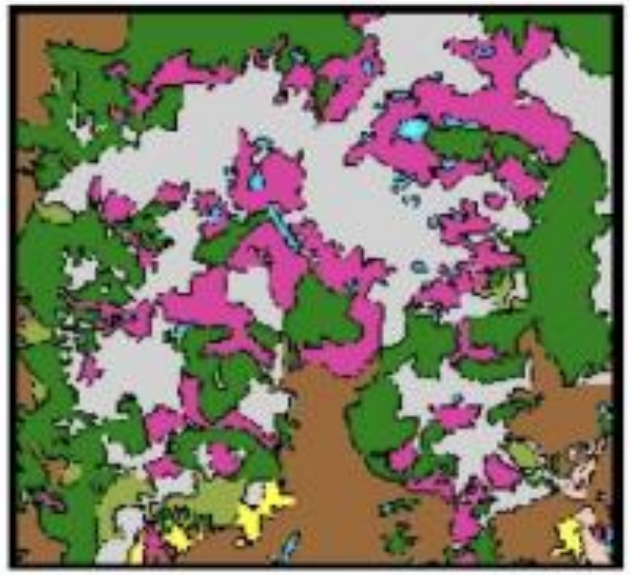
Table 8.5 Seven highly universal and consistent class-level landscape structure components across many different cover classes in 531 landscapes across three very different and disjointed regions of North America (after Cushman et al. 2008)

Component name	Description
Edge contrast	Degree of "contrast" between the focal class and its neighbourhood, where contrast is user-defined and represents the magnitude of difference between classes for one or more attributes.
Patch shape complexity	Shape complexity of patches of the focal class, where shape is defined by perimeter–area relationships.
Aggregation	Degree of aggregation of cells of the focal class, where large, compact clusters of cells of the focal class are considered aggregated.
Nearest neighbour distance	Proximity of patches of the focal class, based on the average or area–weighted average distance between the nearest neighbours.
Patch dispersion	Spatial dispersion of patches across the landscape, reflecting whether patches of the focal class tend to be uniformly distributed or dispersed (clumped) based on the variability in the nearest neighbour distances.
Large patch dominance	The degree of concentration of the focal class area in few, large patches with large core areas.
Neighbourhood similarity	Degree of isolation of patches from nearby patches of the same or similar class (i.e., the degree of similarity of the neighbourhood surrounding patches of the focal class in terms of patch composition).

Table 8.6 Seven universal landscape structure components derived from 531 landscapes across three very different and disjunctive regions of North America (after Cushman et al. 2008)

Component name	Description
Contagion/diversity	Degree of aggregation of patch types (or the overall clumpiness of the landscape) and the diversity/evenness of patch types. Contagion and diversity are inversely related; clumped landscapes containing large, compact patches and an uneven distribution of area among patch types have high contagion and low diversity.
Large patch dominance	Degree of landscape dominance by large patches.
Interspersion/ juxtaposition	Degree of intermixing of patch types.
Edge contrast	Degree of "contrast" among patches, where contrast is user-defined and represents the magnitude of difference between classes for one or more attributes.
Patch shape variability	Variability in the patch shape complexity, where the shape is defined by perimeter–area relationships.
Proximity	Degree of isolation of patches from nearby patches of the same class.
Nearest neighbour distance	The proximity of patches to neighbours of the same class, based on the area–weighted average distance between nearest neighbours.

Levels of Heterogeneity

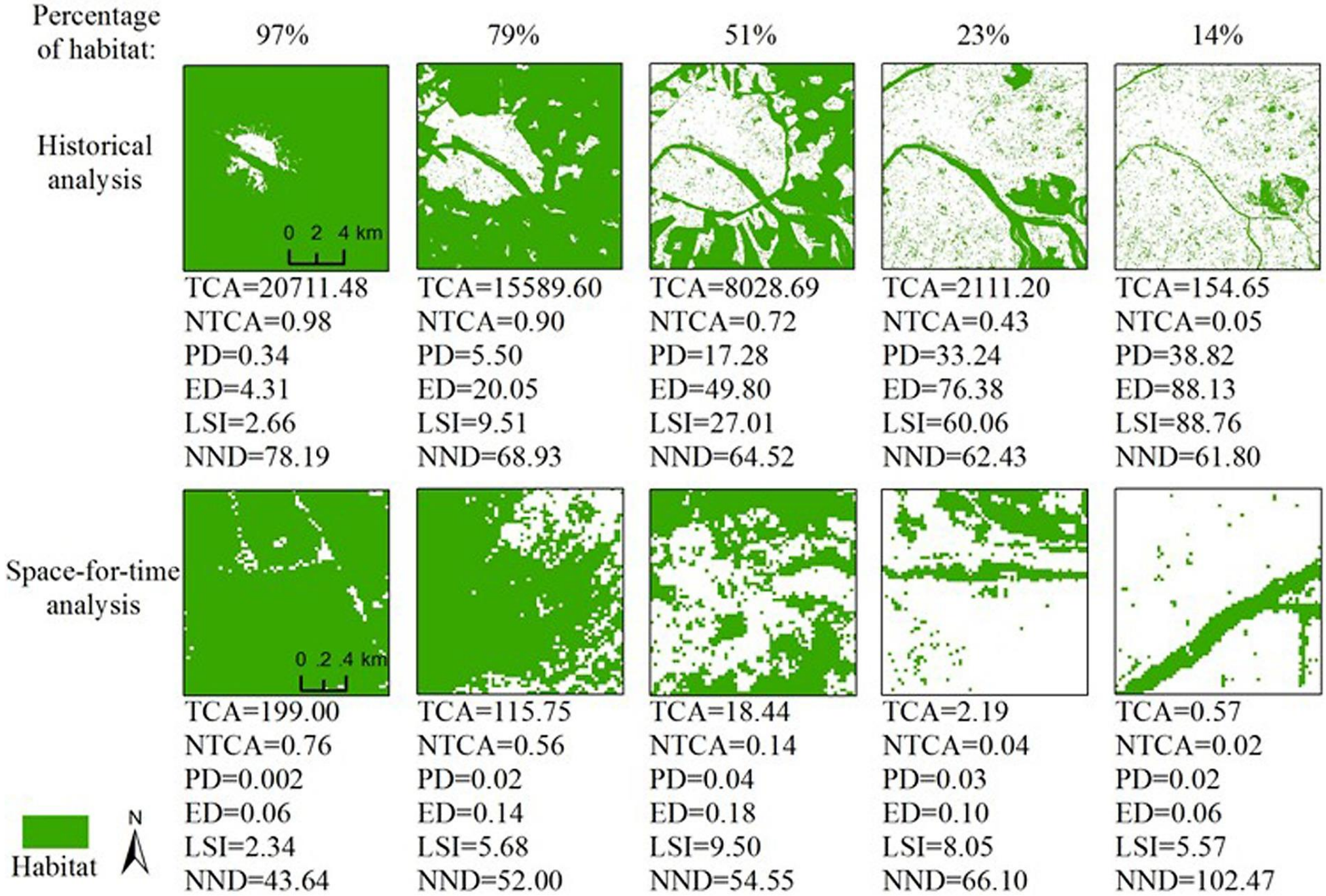


- **Cell-level...metrics defined for individual cells (irregardless of patch affiliation).**

- **Patch-level...metrics defined for individual patches.**

- **Class-level...metrics integrated over all the patches of a given type (class).**

- **Landscape-level...metrics integrated over all patch types or classes over the extent of the data.**


Percentage of habitat:
97%
79%
51%
23%
14%
Historical analysis
0 2 4 km
TCA=20711.48
NTCA=0.98
PD=0.34
ED=4.31
LSI=2.66
NND=78.19
TCA=15589.60
NTCA=0.90
PD=5.50
ED=20.05
LSI=9.51
NND=68.93
TCA=8028.69
NTCA=0.72
PD=17.28
ED=49.80
LSI=27.01
NND=64.52
TCA=2111.20
NTCA=0.43
PD=33.24
ED=76.38
LSI=60.06
NND=62.43
TCA=154.65
NTCA=0.05
PD=38.82
ED=88.13
LSI=88.76
NND=61.80
Space-for-time analysis
0 .2 .4 km
TCA=199.00
NTCA=0.76
PD=0.002
ED=0.06
LSI=2.34
NND=43.64
TCA=115.75
NTCA=0.56
PD=0.02
ED=0.14
LSI=5.68
NND=52.00
TCA=18.44
NTCA=0.14
PD=0.04
ED=0.18
LSI=9.50
NND=54.55
TCA=2.19
NTCA=0.04
PD=0.03
ED=0.10
LSI=8.05
NND=66.10
TCA=0.57
NTCA=0.02
PD=0.02
ED=0.06
LSI=5.57
NND=102.47
Habitat
N

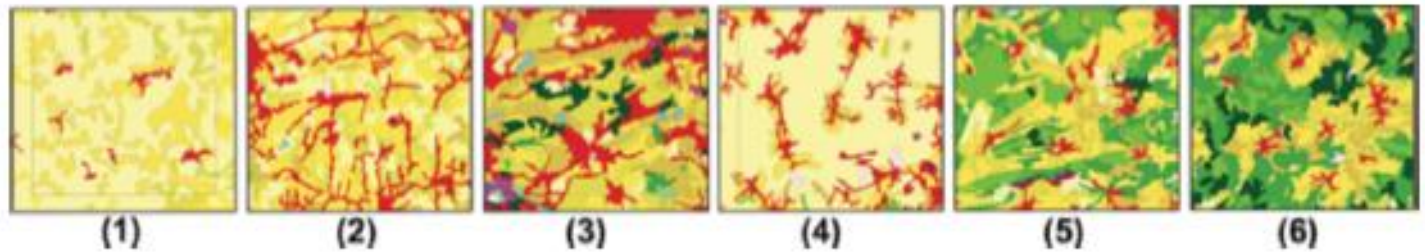
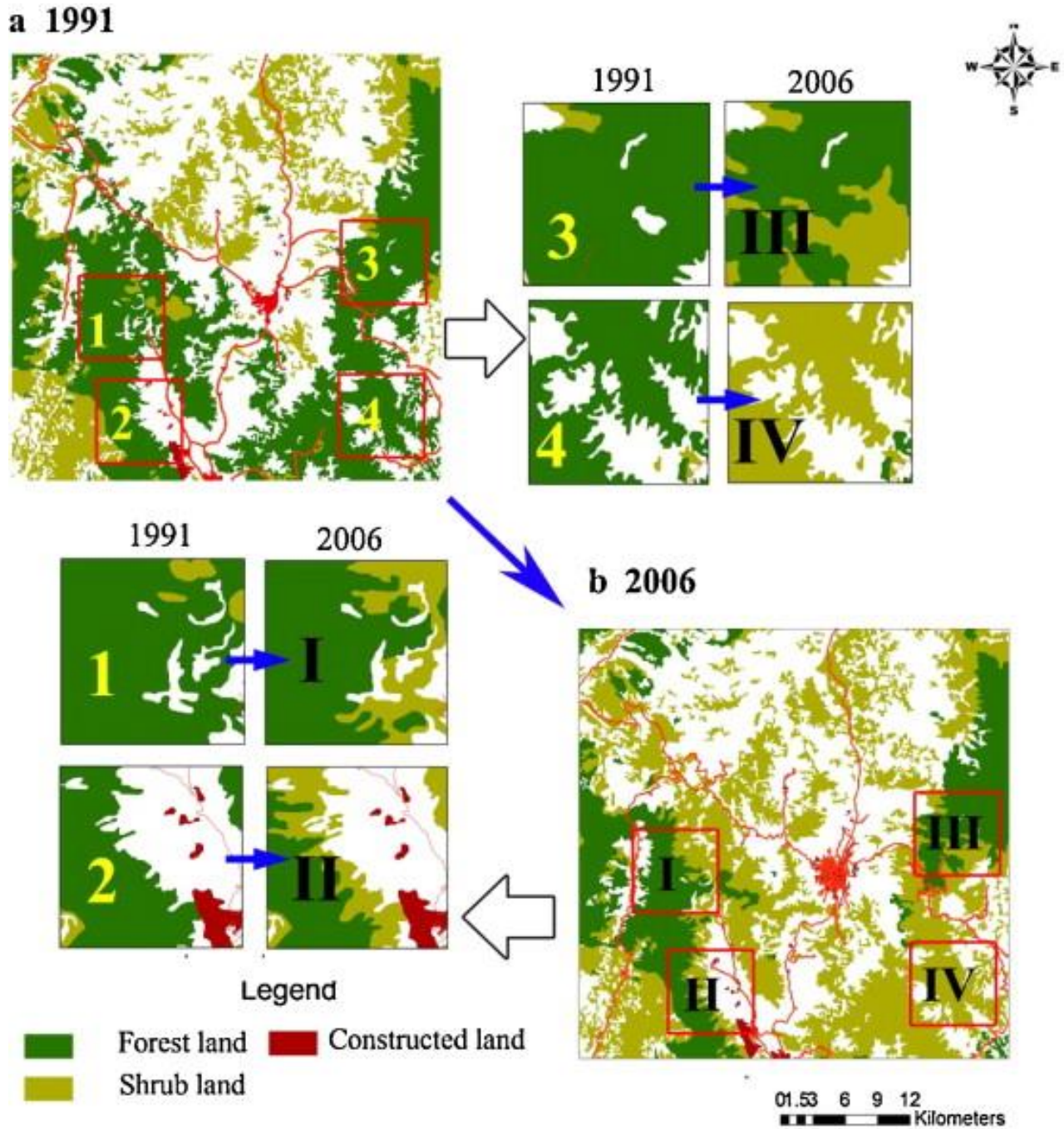


Fig. 8.27 CORINE Land Cover samples of six landscapes in Belgium (after Antrop 2007)

Region:	1 Westhoek	2 Straatdorpen	3 Kempen	4 Haspengouw	5 Famenne	6 Ardennen
%Build-up	<1	87	49	9	8	2
%Agriculture	100	14	45	91	47	18
%Forest	0	0	4	0	44	80
%Other	0	0	<1	0	0	0
%Water	0	<1	1	0	0	00
PR	4	8	13	8	10	11
NP	60	169	124	73	152	190
MPS	4361	393	185	5326	109	139
ED	37	68	71	29	79	67
MSI	4.45	2.76	2.25	3.75	2.20	2.18
MPFD	1.31	1.30	1.29	1.31	1.30	1.29
SDI	0.23	0.68	1.52	0.55	1.77	1.75
SEI	0.13	0.33	0.59	0.26	0.77	0.73

The terminology of Fragstats is used: *PR* Patch Richness, *NP* number of patches, *MPS* Mean Patch Size in m^2, *ED* Edge Density in m/m^2, *MSI* Mean Shape Index (circle = 1, increases with elongation of shape), *MPFD* Mean Patch Fractal Dimension (between 1 = simple, straight borders and two very distorted borders, *SDI* Shannon Diversity Index (increases with number of categories and patches), *SEI* Shannon Evenness Index (as SDI, but varying between 0 = homogeneous and 1 = very heterogeneous) (see Fig. 8.27)


a 1991
1991
2006
1
2
3
4
III
IV
b 2006
I
II
III
IV
Legend
Forest land
Constructed land
Shrub land
01.53 6 9 12
Kilometers