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**APPLICATION OF STATE REFERENTIAL DATA AND CORINE
LAND COVER DATABASE TO ESTIMATION OF LANDSCAPE
STRUCTURE VARIETY IN SELECTED PROTECTED AREAS
IN KUJAWSKO-POMORSKIE VOIVODESHIP**

key words: landscape indices, CORINE Land Cover, SDI, protection areas, referential data

INTRODUCTION

Existing resources of digital spatial data (state referential data) should be applied in studies over geographical space at any level of specificity. Landscape structure and its variability in the space can be analysed in a few ways applying various research methods and tools. Geographic Information Systems (GIS) are the basic research techniques applied in a landscape ecology. These modern systems make possible to estimate a landscape structure with the help of several ecological measures and indices worked out on the basis of various information sources. This technology makes possible fast and recurrent creation of thematic maps, calculation of some indices, comparison analysis, and forecasting changes in the future. Landscape ecology has been applying geoinformation tools and procedures together with standard methods used for many years with success.

Present image of spatial landscape pattern is a result of all the activities and processes which took place in the analysed area in the past. Almost every activity of man concerning space has its result in landscape mosaic created by various forms of land cover and land use.

The aim of the study was the analysis and comparison of land cover diversity of landscape parks in Kujawsko-Pomorskie Voivodeship on the basis of reference spatial data.

STUDY AREA

Studies have been done in the area of landscape parks situated in Kujawsko-Pomorskie Voivodeship (fig. 1). Landscape parks are protected territories because of their natural, historical, and cultural values. They are created to preserve, popularize and disseminate these values in the conditions of sustainable development (Walczak et al., 2001). In the areas founded as landscape parks economical activities take place which are slightly limited and under some strictness. These territories are the basic element of a large-space nature preservation system.



Fig. 1. Localization of landscape parks in Kujawsko-Pomorskie Voivodeship (explaining in the text).
Source: author's compilation.

120 landscape parks were created in Poland till the end of December 2005. Their total area is 2 482 211 ha (about 8% of Polish territory). Within this total number 8 landscape parks were founded in Kujawsko-Pomorskie Voivodeship (over 209 200 ha which is 15% of the Voivodeship area). The following landscape parks were created in Kujawsko-Pomorskie Voivodeship (fig. 1):

- a) **Brodnicki Landscape Park (BLP)** – created in 1985, in the centre of the Brodnica Lakeland; the area of the park is 13 674 ha, 9 338 ha is in Kujawsko-Pomorskie Voivodeship; forests (60%) and water (12%) dominate in the structure of the land-cover,
- b) **Gostyniński-Włocławski Landscape Park (GWLP)** – created in 1979 in the area of the Płock Basin; the area of the park is 38 950 ha, 22 200 ha is in Kujawsko-Pomorskie Voivodeship; forests (60%) dominate in the structure of the land cover,
- c) **Gorzniensko-Lidzbarski Landscape Park (GLLP)** – created in 1990 in the eastern part of the Chełmno-Dobrzyń Lakeland; the area of the park is 27 764 ha, 13 902 ha is in Kujawsko-Pomorskie Voivodeship; forests (70%) dominate in the structure of the land cover,
- d) **Krajenski Landscape Park (KLP)** – created in 1998 in the central part of the Krajen Lakeland; the area of the park is 54 395 ha, woodiness in the area is 30%,
- e) **Nadgoplański Millennium Park (NMP)** – created in 1992 in the area of the Wielkopolska Lakeland; the area of the park is 8 898 ha, water covers 24% of the territory of the park,
- f) **Tucholski Landscape Park (TLP)** – created in 1985 in the Pomorze Lakeland in the central part of the Tuchola Forest: the area of the park is 36 983 ha, forests (86%) dominate in the structure of the land cover,
- g) **Wdecki Landscape Park (WPK)** – created in 1993 in the central-eastern part of the Tuchola Forest; the area of the park is 19 177 ha, forests (70%) dominate in the structure of the land cover,
- h) **Chełmiński and Nadwislanski Complex of Landscape Parks (CNCLP)** – created in 2003 (after the connection of two landscape parks) in the Lower Vistula Valley and the Chełmno-Dobrzyń Lakeland.

MATERIALS AND METHODS

Spatial data which are national reference data for the study area – General Geographic Database (GGD) and CORINE Land Cover (CLC) Database were applied to realise the aim of the study. The applied data are the part of Spatial Data Infrastructure (SDI).

Within the NGIS project for the whole state, according to the same standards, rules and instructions, General Geographic Database is created which informational

range consists of 8 thematic groups. This is done using 3 scales: 1:250 000, 1:500 000 and 1:1 000 000. According to the scale of elaboration some thematic groups have various thematic layers: from 23 for the scale 1:250 000 to 16 for the scale 1:1 000 000. In each scale of the presence of GGD there was the land cover layer worked out, and it illustrates the spatial structure of this element. This base makes possible to distinguish 19 classes of land cover in the biggest scale and 5 classes of land cover in the smallest one. The main source of information applied during the creation of this basis was Vector Map Level 2 (VMAP L2) made by The Board of Military Geographic General Headquarters of Polish Armed Forces or other state registers (e.g. The State Registry of Boundaries, The State Registry of Roads).

CORINE Land Cover is the second database which consists of information about the land cover in the whole state. The map of the land cover for the state was created for 2000 on the basis of Landsat satellite data. CLC is hierarchically organized on three levels, which differ in their scales and numbers of categories of land cover. The third level (state level) covers 44 forms of land cover, within them 31 exist in the area of Poland. There are main 5 categories of land cover in the first level (European level). Source spatial data described and used on the paper, mutually supplement and cover one another.

The structure of landscape in landscape parks was analyzed with the use of landscape indices. The following indices of size, edges, shapes, and diversity describing the structure of landscape were calculated and compared:

- a number of cover classes (**NOCP**), which shows a number of distinguished classes of land cover,
- a number of patches (**NUMP**), which shows a number of distinguished patches of land cover,
- total length of the edge (**TE**), summing up the length of edges between all patches of each category,
- shape index (**MSI**), showing the shape of patches; the higher the value of this index the less regular are landscape patches,
- fractal dimension (**FD**), applied for description of roughness of landscape patches, and it is the index of structure complexity,
- Shannon diversity index (**SDI**), shows the share of separate categories in the structure of the study area.

All indices were calculated on the basis of General Geographic Database and CORINE Land Cover database. Comparisons of indices among parks were done in relation to various scales of source materials (from 1:250 000 to 1:1 000 000).

RESULTS

Maps of land cover were worked out on the basis of referential data (fig. 2). Measures of landscape structure were calculated for each landscape parks in Kujawsko-Pomorskie Voivodeship (tab. 1).

The analysis of spatial structure of the landscape showed that the most substantial diversity is characteristic for: Chełmiński Landscape Park, Nadwislanski Complex of Landscape Parks, Krajenski Landscape Park and Gorznieńsko-Lidzbarski Landscape Park. The smallest diversity is connected with Nadgoplański Millennium Park.

Landscape parks with smaller share of forests in the structure of land cover (>30%) have characteristic bigger number of patches of land cover calculated on the basis of CORINE Land Cover data as well as General Geographic Database. The exception is only the smallest in the area Nadgoplański Millennium Park, where the smallest number of patches was distinguished.

From 9 to 14 classes of land cover were distinguished in the area of landscape parks. The biggest number of types of land cover is characteristic for Chełmiński and Nadwislanski Complex of Landscape Parks and Krajenski Landscape Park. This index is correlated with diversity. The number of classes of land cover was distinguished on the basis of General Geographic Database in the 1:250 000 scale is identical to the number of categories in CORINE Land Cover. Three parks (TLP, KLP and GWLP), where in CLC distinguished 2 more categories are the exception.

The smallest in the area landscape park (TLP) has characteristic the biggest shape index. It shows its substantial irregularity of distinguished patches of land cover.

No substantial correlation among number of distinguished categories of land cover, the fractal dimension, and the total length of borders of patches was defined.

Comparing landscape indices for landscape parks calculated on the basis of analysis of various referential data (fig. 3) it should be noticed that in the range of the most precise scales (CLC and BDO) there is clear similarity in the gained results. It is about all indices. However, in case of SDI and NUMP, it is the most evident. When the scale of referential data decreases, considerable differences in the landscape structure between the analysed areas disappear.

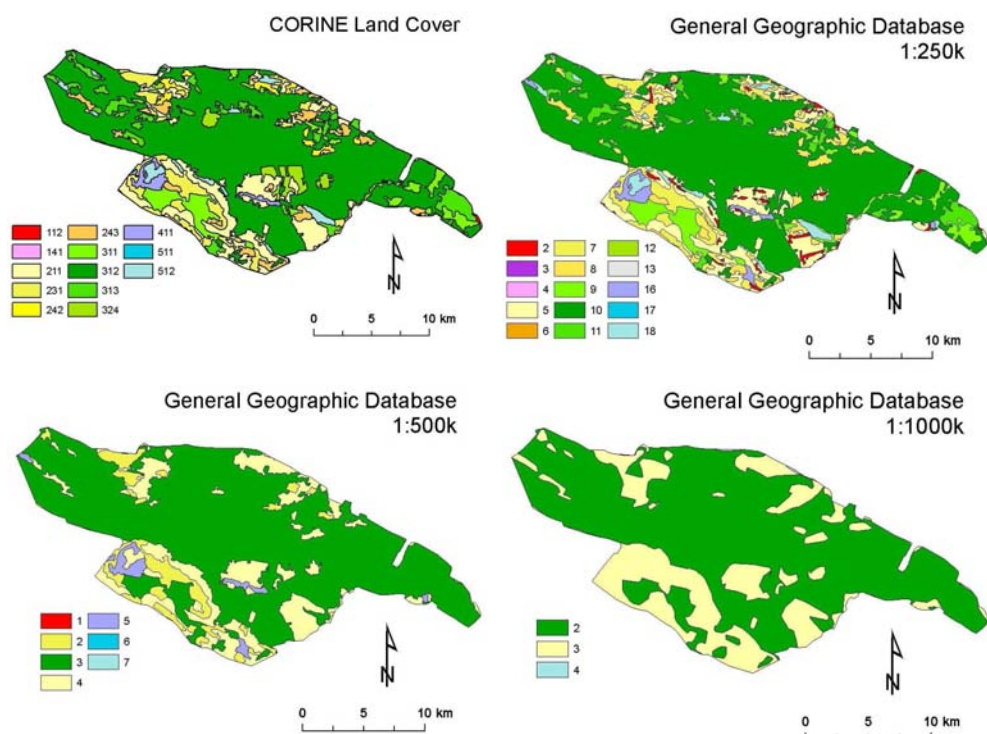


Fig. 2. Land cover of the Gostynisko-Wloclawski Landscape Park (GWLP) according to different data sources. Explanation of land cover categories: CLC – according to European standards; GGD250k - 2-buildings, 3-industry areas, 4-city vegetation, 5-arable fields, 6-orchards, 7-meadows, pastures, 8-other arable fields, 9-deciduous forests, 10-coniferous forests, 11-mixed forests, 12 other vegetation, 13-sands, dunes, 16-swamps, peat-bogs, 17-rivers, 18-waterlands; GGD500k – 1-buildings, 2-meadows, pastures, 3-forests, 4-others, 5-swamps, peat-bogs, 6-rivers, 7-waterlands; GGD1000k – 2-forests, 3-others, 4-waterlands.

Source: author's compilation.

CONCLUSIONS

Analysis of measures of spatial pattern of the landscape worked out on the basis of land cover from database (General Geographic Database and CORINE Land Cover) shows differences in landscape structure. The reason for these differences are specific landscape values of parks (e.g. forests, lakes). The results differentiate landscape parks in an identical way irrespectively of source materials and the scale of data. CLC class seems to be fuller taking into consideration the richness of separated classes. Taking into consideration detailed elements GGD is more precise.

Tab.1. Chosen landscape indices for landscape parks in Kujawsko-Pomorskie Voivodeship in relation to various referential data.

Landscape Park	Source of data	Spatial landscape indices					
		NUC P	NUM P	TE	MSI	FD	SDI
BLP	CLC 2000	9	76	5528.1	2.41	1.28	0.63
	GGD 250k	9	118	6217.4	2.19	1.29	0.65
	GGD 500k	5	38	11051.4	2.77	1.27	0.30
	GGD 1000k	3	16	35135.0	4.64	1.26	0.08
GWLP	CLC 2000	13	164	19111.1	2.54	1.28	0.98
	GGD 250k	11	266	11587.2	2.03	1.29	0.73
	GGD 500k	5	70	32916.6	2.65	1.27	0.17
	GGD 1000k	3	26	91515.4	4.49	1.24	0.05
GLLP	CLC 2000	11	126	4190.6	2.44	1.29	1.12
	GGD 250k	11	156	4408.8	2.30	1.29	1.16
	GGD 500k	6	50	11727.9	2.93	1.28	0.36
	GGD 1000k	2	19	34963.9	3.93	1.24	0.06
KLP	CLC 2000	13	298	6273.9	2.03	1.27	1.29
	GGD 250k	11	422	6714.2	1.87	1.28	1.29
	GGD 500k	6	157	4500.3	1.87	1.26	0.94
	GGD 1000k	3	67	91526.8	2.64	1.24	0.05
NMP	CLC 2000	10	41	12708.1	2.84	1.28	0.15
	GGD 250k	10	89	9919.2	2.32	1.30	0.27
	GGD 500k	6	29	31871.6	3.93	1.29	0.06
	GGD 1000k	3	10	90831.3	9.17	1.30	0.01
TLP	CLC 2000	12	102	7749.9	2.41	1.29	0.77
	GGD 250k	10	160	6179.5	2.12	1.29	0.98
	GGD 500k	6	80	14289.5	2.52	1.28	0.44
	GGD 1000k	3	40	102247.3	4.45	1.25	0.32
WPK	CLC 2000	10	75	6805.1	2.62	1.29	0.54
	GGD 250k	10	106	4919.1	2.26	1.30	0.70
	GGD 500k	5	40	13683.8	3.09	1.28	0.33
	GGD 1000k	3	28	10986.4	2.92	1.25	0.31
CNCLP	CLC 2000	14	318	20314.5	2.59	1.29	1.50
	GGD 250k	14	509	15402.3	2.22	1.30	1.36
	GGD 500k	6	101	30115.0	3.16	1.28	0.88
	GGD 1000k	4	45	49826.9	4.08	1.27	0.59

Source: author's compilation.

In the above Table, marking of landscape parks and landscape measures according to marks presented in parts – study area and materials and methods.

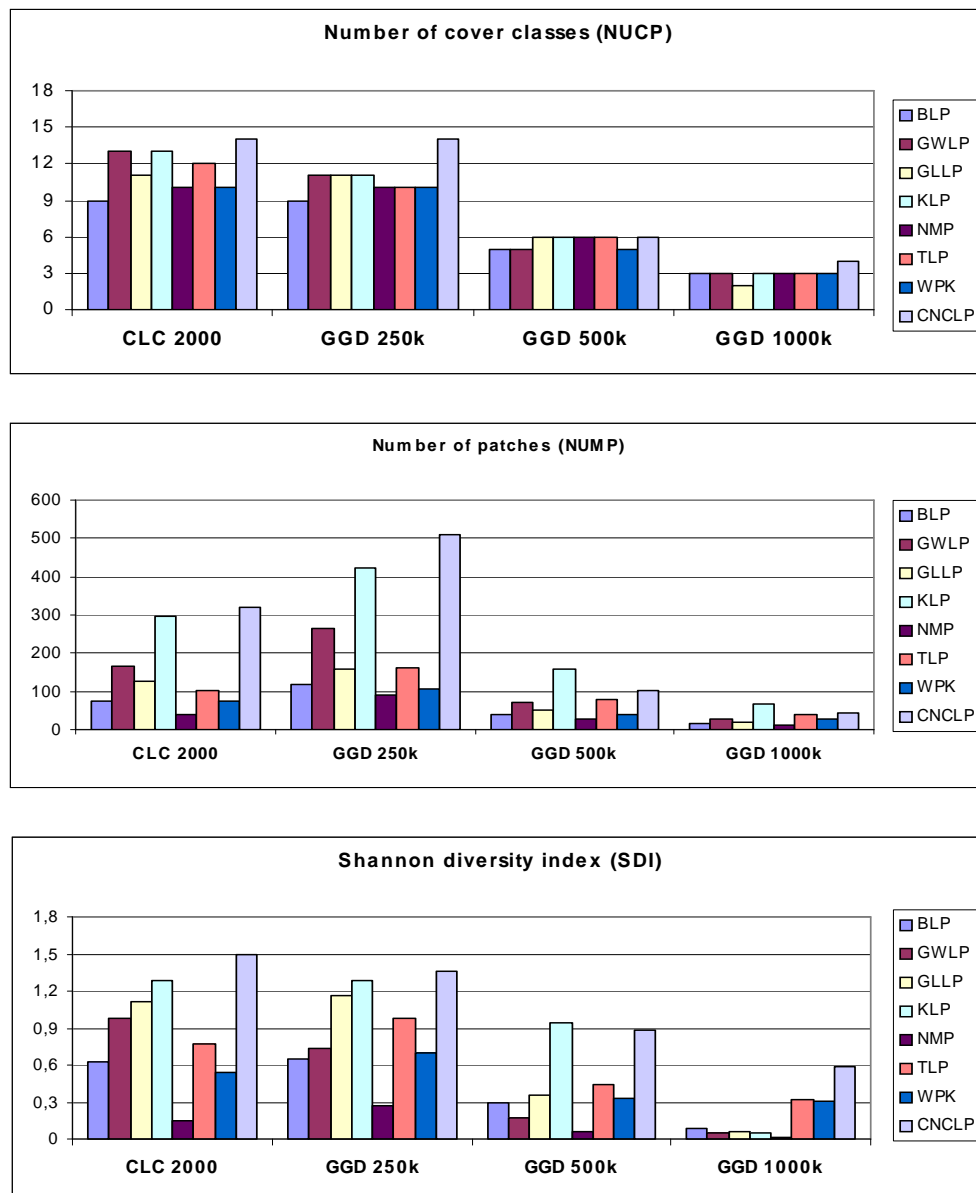


Fig. 3. Comparison of chosen landscape indices in reference to referential data. *Source: by author.*

The applied source materials may be used complementary for observations and estimation of relationship among various forms of a land cover, a landscape state, and its transformation. On the basis of analysis of the results it may be stated that the presented research approach may show structural differences among landscape fragments.

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SUMMARY

Knowledge of a land cover is very essential to understand and know relations between a man and an environment. The land cover is closely related to the rest elements of geographic environment. It also illustrates the variety of the structure of geographic environment. Till the end of the last century, there were no data representing full, reliable and covering the whole country information about the land cover. Maps and studies over this element of landscape were based on other methods of mappings, various scales and spatial ranges. This fact made it impossible to make comparison analysis and to have proper conclusions concerning processes that were taking place. The realization of National Geographic Information Systems (NSIG) and works connected with the creation of CORINE Land Cover (CLC) is a big help in this field. It was impossible without the development of spatial imagery, universality of the application of spatial information systems, and the use of army materials in the civilian, formal cases. Source spatial data used on the paper, mutually supplement and cover one another. Research connected with the analysis of a landscape structure was done in the chosen protected areas in Kujawsko-Pomorskie Voivodeship. All (8) landscape parks were in the Voivodeship. Total area of the preserved territories is almost 12% of the total Voivodeship area, and represent various types of a natural landscape. The structure of the landscape in landscape parks was analyzed with the application of landscape indices. The following indices describing the structure of landscape were calculated and compared: a number of land cover classes, a number of patches, total length of the edge, a shape index, a fractal dimension, and Shannon's diversity index. Comparisons of indices among parks were done in relation to various scales of source materials.