IDENTIFICATION AND EVALUATION OF DEVELOPMENT TRENDS IN THE CONURBATION OF THE CITIES OF MARTIN AND VRÚTKY OVER THE LAST 23 YEARS

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Abstract

In this paper we evaluate the development trends in the conurbation of the cities of Martin and Vrútky which is situated in the northern part of central Slovakia. Two time frames were chosen for our study. The first is the period from 1993 to 2003. It is the period before the accession of the Slovak republic to the European Union. The second period is from 2003 to 2016 – after Slovakia's accession to the European Union. The aim of this paper is to identify and evaluate development trends in the conurbation of the cities of Martin and Vrútky based on the comparison of land use changes over the last 23 years. We discovered that there were more significant changes in the first period (1993-2003). The strongest development trend in this area was afforestation which covered an area of 733.12 ha.

Keywords: secondary landscape structure, land use changes, development trends

Introduction

In recent years, research of landscape development using the historical documents has been on the rise not only in Slovakia but also in other countries of the world. It represents a highly current research issue. That is related, among other things, to the relatively good availability of historical maps as well as the general orientation of research on the cultural landscape.

In this paper we focus on the analysis of land use changes. No author has ever dealt with our study area which consists of two cities. Despite their independence there live in tight social and economic bond. Therefore we decided to study this area as a conurbation. We chose the period between 1993 and 2003 for the analysis of historical landscape structure and the year 2016 for the analysis of present landscape structure. Our aim is to identify and evaluate development trends in the conurbation of the cities of Martin and Vrútky based on the comparison of land use changes over the last 23 years.

Theoretical-methodological bases

The landscape is constantly changing under the influence of natural processes and society's pressure which is due to the diversity of natural conditions

and social interest gain great spatial differentiation (Cebecauerová and Cebecauer, 2005). Human interventions to the landscape are most visibly reflected by the secondary landscape structure as a result of land use. A secondary landscape structure is a set of personally influenced, transformed, created material elements of the landscape that cover the earth's surface (Miklós and Izakovičová, 1997). Changes in landscape structure significantly affect its ecological stability (Lipský, 2000), as well as biological (Löfvenhaft et al., 2004), environmental and aesthetic value (Nassauer, 1995). The understanding of landscape changes requires a sound understanding of the underlying processes that can be triggered by different driving forces (Hersperger et al., 2009, Hreško et al., 2008). We can distinguish five major types of driving forces: political, economic, cultural, technological and natural/spatial (Bürgi et al., 2004; Schneeberger et al., 2007). One possible way to identify landscape development is to use the available historical map data and its processing in geographic information systems (GIS) (Izakovičová, Mederly, Petrovič, 2017, Haladová, Petrovič, 2017, Havlíček et al., 2018, Munteanu et al., 2017, Lieskovský et al., 2018).

In 2016, the map of the present landscape structure for 2016 was created by identifying the landscape elements using satellite images made in 2015 (Mapy.cz) and data from a field survey that was ongoing in 2016. The map of historical landscape structure (HLS) for 2003 was created using the satellite images made in 2003 (Eurosense s. r. o 2003). The map of historical landscape structure (HLS) for 1993 was created using the topographical maps on a scale of 1:10 000, which were provided by the Topographical Institute of Banská Bystrica. For the classification of landscape elements, a modified legend according to Petrovič et al. (2009) was used. We used the second hierarchical level where 18 classes were identified (Table 1). The visualization of all maps and data processing was realised using Geographic Information Systems – QGIS 2.16.2 software.

Table 1: Secondary landscape structures (SLS) legend

SLS1	Name 1	SLS2	Name 2
1	Tree and shrub vegetation	11	Forest
		12	Transitional woodlands/shrubs
		13	Non-forest timber vegetation
2	Grasslands	21	Meadows and pastures
		22	Permanent grassland
3	Agriculture crops	31	Arable land
		32	Gardens
		33	Multiannual cultures
		34	Mosaics of agricultural crops
4	Sub-soil outcrops and raw soils	41	Sub-soil outcrops and raw soils (natural)
		42	Sub-soil outcrops and raw soils (artificial)

SLS1	Name 1	SLS2	Name 2
5	Surface water and wetlands	51	Water courses
		52	Standing waters and wetlands
6	Settlement and built-up areas	61	Housing and complex amenities
		62	Urban and technical vegetation
		63	Sports facilities
		64	Recreational facilities and resort
		65	Industrial and technical objects and areas
		66	Transport objects and areas

Attribute tables for individual maps-layers were exported to the MS EXCEL data format, which allowed us in the following steps to process statistics and create tables. The areas of individual elements of secondary landscape structure (SLS) as well as their percentage of the total researched area were calculated for each of the monitored years. Consequently, merged layers were created for the periods 1993-2003, 2003-2016 and the changes in the SLS that occurred in the researched area were evaluated in the individual monitored periods. Using the classification scheme according to Feranec et al. (2002) and Cebecauerová (2007), we identified 14 development trends in land use changes. The code mark is stated in Table 2.

Table 2: Development trends legend

1	Unchanged	8	Agricultural extensification
2	Urbanisation	9	Afforestation
3	Deurbanisation	10	Deforestation
4	Industrialization	11	Flooding
5	Deindustrialisation	12	Draining
6	Exploitation of mineral resources	13	Environment remediation
7	Agricultural intensification	14	Loss of agricultural land

Localization of the study area

The study area (8 591.28 ha) is situated in the northern part of Slovakia in the Žilina region and the Martin district. It includes two cities: Martin which is situated in the southern part of the study areas and Vrútky which is situated in the northern part. These cities belong into the geomorphological unit of the Malá Fatra Mts. which covers the western part of the study area and the geomorphological unit of the Turčianska kotlina Basin which covers eastern parts. The Turiec river is the main watercourse of the city of Martin. It passes through its area and flows into the Váh river, which crosses the city of Vrútky in its northern part (Map 1).

Map 1: Localization of the study area within the Slovak Republic

Results and discussion

Historical landscape structure in the conurbation of the cities of Martin and Vrútky in 1993

In 1993, we identified that there were 17 areal landscape elements in the study area (Table 3). The group of tree and shrub vegetation occupied the largest part of the study area (3932.49 ha). The most widespread landscape element were forests (3760.95 ha). The group of agricultural crops elements covered an area of 1963.40 ha, out of which the most widespread landscape element was arable land (1416.21 ha). Arable land was represented mostly by large-block fields. The group of grasslands (1321.06 ha) and the group of settlement and built-up areas (1246.52 ha) occupied almost the same area. The group of sub-soil outcrops and raw soils had the lowest areal representation of 40.97 ha.

Historical landscape structure in the conurbation of the cities of Martin and Vrútky in 2003

In 2003, there were 17 areal landscape elements identified in the study area (Table 3). During this year, the group of tree and shrub vegetation still occupied the largest part of the study area 4 635.47 ha. Forests represented an area of 3 934.70 ha. Compared to 1993, the area of all landscape elements from the group of tree and shrub vegetation increased. The second largest area was again represented by the group of agricultural crop elements (2 019.18 ha). The group of settlement and built-up areas occupied an area of 1 383.71 ha. Compared to 1993, a significant decline was recorded in the group of grasslands elements (449.79 ha). The lowest areal representation of approximately 31.74 ha had a group of sub-soil outcrops and raw soils.

Present landscape structure in the conurbation of the cities of Martin and Vrútky in 2016

In 2016, 17 areal landscape elements were identified in the study area (Table 3). The group consisting of tree and shrub vegetation again occupied the largest area (4 649.98 ha). Forests which cover the western part of the study area are the most widespread landscape element (3 833.48 ha). Compared to 1993, the area of transitional woodlands/shrubs elements (399.81 ha) and non-forest timber vegetation (416.69 ha) which are also in the first group of elements increased significantly. Compared to 2003, the area group of agriculture crop elements slightly decreased (1 980.48 ha). On the contrary, the area of settlement and built-up areas increased (1 441.55 ha).

Table 3: Secondary landscape structure in study area (1993, 2003, 2016)

Year	1993		2003		2016	
SLS	Area (ha)	(%)	Area (ha)	(%)	Area (ha)	(%)
1 Tree and shrub vegetation	3 932.49	45.78	4 635.47	53.95	4 649.98	54.12
11 Forest	3 760.95	43.78	3 934.70	45.80	3 833.48	44.62
12 Transitional woodlands/shrubs	25.05	0.29	309.51	3.60	399.81	4.65
13 Non-forest timber vegetation	146.49	1.71	391.26	4.55	416.69	4.85
2 Grasslands	1 321.06	15.38	449.79	5.24	399.26	4.65
21 Meadows and pastures	1 321.06	15.38	449.79	5.24	399.26	4.65
3 Agriculture crops	1 963.40	22.86	2 019.18	23.51	1 980.48	23.05
31 Arable land	1 416.21	16.48	1 512.59	17.61	1 462.84	17.03
32 Gardens	451.96	5.26	503.99	5.87	513.98	5.98
33 Multiannual cultures	95.23	1.12	0.00	0.00	0.00	0.00
34 Mosaics of agricultural crops	0.00	0.00	2.60	0.03	3.66	0.04
4 Sub-soil outcrops and raw soils	40.97	0.47	31.74	0.36	41.27	0.48
41 Sub-soil outcrops and raw soils (natural)	0.36	0.00	0.41	0.00	1.59	0.02
42 Sub-soil outcrops and raw soils (artificial)	40.61	0.47	31.33	0.36	39.68	0.46

Year	1993		2003		2016	
SLS	Area (ha)	(%)	Area (ha)	(%)	Area (ha)	(%)
5 Surface water and wetlands	86.84	1.01	71.39	0.83	78.74	0.92
51 Water courses	61.58	0.72	49.86	0.58	48.73	0.57
52 Standing waters and wetlands	25.26	0.29	21.53	0.25	30.1	0.35
6 Settlement and built-up areas	1 246.52	14.51	1 383.71	16.10	1 441.55	16.78
61 Housing and complex amenities	184.63	2.15	190.62	2.22	202.18	2.35
62 Urban and technical vegetation	422.76	4.92	545.28	6.35	549.40	6.39
63 Sports facilities	25.99	0.30	29.10	0.34	29.31	0.34
64 Recreational facilities and resort	3.17	0.04	3.65	0.04	4.33	0.05
65 Industrial and technical objects and areas	279.37	3.25	249.57	2.90	266.56	3.10
66 Transport objects and areas	330.60	3.85	365.49	4.25	389.76	4.54
Total	8 591.28	100	8 591.28	100	8 591.28	100

Evaluation of development trends

In Table 4 we can see 14 development trends in individual periods which were identified by comparing the changes of secondary landscape structure in our study area. Evaluation of development trends demonstrated relatively small changes in both time periods. The larger percentage of changes occurred in the first period between 1993 and 2003. Altogether 21.05% of the area had changed. The strongest development trend in the first period was afforestation (8.53%). It was mainly reflected by the significant increase of non-forest timber vegetation. Deforestation was also strong during the first period (3.71%) and similar in the second period (3.73%). The trend of agricultural intensification (3.29%) was strong in first period but in the second period this trend had significantly decreased (0.27%). Since 1993, there has been a decline in agricultural land in the Slovak Republic, while after the accession of the Slovak Republic to the EU it has increased (Boltiziar et al., 2016). Urbanisation (1.89%) and industrialisation (0.92%) trends were connected with the loss of agricultural land (1.52%).

Table 4: Development trends of study area in 1993-2003 and 2003-2016

Year	1993-2003		2003-2016	
Trends	Area (ha)	Area (%)	Area (ha)	Area (%)
Unchanged	6782.80	78.95	7806.40	90.86
Urbanisation	162.24	1.89	32.16	0.37
Deurbanisation	27.74	0.32	4.46	0.05
Industrialization	78.77	0.92	28.87	0.34
Deindustrialisation	11.79	0.14	3.48	0.04
Exploitation of mineral resources	15.14	0.18	7.71	0.09
Agricultural intensification	282.72	3.29	23.07	0.27
Agricultural extensification	18.96	0.22	0.07	0.00
Afforestation	733.12	8.53	286.96	3.34
Deforestation	318.98	3.71	320.78	3.73
Flooding	2.55	0.03	2.43	0.03
Draining	0.87	0.01	0.02	0.00
Environment remediation	25.43	0.30	1.28	0.01
Loss of agricultural land	130.17	1.52	73.59	0.86
Total	8591.28	100.00	8591.28	100.00

During the second period the study area was more stable in terms of land use. Only 9.14 % of the study area changed. Trends of deforestation (3.73%) and of afforestation (3.34%) were balanced. This was caused by the logging of wood as a result of reaching the trees' ages and at the same time by the vegetation growth in pastures and meadows due to a significant decline in cattle breeding. Despite the declining values, there was still a loss of agricultural land (0.86%) at the expense of industrialization (0.34%) and urbanization (0.37%) which was reflected mainly in the construction of flats and houses.

Conclusion

The aim of this paper was to identify and evaluate development trends in the conurbation of the cities of Martin and Vrútky based on the comparison of land use changes over the last 23 years.

The largest changes took place in the first time period. They were caused mainly by the change of regime in 1989. Transformation of agricultural cooperatives, restitution of private property and privatization of enterprises also reflected by land use. The strongest development trend was afforestation. The trend of agricultural intensification occurred as a result of the conversion of grasslands into large-block fields. This was directly related to a decline in cattle breeding. In

some unused grasslands, the non-forest timber vegetation started to grow. Since 2000, new foreign investors have been arriving in this area. Large industrial parks were constructed leading to an increase in employment and living standards. Therefore the trends of loss of agricultural land, urbanisation and industrialization are significant.

In terms of changes, the second period which represents the period after Slovakia's accession to the European Union is relatively stable. Compared to the first period, we can see a decrease in all development trends. Considering the fact that trends of afforestation and deforestation were balanced, we can say the most significant trend was loss of agricultural land at the expense of new industrial enterprises which have slowly arisen around both cities. As a result of the increase in the standard of living the process of urbanisation is also visible in several urban areas in the form of family houses and sports and recreational facilities. The new motorway section also influenced the character of the landscape. It is possible that in the future it will also have a great impact on the ongoing industrialisation and urbanisation of the study area.

At present, land re-parcelling could have the most significant influence on the landscape, which could influence not only ownership but also land use change (Muchová, Leitmanová, Petrovič 2016, Muchová, Konc, Petrovič 2018), as well as the modification of hydrological conditions in floodplains (Horáčková et al. 2018, Jakubcová et al. 2016, Petrovič et al. 2017).

Monitoring of the dynamics of changes in the study area can contribute to an understanding of the historical development of land use and can ensure its sustainable development and support the solution of its potential landscape ecological problems.

Acknowledgement

The paper was prepared within the grant project of Slovak Scientific Grant Agency VEGA no. 1/0496/16.

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