DE GRUYTER
OPEN

Ekológia (Bratislava) Vol. 34, No. 3, p. 249–259, 2015
DOI:10.1515/eko-2015-0024

CLASSIFICATION OF LAND USE CHANGES (MODEL AREA: NITRA TOWN)

IVANA HALADOVÁ, FRANTIŠEK PETROVIČ

Department of Ecology and Environmental Sciences, Faculty of Natural Sciences, Constantine the Philosopher University in Nitra, Tr. A. Hlinku 1, 949 74 Nitra, Slovak Republic, e-mail: ivana.haladova@ukf.sk, fpetrovic@ukf.sk

Abstract

Haladová I., Petrovič F.: Classification of land use changes (model area: Nitra town). Ekológia (Bratislava), Vol. 34, No. 3, p. 249–259, 2015.

This paper deals with the new classification of land use changes. We chose Nitra town in Slovakia as a model area. We examined changes of land use for the period 2003–2013. The main result of this work is a table for types of land use changes and a map that shows the location of these changes in Nitra town. Nitra is constantly expanding its area and it is also significantly changing within its borders. Agriculturally used surroundings of the town are being transformed into build-up areas and industrial parks. This transformation causes a loss of agricultural land and vegetation, in general. Agriculture in this region has been gradually declining and disappearing in the past years. On the other side, urbanisation, technicisation and industrialisation are highly supported.

Key words: Nitra, Slovakia, land use, land use changes.

Introduction

Nitra town is situated in a major agricultural area of the Slovak Republic, but agriculture has been declining in the close proximity of the town. This is caused by the expansion of build-up areas and the transformation of agricultural land into urban and industrial areas. The whole process of transformation is manifested as landscape changes.

The rapidity and magnitude of landscape changes strongly accelerated population increase and a growth in urban areas (Antrop, 2005). Urban expansion, paralleled by urban population growth and economic development, is a trend across the globe. Urban expansion causes land cover and land use changes, which are usually associated with economic growth. As a country moves from a rural–agricultural base to an urban–industrial base, urbanisation and economic development go hand in hand (Davis, Henderson, 2003).

In the last few years, many research studies focused on issues of land reform, land policies, land market, land leasing arrangements and emerging market economies in Central and Eastern Europe (Csaki, Lerman, 2000; Bičík, Jančák, 2006; Bojnec, 2011; Jarský, Pulkrab, 2013; Lieskovský et al., 2013; Skokanová et al., 2012; Hartvigsen, 2014; Kanianska et al., 2014; Munteanu et al., 2014).

The land that is affected by landscape changes the most, especially by urban growth, is agricultural land. In Slovakia, changes in cultural and agricultural landscape were studied

by Cebecauerová (2007), Boltižiar and Chrastina (2008), Blažík et al. (2011), Muchová et al. (2010), Ivanová et al. (2013), Krnáčová et al., (2013), Tarasovičová et al. (2013), Kopecká, Rosina (2014)Lieskovský et al. 2014 and Šebo, Kopecká (2014).

This paper deals with the classification of land use changes and it investigates changes in Nitra town during the period 2003–2013. Land cover and land use in Nitra were recently mapped by Bugár et al. (2006) and Mišovičová (2008). A territorial system of ecological stability was created by Mederly and Halada (1995).

Study area

We chose twelve cadastral areas of Nitra town (Zobor, Chrenová, Veľké Janíkovce, Nitra 1, Nitra 2, Mlynárce, Lužianky, Ivanka pri Nitre, Horné Krškany, Dražovce, Dolné Krškany, and Kynek; Figs 1 and 4) as a study area. The size of the studied area is 12,557.97 ha.

According to the number of inhabitants (87,285), Nitra town is the fourth biggest town in the Slovak Republic (Čeman et al., 2007).

Nitra is a capital of Nitra county and Nitra district. It is situated in the northern part of Podunajská lowland, on the border of the Tríbeč mountain range. This location creates specific conditions, suitable for agriculture, industry and also for forest management. The town has a good traffic connection created by an expressway. Good traffic connection is one of the causes that create suitable conditions for industrial and urban development. The Podunajská lowland is also a heavily agriculturally used part of the Slovak Republic. Nitra town has a rich agricultural history connected mainly with the production of wine, hops, fruits and vegetables. However, agriculture in this region has been declining and disappearing in the last few years.

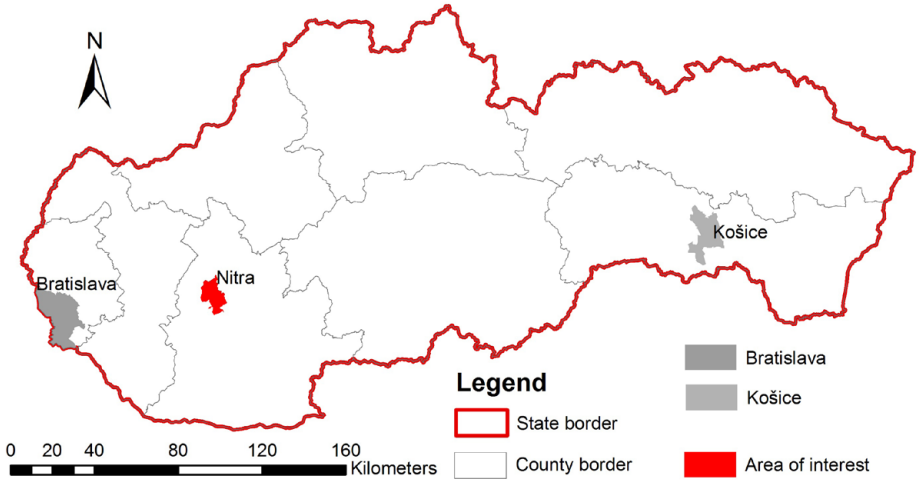

Fig. 1. Location of study area within the Slovak Republic.

Methods

Spatial data that define land use were digitalised manually according to the visual interpretation of aerial orthophotos (from the year 2002) and satellite images (from the year 2010) in the ArcView *geographic information system* (GIS) environment. We used software ArcGIS 9.3 and field survey for the years 2003 and 2013 for processing map layers obtained from orthophoto maps. The mapping scale is 1:5,000. Orthophoto maps were provided by EUROSENSE Slovakia and GEODIS Slovakia.

We classified the land use in Nitra town using the legend created by Petrovič et al. (2009). This legend was created for the purpose of unification and a prospective comparison of results of work from various sources, and it is usable for the entire territory of Slovakia. The legend contains six basic groups:

1. Tree and shrub vegetation
2. Grass-herbal vegetation
3. Agricultural land
4. Bedrock baring and raw soils
5. Water bodies and wetlands
6. Settlements and urban areas.

These basic groups are further divided into more detailed groups marked by two- or three-digit numbers.

We evaluated land use changes through comparison of map layers for the year 2003 with the map layers for the year 2013. Map layers for the year 2003 were created by Vereš (2006) and Hreško et al. (2006). Then we created map layers for the year 2010 and actualised them by field survey in the year 2013. Finally, we compared both map layers, discerned changed and unchanged areas and evaluated types of changes within the changed area.

Only groups of changes from the existing methodology (Cebecauerová, 2007) were chosen. We chose those that were present in land use changes for Nitra town. These groups of changes were slightly modified, to correspond with the larger mapping scale and use in an urban environment. We also created new groups of changes, to match the real changes in the area of interest as much as possible. These changes were divided into sixteen basic groups. There are also some unclassified changes (too small and unimportant to be classified as relevant changes), and the rest is unchanged area (Figs 2–5). To save space, we use shortcuts for these groups in graphs and maps.

1. Afforestation and reforestation (Increase of wooded areas) – a
2. Afforestation and reforestation (Increase of wooded areas), Loss of agricultural land – a L
3. Deforestation (Loss of wooded areas) – D
4. Extensification of agriculture – e
5. Forest management – F
6. Intensification of agriculture – i
7. Intensification of agriculture, Deforestation (Loss of wooded areas) – i D
8. Overgrowing – O
9. Overgrowing, Loss of agricultural land – O L
10. Reconstruction, recultivation – R
11. Industrialisation and technicisation – t
12. Industrialisation and technicisation, Deforestation (Loss of wooded areas) – t D
13. Industrialisation and technicisation, Loss of agricultural land – t L
14. Urbanisation – u
15. Urbanisation, Deforestation (Loss of wooded areas) – u D
16. Urbanisation, Loss of agricultural land – u L
17. Other changes (Unclassified changes) – oz
18. Unchanged area – bz.

These groups contain the most significant changes in our area of interest. The types of changes are generalised and one group may contain several variations of a specific change (various smaller and less significant changes; Fig. 2).

For example, group Afforestation and reforestation (a) includes planting of new forests, planting of alleys and so on. In many cases, this process is followed by a loss of agricultural land (a L). There is also the Overgrowing (O) group, which contains spontaneous growth of shrubs and trees in abandoned areas. On the other hand, the Deforestation (D) group covers any loss of wooded area, such as cutting down a forest, an alley or a park, which is followed by the creation of meadows or grasslands. There is a separate group for Forest management (F), which covers cutting down of a forest to plant a new forest or forest nursery.

Group Intensification of agriculture (i) contains transformation from meadows or small fields (narrow-strip fields) into big, heavily agriculturally used fields. This process is, in many cases, accompanied by deforestation and loss of wooded areas (i D). Extensification of agriculture (e) has a contrary effect, where big and heavily agriculturally used fields are transformed into meadows, abandoned grassy areas or agriculturally used gardens.

Changes such as construction of family houses, construction of blocks of flats, creation of playgrounds, creation of gardens around family houses and so on are placed in the Urbanisation (u) group. Urbanisation can cause a loss of agricultural land (u L) or deforestation (u D).

Year 2003 \ Year 2013	111	121	122	124	131	132	133	134	221	222	223	311	312	321	322	333	344	522	523	611	612	613	614	615	621	622	624	625	631	632	641	651	652	653	654	655	656	661	662	664
111	bz	D	D	F			bz	D	i D											u D																				
113		D																		u D				u D		D												t D	
121		bz						O																															
122	a		bz	F			a	O	i D																												bz		
124	a		bz	bz					i D																														
131					bz															u D						D			u D							t D			
132						bz						i D		u D						u D			u D	u D					D			u D								
133			D			oz	bz		i D			i D		u D			i D							u D		oz	D			u D		t D	t D		t D		u D	t D	t D	
134								bz		i D				u D			i D			u D	u D		u D	u D		u	D			u D		t D	t D					t D		
221	a L					a L	a L	O	bz	bz	bz	i D		u D			i D			u L			u L	u L		u L	bz			u L		t L	t L	t L				t L	t L	
223											bz									u																				
311				O L					e			bz		u		i	e			u L			u L	u L		u L	e	a L		u L	u L	t L	t L	t L	t L	t L		t L	t L	t
321					a L				e			i	i	bz	bz					u	u D		u	u	u	u	oz			oz		t L	t L	t L			t L	t L	t L	
331														oz						u L							e													
333												e		oz		bz																								
341														bz																										
343														bz						u L																				
344									e					oz	bz		bz			u L				u L		u L				u L		t L	t L					t L	t L	
511									oz									oz	oz																			t		
522																		bz		u																				
523						a			oz									oz	bz																				
611																				bz			oz	oz			R			R		t	t					R	R	
612																					bz			oz		t													R	
613																					bz	bz																		
614																	R			bz	bz		bz	oz									t						R	
615																					oz		oz	bz		R				oz		t	t	bz				R	R	
621																				u				u	bz															
622										bz				oz			i			u	u	u	u	u		bz	oz	oz		u		t	t	t	t	u	u	t	t	
624																								u		u	bz						t L						t L	
631																													bz											
632																													bz	bz										
651														R						oz	oz			bz								bz	bz	bz		oz			oz	
652														R						oz	oz			oz								bz	bz				oz	oz	oz	
653									R			R		oz						u	u			u		R				oz		bz	bz	bz		oz	oz		oz	
654												R																							bz					
655								R												R			R			R	R						R			bz				
662																																oz	oz						bz	

Fig. 2. Types of changes based on categories of land use (legend in text, chapter 3).

Industrialisation and technicisation (t) is a process of constructing factories, industrial parks, sewage treatment plants or any technical objects. This process is usually accompanied by a loss of agricultural land (t L) or deforestation (t D).

The opposite process to Urbanisation and Industrialisation or Technicisation is Reconstruction and recultivation (R). In this group we can find a process of demolishing build-up areas and their transformation into some kind of vegetation, for example, alley, park, meadow or abandoned area with shrubs and trees.

Any other type of change falls into the Other changes (Unclassified changes – oz) group. This group contains very small changes within the higher level of classification.

A lot of areas remained unchanged and were classified as Unchanged area (bz).

Unchanged area (bz) and Other changes (Unclassified changes – oz) are not included in the calculation of types of changes in area size.

Results

The size of the area of interest is 12,555.49 ha. 867.86 ha from this area was changed, which represents 6.91% of the studied area (Fig. 3). 11,539.34 ha remained unchanged, which corresponds to 91.89% of the studied area. There are also very small or unimportant changes that were not classified (oz – Other changes/Unclassified changes). The size of this area is 150.77 ha, which is 1.2% of the whole area.

We calculated the percentage of types of changes only from the size of the changed area (Fig. 5). Increase of wooded areas (a – Afforestation and reforestation) represents 1.57% of changes in the area of interest. This group consists mainly of planting trees on grassy areas.

Increase of wooded areas, which negatively affected agricultural land (a L – Afforestation and reforestation, Loss of agricultural land), affected 1.8% of the changed area. This type of change mainly includes creation and expansion of field boundaries or small groups of trees.

Loss of wooded areas (D – Deforestation), followed by the formation of grassy areas, represents 3.23% of the changes. Another kind of change is a loss of forested area, followed by the planting of a new forest or forest nursery as a part of forest management (F – Forest management). This kind of change represents 5.31% changes in the studied area.

Some parts of agriculturally used land were abandoned and transformed into meadows and grassy areas (e – Extensification of agriculture). This type of change represents 9.31% of changes in the studied area.

On the other hand, there are some parts of the town that became more agriculturally used (i – Intensification of agriculture). These areas were predominantly transformed from meadows into fields. Intensification of agriculture represents 1.76% of changes in the area of interest.

Another type of intensification of agriculture is gaining arable land from cutting down trees (i D – Intensification of agriculture, Deforestation/Loss of wooded areas). This type of change represents 2.2% of the changes in the studied area.

There are some abandoned buildings and urban structures in the area of interest that were replaced by greenery or agriculturally used land (R – Reconstruction, recultivation). This type of change takes place on 1.93% of the changed area.

Construction of roads in the urban area is categorised as t – Industrialisation and technicisation. This type of change represents 7.89% of changes in the studied area.

Construction of industrial or technical objects at the expense of wooded areas (t D – Industrialisation and technicisation, Deforestation/Loss of wooded areas) represents 1.06% of changes in the area of interest.

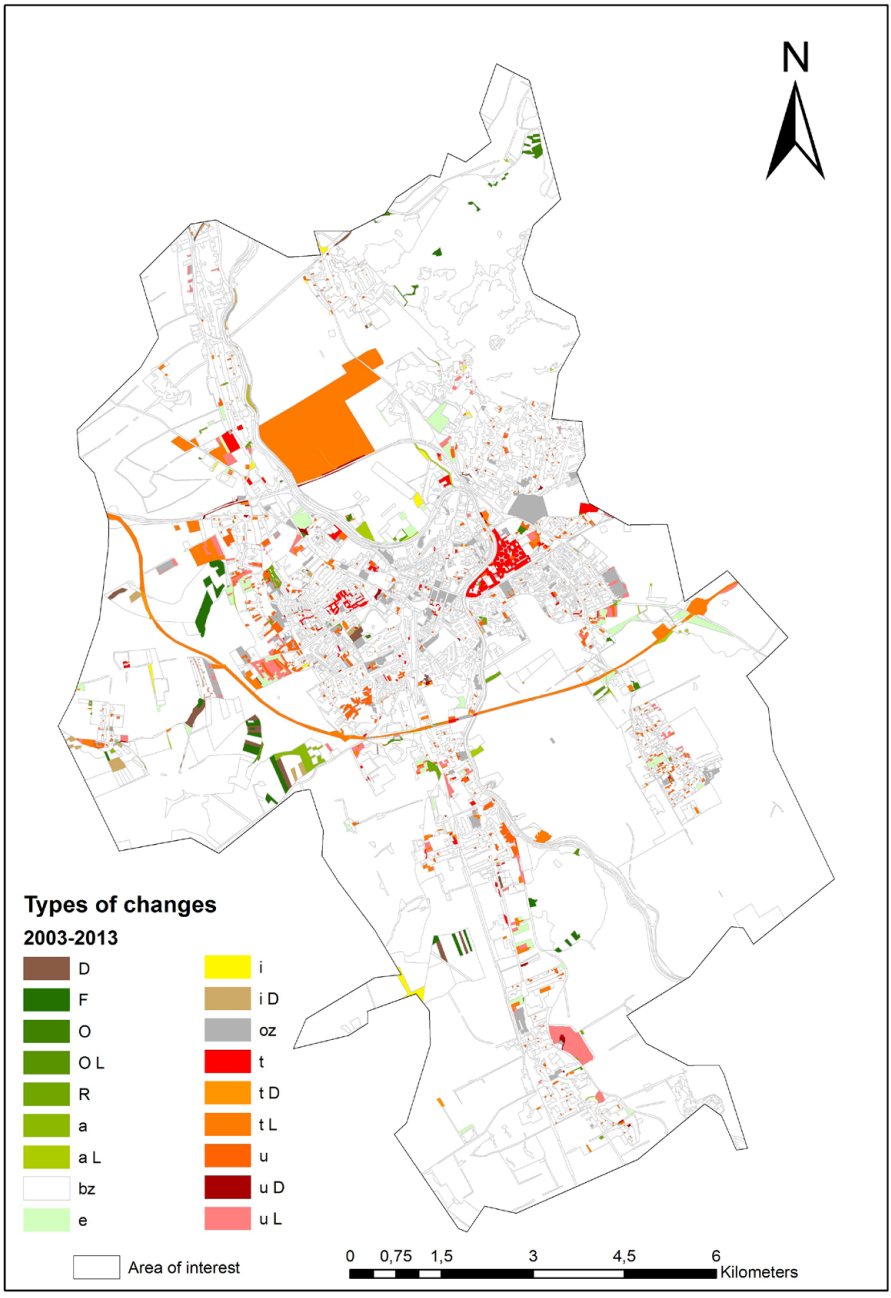

Fig. 3. Location of land use changes in the area of interest (legend in text, chapter 3).

Fig. 4. The industrial park was built in the middle of large fields near the highway (photo: I. Haladová, 2015).

The biggest change in the area of interest is the construction of an industrial park (Fig. 4) at the expense of arable land (t L – Industrialisation and technicisation, Loss of agricultural land). It represents 38.91% of changes in the study area.

Expansion of urban area (u – Urbanisation) without an effect on wooded areas or arable land represents 10.46% of the changed area.

Urbanisation, which had influence on the loss of wooded areas (u D – Urbanisation, Deforestation/Loss of wooded areas), takes place on 1.51% of the changed area.

Construction of urban objects on arable land (u L – Urbanisation, Loss of agricultural land) affected 10.68% of the changed area.

In different cadastres of the town, different types of changes are dominant (Fig. 6).

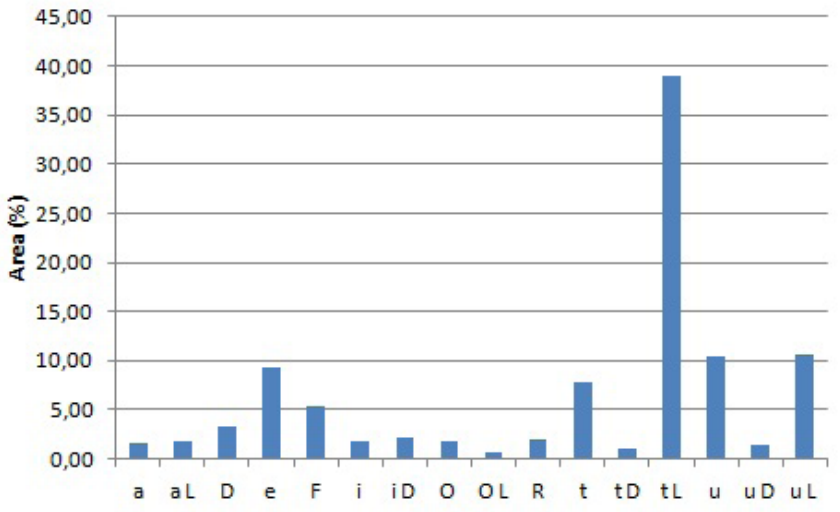

Fig. 5. Extent of changes (legend in text, chapter 3).

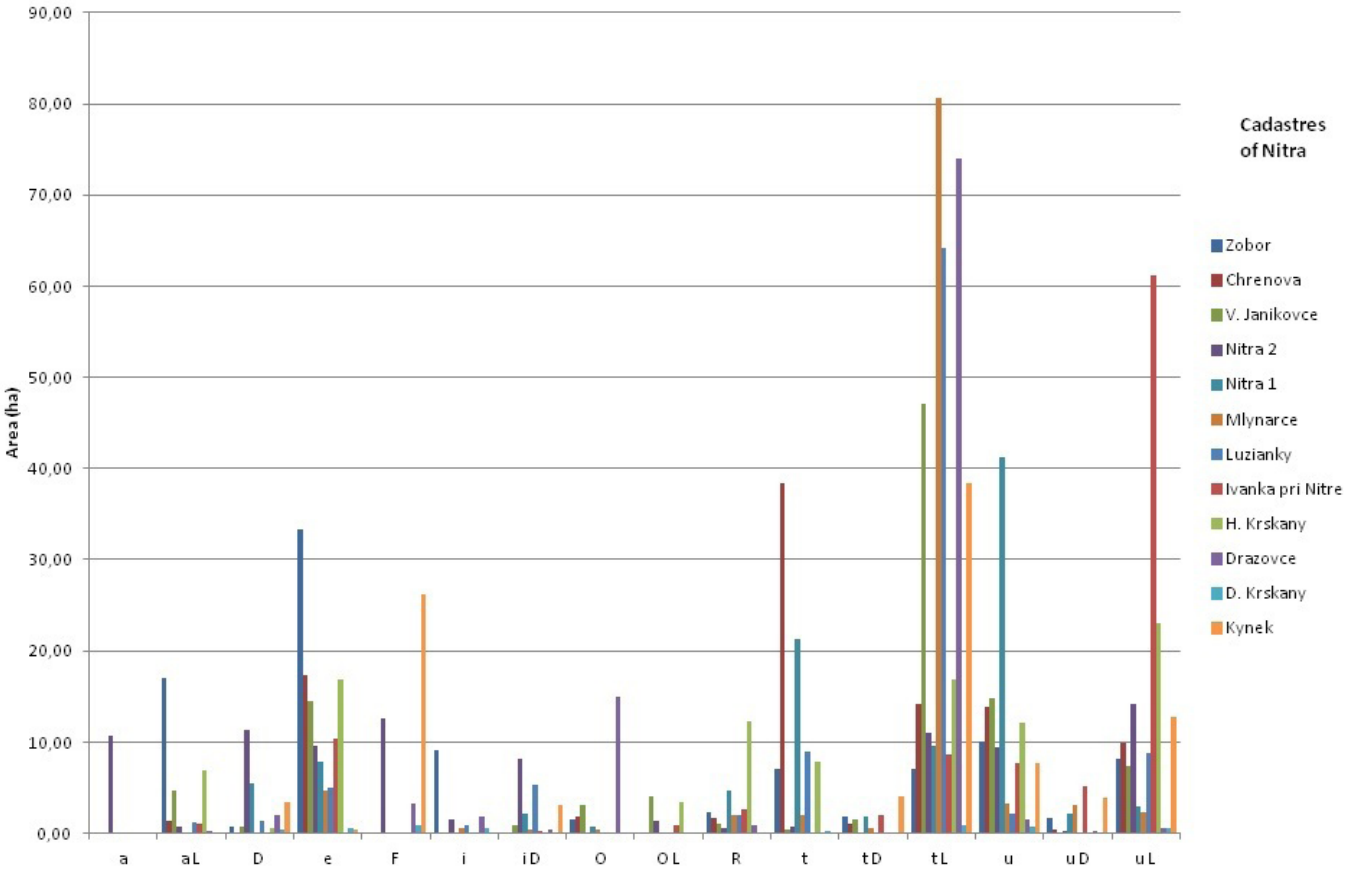

Fig. 6. Types of changes in different cadastres of Nitra town (legend in text, chapter 3).

Discussion

The area of Nitra town is relatively small. This is why a larger mapping scale is required, to record every important change in the land use. A larger mapping scale requires more precise classification of land use and also its changes.

There are several studies on land cover and land use in Slovakia mapped on a large scale. Petrovič (2006) focused his research on scattered settlements. His study evaluated land use changes in relation to the use and ecological stability of the land. However, he did not use the separate classification of the groups of changes. Pucherová et al. (2007) used a similar approach. Land use elements were divided into groups and they were subsequently compared by changes in the size of their areas.

On the other hand, Cebecauerová (2007) created different classifications of the types of changes. However, this classification is designed for a small mapping scale, and its use in an urban area at the cadastre level is not detailed enough. A similar issue was addressed in a study by Kalivoda et al. (2010), which interpreted the relationship between trends in land use and communities of birds and butterflies. This clearly confirmed the direct relationship between land use trends and specific species. Similar results were confirmed for different types of landscapes (Baus et al., 2014; Druga, Falťan, 2014; Falťan et al., 2011; Feranec et al., 2014; Havlíček et al., 2012; Havlíček, Chrudina, 2013; Mojses, Petrovič, 2013; Štych, 2011).

We decided to modify the existing classification of land cover changes (Cebecauerová, 2007) and adapt it to the classification of land use changes, based on the classification of land use created by Petrovič et al. (2009). The aim of this study is to create a proper classification of land use changes, in a large mapping scale by using unified classification methodology.

Conclusion

Landscape within and around towns always reflects economical and political changes and human needs. Agriculture in this region has been declining and disappearing in the last few years; on the other hand, urban and industrial areas have been expanding. This is caused mainly by the construction of family houses and industrial parks on the arable land on the outskirts of the town. Also, the most common change within the borders of the town is urbanisation, usually caused by the construction of family houses in gardens.

Expansion of the build-up area is a natural consequence of town development. Unfortunately, urban development is paralleled by a loss of vegetation and agricultural land. Balanced management is needed to protect environment without deceleration of the town development. Detailed mapping of the land use changes can help to develop the town while taking into account the protection of the environment.

Acknowledgements

This research is supported by Scientific Grant Agency of the Ministry of Education of the Slovak Republic (ME SR) and Slovak Academy of Sciences (SAS), VEGA grant No. 1/0232/12 and KEGA No. 025UKF-4/2015.

References

Antrop, M. (2005). Why landscapes of the past are important for the future. *Landsc. Urban Plann.*, 70(1–2), 21–34. DOI:10.1016/j.landurbplan.2003.10.002.

Baus, P., Kováč, U., Pauditšová, E., Kohutková, I. & Komorník J. (2014). Identification of interconnections between landscape pattern and urban dynamics - Case study Bratislava, Slovakia. *Ecological Indicators*. 42, 104–111. DOI: 10.1016/j.ecolind.2013.12.011.

Bičík, I. & Jančák V. (2006). Czech agriculture in the integrating Europe. *Acta Geographica Universitatis Comenianae*, 48, 155–165.

Blažík, T., Falťan, V., Tarasovičová, Z. & Saksa M. (2011). Land use changes in chosen districts of various productive agricultural regions in the context of transformational processes (in Slovak). *Geografický* Časopis, 63(4), 301–323.

Bojnec, Š. (2011). Land Markets in the EU Candidate Countries of Croatia, Former Yugoslav Republic of Macedonia and Turkey. In *Factor markets working paper No. 1*. Brussels: Centre for European Policy Studies. http://aei.pitt.edu/id/eprint/58505

Boltižiar, M. & Chrastina P. (2008). Land-use changes of the low land agricultural landscape on the example of the Nové Sady village (in Slovak). *Geoinformation*, 4, 16–35.

Bugár, G., Petrovič, F., Boltižiar, M., Hreško, J. & Vereš J. (2006). Interpretation of changes in secondary landscape structure in relation to biodiversity (in Slovak). In *Krajina Nitry a jej okolia* (pp. 56–61). Úvodná etapa výskumu. Nitra: UKF.

Cebecauerová, M. (2007). Analysis and assessment of changes of landscape structure (case study of selected part lowland Borská nížina and the mountains Malé Karpaty) (in Slovak). *Geographia Slovaca*, 24, 147 pp.

Csaki, C. & Lerman Z. (2000). Structural change in the farming sectors in Central and Eastern Europe. Lessons for EU accession. In *Second World Bank/FAO Workshop*. 27–29 June 1999. World Bank Technical Paper No. 465. Washington: The World Bank.

Čeman, R. et al. (2007). *Atlas Slovak Republic (in Slovak).* Bratislava: Mapa Slovakia Plus.

Davis, J.C. & Henderson J.V. (2003). Evidence on the political economy of the urbanization process. *Journal of Urban Economics*, 53(1), 98–125. DOI:10.1016/S0094-1190(02)00504-1.

Druga, M. & Falťan V. (2014). Influence of environmental drivers on the land cover structure and its long-term changes – case study of Malachov and Podkonice villages in Slovakia. *Moravian Geographical Reports*, 22(3), 29–41. DOI: 10.2478/mgr-2014-0016.

Falťan, V., Bánovský, M. & Blažek M. (2011). Evaluation of land cover changes after extraordinary windstorm by using the land cover metrics: a case study on the high Tatras foothill. *Geografie*, 116(2), 156–171.

Feranec, J., Solín, L., Kopecka, M., Otaheľ, J., Kupková, L., Štych, P., Bičík, I., Kolár, J., Čerba, O., Soukup, T. & Brodský, L. (2014). Analysis and expert assessment of the semantic similarity between land cover classes. *Progress in Physical Geography*, 38(3), 301–327. DOI: 10.1177/0309133314532001.

Hartvigsen, M. (2014). Land reform and land fragmentation in Central and Eastern Europe. *Land Use Policy*, 36, 330–341. DOI:10.1016/j.landusepol.2013.08.016.

Havlíček, M., Krejčíková, B., Chrudina, Z. & Svoboda J. (2012). Long-term land use development and changes in streams of the Kyjovka, Svratka and Vělička river basins (Czech Republic). *Moravian Geographical Records*, 20(1), 28–42.

Havlíček, M. & Chrudina Z. (2013). Long-term land use changes in relation to selected relief characteristics in Western Carpathians and Western Pannonian basin – case study from Hodonín District (Czech Republic). *Carpathian Journal of Earth and Environmental Sciences*, 8(3), 231–244.

Hreško, J., Pucherová, Z., Baláž, I., Rybaničová, J. et al. (2006). *Landscape of Nitra and its surroundings (initial stage of research) (in Slovak)*. Nitra: FPV UKF.

Ivanová, M., Michaeli, E. & Boltižiar M. (2013). Analysis of changes in the spatial structure of land cover (case study in the territory north of the Zemplínska Šírava reservoir) (in Slovak). *Geografický Časopis*, 65(3), 235–250.

Jarský, V. & Pulkrab K. (2013). Analysis of EU support for managed succession of agricultural land in the Czech Republic. *Land Use Policy*, 35, 237–246. DOI:10.1016/j.landusepol.2013.05.020.

Kalivoda, H., Petrovič, F., Kalivodová, E. & Kürthy A. (2010). Influence of the landscape structure on the butterfly (Lepidoptera, Hesperioidea and Papilionoidea) and bird (Aves) taxocoenoses in Veľké Leváre (SW Slovakia). *Ekológia (Bratislava)*, 29(4), 337–359. DOI: 10.4149/ekol_2010_04_337.

Kanianska, R., Kizeková, M., Nováček, J. & Zeman M. (2014). Land-use and land-cover changes in rural areas

during different political systems: A case study of Slovakia from 1782 to 2006. *Land Use Policy*, 36, 554–566. DOI:10.1016/j.landusepol.2013.09.018.

Kopecká, M. & Rosina K. (2014). I | Identification of changes in urbanized landscape based on VHR satellite data: Study area of Trnava (in Slovak). *Geografický Časopis*, 66(3), 247–267.

Krnáčová, Z., Hreško, J., Kanka, R. & Boltižiar M. (2013). The evaluation of ecological factors affecting environmental functions of the soils in area of traditional Agrarian structures. *Ekológia (Bratislava)*, 32(2), 248–261. DOI: 10.2478/eko-2013-0021.

Lieskovský, J., Kanka, R., Bezák, P., Štefunková, D., Petrovič, F. & Dobrovodská M. (2013). Driving forces behind vineyard abandonment in Slovakia following the move to a market-oriented economy. *Land Use Policy*, 32, 356–365. DOI:10.1016/j.landusepol.2012.11.010.

Lieskovský, J., Kenderessy, P., Špulerová, J., Lieskovský, T., Koleda, P., Kienast, F. & Gimmi U. (2014). Factors affecting the persistence of traditional agricultural landscapes in Slovakia during the collectivization of agriculture. *Landsc. Ecol.*, 29, 867–877. DOI: 10.1007/s10980-014-0023-1.

Mederly, P. & Halada Ľ. (1995). *Territorial system of ecological stability - town Nitra, phase of analyses end evaluations (in Slovak)*. Nitra: Regioplán.

Mišovičová, R. (2008). *Landscape-ecological assumptions of the development of Nitra and its contact area (in Slovak)*. Nitra: UKF.

Mojses, M. & Petrovič F. (2013). Land use changes of historical structures in the agricultural landscape at the local level – Hriňová case study. *Ekológia (Bratislava)*, 32(1), 1–12. DOI: 10.2478/eko-2013-0001.

Muchová, Z., Dumbrovský, M., Váchal, J., Ručková, A. & Váchalová R. (2010). Long-term evolution of the landscape highlighted by descriptive statistics (in Slovak). *Littera Scripta*, 3(1–2), 190–203.

Munteanu, C., Kuemmerle, T., Boltižiar, M., Van Butsic-Gimmi, U., Halada, L., Kaim, D., Király,G., Konkoly-Gyuró, E., Kozak, J., Lieskovský, J., Mojses, M., Müller, D., Ostafin, K., Ostapowicz, K., Shandra, O., Štych, P., Walker, S. & Radeloff V.C. (2014). Forest and agricultural land change in the Carpathian region—A meta-analysis of long-term patterns and drivers of change. *Land Use Policy*, 38, 685–697. DOI: 10.1016/j.landusepol.2014.01.012.

Petrovič, F. (2006). The changes of the landscape with dispersed settlement. *Ekológia (Bratislava)*, 25(1), 65–89.

Petrovič, F., Bugár, G. & Hreško J. (2009). The list of landscape elements mappable at the area of Slovakia (in Slovak). *GeoInformation*, 5, 112–124.

Pucherová, Z., Boltižiar, M., Derneš, S., Hreško, J., Mišovičová, R., Ružička, M. & Tuhárska K. (2007). *Secondary landscape structure (Methodical guide to mapping) (in Slovak)*. Nitra: FPV UKF.

Skokanová, H., Havlíček, M., Borovec, R., Demek, J., Eremiášová, R., Chrudina, Z., Mackovčin, P., Rysková, R., Slavík, P., Stránska, T. & Svoboda J. (2012). Development of land use and main land use change processes in the period 1836-2006: case study in the Czech Republic. *Journal of Maps*, 8(1), 88–96. DOI: 10.1080/17445647.2012.668768.

Šebo, D. & Kopecká M. (2014). Abandonment of agricultural landscape after 1989: A case study from the Považie Region, Slovakia. *Geografický Časopis,* 66(4), 323–339.

Štych, P. (2011). Comparative analysis of the impact of slope inclination and altitude on long-term land use changes in Czechia. *AUC Geographica*, 46(1), 71–76.

Tarasovičová, Z., Saksa, M., Blažík, T. & Falťan V. (2013). Changes in agricultural land use in the context of ongoing transformational processes in Slovakia. *Agriculture*, 59(2), 49–64. DOI: 10.2478/agri-2013-0006.

Vereš, J. (2006). *Secondary landscape structure of selected cadastral areas of Nitra town, villages Lužianky, Ivanka pri Nitre and* Štitáre *(in Slovak)*. RNDr work. Nitra: KEE FPV UKF.