

**CHANGES IN LAND COVER AND LAND USE IN THE KARST AREA
OF BOSNIA AND HERZEGOVINA**

Marija MISILO^{1*}, Melisa LJUŠA²

Original scientific paper

UDK 631.4:551.435.8(497.6)

ABSTRACT

Natural characteristics of karst areas (lack of water on the surface, scarce soil and vegetation) are rather specific and because of them they are often viewed as unsuitable for human habitation. They are often described as inhospitable and passive areas, and Aley (1992) states that karst areas in America are correlated with areas of rural poverty. A large part of Bosnia and Herzegovina consists of karst areas (karst land extending northwest-southeast) which on average are quite sparsely populated. The scarcity of nature, and especially of soil functions in terms of agriculture, as well as the previous period of industrial development caused depopulation which became particularly apparent after the recent war. This contributed to the fact that in some karst areas population has been drastically reduced, in some places by more than 60%, which affects the condition of land cover and land use as well as change in functions of soil in the ecosystem.

Given the fact that the soil formation process on karst terrain is very slow (these are mainly shallow and skeletal soils) and in view of the importance of soil and its multi-functionality, this paper is aimed at analyzing the extent and nature of changes which occurred in land cover and in land use in this part of BiH, namely at analyzing the causes and effects. In order to be able to make such analysis, we used land cover databases, aerial photographs as well as orthophoto maps of the terrain.

Keywords: *land cover, land use, karst area, Bosnia and Herzegovina*

INTRODUCTION

According to FAO (URL), land cover (LC) is "the observed (bio) physical cover on the earth's surface." In the narrow sense includes vegetation and anthropogenic forms, while in a broader sense includes bare soil and water surfaces. At the same time, land

¹ University of Sarajevo, Faculty of Science, Department of Geography, Zmaja od Bosne 33-35, 71000 Sarajevo, Bosnia and Herzegovina

² University of Sarajevo, Faculty of Agricultural and Food Sciences, Institute of Soil Science, Zmaja od Bosne 8, 71000 Sarajevo, Bosnia and Herzegovina

*Corresponding author: marijamisilo@gmail.com

use (LU) "is characterized by the arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it." Changes in land cover and land use are a reflection of the interaction between society and the environment and are particularly pronounced when economic and social systems are changing (Cvitanović, 2014).

Karst areas are specific for their natural characteristics, primarily scarcity of water, vegetation and soil. In such conditions adaptation of man is difficult. It is the level of man's adaptation to the specific natural features of karst that development of these areas is dependent on. Information on the type of land cover, extent of change and the purpose it is used for can be used for the assessment of sustainability, vulnerability and resilience of the land system (Han *et al.*, 2004), which is particularly important in sensitive natural systems such as karst.

Bosnia and Herzegovina has undergone - and is still undergoing – significant social change and effects on space are enormous. This being said, the objective of the paper is to analyze the way and extent to which social processes influenced changes in land cover and land use in the isolated karst areas.

MATERIAL AND METHODS

In Bosnia and Herzegovina, the karst region extending from the northwest to the southeast has two distinctive areas – the predominantly mountainous part (belt of high karst) and the area of low Herzegovina (karst plateaus and the valley of the Neretva river and its tributaries). The low-Herzegovina area is more densely populated due to more favorable natural conditions (fertile soil, mild climate, water) as well as to better road connections which enabled a better economic development. The area of high karst has always been sparsely populated. Major settlements are situated mostly around the karst fields that represent oases of life. The population was traditionally involved in livestock farming and growing crops suited to harsh climate conditions. Today, particularly in the highest parts, the population is drastically reduced.

For the purpose of this study, selected were three municipalities in which the analysis of change in land cover/land use was made: Glamoč, Široki Brijeg and Gacko. Selected municipalities are located in geographically different areas and undergoing different social changes.

Analysis of changes in land use/land cover was carried out according to the CORINE Land Cover data for BiH.

RESULTS AND DISCUSSION

Total change in LU/LC in karst areas (high karst and low-Herzegovina) in the period 2000-2012 amounts to 23,595.23 hectares (Figure 1) of which more than 19,500 hectares are related to changes that occurred in the period 2000-2006. In the area of high

karst, changes are recorded on an area of 14,867.6 hectares, and in low-Herzegovina on an area of 8,727.64 hectares (Figure 1).

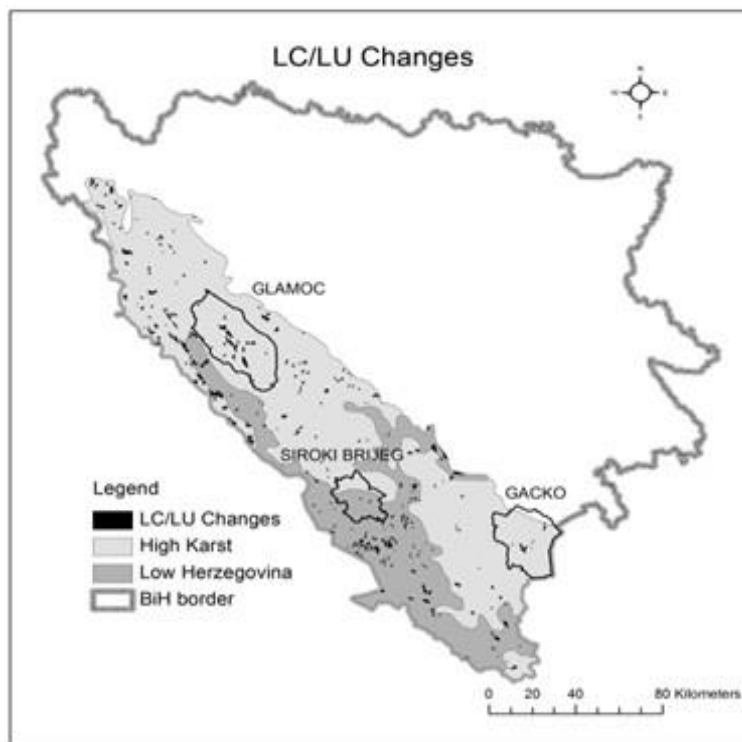


Figure 1. Changes in LC/LU in karst area (2000-2012)

The biggest changes are related to forest vegetation and account for 76% (17,967.58 hectares) of recorded changes in LU/LC in karst (Table 1). The analysis of change in the category of forest vegetation and other natural areas shows that a smaller part of the total change pertains to the transition to artificial (5.7%) or agricultural areas (2.2%). Changes within categories account for a total of 16,538.22 hectares or 92%, of which 69.7% are areas affected by the fires. Most of these changes are related to the area of high karst (11,495.68 hectares).

Total changes in the category of agricultural areas in the period 2000-2012 amount to 5,168.10 hectares or 21.9% of the total change in LU/LC in karst areas (Table 1). 66.5% of changes occurred within the category (transition to the groups of arable land parcels, non-irrigated fields and to some smaller extent to vineyards and orchards), 19.6% or 1,014.25 hectares in artificial surfaces and 12.8% or 662.13 hectares in succession of forest vegetation and natural grassland. The loss of agricultural areas in favor of

artificial surfaces and the category of forest vegetation and natural grassland is slightly higher in low-Herzegovina (totaling 963.47 ha).

In the period 2000-2012, the category of artificial surfaces increased by 2,032.31 hectares, mostly in urban areas, construction sites and mineral resources exploitation sites. The expansion of artificial surfaces largely occurred at the expense of the loss of agricultural areas (loss of 1,014.25 ha).

Table 1. Changes in LC/LU (ha) in karst areas of BiH (2000-2012)

		LC/LU changes (ha)		
		2000-2006	2006-2012	2000-2012
Low Herzegovina	Artificial surfaces	286.24	0.00	286.24
	Agricultural areas	1649.15	320.36	1969.51
	Forests and semi-natural areas	4314.54	2157.33	6471.87
	Total	6249.95	2477.69	8727.64
High Karst	Artificial surfaces	42.81	90.88	133.69
	Agricultural areas	2893.92	304.67	3198.59
	Forests and semi-natural areas	10431.46	1064.22	11495.68
	Wetlands	8.85	0.00	8.85
	Water bodies	30.79	0.00	30.79
	Total	13407.83	1459.77	14867.60
Karst	Artificial surfaces	329.05	90.88	419.93
	Agricultural areas	4543.07	625.03	5168.10
	Forests and semi-natural areas	14746.00	3221.55	17967.55
	Wetlands	8.85	0.00	8.85
	Water bodies	30.79	0.00	30.79
	Total	19657.77	3937.46	23595.23

Most of the changes in LU/LC are those in the category of forest which was expected given the sparsely populated area, especially in the high karst belt. Although this area has always been sparsely populated, the process of depopulation the ageing of the population started 50 years ago as a result of social change. According to Čustović *et al.* (2013), changes in the demographic structure and the abandonment of rural areas have the following effects: the loss of biodiversity, degradation of ecosystem as a whole and the destruction of natural and cultural heritage.

The analysis of the three selected municipalities (Glamoč, Široki Brijeg and Gacko) was intended to determine the differences in changes in LU/LC with respect to different geographic location and demographic characteristics. Of the three studied

CHANGES IN LAND COVER AND LAND USE IN THE KARST AREA
OF BOSNIA AND HERZEGOVINA

municipalities, only Široki Brijeg recorded an increase in population, both in the pre-war and post-war period (Table 2). Unlike it, the municipalities of Glamoč and Gacko record a continuous population decline, where the decline in the municipality of Glamoč amounted to 67% in the period 1991-2013. Changes in population before 1991 are definitely related to the geographic location (mountainous area of high karst and more favorable climate and better road connections in low-Herzegovina) and socio-economic changes that occurred at that time (industrialization, deruralization, depopulation), but those after 1991 were significantly influenced by the war activities in BiH. The geographic location and demographic trends are directly related to the economic activities of the observed area as evidenced by the fact that Široki Brijeg municipality has significantly better economic indicators compared to the other two municipalities.

Table 2. Population of the municipalities of Glamoč, Široki Brijeg and Gacko in 1961, 1991 and 2013

Municipality	Area (km ²)	Population			Change in population 1961-1991 (%)	Change in population 1991-2013 (%)
		1961	1991	2013		
Glamoč	1096	17250	12593	4038	-27,0	-67,9
Široki Brijeg	388	24732	27160	29809	+9,8	+9,8
Gacko	736	14033	10788	9734	-23,1	-9,8

The biggest changes in LU/LC in the 12-year period were recorded in the municipality of Glamoč, totaling 2,846.38 hectares. Changes occurred in the categories of agricultural and forest areas, mainly within the categories. In the municipality of Gacko, changes were recorded on an area of 504.17 hectares, while smallest change was recorded in the municipality of Široki Brijeg (271.87 ha of which 225 ha in the category of forest vegetation and other natural surfaces). In both municipalities, the majority of changes occurred in the categories of agricultural and forest areas. The analysis indicates that changes in LU/LC affected about 2.6% of the territory of the municipality Glamoč, and about 0.7% of the territory of the municipalities Gacko and Široki Brijeg.

Recognizing that the population is one of the main factors of changes in space, the question is why are those the smallest in the municipality of Široki Brijeg, despite an increase in population and substantial economic activity? The fact is that most of the population and economic activities are related to the area of Široki Brijeg, therefore the biggest changes, i.e. most of them, occurred there before 2000, which is the reference year for CORINE. Changes are clearly visible on the maps in Figure 2.

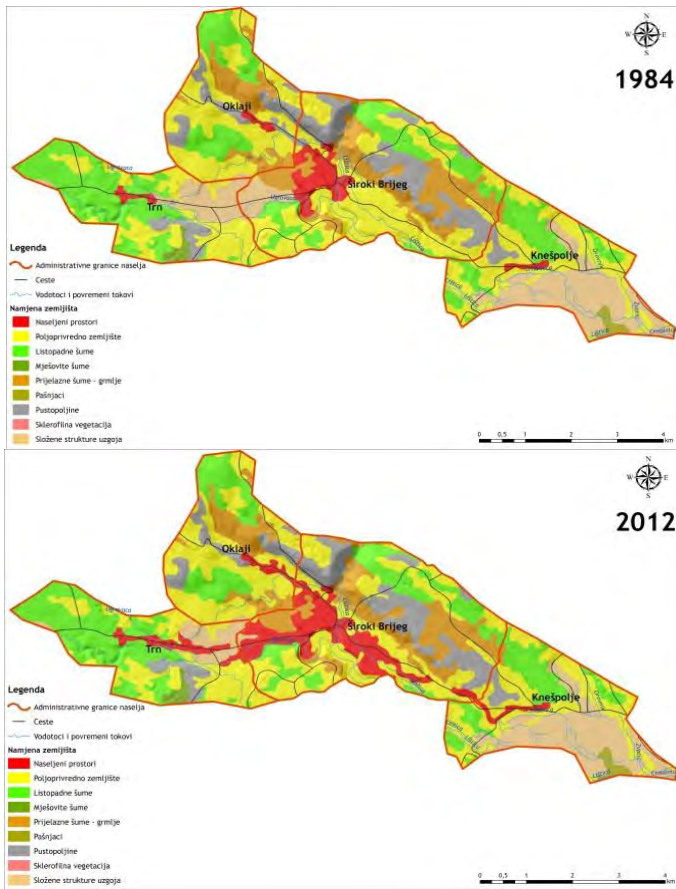


Figure 2. Changes in LU/LC in the wider area of Široki Brijeg (1984-2012)

CONCLUSIONS

Karst area, due to its natural features, has always been sparsely populated. Further depopulation was boosted by socio-economic changes both in the pre-war and post-war period. Natural and demographic characteristics of this area proved to be crucial for changes in land use/land cover. The most significant changes in building artificial surfaces took place before 2000, so that the biggest changes in LU/LC were recorded in the category of forest and other natural surfaces – they account for 76% of total recorded changes. Particularly pronounced here is the effect of forest fires to which poorly accessible mountainous areas of high karst are exposed (the areas affected by fire account for 70% changes in the category of forest). Karst as a whole, but mountainous areas of karst in particular, due to steep inclination, shallow soil and climate

characteristics, is naturally susceptible to erosion. The fire affected areas are additionally exposed to this type of soil degradation.

Lengthy process of depopulation and aging population of the karst areas associated with processes of deruralization and urbanization accelerate the trend of land abandonment and neglect in general. Particular attention should be paid to the conversion of agricultural land into artificial surfaces which, in the above stated circumstances, has been simplified.

REFERENCES

- Aley, T. 1992. The Karst Environment and Rural Poverty. *Ozarks Watch*, Vol. V, No. 3, pp. 19-21. <https://thelibrary.org/lochist/periodicals/ozarkswatch/ow50327.htm>, Accessed: January 2015.
- Čustović, H., Kovačević, Z. and Tvica, M. 2013. *Rural ecology*. University of Sarajevo.
- Cvitanović, M. 2014. Promjene zemljišnog pokrova i načina korištenja zemljišta u Krapinsko-zagorskoj županiji od 1991. do 2011. *Hrvatski geografski glasnik*, 76/1, 41-59.
- FAO, <http://www.fao.org/docrep/003/x0596e/x0596e01e.htm>, Accessed: January 2015.
- Han K.S., Champeaux, J.L. and Roujean, J.L. 2004. A land cover classification product over France at 1 km resolution using SPOT4/VEGETATION data. *Remote Sensing of Environment*, 92(1), 52-66.