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ANALYSIS OF LAND COVER CHANGES IN THE AREA OF THE TOWN OF GORAŽDE

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UDC: 911.3:711.061(497.6 Goražde)"1980-2018"

ABSTRACT
Analysis of land cover changes in the area of the town of Goražde
The subject of the research is the analysis of the land cover changes in the area of the town of Goražde. In the period after 1995, throughout the entire Bosnia and Herzegovina, a visible spontaneous spatial planning contributed to significant changes in the land cover. The research aims to determine how many changes have taken place in the last few decades in the researched area when it comes to land cover. The analysis is based on topographic maps from 1980, Google Earth images, then Corina Land Cover images from 2000, 2006, 2012, and 2018. Research on the topic was conducted through several phases. The first part of the paper refers to determining the geographical location of the research area and defining all its components. The second part of the paper deals with a detailed analysis of all categories of land cover in the last twenty years. The third part of the paper involves a comparative analysis of quantitative and qualitative indicators of land cover in the town of Goražde. The complete procedure of the analysis was performed using GIS, where the corresponding databases were created and a cartographic visualization for the investigated area was performed.

KEY WORDS
Goražde, planning, space, land cover changes, GIS.

1. Introduction

Humankind has been changing its natural environment for thousands of years. Land cover denotes the natural characteristics of the Earth's surface and the part immediately below the surface (forest grasslands, water, soil, buildings, etc. (Cvitanović, 2014) The study of land cover has come to the fore with the development of remote sensing and GIS. Analysis of land-use change is a very important segment in the field of spatial planning. Land cover mapping aims to show the spatial structure of the land, i.e., to single out zones of agricultural land, forest and unproductive land in order to enable proper planning of settlement expansion and other human activities (Kicošev and Dinčić, 1998). Conflicts of interest between agriculture and urbanization often occur in the vicinity of cities, especially those located in agricultural regions. In the recent period, new contrasts have emerged between urban areas and agricultural regions. Many farmers require positive action to regulate land use according to their physical properties (Marinović – Uzelac, 2001; Kicošev and Dinčić, 1998). Recently, we have witnessed changes in land cover in Bosnia and Herzegovina, which are often not in line with legislation and spatial planning documentation. Today's construction in the center of the town of Goražde is significantly higher compared to the previous few decades. The need for urban infrastructure construction has increased due to the functional diversification of space as well as the migration of the population on the rural-urban route, which significantly changed the land cover.

Undeveloped land is the only remaining alternative location for new construction (Đorđević, 2004). The land is one of the greatest natural resources of an environment. Modern processes in the development of the human community, especially the processes of industrialization and urbanization, have led to colossal devastation and degradation of the highest quality agricultural land. If the highest quality agricultural land is not currently used for agricultural purposes, it does not mean that it should not and cannot remain agricultural and that it should be used for another activity. Agronomic disinterest does not mean ecological disinterest. As a result of intensive use, the land is increasingly exposed to erosion processes and other adverse effects. One of the leading causes is the change of surface cover, deforestation of forest resources, etc. Also, construction in inadequate places and in an inadequate way is a common cause of the aforementioned adverse effects. The consequence is not only soil leaching, but the penetration of water into deeper layers disrupts the geomechanical properties of the soil, leading to the collapse of built structures or landslides (Marinović – Uzelac, 2001).

2. Geographical location

The Town of Goražde is located in the southeastern part of Bosnia and Herzegovina. According to the geographical regionalization of Bosnia and Herzegovina, the town belongs to the macroregion of Mountain-Valley Bosnia, i.e., the Upper Drina Mesoregion, and represents a mesoregional center. With its modern administrative structure, it belongs to the Bosnia-Podrinje Canton (Figure 1).

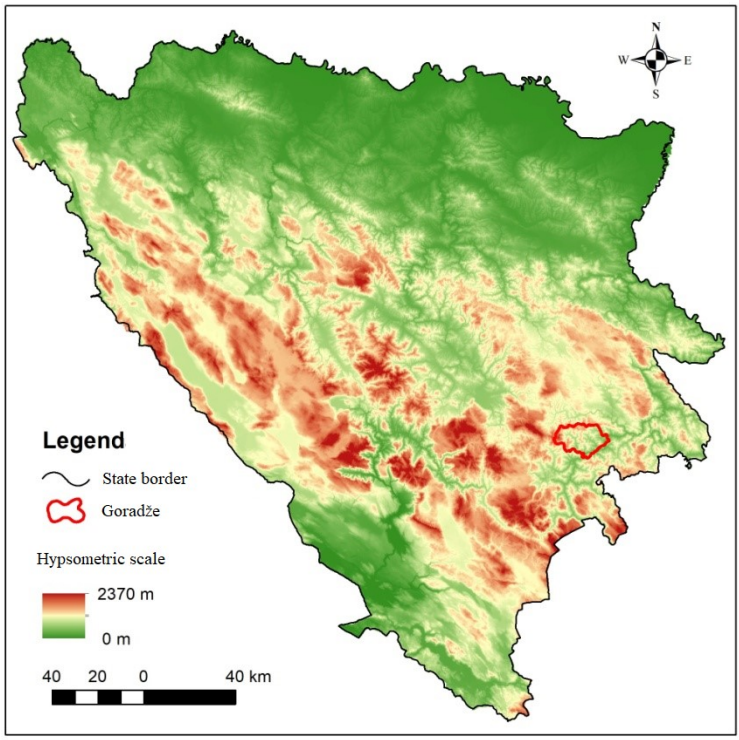

Figure 1: Geographical location of the Town of Goražde.
Source: GIS database (adapted and edited by the authors).

Geologically, the area of the Town of Goražde is predominantly built by younger Paleozoic deposits (clastic limestones and phyllites) with interbeds of the Lower Triassic (limestones and clasts) of the Middle Triassic (limestones and dolomites), Middle-Upper Triassic (dolomites, limestones and clasts), Devonian (clasts, limestones and phyllites) and quarters. In terms of geomorphology, fluvial denudation and fluvial accumulation forms of relief stand out. The fluvial denudation forms of relief are most dominant and cover almost the entire research area. Fluvial accumulation forms of relief are expressed in the valley extensions of the Drina River. Three climatic types alternate in the researched area: temperate-continental, pre-mountainous temperate-continental and

mountainous temperate-continental type. Average air temperatures range from 20C on the highest mountain peaks to 120C in river valleys. The average rainfall ranges from 700 to 800 mm at lower altitudes, while at higher altitudes the average rainfall is from 1000 to 1250 mm. In the hydrographic sense, the research area belongs to the Black Sea basin. The backbone of the river network is the river Drina (Hrelja et al., 2012), which is formed by merging the two rivers Piva and Tara near Šćepan Polje at 433 m above sea level. In terms of biogeography, Goražde is located in the Euro-Siberian subregion, in the ecosystem of Hungarian oak, beech and beech-fir forests.

Favorable climate, hydrographic and biogeographical characteristics, as well as fertile soil and geographical position, have been favorable natural conditions that have enabled settlement in this area since ancient times. The largest number of settlements, i.e., the highest population density, is along with river courses, primarily in the valley extensions of the Drina River. The Drina Valley is the main traffic artery and is part of an important road that connects the Adriatic coast with the interior of Eastern Bosnia and Herzegovina. Economically and geographically, Goražde has a tradition of agricultural (fruit growing) and industrial production. In the earlier period, the specialized and chemical industries were exclusively represented, while in recent times the textile and electrical engineering and mechanical industries have developed significantly (Hrelja et al., 2017).

3. Research methodology

The methodological concept of the research is defined according to the goals and set tasks of the paper, which refer to the analysis of the change of land cover in the area of the Town of Goražde. The following scientific methods were applied for the research: spatial analysis method, geostatistical method, quantitative method, comparative analysis method (comparative method), GIS method, field observation method, and synthesis of all collected and analyzed data. The research of land-use change included a detailed analysis of:

- Topographic maps of Goražde 1:25 000 from 1980 and Google Earth image,
- Analysis of Corina Land Cover images for 2000, 2006, 2012 and 2018 and
- Analysis of the area and manner of using the soil capability of the land.

The CLC database contains data on the land cover for the reference years as well as data on the change in land cover between the stated reference years. The standard approach of CLC database development is based on visual interpretation of satellite images according to the accepted standard CLC methodology, giving vector data on the land cover at a scale of 1: 100,000,

minimum polygon width 100m and minimum mapping area 25 ha, or 5 ha for land cover change base. The defined CLC nomenclature includes 44 classes, arranged in 3 levels, each of which describes a different land cover (www.haop.hr). Available CLC images were collected, imported into GIS, and then allocated to the Goražde area. After that, a comparative analysis of land cover data and a synthesis of the analyzed data were performed.

4. Analysis of change in land cover

The analysis of land cover change in the researched area was performed for the period from 2000 to 2020. In order to obtain land cover change data, Corina Land Cover images were analyzed. The analysis involves a detailed analysis of the change in land cover visible from a topographic map at a scale of 1:25 000 and a Google Earth image. Special attention is paid to the analysis of soil capability, their distribution, area and method of use. In order to obtain precise data on changes in land cover, a database was formed for them in order to quantify the indicators. The aim of the analysis of Corina Land Cover images is to determine the change in the purpose of land cover in the last twenty years. CLC recordings for four years were analyzed: 2000, 2006, 2012 and 2018. In the area of the Town of Goražde according to the CLC, the following first level classes are represented: artificial surfaces, agricultural areas, forests and semi-natural areas, water bodies (Figure 2).

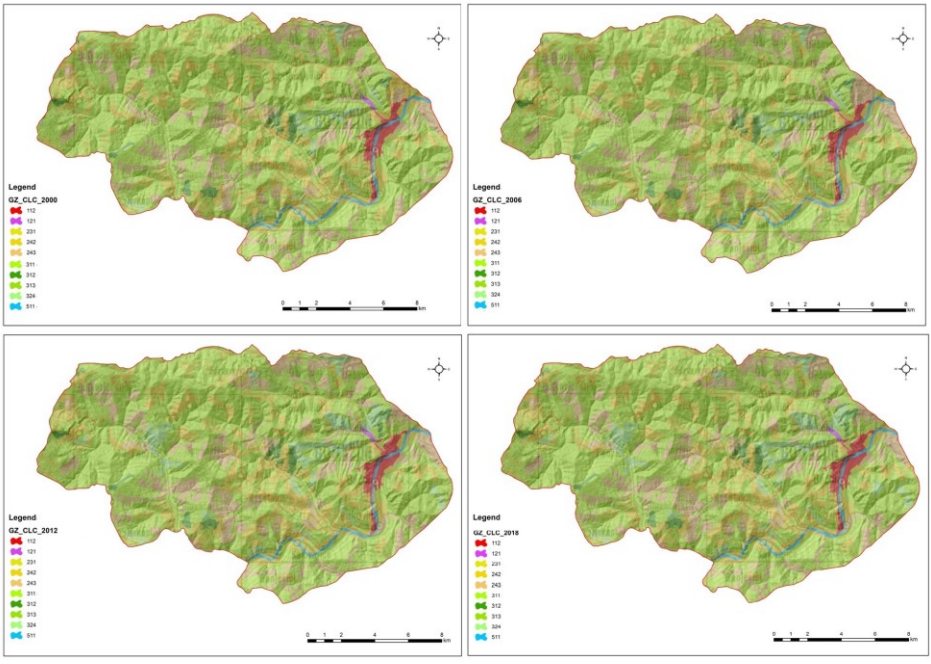

Figure 2: CLC 2000 – 2018.
Source: www.copernicus.eu (adapted and edited by the authors).

According to the 2nd level, the following are represented: urban fabric, industrial, commercial and transport units, pastures, heterogeneous agricultural areas and forests and inland wetlands (Table 1).

Table 1: CLC in the area of the Town of Goražde for the period 2000 - 2018.

CLC code	CLC class	2000	2006	2012	2018	2000-2018 change %
		area (km²)				%
112	Discontinuous urban fabric	3,4	3,4	3,7	3,7	**8,2**
121	Industrial or commercial units	0,3	0,3	0,3	0,3	**0,0**
231	Pastures	6,0	6,0	6,0	6,0	**0,3**
242	Complex cultivation patterns	41,5	39,9	40,4	40,4	**-2,6**
243	Land principally occupied by agriculture, with significant areas of natural vegetation	31,6	34,0	35,4	35,4	**12,1**
311	Broad-leaved forest	153,0	152,2	143,8	143,4	**-6,2**
312	Coniferous forest	3,4	3,4	3,7	3,7	**8,5**
313	Mixed forest	4,0	4,0	3,7	3,7	**-7,1**
324	Transitional woodland/shrub	4,9	4,9	11,0	11,4	**134,3**
511	Water courses	2,5	2,5	2,5	2,5	**0,0**

Source: www.copernicus.eu (adapted and edited by the authors)

The analysis of land cover data in the area of the Town of Goražde established broad-leaved forest has the highest surface area, which is conditioned by the physical-geographical limitation of settlements, infrastructure and human activities on a very small area - valley extensions along Water courses. Considering the mentioned factors, significant areas belong to the group of arable plots and agricultural areas with the share of vegetation cover. In the analyzed period, significant changes occurred in the land cover. From 2000 to 2006, there was a decrease in the area of the group of arable plots and broad-leaved forest, while a slight increase in agricultural areas with a share of natural vegetation was found. Such changes are the result of abandonment and overgrowing of arable land with natural vegetation, especially in rural settlements, and such changes have been continuous to this day.

In the second observed period, from 2006 to 2012, significant changes in land cover stood out. An increase in discontinuous urban fabric, a group of arable plots, agricultural areas with a share of natural vegetation, coniferous forest, and areas of the transitional woodland/shrub was determined. These changes occurred at the expense of reducing the cover of broad-leaved forest and mixed deciduous and coniferous forest (Figure 3).

Figure 3: Increasing discontinuous urban fabric.
Photo: Edin Hrelja

By 2018, there has been an increase in the transitional woodland/shrub at the expense of reducing the area of broad-leaved forest. In the entire researched period, from 2000 to 2018, the largest increase in cover was expressed in the transitional woodland/shrub, land principally occupied by agriculture, with significant areas of natural vegetation, discontinuous urban fabric and coniferous forest. In contrast to the above areas, the highest decrease was expressed in the group of arable plots, broad-leaved forest and mixed deciduous and coniferous forest (Figure 4).

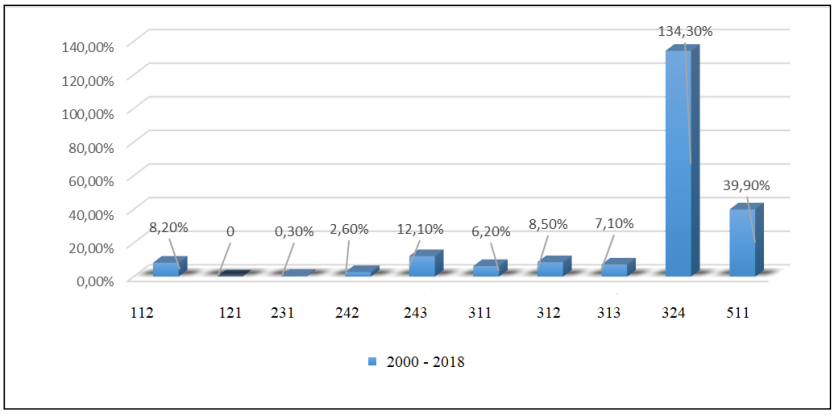

Figure 4: Rate of change CLC 2000 – 2018.
Source: www.copernicus.eu (adapted and edited by the author)

Due to limited areas in the inner town area, the most intensive changes in land cover were expressed in agricultural areas. Also, this part of the research aims to determine the endangerment of soil that is protected by law. According to Article 48 of the Law on Agricultural Land, agricultural land is classified into eight soil capability categories, whereby soil from categories 1 to 4 is used exclusively as agricultural land (I agrozone) (Figure 5 and 6).

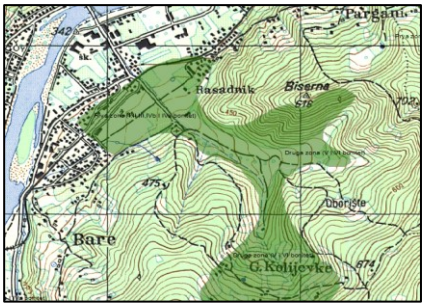

Figure 5: I agrozone of settlement Rasadnik.

Figure 6: A clip of a Google Earth image.

The separation of soil capability classes aims to prevent the conversion of the most productive land into construction land, i.e., to reserve and preserve the highest quality land complexes for agriculture, which is also regulated by law (Kicošev and Dinčić, 1998). This analysis established that a large number of facilities have been built in Goražde in the area of the first agrozone (settlement Rasadnik) in the last few years, which directly does not comply with the established legal regulations on the protection of agricultural land.

There are many examples in the area of the Town of Goražde. Of particular concern is the fact that there are plans to further influence the most valuable agricultural areas by building settlements, urban infrastructure and industrial plants (Kodžaga Polje).

Therefore, spatial planning is necessary to do everything to preserve, protect and rationalize the use of higher quality agricultural land. For the needs of urban planning, pedological conditions are considered in order to maximally protect better quality agricultural lands due to the process of expansion and development of urban areas, industrial complexes and infrastructure systems (Marinović - Uzelac, 2001).

5. Conclusion

The conducted research ultimately confirmed the research assumptions from the introductory part of the paper. Based on the results of the research, it is possible to single out the following concluding assumptions:

- In the area of the Town of Goražde in the last twenty years there have been significant changes in land cover;
- The increase in land cover is expressed in the transitional woodland/shrub, land principally occupied by agriculture, with significant areas of natural vegetation, discontinuous urban fabric and coniferous forest.
- The decrease in land cover is expressed in the group of arable plots, broad-leaved forest and mixed deciduous and coniferous forest.
- The reduction of agricultural land in rural areas is the result of the abandonment of rural areas - overgrowing with natural vegetation.
- Endangering the highest quality agricultural land in the urban area (I-IV soil capability category) is done by building settlements and urban infrastructure.
- The plan for the construction of new facilities does not respect the spatial planning and legal regulations (new buildings in Rasadnik, the industrial zone Kodžaga polje, agricultural areas in the town center, etc.)

Confirming the set assumptions imposes the conclusion that there are significant changes in land cover in the research area. If the spatial planning documentation and legislation do not stop these changes, they will ultimately lead to significant problems in sustainable development.

Areas for agriculture are limited and must be viewed as a limited good. Urban and industrial spaces are mostly expanding at the expense of the pedospheric complex. Agricultural land, wherever it is and whatever it is, must be saved to the greatest extent because it is on the verge of exhaustion. Spatial planning, as a broader and integral discipline, should make the final decision on what a specific spatial plan should be used for (Marinović – Uzelac, 2001).

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