

ARTICLES

TRENDS OF SPATIAL DEVELOPMENT IN BOSNIA AND HERZEGOVINA IN PERIOD 2000-2018*AUTHOR***Branislav Drašković**

University of East Sarajevo, Faculty of Agriculture, Vuka Karadžića 30,
71123 East Sarajevo, Bosnia and Herzegovina.

E-mail: branislav.draskovic@pof.ues.edu.ba

UDC: 911.37:711.4(497.6)"2000-2018"

ABSTRACT

Trends of spatial development in Bosnia and Herzegovina in period 2000-2018
Bosnia and Herzegovina (BiH) has undergone significant changes in land use during the last 20 years. According to CORINE Land Cover (CLC) artificial areas have increased spatial coverage, forests and semi-natural areas as well, while agricultural land has decreased. It is to be expected that such trends will continue, having in mind demographic processes, urbanization processes, infrastructure and economic projects, etc. The CLC project has started about 40 years ago and coordinated by the European Environment Agency (EEA). BiH has been participating in the project since 2000. Every six years, new data are published in form of land cover types and changes comparing to the previous period, so that trends in spatial development can be followed. In this regard, there are already four databases in BiH: for 2000, 2006, 2012 and the most recent for 2018. Data are obtained mainly by satellite image processing and divided into three levels: the first level contains 5 main classes (artificial surfaces, agricultural areas, forests and seminatural areas, wetlands and water bodies), the second level has 15 subclasses and the third level, the most detailed, has 44 subclasses. At the third level, there are distinction between similar land cover types, e.g. continuous and discontinuous urban areas or between broad-leaved and coniferous forests, etc. This has resulted in a unique database that aims to determine the state and trends of spatial development, which is useful for creating strategic plans: in the field of spatial planning, forestry, agriculture, natural resources management, environment, etc.

KEY WORDS

trends, spatial development, land cover, BiH, CLC project.

1. Introduction

Bosnia and Herzegovina (BiH) is a country situated in western part of the Balkan peninsula and covers an area of 51,209 km². B&H is composed of two political entities: The Federation of Bosnia and Herzegovina (FBiH) and Republic of Srpska (RS), including a third unit as well, Brčko District (BDBiH). According to the last census from 2013, BiH has about 3.53 million inhabitants (Agency for Statistics of Bosnia and Herzegovina 2016), with a population density of just about 68 persons per km², one of the lowest in Europe. Population decreased by 845 thousand comparing to the previous census from 1991, when it was 4.37 million inhabitants.

Natural and socio-economic processes have different effects on land cover and land use (LCLU) as well as changes in spatial development. Natural processes happens without human influence, e.g. overgrowing of abandoned agricultural areas into shrubs, transition from one type of land cover to another within the same class (e.g. step-by-step transformation of broad leaved forest into mixed or vice versa) and usually take place slowly (except in case of natural disasters: floods, earthquakes, wild fires, etc.). On the other hand, socio-economic processes are faster and they are the main driver of changes, where man adapts Earth's surface to his needs.

Depopulation is the dominant socio-economic process in B&H, especially during the second decade of the 21st century. Republic of Srpska has been noted a negative birth rate since 2002, and in the period from 2013-2018 it averages -4,732 per year (Republic of Srpska Institute of Statistics 2020). The situation is similar in the Federation of B&H, which later started with negative birth rate, for the first time since 2013, while losses in the period 2013-2018 average -4,580 per year (Institute for Statistics Federation Bosnia and Herzegovina 2020).

Official data of the entity statistical agencies shows that in the period 2013-2018. Republic of Srpska lost 23,277 and Federation of B&H 22,898, which is in total 46,175 inhabitants, just in five years. Over time, due to industrialization, deagrarianization, and urbanization, the result was depopulation in rural areas. The intensity of urbanization in Republic of Srpska is lower than in the entity of Federation of B&H because of the fact that only 35 % of the B&H population lives on 49 % of the B&H territory (i.e., RS territory) (Dražković et al 2020). Speaking about migration, the situation is even worse. There is strong demographic trend, the process of young people leaving to EU countries (no official numbers). In the first six-year period (2000-2006), the refugee return process was more intensive, which was reflected in land use changes in the form of faster growth of artificial areas compared to the second and third periods.

2. Methodology

The changes that occur on the Earth's surface are visible on satellite images, and over time they can be compared and subsequently determine changes and trends in spatial development. The CORINE Land Cover project, which includes 39 European countries, is based on the principle of visual interpretation of satellite images. The interpretation was supported by ancillary data such as orthophoto maps, topographic maps, statistical data, field work, etc.

The thematic mapping of the biophysical cover can be viewed from two aspects: (1) surface cover or soil cover deals with the nature of certain features (forests, crops, water bodies, naked rocks, etc.); (2) The use of land deals with the socio-economic function and the purpose of the basic areas (agriculture, habitats, environmental protection) (Dražković and Drešković 2017). By harmonizing these principles, a nomenclature with a structural classification comprises three hierarchical levels (EEA 2019b). Databases (vector and raster) of land cover types (CLC) and land use change (CHA) are available on the Copernicus website. Copernicus is the European Union's Earth observation program coordinated and managed by the European Commission in partnership with the European Space Agency, the EU Member States and EU Agencies. The 2018 version also funded by Copernicus was produced in less than 1 year (Copernicus Land Monitoring Services 2019). For analysis of spatial changes, it is recommended to use CHA database which is more precise (5 ha) than CLC database (25 ha).

The vector data were processed in GIS software and extracted for territory of BiH, for each period separately. The data are exported to Microsoft Excel and classified in order to obtain more complex information. Then, the individual sums are calculated using SUBTOTAL SUM tool by land cover types, changes and periods. By processing this information, it can be obtained a spatial and temporal insight into all the processes which take place in the field. Land Cover in Bosnia and Herzegovina is characterized by 35 out of 44 classes of the CORINE Land Cover nomenclature.

3. Results and discussion

Analysing the CHA database from 2000 to 2018, sum of total changes amounting to 105,004 ha (or 1,050.04 km²), which is about 2 % of the territory of B&H (Figure 1), or 0.11 % annually. At the first level of classification, Table 1 shows that forests and semi-natural areas increased the spatial coverage from 61.08 % to 64.36 %, while agricultural areas decreased (by almost the same percentage) from 36.81 % to 33.15 %. Artificial areas increased from 1.35 % to 1.70 %, while wetlands and waters stayed on the same level.

Table 1: Land cover types at first classification level (CODE 1) for 2000 and 2018

COD	Land cover types	CLC 2000	P (%)	CLC 2018	P (%)
1	Artificial surfaces	68,933	1.35	86,870	1.70
2	Agricultural land	1,885,125	36.81	1,697,995	33.15
3	Forest and seminatural	3,128,293	61.08	3,296,235	64.36
4	Wetlands	5,350	0.10	5,943	0.12
5	Water	33,757	0.66	34,416	0.67
	Total	5,121,459	100.0	5,121,459	100.0

Source: Copernicus Land Monitoring Service, 2019

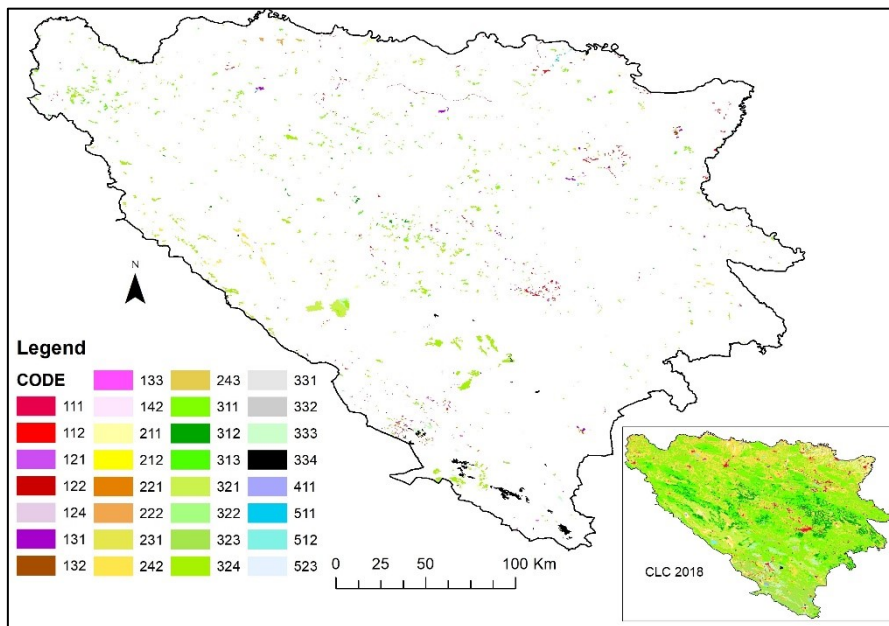


Figure 1: Spatial distribution of land cover changes in B&H during the period 2000-2018.

Table 2 shows that at the second classification level forests (3.1) had the largest expansion by 2.07 %, while heterogeneous agricultural areas (2.4) had the highest decrease rate by 3.36 %. Urban areas increased from 0.99 % to 1.27 %. Anyway, forest (3.1.) cover most of the territory in B&H, from 44.27 % in 2000 to 46.34 % in 2018, followed by heterogeneous agricultural areas (2.4.) from 26.48 % to 23.12 % and shrub and/or herbaceous vegetation associations (3.2.) from 15.54 % to 15.51 %.

Table 2: Land cover types at second classification level (CODE 2) for 2000 and 2018.

CODE	Land cover types	CLC2000	%	CLC2018	%
1.1.	Urban fabric	50,958	0.99	64,952	1.27
1.2.	Industrial, comercial and transport units	6,895	0.13	9,808	0.19
1.3.	Mine, dump and construction sites	10,586	0.21	10,747	0.21
1.4.	Artificial, non-agricultural vegetated areas	494	0.01	1,363	0.03
2.1.	Arable land	114,056	2.23	178,711	3.49
2.2.	Permanent crops	6,156	0.12	11,018	0.22
2.3.	Pastures	408,597	7.98	324,206	6.33
2.4.	Heterogeneous agricultural areas	1,356,307	26.48	1,184,060	23.12
3.1.	Forest	2,267,192	44.27	2,373,538	46.34
3.2.	Shrub and/or herbaceous vegetation associations	795,622	15.54	814,678	15.91
3.3.	Open spaces with little or no vegetation	65,479	1.28	108,019	2.11
4.1.	Inland wetlands	5,350	0.10	5,943	0.12
5.1.	Inland waters	32,296	0.63	34,416	0.67
5.2.	Marine waters	1,461	0.03	0	0.00
Total		5,121,449	100.00	5,121,449	100.00

Source: Copernicus Land Monitoring Service, 2019.

At the third level of classification, Table 3 shows that during 18 years the highest spatial growth was noted by sclerophilous vegetation (3.2.3.) with 139,263 ha (increase by 166.82 %) compared to the initial year. But, it should be mentioned, according to B&H Final Report (EEA 2019a) class 3.2.3. (sclerophyllous vegetation) was wrongly interpreted as 3.2.4. (transitional woodland shrub) and in some cases as 3.1.1. (broad-leaved forest). This was a systematic mistake identified in southern part of the country in Herzegovina region. It is followed by non-irrigated arable land (2.1.1.) with 65,298 ha (58.74 %), broad-leaved forest (3.1.1.) with 55,231 ha (3.42 %), sparsely vegetated areas (3.3.3.) with 40,078 ha (67.17 %), natural grassland (3.2.1.) with 39,806 ha (16.03 %), mixed forest (3.1.3.) with 27,079 ha (6.68 %), coniferous forest (3.1.2.) with 24,036 ha (9.76 %), discontinuous urban area with 13,976 ha (27.53 %), etc. The largest spatial decrease was in: transitional woodland/shrub (3.2.4.) with -160,345 ha (-36.17 %), land principally occupied by agriculture, with significant areas of natural vegetation (2.4.3.) with -32,855 ha (-23.93 %), pastures (2.3.1) with -84,391 ha (-20.65 %) and complex cultivation patterns (2.4.2) with -32,855 ha (-4.25 %) (Figure 2).

Table 3: Land cover types at third classification level (CODE 3) for 2000 and 2018.

Code	Land cover types	CLC 2000		CLC 2018	
		P (ha)	P (%)	P (ha)	P (%)
1.1.1.	Continuous urban fabric	187	0.004	205	0.004
1.1.2.	Discontinuous urban fabric	50,771	0.991	64,747	1.264
1.2.1.	Industrial or commercial units	5,726	0.112	7,512	0.147
1.2.2.	Road and rail networks and associated land	172	0.003	1,093	0.021
1.2.4.	Airports	997	0.019	1,203	0.023
1.3.1.	Mineral extraction sites	9,452	0.185	8,685	0.170
1.3.2.	Dump sites	702	0.014	1,379	0.027
1.3.3.	Construction sites	432	0,008	683	0.013
1.4.1.	Green urban areas	0	0.000	26	0.001
1.4.2.	Sport and leisure facilities	494	0.010	1,337	0.026
2.1.1.	Non-irrigated arable land	111,161	2.170	176,459	3.445
2.1.2.	Permanently irrigated arable land	2,904	0.057	2,252	0.044
2.2.1.	Vineyards	1,460	0.029	3,021	0.059
2.2.2.	Fruit trees and berry plantations	4,696	0.092	7,997	0.156
2.3.1.	Pastures	408,597	7.978	324,206	6.330
2.4.1.	Annual crops associated with permanent crops	0	0.000	52	0.001
2.4.2.	Complex cultivation patterns	773,587	15.105	740,732	14.463
2.4.3.	Land principally occupied by agriculture, with significant areas of natural vegetation	582,720	11.378	443,276	8.655
3.1.1.	Broad-leaved forest	1,615,194	31.538	1,670,425	32.616
3.1.2.	Coniferous forest	246,345	4.810	270,381	5.279
3.1.3.	Mixed forest	405,653	7.921	432,732	8.449
3.2.1.	Natural grassland	248,341	4.849	288,147	5.626
3.2.2.	Moors and heathland	20,468	0.400	20,800	0.406
3.2.3.	Sclerophyllous vegetation	83,483	1.630	222,746	4.349
3.2.4.	Transitional woodland/shrub	443,330	8.656	282,985	5.525
3.3.1.	Beaches, dunes, sands	591	0.012	101	0.002
3.3.2.	Bare rock	5,153	0.101	5,898	0.115
3.3.3.	Sparsely vegetated areas	59,665	1.165	99,743	1.948
3.3.4.	Burnt areas	70	0.001	2,277	0.044
3.3.5.	Glaciers and perpetual snow	0	0.000	0	0.000
4.1.1.	Inland marshes	5,350	0.104	5,244	0.102
4.1.2.	Peatbogs	0	0.000	699	0.014

5.1.1.	Water courses	13,145	0.257	14,012	0.274
5.1.2.	Water bodies	19,151	0.374	20,404	0.398
5.2.3.	Sea and ocean	1,461	0.029	0	0.000
Total		5,121,459	100.000	5,121,459	100.000

Source: Copernicus Land Monitoring Service, 2019.

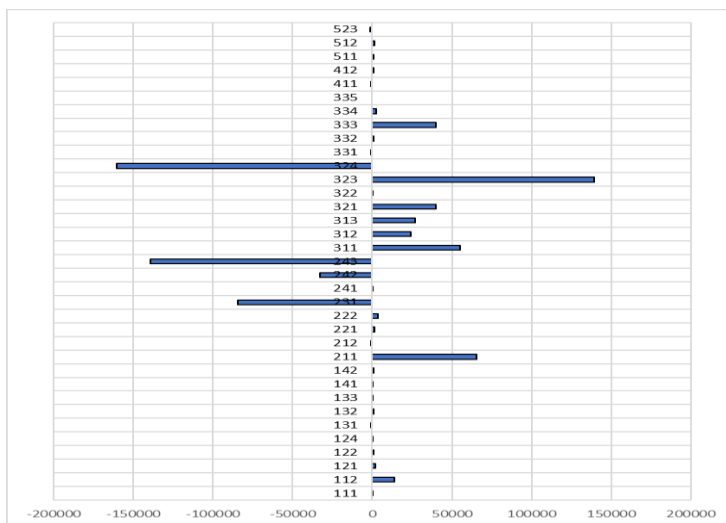


Figure 2: Changes at third level of classification during the period 2000-2018 (ha).

Urban areas significantly increased the spatial coverage compared to the initial year, continuous by 9.63 % and discontinuous by 27.53 %. This can be related to the process of refugee return in the near post-war period, construction of new housing, settlement development, etc., especially since these changes in the first period (2000-2006) were much more intense (artificial areas increased from 1.35 % to 1.54 %) compared to the other two (2006-2012, an increase from 1.54 % to 1.65 %, and 2012-2018, an increase from 1.65 % to 1.7 %). In general, the growth rate of artificial areas was among the highest in Europe, even during the second and third periods when there was a slowdown. The reason can be related for migrations, which were much more than in other European countries.

Analysis of changes for the three six-year periods (databases CHA 2000-2006, CHA 2006-2012 and CHA 2012-2018) shows that most of them happened during the first period, 0.93 % (Table 4). In the second period, the intensity of changes decreased to 0.39 % or more than twice less than in the first. The dynamics of spatial development slowed down significantly and according to the European Environment Agency report for B&H (2017) was one of the slowest in Europe due to the reduction of the intensity of changes related to forests and semi-natural areas (less logging and transitions).

Other slower processes compared to the first period were lower volume of housing construction and reduced internal conversion in agriculture. In the third period, the changes are growing again and reach the value of 0.73 %.

Table 4: Total changes by periods

Period	P (ha)	P (%) of total changes (2000-2018)	P (%) of territory BiH
2000-2006	47,573	45,31	0,93
2006-2012	19,785	18,84	0,39
2012-2018	37,646	35,85	0,73

Source: Copernicus Land Monitoring Service, 2019

Figure 3 shows the cumulative changes by individual types in all periods, from 2000-2018. Two processes dominate: the conversion of broad leaved forest into transitional woodland/shrub (19.34 %) and vice versa (14.53 %), with more than a third (33.82 %) of all changes.

It is followed by revitalization processes of burnt areas: the transition of burned zones to low-productivity natural grassland (3.3.4.-3.2.1.) and the transitional woodland/shrub (3.3.4.-3.2.4.) with 5.88 % and 5.32 %. Among the processes related to urbanization, the largest changes are noted regarding to conversion of complex cultivation and non-irrigated arable land into a discontinuous urban area (2.4.2.-1.1.2. and 2.1.1.-1.1.2.) respectively with 3.49 % and 1.17 %. So, it can be concluded that the settlements are spreading mostly at the agricultural land which are in a way permanently lost.

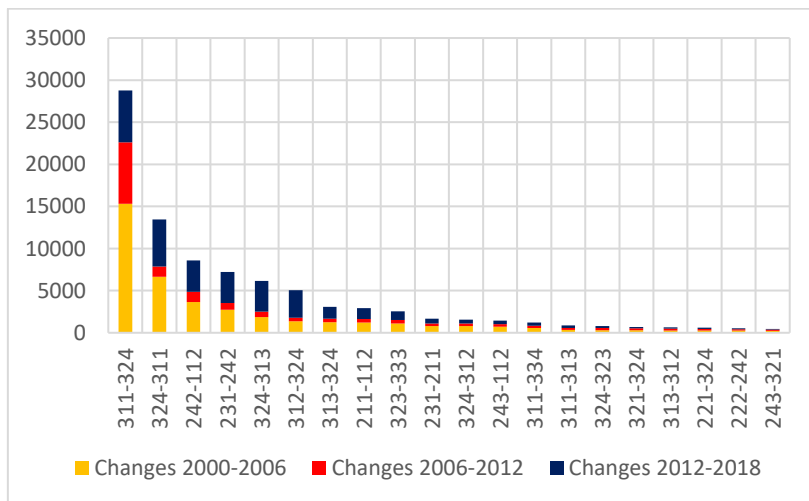


Figure 3: The quantity of changes by land cover types during the periods (ha)

Table 5 shows structure of changes by periods, for artificial areas, agricultural areas and forests and semi-natural areas (codes 1, 2 and 3), which consist 99.96 % of the total changes. It is notable that artificial areas and forests and semi-natural areas are increasing, while agricultural areas are decreasing.

Table 5: Structure of changes at first level of classification in BiH (ha)

Changes*	2000-2006	2006-2012	2012-2018	Total
1.x.x.-x.x.x.	746	712	536	1,994
x.x.x.-1.x.x.	8,605	2,364	3,352	14,321
1.x.x.-1.x.x.	294	58	195	547
2.x.x.-x.x.x.	13,728	3,247	3,333	20,308
x.x.x.-2.x.x.	5,115	2,353	1,535	9,003
2.x.x.-2.x.x.	4,563	1,247	425	6,235
3.x.x.-x.x.x.	32,772	15,122	33,692	81,586
x.x.x.-3.x.x.	32,950	14,284	32,544	79,778
3.x.x.-3.x.x.	31,330	13,474	31,481	76,285
Total	47,537	19,785	37,646	104,968

*x can be any number from 1 to 4 and also 5 for the first column.

Source: Copernicus Land Monitoring Service, 2019.

In the first period, artificial areas changed the type of land cover in the amount of 746 ha, of which 294 ha or 39.4 % belongs to internal conversion. In the second period, the changes amount to 712 ha, and the internal conversion decreases to 58 ha or 8.15 %. In the third period, there was a decrease in changes to 536 ha, but internal conversion returns to the level of the first period and amounts to 195 ha or 36.38 %. The conversion of other types to artificial areas is much more larger. Geographically, the artificial development is distributed over the whole country of B&H. During the first period it was 8,605 ha, in the second 2,364 ha and third 3,352 ha. So, in total, artificial surfaces were spread to other types in amount of 14,321 ha.

The flow with rapid decrease of intensity were urban residential sprawl. It has to be mentioned here, that the sprawl in the period 2006–2012 was driven mostly by the extension of mining areas and by construction, while residential sprawl—the main driver of artificial development in the previous period—almost disappeared from the landscape (EEA 2017). Conversion of agricultural areas into other types over the period 2000-2006 was 13,728 ha. The next two periods were followed by a significant reduction to 3,247 ha (2006-2012) and 3,333 ha (2012-2018).

In the opposite direction, the conversion from other types into agricultural areas had a significantly lower intensity in all periods. In the first period it was 5,115 ha (4,563 ha belongs to internal conversion, ie change of one type of agricultural area to another), in the second period 2,353 ha (internal conversion 1,247 ha) and in the third 1,535 ha (internal conversion 425 ha). Agricultural areas are mostly converted into artificial, namely complex cultivation (2.4.2.), non-irrigated arable land (2.1.1) and land principally occupied by agriculture, with significant areas of natural vegetation (2.4.3.) in discontinuous urban area (1.1.2.). The total amount of conversion of agricultural areas into artificial zones is 10,465 ha (almost 10 % of all changes). Agricultural areas was also converted into forest and semi-natural areas in the amount of 3,235 ha (about 3.1 % of all changes).

Speaking about forests and semi-natural areas, internal conversion during the period 2000-2006 it amounted to 31,330 ha or 65.8 % of the total changes. In the period 2006-2012 it was almost three times smaller and amounted to 13,474 ha or 68.1 %. According to EEA (2017) the slowdown during the period 2006–2012 was caused mostly by the rapid decrease of the intensity of forest creation and management. The third period noted the largest internal changes: 31,481 ha or 83.62 % of the total changes. It shows that internal conversion within forests and semi-natural areas (transition from one subclass to another) has the highest intensity of change (this is expected considering the large spatial coverage), which is also common trend in other European countries.

4. Conclusion

The analysis of the CORINE Land Cover database and changes that have taken place on the ground there are three main trends of spatial development of B&H in period 2000-2018. The first trend has a qualitative attributes and refers to the growth of artificial areas, which increased the spatial coverage from 1.35 % to 1.7 %. During the time this growth has become slower, as a result of negative demographic and socio-economic processes, and is likely to continue in the future.

The second significant trend is quantitatively the most intensive and refers to the decrease in agricultural land, which noted decrease of 3.65 % compared to the initial year. Discontinuous urban areas (around 2/3) and forests and semi-natural areas (1/3) are the most widespread across agricultural land.

The third trend is related to increasing of spatial coverage of forests and semi-natural areas in amount of 3.24 %. The most common process of conversion of other land cover type into forest and semi-natural areas is related to overgrowth of heterogeneous unproductive agricultural land into shrubs and natural grasslands.

5. References

- Agency for Statistics of Bosnia and Herzegovina 2016: Agencija za statistiku BiH, Popis stanovništva, domaćinstava i stanova u Bosni i Hercegovini 2013, Sarajevo. <http://www.statistika.ba/> (15.11.2020)
- Copernicus Land Monitoring Services 2019: CORINE Land Cover [Database]. <http://land.copernicus.eu/pan-european/corine-land-cover/> (20.02.2019)
- Drašković B., Ponosov A., Zhernakova N., Gutalj M., Miletić B. 2020: Land cover types and changes in land use in Republic of Srpska (Bosnia and Herzegovina) over the period 2000-2018. *Journal of the Geographical Institute "Jovan Cvijić" SASA*, 70 (1), pp 81-88. Internet <https://doi.org/10.2298/IJGI2001081D>
- Drašković B. and Drešković N. 2017: Trendovi prostornog razvoja na području opštine Pale u periodu 2000–2012, Zbornik radova sa naučnog skupa: *Nauka i stvarnost*, Knjiga 11, Tom 2, 523–536.
- European Environment Agency (EEA) 2019a: BiH Final Report 2018. http://cdr.eionet.europa.eu/ba/eea/clc/envw6skew/CLC2018_BA_Final_Report_Information.pdf (05.12.2019)
- European Environment Agency (EEA) 2019b: Corine Land Cover Nomenclature Guidelines, <https://land.copernicus.eu/user-corner/technical-library/corine-land-cover-nomenclature-guidelines/html> (10.11.2020)
- European Environment Agency (EEA) 2017: Bosnia and Herzegovina land cover country fact sheet 2012. <https://www.eea.europa.eu/themes/landuse/land-cover-country-fact-sheets/ba-bosnia-and-herzegovina-landcover-2012.pdf/view> [18.05.2019.]
- Institute for Statistics Federation Bosnia and Herzegovina 2020: Federalni zavod za statistiku, Tematski bilteni – stanovništvo i registar, Sarajevo. <http://fzs.ba/index.php/publikacije/godisnji-bilteni/stanovnistvo-i-registar/>(18.11.2020)
- Republic of Srpska Institute of Statistics 2020: Republički zavod za statistiku Republike Srpske, Statistički bilten, Demografska statistika. https://www.rzs.rs.ba/static/uploads/bilteni/stanovnistvo/BiltenDemografskaStatistika_2020_WEB.pdf (18.11.2020)

