

ARTICLES

MORPHOLOGIC CHARACTERISTICS OF THE UNA-SANA CANTON RELIEF AS SPATIAL PLANNING FACTOR*AUTHORS**Aida Korjenić, Marija Misilo**Department of Geography, Faculty of Science, University of Sarajevo, Zmaja od Bosne 33-35, 71000 Sarajevo, Bosnia and Herzegovina, e-mail: aidakorjenic@yahoo.com; m.misilo@yahoo.com*

UDK: 911.2:711.061(497.6-16)

*ABSTRACT****Morphologic characteristics of the Una-Sana Canton relief as spatial planning factor***

In preparation of spatial plans a significant place belongs to geomorphologic characteristics of the given area. With analysis of general geomorphologic characteristics, the particular relief units and their elements are distinguished, by which global and specific characteristics of relief may be noticed. This reflects on the level of complexity of the analysis of geomorphologic features in the spatial plan, and with proper evaluation of macro-relief characteristics of the observed area, a high level of valorisation of their values is achieved.

For the purpose of analysis of morphological features of the Una-Sana Canton relief, the following quantitative geomorphologic methods are applied: analysis of hypsometric relations, analysis of slopes, analysis of vertical diversity of relief and analysis of expositions. Results of the analysis indicate to a high level of dependence of distribution of settlements and economic activities on morphologic features of relief, as well as on further opportunities of spatial development of the Canton.

*KEYWORDS**morphologic features of relief, Una-Sana Canton, spatial planning*

1. Introduction

The basic point of this paper is an idea of spatial planning as „geographical reflexion of economic, social, cultural and ecological politics of a society which, at the same time represents scientific branch, but also administrative technique and politics developed as interdisciplinary and comprehensive approach directed to balanced regional development and spatial organization“ (CEMAT). The achievement of spatial sustainability is one of the essential aims of spatial planning. Spatial sustainability implies well organized distribution of human activities which will use the resources in effective way and at the same time protect the environment (Working community Alpe-Jadran, 2002.). With right estimation of the spatial present condition as well as with estimation of its developing potentials, a frame is defined inside which sustain development will be enabled to a certain area. Physical-geographical characteristics are of great importance for spatial development of some area, and relief is one of the most important, because it affects, directly and indirectly, other elements: climate, hydrography, pedologic substrate and biogeographic characteristics. The shape of relief, its modifications and stability, as well as morphologic processes which shape it, all they have sporadic conclusive role in the economic activities and in general in the population arrangement (Bognar, 1990.), and therefore, when drafting spatial plans, significant attention goes to relief. Analyzing general geomorphologic characteristics, certain relief units and its elements are selected, by which global and specific relief characteristics are perceived, while with right estimation of micro-relief characteristics in the observed area, is reached high degree of valorisation of their values (Kicošev, Dunčić, 1998.).

1.1. Aim and methodology of the research

The basic aim of this work is to establish the relationship between morphologic characteristics of relief and arrangement of settlements and economic activities in the Una-Sana Canton area. Gained results, along with further researches, can give guidelines in selecting spatial units, the most suitable for settlement spreading, for building infrastructure, agriculture development, and possible touristic valorisation as well as for the environment protection.

Methodologically, the paper is based on the analyze of available literature which deals with spatial planning, especially researching the relief role in spatial planning, then on the analyze of cartographic and statistical data and on terrain space observation. For the purpose of determining the relationship between morphologic characteristics of relief and arrangement of settlements and economic activities in the Una-Sana Canton area, the following quantitative geomorphologic methods were applied: analyze of hypsometric

relations, slope analyze, analyze of the relief's vertical decomposition and analyze of expositions.

2. Basic characteristics of the researched area

The Una-Sana Canton is situated in the northwest part of Bosnia and Herzegovina and with area of 4125 km² it represents, by size, the third canton inside the Federation of Bosnia and Herzegovina. According to assesments¹, in 2008 in the canton lived 287,998 inhabitants in eight municipalities, and an average population density amounted 69.8 inhabitants per km² (FZS, 2009.). Administrative, political, cultural, educational and traffic centre of the Canton is the City of Bihać. Other significant settlements in the Canton are municipal centres of: Velika Kladuša, Cazin, Bužim, Bosanska Krupa, Ključ, Sanski Most and Bosanski Petrovac. The Canton stretching axis east-west is almost as equal as the stretching axis north-south, but concerning its total size one can concludes that dominant stretching direction is northwest-southeast.

As regards to climate, the Una-Sana Canton has Cfb climate characteristics (so called beech climate) with moderate cold winters and warm summers with an average annual temperature of 9.8 °C and precipitation quantity of 1170 mm (Korjenić, 2009.). The Canton hydrographical frame is presented by the Una River, and waters of the Canton belong to the Una, Glina and Korana river basins. Geological, geomorphologic, climatic and hydrographical characteristics in the region of the Canton caused forming of various soil types among which the most representative ones are the following: calcocambisol, luvisol, smonitza, distric cambisol, fluvisol and anthropogenic soils (Korjenić, 2009.).

Researched area as whole belongs to the Dinarides mountain system inside which dominate wrinkled-onlayered and laminate structures. According to Pamić (1996.), the following Mesozoic-Palaeogene lithofacies complexes are presented in the researched area: Mesozoic limestones and dolomites originated within the frame of carbonate platform and carbonate-clastic Jurassic-Cretaceous sediments originated on passive rim (in literature known as Durmitor flysch and flysch Bosniaque). Beside these two lithofacial complexes, there were sorted out complexes which are not linked to Mesozoic-Palaeogene Tethyan evolution. Those are allochthonous Triassic and Palaeozoic complexes (the Sava nappe) which in eastern parts of the Canton are presented by Palaeozoic metasediments, and along north and north-eastern Canton border by Triassic limestones and dolomites and subordinated by clastites, cherts, tuffs and volcanogenic rocks. Another complex is presented by Oligocene and Neogene with/or Quaternary sediments originated after the Pyrenees phase (that is after the Dinarides consolidation). They are presented mainly by conglomerates, sandstones, feldspars, marls and limestones.

Regarding geomorphology, all three structural geomorphologic relief categories can be sorted out in the Canton area. Accumulation-tectonic relief is presented with floated lowlands and river terraces in river valleys while denudation-accumulation relief is related to the mountain massifs' foreland steps, to the foothill zones and fields in karst. Denudation-tectonic relief by size is the least presented and is related to higher zones of mountain massifs in the central and south part of the Canton. Morphogenetically, in the Canton's relief dominate fluvial, karst and hill-side type of relief with well developed relief shapes.

3. Morphologic characteristics of the Una-Sana Canton Relief

Relief shaping of the Una-Sana Canton is conditioned by lithological material and structural characteristics of this area (folds, faults, onlays) what is clearly reflected in morphometric relief characteristics. The two main relief units can be sorted out in the Canton area. The first unit is presented with clearly expressed mountain and middle-mountain area in south and southwest part of the Canton, as well as lower east and north part of the Canton with hilly relief, foothills and lowland relief in river valleys (Fig. 1).

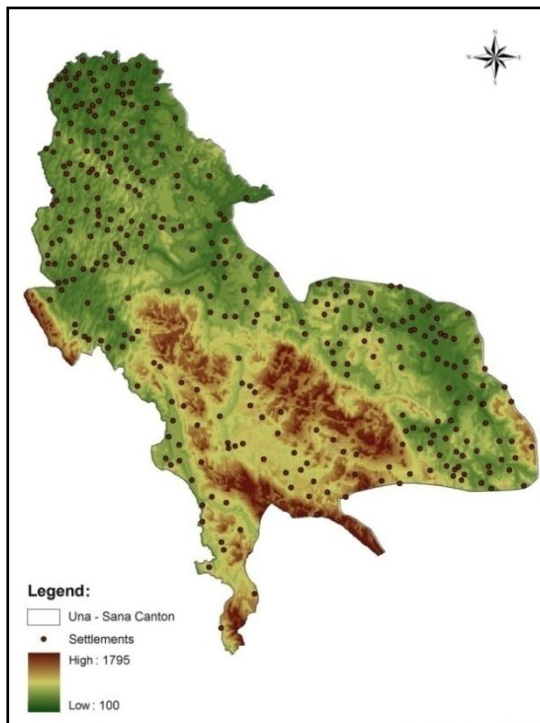


Figure 1. Hypsometric map of the Una-Sana Canton

It can be said in general that heights in the Canton area decrease from south towards north, and maximum height discrepancy is larger than 1500 m. The greatest part of the Una-Sana Canton is presented with hilly-mountain relief.

Altitudes up to 600 m make around 65% of the Canton area, counting that the part of hypsometric categories from 300 to 600 m is almost 50%. Real lowland areas are the least presented. Hypsometric categories above 600 m (central – mountain and high - mountain) make around 35% of the Canton area. In central, south and southwest parts of the Canton dominate Grmeč (1064 m), Osječnica (1795 m) and slopes of Plješevica (1648 m). Among Osječnica, Grmeč and Sretica there is Petrovačko polje field on altitude of 520-730 m, and between Grmeč and Sretica there is Bravsko polje field with altitudes 580-850 m.

In outmost southwest and west parts of the Canton dominates the Una River with its valley characterized by exchanges of canyons and valley extents. The whole area is dominantly built from Mesozoic carbonates so that all karst relief shapes are presented. North and eastern part of the Canton have significant lower altitudes as consequences of geological structure as well as bold fluvial and hill-side processes which dominantly took part in relief shaping. In these regions relatively dense net of water flows is developed, and as the most important flow outshines the Sana River in eastern part of the Canton.

In the territory of the Una-Sana Canton all categories of slopes are presented. Lowlands and slightly inclined terrains (slope to 5 degrees) amount 28% of total territory and this category include floated lowlands in river valleys, river terraces, karst fields and plateaus. Terrains with the highest slope values amount about 4% of total territory and are related to the high-mountain Canton region, and along the canyon of the rivers of Una, Unac and Sana. In the zones of these slopes there are intensive hill-side processes. Significant part (42.5%) is taken by terrains with slope of 10-30 degrees, and can be found mainly in hill-side zones of mountain massifs. Vertical relief decomposition (energy of relief) is in accordance with other morphometric indicators. The greatest part of the Canton is characterized by slight vertical relief decomposition, because in the 70% of the territory it amounts less than 100 m/km². The largest decomposition categories are related to karst mountain space (more than 150 m/km²).

Concerning the fact that, the expositions of various relief shapes were originated as result of actions of geomorphologic factors in the area decomposition process, they are in direct connection to geomorphologic characteristics of the researched terrain. Flattened terrains without expositions are individually the most presented category and they take spaces with the smallest bias. Concerning that the largest relief shapes of this area have mainly

Dinaric stretching direction significantly are presented northeast and southwest expositions (31.5%). The least are presented north, south and southeast expositions.

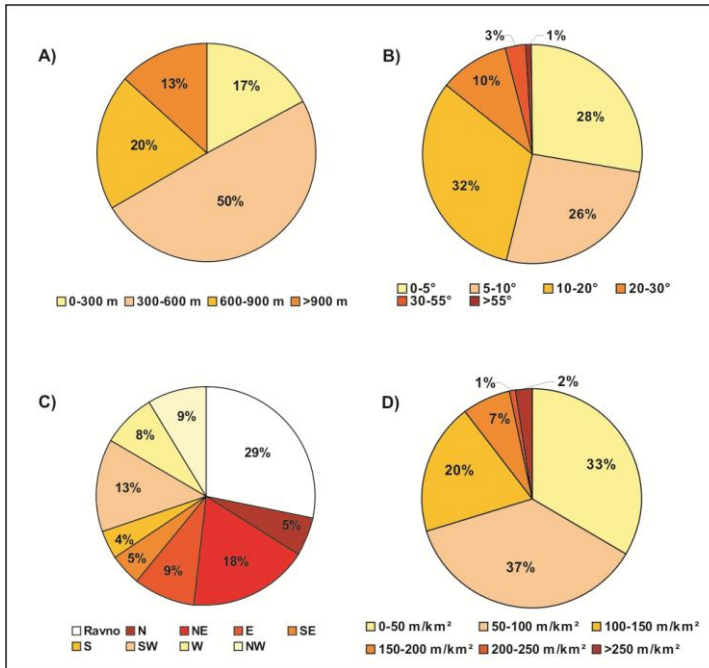


Figure 3. Morphometric characteristics of the Canton – the participation of certain categories of morphometric indicators: hypsometry (A), slopes (B), expositions (C), vertical decomposition (D)

4. Influence of morphologic relief characteristics on the Una-Sana Canton population and economy

Lower hypsometric levels, due to favourable climate, relief relations and traffic availability attract greater number of inhabitants and therefore analysis of hypsometric characteristics of some area is very important in spatial planning. Analyze of the population according to hypsometric zones can indicates potentially present economic activities, but also the life of inhabitants. In the territory of the Una-Sana Canton, arrangement of inhabitants is in accordance with the arrangement of settlements, because hypsometrically higher settlements have smaller number of inhabitants in comparing to the ones in lower zones. The greatest number of settlements² is concentrated in altitude zone up to 500 m and it is mostly in river valleys. During the two decades period (1971.-1991.) was noticed increase in number of inhabitants in this zone and at the same time decrease in altitude zones above 500 m (Islamović, 2005.).

According to the same author, village-town migrations dominate there as a consequence of industrialization and urbanization processes followed by processes of deagrarianization and de-ruralisation. Until 1991, industry was dominant economic activity with the greatest number of employees (Korjenić, 2009.). Prior as war consequence, but also because of slow process in adaptations to new market and technologic conditions, industry records the fall in number of employees. The fact that economic activities are connected to areas with largest population density and the best traffic connection conditioned that also the greatest number of economic subjects is situated in hypsometric altitude zone up to 500 m.

The terrain's slope has the greatest importance in spatial planning because it directly determines favourable or unfavourable terrains for building of certain urban segments, for development of infrastructure net, but also in general for type of settlements and houses. Also, hill-side slope indirectly impacts valorisation of certain area because together with exposition it also affects topoclimatic slope conditions, as well as erosive, and accumulation processes in some area. For the needs of drafting spatial plan, special attention is devoted to treatment of terrain's slope for the purpose of planning housing settlements, agriculture activities, industrial complexes and building of roads. According to slope categorization, in regard to favour for agricultural usage and efficiency in architecture³, total of 28% of the Canton area is counted into very favourable and favourable for building and they cover floated lowlands in river valleys, river terraces and fields in karst. Terrains with slope of 5-12 degrees sorted out as favourable with certain arrangement measures cover about 25% of the Canton area and they cover mainly slopes of foothills and foreland steps. More than 40% of areas are unfavourable for building and they are effective only with significant interventions, and about 4% belong to areas which in total are unfavourable for building.

Analyze of the USK settlement arrangement covered by this research indicates that the greatest number of settlements (45%) is situated on flattened terrains and terrains with slope smaller than 5 degrees. In this category all municipal centres of the Canton are counted, what at the same time means that also the greatest number of USK inhabitants is settled in areas with slope smaller than 5 degrees. Settlement participation decreases with increase of hill-side's slope, and on areas with slope larger than 30 degrees was not recorded even a single settlement. (Tab. 2.). In the Canton area in 2008 were registered 11 049 business subjects what in average makes 38.4 business subjects on 1000 inhabitants (FZS, 2009.). Spatial arrangement of business subjects is in accordance to the arrangement of settlements and inhabitants so that municipalities with larger share of inhabitants also record larger part of registered business subjects (Tab. 1).

Of total number of business subjects, about 50% are those who are counted in activities of agriculture and forestry, then processing industry, mining and trade (FZS, 2009.), that is activities which have the greatest need for space.

Table 1. Relation between number of inhabitants and registered business subjects per USK municipalities (2008)

Municipalities	Inhabitants		Business subjects	
	No	%	No	%
Bihać	61 191	21,2	3 360	30,4
Bosanska Krupa	28 227	9,8	1 139	10,3
Bosanski Petrovac	7 730	2,7	447	4,0
Bužim	17 838	6,2	425	3,8
Cazin	62 252	21,6	1 907	17,3
Ključ	19 771	6,9	767	6,9
Sanski Most	44 699	15,5	1 672	15,1
Velika Kladuša	46 290	16,1	1 332	12,1
Una-Sana Canton	287 998	100,0	11 049	100,0

Source: Una-Sana Canton in numbers, FZS, 2008.

Agriculture areas take 52,1% of the Canton territory and mainly they are connected to areas with smaller terrain's slope (mainly river valleys and fields in karst) (Korjenić, 2009.) which means that the most favourable terrains, regarding agriculture activity, are mainly analogue with those stated for architecture, so in that sense certain spatial conflict appears. Significant characteristic of agriculture estates is also their large size degradation which decreases with altitude's increase, but at the same time with altitude increase, share of surfaces under meadows and pastures grows (Korjenić, 2009.).

Relief energy as well represents significant indicator which is analyzed for the needs of determination of precipitation stability in the aim of agriculture production, forestry and settlement arrangement and development. Of 161 analyzed settlements, 85 are situated in a space which comes into category of relief energy up to 50 m/km², that is on the most favourable areas, regarding the relief energy (flattened relief and slightly decomposed lowlands). Slight to moderate decomposed relief includes categories of the relief energy of 50-100 m/km² and 67 settlements are situated in areas within this category (Tab. 3.). Those are the fields on which intensive agriculture production is possible and road building is facilitated, what represents, along with water, one of the main conditions for settlement development in some area.

Table 2. Settlement arrangement of the Una-Sana Canton concerning hill-side slopes

	Categories of hill-side slopes						
	0°	0,1-5°	5,1-10°	10,1-20°	20,1-30°	30,1-50°	>50°
No. settlements	33	39	54	24	11	-	-

Table 3. Settlement arrangement of the Una-Sana Canton concerning relief energy

	Categories of relief energy (m/km ²)					
	0-50	50-100	100-150	150-200	200-250	>250
No. settlements	85	67	8	1	-	-

Table 4. Settlement arrangement of the Una-Sana Canton according to expositions

	Expositions								
	flat	N	NE	E	SE	S	SW	W	NW
No. settlements	48	2	28	18	9	7	22	19	8

Slope exposition modifies light and heat influence on number of interconnected appearances: on soil and air temperature, length of vegetation period, agriculture crops, on sunny and air humidity, rocks' decay etc. From above-mentioned arises the need for analyze of expositions for spatial planning needs. Analyzing the Una-Sana Canton settlement arrangement and concerning expositions is noticed high degree of interconnected dependence between settlement positions and expositions. There dominate settlement on flattened areas that is in areas without expositions, followed by northeast and southwest expositions which are conditioned by stretching of relief structures (Tab. 4.). In these areas there are 98 settlements in total. Only two settlements are situated in the most unfavourable north expositions.

5. Conclusion

Physical-geographical researches and valuation of natural environment have their appliance in numerous aspects of spatial planning and usage – from agriculture, architecture, tourism all until space protection. Spatial plan, as outmost product of spatial planning activity, must, from scientific, professional and technical side give guidelines towards the region's balanced development and spatial organization through clearly defined time period.

On the base of analyzed data it is clearly noticed that areas of the Una-Sana Canton, which, from the aspect of morphologic relief characteristics are the most suitable for settlement development, building and agriculture development, in first they are defined by slope up to 5 degree and lower hypsometric levels (with derivations in the field areas in karst which are situated on higher altitudes). Almost all larger and more important Canton

settlements are situated in flattened parts of river valleys, on altitudes up to 500 m. These areas cover about 35% of the Canton and over 75% of inhabitants live there. In contribution to this, speak also facts that majority of settlements is situated in terrains without expositions and in areas with the smallest relief energy amount. Obtained results indicate competition among the largest area beneficiaries (settlements, agriculture, industry, trade) exactly for the most favourable areas regarding morphologic characteristics of relief. It is estimated that in Bosnia and Herzegovina annually 3000 ha of agriculture land is permanently lost on account of other land beneficiaries (Čustović, 2005.), and following that context, the aim of spatial planning is to direct the spatial development of these two group of activities.

Obtained results indicate that future detailed researches in the Una-Sana Canton space should be directed towards the most inhabited areas (municipal centres and areas along the main roads) in order to get more detailed insight in space condition as well as to get evaluation of its development possibilities for the purpose of provision of sustainable development. Such researches would provide selection of space units which are the most favourable for settlement spreading, infrastructure building, agriculture development, possible touristic valorisation as well as environment protection.

6. References

- Bognar, A., 1990: Geomorfološke i inženjersko-geomorfološke osobine otoka Hvara i ekološko vrednovanje reljefa, geografski glasnik br.25, zagreb, 49-65 p.
- Bognar, A., 1992: Inženjersko-geomorfološko kartiranje, Acta geographica Croatica br.27, Zagreb, 173-185 p.
- CEMAT, 1983: European regional/spatial planning Charter (Torremolinos Charter), <http://www.coe.int/CEMAT>, 25.4.2010.
- Čustović, H., 2005: AN overview of general Land and Soil Water conditions in Bosnia and Herzegovina, 73-82. p. U: Soil Resources of Europe, second edition. R.J.A. Jones, B. Houškova, P. Bullock and L. Montanarella (eds). European Soil Bureau Research Report No.9, Eur 20559 EN, (2005), 420pp. Office for Official Publications of the European Communities, Luxembourg.
- Islamović, A., 2005: Razmještaj stanovništva Unsko-sanskog kantona prema hipsometrijskim karakteristikama, Zbornik radova Prvog kongresa geografa Bosne i Hercegovine, Geografsko društvo FBiH, Sarajevo, 321-329 p.
- Kicošev, S., Dunčić, D., 1998: Geografske osnove prostornog planiranja, Institut za geografiju PMF Novi Sad, Novi Sad.
- Korjenić, A., 2009: Fizičko-geografske determinante kao osnova za izradu prostornog plana područja posebne namjene u Unsko-sanskom kantonu, magistarski rad, Prirodno-matematički fakultet, Sarajevo, 166 p.

- Pamić, J., 1996: Magmatske formacije Dinarida, Vardarske zone i jugozapadnih dijelova Panonskog bazena, Časops „Nafta“, Zagreb, 255 p.
- Radna zajednica Alpe-Jadran, 2002: Prostorno planskim instrumentima do djelotvornih rješenja, I. Susret, MZOPU, Zagreb.
- http://www.mzopu.hr/doc/PP_instrumentima_do_rješenja.pdf, 25.10.2008.
- Federacija u brojkama, Federalni zavod za statistiku, Sarajevo 2009.
- Statistički godišnjak 1992., Republički zavod za statistiku, Sarajevo 1994.
- Unsko-sanski kanton u brojkama, Federalni zavod za statistiku, Sarajevo 2009.

Complimentary notes

1. Due to war and specific political-geographic situation, the last official census in Bosnia and Herzegovina was conducted in 1991. All data for period after 1991 is based on assessments.
2. Due to lack of data, for analyze of settlement arrangements in compare to morphologic relief characteristics, were taken settlements with more than 500 inhabitants.
3. At relief evaluation for the purpose of building efficiency and for the needs of agriculture exploitation (Bognar, 1990., 1992.) hill-sides, concerning slopes, are dived in the following categories:

0-2°	(lowlands)	very favourable for building
2-5°	(slightly declined terrain)	favourable for building
5-12°	(declined terrain)	favourable with restructuring
12-32°	(significantly declined terrain)	unfavourable, effective only with significant interventions
>32°	(very steep slopes)	unfavourable for building

0-5°	slopes favourable for agriculture
5-12°	slopes relatively favourable for agriculture due to present erosion risk
12-25°	ultimate slope category for more significant agriculture exploitation
25-40°	slopes effective in agriculture along with terracing
>40°	slopes effective only in forestry

