GEOECOLOGICAL EVALUATION OF TERRAIN IN NATIONAL PARK UNA

Edin Hrelja[1]
Nusret Drešković[2]
Ranko Mirić[3]
Boris Avdić[4]

Abstract: This paper has a geoecological evaluation of terrain in National Park Una as its study object. Aim of the research is to clarify how valuable and useful are particular terrain segments for tourism valorization, construction of various objects, certain economic activities etc. Geoecological evaluation of terrain is strongly relevant methodological procedure, which can be used for acquiring of results about real value of particular areas.
Paper consists of several parts. First part defines the exact area of exploration and geographic position of National Park Una. Second part is concerned with geomorphological characteristics of explored area and possibilities of its valorization, by detailed analyses of hypsometric facts, angle of slope inclination, vertical articulation and terrain exposition. Geoecological evaluation of terrain is performed in third part, for which purpose a bonity categories are used.
Geoecological evaluation of terrain is based on previous geomorphological analysis. Methods used in this paper are: analysis, synthesis, statistical method, cartographic method and GIS analysis. Method of terrain evaluation is also used, through four categories: hypsometric characteristics, angle of slopes, vertical articulation and terrain mobility.

Key words: Geoecological evaluation, GIS, bonity category, National Park Una

INTRODUCTION

Because of the increasing need for the environment protection and conservation, spatial management and land use should be optimized. For that purpose various methodological procedures are developed and used for adequate valorization of geographical space.
Geoecological spatial evaluation objective is determination of environmental advantages and limitations for certain social purpose. Also, it is useful for exploration and categorization of natural resources. All that contribute to proper environmental management in order to achieve sustainable development. Besides the need for spatial development, geoecological evaluation can be conducted also for spatial planning. In this procedure, more valuable areas are differentiated from less valuable.
Relative geoecological evaluation of terrain in National Park Una is conducted by categorization of absolute altitude, angle of slopes, vertical articulation and terrain mobility. This kind of methodological procedure includes various geomorphological analysis. By application of GIS, basic results of geoecological evaluation of terrain in the

[1] Senior Teaching Assistant, Department of Geography, Faculty of Science, University of Sarajevo, Sarajevo, Bosnia and Herzegovina.
[2] Associate Professor, Department of Geography, Faculty of Science, University of Sarajevo, Sarajevo, Bosnia and Herzegovina.
[3] Assistant Professor, Department of Geography, Faculty of Science, University of Sarajevo, Sarajevo, Bosnia nad Herzegovina.
[4] Teaching Assistant, Department of Geography, Faculty of Science, University of Sarajevo, Sarajevo, Bosnia and Herzegovina.

National Park are gained. Application of this methodology is possible in any land area on the planet Earth and for any purpose.

GEOGRAPHICAL LOCATION OF NATIONAL PARK UNA

National Park Una is proclaimed as protected area in 2008 and it is one of the three national parks in Bosnia and Herzegovina. It is located in the northwestern part of the country, bordering Republic of Croatia. Protected area covers the canyonlike part of upper valley of Una river. It streches from village of Lohovo, through Una and its tributary Unac valleys, to Drvarsko Polje, as well as interspace between these two rivers. Whole territory of National Park, with covered area of 19.800 ha, is administrative part of City of Bihać.
This area is characterized by rare natural geographic elements, which make it unique enough to get a status of national park. Physical geographic uniqueness of studied area is emphasized through component geological, geomorphological, climate, hydological and biogeographical elements, all of which makes this National Park an area of complex landscape diversity. Beside natural components, this area also have rich cultural and historical heritage, which contibutes to attractiveness in the context of tourism development. Natural values in the National Park are protected by the law on nature protection, while the areas of cultural significance are regulated in accordance with law provisions about cultural heritage.
According to the Law on National Park Una, territory of 19.800 ha in total size is divided into two different zones – first with regime of strict and targeted protection (13.500 ha) and second with regime of targeted development (6.300 ha). Zone of regime of strict and targeted protection is intended for achieving the goals of natural resources protection, protection and conservation of ecosystems and natural processes without human intervention, as well as preservation of unspoiled natural areas, biodiversity and natural habitats. Visits to National Park for tourism, recreation, education or scientific research are enabled to the extent where adverse impact is kept at the minimal level. In the zone of targeted development, some traditional and previously existed economic activities (e.g. agriculture, food production, forestry, tourism atc.) are allowed, under the condition of compatibility with local specificities.

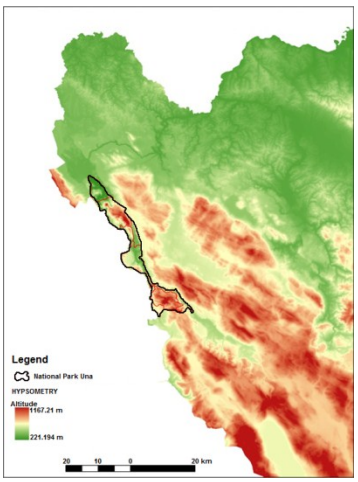

Fig. 1. Location of National Park Una

TERRAIN FEATURES IN NATIONAL PARK UNA AND VALORIZATION POSSIBILITIES

Terrain features are very important factor with impact on spatial planning processes, where morphological, hypsometric and morphographic features are taken into account. Morphological features are valorized through analysis of diversity and attractiveness of terrain.

During tourism valorization of terrain, it is very important to consider its morphometric characteristics, especially:

- Altitude;
- Slope inclination;
- Vertical articulation;
- Slope exposure.

Morphometric and morphological advantages and limitations significantly affect distribution of population, building different objects, roads, as well as way of life and tourism activities. In the terms of vertical categorization, it could be said that terrain under 200 meters represents lowland; terrain between 200 and 500 meters usually is represented by hills; lower mountains are between 500 and 1000 meters high; medium mountains lies between 1000 and 2000 meters, and terrain above 2000 meters is regarded as high mountain.

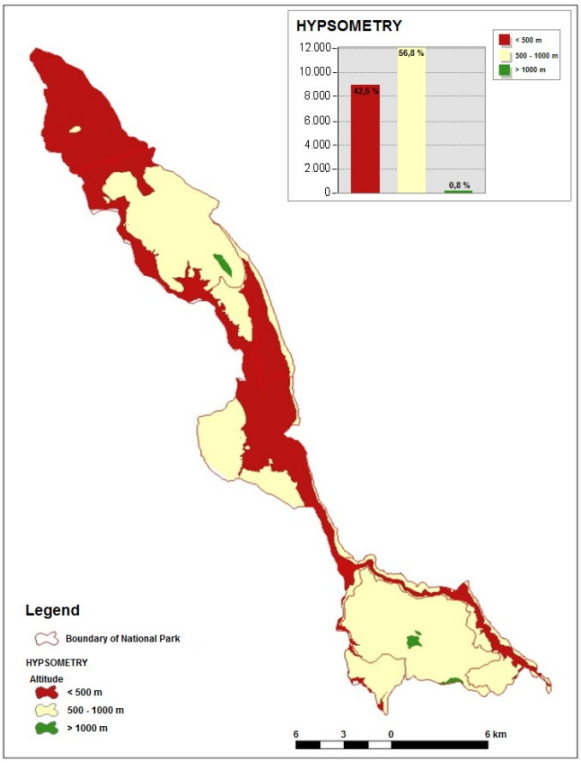

Fig. 2. Hypsometric features of National Park Una

According to this categorization, GIS analysis showed that whole terrain of National Park Una can be classified into three vertical zones – first under the 500 meters (221 – 500 m),

second between 500 and 1000 meters, and third above 1000 meters (1000 – 1167 m). Zone that lies between 221 meters (lowest point of Nation Park) and 500 meters occupies 42,4%, zone between 500 and 1000 meters takes 56,77% and highest zone (above 1000 meters) has share of only 0,76% in total land area. On the basis of altitudinal belts analysis, hypsometric structure is used for determination of possibilites for various activities, like cultivation of different crops, zonal differentiation in forestry, winter sports, recreation etc.
Slope inclination analysis provides determination of advantages and limitations for various types of land use. Slope inclination angles are differentiated in accordance with difficulty and costs of object construction from the aspect of land use. Even terrain with steep slopes (less suitable) can be used for various purposes, but it requires higher expenses due to adjustment. In evaluation of terrain usefulness for construction, following categories are considered:

- 0-2° - very suitable for construction;
- 2-5° - suitable for construction;
- 5-12° - suitable with minor adjustments;
- 12-32°- unsuitable, only with major adjustments can be used for construction;
- 32° or more - totally unsuitable for construction. (Bognar, 1992)

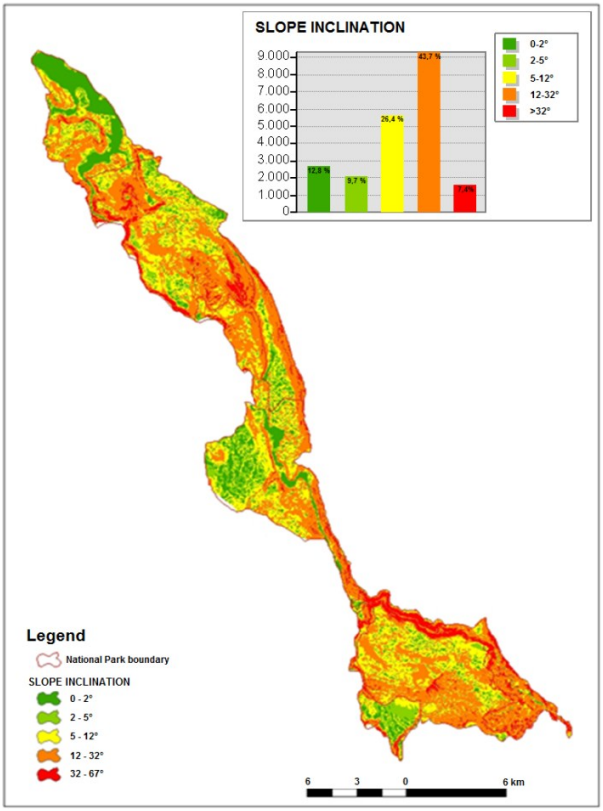

Fig. 3. Slope inclination in National Park Una

Based on cartographic and graphical representation, it can be concluded that unsuitable terrain that can be used for construction of objects only with major adjustments has the largest share in total area of National Park Una, with 43,7%. Generally suitable terrain with

minor adjustment needed comes second with percentage of 26,39%, while suitable and very suitable terrain covers 22,52% in total. Completely unsuitable terrain makes only 7,39% of total National Park area. Even though the object of this analysis is terrain of a National Park, it is important to examine slope inclination in the context of construction, not only of residential objects, but also other objects and infrastructure for tourism and monitoring of environment.

Analysis of vertical articulation implies determination of difference in altitude between the highest and the lowest point on the unit of area (m/km²). This method is very significant from the aspect of possibility of its valorization for various economic purposes. There are several categories of vertical articulation: values up to 10 m/km² represent flattened terrain; values of 10 to 40 m/km² represent slightly broken plains; 40 to 60 m/km² stands for slightly broken terrain; values 60 to 100 m/km² implies moderately broken terrain; 100 to 300 m/km² represents broken terrain and values higher than 300 m/km² imply extremely broken terrain.

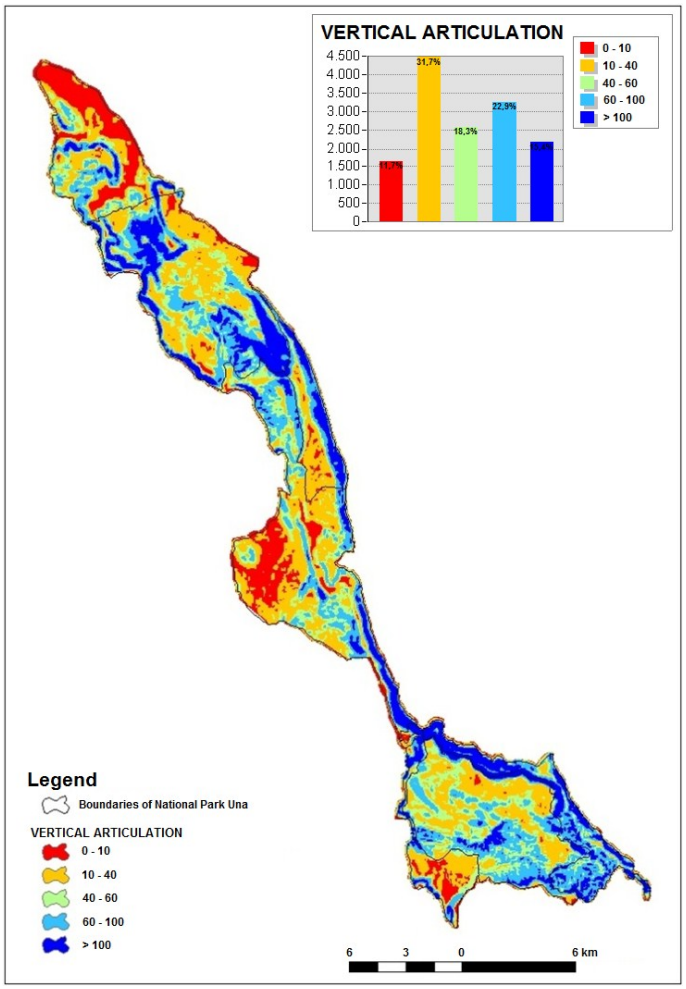

Fig. 4. Vertical articulation in National Park Una

GIS map and chart of vertical terrain articulation show that five out of six mentioned categories can be found in the territory of National Park – there is no extremely broken

terrain (above 300 m/km²). Slightly broken plains are represented by largest percentage of 31,69%, followed by moderately broken terrain (22,89%), slightly broken terrain (18,3%), broken terrain (15,45%) and flattened terrain with only 11,67% in total land area.
Evaluation of slope exposure is very important procedure for general valorization of some area. Slope exposure orientation of terrain surface is in relation to the Sun. In the context of various purposes, slope exposure can be identified as suitable or unsuitable. For example, southern exposures are very suitable for agriculture, while northern exposure is better for development of ski tourism. This is the reason why evaluation of slope exposure is an integral part of comprehensive geographical terrain analysis. GIS methodology is used for cartographic and chart presentation of distribution of different types of slope exposure in National Park Una. Through this visualisation, it became very clear that highest percentage of slopes belongs to northeastern, eastern, southwestern and western exposure, due to general direction of Dinaric mountain chains. However, this category of terrain is more useful for detailed specific analyses than for general geoecological analysis like this one.
These simple percentage-based representations of certain terrain elements don't show the real picture of possibilites for various activities. Functional evaluation of terrain requires analysis of multiple elements, cartographic overlapping of oleates and drawing complex conclusions based on that.

GEOECOLOGICAL ANALYSIS

Geoecological evaluation of natural environment includes optimal space management, whose objectives are determination of environmental advantages and limitations for certain social activity, like tourism, sport or recreation. Except for spatial development, geoecological evaluation can be conducted for the purpose of spatial planning in terms of environmental protection. In spatial planning, natural resources must be taken into account, to that right decisions about its exploitation can be made in accordance to principle of sustainable development.
Applied method is based on summarizing the values for defined elements. Obtained summation coresponds with bonity category of evaluated terrain. Certain terrain categories were evaluated, and evaluation methodology is adjusted to terrain specificities of researched area.
Geoecological evaluation of terrain in the National Park Una is conducted with methodology of summarizing values for categories of hypsometry, slope inclination, vertical articulation and terrain mobility. Evaluation procedure is implemented in a manner of overlapping of net consisting of units of area (62.500 m^2 – 1x1 cm on the map of scale 1:25000) net and maps of slope inclination, vertical articulation and hypsometry. To each unit of area is given adequate numerical value for each category: vertical articulation, hypsometric features and terrain mobility in accordance to slope inclination.
General hypothesis of terrain valorization method is that zones with the lowest hypsometric level, minimal slope inclination, minimal vertical articulation and minimal gradient of terrain mobility have the highest value, and vice versa. Terrain of the highest value received 100 points, and terrain of the lowest value got 16,4 points in total.
Terrain mobility is evaluated according to the potential mobility and slope inclination:

- $0\text{-}2^0$ (stable slope);
- $2\text{-}5^0$ (weak erosion);
- $5\text{-}12^0$ (increased erosion with landslides);

- 12-32^0 (intensive erosion)
- 32-55^0 (intensive material movement, slopes are generally without vegetation);
- > 55^0 (occurance of escarpment and talus slopes). (Bognar, Bognar, 2010)
-

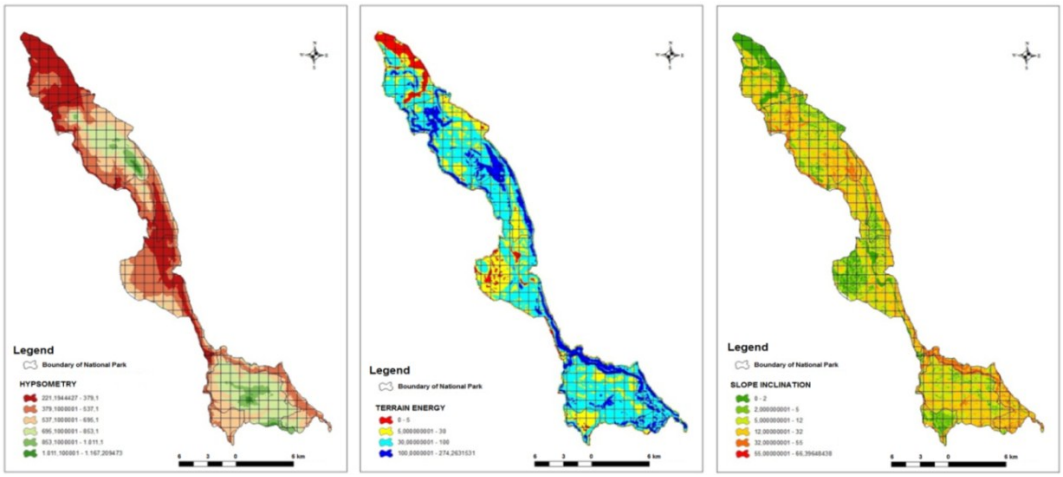

Fig. 5. Methodology of terrain evaluation in National Park Una by using the units of area net

Tab. 1. Points by categories within geoecological evaluation of terrain in National Park Una

Cat.	Altitude (m)	Points	Slope incl. (^{0})	Points	Terrain art. (m/km^2)	Points	Terrain mobility	Points
1.	221,1-379,1	25	0-2	25	0-5	25	stable terrain	25
2.	379,1-537,1	20,8	2-5	20,8	5-30	20,8	moderate erosion	20,8
3.	537,1-695,1	16,6	5-12	16,6	30-100	16,6	erosion and landslide	16,6
4.	695,1-853,1	12,4	12-32	12,4	100-300	12,4	intensive erosion	12,4
5.	853,1-1011,1	8,1	32-55	8,1	300-800	8,1	material movement	8,1
6.	1011,1-1167,2	4,1	>55	4,1	>800	4,1	large escarpment	4,1

By using this methodology of geoecological evaluation of Terrain in National Park Una, numerical indicators for each unit of area are obtained. These indicators were basis for defining terrain value. After summarizing the points by defined categories, it is conducted classification of terrain areas by bonity categories with values form 0 to 9, i. e. from extremely unsuitable terrain to one of the highest value.

Tab. 2. Terrain bonity categories

Category	Class	Points
9	Terrain of the highest value	91-100
8	Highly valuable terrain	81-90
7	Generally valuable terrain	71-80
6	Relatively less valuable terrain	61-70
5	Generally less valuable terrain	51-60
4	Relatively unsuitable terrain	41-50
3	Gennerally unsuitable terrain	31-40
2	Unsuitable terrain	21-30
1	Very unsuitable terrain	11-20
0	Extremely unsuitable terrain	1-10

Source: Bognar, Bognar (2010)

By using this methodology of geoecological evaluation of terrain in National Park Una, numerical indicators for each unit of area are obtained. These indicators were the basis for defining terrain value. After summarizing the points by defined categories, it is conducted classification of terrain areas by bonity categories with values form 0 to 9, i. e. from extremely unsuitable terrain to one of the highest value.

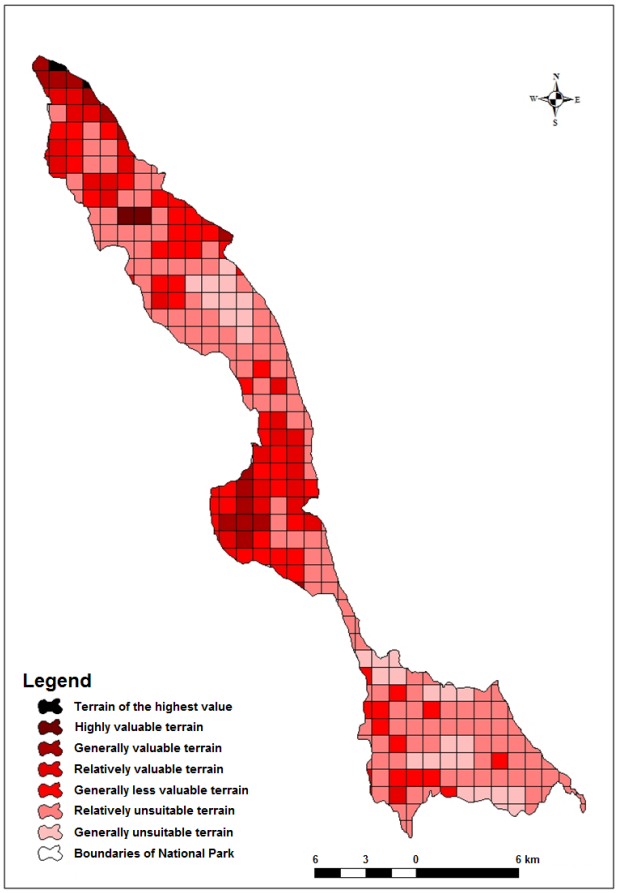

Fig. 6. Bonity categories of terrain in National Park Una

According to conducted evaluation, it can be stated that in the researched area does not exist extremely unsuitable, very unsuitable and unsuitable type of terrain. On the other hand, generally unsuitable, relatively unsuitable, generally less valuable, relatively les valuable, generally valuable, highly valuable and terrain of the highest value are registered. Detailed anaysis and cartographic visualization proved that, despite its exceptionally attractiveness (unique hydrological, geomorphological and biogeographical features), National Park Una has only modest potential in term of its terrain characteristics.
On the basis of precise numerical values, it can stated that over a half (51,5%) of the National Park territory belongs to the bonity category of relatively unsuitable terrain. Generally less suitable terrains come second with 21%, followed by category of generally less valuable terrain (10,4%), relatively less valuable terrain (10,4%), generally valuable terrain (5,4%). Terrain with the highest value and highly valuable terrain have the lowest share in the territory of National Park Una, with only 0,7% each.

CONCLUSION

On the basis of analysis presented in this paper, it can be concluded that geoecological evaluation is significant methodological procedure, which is used for obtaining the real value of terrain in National Park Una. This kind of methodology includes various geomorphological analyses. During the first phase, geomorphological research of the terrain is conducted. Various analyses of certain terrain elements (hypsometric characteristics, vertical articulation, slope inclionation and terrain exposure) are conducted within this research. However, it is not possible to get the relevant results for the total value of terrain in explored area by these individual anaylises only.
Geoecological research has determined specific characteristics of terrain in Nation Park Una. It is obtained on the basis of complex geomorphological analysis of cartographically visualised geomorphological features. Terrain in National Park Una is evaluated through method of analyzing the criteria of hypsometry, slope inclination, vertical articulation and terrain mobility. In this way, various types of terrain are clearly differentiated into generally unsuitable, relatively unsuitable, relatively less valuable, relatively valuable, generally valuable, highly valuable and terrain with the highest value. It can be stated that most of the territory of National Park do not provide great opportunity for development of high number of activities, like mass tourism, except in certain limited locations. Obtained results are very important, because in the spatial planning for special purpose taking it into account can significantly improve, remediate or adjust certain integral elements of terrain, as well as geoecological and tourism value of this protected natural area.

REFERENCES

1. Bognar, A. (1992). Inžinjersko geomorfološko kartiranje. Zagreb
2. Bognar, A., Bognar, H. (2010). Geoekološko vrednovanje reljefa Republike Hrvatske, Geoekologija XXI vijeka – Teorijski i aplikativni zadaci. Nikšić.
3. Maksin-Mićić, M. (2008). Turizam i prostor. Belgrade: Univerzitet Singidunum.
4. Martinović-Uzelac, A. (2001). Prostorno planiranje. Zagreb.