

UDK 551.435.9 (497.5)

Primljeno (Received): 20.12.1994

Prihvaćeno (Accepted): 25.3.1995.

Izvorni znanstveni članak

Original Scientific Paper

THE ROLE OF GEOMORPHOLOGICAL RESEARCH IN GEOECOLOGY

Illustrated by the example of geoeological relief evaluation in the National Park Paklenica

MAJA SALETTO JANKOVIĆ

Geomorphological research is getting increasingly applied in many sciences, and so in Geoeology (Landscape Ecology), as well. This paper shows on the example of geoeological relief evaluation in the National Park Paklenica a bare necessity to accomplish geomorphological research in order to obtain a comprehensive insight into the relief as of the fundamental landscape element.

ULOGA GEOMORFOLOŠKIH ISTRAŽIVANJA U GEOKOLOGIJI na primjeru geokološkog vrednovanja reljefa NP Paklenica

Geomorfološka istraživanja nalaze sve veću primjenu u mnogim znanostima, pa tako i u geokologiji. U radu je, na primjeru geokološkog vrednovanja reljefa NP Paklenica prikazana neophodnost uključivanja geomorfoloških istraživanja u svrhu cjelovitog upoznavanja osobina reljefa kao temeljnog elementa krajolika.

INTRODUCTION

The results of geomorphological research, as of a science on properties, genesis, evolution and on a contemporary relief dynamics of the Earth surface (Bognar, 1994) have been increasingly applied in a whole range of other, more or less related sciences, and in an everyday practical work, too. Since relief and landscape are in a cause-effect relation to one another, or rather since relief forms and geomorphological processes have an immediate effect on landscape evolution (both, on natural landscape and on geographical, too), there is a need to include in all geoe-

ological research works the geomorphological research and mapping, as well. All over the world, numbers of geoeological papers have been dedicated to discovery of mutual dependancy between the landscape and its valorization in recreation purpose (Zee van der, 1990), or rather to the problem of adequate use of a particular natural landscape in tourism. This paper shows on the example of geoeological relief evaluation in the National Park Paklenica a necessity of geomorphological research in order to obtain a comprehensive insight into the relief of the area as of he

fundamental landscape element. The valorization has been performed from the aspects of tourism¹ actually from the aspect of recreation² and sport³.

AIM AND OBJECTIVES OF RE-SEARCH

The aim of the research was to find out how valuable are particular parts of the National Park Paklenica, from the view of tourism, recreation and sport. The question of actual and of potential relief value is extremely significant for the optimal landscape utilization and for the best environment management. This problem is quite important in the areas like national parks, particularly in the NP Paklenica, where the relief forms and its properties represented one of the basic criteria for its proclamation, as the area of special social (scientific, educational; tourist) interest. For a purpose to realize the objectives of our research, it was necessary, to fulfill the following objectives:

1. *a detailed inventory listing and relief analysis*
2. *selection of criteria relevant for a geoecological relief evaluation and conducting on these grounds*
3. *a relief evaluation with reference to tourism, recreation and sport, and*
4. *a selective evaluation of valuable and potentially valuable relief parts in the NP Paklenica (for tourism, recreation and sport purposes).*

The most important and therefore the most complex stage of research, is by all means, the primary stage, in fact, an inventory listing and geomorphological relief analysis. This very stage is a predisposition for all other stages and therefore a special attention should be paid to it. Namely, on basis of study and of the data obtained by a detailed relief inventory listing and by its geomorphological analysis, the evaluation criteria shall be elaborated.

METHODS OF INVENTORY LISTING AND OF RELIEF ANALYSIS

The first and naturally, the fundamental method in all geoecological explorations, therefore in this one as well, is a field inspection. During numerous terrain inspections (field work) a detailed geomorphological mapping has been conducted (on map 1: 25 000) resulting in identification and inventory listing of all relief forms and of geomorphological processes, in determination of their affiliation to a particular relief type, and in scanning of all geomorphological processes. Due to a rather specific task (geoecological relief evaluation!) a special attention was dedicated to the relative assessment of qualitative relief properties, too. This was performed on basis of numerous quantitative indicators.

In order to achieve this, relief shapes have been systemized according to the basic manifested morphographic shapes - summits, hums, caves⁴, etc. Especially important for a relief evaluation are geomorphological processes which may represent a vital limiting factor, about which we shall report later in the text. Apart from the detailed geomorphological mapping, the morphometric relief analyses have been performed, too. The height

1. *Tourism - the sum of the phenomena and relationships arising from the travel and stay or non-residents, in so far as they do not lead to permanent residence and are not connected to any earning activity (Hunziker and Krapf, from: Zee, 1992.)*

2. *Recreation (recreate - to refresh) - aspect of tourism used for a rest, including the activities of relaxation, refreshment, pastime enjoyment.*

3. *Implies sport activities (walking tours, climbing - mountaineering and alpinism/rock climbing, orientation) with a purpose to develop and strengthen human body and for competition (orientation and some aspects of rock climbing).*

4. *For analysis and evaluation of caves, we used the results from potholing research works (Božičević, 1965). Some caves in the NP Paklenica have not been completely explored yet.*

	PTS.	APP.CAT.	MOD.FACT.	NEG.PTS.
1. SLOPES (>5°)	50-10	4-0	Inclination 6-12°	5
			13-32°	10
			33-55°	20
			N exposure (wind Bora)	10
			State of balance - mobile	10
2. ESCARPMENTS (>55°)	100-30	9-2	Relative altitude <300m	5
			<200m	10
			<100m	15
			N exposure (wind Bora)	20
			Ascendable with in > 1h	5
			> 3h	10
			> 5h	15
State of balance - mobile	20			
3. PEAKS	100-15	9-1	Altitude 1200 - 1300 m	5
			1000 - 1200 m	10
			800 - 1000 m	15
			< 800 m	20
			View - two directions	10
			- only one direction	15
			Shape - peaked and rocky	0
			Large - domal	5
			- rounded	15
			Small - conical	10
			- rounded	20
Accessible with in: 3 - 5 h	10			
5 - 7 h	15			
> 7 h	25			
4. KARST TOWERS	100-30	9-3	Relative altitude < 250 m	5
			200-100 m	10
			< 100 m	15
			State of balance - mobile	20
			N exposure (wind Bora)	10
			Accessible with in: 3 - 5 h	10
			5 - 7 h	15
> 7 h	25			
5. VALLEY BOTTOMS	80-20	7-1	Width < 10 m	5
			< 5 m	10
			Dry period < 9 mth.	10
			< 6 mmth.	15
			Rockiness - small material	10
			- rock bblocks	20
			Inclination 3-5°	5
6-12°	10			
13-32°	15			
6. CAVES	100-35	9-3	Length < 100 m	10
			Accessible with in: 3 - 5 h	10
			5 - 7 h	15
			> 7 h	25
			Lack of ornaments	20
Impassable (pathless)	10			

Table 1. Criteria for evaluation
 Tab. 1. Kriteriji vrednovanja reljefa

relations (hypsothetic map), slope inclinations and vertical relief dissection have been analysed.

SELECTION OF CRITERIA FOR A GEOECOLOGICAL RELIEF EVALUATION

Evaluation of relief, as an independent factor among the given elements within the natural environment, is one of the most difficult tasks (A. Bogner, 1990) and therefore a

gotes (karst towers), escarpments, caves, valley bottoms and slopes.

The next step is defining which requirements a relief must fulfill in order to meet the demands of the above quoted recreation types. These are the following factors: physical convenience, scenic quality and accessibility. An answer on almost all questions concerning these three requirements can be found in geomorphological and morphometric maps.

Namely, when we speak about the *physi-*

QUALITY CATEGORY	POINTS
9 - the most valuable terrains or relief forms	91 - 100
8 - fairly valuable terrains or relief forms	81 - 90
7 - predominantly valuable terrains or relief f.	71 - 80
6 - comparatively valuable terrains or relief f.	61 - 70
5 - predominantly less valuable terrains or r.f.	51 - 60
4 - comparatively unsuitable terrains or r.forms	41 - 50
3 - preaominantly unsuitable terrains or r.forms	31 - 40
2 - unsuitable terrains or relief forms	21 - 30
1 - rather unsuitable terrains or relief forms	11 - 20
0 - greatly unsuitable terrains or relief forms	1 - 10

Table 2 Relief quality categories

Tab. 2. Bonitetne kategorije geoekološke vrijednosti reljefa

selection of relevant evaluation criteria is a rather delicate and demanding job. The first step is defining of *recreation types* for which the evaluation shall be conducted. In this case, 3 recreation types (sports) have been remarkably represented in the NPPaklenica: walking tours (up to 3 hours walk), active mountaneering (more than 3 hours walk) and free climbing. According to these recreation types attractive relief types have been singled out, separately evaluated and finally classified into six morphographic categories: summits, mo-

cal requirements, we mean the relief forms, in fact, a defining of relief forms, which in this case are convenient for walking, mountaneering or free climbing. For evaluation of physical requirements, vital are information on relief farms, slope inclinations and slope mobility. When we speak about the slope mobility, we think of all destructive slope processes⁵ which possibly occur on a particular

5. Destructive slope processes are: collapsing, drifting of rock fall, rock sliding, soil flowing, creeping, run-off and gullyng

RELIEF APPRAISAL MAP NP Paklenica

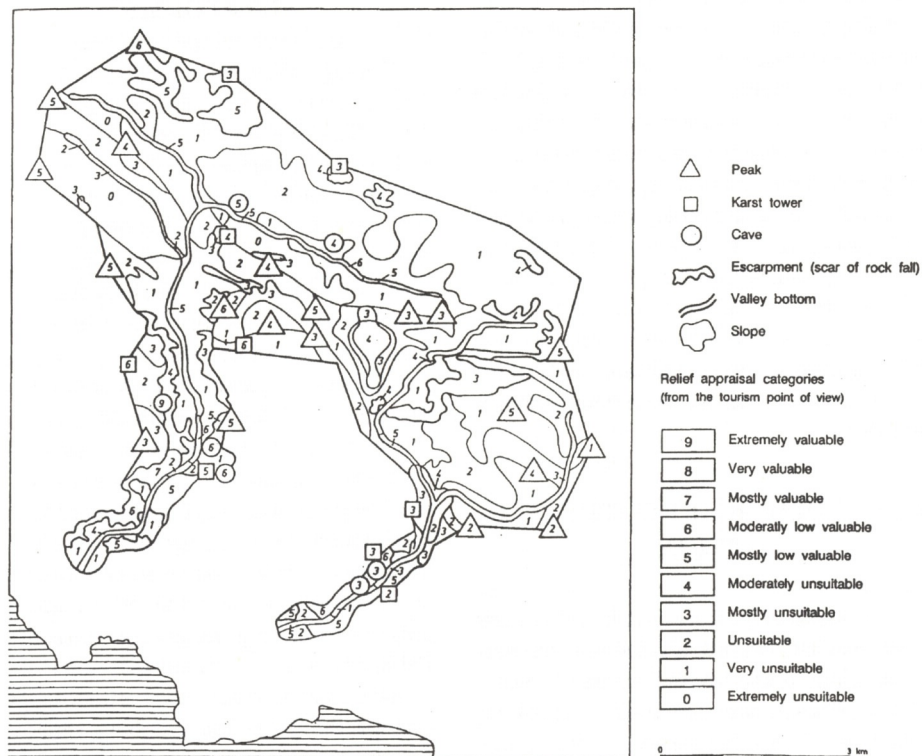


Fig. 1. Relief Appraisal map

Fig. 1. Karta geokoloških vrijednosti reljefa NP Paklenica

slope, influencing the physical convenience of a relief for tourist valorization. Actually, these processes have an immediate impact on slopes stability (collapses, drifting, rock falls etc.) and therefore on decreased safety (for tourists). An exposition of slopes to the north-eastern wind (Bura) should not be forgotten either, being essentially important for free climbing (as a limiting factor). Therefore, in geoecological evaluation, a special attention has been paid to slope mobility and to slope exposition.

As for the *scenic quality* we primarily think of landscape attractiveness, or rather of

relief property able to attract by its outward appearance a large number of tourists. Although attractiveness is a matter of subjective or personal evaluation, we tried to select as most "objective" criteria as-possible, and used data like altitude above sea level or relative altitude, a view extension from a particular spot, availability of specific attractive caves "ornaments" (speleothems) and so on.⁶

Accessibility can be defined as the general proximity in terms of time of all points in a

6. For selection of criteria on attractiveness, inquiry results conducted among the visitors of the NP Paklenica, in summer 1987 and 1988, have been used.

region (in the NP in this case) to a given kind of activity or facility, reflecting the degree to which a resource can be approached (Grinde and Kopf, 1986, from: Zee 1992.). Actually, we tried to measure how long and how difficult is walking from one place in the NP Paklenica to another. For evaluation of accessibility, the maps with marked tracks⁷ have been used, maps with slope inclinations, map with vertical relief dissection and a geomorphological map (slope stability). Taking into account all positive (availability of a good track) and negative (high inclinations and relief dissection, slope mobility where the footpath runs) factors, accessibility is indicated in walking hours needed to reach certain point within in the Park.

GEOECOLOGICAL RELIEF EVALUATION

As we already said, attractive relief parts have been singled out, divided into six morphographic categories and separately evaluated. These are: summits, mogotes, escarpments, caves, valley bottoms and slopes. Each category was given an appropriate number of points with clearly indicated upper and lower limit⁸ thus expressing its tourist value (Table 1). At the same time, a negative scoring system for limiting relief properties, which can reduce or correct a given number of points (Table 1), was applied, too. About 20 summits, 9 hums, 8 caves, 27 escarpments (55°), valley bottoms of 5 brooks and all sloped (5°) in the NP have been evaluated, which, according to the total number of points (initial number of points reduced for a sum of negative points), have been ranged in one of 10 quality categories (Table 2).

IDENTIFICATION OF VALUABLE AND POTENTIAL VALUABLE RELIEFFORMS

On the results of the performed analysis and taking into account the given criteria, we have conducted an evaluation of relief in the NP Paklenica from the aspect of tourism, or rather, recreation and sports activities. A map of relief quality categories (Fig.1) shows the value of particular evaluated relief forms for the recreation and sports requirements. Value of the summits ranges between the 6th and 1th quality category. According to this evaluation, the most valuable summits lie in the northwestern part of the Park and along the brook Velika Paklenica, while the summits in the south and southeastern part (along the valley of Orljača) are rather unsuitable for tourism purposes. There is also a certain differentiation among mogotes. Namely, the mogotes along V. Paklenica are more valuable for tourist purpose (6th - 5th quality category) than the mogotes in other parts of NP Paklenica. A special attention has been given to escarpments representing attractive, even one of the best free climbing ranges in Europe. Bearing in mind the factors influencing the climbers safety (slope mobility and exposition to the north-east wind Bura), the most valuable escarpments happen to be those along the west shores of the brooks Velika and Mala Paklenica. Caves are exceptionally precious tourist attractions. According to our evaluation⁹ the most significant is Manita Peć, where no limiting factor affects its

7. Excursion map of the NP Paklenica 1989.

8. Scoring principle adopted from A. Bognar, 1990

9. The big problem in evaluation was a shortage of relevant data for the caves Lucinka, Pozdrovača and Mokrača. Maximum number of negative points was therefore given to these caves except for accessibility. In future explorations of these caves should be obtained and their evaluation should be made, too.

value, so it belongs to the highest 9th category. Valley bottoms of 5 brooks¹⁰, depending whether there are alluvial plains or not, display rather different qualities. The most valuable is in almost all its parts a valley bottom of Velika Paklenica. The least attractive for recreational purposes are slopes (meaning as a relief form only, not as a landscape which would include forests and whole environment) due to their abrupt falls, except in the region of Velika Močila and Jurline where small planations appear. Slopes are ranged into the lowest quality categories (3 - 0).

During the evaluation, we have defined some specific limiting factors that greatly reduce the value of single relief parts. By the identification of those factors (slopes mobility, exposition to Bura and inaccessibility) a prerequisite was realized for discrimination of those parts where certain restrictive conditions could be changed and negative influence could be annulled. Assuming that by elimination of some limiting factor the value of a particular relief part could be increased, this part could be defined as a "potentially valuable". A potential value of certain relief form depends upon evaluation aspects (to what purposes the evaluation is conducted) and on possibility (and justifiability!) to eliminate certain limiting factors. Therefore, a question is whether this problem could be avoided or not, in which way, and what could be achieved by doing this (namely, it is possible that besides the expected positive results some negative consequences appear as well).

In the NP Paklenica there are a lot of parts meeting the majority of physical and esthetic conditions for recreation, however, due to their inaccessibility, they cannot be consequently evaluated. This applies mostly to the eastern part of the National Park, within the area of Mala Paklenica, which, as a zone of wilderness is a strictly preserved area. This in

turn sets the question how justifiable is to open this part of the National Park to the wider tourist valorization. One of the compromise solutions which would primarily meet the protection criterion and the tourist functions of the national park, is an organization of the specially conducted excursions. In this way, we could enable the tourists to visit this part of the NP, however, at the same time strictly controlling their number and movements, achieving a maximum protection of natural environment.

CONCLUSION

Geoecological evaluation has been increasingly applied for different purposes (agriculture, forestry, archeology, civil and military engineering etc.), but most frequently for improvement of land use and environment. Since the already given relief conditions influence all other physical landscape properties (climate, soil, vegetation, water) the research and relief evaluation represent an essential prerequisite of any geoecological research. Relief research implies a detailed geomorphological inventory listing and analysis. Apart from the geomorphological mapping and analysis of geomorphological processes, it is necessary to conduct morphometric relief analysis, thus completing the indispensable data base. Such data are fundamental for a selection of evaluation criteria, namely, for defining of limiting factors, both for tourist exploitation and for any other form of valorization. Therefore, a detailed geomorphological analysis is a prerequisite for the integral acquaintance and a proper control over our environment, or rather, it is the first and fundamental stage for all geoecological and landscape evaluation (including hydrological, vegetation, paedologic and other research works).

10. *Velika Paklenica with tributaries Brezimenjača and Suha Draga, and Mala Paklenica with a tributary Orljača*

REFERENCES:

1. BOGNAR, A. (1979), Uloga i zadaci geomorfologije u proučavanju i zaštiti okoliša. *Geographica Slovenica*, 9, Inštitut za geografiju Univerze v Ljubljani, Ljubljana, str. 127-130.
2. BOGNAR, A. (1990), Geomorfološke i inženjersko-geomorfološke osobine otoka Hvara i ekološko vrednovanje reljefa. *Geografski glasnik*, 52, Savez geografskih društava Hrvatske, Zagreb, str. 49-66.
3. BOGNAR, A., BLAZEK, I. (1986), Geomorfološka karta područja Velike Paklenice 1:25 000. *Acta Carstologica* 14/15, SAZU, Ljubljana
4. BOŽIČEVIĆ, S. (1965), Pećine Paklenice u J Velebitu., Prirodoslovna istraživanja, knjiga 35, *Acta Geologica*, Zagreb
5. GAMS, Ivan (1986), Osnove pokrajinske ekologije. Filozofska fakulteta Univerze Edvarda Kardelja v Ljubljani, Oddelek za Geografiju, Ljubljana
6. MITCHELL, C.W. (1992), *Terrain Evaluation*. Second edition, Longman Group UK, Limited, England
7. RICHLING, A. (1992), On Methodology of Assessment of Aestetical values of Landscape. *Miscellanea Geographica*, vol. 5., Warszawa, pg. 5-9
8. SALETTTO, Maja (1990), Geomorfološke osobine porječja Male Paklenice. Zbornik referatov 5. znanstvenega posvetovanja geomorfolgov Jugoslavije, *Geomorfologija in geoeкологија*, Krško, 18-23. 6. 1990, Ljubljana, str. 247-252
9. SALETTTO, Maja (1992), Geomorphological characteristics of the Velika Paklenica river basin. Proceedings of the International Symposium "Geomorphology and Sea", Mali Lošinj 22-26. 9. 1992., Department of Geography, Zagreb, str. 145-152
10. SALETTTO JANKOVIĆ, Maja (1994), Geokološko vrednovanje reljefa NP Paklenice. Simpozij u povodu 45. godišnjice NP Paklenica, Starigrad Paklenica, u tisku
11. ZEE, D. Van der, (1990), The complex relationship between landscape and recreation. *Landscape Ecology*, vol.4., SPB Academic Publishing bv, Hague, pg. 225-236
12. ZEE, D. Van der, (1992), Recreation studies from above. Air-photo interpretation as input into land evaluation for recreation, ITC publication No 12., Wageningen

Sažetak

ULOGA GEOMORFOLOŠKIH ISTRAŽIVANJA U GEOEKOLOGIJI

na primjeru geokološkog vrednovanja reljefa NP Paklenica

MAJA SALETTTO-JANKOVIĆ

Primijenjena geoeкологија (geoeкологија u službi što optimalnijeg korištenja i maksimalne zaštite krajolika) nezamisliva je bez detaljnog kartiranja (inventarizacija prirodne osnove) i brojnih, usko specijaliziranih istraživanja i analiza. Glavna pretpostavka za vrednovanja reljefa je provođenje kompleksnih geomorfoloških istraživanja što je prikazano na primjeru vrednovanja reljefa NP Paklenice i to za potrebe rekreacije i športa (šetnja, planinarenje, alpinizam i slobodno penjanje).

Provedene su morfometrijske analize (analiza visinskih odnosa, nagiba padina i vertikalne raščlanjenosti reljefa), te detaljno geomorfološko kartiranje. Na temelju prikupljenih podataka i provedenih analiza, te precizno određenih zahtjeva svake od navedenih tipova rekreacije i športa, defini-

rani su kriteriji za vrednovanje reljefa NP Paklenice. Vrednovanje reljefa je provedeno u skladu s tri glavna pokazatelja - (a) fizička pogodnost reljefa, (b) njegova estetka vrijednost i (c) dostupnost, pri čemu su od velike važnosti bili podaci o apsolutnoj i relativnoj visini, o nagibu i mobilnosti padina, te o obliku pojedinog dijela reljefa. Vrednovan je cjelokupni reljef NP Paklenica, i to u okviru šest morfografskih kategorija: vrhovi, kukovi, stranci, špilje, dolinska dna i korita, te padine.

Kao glavni ograničavajući faktor za turističku valorizaciju pojedinih dijelova Parka javlja se nedostupnost, te je, na kraju rada, dan prijedlog o mogućem rješenju tog problema.

U radu se ističe važnost i primijenjivost rezultata ovakvog vrednovanja za potrebe očuvanja krajolika, njegove zaštite i optimalnog korištenja.

Mr. Maja Saletto-Janković, asistent
Geografski odsjek PMF
41000 ZAGREB, Hrvatska
Marulićev trg 19