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MAN AND THE ENVIRONMENT IN THE CENTRAL VELEBIT AREA - BAŠKE OŠTARIJE AND SURROUNDINGS

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Abstract:

The aim of this paper is to trace the human impact on the environment through the way of life, corresponding subsistence economy as well as to define the degree and the mode of change through time. The special account is given to the evaluation of optimal possibilities of sustainable development (mainly in tourism) and preservation through the geoecological evaluation of the landscape embracing the evaluation of few geomorphologic parameters and the aesthetic one. It has been based on the multivariate cluster and discriminant analysis.

Key words:

environment, environmental change, human impact, Velebit, pastoralism, transhumance, historical geography, environmental history, multivariate analysis, geoecological evaluation

ČOVJEK I OKOLIŠ SREDIŠNJEG VELEBITA - BAŠKE OŠTARIJE I OKOLICA

Izvadak:

Cilj je ovog rada odrediti utjecaj čovjeka na okoliš kroz način života i odgovarajući oblik egzistencijalnog gospodarstva, te definirati stupanj i oblik promjena kroz vrijeme. Posebna je pažnja posvećena evaluaciji optimalnih mogućnosti održivog razvoja (pretežno u turizmu) i zaštiti kroz geoekološku evaluaciju pejzaža koja obuhvaća nekoliko geomorfoloških parametara i jedan estetski. Evaluacija je temeljena na multivarijantnoj cluster i diskriminantnoj analizi.

Ključne riječi:

okoliš, promjene okoliša, ljudski utjecaj, Velebit, pastoralizam, transhumanca, historijska geografija, ekohistorija, multivarijantna analiza, geoekološko vrednovanje

Introduction

Space and time, nature and culture, in various mixes have been the stock-in-trade and major strenght of all geographers (WILLIAMS, 1994). The basic conceptual and methodogical context of the following research is the clear notion of the strong symbiotic relation between human occupancy and environmental change.

In some recent reports it has been stated that geography finally seems to be taking the environment, and particularly nature seriously in conceptual terms (EDEN, 2001), although geographers have been playing a key role and have a key role to play in the future. "Geography matters for the environment of the twenty-first century" stated Prof. Crofts in his lecture given at the Conference of the Council of British Geography in Oxford, 1998 (CROFTS, 1999).

Basic Conceptual and Methodological Framework

The meeting point between man and the environment (or nature and society) has been one of the main subjects of geography, as well as for number of related disciplines (mainly anthropology, archaeology, history, ecology), including the new emerging research-field of environmental history. The environmental history has been developed only during the last twenty five years or so. For much longer, numerous studies in historical geography have explicitly reconstructed the relations between people and their environments at some time or during some period in the past (BAKER, 1994).

The reconstruction of the physical and ecological environments within which successive phases of human occupance took place, and which were subject to major phases of modification by, for example, woodland and forest clearing, changes in drainage and of establishment of settlements and networks of communications is a long tradition in the field of historical geography (BUTLIN, 1993, 98). Historical geography made a deliberate investment in the investigation of environmental change long before the stimulus of the environmental movement intensified the kinds of converging inter-disciplinary research (POWELL, 2000, 186).

The problem of the relations between people and their environments in the past is of concern not only to many historical geographers and environmental historians, but also to others (physical geographers, geoecologists, cultural geographers, ecological anthropologists...). The need for not only inter-discplinarity, but for multidisciplinarity in environmental studies is logically grounded. However, stressing the differences and putting academic lables on pieces of work is of less importance than highlighting the similarities and the knowledge of what each has to contribute to the central issues of how people interact with the natural world (WILLIAMS, 1994, 16). Some of the authors emphasize the distinction between nature and environment (EDEN, 2001) explaining that nature is more often connected with the notion of wilderness, while the

environment is as much a social construct as a physical presence (BENTON, SHORT, 2000). Consequently, the links with the life sciences, the earth sciences and the social sciences in this discourse are vital for geography. Geography has to be careful not to be isolationist (CROFTS, 1999, 352).

Within the broad and complex environmental discourse a number of distinct models were developed aiming to embrace the people-nature perspective. Some of these models and approaches labeled specific traditions such as Berkeley School, Chicago School and cultural ecology.

Recent model integrating culture, environment and history elaborated by Simmons (1996) propose a dynamic system, the ecosystem as a conceptual tool. The same author structured the humanity-nature relations in a regional environmental history framework around matrices of regions (in Europe) against economic type: one each for environmental opportunities, constraints, environmental impact and environmental hazards (SIMMONS, 1998). This particular model has been applied in our research in order to trace the environmental impact in the central Velebit area.

The man-environment relations in future are questioned through the geo-ecological evaluation of the present landscape, notably its aestetic values for a purpose of tourism as the sustainable mode of development.

Basic traits of natural environment

If looking at Velebit Mountain from the Lika side or from the seaside, it appears as a uniform ridge with rare natural passes (Fig. 1). Nevertheless, these passes are those to define segmentation of the Velebit Mountain. Its width varies from 8 km in Southern Velebit to maximum of 28 km in Northern Velebit, with average of about 17 km. In cross section Velebit Mt. is characterized by distinct asymmetry. The seaside slope is much steeper than the one on Lika side, and two breaks in slope are developed at 100 - 300 m and 600 - 900 m a.s.l., respectively. Actually, these breaks in slope represent gentle slopes of piedmont steps - pediments which were formed by slope processes (rockfalls and slope failures) during periods of dry climate.

Fig.1. The investigation area; Central Velebit – Baške Oštarije and surroundings
Sl.1. Područje istraživanja, Srednji Velebit – Baške Oštarije i okolica

Their different altitudes, however, indicate uneven uplift of the Velebit Mt. during the geological history. Breaks in slope on the Lika slopes, are visible only at the South Velebit Mt., whereas the Middle and Northern Velebit Mt. is dissected by deeply incised valleys with east-west strike. The summit part of the Velebit Mt. is in most part very wide and represents unevenly dissected highland, even where it is the narrowest, and is characterized by a series of peaks and short parallel ridges which are separated by a system of swallow-holes, dolines and smaller karst poljes (Fig.2). This is exactly the case in environs of Baške Oštarije where Suvaja brook valley and Oštarije karst polje devide Velebit Mountain into Middle and Southern Velebit. The central position of this natural pass had very high importance during the history (PERICA, 1998).

This part of Velebit Mountain is largely built of water permeable carbonate rocks which also predominate in the western and the northern part. Limestones and "Tertiary breccias", known as Jelar deposits, are very prominent in the relief of Velebit. Water impermeable shales, sandstones and conglomerates of the Paleozoic age predominate in the eastern part (only thin intercalations of carbonate rocks occur). Structurally, Velebit represents a SW flank of a broken anticline with seaward bedding dip and general strike direction SE-NW, and a core is built of Paleozoic rocks.

The present image of Velebit was highly influenced by neotectonic movements when uplift ranged between 500 and 1300 meters. Very strong vertical displacements along the Lika fault (which separated formerly uniform anticline) exceed even 500 m locally.

Velebit represents a bordering zone between the seaside area and the inland , which is characterized by climate. It is the

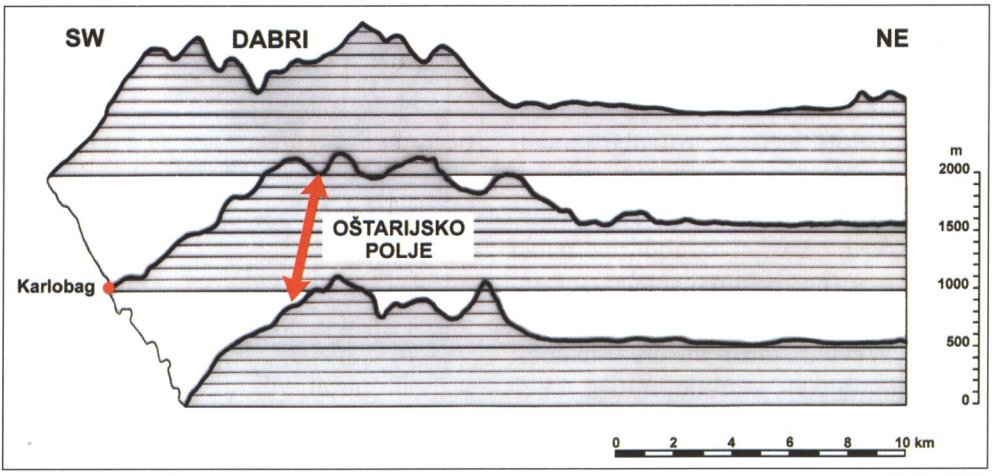

Fig. 2. Transversal cross-sections of the Central Velebit
Sl. 2. Poprečni profili Srednjeg Velebita

Fot. 1. The pasture
Fot.1. Pašnjak

barrier which does not allow mixing of the lowest air masses on both slopes up to 1000 m a.s.l. Since the substrates are different on both sides, the air characteristics are very different, too. Seaside slope is influenced by sea-water, while the environs of Lika is adjusting to terrestrial conditions. Hight change causes drop down of temperature, which is more significant on the seaside then on the inland. The lowest parts of the seaside slope have average yearly air temperature around 15 °C, and the inland area around 8,8 °C, and on the 1594 m high Zavižan there is 3,5 °C. The relief influence becomes distinct in amount of precipitation. Even if the lowest parts of seaside slope get around 1100 mm precipitants per year, summer months are dry. The highest precipitation is during colder part of the year, while 1/3 of yearly precipitation is in warmer part of the year. Amount of precipitants grows by hight a.s.l., so part above 900 m a.s.l. get over 2000 mm precipitation per year with more even distribution (PERICA, OREŠIĆ, 1997.).

On the littoral slope, as well as on the SE exposed slopes of Oštarije karst polje, there is submediterranean vegetation of holm oak (*Quercus pubescens*) with eastern hornbeam (*Carpinus orientalis*) and hop hornbeam (*Ostrya carpinifolia*) and littoral beech forest (*Fagus sylvatica*) in higher parts. In other, colder and shady areas, forests of mountain beech (*Fagus sylvatica*), fir (*Abies alba*) and Norvegian spruce (*Picea excelsa*) and austrian pines (*Pinus nigra*) predominate (HORVAT,

Fot. 2. The rocky karst
Fot. 2. Krški kamenjar

Fot. 3. The pedological profile
Fot. 3. Pedološki profil

1949). On the seaside slope forest cover is significantly degraded down to macchia and garrigue, and in some areas completely degraded to pastures (Fot. 1). In dolines of Oštarije karst field the autochthonous forests have been destroyed by fires in order to produce agricultural areas. As consequence of the devastation of forests and rainfalls commonly short lasting, strong surface erosion of pedogenic horizon occurs. Therefore, rocky karst predominate today (Fot. 2). Strong outwash is also indicated by continuous occurrence of ash particles in pedohorizons up to 2,2 m and colluvial soils of swallow holes. (Fot. 3)

Environmental Impact in the Central Velebit Area

Different types of natural environment have varying influences on a primary

concentration of population, on location and types of settlements as well as on the type of the subsistence economy. This humanity – nature relations result in a various types of environmental impact and change through time.

According to Simmons (1998) each particular area, regarding the economic type, has its opportunities, constraints as well as environmental impact. The relation between the environmental constraints and opportunities defined the type of subsistence economy of the mountain Velebit as well.

Velebit is a mountain of pastoral economy from the prehistoric times. The constraints of climate and relief upon agriculture are obvious in mountain areas, although this did not result always in the preservation and wilderness. Natural mountain grasslands and cleared woodlands became the focus of pastoralism most often of sheep and cattle (SIMMONS, 1998). As an adaptation to the seasons transhumance of a particular type was practiced even during the last century; either on the local scale from littoral to the higher pastures in summer, or on a regional scale from Dalmatian hinterland (MARKOVIĆ, 1980, ROGIĆ, 1957,1958, VINŠĆAK, 1989). Those particular pastoral seasonal movements from the littoral to the higher pastures have, according to Belaj (1986), very much in common to the alpine model.

The general climatic and ecological picture of this area very clearly determines pastoralism as the most convenient and most adaptable form of subsistence economy. Herding as well as agriculture, is directly dependent on a characteristic type of climatic and vegetation zones. In this sense, the humid to perhumid climate of the mountain, with a particular complementary relationship between the Mediterranean-Sub-Mediterranean area and the high Dinaric, karstic mountainous areas, offers extraordinary conditions for developing herding of the traditional transhumanic type (FÜRST-BJELIŠ, 1998) Transhumance, traditional in the region of Dinaric karst, dates back to prehistoric times and as the socio- cultural and geographic deterinant of the Dinaric region has been dominant in all phases of historical-geographical develop-ment up to the 20th century (ROGIĆ, 1982).

The overall ecology of the area is most affected by climate, specific hypsometric and corresponding vegetation zones. The Velebit littoral suffers from summer drought and lack of arable land. Higher mountain zones receive much more precipitation (an average over 2 000 mm per year). Consequently the largest area of mountain pastureland is developed at the altitude over 1 000 m. Additionally, the pasture development optimum happen to be in the summer, during the drought time in the littoral. The man has understood and taken advantage of those phenological relations in the annual distribution of pasture vegetation long ago.

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Fig. 3. "Passo di Licca", PASSAGE TO LIKA, the oldest and the most important transversal pastoral route from Karlobag- via Baške Oštarije – to Lika, indicated on the map of Northern Dalmatia and Croatian Littoral by L.N. Bellini from 1771.

Sl. 3. "Passo di Licca", LIČKI PROLAZ, najstariji i najvažniji transverzalni stočarski put između primorske i ličke strane preko Baških Oštarija. Prikaz na karti sjeverne Dalmacije i hrvatskog Primorja L. N. Bellinija iz 1771. godine

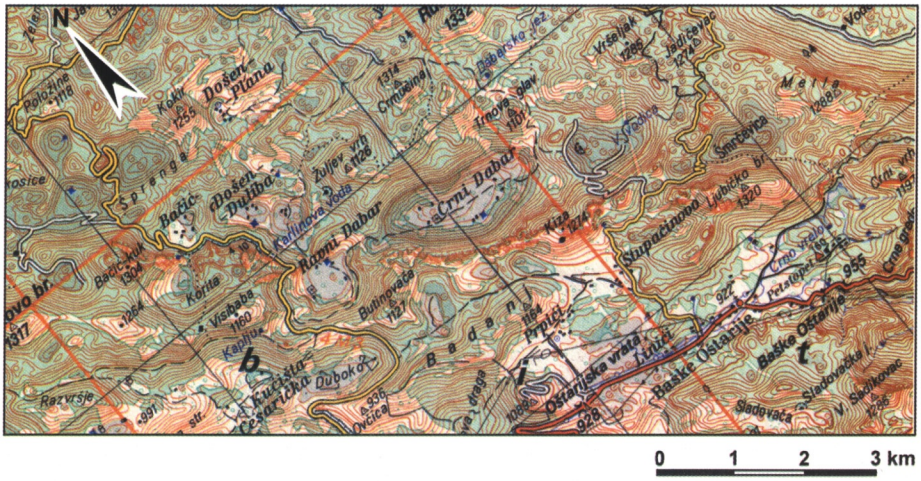

Fig. 4. The longitudinal succession of karst uvalas of Dabri and the karst polje of Baške Oštarije

Sl. 4. Longitudinalni niz krških uvala Dabri i Oštarijskog polja u kršu

Tab.1 Environmental impact in the Central Velebit area
Tab.1. Periodizacija ljudskog utjecaja i promjena u okolišu; Srednji Velebit

Phase	Opportunities/ Constraints	Environmental impact
I. Untill 17th century	- Summer drought in the littoral, lack of arable land - Rich pastures in the higher mountain zone (during the summer) - Population density	-Relative balance between the carrying capacity of the environment and the human impact
II. From 17th – 20th century	-Immigration, increased population density -Rich mountain pastures -Free land, potentially arable after burning -Rich forests for timber production	- Intense deforestation (due to the burning and cutting) -Accelerated soil erosion from wind and pecipitation
III. 20th century	-Depopulation	-Abandoning of land to the natural succession -Slight reforestation

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In the Central Velebit area, as one of the most important pastoral areas, pastures are dispersed through a number of karst depressions like uvalas, dolines and karst poljes. The area was transpassed by a number of local longitudinal pastoral routes as well as by the oldest transversal pastoral route, known from the prehistoric times and used through the whole history: from Karlobag- via Baške Oštarije – to Lika (Fig. 3). The longitudinal succession of karst uvalas of Dabri and the karst polje of Baške Oštarije in the zone of approximately 900 m of altitude (Fig. 4) have always been the summer destination of transhumanic pastoralists, but also from the early modern period the location of the first (and the highest) sedentary settlements. Furthermore, sedentarization introduced agriculture that have considerably changed the environmental impact and pressure on the land.

From the viewpoint of the intensity and type of the environmental impact in the central Velebit area it is possible to differ three distinctive phases:

I. Untill 17th century;
II. From 17th – 20th century;
III. 20th century.

I.

Although even light grazing pressure changes the species composition of an ecosystem, especially if repeated over a long period of time (Simmons, 1998), it looks like carrying capacity of the environment maintained the transhumance

pastoralism in the period before the Ottoman border disturbances and the early modern immigration (in the 17th century).

Low population density is one of the main causes of the lack of intensive environmental manipulation. Climatic constraints have additionally accentuated in the middle ages due to the "Little Ice Age", combined with the war time insecurity of the Triple border area in the early modern period, conditioned that central Velebit area was still permanently uninhabited, used for grazing only several months per year.

II.

The balance between the carrying capacity of the environment and the human impact was affected by considerable immigration of pastoral population from the Dinaric interior in the 18th century.

The first sedentary settlements were established in the uvalas of Dabri. A number of historical records refer to the intensive burning of huge coniferous forests in order to cultivate the land, as well as to cutting the wood for timber production (GUŠIĆ, 1959). Some recent remote - sensing and archaeological investigations (FABER, 1984) showed the presence of a number of cultivated parcels in the uvalas of Velebit at the altitude of 1400 m (Mirovo), dating from the 19th century. As a consequence of the increased number of population and the increased number of sheep, goats and cattle (ROGIĆ, 1958), the pastures were exhausted by excessive grazing. The excessive pressure led to intense deforestation, as well as increased soil erosion and dispersion of rocky karst area.

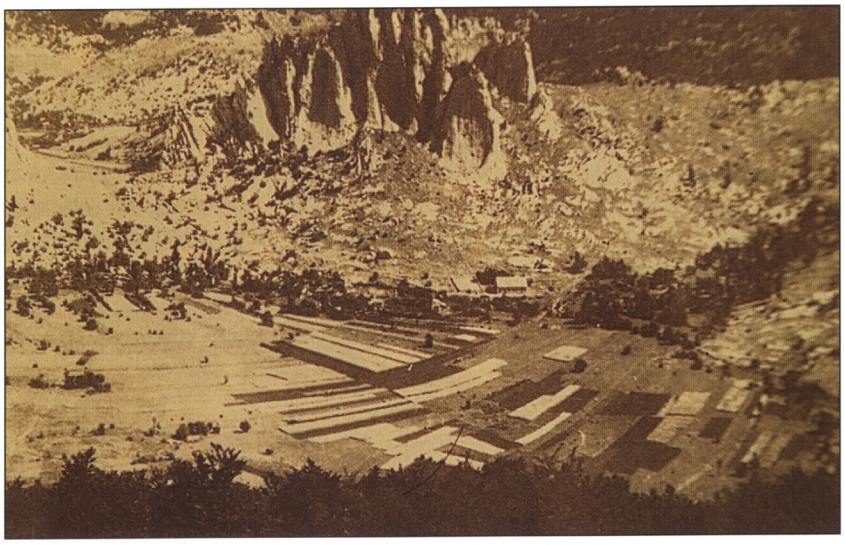
III.

The general process of depopulation that affected the central Velebit area as well characterizes the third phase of the environmental impact. Abandoning of land to the natural succession and slight reforestation followed depopulation.

Each of these phases has left some traces of its existence in today's landscape (Fot. 4a, 4b). Moreover, a great part of it have a high scenic, aesthetic as well as biological and geomorphologic diversity that is very attractive for tourism.

Geoecological evaluation of landscape potential in tourism (from an aestethic aspect)

Relief parametres can be important assesors of the aesthetic value of a landscape. Consonant with that assumption, it has been quantified basic parametres of relative height, length of the slopes (expressed in metres) and calculated length and height ratio (which represents a parameter of inclination), on 151 slope units of the investigated area. As an additional element in the analysis, it has been introduced a new parameter which is not strictly geomorphological. It can be called a "openness of view" and shows how far and clear a view is from a certain slope. For example, one slope can be exposed toward some other slope, or slopes. On the other hand a slope can be exposed toward a karst valley, sinkhole, planation surface



Fot.4a. Uvala Ravni Dabar at the beginning of the 20th century.
Fot.4a. Uvala Ravni Dabar početkom 20. stoljeća

Fot 4b. Uvala Ravni Dabar at the beginning of the 21st century
Fot.4b. Uvala Ravni Dabar početkom 21. stoljeća

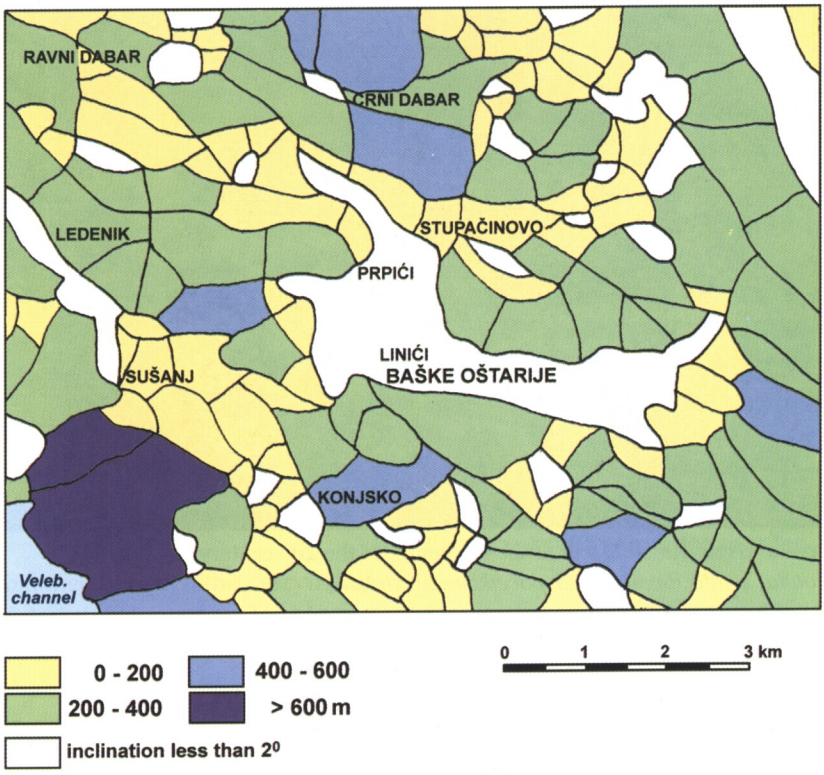


Fig. 5. The distribution of relative height categories
Fig.5. Raspored kategorija relativne visine

or sea. In the first case, the "openness of view" on that slope will be less (expressed by coefficient 0); in the second case we have inverse situation (expressed by coefficient 1).

The basic idea is to establish synthetic criterion which will be the most appropriate to define attractivity of the landscape. The term "attractivity" is not such so simple explain because it may have many interpretations (LINTON, 1951), but for the purpose of this investigation it was defined as a "contrast of landscape". In other words, if landscape units close in position are more different, they are also more contrasted and dynamics of landscape is more expressed. Because of that, a synthetic criterion which denotes attractivity of landscape can be called "dynamics of landscape".

The pictures (5, 6, 7 and 8) show a distribution of numeric values of four parametres (expressed in metres, indexes and coefficients), represent a starting point for further investigation.

The next step in the analysis was the evaluation of slopes by help of the multivariate analysis. In the first phase 151

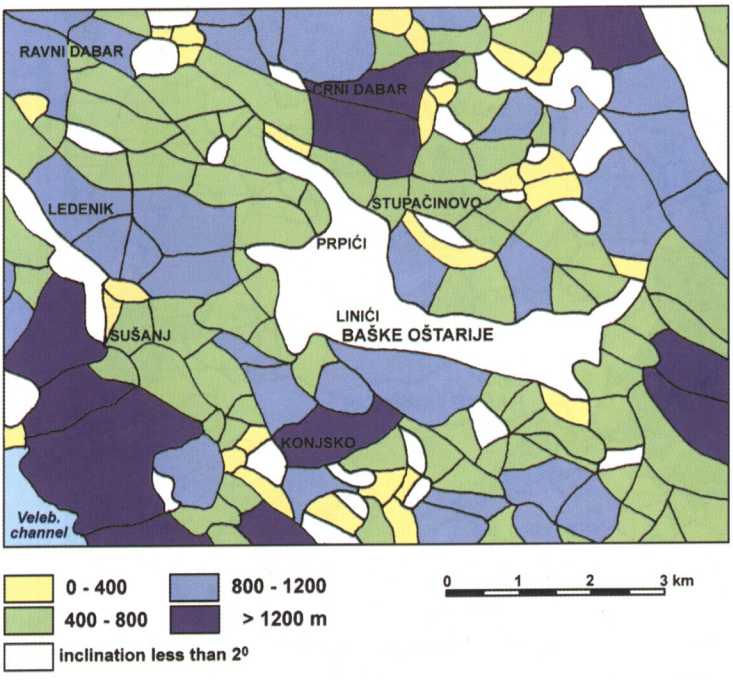


Fig. 6. The distribution of the slope lenght categories
Sl. 6. Raspored kategorija dužine padina

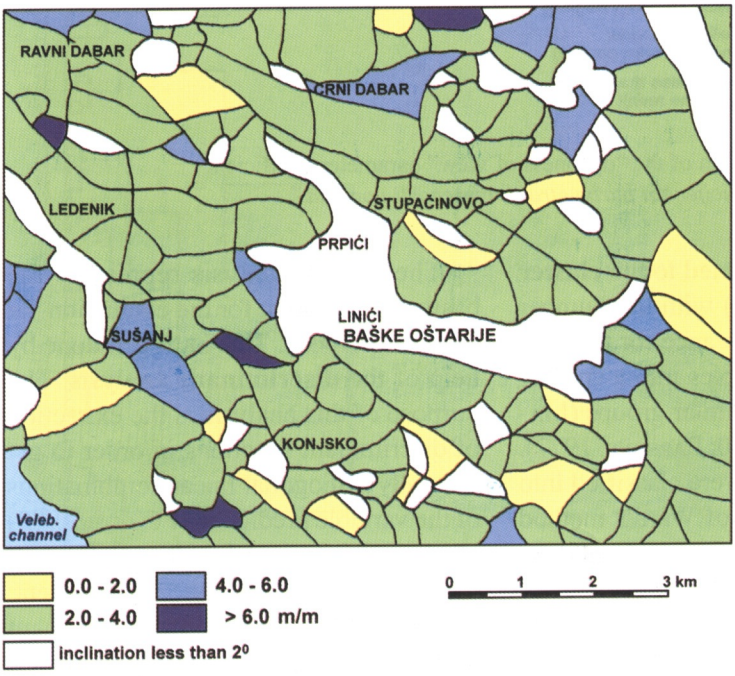


Fig. 7. The distribution of length and relative height ratio categories
Sl. 7. Raspored kategorija indeksa dužine i relativne visine

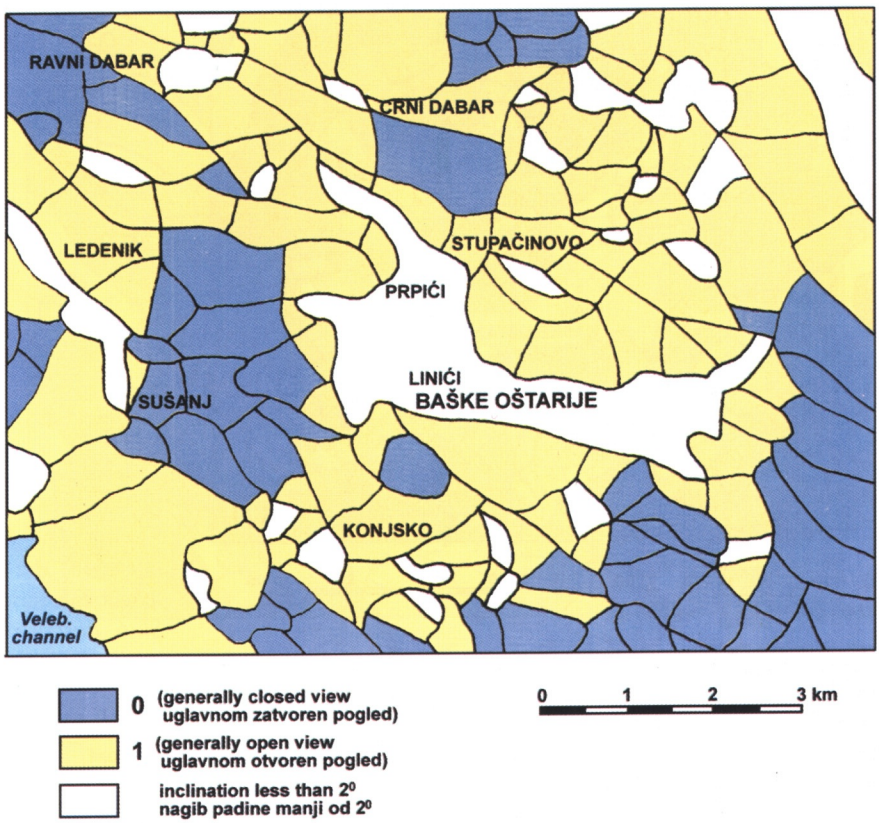


Fig. 8. The distribution of the "openness of view" parameter coefficient
Sl. 8. Raspored koeficijenata parametra "otvorenosti pogleda"

slope units were subjected to the **cluster analysis** (LOZIĆ, 2000) with the number of clusters given in advance for the purpose of grouping samples into a smaller number of mutually similar groups (MATHER, DOORNKAMP, 1970; PARSONS, 1977). In that way the units were classified into 6 groups on the basis of Ward's method of grouping (WARD, 1963) and Euclidean distance (Fig. 9). The centroids of these groups represent the variable average value of all members of each group.

The cluster analysis represents the basic starting point for the evaluation for touristic purpose. This has been done by help of the **discriminant analysis**. The purpose of this analysis is the extraction of discriminant functions in order to get mutually orthogonal linear combinations of the variable predictors (FULGOSI, 1979) composed so that each of them takes part in the discrimination to the fullest extent. After this procedure four discriminant functions were singled out. Chisquare test

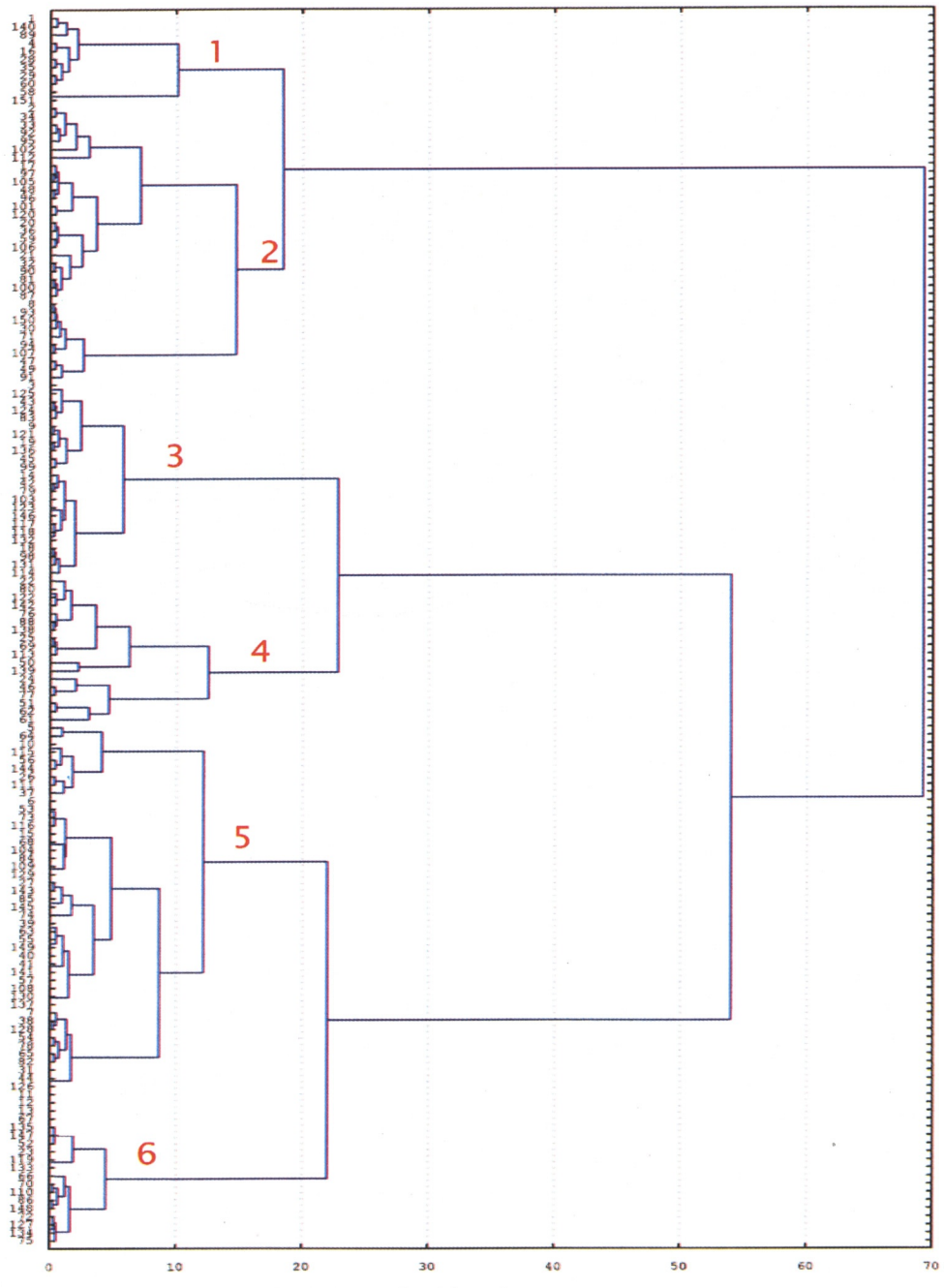


Fig. 9. Cluster dendrogram for 151 samples (slopes)
Sl. 9. Cluster dendrogram za 151 uzorak (padine)

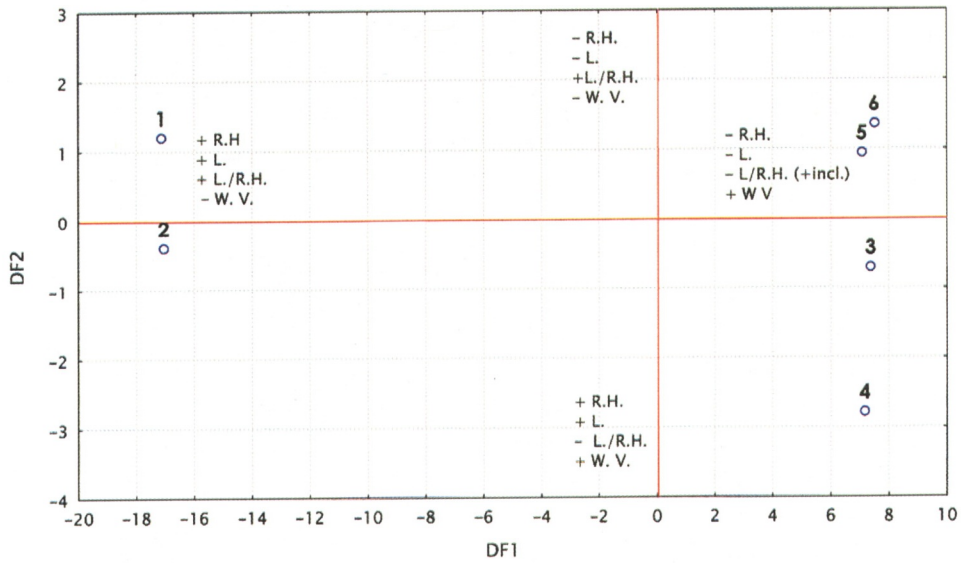


Fig. 10. Model of the relationship between clusters and DF 1 and DF 2
Sl. 10. Model odnosa clustera i diskriminantnih funkcija 1 i 2

showed that first two functions were most significant, becouse they explain almost all system variance (99 %).

The model of the relationship between previously established cluster groups with discriminant functions 1 and 2 was constructed on the base of the standardized coefficients (or means of the variables in the discrimination). Then the position of the groups in the discriminant space could be determined (Fig.10). DF 1 is burdened with lesser values of relative height, length and greater values of inclination and "openness of view" parameter on the positive side of the x - axis. On the other side of function situation is quite opposite. DF 2 is burdened with all negative values on the positive side of the y - axis, and with the positive values at the opposite side. Generally, the higher values of all parameters represent a higher degree of landscape dynamics, and inversely. Consonant with that assumption, the groups positioned in the discriminant space has been evaluated.

The group 4 has the best position, then come groups 3, 5 and 6. The groups 1 and 2 are positioned on the opposite side of the model, which means that their characteristics are less attractive.

On the basis of this model, 6 appraisal landscape categories were singled out, which is presented on the appraisal map (Fig. 11). It's obvious that most valuable slopes (shown with darker colours) are concentrated around sinkholes, karst valleys, planation surfaces or near the sea. Less valuable slopes are situated in the mostly closed areas, where there is a greater number of slopes on in a short distance.

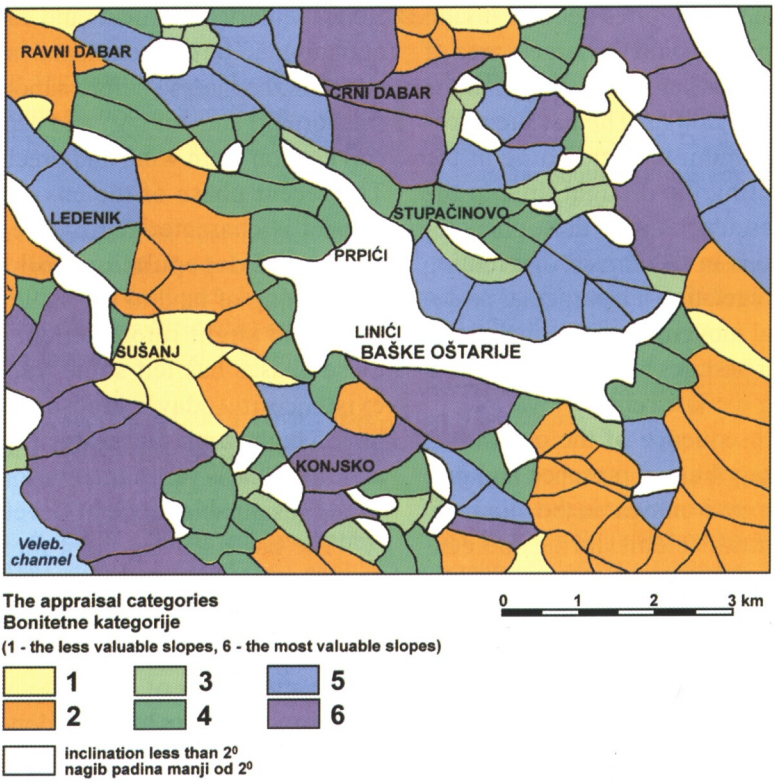


Fig. 11. An appraisal map of the investigated area
Sl. 11. Bonitetna karta istraživanog područja

The ecological aspect of this investigation must be pointed out, because the most valuable landscapes must stay preserved from negative human influence like non-rational valorization and devastation. It is necessary if we want to keep natural beauty of this landscape for future.

Conclusion

According to Simmons' model (1998) each particular area, regarding the economic type, has its opportunities, constraints as well as environmental impact. The relation between the environmental constraints and opportunities defined the type of subsistence economy of the mountain Velebit as well.

The general climatic and ecological picture of this area very clearly determines pastoralism as the most convenient and most adaptable form of subsistence economy. The overall ecology of the area is most affected by climate, specific hypsometric and corresponding vegetation zones. The Velebit littoral suffers from summer drought and lack of arable land.

Higher mountain zones receive much more precipitation and the largest area of mountain pastureland is developed at the altitude over 1 000 m. The pasture development optimum happens to be in the summer, during the drought time in the littoral. As an adaptation to those phenological relations in the annual distribution of pasture vegetation the particular pastoral sea-sonal movements from the littoral to the higher pastures have been practiced, even during the last century.

As a consequence of the occasional and temporary human presence and pressure on the environment in the mountain area of central Velebit during the centuries, the relative balance between the carrying capacity of the environment and the human impact have been maintained till the process of immigration in the 17th century.

From the viewpoint of the intensity and type of the environmental impact in the central Velebit area it is possible to differ three distinctive phases: Until 17th century; from 17th – 20th century; 20th century. The main phase of the environmental manipulation have begun at the 17th - 18th century, as a consequence of the immigration, the increased number of population and the increased number of sheep, goats and cattle, the establishment of the first sedentary settlements and introduced agriculture. The environmental impact resulted in the intense deforestation (due to the burning and cutting) and accelerated soil erosion from wind and precipitation. The recent phase of the environmental impact is characterized by the general process of depopulation, followed by abandoning of land to the natural succession and slight reforestation. Each of these phases has left some traces of its existence in today's landscape, which have a high scenic and aesthetic diversity and value that is very attractive for tourism as the sustainable mode of development.

The basic starting point for the geo-ecological evaluation for touristic purpose was establishing the synthetic criterion which will be the most appropriate to define attractivity of the landscape. Evaluation of the slopes has been done by help of the multivariate cluster analysis classification and discriminant analysis model. On the basis of this model, 6 appraisal landscape categories were singled out. The most valuable slopes are concentrated around sinkholes, karst valleys, planation surfaces or near the sea. Less valuable slopes are situated in the mostly closed areas, where there is a greater number of slopes on in a short distance.

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Sažetak

ČOVJEK I OKOLIŠ SREDIŠNJEG VELEBITA - BAŠKE OŠTARIJE I OKOLICA

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Svako područje s obzirom na tip gospodarstva ima svoje mogućnosti, ograničenja, a karakterizira ga i odgovarajući utjecaj čovjeka na okoliš. Odnos između ograničenja i mogućnosti prirodne sredine odredio je i dominantni oblik egzistencijalnog gospodarstva planinskog velebitskog područja.

Osnovna klimatsko-ekološka slika vrlo jasno određuje pastoralizam kao najprihvatljiviji oblik egzistencijalnog gospodarstva. Pastoralizam transhumantnog tipa, tradicionalan u regiji dinarskog krša, datira još iz prethistorije, a kao geografska i sociokulturna odrednica dominantn je u svim fazama historijsko-geografskog razvoja sve do 20. stoljeća.

Ključni odnosi koji su odredili sezonska kretanja stočara iz nižeg primorskog dijela u viši planinski su koincidencija ljetne suše (uz nedostatak obradive zemlje) u primorju s optimumom razvoja pašnjačke vegetacije u planini. Čovjek je odavno spoznao i iskoristio fenološke odnose u godišnjem hodu razvoja pašnjačke vegetacije. Najprostranije zone planinskih pašnjaka su razvijene na nadmorskoj visini od oko 1000 m. Pašnjačke površine su dispergirane u brojnim krškim depresijama - uvalama, ponikvama i poljima u kršu (uvale Dabri i Oštarijsko polje).

S aspekta intenziteta i tipa čovjekovog utjecaja na promjene u okolišu na srednjem Velebitu moguće je izdvojiti tri karakteristične faze: I - do 17. stoljeća, II - od 17. do 20. stoljeća i III – 20. stoljeće. Analiza promjena u okolišu prema Simmonsovom modelu (1998.), uzimajući u obzir ograničenja i mogućnosti u svakom pojedinom karakterističnom razdoblju, pokazala je da do 17. stoljeća postoji relativan sklad i ravnoteža između praga nosivosti prirodne sredine i ljudskog djelovanja. Razdoblje od 17. do 20. stoljeća je razdoblje imigracija, sedentarizacije i uvođenja ratarstva (uz stočarstvo). Ti su procesi značajno pojačali pritisak na prirodnu sredinu. To je razdoblje različitih oblika degradacije (deforestacija, erozija). Kao posljedica depopulacije od 20. stoljeća počinje treća karakteristična faza u odnosima čovjeka i okoliša, obilježena i prepuštanjem zemlje prirodnoj sukcesiji i laganoj deforestaciji.

Na temelju pretpostavke da numerički parametri reljefa mogu biti važni indikatori estetske vrijednosti krajolika, uspostavljen je sintetički kriterij dinamike pejzaža za potrebe vrednovanja u turističke svrhe s aspekta estetske vrijednosti. Ovaj sintetički kriterij sastoji se od nekoliko kvantitativnih geomorfoloških pokazatelja (relativna visina, dužina padina, indeks dužine i relativne visine) i jednog estetskog parametra kojim se kvantificira otvorenost pogleda s određene padine.

Evaluacija pejzaža (151 uzorak) provedena je pomoću multivarijantne cluster i diskriminantne analize, odnosno modela odnosa cluster grupa i diskriminantnih funkcija. Izdvojeno je 6 bonitetnih kategorija pejzaža, što se može primijeniti u budućem planiranju aktivnosti u turizmu istraživanog područja.

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