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## THE PROBLEM OF DELIMITATION IN MOUNTAIN REGIONS. THE EXAMPLE OF THE GOČ MOUNTAIN

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**Abstract.** It has been proved for countless number of times that consulting geographers for various questions is obligatory. This is also the case of the Goč Mountain. The topic of this work is the necessity of establishing borders in mountain regions and ways in which it could be performed. It also points to the fact that toponyms could create confusion. The results of the paper have led to paradox situation. By establishing borders of the Goč Mountain, it has been proved that certain, terrains close to it, which were considered to belong to Goč, are in fact on the slopes of the other mountain, and in addition to it, between them there is one more lower mountain. Namely, it is interesting that conducting an interview among local population in southeast part of the mountain contributed to the process of confirmation of the border established by applying geographic knowledge, while on the southwest part of the Goč Mountain it was not the case. Additional analysis gave the explanation for the diversity. There is no local population in southwest part of the Goč Mountain. Interview was conducting between employees in tourist facilities, forestry workers and weekenders.

**Keywords:** *Mountain region, Goč Mountain, West Morava valley, delimitation, interview*

### I. INTRODUCTION

The areas of mountains, certain hypsometric regions and their shares have multi-purpose application and they can be easily calculated by digitalization of topographic maps and usage of different Gis applications (Pradhan, 2001; Taillefumier and Piegay, 2003; Liu et al., 2006; Gustavsson et al., 2008; Hyun-Joo et al.; 2011). However, before that it is necessary to determine where the furthest borders of a certain mountain are.

The establishing of borders of regions, which have been determined according to physical geographical features, is often problematic (Klemenčić, 1994; Mark and Smith, 2004; Regato and Salman, 2008, 14), especially if we talk about drawing the border between the mountains and the valley of certain river or something similar. Borders between mountains are the most frequently determined by water courses which flow between them. This fact gives the impression of simplicity of establishing the point where one mountain ends, and the other begins. However, experiences show that problematic zones could occur also there, or as Pipan (2008, 333) says unforeseen problems.

## II. STUDY AREA

Goč Mountain is located in Central Serbia, where Šumadija region reaches Kopaonik region. Goč belongs to mountains of Kopaonik system, and its northern slopes are part of the West Morava valley. Most of Goč Mountain' borders are clearly distinguished. The northern border of Goč foothill should be in the West Morava valley, at about 200 m of absolute height; western on the Ribnica River, and eastern on the Popinska River (Fig. 1). The southern side of the mountain coalesces into other terrains. Its determination represents the goal of this work.

The most northern point of Goč, i.e. its foothill is located at the mouth of the Ibar into the West Morava ( $43^{\circ}43'37''$  Nφ, 184 m), the most western is in the Ribnica valley, under the Čvorovka hill (398 m) in Trebićka Mala ( $20^{\circ}41'22''$  Eλ, 260 m), the most southern point is at the mouth of the Krivača River into the Zagrža River ( $43^{\circ}31'05''$  Nφ, 694 m), while the most eastern point is at the mouth of Suvački stream into the Leskovačka River ( $20^{\circ}59'34''$  Eλ, 382 m) (According to Greenwich). By rectilinear connecting of outermost points the result is gained that latitude (east-west) of Goč Mountain and its foothill is 25.2 km, and longitude is 25.7 km (north-south). The highest point is on Krnja Jela, 1127 meters above sea level, and the lowest on the West Morava, 166 m, at the mouth of Popinska River. The division of relief amounts 961 m relative heights. The area of Goč Mountain and its foothill has a shape of unsymmetrical rectangular with the orientation northwest-southeast. The massif of Goč is disproportionately long compared to its latitude (Fig. 4). The massif of the Goč Mountain itself is oriented in the direction west-east, while the shorter and steeper eastern part goes to northeast.

From the aspect of tectonics, the Goč Mountain belongs to Kopaonik block of the Šumadia Zone (Anđelković, 1970). It lies between Western and Central Fault, i.e. in the zone of Inner Dinaridi (Vukašinović, 1973). Western-Morava tectonic trench or Morava fault extending at the direction east-west comprises the

border between the Gledić Mountains on the north and mountains of Kopaonik system on the south (Grupa autora, 1976, 301).

Anticline of Goč and Stolovi Mountain is divided by Rasinska-toplička syncline from Željinska Kopaonik anticline (Miljković and Kovačević, 2001). Fissure systems are present mainly among rocks of Palaeozoic age (Osnovna geološka karta SFRJ, 1970). Vrnjačko-pleška dislocation stretches in the direction north-south and represents the system of deep expansion and reverse faults, which in some of their parts served as supply channels of magmatic masses of gabbros and diabases (Milojević et al., 1974). The numerous faults have predisposed river and stream valleys (Fig. 2, 3, 5, 6).



**Fig. 1.** Geographical position of Goč Mountain in Serbia and locations of disputed border zone

### III. METHODS

Determining borders of the Goč Mountain demanded the use of various literature and cartographic sources. From the moment these sources proved as insufficient, i.e. when they became contradictory, other methods have been used. One of them is making the profile of the terrain, using the topographic and geological map and using the following software Arc Gis 9.2, Adobe Illustrator CS3 and Adobe Photoshop CS3. The other is the questionnaire, which because of the noted state on the terrain gained the form of the interview, according to Thom (2009, 193). Results of the survey were graphically presented and their comment was given.

Mountains are sparsely populated areas (Euromontana, 2004; Wohl, 2006), and that is also the case with the Goč Mountain (Kovačević et al., 2007), so the number of sample of respondents had to be smaller than planned. Factor analysis should not be done with less than 100 observations (Bartlett et al, 2001). But, in interview studies, sample size is often justified by interviewing participants until

reaching “data saturation” (Francis et al, 2010). In the south-eastern, disputed area, it amount 50 interviewees and most of them were women. The local population lives in elderly households with a few family members. Women live longer. They were asked for the three questions: 1) Do you live on the Goc Mountain?; 2) Please, show with the hand where are the slopes which you consider for the Goč Mountain; 3) Do you consider the Viljac hill and Mali vrh hill as the part of the Goč massif?

On the south-western part of the mountain the sample consisted of 30 interviewees, 50% of them were men. Respondents were, because of the absence of local population, weekenders and employees of two hotels, “Dobre vode” and “Piramida”, and some other accommodation facilities. The first and the second question were the same, but the third question was: Have you ever heard for the Ravna Mountain? Please, show with the hand where are the slopes which you consider for the Ravna Mountain.

#### **IV. RESULTS AND DISCUSSION**

In order to prove borders of Goč Mountain and its foothill, two of the eight attributes of the mountain were required (Gallant and Wilson, 2000, Deng et al, 2006, 1456), and those are altitude and profile. In the south-eastern Europe, the definitions of the mountain region are mainly based on elevation, occasionally on other criteria (Buttoud, 2001; Price et al., 2004; Jiang, 2008; Popescu and Petrișor, 2010). Determining the range of mountain, Goč is simple when the mountain slopes continue to the river valley. The West Morava valley represents northern border of Goč in physical, but also in social and geographical sense (Fig. 1).

During the last two decades bridges were built on West Morava line of Goč foothill. Before that, ferries had been used for centuries, which show weak connections with the scarce population on the south side of the Gledić Mountains. Stronger relations would, according to the residents, build a bridge (Kovačević, 2010). If the borders are being established in the mountain region, i.e. if the mountains are being demarcated, initially the lowest points out of which the mountain slopes start have to be determined. Popinska River, Brezovička River and Bršljanica with Stublička River (Fig. 4) divide Goč from foothills of Župa region (Kovačević and Jeremić, 2006). With this border coincides also the geological dividing line. Namely, on the east from Goč Mountain, i.e. the Valley of Popinska River continuously extends Mesozoic flysch constructing foothills which morphologically and hypsometrically “fall” towards Župa (Topografska karta, 1984, 1984a; Osnovna geološka karta, 1970).

The Ribnica River divides western part of the Goč Mountain from the mountains, observed in the direction north-south, Ozren (956 m) and Stolovi (1324 m). Undisputed parts of south border comprise, going from west to east, Sokolja River, which divides Goč Mountain from the mountain Baba (931 m), the South Goč River and Zagrža River, which border with the mountain Ljukten (1216 m), and the Krivača River (Fig. 1), which demarcates hills of Goč and Viljac (1077 m) as well as Mali vrh (991 m).

On the south of Goč Mountain spread hills and mountains that have almost grown with it, but they often surpass it. The controversial zones on the south border appeared as the result of imprecision of the authors of some special maps, i.e. as a result of usual disengagement of geographers in reviewer and professional teams. For example, on basic geological map (1970), the letter G (of the word Goč) is on the Ljukten Mountain, which is very near Goč, but for 93 m of relative altitude it is higher than the Goč Mountain. On the southeast Ljukten gradually goes into Ravna Mountain, 419 m higher than Goč Mountain. According to that, the intensity of erosion of the river Goč made the incision and created the deep valley between Goč and Ljukten Mountain, and in that way determined part of the southern border. Two areas with the largest surface on the south border were named according to their geographic position, and those are south-eastern and south-western controversial zone.

#### **IV.1. South-eastern controversial zone**

For the purpose of achieving complete precision, appeared a need to check whether the river Krivača, tributary of the Zagrža River, whose spring extensions are only 360 meters away from the Stublička River, south-eastern border of Goč Mountain, really is the true border line. To find out whether also mentioned southern, low mountains Mali vrh i Viljac belong to the massif of Goč (Fig. 2, 4).

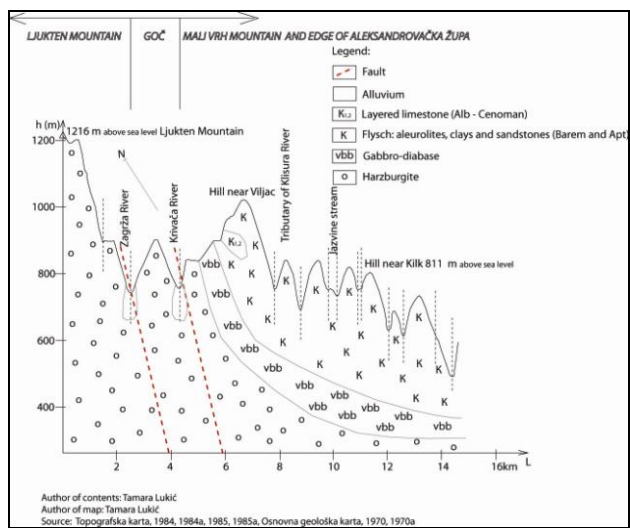
Profile 1 traced from the top of the Ljukten Mountain, mountain south of the Goč Mountain, towards town Aleksandrovac in Župa region, confirmed that south-eastern border of the Goč Mountain is on the Krivača River. Lowered river watershed, or as it is called in the terminology of Serbian language “povija”, between springs of the Krivača River and Stublička River connects the Goč Mountain to the Mali vrh Mountain. From Krivača River the terrain constantly hypsometrically descends towards the Rasina River and the Župa region, tectonically is compact, constructed of the same type of rocks, homogeneous and fluvial shaped, and as such cannot belong to Goč.

The terrain model (Fig. 2) has proved that the one fault divides the Goč Mountain and the Ljukten Mountain. Other fault divides the Goč Mountain and the terrain southeast and east from him, named Župa region.

To what extent the determined physical - geographic border coincide with the perception of local population was checked by interviewing the population of hamlet: Bzenice, Rogavčina, Strmenica and Stanišinci. Over 4/5 of the population, i.e. 82% , from hamlets Bzenica, Rogavčina and Strmenica claimed not to be living on the Goč Mountain, while the others, who were only women, said they did not know. Those who gave sure response, all knew to show with their hand where the slopes which they consider to be the Goč Mountain are. Among the population of village Stanišinci, which is located on the Goč Mountain, all respondents explicitly declared that they did not consider the mentioned hills (Viljac and Mali vrh) to be part of the Goč massif.

In that way, relief and hydrographical borders were confirmed with anthro-geographical borders.

Administrative borders of municipalities influenced the fact that people from this region, which leans on Goč, gravitate towards south, towards Aleksandrovac municipality.



**Fig. 2.** Profile 1 across Krševi (916 m) the most southern part of Goč Mountain

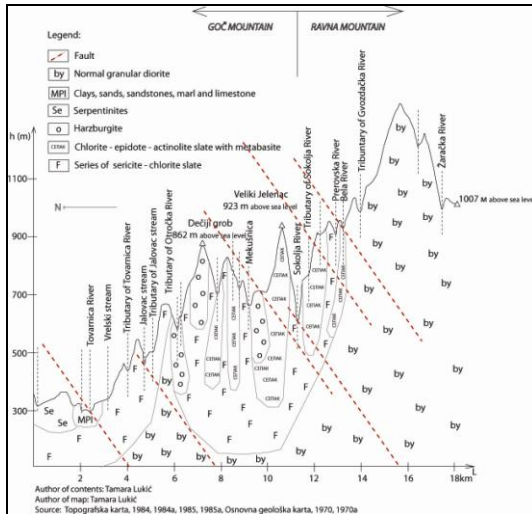
#### IV.2. South-western controversial zone

On the west of the South Goč River (Fig. 4), in the area between rivers Sokolja and Prerovska, i.e. Gvozdačka River, rises the line Prerovo 1002 m. In its south region there are two tourist points, “Dobre vode” (Fig. 1) and “Goč-Gvozdac”, which are considered to be on Goč Mountain. “Goč-Gvozdac” operates within the Educational and Scientific base of Forestry Faculty of the University of Belgrade. Accommodation complex consists of Hotel “Piramida” and villas: “Vlasta”, “Planinka” and “Studenac”. Educational-hunting centre “Goč-Gvozdac” also claims this complex. The water of Gvozdačka River is dammed and two little lakes are formed (Kovačević, 2005, 30-32). In the Valley of Prerovska River, the

component of Gvozdačka River, there is an attractively arranged environment around the fountain of professor Simonović. The fountain has been used since the beginning of the 20<sup>th</sup> century, but its immediate environment (wooden bridges, stairs, paths, benches, tables) was arranged in 2000. The fountain capacity is 0.25 l/s, pH value of water is 7, temperature of the water is 7°C and it contains 50 mg of dissolved substances per litre (Ristić, 2003). One kilometre away on the east from the site “Goč-Gvozdac” there is the Tourist centre “Dobre Vode” (924 m). It consists of the hotel with the same name and mountain home which belongs to Mountain ski society from Kraljevo. Next to the hotel there are sports facilities for basketball, handball, tennis, football and a running track (Kovačević, 2005, 30-32). Skiing infrastructure consists of slopes for sledding, two ski slopes long about 300 metres with two ski lifts and a ski slope 1.400 m long and 40 m wide with a ski lift 1.150 m long, located only about 150 metres from the hotel. Five marked cross country ski tracks are all of different length and slope. Ski jump that is 30 metres high is the only place in Serbia for training practising of skier jumpers (Kovačević, 2010, 247-249). In scientific works that were the result of research in educational and scientific base of Forestry Faculty of the University of Belgrade, is also written that the base is located on the Goč Mountain (Nikolić et al., 1976; Macan and Sajić, 1977; Macan, 1979, 1985a, 1985b; Macan 2002).

The Goč and the Ravna Mountain stretch parallel to each other. By drawing the hypsometrical profile 2 (Fig. 3), direction of stretching which is normal on directions of stretching of these mountains, it was determined that from the valley of the Sokolja River the terrain raises hypsometrically towards the south until the top of the Ravna Mountain (1542 m). The terrain model proves that the base of the Goc Mountain and the Ravna Mountain consists of diorit. Over this intrusive igneous rock are slates and metamorphites (serpentinites and harzburgites). Vertical erosion is more intensive in the “soft” chlorite - epidote – actinolite or sericite – chlorite slates in compare with metamorphites. Rivers and streams have eroded deeper valleys on the places of faults, e.g. the Sokolja River, in compare with valleys which are not tectonically predisposed.

The site of “Goč-Dobre vode” is located in the Valley of the Gvozdačka River, waterway which is hypsometrically on higher absolute height than the valley of the Sokolja River and which, according to that, “flows” down the Ravna Mountain. The Valley of the Sokolja River is 200-300 metres lower than the Valley Prerovska, i.e. Gvozdačka River (Fig. 3). The conclusion is that south-western border of Goč Mountain can stretch only across Valley of the Sokolja River. The Valley of Gvozdačka River, or as it is called downstream, Prerovska River, is according to it located in the Ravna Mountain.



**Fig. 3.** Profile 2 north – south across the west end of Goč Mountain and its contact slope with Ravana Mountain

The distance between sources of the Sokolja River and the most western tributary Zagrža River is 300 m. It is the width of “povija” (lowered river watershed) which connects the Goč and the Ravana Mountain (Fig. 4). The name for the site “Goč-Dobre vode” and scientific base was not determined by geographers, but it was given by inertia or for marketing reasons.

Even the ancient Romans exploiting the mineral wealth used river valleys for transportation of ore and built cobbled roads close to it (Borović-Dimić, 2005). Until the beginning of construction of Ibar highway in 1883 (Kraljevo - Raška), the Valley of the Ribnica River had a great traffic influence for the roads towards the south parts of Serbia (Lučić, 2001). The Valley of the Ribnica River was the route also for the road through the Goč Mountain, as the people used to call it, by inertia, passing the information from generation to generation, since no one had determined the borders of it. By field research it was determined that there are two uncategorized roads of local importance which lead towards the saddle on the Goč Mountain. One of them is traced through the Valley of Sokolja River, i.e. across the western border of Goč Mountain, and the other through the Valley of Prerovska and Gvozdačka River, i.e. across the northern slope of the Ravana Mountain.

Marketing reasons have been interpreted in the following way. On the east side of Goč Mountain there are two tourist sites “Stanišinci” and “Beli izvor” which were created before sites “Goč - Gvozdac” and “Goč-Dobre vode”. It could be said that “Stanisinci” are the “brand name” of the Goč Mountain. So, for marketing reasons it is easier to locate new tourist site on a well known mountain. Toponym the Ravana Mountain is not unique in Serbia, but Goč is. There are no villages on the south-western part of the mountain. For that reason interview was conducted only on employees in tourist facilities, forestry workers and weekenders on the site Sokolja. According to them, 90% of respondents claimed they were on



the Goč Mountain, while the others, surprised by the question, responded they did not know. Three quarters of respondents (77%) never heard of the Ravna Mountain, while the others who had, mostly forestry workers, unmistakably pointed towards its highest peak.

### IV.3. Toponymic confusion

Toponymic confusion on small scaled and weak-read maps influenced the creation of wrong perception on how the Brezanska River, which emerges from the Gvozdačka River, surrounds the Massif Baba and with the Sokolja River creating the Ribnica River, flows towards the north.

In the area of the village Brezna there are more watercourses, two of them are called Brezanska Rivers. Water sources of these rivers are close to each other, at a distance of only 0.5 km, which was checked during the field research. Namely, the Gvozdačka River flows into the south Brezanska River and their waters flow towards the west. The mouth is on the gorge of the Ibar River. The north Brezanska River with the Sokolja River creates the Ribnica River and flows towards the north. Its source branches are in village Brezna. So, there exist two drainage basins, differently orientated. The Mountain Baba (931 m) is a “wedge” that separates these two drainage basins, and by that also at one point the Goč Mountain with Ravna Mountain (Fig. 4).

It is important to mention that downstream, between the Sokolja River and Gvozdačka River, rises the Massif Baba 931 m whose slopes direct the Gvozdačka River towards the east where it flows into the Ibar River (Fig. 4). The Sokolja River ends in the Valley of Ribnica River, which is the west border of the Goč Mountain.

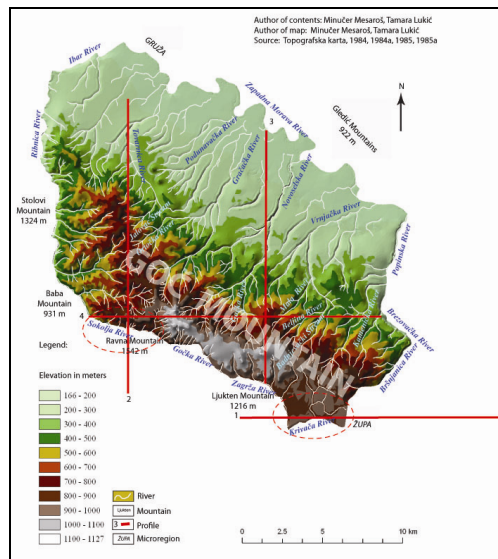


Fig. 4. Map of digital elevation model

#### IV.4. The Goč Mountain

When the borders of Goč Mountain have been determined it could be said that its Massif starts from the hill Čava (550 m) which rises over the Ribnica River, through the village around the lower course of the Ribnica River, then “grows” over Čeljevo (561 m), Čukar (644 m), Crni vrh (west small hill of 741 m), Crni vrh (east small hill of 828 m), to Razbojište, Klupa (798 m) and Dečiji grob (862 m), then across the lower watershed between South Goč River and Mekušnica which is called Palež (853 m), then to Vrletnica (977 m) and Krnja Jela (1127 m), where is its highest point, and from it to the near peak (of 1117 m) all the way to Rašovka (Topografska karta, 1984, 1985).

Peaks: Rašovka (1040 m), Golo brdo (1066 m), Krst (1123 m) (Fig. 5), Vodičko brdo (1121 m), Lisača (1053 m), Pogled (1027 m), hill near Miodragović site (1001 m) i Drenovača (931 m) with Iričko brdo (902 m) represent Goč in the true sense of the word. From Drenovača the terrain goes down through Drenjak (716 m) and hills over Jočići (528 m) in the drainage basin of Popinska River towards the Brezovačka River (Topografska karta, 1984).

Profile 4 (Fig. 6) from west to east of the Goč Mountain show that the morphological discontinuities correlated with different geological features. Rivers and stream valleys have often formed in ramshackle slates. They have the most influenced on the shaping of topographic surface, especially when faults exist. The west part has more faults than the east. The west half of the Goč Mountain is higher than the east. Hence the profile proves intensive tectonic uplifts on the west. Marble come up to the surface on the west side. Marble have facilitated the emergence of wells. They occur at the contact of different rocks.

Using GIS applications it was calculated that Goč Mountain and its foothill cover 339.5 km square. In the administrative sense they belong to a larger part of the municipality Vrnjačka Banja, small part of the municipality of Kraljevo and “symbolic” part of the municipality Trstenik. In the relief of the Goč Mountain and its foothill on digital model, resembling Stefanescu et al. (2011, 39), ten hypsometric lines were singled out (Fig. 4). According to them, the Goč Mountain is a low mountain. The terrain between 166 and 500 m covers the area of 245.1 km square or 72.2% of the entire territory. Those are plain terrains and hills, and they belong to foothill. Above the 500 metres of altitude are 94.4 km square (90.0 km square between 500 and 1000 m) or 27.8% of the total territory. According to that, to the Massif of Goč belong slightly more than  $\frac{1}{4}$  of the territory of the Goč Mountain and its foothill. On more than 1000 m there are 4.4 km square or only 1.3% (Table 1).

To the Massif of the Goč Mountain belong also the hills of the south foothill, in the area between Krivača River and Zagrža River, south from the hill near Miodragović site: Krševi (916 m) and Trnovača (982 m), then Veliki Jelenac, east hill (923 m) and Veliki Jelenac, west hill (823 m) in the area between Mekušnica River and Sokolja River, south eastern from Vrletnica. On the more spacious north foothill the only Goč hill higher than 500 m that disturbs the continuous slopes is the hill Krečane (658 m), south of Krnja Jela (Fig. 4).

Compared to the surrounding area the highest peaks of the Goč Mountain are steep and well-marked. The north foothill is spacious, while the south is very narrow and steep, so it could be said that it does not exist (Fig. 5).

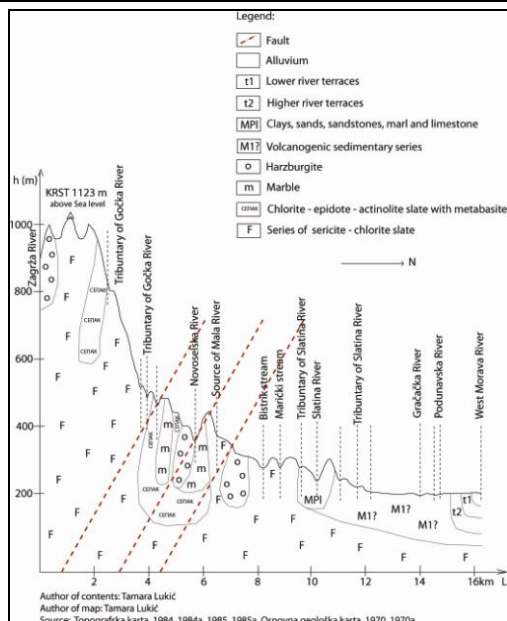
In relief there can be noticed the extreme division of respected terrain on: the Goč Mountain, which covers south and south-eastern part, and basin, which is dominant in the northern part of micro - region of the Goč Mountain and its foothill. According to data from the table 1, the average altitude of micro-region, which consists of the Goč Mountain and its foothill, was calculated on the basis of the following form:

$$H_{sr} = \frac{f_1 \cdot h_1 + f_2 \cdot h_2 + \dots + f_n \cdot h_n}{F} \quad (1)$$

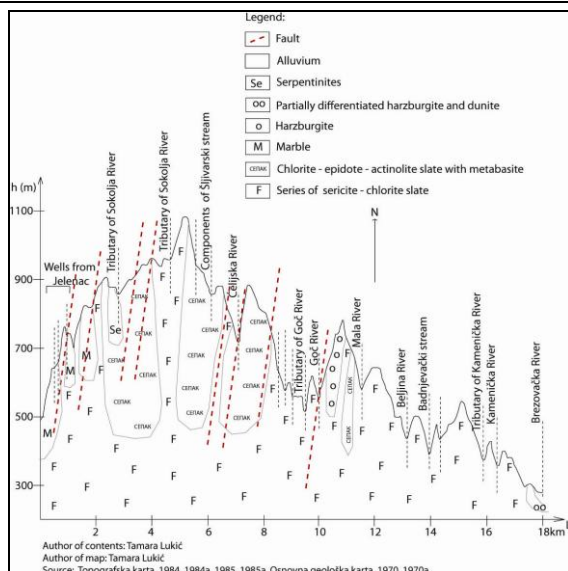
where there are:  $f_1, f_2, \dots, f_n$  – area between appropriate contour lines,  $h_1, h_2, \dots, h_n$ , of middle height between appropriate contour lines,  $H_{sr}$  – average altitude and  $F$  – the area of micro-region of the Goč Mountain and its foothill.

$$H_{sr} = \frac{135879,4}{339,5} = 400,2m \quad (2)$$

The average altitude of micro-region the Goč Mountain and its foothill is 400.2 metres.



**Fig. 5.** Profile 3 south-north from the south border on the Zagrža River across Krst, the peak second in height on the Goč Mountain until the north border (est Morava River)



**Fig. 6.** Profile 4 west-east, from the valley of Sokolja River (south-west border line) to the Valley of Brezovačka River (east border line) across middle part of Goč Mountain

**Table 1.** Hypsometrical characteristics of Goč and its fothill

Altitude (in m)	Surface (in km <sup>2</sup> )	Share in total surface (in %)
166-200	75.0	22.1
200-300	80.1	23.6
300-400	49.6	14.6
400-500	40.4	11.9
500-600	28.9	8.5
600-700	24.8	7.3
700-800	16.0	4.7
800-900	13.9	4.1
900-1000	6.4	1.9
1000-1127	4.4	1.3
Total	339.5	100.0

Source: Topografska karta 1984, 1984a, 1985, 1985a

## V. CONCLUSION

Mountains, as it was noted by Mark and Smith (2004), often transit gradually into neighbouring mountains or they fade into foothills or plains and into the body of the Earth beneath. Problems about delimitation of mountains are the result of the absence of geographers while perception of space. Determination of natural objects which represent end-points of the Goč Mountain was performed applying several methods: using topographic and geological maps, literature sources, field observation and interviewing the population. On that occasion it was concluded that in the south-western part of the Goč Mountain borders do not overlap with the borders as seen by the population who rarely live, but more often work at the disputed area. It is easier to understand and confirm borders in the south-eastern part of the Goč Mountain, which is dominated by local population. Besides that, in the work it has been pointed out that toponyms could also create confusion. The evaluation of the present state south from the south-eastern part of the Goč Mountain, i.e. on the slopes of the Ravna Mountain, has a complete marketing justification.

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