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## RELIABILITY OF INTERNET SOURCES IN GEOGRAPHY: CASE STUDY OF MOUNTAINS STUDENA AND ŽARAČKA, SERBIA

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**Abstract:** Jovan Cvijic said that geography is learned on foot. Besides fieldwork, the modern studies imply the usage of various software packages, as well as the data sources available from the Internet. All the data acquired from the Internet need to be carefully checked, unless they are retrieved from the websites of the established formal institutions (Government, Institutes, and Offices). Very often the Internet information may be in the form of data which should be additionally processed by using mathematical and statistics methods. Possibilities for Internet usage will be shown through presentation of the relief characteristics of the mountains Studena and Žaračka, which belong to Kopaonik system. They make a connection between Mt. Goč and Mt. Stolovi in the north and the massif of Mt. Željic and Mt. Kopaonik in the south. Taking into consideration that Mt. Studena and Mt. Žaračka were not previously studied by geographers, this paper is the contribution to the knowledge on these mountains.

**Key words:** relief, Internet, Mt. Studena, Mt. Žaračka

### Introduction

Terrain research as one of the methods for exploring the relief is valuable and very often necessary. Terrain research has many limited factors as it is an example of shortage of material resources for their carrying out. Terrain observation is more qualitative out of vegetation period. During cold part of the year, a more difficult factor may be bad weather conditions. Besides, relief and vegetation obstacles are very often met. As a result, the researchers abandon the research or carry it out partially. The science and techniques development is enabled by the alternative research ways and methods. They are most often complementary with the terrain research. Under normal conditions for research, Internet should be used before going on the terrain. The terrain research enables to check the received results and clarify some confusion.

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This work is trying to find out how much Internet might be useful in the scientific research. The first association to Internet might be connected with the thought about pages with written text. The accuracy of data placed on that occasion depends on the competence of those who write the text and the aims they should achieve. Therefore, it is necessary to approach very critically toward all those texts. The texts on the Internet to which can be trusted are scientific papers and they are obligatory within the scientific research. However, the aim of this work is to show the possibility given by the Internet, which is not of textual type. The mountains Studena and Žaračka were chosen. They haven't been studied by geographers so far, but they make an important level of raising the relief on the north part of Kopaonik system.

Papers concerning the field in the environment may be seen in literature. Jovan Cvijić (1924) walked by foot from Vrnjačka Banja Spa to a Duga and Leska slope of the Goč Mountain, which is 5 km northeast of the Studena Mountain. According to Miljković and Kovačević (2001), Cvijić described and analyzed geological structure. Herder researched temperature and chemical characteristics of thermal springs in 1835 on the mountain Željin, in cadastral municipality of the village Rudnjak (Jović, 2008), which partially spreads out on the mountain Studena. Investigation of geological structure of Serbia in the papers of Knezevic, Joksimovic, & Jovsic (1998), Vukov & Milovanović (2002), Schmid et al. (2008), Schefer et al. (2010), Lesić, Márton, Cvetkov, & Tomić (2013) also covered the area of the mountains Studena and Žaračka. Others, such as Obradović & Filipović (2009), explored foothill of the mountain, for example, water quality of the river Ibar. Botanists, Tatić (1969), Tatić & Veljović (1992), Marin & Tatić (2001), Kuzmanović, Vukojičić, Barina, & Lakušić (2013) tried to find the connection between geological structure and plant types on the mountain Studena.

### **Methods and Data**

The information taken from the websites of the planetary significance were very useful for this work but also those referring to Serbia and surrounding countries. Website [kartografija.ba](http://kartografija.ba) (2015) contains different maps of Bosnia and Herzegovina, part of Croatia and part of Montenegro. For the area of the Republic of Serbia, the topographic maps may be found in ratio 1:100,000, which have also been used in this paper. Similar contents could be found on other websites, too. As they do not exist today, one should point out the uncertainty of their existence as one of the potential threats of sustainable usage.

Data about geologic structure were obtained by using geologic map of the Geologic Information System of Serbia, website of the Ministry of Energy, Development and Environmental Protection of the Republic of Serbia. Basic geologic maps of the whole Serbia in ratio 1:100,000 could be found there, which could be magnified for needed dimension (GeolISS, 2015). As it is not provided to download them, the function “prt sc” is used to go to further processing for the needs of the paper. Beside this website, the facts have also been taken from literature.

Software Google Earth Pro (2015) can be found by Internet browser and it is taken free of charge. Relief model in three dimensions and relief profile were formed by using the optional tools. They could be called the most important source of information about relief as they show cardinal points, geographic coordinates and values of altitudes of each point shown by cursor. Navigation functions enable rotation of geographic objects for 360° and make easier seeing from all cardinal points. Relief profile is formed by connecting two or more points. It enables to read the length, altitude (initial, final, average) and inclination (maximum, average). The information about altitude, distance from the initial point and relief inclination are given for each point on the profile. Dimensions of geographic objects, size and surface are calculated by optional tools. If there are photos of terrain, they can complement the observation. There is the need for critical approach toward photos because they may be located wrong. Besides, numerous other options (borders, roads and others), which are not necessary for studying the relief, may be useful for other kinds of studies.

The Google Maps (2015) enable qualitative relief perceiving because the option “terrain” activates contour lines equidistance of 100 m, which are very clear. Colors give the contribution to transparency. They reveal exposures, sunny and shady sides, and vegetation cover (Figure 4). Borders of the cadastral municipalities are also very clear and marked precisely. Data about their spreading and surface are taken earlier from the cadastral. Data about surface may be calculated by combination of analysis of the cadastral municipalities spreading and Google Earth Pro. There are other ways for getting the same data which are used for checking the calculated values. For example, the most precise among them is the one when the map is “inserted” into ArcGis, then interpolated, digitized and as such available for further calculations.

Concerning the level of satisfying the basic research, Google Earth Pro is more competitive in comparison to Arc Gis, due to its simplicity and access free of charge. Maps taken from Google Earth, Google Maps and Cartography, etc. are adjusted for the needs of paper by software such as Adobe Illustrator and

Photoshop from Adobe package. Drawn mountain profile and enriched supplements contents were originally taken from Internet as illustrations. Different values of geographic objects and phenomenon were calculated by using the mathematics and statistical methods.

### **Study Area**

The mountains Studena and Žaračka belong to the mountains of Kopaonik system. They are rising at its northwest part, over the valley of the river Ibar, more on the east of the Ibar highway, which connects Kraljevo and Raška.

The mountain Studena is placed more on the south from the mountain Stolovi from which it is divided by the Valley of the river Brezanska, the right tributary of the river Ibar (8.7 km). East from the river Brezanska, the flow of Gvozdačka River (2.8 km) stretches. The river Gvozdačka separates the Mountain Studena on the south from lower Baba and massif Prerovo on the north. The left tributary of the river Gvozdačka makes a part of the east border. It is a periodical flow (2.8 km) which runs into the river Gvozdačka by the contact of massif Studena and Ravna Mountains. Watershed (0.8 km) of the relative height up to 29 m is placed between mentioned flow and riverbed of the spring arm of the river Rudnjačka. The valley of the river Rudnjačka limited the mountain Studena from the east (5.5 km) and separated it from the mountain Ravna. The south border of the mountain Studena includes the right tributary of the river Rudnjačka, the Mala River (1.5 km); then the watershed of 126 m of relative height (1.7 km) between the Mala River and the Popova River (5.9 km), the right tributary of the river Ibar which separates the massif of the mountains Studena and Žaračka. The valley of the river Ibar extends west from the mountain Studena (8.1 km) and west and southwest from the mountain Žaračka (8.6 km). The north border of the mountain Žaračka is identical with the south border of the mountain Studena. The river Rudnjačka expands (1.5 km) to the east from the mountain Žaračka. Then it flows into the river Gokčanica, which separates (4.6 km) the mountain Žaračka at the southeast and the east from the Željcin Mountain. The mouth of the Gokčanica River is in the river Ibar (Figure 1).

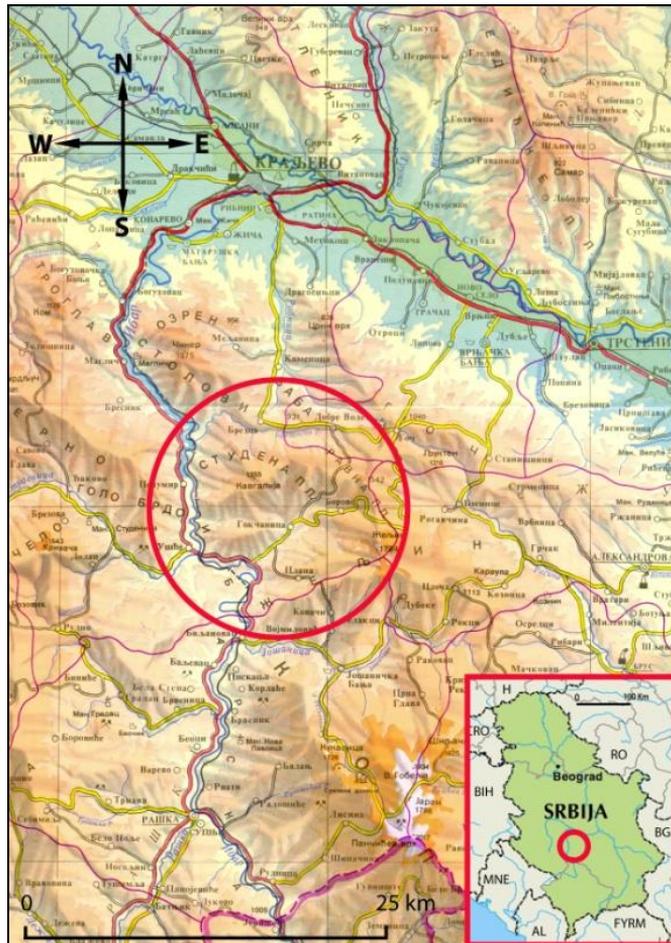


Figure 1. Geographical location of Studena and Žaračka Mountains (Source: the main map is adapted from Ristanović (2006); small map is adapted from the Serbia map, 2015).

The mountain's volume is calculated by these data. The volume of the mountain Studena placed on the waterways makes 35.7 km, respectively with watershed is 37.8 km. The volume of the mountain Žaračka is 20.6 km in the form of the water flows, but with the watershed it is 22.3 km.

## Results and Discussions

### *The mountain Studena*

The mountain Studena represents the massif of 1,355 m of the absolute height, Kavgalija peak. The highest ridged elevations are over 1,000 m high and form

the Cyrillic Letter U, oriented by direction north-south. The entire mountain massif as the crow flies covers direction north-south about 7.5 km (bed of the river Brezanska — bed of the river Popova). Similar value of 7.4 km reached in direction of the east-west (bed of the river Ibar, at the railway station Polumir — bed of the river Rudnjačka). The mountain Studena covers 54.4 km<sup>2</sup>.

The mountain Studena is made by ultramafic and mafic rocks (Popović, 1999). According to the geological map made by Urošević et al. (1970), the greatest part of the mountain Studena is covered by Paleozoic harzburgite (Figure 2). At the highest mountain's elevations harzburgite are rich with pyroxene. The uniform geologic structure on the east part is discontinued by small Paleozoic series of sericite chlorite slates with metamorphosed sandstones, called Series of Goč, Željina and Central Kopaonik. There are neogen dacite andesites by themselves or with their pyroclastics in the upper flow of the river Popova. Between the mountain Studena and Ravna there is clearly defined faults zone toward north-south. Schefer et al. (2010) and Andrić, Fügenschuh, Životić, and Cvetković (2015) referred to tectonic map of the southern Dinarides modified after Schmid et al. (2008). Accordingly, the space of the mountain Studena belongs to the Western Vardar Ophiolites. More towards the south from the village of Polumir, there is Studenica Metamorphic Series (Paleozoic to Jurassic), as a part of Drina–Ivanjica thrust sheet. It is about a kilometer away from Polumir granites on the territory of the mountain Studena (Vukov & Milovanović, 2002; Lesić et al., 2013; Vukov, 2014).

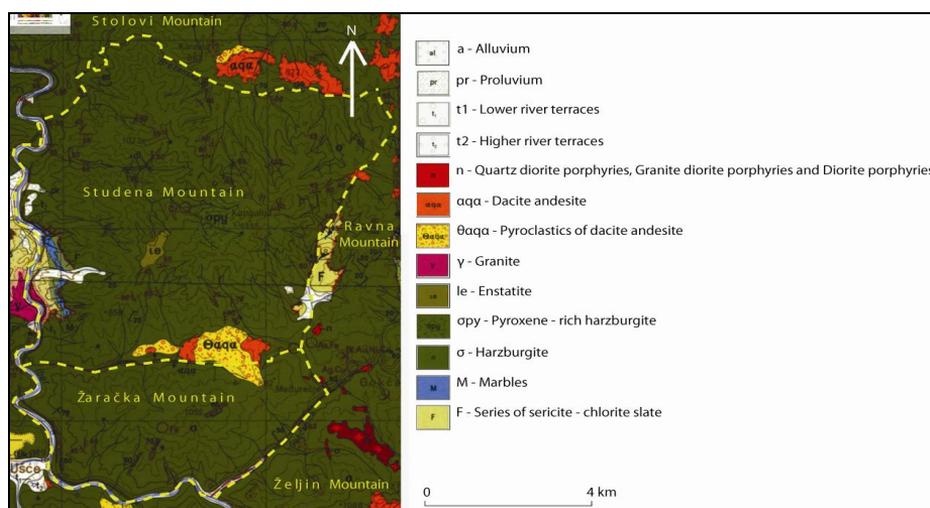


Figure 2. Geological map of the mountains Studena and Žaračka (Source: GeolISS (2015); Made by the authors of the paper in the Adobe Illustrator, 2015)

Within the drainage basin of the river Rudnjačka, placed more eastern of the massif of mountains Studena and Žaračka, chrome, iron, and arsenic were registered. Bogosavljević-Petrović (2006) wrote about medieval locations for melting of ores. Some of them were found at foothill of the mountain Studena, respectively, in the valley of the rivers Brezanska and Gokčanica. They were beside the water flows which were canalized and directed because of the needs for water in the production process. The wood was used as the energy substance for stoves. Bearing this in mind, the absence of woody vegetation at certain hillsides discovers the location where the ore was melted.

The annual average sum of precipitation in the second half of the 20<sup>th</sup> century in the weather stations of the region is about 800 mm, for example: Kraljevo 763.7 mm (1951–2010) (Stanojević, 2012). This means it is higher in the mountainous regions. Nešić, Belij, & Milovanović (2009) have found that there is 917.9 mm on Kopaonik (1950–1994). Mentioned quantities of rainfalls enabled erosion which divided the relief of the rocks of Paleozoic into numerous valleys, small valleys and slopes, where permanent or periodical watercourses run. Bulliqi, Isufi, Kastrati, & Jaha (2014) described Kopaonik as the mountain with great value of depth and density of fragmentation, which have defined morphological contrasts quite evident between the abruptness of the mountain ranges and divisive valleys quite deep, which may be recognized at the mountain Studena. Prevalence of structural landscape, parallel to the fluvial mainly of the torrential character exists thanks to the height of these mountains and it is linked with these morphostructural phenomena. Thus, the mountain Studena is furrowed by the valleys and the relief divided as Kopaonik and other mountains of its system. Its terrains are susceptible of easy rinsing and destroying. Tatić (1969) pointed out that the greensward of Đipovina resisted the erosion strength, but indirectly helped the moving of new plant types, especially at the deforested surfaces, which would be washed away by the rains very quickly. At the small village Gajević, northwest to the top of the highest peak of the mountain Studena, Kavgalija, torrent flows formed by abundant rains, have shown the parts of the black pine. This is the evidence of great erosion in this area. The same author wrote about the existence of the shallow soil at the forest overgrown cliff of Borovita slope, at the north side of the mountain Studena, which was easily washed away by the weak rain.

The same author noticed the small degree of inclination: at the lower surfaces, the small village Krunići, on the river Popova, at Rošac; on the small flat surface by the peak of Cvetalica (1,055 m) at the north part of the mountain Studena. The villages at the mountainous hillsides are located at the lower inclinations. Great inclinations covered the surface on the north and northwest. Because of

divided relief there is a great area on the mountain Studena exposed differently toward the sun illumination. The north part of the mountain up to the peak Kavgalija has northwest-southeast direction, so expositions are more southeast and northeast. From Planinica (1,022 m) over Kavgalija (1,355 m), toward Zli čukar (1,245 m) the mountain orientation is southwest-northeast.

Observation of space by Internet applications enabled the perception of following facts. The east side is made by three mountainous slopes which are separated from the highest elevations of the mountain Studena. Two are in the southeast direction, but one at the very north is directed toward the east. Two, toward the south, are about 2 km long each. They reach the relative difference of 661 m (the southern one) and 619 m (the northern one) and have the average inclination of about 30%. The northernmost, 2.6 km long, reaches only 284 m of relative height, so its average fall is 12.9%. In comparison with the other two, this slope does not fall evenly, but it is the steepest at the end of the east part. At the upper part of their interspace there is headwater of two periodical flows. The northern headwater looks like cirque. As their valleys are getting narrow toward the valley of the river Rudnjačka with lower altitudes, the massifs of the east slopes of the mountain Studena are coming closer. The east part ends with the watershed between the river Rudnjačka which goes away toward south and tributary of the river Brezanska which goes away toward northwest. The watershed has relative height of 29 m and length of 832 m. Below Zli čukar (1,245 m), the northernmost peak of the east hillside of the mountain Studena, the right tributary of the river Rudnjačka makes a waterfall and smaller cascades. This side of the mountain is sporadically covered by bushy vegetation.

On the northern part four mountain slopes could be seen, southeast-northwest direction. Three slopes on the east start under the mountain peak spread parallel and cover the width of about 5 km. They are over 2 km long and reach from 350 to 500 m relative height (from the east toward west). They are totally covered by woody vegetation. The first and the third slopes are made of one massif. The second one is complex because it forks into two smaller ones. The fourth slope, at the very west, covers the largest space. It goes down from the highest altitudes of the mountain Studena for about 6.2 km long, reaching 910 m of relative height. This slope at the highest altitudes has the mildest inclinations in comparison to other inclinations of the north hillsides of the mountain Studena. The lowest altitudes, one kilometer from the basin of the river Brezanska, are the steepest, diversified and cover the inclination value from 35 to 50%. The very west of the slope at the north side of the mountain Studena is surrounded from the east, north and west side by the river Brezanska. Significant part of this slope is oriented toward the west and north-west.

The west hillsides are the most dissected, especially by fluvial erosion (Figure 3). Besides the river Brezanska, the river Gajovska, Bukovac, one no named water flow and the river Popova flow towards the river Ibar from the east hillsides. The river Brezanska has gorge valley where one big and a number of small strangulated meanders could be seen. The gorge valley of the river Gajovska (6.8 km) is formed under the highest elevations of the mountain Studena (1,355 m) and spreads out mostly toward the west. It is deeply cut in its valley, which divided the mountain Studena into two parts. The higher is northern part and the lower is southern part, where the highest elevation is at Planinica (1,022 m). The northern part of the western hillside is more toward the south and southwest orientation, mostly covered with bushy vegetation and grass. The southern part of the western hillside of the mountain Studena is unique for about 2.5 km length. It reaches the height difference of 290 m and has some mild inclinations, average about 12.8%. At the altitude of about 1,000 m this slope bifurcates into three larger ones and many smaller ones, oriented towards northwest, west and southwest. On the first 2 km there are mild inclinations, not over 9% and then they fall down making the gorge valley of the river Ibar. The highest altitudes of the southern, lower part of the west hillside of the mountain Studena are covered by woody vegetation while the lower ones are bare. The nature may influence the bareness in the sense of the heavy forming of woody vegetation on the steep terrains. However, a man also contributed to bareness because of his needs to have wood.

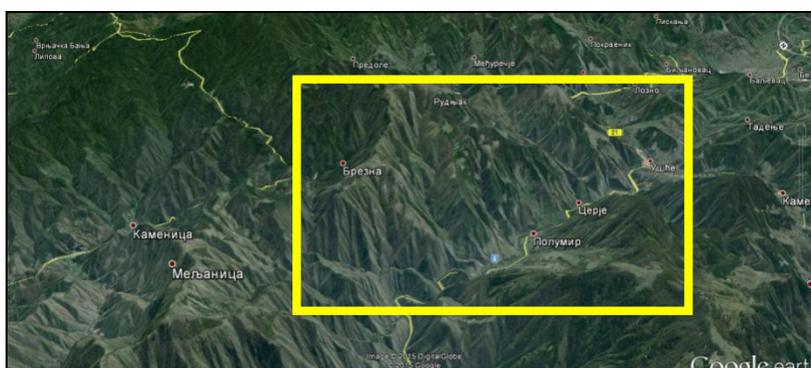


Figure 3. West hillsides of the mountains Studena and Žaračka (Source: Made by authors of the paper in the Google Earth Pro, 2015)

The southern side of the mountain Studena is made by one slope only. It starts sloping down from the highest altitudes in the north-south direction for about 400 m, reaching 100 m of relative height, and average inclination of 26%. Then it branches out toward the southwest for about 1.4 km length, reaching 380 m and inclination of 30% and toward the southeast of 1.5 km length, reaching 340

m and inclination of 25%. The southeast side of this slope is branched out further on toward southwest for about 1.7 km, reaching 260 m and inclination of 15% and toward southeast to 0.9 km length, reaching 82 m and inclination of 12%. At this end of the slope there is a watershed which makes the border between the mountains Studena and Žaračka. Thus, the south slope of the mountain Studena rises slightly from the lowest elevations and then the highest parts are getting steep and covered by wood. As distinguished from the other slopes of the mountain Studena this slope does not ‘fall’ directly into the river valley. The river Popova did not have such erosive power to carve riverbed as valleys formed in the surroundings. Besides, it is filled in. According to Tatić (1969), during digging the road between the villages Popova reka and Ušće, in the 30's of the 20<sup>th</sup> century, on the hillsides of Čela the tree stumps of pines with the roots were found on depth of two meters.

The mountain range of Studena is made of watershed between some tributaries and rivers, but the direction of flows of each one is toward the river Ibar. The moist and almost leveled sites were noticed at the station Polumir, at the mouth of the river Popova into Ibar and some smaller surfaces by the small village Popova Reka. Among other springs, two smaller ones are known on the bare hill above the tunnel Polumir. The water soaks two smaller surfaces inclined for about 50–60°. Among other springs, the most famous is Maretov well at the east base of the Kavgalia peak.

Pastures and meadows are made by destroying woods, but the terrain is completely bare on steeper inclinations. The pastures are on the lower terrains, while meadows are on the ridges and rarely on the stony surfaces. The pastures appeared from the woody vegetation influenced by man. Qualitative pasture is on the south and west hillsides. The mountain ridge is the grassy field, but on the Cvetalica peak daffodils can be found known as Kaloper (Tatić, 1969). The unreachable part of the massif is covered by wood, the north expositions. The pine trees, older ones, are jeopardized because of the cutting of lower parts for getting kindling wood. Strong winds blow during autumn and winter, knocking down a great number of notched trees.

Photos and statements of the mountaineers at different nets may complete the knowledge about some space (Greben, 2013; Žeželj, 2013). Various websites offer the information about the mountain lodge “Zorica Gizdavić” at Brezna and strictly natural reserve of Brezna which is under protection of the Law. Besides mountaineering on the mountain Studena, free biking and contest in the mountain orientation are being practiced. The cadastral municipalities of the

villages on this mountain are: Brezna in the north, Cerje on the west foothill, Popova reka in the south, Gokčanica and Rudnjak on the east side.

### *The mountain Žaračka*

Range of the massif of the mountain Žaračka is stretched toward west-east (Figure 4) with its ends bended toward the north of about 8.7 km length, while its width is not over 4 km. The mountain's area covers 21.1 km<sup>2</sup>. The mountain Žaračka reaches 1,051 m above sea level on the Bandera peak which is rising from the central part of the mountain.

The valley of the river Popova, which determine boundaries of the mountain Studena on the north and the mountain Žaračka on the south, is clear. It stretches by the average inclination of 8.8% toward the west. On the west part of the river basin, at the mouth, the mountains are mutually getting closer; the valley is getting narrow and the river Popova has two strangulated meanders. The connection between these two mountains is the watershed of the rivers Popova and Mala River on the east for about a hundred meters of relative height.

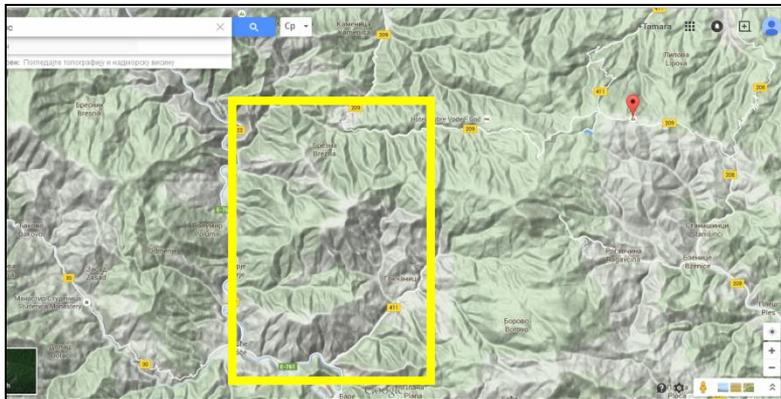


Figure 4. The mountains Studena and Žaračka (Source: Made by authors of the paper in the Google Maps, 2015)

Because of geological structure, which is the same as the greatest part of the mountain Studena, the mountain Žaračka may be called the southern part of the mountain Studena. So, the mountain Žaračka is made by Paleozoic harzburgite. Only on its northeast side quaternary, respectively neogen pyroclastic of dacite andesite were found (Figure 2). However, tectonic predisposed valley of the river Popova from the north side and valley of the river Gokčanica from the southeastern side, deepened by fluvial erosion, morphologically clearly separate this mountain from the surrounding morphological forms.

The mountain Žaračka is limited by gorge of the river Ibar from the west and southwest. Widening of the valley of the river Ibar predisposed the appearing of the settlement called Ušće, at the mouth of the river Studenica into the river Ibar. The greatest part of this mountain are the northern hillsides (Figure 5), which are steeper than the southern one, while the western side is steeper, especially at the lower elevations, in comparison with the eastern side.

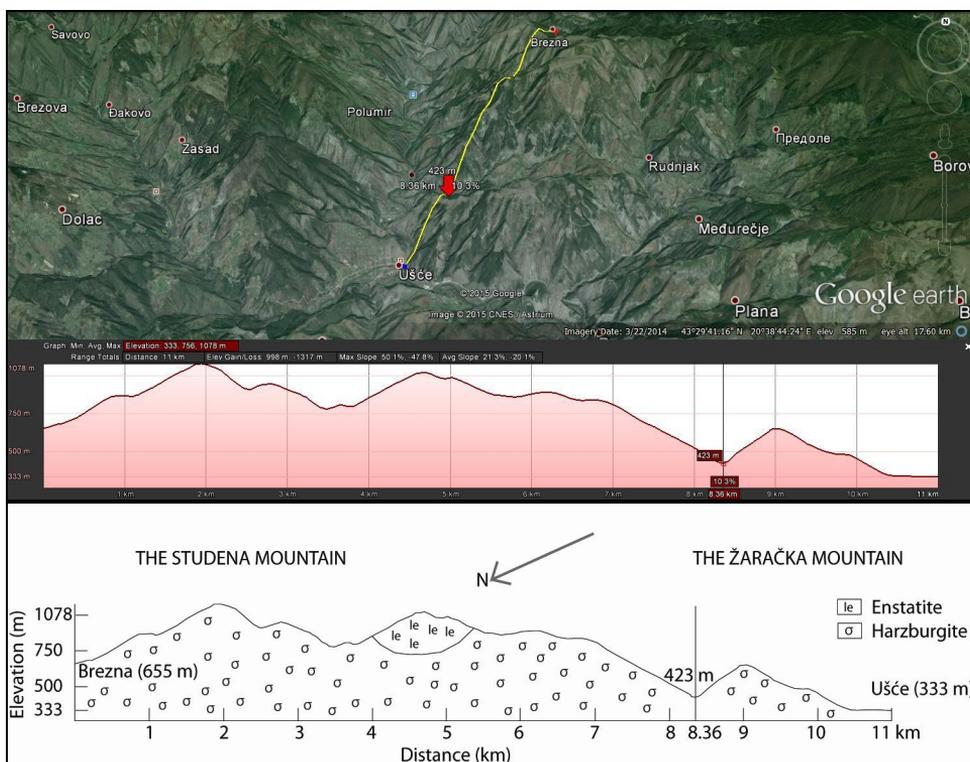


Figure 5. Illustration of the observed Profile (Source: Made by authors of the paper in the Google Earth Pro, 2015) and Profile adapted to this paper (Source: Made by authors of the paper in the Adobe Illustrator, 2015).

The slopes are not divided onto the mountain Žaračka. Only on the south part of the mountain there are five weaker expressive slopes. They cover the length of 1.5 to 2.0 km coming down from the peaks of the mountain Žaračka, gently bending toward the southwest and surmounting 689 m of relative height. The average inclination between the highest altitude Bandera 1,051 m and the mouth of the river Gokčanica into the river Ibar (362 m) makes 32.8%. The geological map shows smaller and shorter fault zones in the southern part of the mountain Žaračka. It means that some of the streamed valleys are tectonically predisposed

and formed by fluvial denudation processes. The east end of the mountain is lower and the gentlest in comparison to the other mountain sides. It consists of four entities. The highest hillsides are covered with woody vegetation and it goes down toward the lowest altitudes into the southerners' part of this hillside. On the northern side, the terrain of the east hillside grows hypsometrically, firstly over the pasture, then woody and bushy vegetation. The east sides of the mountain at the lowest altitude are very steep. The northeast side is bare and less steep in comparison to the south and north hillsides of the mountain Žaračka. Tectonics influenced the formation of relief on the mountain Žaračka, but the crucial role in its formation had decomposition of rocks under the influence of the sun, different forms of denudation and fluvial erosion.

Good conditions for stone exploitation are at the mouth of the river Gokčanica into Ibar. The ore deposit is found on the southwest from the highest mountain altitude. According Kovačević (2010), mine shafts (pings) traces on the mountains of the Kopaonik system give evidence about the locations where the ore was exploited. Archaeologists had found that the most extensive exploitation of the ore was during the Roman period and at the Mediaeval Serbia. The existence of ore does not mean that there are quantities that are cost-effective for exploitation. On the geological map silver, copper, bismuth, gold, nickel and cobalt can be seen at the foothill of the mountain Žaračka which belongs to Gokčanica cadastral municipality.

Generally observed, woody vegetation appears on the higher, northern and western altitudes. On the lower altitudes, pastures, meadows and rocks without vegetation alternate. Ušće is on the south-west, at the foothill of the mountain Žaračka, the cadastral municipalities of Seoci and Pustopolje are in the west, the Popova Reka is on the north of the foothill, while Međurečje, Gokčanica and Rudnjak are nearby the southeastern and eastern hillsides. Small parts of villages Zasuplje and Đokovići are on the southeastern hillsides. They are placed in the ravine extended in the north-south direction.

### **Conclusion**

Until the Internet application has not been improved, determination of dimensions of geographic objects and similar calculations were made by topographic map, drawing of different profiles, or by expensive software such as ArcGis. At this historic moment, exploration of Serbia and some of the surrounding countries is possible to be made by the websites of Google Earth, Google Maps, Cartography, Geological Information System and similar. In comparison with the classic cartographic methods, the usage of these Internet

applications makes possible to do the same things more quickly and from the cabinet. By shortening the time of exploration, the speed of publishing of obtained results increased and allowed the increase of the research volume. Besides, the advantage of such kind of the cabinet research is that they are not conditioned by finances, they do not depend on the weather conditions nor they could be disturbed by relief and vegetation obstacles which appear during overcoming of unreachable areas. If the geographic object is nearby larger settlements, then there are more chances to be visited. Contemporary electronic means (phones, cameras) enable us to photograph the terrain by different techniques and then to get the shots by the Internet, so this is the way to get certain data.

Described way of studying the relief may be useful to geographers in their scientific research, study of the local environment or may be put in the function of teaching and education. Besides the geographers, the research results or the methods for obtaining data may be used by other researchers, local inhabitants, local administration, unexpected guests, nature admirers, adventurers, various sportsmen and others.

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