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REGRESSION ANALYSIS OF PRECIPITATION DEPENDENCE ON THE ALTITUDE IN RASINA RIVER-BASIN

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Abstract: Precipitation is the most significant climate element in hydrologic study. Basic characteristics of the regime of surface and underground waters are directly conditioned by intensity, as well as space – time distribution. As the basis for hydrologic study in Rasina river-basin, a regression analysis of precipitation dependence on the altitude based on the data on average annual precipitation amount in the period 1961 – 2009 was done. The study comprised 10 rainfall measurement stations in the very basin of Rasina and its immediate surroundings.

On the basis of studies conducted we obtained data on the amount of precipitation in the areas where there are no rainfall measuring stations. Assumed precipitation dependence on the altitude is confirmed by a high correlation quotient of 0.85.

On the basis of defined dependencies for the territory of Rasina river-basin, we obtained mean precipitation amounts in altitude zones, as well as mean precipitation amount for the river-basin of 755.3 mm. An isohyet map of Rasina river-basin was made on the basis of these data and altitude zones map.

Key words: precipitation, altitude, regression analysis, Rasina

1. Introduction

Rasina river-basin is situated in the south part of Central Serbia on the surface of 979.6 km² (Dimitrijević, 2010.). The basin is bounded by the mountains of Goč (1124 m), Ljukten (1219 m), Crni vrh (1543 m) and Željin (1785 m) in south-west and west.

South-west part of the basin is represented by the mountain of Kopaonik with the highest tops in the basin Karaman and Gobelja (1934 m). Farther towards the east the basin is bounded by the mount of Lepenac, easternmost slopes of which extend to the left part of Jankova gorge. Mountain range of Jastrebac with its top Zmajevac (1381 m), which is the highest mountain top in this part of Rasina river-basin, continues east of Lepenac.

In the outmost north-east, Rasina river-basin reclines to Mojsinjske mountains (501 m), which represent a part of the Stalać horst. This horst is fully surrounded by Pomoravlje tertiary.

There are several basins among these mountains. Broad Kruševac basin extends to north and north-east. Secondary Župski basin continues south-west from Kruševac basin. Dobroljubačka basin, which takes up central position in this area, lies east of Župski basin. In the outmost south-east, there is a part of Toplički basin, which is separated from the middle part of Rasina river-basin by Jankova gorge (Dimitrijević, 2010).

Since watercourses are formed by precipitation, they represent the most important climatic element in hydrologic study. Intensity, as well as space and time distribution of precipitation directly condition basic characteristics of a watercourse regime. To study precipitation in Rasina river-basin, the data of Republic Hydro-meteorological service of Serbia for the period from 1961 to 2009 were used.

The amount of precipitation most often increases with the altitude, although there are cases when the highest terrains do not pick up the highest amount of precipitation.

The highest annual amount of precipitation in the immediate Rasina river-basin was measured on the mountain of Goč (990 m altitude) - 1005.7 mm. The station on Kopaonik (1710 m), where 981.8 mm average annual precipitation amount was recorded is on the highest altitude in the river-basin. Such a state is largely conditioned by the position and orientation of Kopaonik ridge. Namely, humid air masses development from the west is conditioned by numerous mountain notches over which the masses smoothly pass and excrete larger amount of precipitation on lower areas on the east slopes of this mountain (Stričević, 2015).

At the stations of Kupci, Razbojna and Petina, situated at the altitude of 200 – 335 m high mean annual amount of precipitation is measured. These stations are located on the north-west slopes of Jastrebac, where humid air masses get smoothly and excrete larger amount of precipitation. On Jastrebac, as well as on Kopaonik, there is a significant difference in the amount of precipitation on the north and the south expositions. Slopes on the south have considerably lower precipitation, which can be confirmed by the data from the stations in Kupci and Velika Plana. Namely, the village of

Kupci which lies in the north-west mountain region of Jastrebac at the altitude of 200 m gets about 250 mm of sediment more annually when compared to Velika Plana which is situated in the south bottom of the mountain at 505 m altitude (Ducić V., Radovanović M., 2005).

Table 1 - Comparative view of annual precipitation amounts (mm) for the periods 1961-1990, 1991-2009 and 1961-2009

Station	N	E	altitude (m)	Pcp. 1961-1990	Pcp. 1991-2009	Pcp. 1961-2009
Kruševac	43º34′32′′	21º21′08′′	166	647.8	614.4	641.8
Kupci	43º27′09′′	21º14′09′′	200	726.1	748.7	733.2
Razbojna	43º20′37′′	21º10′18′′	320	807.7	717.1	780.1
Petina	43º29′27′′	21º25′25′′	335	725.6	686.2	714.5
Blace	43º23′04′′	21º17′37′′	395	656.3	649.0	655.7
Brus	43º23′04′′	21º02′09′′	440	684.0	611.1	662.4
Milentija	43º26′06′′	20º59′44′′	500	676.9	650.9	669.0
Pleš	43º29′02′′	20º55′16′′	600	815.7	785.3	806.7
Goč	43º34′10′′	20º47′52′′	990	1003.8	1049.6	1005.7
Kopaonik	43º20′56′′	20º47′25′′	1710	920.9	991.4	981.8

To analyze the change in mean annual precipitation amounts, we used 30-year period from 1961 – 1990, according WMO recommendation, as well as the period from 1991 – 2009, so as to track recent developments in pluviometric regime.

When analyzing the data on mean precipitation amounts in given periods given in Table 1, it was determined that precipitation amount has been in the increase in three rainfall measuring stations in the last nineteen years of study, while there has been decrease in precipitation amount in seven stations. Increase in mean annual precipitation amount goes from 22.6 mm in Kupci station to 70.5 mm in Kopaonik station. The biggest decrease in mean annual precipitation amount in the last 19 years was recorded in Razbojna station – 90.6 mm, whereas the lowest decrease was recorded in Blace station – 7.3 mm.

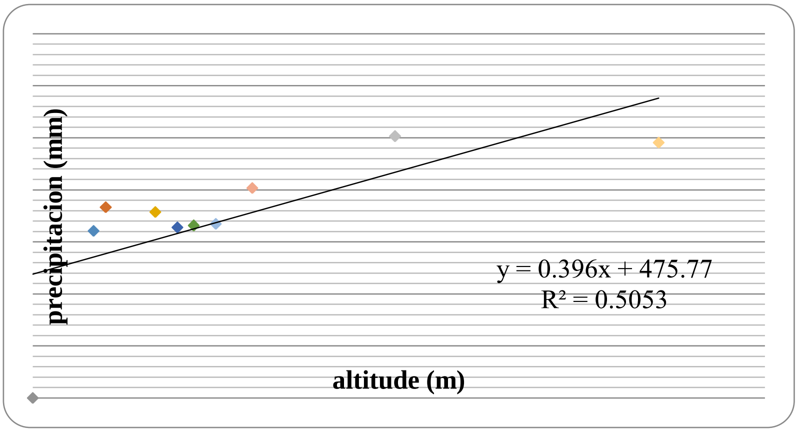
2. Study methodology

Dependence of precipitation and altitude is not consistent. Precipitation amount increases with the altitude up to a certain altitude, and then it gradually decreases. If we analyze the changes in mean annual precipitation values in Rasina river-basin with the altitudes of measuring stations where precipitation was measured, we can observe that precipitation amount gradually increases from the lowest Kruševac station up to Razbojna station, and then decreases upstream to Milentija, only to increase again up to the highest stations in the river-basin.

To determine how precipitation amount changes with the increase in altitude as precisely as possible, we performed a correlation between the values of mean annual precipitation in the period 1961 – 2009 and the altitudes on the territory of Rasina river-basin and its immediate surroundings. In the dependence analysis we exempted the data for Razbojna station which is situated at low altitude and has high precipitation amount. The obtained correlation quotient amounts to 0.85, whereas vertical precipitation gradient is 24.6 mm/100 m.

Analytic form of the applied model for determining precipitation amount in Rasina river-basin is:

$$X_0(mm)= 0.246 * H + 617{,}5; \quad R^2=0.72$$



Picture 1 – Linear regression precipitation dependence on the altitude in Rasina river-basin

3. Study results

Based on the obtained results, shown in Table 2, we can conclude that the highest difference in obtained and measured values was noticed in Petina, Blace and Pleš. Mean multi-annual precipitation amount in these stations, based on the formed dependence, should be from 8.6 to 10% higher than measured values. In Petina station, located on north-west slopes of Jastrebac, calculated precipitation amount has 10% higher value than the amount obtained by measuring. This station is located in the direction of humid air masses from the west, that is, north-west, which bring higher precipitation amount to this area. Such high measured values of mean annual precipitation amounts on low altitudes can also be the consequence of inadequate position of the station.

Table 2 – Comparative view of measured and obtained values of mean annual precipitation amounts

Station	**altitude (m)**	Measured	Obtained	Difference (%)
Kruševac	166	641.8	641.2	-0.1
Kupci	200	733.2	690.6	-5.8
Razbojna	320	780.1	775.3	0.6
Petina	335	714.5	785.9	10.0
Blace	395	655.7	714.7	9.0
Brus	440	662.4	699	5.5
Milentija	500	669	713.3	6.6
Pleš	600	806.7	737.2	8.6
Goč	990	1005.7	932.1	7.3
Kopaonik	1710	981.8	1002.5	2.1

The territory of Rasina river-basin belongs to Moravički region according to M. Ocokoljić (1987) classification. He determined that precipitation in this area increases up to approximately 1000 m above sea level, and then decreases in a non-linear way. These data are in accordance with the data obtained in measuring stations on the territory of the district and its immediate surroundings, since mean multi-annual precipitation amount of 1005.7 mm was recorded in Goč station (990 m altitude), while in the highest station Kopaonik (1710 m altitude) the same precipitation amount was 981.8 mm.

Table 3 - Vertical precipitation gradient (mm/100 m) in the period 1961- 2009

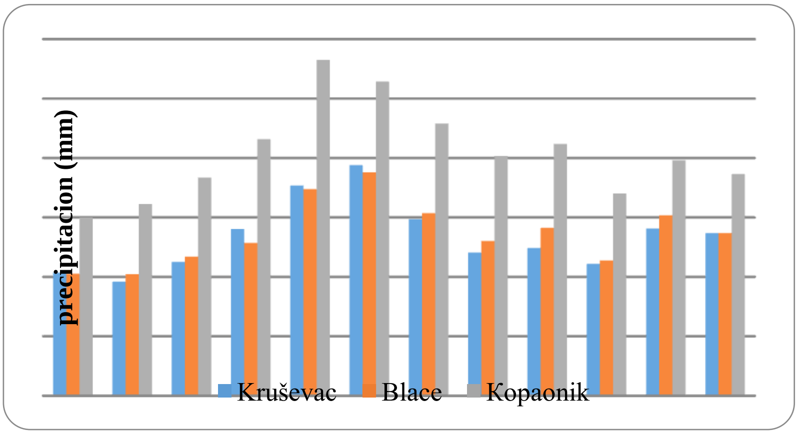
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**Annually**
Kruševac - Kopaonik	1.17	1.64	1.79	2.01	2.85	1.84	1.91	2.12	2.44	1.35	1.30	1.26	21.68
Brus - Kopaonik	1.59	1.69	1.97	3.02	2.26	1.80	2.68	3.30	3.31	0.57	1.48	1.47	25.15
Blace - Kopaonik	1.44	1.79	2.02	2.65	3.31	2.32	2.30	2.17	2.14	1.72	1.41	1.51	24.80

Živković and Anđelković (2004) engaged in analysis of precipitation gradients on the territory of Serbia, south of Sava and Danube. In so doing, they distinguished 59 homogenous areas for the relation precipitation – altitude. Vertical precipitation gradients were also calculated for Rasina river-basin. They reflect well the increase in precipitation together with the altitude.

Precipitation gradient values, done on the basis of measured monthly and annual precipitation amounts are shown in Table 3. These data show that annual precipitation amount on the profile Brus – Kopaonik increases 25.15 mm each one hundred meters. The highest amounts were recorded in August, 3.30 mm/100 m, while the lowest amounts were recorded in November – 1.41 mm/100 m.

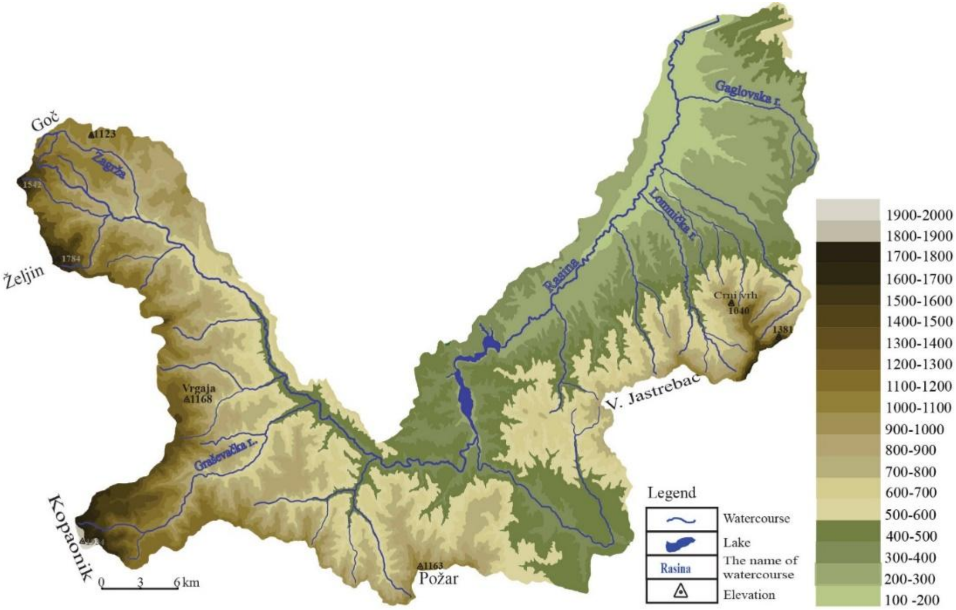
On the profile Kruševac – Kopaonik annual precipitation amount increases 21.68 mm each one hundred meters. The highest amounts were recorded in May - 2.85 mm/100 m, whereas the lowest amounts were recorded in January – 1.17 mm/100 m.

Gradient value obtained in the relation altitude - precipitation amounts to 24.60 mm/100m on annual level.

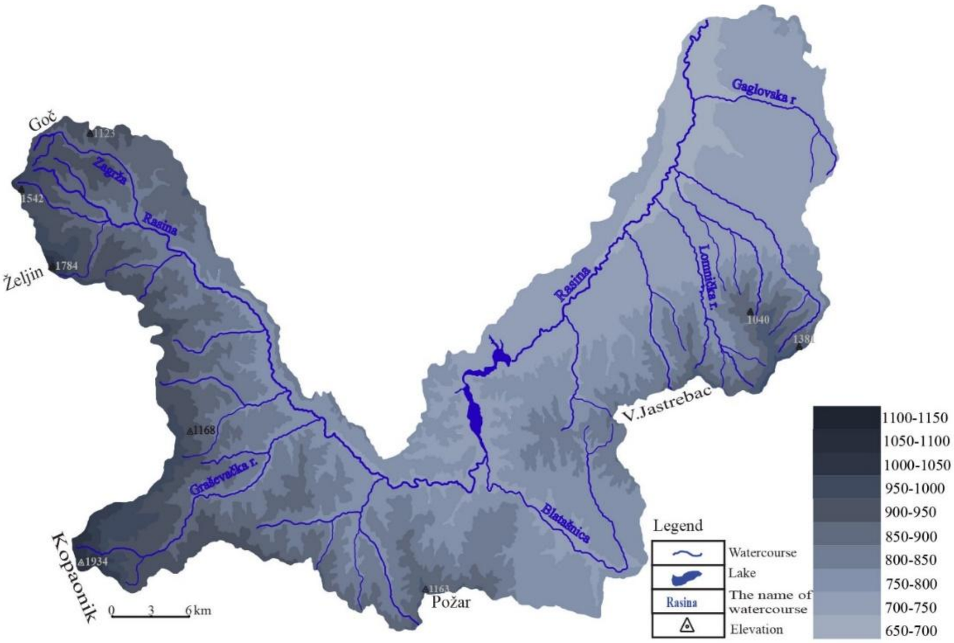


Picture 2 – Comparative view of annual precipitation distribution on the stations Kruševac, Blace and Kopaonik in the period 1961-2009

On the basis of defined dependences for the territory of Rasina river-basin, we obtained mean multi-annual values of precipitation amounts for altitude zones, as well as mean precipitation amount for the river-basin which amounts to 755.3 mm. Based on these data and altitude zones map, an isohyet map of Rasina river-basin was made. To construct these maps we used topographic maps 1: 50 000 which comprise the territory of Rasina river-basin as the basis for computer programs (Inkscape and GIMP).



Picture 3 – Altitude zones in Rasina river-basin



Picture 4 – Isohyet map of Rasina river-basin

4. Discussion

When analyzing the data shown in this study, it can be concluded that dependence of precipitation and altitude is not consistent. Precipitation amount increases with the altitude up to a certain altitude, and then it gradually decreases. Analyzed changes in mean annual precipitation values in the very river-basin and its immediate surroundings, together with the altitudes of the stations where they were measured, point to certain specificities. They are reflected in the fact that high precipitation amounts, which could be expected at significantly higher altitudes, were measured on the stations located at low altitudes, in river valleys. Likewise, a significant difference in precipitation amount on higher grounds is noticeable. It is largely conditioned by the orientation of mountain ridges and their exposure to dominant air flows. So the highest precipitation amount in the analyzed period was measured on Goč, where 1005.7 mm of precipitation was measured at the altitude of 990 m. Except on Goč, higher precipitation amount was measured on the mountain of Jastrebac, where 979.7 mm of annual sediment amount was registered at the altitude of 575 m, which is almost the same amount as on Kopaonik, at 1710 m altitude. Such a high precipitation amount on north-west slopes of Jastrebac is the consequence of penetration of air masses from the north-west which freely move from the valley of Zapadna Morava to the valley of Rasina. These air masses have so called foehn characteristics which condition their rising anew and increased precipitation excretion. North-west slopes of Jastrebac are in a direct way of these fronts (Živković and Anđelković, 2004).

Studies so far on dependence of mean annual precipitation amounts on altitudes where rainfall measuring stations are located, as well as what was done in this study, point to the fact that regression analysis represents a good way to determine the difference in spatial precipitation distribution, as well as to determine vertical precipitation gradients.

By applying this method it is possible to determine the values of mean annual precipitation amounts on certain territories where measures are not done, which also enables more adequate hydrologic studies in these environments.

Taking into consideration that precipitation is a very changeable climatic element conditioned by the influence of numerous factors, such as relief, directions of air masses development, etc., a detailed analysis of the change in precipitation amount should be included in the future development of the model.

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FLUVIO-DENUDATIONAL STRUCTURES IN THE VALLEY OF THE TOPLICA IN THE AREA OF THE SETTLEMENT OF PLOČNIK

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Abstract: The studied area comprises the settlement of Pločnik situated in the western part of Southern Serbia on the easternmost slopes of Kopaonik. It is situated on the left valley side of the Toplica river, in the scope of Topličko-Kosanička basin of the midmost Toplica, from the village of Vlajnje to Gubetin. Only few geomorphologists dealt with these issues. This study represents continuation of the studies of Jovan Cvijić and Sima Milojević. On the basis of their studies, as well as on the high diversity of the studied ground, we explored geotectonic structure and morphologic characteristics of the relief with special attention to fluvial and denudational structures. The methodology applied principally implied analysis and synthesis of the results. On the basis of that we carried out field study which implied comparing fluvio-denudational structures singled out by S. Milojević, with the facts on the field. It enabled quality geomorphologic mapping. Modeling method, through GIS (Geographic Information System) usage joined the methods of remote detection, geomorphologic mapping and visualization. Topographic and geologic map were then geo-referenced in QGIS (quantum GIS), the area of the settlement of Pločnik was defined, digitalization of content was done, while geologic foundation was divided according to the age and type. Detailed analysis of the studied area enabled the review of abrasive elements to be updated. We defined the existence of the inter-abrasive level (567-598 m) between the first two abrasive floors (520-560 m and 610-640 m) according to S. Milojević. As for the valley morphology, that is, fluvial erosion, two more fluvial terraces were spatially defined (I - Šanac at about 440 m and II - Barutana 400 m and Bandera at about 380 m sea level).

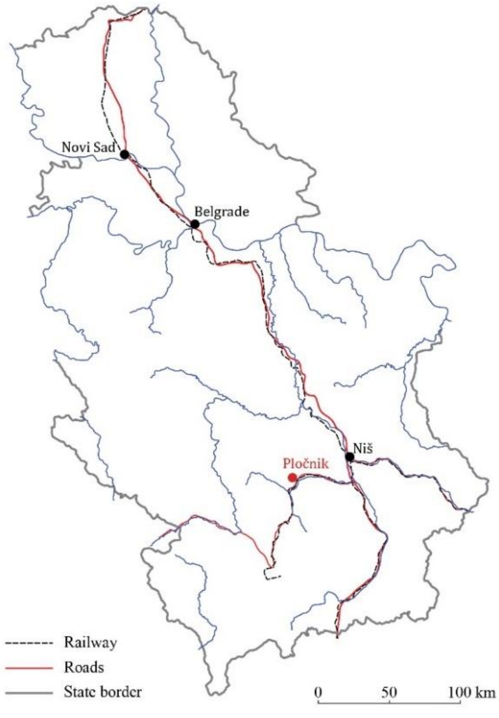
Key words: Fluvial terraces, denudation, the valley of the Toplica, the settlement of Pločnik

1. Introduction

The studied area comprises the settlement of Pločnik which is situated in Southern Serbia according to macro-geographical position. On the basis of regional geographical distribution, it belongs to the micro region of Toplica, which is situated in the western part of the mesoregion of Southern Serbia, comprising the basin of the river of the same name (Marković, J. 1995). It is situated on the territory of municipality of Prokuplje and it belongs to Toplički district.

In physical-geographic sense Pločnik is situated on the easternmost slopes of Kopaonik on the left valley side of the Toplica. Average sea level of the settlement is 420 m. It also includes the following tops: Bojovo hill (567 m), Ovsište (564 m), Paramida (561 m), Prisoje (533 m), Vesova čukara (469 m), Ravan (412 m) and Bandera (384 m), as well as the area up to the river of Toplica on sea level of about 300 m.

Pločnik has a very favorable traffic position, because main road M–25, Niš – Prokuplje – Kosovska Mitrovica runs through the very settlement, as well as the railway route Prokuplje – Kuršumlija - Priština.



Picture 1 – Geographic and traffic position of Pločnik in the Republic of Serbia

On the basis of the previous studies and the high diversity of the studied area, a part of Toplica valley in the area of the settlement of Pločnik, we explored geotectonic structure and morphologic characteristics of the relief, with special attention to fluvial and denudational structures. Very few geo-morphologists explored the valley of the Toplica. One of them was Jovan Cvijić, but he only superficially dealt with the area. Somewhat higher contribution came from Sima Milojević who analyzed main morphological characteristics of the relief in the valley of the Toplica. This study represents continuation of their analysis in the part of the Toplica valley to which the settlement of Pločnik belongs, firstly in the sense of a more detailed analysis of fluvio-denudational structures.

2. Material and method

To adequately examine fluvio-denudational structures in the studied area we applied many scientific methods. Analytical method primarily implied studying of both our and foreign literature which deals with these issues, in the sense of finding and systematization. The second phase of the application of this method implied critical review on the hitherto studies in this field. The final phase of the analytic work implied the application of synthetic method. By a synthesis of all relevant factors and agents fluvio-denudational processes in the settlement of Pločnik were completely defined and the connection among certain isolated parameters which influence this process was found. By a comparative method the obtained results were compared to the results from hitherto studies in this area.

In the analytical part of the work, by cartographic methods, we obtained numerical, that is, morpho-metric data which are relevant to the studied phenomenon. A topographic map was used, 1:25000, sheet Kuršumlija 4-1. In the synthesis part of the work, by the procedures of thematic cartography, as specialized maps, geomorphologic and geologic, we provided insight to the spatial distribution of the studied parameters.

A very important method in studying fluvio-denudational structures is field study. Field study implied defining facts in the field on several occasions, where this method was frequently combined with the method of geomorphologic mapping. Detailed geomorphologic mapping contributed to collecting qualitative new data from the studied field. This field study is superimposed with teledetection methods on the basis of satellite records.

Topographic map which shows the area of the settlement of Pločnik is from 1972, so that the differences related to factual condition in field are defined. Apart from field study, we also used program Google Earth.

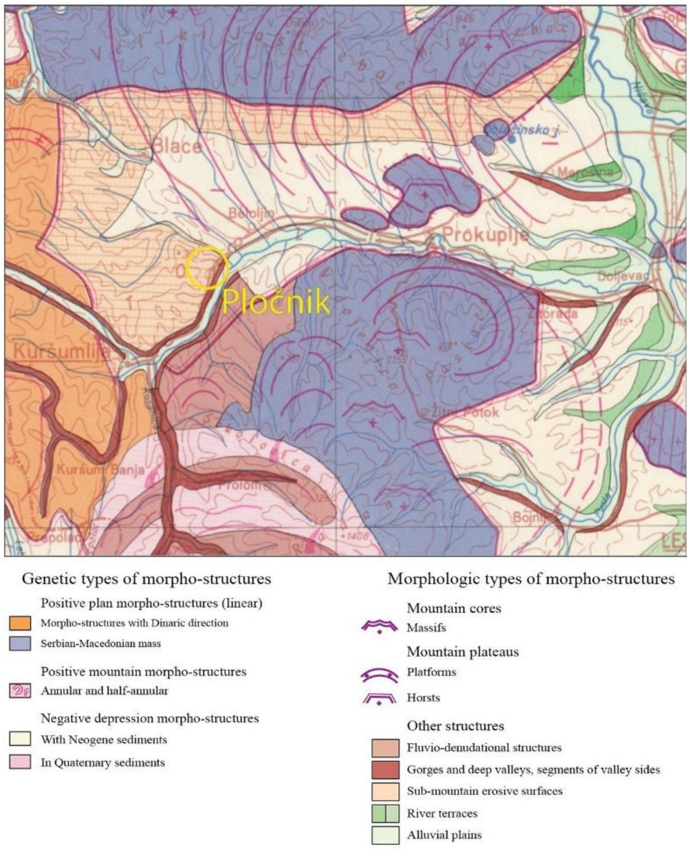
Finally, modeling method joined methods of remote detection, geomorphologic mapping and visualization through GIS usage. Topographic and geologic map were geo-referenced in QGIS, the area of the settlement of Pločnik was defined, and content digitalization was done, while geologic foundation was divided according to the age and the type.

3. Results and discussion

The relief of Toplica belongs to the oldest part of the mainland of the Balkan Peninsula – Serbian-Macedonian mass and Dinaric zone of folded mountains. It was formed during Alpine orogenesis. In the middle of Oligo-Miocene there was a segmenting of old Rodopi mountain mass, and the consequence of these processes was the formation of block mountains and basins which are separated by faults. Topličko-kosanička basin with its rims was also formed in this geologic period. It is situated among Mali Jastrebac and Veliki Jastrebac in the north, Kopaonik and Požar in the west, Prolomske mountains, Sokolovica, Arbanaške mountains, Vidojevica and Pasjača in the southwest and south (Rudić, B. V. 1978). During Neogene a bay of Panonian lake permeated Topličko-kosanička basin and filled it with water the level of which reached 760 m sea level. After the recession of the lake in the bottom of the central lake plain, the Toplica incised in time and constantly changed shape, forming shallow and broad valley with the network of its tributaries (Cvijić, J. 1911). The basin stretches in the direction east-west, with longer axis of about 30 km, while the shorter is 10 km. The relief is mildly hilly and gradually declines from the north to the south (Group of authors, 1977).

Geologic foundation of Toplica consists of metamorphic schists (especially gneiss and micashist) through which eruptive masses of granite and gabbro sporadically break through (Milojević, S. 1929). Above the metamorphic basis sedimentary rocks were deposited. On the western rim of Toplica basin, Kopaonik and Sokolovica cretaceous sediments are present: quartzite and clay sandstone, as well as marls and basal conglomerates (Rakičević, T. 1969). Younger lake sediments are present in middle and lower course of the Toplica. They are made of sand, clay and marls.

Toplica valley is composite; it consists of many broadenings and gorges. It is composed of four morphological units: 1. Gorge valley of the upper Toplica from the spring to the village of Vlajnje; 2. Topličko-kosanička basin (the basin of middle Toplica) from Vlajnje to Gubetin; 3. A short breakthrough between Gubetin and Prokuplje; 4. The valley of the lower Toplica incised in the lake floor of Dobrič (Milojević, S. 1929). According to this morphological division of the valley of the Toplica introduced by S. Milojević, Pločnik is situated in the scope of Topličko-kosanička basin of the middle Toplica, from the village of Vlajnje to Gubetin.



Picture 2 – Geo-morphologic map of the territory of Pločnik and Toplica basin according to geomorphologic (morpho-structural) map 1:500 000 (Zeremski, M. 1990)

Mountain area of Pločnik is represented by the tops of Bojovo brdo (567 m), Ovsište (564 m), Paramida (561 m) and Vesova čukara (469 m) which represent the slopes of mountains under Kopaonik. Lower parts are hilly with smoother elevation than it is on the right valley side in the village of Točane. The field is decomposed by weak and intermittent courses among which elongated inclined planes stretched. It is represented by spacious and flattened fluvial terraces.

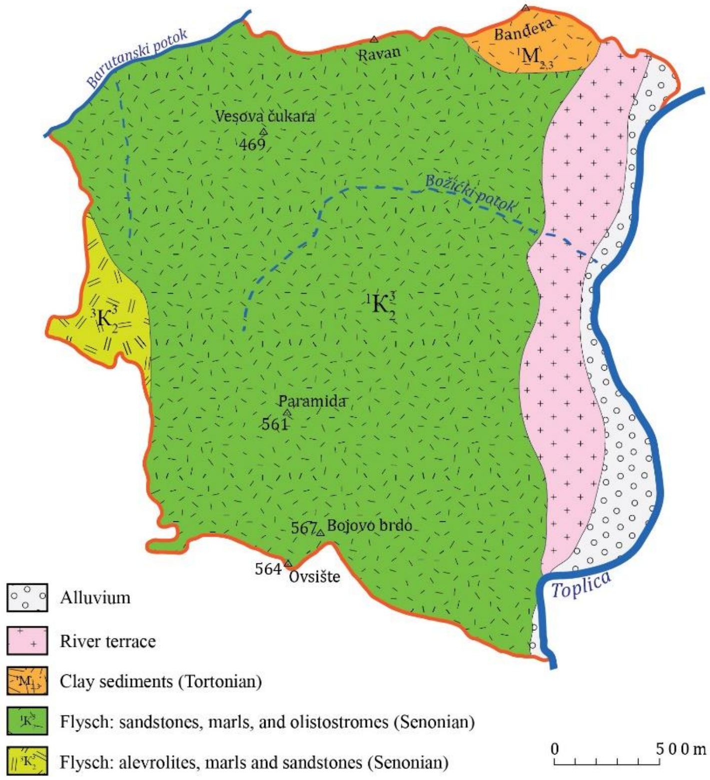
On the basis of geomorphologic (morpho-structural) map 1:500 000 (Zeremski, M. 1990) (Picture 2) bigger part of the settlement of Pločnik is represented by sub-mountain erosive surfaces, while gorges and deep valleys, that is, segments of valley sides are southernmost of the settlement, on Barlovski Vis. From the very spring of the Toplica to Pločnik the valley is gorge-like, while it downstream broadens into a shallow and spacious valley. In the low belt northernmost of the settlement, towards the village of Bace, negative depression morpho-structural configurations are present. They are represented by poorly preserved sediments or without Neogene sediments. Alluvial planes stretch immediately along the whole course of the Toplica in Pločnik.

Picture 3 – Late Cretaceous flysch on Barlovski Vis

According to the latest geological research and according to BGM (Basic Geological Map) of Serbia (К 34-19, sheet Kuršumlija, 1:100 000, 1980) on the territory of Pločnik there are (Picture 4):

- Flysch: alevrolites, marls and sandstone (Cretaceous / Senonian)
- Flysch: sandstones, marls and olistostromes (Cretaceous / Senonian)
- Clay sediments (Miocene/ Tortonian)
- River terrace
- Alluvium

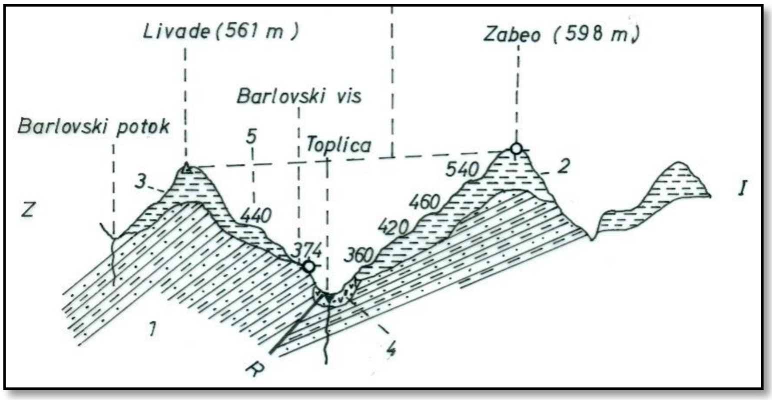
Flysch rocks are represented in the most part of the territory of Pločnik, comprising higher parts of the terrain and all the tops, except Bandera. Clay sediments are situated in a small northern part of Pločnik, that is, southern slopes of the mountain top Bandera. River terrace is situated between flysch rocks and alluvium which is present in the narrow zone near the river of Toplica.



Picture 4 – Geologic map of the settlement of Pločnik according to BGM of Serbia 1:100,000, Military-geographic Institute (1980)

Serbian–Macedonian mass represents a separate tectonic unit which comprises the area of Central and Southern Serbia. There are different opinions on tectonic structure of Serbian–Macedonian mass, its position and borders. Anđelković M. singled out Šumadija zone as a distinct tectonic unit of the first rank within Serbian-Macedonian mass (Anđelković, M. 1963, 1967, 1970). It is situated between Morava zone in the east and the zone of Western Serbia in the west, while it is bounded by the sank part of the Panonian massif in the north-west. This very labile area is characterized by structural directions NNW – SSE. There are numerous radial configurations of meridional direction which are intersected by transversal and diagonal faults. Plicative tectonic configurations represented by folds of different shape and size appear often, too (Group of authors, 1976).

Senonian flysch on the territory of Pločnik belongs to Serbian–Macedonian mass, that is, Šumadija zone. It is stratified and it extends in the direction NNW-SSE, while its layers fall to WSW at different angles. Flysch rocks in the very river-bed of the Toplica on the left valley side are at the angle of 30-40°, while at Barlovo height they are at somewhat bigger angle of 40-50°. Field research showed that there are no flysch rocks on the right valley side of the Toplica, that is, in Točane, which leads to the conclusion that the right bank declined, while the left in Pločnik emerged. This leads to another conclusion, which is that the course of the Toplica follows faults, which is shown in the profile (Picture 5). The fault has a reverse plain; some mineral waters and springs which are profuse in this area point to the fault.



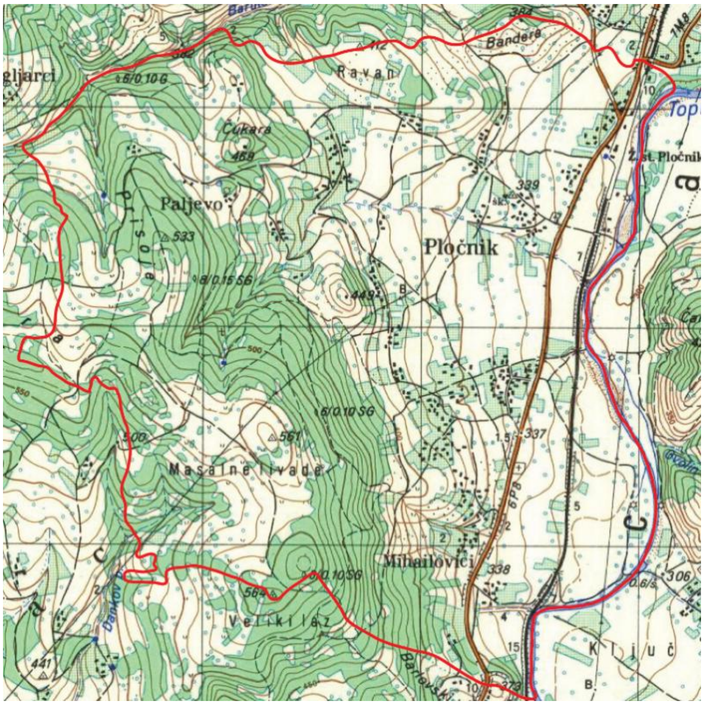
Picture 5 – Morpho-tectonic profile of Toplica valley at Pločnik (Legend: 1 Senonian flysch, 2. Lake sediments of Miocene, 3. Mio-Pliocene, 4. Alluvium, 5. 374 and 440 m fluvial terraces, R fault)

According to Cvijić, Toplica valley was a lake in Pliocene, which is confirmed by the sediments on the bottom of the valley (Cvijić, J. 1911). Toplica valley was studied in somewhat more detail by Milojević S., by singling out four abrasive levels: 520-560, 610-640, about 740 and 800-850 m. Only the lowest floor 520-560 m was studied in detail. Inclination of the floor is morphologically interesting, because it is not regularly inclined towards central plain and the valley of the Toplica, but vice versa, it is inverse. Higher lake floors in this area are not disrupted, but normally inclined (Milojević, S. 1929). Central lake plain resulted from the activities of denudational and fluvial processes. Denudation originates from Latin word denudatio, which means stripping, derivation and divestment (Martinović, Ž. 2004). It is manifested in several ways, but mechanical action of affluence of surface waters which cause rock destruction is often dominant.

The remains of the bottom of the central lake plain on the territory of Pločnik, which is at the same time the last abrasive terrace (the oldest terrace) are the highest mountain tops: Bojovo hill (567 m), Ovsište (564 m) and Paramida (561 m). These mountain tops are flattened broad surfaces with a section and a terrace which is unformed and extends in the direction SE-NW. Clay sediments, which are processed, are present there. All the other terraces are the result of fluvial erosion and they are situated on lower on the sea level. It can be concluded that there is another abrasive floor in this area which is situated between the first two floors which are specified by Milojević. Namely, the highest tops in Pločnik, Bojovo hill (567 m), Ovsište (564m) and Paramida (561m) are somewhat higher than the above mentioned first floor according to S. Milojević, as well as the top Zabeo (598 m) on the right valley side of the Toplica in the village of Točane, so it can be concluded that the remains of central lake plain in this part represent mid-level (567-598 m), between the first two abrasive floors (520-560 m and 610-640 m).

Fluvial erosion has two basic components: vertical – manifested by incising river courses into topographic surface and lateral – inclined to broadening of the river-bed and river valley. Which of these two components will be dominant depends on the existing decline in the river-bed. Two basic structures of fluvial relief are erosive and accumulative structures (Petrović, D. 2003). By the incision of the river course into topographic surface the river forms erosive and accumulative fluvial structures.

On the territory of Pločnik valley morphology, that is, fluvial erosion is known, but not sufficiently studied in detail. Milojević S. distinguishes five fluvial terraces in this area: I - (1-3 m), II - (8-12 m), III- (23-31 m), IV- (65-70 m), V- (94-102 m). The lowest terrace 1-3 m is incised into river drift, sporadically into hard rock, too. It is present continuously either on one or the other valley side. Terrace 8-12 m is sporadically incised on the left valley side into eluvial clay. The remaining terraces are rocky, of narrower angular point and often appear together, two or more. The highest terrace 94-102 m was observed only between settlements Barlovo and Pločnik (Milojević, S. 1929).



Picture 6 – Topographic map with the border of the settlement of Pločnik, sheet Kuršumlija 4-1, ratio 1:25000, Military-geographic Institute, 1972, Belgrade.

By detailed field study the existence of these terraces according to S. Milojević was confirmed. The terraces extend to the following areas on the territory of Pločnik:

- The flat one represents the highest fluvial terrace (94-102 m of absolute height, that is, 397-405 m sea level). It has two flattened levels overgrown with pastures and bushes, the lower of which is in decline because of denudation. Fluvial terrace Ravan at about 410 m sea level belongs to this fluvial level. It is situated in the northernmost border of the village area.
- Lower fluvial terrace 365-370 m sea level extends to the area south from the top Ravan (412 m sea level), as well as Barlovski Vis southernmost of the village area.
- Fluvial terrace at 320-335 m sea level is of elongated shape. Main road is traced in one part of it.
- The terrace at 308-312 m sea level is situated in the continuation of the lowest fluvial terrace where the railway is traced.
- Lug is the lowest fluvial terrace at 304-306 m sea level of broad angular point with mild decline. It extends from the Toplica to the railway station.

Picture 7 – Fluvial terraces in the settlement of Pločnik

Apart from these five fluvial terraces in the area of Pločnik settlement, detailed field study showed that there are two more which are not in the terrace system according to S. Milojević:

- Šanac at about 440 m sea level, situated above fluvial terrace (365-370 m) according to Milojević. Its angular point is narrow and it is situated in the central part of the village area. It represents the highest fluvial terrace in Pločnik.
- Barutana at 400 m sea level, which is very spacious and of broad angular point, as well as Bandera at about 380 m sea level, of somewhat narrower angular point. They are situated in the northern rim of the village area. This fluvial terrace represents mid-level between the highest terrace (397-405 m) and lower fluvial terrace (365-370 m) according to S. Milojević.

Picture 8 - Fluvial terraces in the settlement of Pločnik

The river of Toplica on the territory of Pločnik incised into flysch rocks, forming several constrictions and broadenings by the processes of fluvial erosion. There are rapids on shorter sectors, and sporadically there are cavities in the river-bed – "giant pots". Gullies are noticed in several places.

Sedimentation of alluvial drift resulted in small river islands which are flooded during high water-levels.

The valley of the Toplica in the area of Pločnik and Točane is asymmetric; the left valley side where Pločnik is situated is lower, with milder decline and many forest complexes, which prevents rinsing and higher erosion. On the right valley side in Točane erosion is more prominent because of the steeper slope and denuded sites. The flysch present in Pločnik is subject to denudation and decomposition, which causes accumulation of debris material.

4. Conclusion

Detailed study of the examined field, a part of the Toplica valley in the area of the settlement of Pločnik, which is little known in geomorphologic literature, an attempt has been made to obtain a better notion of the basic relief characteristics, with special attention to fluvial and denudational structures. From what has been done, the following conclusions can be made:

Geological structure is simple, without any significant details (flysch rocks, clay sediments and alluvium).

Tectonic configuration of the studied field is not very well-known. This study attempts to define certain elements: decline and direction of rock layers were determined, as well as their structure and the existence of the fault, which has a reverse plain and to which the course of the Toplica in this sector sticks.

Morphology of the studied area is known, but not in detail. This study complements the review on abrasive elements. A mid-level of the central lake plain (567-598 m), was determined, between the first two abrasive floors (520-560 m and 610-640 m) according to S. Milojević.

As for the valley morphology, that is, fluvial erosion, some complements relating to fluvial terraces were also spatially determined. In the terrace system according to S. Milojević five terraces were singled out. This study defined them. Apart from that, the existence of two more fluvial terraces was confirmed: Šanac at about 440 m sea level, which represents , the highest fluvial terrace in Pločnik; and Barutana 400 m, as well as Bandera at about 380 m sea level, which represent mid-level between the highest terrace (397-405 m) and lower fluvial terrace (365-370 m) according to S. Milojević.

The valley of Toplica in the areas of Pločnik and Točane is asymmetric, left valley side where Pločnik is situated is lower, with milder decline and many forest complexes, which prevents rinsing and higher erosion. The flysch present in Pločnik is subject to denudation and decomposition, which causes accumulation of debris material.

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THERMAL REGIME OF THE KRAGUJEVAC BASIN

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Abstract: Thermal regime, as a measure of thermal conditions, is used for better climate characterization and it is an integral part of the overall climate characteristics of a specific geospatial. Thermal characteristics of the Kragujevac Basin were determined by using measurement data from the only higher order station, MWS Kragujevac, for the period from1981 to 2010. The analysis includes mean monthly air temperatures, extreme and absolute temperatures, incidence of typical days, as well as the linear trend of the mean annual air temperatures. Other than the method of analysis, comparative method and the method of linear regression were also employed in processing statistical data.

Based on the presented data, it can be concluded that Kragujevac and its surroundings belong tothe thermal continental climate regime, which is indicated by the mean annual temperature amplitude. This fact is additionally supported by the thermodromic coefficient by Kerner.

Another fact of a great importance is that the mean annual temperatures increase trend is pronounced which is explained as an influence of the urban environment on the temperature regime.

Key words: thermal regime, air temperature, Kragujevac Basin, comparative method, method of the linear regression

1. Introduction

Kragujevac Basin is a smaller tectonic-fluvial extension of the compound valley of Lepenica. General geomorphological depiction was presented by Ž. Stepanović (1966) who regarded its relief in a strict sense i.e. to the drainage divide between Lepenica and Gornja Rača.

The Basin also continues over the drainage divide as a complete negative morphostructure so the valleys of Jasenica and Gornja Rača are its morphological borders in NW. Proceeding from the morphology, Kragujevac Basin has more characteristics of a valley. Its axis (30 km), positioned between the valley of Jasenica (in the NW) and the peak of Žeželj (in the SE), is almost twice as long as its transverse axis, between Majdan (in the SW) and crystalline peak of Prnjavor-Šupljaja-Gradište (in NE) which is 16 km long (Zeremski, 1983).

Valley area of the Great Morava, which is connected to the Kragujevac Basin, is opened to the North because of the impact of the local orographic conditions. Namely, cold air masses from the northern quadrant, which often penetrate from the Pannonian Plain over the valley of the Great Morava, have considerable influence on the climate characteristics of the researched territory, primarily on the thermal regime (Milosavljević, 1969).

Thermal characteristics of the Kragujevac Basin were not elaborated in detail in the literature. First of all, they were discussed as a part of the research on Serbian climate (Radinović, 1966; Rakićević, 1980; Ducić et al, 2005) and as part of the research on the valley of the Great and South Morava (Milosavljević, 1969). For the reasons mentioned, we have decided to give detailed and versatile explanation on air temperature characteristics of the Kragujevac Basin.

2. Material and method

Thermal charcteristics of Kragujevac and its surrounding were calculated according to the data from the station of the first order, MWS Kragujevac (φ=44º02´N; φ=20º56´E; Hs=185 m), for the period from 1981 to 2010. They were calculated by the statistical, graphical and comparative method. Those methods were used to analise: mean monthly air tmperatures, mean maximum and minimum air temperatures, and incidence of typical days and the mean annual air temperature change trend was calculated by the method of linear regression.

3. Results

Mean Monthly Air Temperatures

The city of Kragujevac and its surroundings are located in the region of temperate latitude and they belong to the temperate zone climate. That is why maximum and minimum temperature can be distinguished in the movement of the annual air temperature i.e. it shows certain regularities (Chart 1). Namely, the temperature increases regularly from January to July when it reaches its maximum (21,9ºC),that is to August and then it decreasesregularly to January when it reaches its annual minimum (0,9°C). There is a noticeable temperature jump in March, which indicates the beginning of the warmer part of the year, which coincides with the beginning of the growing season. The annual air temperature amplitude is above 20°C (21,0ºC).

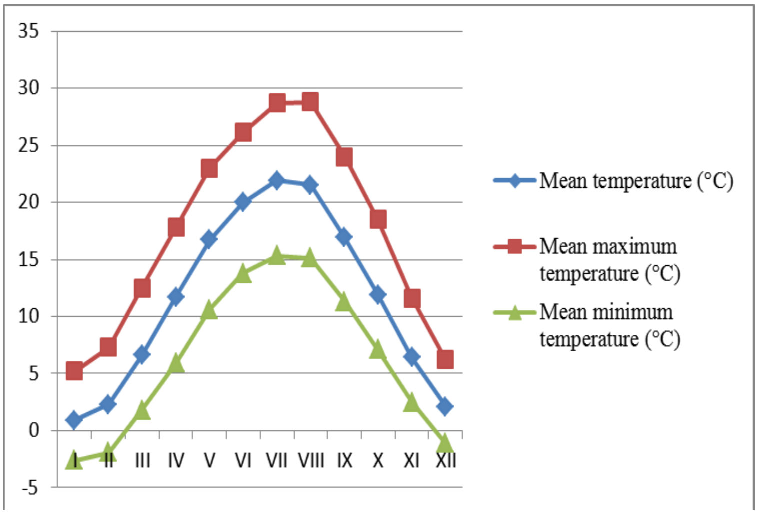

Chart 1–Mean monthly, mean maximum and mean minimum air temperatures in Kragujevac (1981-2010)

The extreme annual temperatures flows behave almost identically as the mean annual temperatures. The highest mean maximum temperature is not in July, but it has shifted to August (28,8°C), while the lowest mean temperature remained in January (-2,6ºC). Mean annual maximum temperature is 17,5°C. In the flow of the mean annual maximum temperatures it is also possible to observe negative values during three winter months. The lowest mean minimum temperature in January is (-2,6ºC), and the highest in July(15,3°C). Temperature in August is similar to the one in July(15,1ºC). Mean annual minimal temperature is 6,5ºC.

Based on the mean monthly temperatures, mean temperatures of the seasons were also calculated (Table 1).

Table 1 - The mean temperature of the seasons in Kragujevac (1981-2010)

Season	Spring	Summer	Autumn	Winter
Tsr (°C)	11,2ºC	21,1ºC	11,7ºC	1,8ºC

Mean winter and summer temperatures are extremely high while the spring and autumn (transitional seasons) temperatures are more equable.

The presented mean air temperature values and the annual temperature amplitude of the Kragujevac Basin specify moderate continental climate (the amplitude is between 20-22 ºC) (Krstić et al, 2002). However, there are many equations which are used to determine more precisely the character of continentality.

One of the equations, that is often applied, is the one by F. Kerner which calculates theso-called thermodromic coefficient. Kerner completes the equation with the so-called relative thermodromic coefficient, which eliminates impact of the latitude. That gives advantage to Kerner's model over the models of other authors (Gorzynski, Cenker).

This coefficient is calculated by the formula:

$$K=[(Tx-Tiv) : A] * 100\ (\%),$$

where **Tx** means monthly temperature in October (11,9°C), **Tiv** means monthly temperature in April (11,7°C), **A** is an annual temperature fluctuation (21,0°C). October and April are taken into account because their mean values are the closest to the mean annual air temperature. Mean April temperature is higher for 0.1°C and the mean October temperature is higher for 0.3°C, comparing to the annual climate normal (11.6°C). If $K>15\%$, climate is maritime in that region. In a region of the continental climate $K<15\%$; the lower the K is from 15%, the higher the degree of continentality is. If the continentality is fairly pronounced the coefficient has a negative sign (Vujević P., 1956).

Relative thermodromic coefficient is calculated according to the equation:

$$K' = [(Tx-Tiv) : \alpha] * 100\ (\%),$$

where **α** is a relative amplitude of the annual temperature fluctuation which is calculated according to the formula **α = A:sinφ,** when A is an annual temperature fluctuation (21.0°C), **φ** is the MWS Kragujevac latitude (φ=44º02' N).

Thermodromic coefficient in the region of Kragujevac Basin is under the limit of 15% which separates maritime areas from the continental areas. It is **1.0%** and it indicates moderate continental climate while the relative thermodromic coefficient is **0.7%** and indicates more pronounced continental influence.

Absolute Temperatures

Analysing absolute temperatures, we reached a conclusion that air temperatures in the Kragujevac Basin are extremely low and extremely high (Table 2).

Table 2 – Absolute maximum and absolute minimum air temperatures in Kragujevac (1981-2010)

	I	II	III	IV	V	VI
max	31.01.2002. 20,6°C	25.02.2008. 24,2°C	25.03.2001. 29,4°C	30.04.2003. 31,4°C	28.05.2008. 35,4°C	26.06.2007. 39,4°C
min	**31.01.1987. -27,4°C**	14.02.1985. -23,8°C	01.03.2005. -18,3°C	09.04.2003. -5,8°C	08.05.1983. 05.05.1994. 05.05.2000. 1,4°C	10.06.2005. 4,1°C
	VII	**VIII**	**IX**	**X**	**XI**	**XII**
max	**24.07.2007. 43,9°C**	11.08.1994. 40,4°C	15.09.1987. 37,4°C	01.10.1991. 32,6°C	01.11.1990. 27,6°C	17.12.1989. 08.12.2010. 21,0°C
min	28.07.1987. 7,2°C	29.08.1981. 4,6°C	09.09.1991. 1,6°C	28.10.1991. -6,6°C	26.11.1988. -11,8°C	21.12.2009. -20,6°C

Absolute maximum temperature has been recorded on July 24, 2007 and it was 43,9°C. 2007 was well known for significantly high temperatures. From July 18 to July 24 of the said year, so for seven days in a row, the air temperature was over 40 Celsius degrees and then on July 24 it reached the absolute maximum for the observed period.

When it comes to absolute minimum temperatures, extremely low temperatures could also be recorded during the observed period. The absolute minimum temperature was recorded on January 31, 1987, it was -27,4°C. Absolute minimum was lower than 20°C during February too, it was (-23,8°C).

Absolute fluctuation is large and it is 71,3°C. There are other temperatures during the year within the absolute extremes. Negative extremes occur from October (-6,6°C) to April (-5,8°C) and they are manifested as an early or late frost.

Characteristic Days

When considering climate it is of a great importance to know the number of days with extreme temperatures which have certain limit value in a month or a year. Being familiar with these climatic parameters makes the picture about temperature conditions of the studied territory complete. For this occasion we have analysed frosty days ($T_{min} < 0°C$), tropical days ($T_{max} > 30°C$), cold days ($T_{max} < 0°C$) and summer days ($T_{max} > 25°C$ - Chart 2).

Frosty days are those in which minimum air temperature is lower than 0°C. During summer we do not have frosts. Early frosts occur rarely in October (2 days). There is an increased incidence of frosty days with the beginning of November (8 days). Generally, frosty days are commonplace in the winter part of the year. Period of frost ends in April (2 days) and the highest number of frosty days occur in the coldest month, January (20 days). The average number of frosty days decreases from February (17 days) to spring months. The average number of frosty days is 76 days with frost.

Tropical days are the days in which maximum temperature is higher than 30°C. They typically occur in the warmest part of the year. They can appear from May to September and have a negative influence on vegetation because they cause longer or shorter dry periods. July and August are the months with the most increased incidence of tropical days (13 days). It was recorded that on average there are 38 tropical days during the referent period.

Cold days are those days in which the minimum temperature is lower than 0°C. The most increased incidence of cold days is in late autumn, especially December (4.6 cold days) and in winter months – January (6.1 cold days) and February (3.6 cold days). On the territory of the Kragujevac Basin there were 15 cold days in total.

Air temperature is one of the characteristics of summer days which has to be (even for a moment) equal or higher than 25°C during 24 hours period. Maximum incidence of summer days is during summer (in July 24.5 days and in August 24.8 days). Interesting fact is that summer days also occur in early spring and late autumn. Within incidence of the days with specific temperatures, it was the highest annual number of summer days that were recorded; even 99 days whose temperature is equal or higher than 25°C.

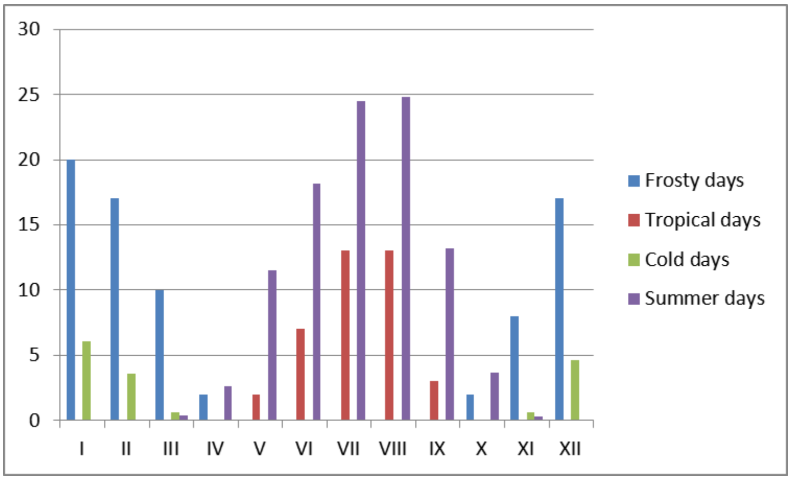

Chart 2 – Incidence of characteristic days in Kragujevac (1981-2010)

Mean Annual Air Temperatures

Based on the mean annual air temperature of the Kragujevac Basin for the period from 1981 to 2010, it was calculated the average mean annual air temperature of 11.6°C which can be registered as so called climate normal. However, although the subject is the climatic normal, the influence of the "urban heat island" which is closely connected to the population growth, a parameter which reflects the very size of the city is obvious (Unkašević, 1994).

This assertion can be proved by applying the method of regression analysis. Regression analysis represents a statistic procedure which puts two phenomena into causal relationship. Studying of the two phenomena variability is performed as a part of the analysis. One of them occurs as an independent variable and the other represents a dependent variable value. A display like this is called dispersion or scatter diagram. Points on the diagram can be completely scattered (there aren't any connection between the phenomena) or they can be arranged in a strictly defined order. Line of regression represents the line which goes through the points on the dispersion diagram and in this particular case it is a straight line (Savić et al, 2015).

General form of the linear equation is:

$$\mathbf{y=ax + b,}$$

where **x** is an independent variable, **y** is a dependent variable, **a** is a constant in a linear equation and **b** is the linear regression coefficient. The goal of the linear regression method is to predict values for the certain **x** values. Based on the statistic data for the time interval (1981-2010) function has the following form: **y=0,0509x + 10.831** (Chart 3). In the linear trend equation **y** is a mean annual air temperature; **x** is a time interval (30 years), **b**-linear regression coeficient (Gavrilov et al, 2017). Based on the magnitude (change) of the trend ***Δy*** (°C) it can be determined positive or negative trend, according to the next equation:

$$\Delta y=y_2-y_1;\ y_2=0{,}0509*x+10{,}831;\ y_2=0{,}0509*30+10{,}831;$$
$$y_2=1{,}527+10{,}831;\ y_2=12{,}358;\ \Delta y=12{,}358-10{,}831;\ \mathbf{\Delta y=1{,}5°C}$$

Solving the equation we can realize that the mean annual air temperature trend for the analyzed period is positive. Average deviation of the mean annual air temperatures from the climatic normal of 11,6°C is **1,5°C**.

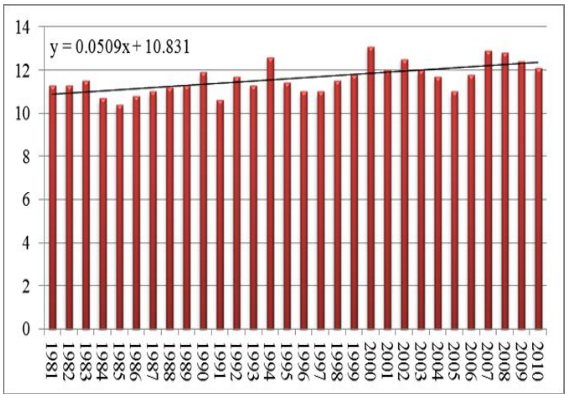

Chart 3 – Linear trend of the mean annual air temperature change and the line of regression in Kragujevac (1981-2010)

4. Discussion

Annual flow of, air temperature in the region of Kragujevac Basin indicates that there is a maximum temperature (after the summer solstice) and a minimum temperature (after the winter solstice). Increasing of temperature from winter to summer is somewhat slower than decreasing of temperature from summer to winter. On the other hand, temperature changes are less pronounced in winter and summer months and more pronounced in transitional seasons.

Positive mean temperature in January (0.6°C) is rare in Serbia because only a few synoptic stations have similar temperature in January: Niš -0,6°C (Ivanović et al, 2011). It is possible to find other synoptic stations in resources which have identical or higher temperature in January: Valjevo (0.6°C), Smederevska Palanka (0.7°C) (Meteorological yearbook RHMZS).

Also, the mean temperatures in July are highas well (21.9°C). Synoptic stations like Novi Sad-Rimski Šančevi, Sombor etc. show identical trend. Leskovac Basin (22.4°C), Niš Basin (22.5°C) (Ivanović et al, 2011) and especially Belgrade (23.0°C), where the influence of the urban heat island is dominant (Meteorological yearbook RHMZS), show higher temperatures. Based on these kind of temperatures from January and July it can be concluded that winters in Kragujevac are mild and that summers are warm. It should be expected that the surroundings is a few tenths of a degree cooler. Temperature amplitude is 21.0°C, which classifies this region as a territory with humid continental climate (amplitude is lower than 23°C) (Rakićević, 1980).

Mean maximum and mean minimum temperatures show the same flow as the mean monthly temperatures. When it comes to the mean maximum temperatures, the trend is similar in Leskovac Basin (17.6°C), Ćuprija (17,5°C), and Smederevska Palanka (17,4°C). On the other side, identical or similar mean minimum temperature was recorded in Niš Basin, Veliko Gradište (6,4°C), Negotin (6,7°C) (Ducić et al, 2005). Relief has a great influence on the flow of the mean monthly and extreme air temperatures because of the stations which have similar hypsometric range.

When it comes to the mean temperatures of the seasons, it can be noticed that the amplitude of the mean monthly temperatures is low and that autumn is warmer than spring. High temperatures in autumn, especially in September and October, have a great impact on vegetation period causing its prolongation. There are similar data in literature about Niš (Ivanović et al, 2011), Prizren (Ducić et al, 2005) and others. Based on the thermodromic coefficient we can come to a conclusion that Kragujevac and its surroundings have characteristics of the moderate-continental climate. Amplitude of the absolute air temperatures shows a great fluctuation, which is a general characteristic of the areas with the continental thermal regime.

Winters are long, but not too cold. Positive mean January temperature indicates the general nature of the winter in Kragujevac. However, periods with negative temperatures are certainly possible. Frosty days are characteristic for the winter part of the year and they can influence vegetation in April and during September. Cold days are not so rare, also. Summer is long and warm in the area of the Kragujevac Basin. During July and August all days have temperature over 25°C (summer days) and almost every other day is tropical.

With mean annual temperature of 11.6°C, Kragujevac and its surroundings are one of the warmest city areas in Serbia. The linear trend of the mean annual temperature change points to a deviation of 1.5°C from the average mean annual temperature, the situation when a climate of the city dominates modificatation of the air temperatures values.

The final goal of the thermal studies is a climate regionalization. The detailed climate map of Yugoslavia was made by A. Milutinović (1974) based on the Köppen climate classification (Šegota, 1988). According to said classification, Kragujevac and its surroundings belong to the Cfb climate "moderately warm, humid climate with a warm summer" (mean July temperature is about 20-22°C, and the mean January temperature is from 0°C to -3°C. According to the Köppen climate classification, T. Rakićević (1980) created even more detailed map of the Serbian climate regions (Ducić et al, 2005). Based on the classification it can be concluded that Cfbx climate is present in the Kragujevac Basin, which means that the temperature of the coldest month is above -3°C and under 18°C and the mean temperature of the warmest month is lower than 22°C. T. Rakićević (1980) established that Kragujevac and its surroundings belong to climate region of Šumadija, with four clearly pronounced seasons. The first half of autumn is especially pronounced as dry and warm.

Based on all the above said, we endeavored to give a small contribution to studies about the thermal regime of the Kragujevac Basin and urban area, with special emphasis on the last decay of the XX century and the beginning of the XXI century. However, it should be kept in mind that for a more detailed characterization of the thermal regime it is necessary to possesses series of longer observation. That way is possible to interpret changes and trends of the thermal regime more adequately.

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DEMOGRAPHIC PROCESSES IN THE MUNICIPALITIES OF THE TOPLICA DISTRICT

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Abstract: This paper analyses the long-term demographic processes on the territory of the Toplica District, which marked the last sixty-year period. The results of the 1948 to 2011 Censuses were used in the analysis. The processes which marked this period were depopulation (total and natural) and the aging of the population (both total population and specific age groups). The intensity of depopulation in some periods is investigated on the basis of intercensus changes in population. The age structure is presented by means of the aging index, the aging coefficient, the median age and the percentage share of age groups in the total population. In order to create a more complete demographic picture, the analysis of demographic data was done by the type of settlement, at the level of municipalities as well as the district as a whole.

Keywords: Toplica district, depopulation, age structure, aging of the population

1. Introduction

Demographic processes on the territory of the Toplica District in the second half of the twentieth and early twenty-first century are characterized by extremely unfavorable trends, affecting both present and future demographic and economic development. The processes of total and natural depopulation and the aging of the population are seen as fundamental demographic processes on the territory of both Serbia and the Toplica District (Djokic, 2015). The intensive process of depopulation, caused by extensive emigration of the population and a negative population growth, has led to significant changes in the age structure of the population of the analysed area. Negative demographic processes which have marked the entire period exhibit different intensity if they are analysed at lower administrative-territorial units (municipalities and the type of settlement). Demographic dynamics demonstrates an ever stronger spatial polarization, which is particularly evident when it comes to urban and non-urban settlements (Jukic, Turk, 2010). It is notable that in certain territorial units of districts, these processes take place more slowly, while in others, they have led to a complete degradation of demographic resources.

The basic demographic processes that are discussed in this paper are depopulation and the aging of the population.

2. Materials and methods

The timeframe of the research covers the period from 1948 to 2011. The results of eight post-war Censuses were used for the analysis of demographic processes. When analyzing the numerical population trends, it should be taken into account that starting from the 2002 Census, there are differences in the census methodology, which makes it difficult to comparethe data. The 2002 Census in Serbia applied international recommendations which suggest that the permanent resident population includes the population living in the country and persons with temporary work and residence abroad for less than a year. Foreign nationals with work and residence in Serbia for longer than a year are also included in the permanent resident population.

The analysis of demographic processes on the territory of the Toplica District and its lower administrative-territorial units is based on the use of relevant demographic variables, which serve to calculate the demographic indicators of negative demographic processes. Several variables were used to shape the indicators: the percentage share of the population by five-year age groups, the percentage share of the population younger than 20 years of age, the percentage share of the population over 60, intercensal population change and median age. Based on these, the aging index and the aging coefficient were calculated. The obtained results determined the direction and intensity of changes in the analysed period, and pointed to the consequences of such developments.

3. Population changes

Change in the total population is a synthetic indicator of demographic trends and processes in a particular area (Turk, Jukic, 2009). It is a result of natural and spatial mobility of the population. The territory of the Toplica

District and its component parts are characterized by the processes of total depopulation and extreme aging of the population. In the period from 1948 to 2011, population growth was only recordedin the observed area in the first intercensus period (1948-1953), whereas stagnation was recorded in all other periods. Total population decline from 1948 to 2011 amounted to 49,748 or 35.16%. The long-term process of depopulation threatened the vital characteristics of the population, and it is certain that the population decline will continue in the future as well. The decrease of population in the observed period was recorded in all municipalities. It ranged from 22.97% in the Municipality of Zitoradja to 50.35% in the Municipality of Blace. The municipalities of Prokuplje and Kursumlija recorded a decrease of 25.08% and 48.47% respectively. Table 1 shows that the Municipalities of Blace and Kursumlija have extremely negative demographic characteristics. The population of these municipalities belongs to the strong depopulation type (Kursumlija) and the first phase of extinction type (Blace).

The extent of depopulation can best be seen if analysed by the type of settlement. Only 16 settlements, four of which are municipal centers, had an increase in population, while the trend of population decline was recorded in 251 settlements. Three rural settlements were affected by total depopulation: Vukojevac and Tacevac in the Municipality of Kursumlija and Obrtnica in the Municipality of Prokuplje. An interesting example is the village of Rastelica (Municipality of Kursumlija) where the 2002 Census did not record a single resident, while the following Census recorded three inhabitants. All these settlements are located in the altitude zone of 750 to 850 meters above sea level. The most intensive depopulation process, where the population decreased by more than 90%, was recorded in 59 settlements. 167 settlements belong to the second group of settlements with extremely unfavorable demographic characteristics, where the decrease ranged between 40 to 90%. 17 settlements belong to the group of settlements with slightly more favorable characteristics, although still negative (decrease from 10 to 40%). Only 5 settlements experienced a decrease of 10%.

In order to gain a better understanding of demographic processes and potential, hypsometric distribution of the population and settlements was analysed as well. For this purpose, settlements are classified into three groups: settlements located in the altitude zone of 200 to 499 meters above sea level, settlements located in the altitude zone of 500 to 999 meters above sea level and settlements located in the altitude zone above 1000 meters above sea level. Demographic problems are particularly pronounced in the parts of the district with high altitude, which have been characterized by extreme depopulation for several decades, caused by emigration of the working-age and fertile-age population (Ivkovic, Todoric, 2013). Most of the settlements, 147, are located in the altitude zone of 200 to 499 meters, which represents 55.06% of the total number of settlements. 116 settlements are located in the next altitude zone (500 to 999 metres) which represents 43.45%, while only 4 settlements are located in the altitude zone above 1000 meters (1.5%). Analyzing the settlements and population by hypsometric zones, it can be clearly observed that the depopulation is more pronounced with higher altitudes (Ivkovic, Todoric, 2013). The most intensive population decline occurred in the highest altitude zone. The percentage share of the population of this zone in the total population during the period under review decreased from 0.97% to 0.13%. The population of the four settlements in this zone, according to the last Census, makes up only 8.78% of the population in 1948.

Table 1. Population change by type of settlement from 1948 to 2011

	1953/48	1961/53	1971/61	1981/71	1991/81	2002/91	2011/2002	2011/1948	Type of change 1948-2011	Type of change 2002-2011
Toplica District	105.60	94.46	91.78	94.13	91.70	91.29	89.89	64.84	R_4	R_3
Urban	115.01	130.76	154.27	131.50	113.45	101.49	97.79	343.50	P_1	R_1
Other	104.62	90.30	81.41	82.37	80.78	84.10	83.16	35.79	R_4	R_4
Blace	103.94	89.80	87.47	89.69	90.60	87.59	85.43	49.65	R_4	R_4
Urban	119.57	117.56	131.55	130.71	118.58	104.53	96.12	287.99	P_1	R_2
Other	102.63	87.10	81.69	81.02	81.07	79.13	78.38	29.75	R_4	R_3
Zitoradja	105.54	98.41	96.16	97.58	94.37	93.15	89.90	77.03	R_4	R_3
Other	105.54	98.41	96.16	97.58	94.37	93.15	89.90	77.03	R_4	R_3
Kursumlija	106.67	92.77	85.84	87.23	85.38	91.60	88.92	51.53	R_4	R_3
Urban	112.05	122.78	195.37	142.96	118.25	108.50	96.49	475.72	P_1	R_2
Other	106.24	90.20	73.09	69.89	64.45	71.86	75.56	17.13	R_4	R_4
Prokuplje	105.60	95.94	95.41	98.15	94.16	91.56	91.58	74.92	R_4	R_3
Urban	115.00	136.11	146.97	127.35	110.55	97.77	98.77	312.77	P_1	R_1
Other	103.98	88.27	80.20	82.38	80.47	84.44	82.03	33.80	R_4	R_4

Source: Census of population, households and apartments in 2011 in the Republic of Serbia, Comparative overview of population 1948/2011, Data by settlements, Book 20, RSO Belgrade, 2014.

The settlements in the altitude zone from 500 to 999 meters recorded a slightly lower decrease in the total population. In 116 settlements in this zone, the percentage share of the population in the total population decreased from 31.09% in 1948 to 8.4% in 2011. The current population of these settlements represent only 17.51% of the population at the beginning of the period under review. Bearing in mind that this hypsometric zone, where 43,45% of the settlements are located, is now inhabited by only 8.40% of the total population of the district, it is clear that the spatial demographic imbalance in the network of settlements, which existed in the past decade, continues to grow (Ivkovic, Todoric, 2013).

Table 2. The hypsometric distribution of the population and settlements in the Toplica District according to the 1948 Census and the 2011 Census

	Number of settlements	**Hypsometric zone**					
		200-499		**500-999**		**1000-1499**	
		Number of settlements	**%**	**Number of settlements**	**%**	**Number of settlements**	**%**
Blace	40	31	77.50	9	22.50	-	-
Zitoradja	30	28	93.33	2	6.67	-	-
Kursumlija	90	28	31.11	58	64.44	4	4.44
Prokuplje	107	60	56.07	47	43.93	-	-
District	267	147	55.06	116	43.45	4	1.50
1948							
	Population	**200-499**		**500-999**		**1000-1499**	
		Population	**%**	**Population**	**%**	**Population**	**%**
Blace	23676	18353	77.52	5323	22.48	-	-
Zitoradja	21250	20294	95.50	956	4.50	-	-
Kursumlija	37284	16758	44.95	19147	51.35	1379	3.70
Prokuplje	59292	40728	68.69	18564	31.31	-	-
District	141502	96133	67.94	43990	31.09	1379	0.97
2011							
	Population	**200-499**		**500-999**		**1000-1499**	
		Population	**%**	**Population**	**%**	**Population**	**%**
Blace	11754	10275	87.42	1479	12.58	-	-
Zitoradja	16368	16318	99.69	50	0.31	-	-
Kursumlija	19164	16437	85.77	2606	13.60	121	0.63
Prokuplje	44419	40848	91.96	3571	8.04	-	-
District	91705	83878	91.47	7706	8.40	121	0.13

The 2011 Census recorded 83,878 residents in the lowest altitude zone, in which 147 settlements are located (55.06% of the total number of settlements). The percentage share of the population of this zone in the total population increased from 67.94% in 1948 to 91.47% in 2011. All 16 settlements which recorded population growth compared to 1948 are located in this altitude zone (Glasince - increase index of 102.36, Staro Momcilovo

102.52, Djurovac 108.40, Drenovac 110.19, Babin Potok 115.30, Samarinovac 118.36, Recica 120.12, Bela Voda 120.47, Jasenica 127.0, Zitoradja 138, Berilje 158.03, Novo Selo 197.97, Donja Strazava 286.38, Blace 287.99, Prokuplje 312.77 and Kursumlija 554.16).

Table 3. Settlements in the Toplica District according to population size in 2011

1948											
	Total	Without	1-9	10-49	50-99	100-299	300-499	500-999	1000-1999	2000-4999	5000+
Blace	40					6	15	14	5		
Zitoradja	30					4	6	16	3	1	
Kursumlija	90				2	38	27	20	2	1	
Prokuplje	107				2	35	30	32	6	1	1
District	267	-	-	-	4	83	78	82	16	3	1
2011											
	Total	Without	1-9	10-49	50-99	100-299	300-499	500-999	1000-1999	2000-4999	5000+
Blace	40			1	16	17	5	1	5		1
Zitoradja	30			4	2	4	9	9	1	1	
Kursumlija	90	2	7	36	23	21					1
Prokuplje	107	1	8	33	10	38	8	7	1		1
District	267	3	15	74	51	80	22	17	7	1	3

The structure of settlements by population size is clearly differentiated and indicates uncontrolled concentration of the population primarily in the center of the municipality ("the centre of growth") and spontaneous depopulation and fragmentation of other settlements. During the observed period, a decrease in the number of medium-sized settlements is evident as well as a significant increase in small settlements. The largest number of settlements in 1948 had between 300 and 999 inhabitants. These settlement made up 59.93% of the total number of settlements. The settlements with 100 to 299 inhabitants had a significant share, which amounted to 31,08%. The share of the largest settlements (with more than 1000 inhabitants) was 7.49%, while the share of the smallest (from 50 to 99 inhabitants) was 0.15%.

In the conditions of extreme depopulation and demographic emptying of the settlements until 2011, there have been significant changes in the population size of the settlements (Martinovic, 2012). According to the latest Census, the settlements with up to 99 inhabitants are the most numerous. Their share in the total number of settlements increased from 0.15% in 1948 to 53.56%. The 2011 Census registered the smallest settlements in terms of population (up to 50 inhabitants), which were not listed in the 1948 Census. There were 89 of these settlements (33.33% of the total number of settlements). Settlements which no longer have inhabitants belong to a separate group of settlements. This group of settlements was not listed until the 1991 Census, when a settlement without inhabitants (Vukojevac) was registered for the first time. Each subsequent Census recorded an increase in the number of these settlements. In 2011, there were three.

4. Changes in the age structure of the population

The age structure, together with the sex structure, reflects the actual biodynamics and potential vitality of a certain area (Nejasmic, 1992). It is important for the current and future demographic and economic development of an area because the key contingents for biological reproduction, as well as for the formation of work force, stem from it (Wertheimer-Baletic, 1999). It is formed under the direct influence of the three basic components of population movements (birth rate, death rate and migration), and in turn, the distribution of population by age directly affects the number of births, deaths, as well as the intensity of spatial mobility of the population, in other words, it directly affects birth rates, death rates, as well as the migration rate (Radovanovic, Gigovic, 2010).

Unfavourable demographic processes in the Toplica District took their toll on the age structure of the population. The process of demographic aging of the population in the district intensified in the 1970s. The analysis of the age structure indicators in the period from 1971 to 2011 shows a strong progression of the aging process. Unfavorable age structure of the population of the Toplica District is the result of depopulation, which in turn is caused by intensive emigration and negative natural movement (Djokic, 2015).

Changes in the age composition of the population are reflected through two parallel demographic processes: decrease in the share of the young population with a simultaneous increase in the share of the old population (Nejasmic, Toskic, 2013).

The reached level of population age is visible from the proportion between large age groups. Since the aging process occurs when the share of the old population (60 or 65 years of age and over) in the total population reaches 12%, it can be said that the population of the Toplica District and its component parts began the aging process in the 1960s. According to the 1971

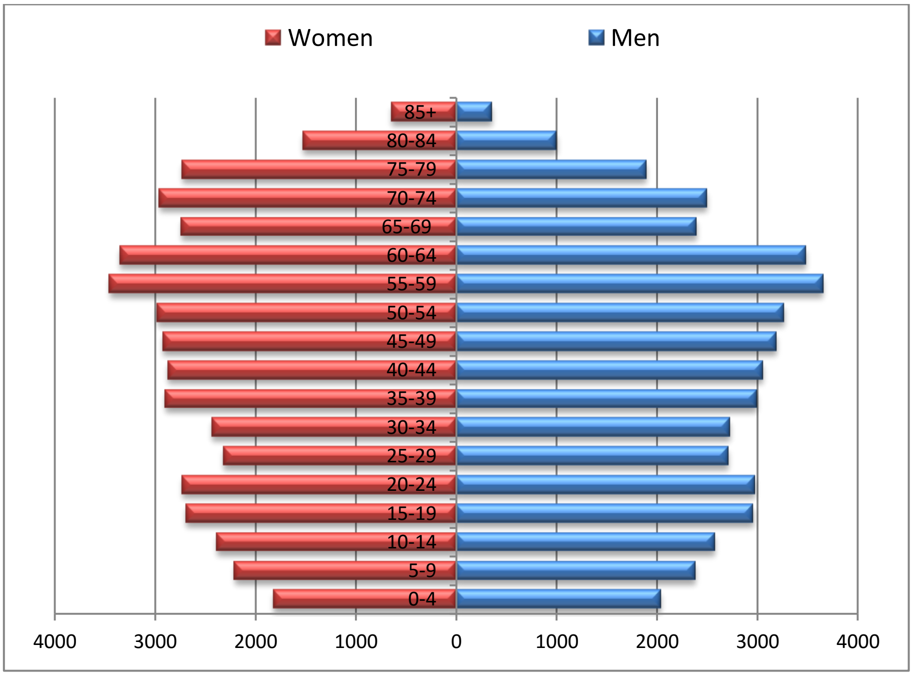
Census, the share of the population over 60 years of age amounted to 13.96%, while the share of young people (aged 0-19) was relatively high (33.71%). The subsequent Census periods, in addition to an increase in the percentage of the old population, recorded a decrease in the percentage of young people. The comparison of the results of the 1971 Census and the 2011 Census points to a significant intensification of the process of aging and a high aging index. In the analysed period, there was a significant increase in the percentage of the old population, while at the same time the share of the young decreased to a value that indicates the stage of the deepest demographic old age. The share of young people in the 2011 Census was 20.76% (33.71% in 1971), while the share of the people aged 60 and over was 27.75% (13.96% in 1971).

Table 4. Selected indicators of population age structure in the Toplica District according to the 1971 Census and the 2011 Census

	1971						**2011**					
	0-19	**20-39**	**40-59**	**60+**	**median age**	**index**	**0-19**	**20-39**	**40-59**	**60+**	**median age**	**index**
Blace	30.33	27.36	26.06	15.84	35.29	52.22	17.70	20.90	27.96	33.45	46.4	189.04
Urban	33.68	36.88	20.10	9.13	30.31	27.11	22.84	26.27	28.67	22.22	40.4	97.25
Other	29.63	25.35	27.32	17.26	36.34	58.25	13.54	16.55	27.38	42.53	51.2	314.20
Zitoradja	31.56	30.60	28.52	13.61	35.96	43.13	21.34	23.42	25.71	29.52	43.4	138.33
Urban	33.27	32.11	22.53	11.58	31.86	34.81	23.68	26.02	25.79	24.51	40.7	103.51
Other	31.30	30.36	29.45	13.93	36.59	44.50	20.73	22.75	25.70	30.82	44.1	148.65
Kursumlija	37.91	26.55	22.37	12.77	31.84	33.69	20.73	23.70	28.96	26.62	42.9	128.43
Urban	39.96	34.83	18.65	16.08	27.69	15.22	24.06	26.81	29.59	19.54	39.3	81.20
Other	37.31	24.12	23.46	14.73	33.05	39.50	13.20	16.69	27.54	42.56	51.2	322.31
Prokuplje	33.32	28.91	23.28	14.11	33.36	42.33	21.38	24.61	27.72	26.29	42.3	122.99
Urban	35.86	34.35	20.33	8.11	29.45	22.62	23.26	27.67	28.80	20.26	39.4	87.12
Other	31.95	25.97	24.87	17.34	35.46	54.28	18.36	19.71	26.00	35.93	47.0	195.70
District	33.71	28.38	24.33	13.96	33.70	41.41	20.76	23.73	27.65	27.85	43.1	134.15
Urban	36.30	34.52	20.13	8.07	29.37	22.25	23.45	27.26	29.01	20.28	39.5	86.49
Other	32.81	26.23944	25.80	16.01	35.21	48.80	18.08	20.20	26.29	35.43	46.8	196.02

Source: Sex and age, the 1971 and 2011 Census results

The aging index is used as a relevant indicatorin the analysis of the age structure of the population, and especially in the assessment of the level of demographic aging (Djokic, 2015). The aging index, calculated as the ratio between the population aged 60 and over and the population younger than 20, was 134.15 in the Toplica District in 2011. This is a significant increase compared to 1971, when it was 41.41. Since it is considered that the process of aging starts when the index value exceeds 40, it can be said that the population of the Toplica District began the process of demographic aging as early as 1971. A more favorable ratio between the mentioned population groups compared to the median value of aging index for the district was present in the Municipalities of Prokuplje (122.99) and Kursumlija (128.43). The other two municipalities, Blace and Zitoradja, recorded values which are higher than the median. The scope and intensity of the aging process can best be seen when it is analysed by the type of settlement. All municipal centers, except Zitoradja, have index values lower than 100. A particularly extreme situation was observed in rural areas, where the effects of extreme depopulation led to index values of over 300. The rural settlements in the Municipalities of Blace (index value of 314.20) and Kursumlija (index value of 322.31) have the highest values.



Graph 1. The age-sex structure of the Toplica District population in 2011

The data on the median age of the population also provide evidence on the reached level of demographic aging. It is considered that the populations whose median age is 30 are in the first phase of demographic aging. The median age of the population of the Toplica District reached the threshold value as far back as the 1971 Census, when it was 33.70 years. All subsequent Censuses recorded an increse in the value, and in 2011 it reached 43.1 years.

The unfavorable age structure of the population of the Toplica District is best illustrated by the age pyramid. It can be observed that the base of the pyramid is significantly narrower compared to the middle part. The analysis of the age-sex pyramid shows a narrowing in the younger age groups and an expansion in the older age groups (50 and over). Based on the presented proportions of the five-year age groups and the analysis of the pyramid, we can say that the Toplica District belongs to the group of demographically endangered areas, and its population belongs to a regressive type.

The population of the Toplica district, based on analytical indicators, is characterized by deep demographic aging.

5. Conclusion

Demographic development of the Toplica District in the analysed period is characterized by unfavorable demographic processes, total and natural depopulation, the aging of the population and reduced reproductive potential. All these processes have contributed to the weakening of the demographic base and total demographic potential. The analysis of the indicators at the level of lower administrative-territorial units (municipalities and settlements) revealed visible spatial differences in demographic processes, which are especially pronounced between urban and rural settlements (Spevec, 2009). The Toplica District recorded a positive population change only in the period from 1948 to 1953 (up by 5.6%). In all other Census periods (from 1953 to 2011), thestudied area is characterized by a negative growth (in the period from 1953 to 2011, the decrease was 38.6%). The analysis of census data in terms of rural-urban polarization shows that in the period from 1948 to 2011, the population in rural settlements decreased by 64.21%, while in urban settlements, it increased by 243.5%.

The age structure of the population of the Toplica District is analysed using the aging index and the median age. It is considered that the aging of the population begins when the aging index exceeds 40%, and the share of the population aged 60 and over exceeeds 12% (Wertheimer-Baletic, 1999). The analysis of the age composition of the population in the period from

1971 to 2011 showed that the aging index and the median age exceeded the critical values as early as 1971. In all subsequent Census periods, there is an increase of the index value, so that in 2011, it amounted to 134.15. At the same time, the median age increased from 33.7 to 43.1 years.

Based on the analysed indicators of age structure, it can be concluded that theToplica Districtis demographically a highly endangered area, whose population is in the stage of deepest demographic old age.

Further demographic developments will take place under a strong influence of the aging of the population and changes in the age structure. The consequences of these processes will be: intensified depopulation, decreased birth rates, increased overall mortality rates, reduced migration of the population, deterioration of the composition of the population by age and sex, and aging of the working-age population (Werheimer-Baletic, 1999).

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THE POSSIBILITIES OF DEVELOPING MOUNTAIN TOURISM ON THE MOUNTAIN OF GOLIJA

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Abstract: The mountainous area of Golija has substantial potential for the development of tourism. Mountain, sports and recreational tourism require that tourists stay for extended periods of time, longer ski seasons, as well as establishing contact with nature. Serbia is a country rich in mountains which possesses exceptional potential for the development of mountain tourism. Despite that, mountain tourism in Serbia is not at a satisfactory level. A case in point is the mountain of Golija. If the economic and social situation of the country were any different when it comes to the tourism market and the natural resources which our mountains possess, it is undoubtable that many mountainous areas would by now have become prominent tourist destinations on the European market. Golija, with its numerous idiosyncrasies and specificities, as well as its location and elevation, has a strong modifying influence on the climate, hydrography and flora and acts as a traffic barrier in south-west Serbia. The subject matter of this paper is the analysis of the possibilities for the development of tourism on the mountain of Golija, with the aim of identifying the key potential for the development of mountain, sports and recreational tourism. The authors will indicate certain locations on and roles of the mountain Gollija in the development of the mountain, sport and recreational tourism in Serbia, while placing special emphasis on the role that Golija has as a tourist attraction on the tourism market of Serbia.

Key words: Golija, development, mountain tourism, natural and ecological values

1. Introduction

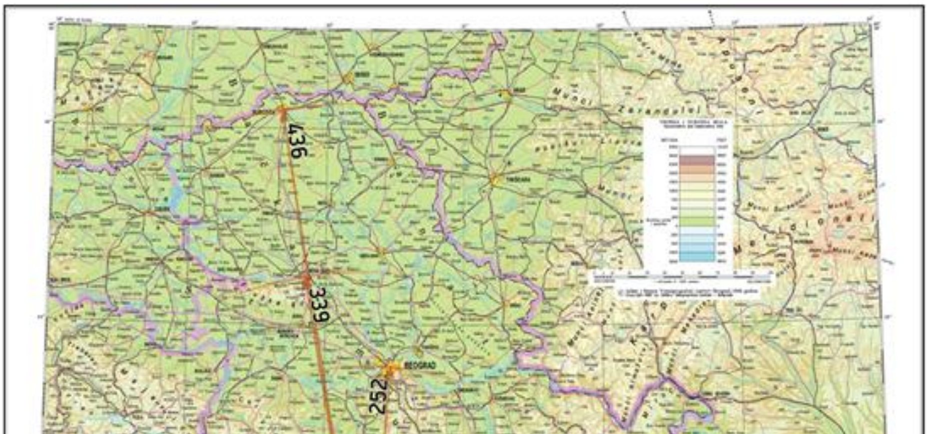
The possibility of developing mountain tourism on Golija is based on its favorable geographic location, the wealth of its natural tourist values (especially the plant life) and anthropogenic values. What is also of special importance is the possibility of developing the sports and recreational tourism which would in turn complement rural tourism, along with mountain tourism. The possibility of developing sports and recreational tourism along with rural tourism on Golija is significantly greater than the current state of affairs, including the development of the material base, the content and length of the tourist stay. The idiosyncrasies of the development of tourism on Golija are viewed in relation to its potential to attract tourists. The tourist values of Golija are increased by the Golija nature park, which covers an area of 75.183ha which contains 963 taxons, 724 of which are vascular plants, including approximately thirty endemic and relict types, tertiary and glacial types, and also numerous herbs and other rare and endangered species. (Nikolić, 2011) The park consists of three zones which abound in plant life with special protection rules in place. The greatest natural values, and the park centers where tourism could be developed to the fullest extent include: Golijska reka, Bele Vod, Studenica, Odvraćenica, Rudno, Kušići and Šeremetovići.

The development of tourism on this mountain requires suitable conditions for the regular transport and accommodation for tourists in village households or in other forms of accommodation, who would stay there with the aim of recovery or recreation (Bratić, M., 2015). Golija is well-known for its great wealth of natural and economic resources which offer a good living environment for the rural population, and now a good chance for the development of tourism, but is unfortunately, today characterized by economic neglect and depopulation.

The further development of tourism on Golija would be a significant factor in the transformation of the mountain itself, and on the other hand, would lead to an increase in the income of the population of Ivanjica, who are primarily involved in tourism. The consequence could be that tourism would emerge as the most important factor of the process of revitalization.

2. Tourist-geographic position

The Golija mountain is located in the south-west part of Serbia. It extends from west to east. The borders of the mountain are determined by rivers. To the north the mountain stretches to the Studenica river, then across the Ibar to the east, the Ljudska reka and Vapa to the south, and to the Moravica and Nosnica rivers to the west. In a morphological sense it includes the central part of the Dinar system. It belongs to the Starovlaška-raška highland. The elevation of various parts of Golija differ significantly. The mountain is located at an altitude of 500-1.843m. The highest peak is Jankov kamen (1.843m). In the morpho-metric sense Golija has pronounced mountain peaks, horsts, high structural surfaces, ridges and other morpho-structural forms. The basic morphographical feature of this area is the arch network of mountain ridges, which are interspersed with deep gorges, river valleys of the mouths of the Moravica, Studenica and the left tributaries of the Ibar. In addition to the main peak, there are several other prominent peaks: Crni vrh (1.795m), Čardak (1.688m), Kulina (1.642m), Jadovita (1.56 m) etc. (Bratić, 2015).



Map 1: The position of the Golija mountain in relation to the main dispersion zones (Bratić, 2015)

The satisfactory tourist-geographic position of the mountain is based on its natural-geographic characteristics, a variety of different geographical features and favorable traffic conditions regarding access to the main roads in our country, since it is located near the Ibar highway which connects this mountain to Macedonia, Kosovo and Metohija and Montenegro via Belgrade. The main tourist attractions of this area include the Golija mountain, Obudovica, and the courses of the Studenica and Moravica rivers. The basic tourist attraction is the mountain Golija, while the others are complementary ones. There is an asphalt road which link the mountain to the main highway and indirectly connects it with the larger urban-industrial centers of our country.

In the first zone, at a distance of 100 km from Golija we find Ivanjica, Raška, Sjenica, Novi Pazar and Turin. The second zone is made up of cities and industrial centers at a distance of 200 km: Kragujevac, Kraljevo, Užice, Čačak, Kruševac. The third zone consists of urban-industrial centers at a distance of 200 km to 500 km: Podgorica, Niš, Novi Sad, Subotica, Priština, Kosovska Mitrovica, Leposavić and Belgrade.

In terms of transportation, this mountain is well-connected. However, the poor quality of the local roads, the unsatisfactory quality of the regional and national highways, as well as other roads, make this area unfavorable. The biggest roads in the vicinity are the national highway M22 (Kraljevo-Raška-Novi Pazar) M21 (Požega-Ivanjica-Sjenica) and M8 (Prijepolje-Sjenica-Novi Pazar). The railway lines are not highly categorized, nor is air travel. In the vicinity of Sjenica (around Duga Poljana) there is an air strip which has potential for further development, but to this day it has not been exploited.

From this we can conclude that the position of Golija in terms of tourist attractions, geography and accessibility is relatively favorable and that there is the possibility of tourists coming in from various areas. However, what makes this mountain unfavorable is the fact that it is surrounded by the mountain ranges of Jelica, Kopaonik, Čemerni, Radočel, Javor, Zlatar, Javornik and the Pešter highland. These mountain ranges represent the main competition when it comes to developing tourism on Golija, which is especially true of Kopaonik and Zlatibor which are large tourist centers. These centers, in relation to Golija, have better facilities both in terms of infrastructure and superstructure. They also possess more adequate and modern ski hills, amusement parks, roads and are better equipped and more developed than Golija in terms of tourism.

3. Natural tourist values

The attractive natural elements which are conducive to the development of the mountain tourism of Golija can be seen in the geo-morphological, climatic, hydrographic and bio-geographical natural values. In the development of the tourist potential of this mountain so far, some of these natural tourist values have been recognized (the main mountain ridge), while the others are significantly below the limits for the optimum possibilities for promoting and developing tourism. (Radivojević i sar. 2006)

Various types of geological structure, as well as intense geo-morphological processes in this area have led to the formation of various shapes and forms, some of which possess significant possibilities for tourism. The relief of the mountain are of Golija is divided up by mountain ranges, river valleys and basins. This mountainous area in terms of its general position extends south to north, but with extensive deviations in some of its parts. Thus, the main mountain range with the highest peaks and ranges appears to be curvy, resembling the letter S, for approximately 33 km. This, so-called high mountain range extends towards the south and south-east and then takes a sharp turn downward towards Pešter and the valley of Novi Pazar, while towards the north it is deeply divided by the river valleys of the Studenica, Moravica and Nošnica into three mountainous areas. In a continued long decline, on the one hand in the direction, of the north-west, on the other towards the north, and even toward the north-east. Because of its location, it makes a very sharp orographic barrier, due to which the mountain is exposed to more cold northern influences of the climate. These high mountain ranges have sharp and smooth sides, and due to the elevation and a more severe climate, they represent the main and best terrains for the development of all forms of winter sports. (Nikolić, 2011)

The development of mountain tourism in this area is supported by a suitable climate, which brings a pronounced recreational tourist appeal, especially in the winter season. In correlation with the preserved, healthy environment, this type of motivated movement, has a stimulating and appropriate influence on the development of mountain tourism. The climate represents a complex product of the superposition and interaction of several factors, such as longitude, latitude, altitude, surface vegetation, etc. On the Golija mountain, moving upwards from the lowest parts all the way up to the highest peaks we find alternating climate zones. From a moderate-continental to the temperate climate with a sub-Mediterranean character in the lowest parts, and all the way to the zone of the pre-Alpine climate in its highest parts.

In a hydrographic sense Golija represents the main hydrographic knot of western Serbia, since according to the data of the water management plan of Serbia, it has the highest density grid of water courses in Serbia, represented by fifteen small and big rivers. Of the rivers we place special emphasis on Studenica, which is located on the north-east side of Golija. This river valley represents the most specific geo-morphological and hydrographic occurrence in the relief of Golija. With its deep gorge valley it completely separates the bigger, north-east, mountainous part of Golija from the middle one, as well as from the mountain range of Čemerna. Its unique gorge is 30 km long, and in certain parts it has almost vertical limestone sides, and a depth in certain parts of approximately 800m. It is one of the biggest and most eye-catching in Serbia. It is rich in water resources, tributaries and forested regions. Along the valley there is an old, partly asphalt regional road which leads from Devići to Ivanjica.

The diversity of the bio-geographical tourist motifs of the area to a great extent influence the significance of the complementary nature of the mountain, that is, sports and recreational, health and wellness, and mountain tourism. The vegetation of this area is marked by grassy and forest phytocenoses which are mainly located in the zone of the Golija nature park which takes up most of the mountain. The five vegetation zones which can be found on the vertical profile of the mountain have a special significance for Golija. They include the belt from 400m in elevation to the highest mountain peak. Here at the foot of the mountain we find degraded forest complexes, meadow and pasture communities, a river. At an elevation of 600 m we find degraded forests, meadows and several types of mixed oak forests - Hungarian oak, Turkey oak, Sessile oak living alongside hornbeams, ash, sometimes even beech trees, beech and spruce forests all the way to the sub-Alpine mixed beech-spruce and spruce forests. Above this level we find high mountain pastures. “The most complex and high quality forests of spruce trees, pine trees and beech trees can be found in the area of Crni vrh – Radulovac, which represents a natural resource and rarity of the entire

European continent." (Nikolić, 2011) The vegetation of the Golija mountain is represented by high quality and easily available forest complexes, and with its picturesque nature has a positive effect on human beings, which is one of the preconditions for the development of mountain and recreational tourism.

4. Anthropogenic tourist values

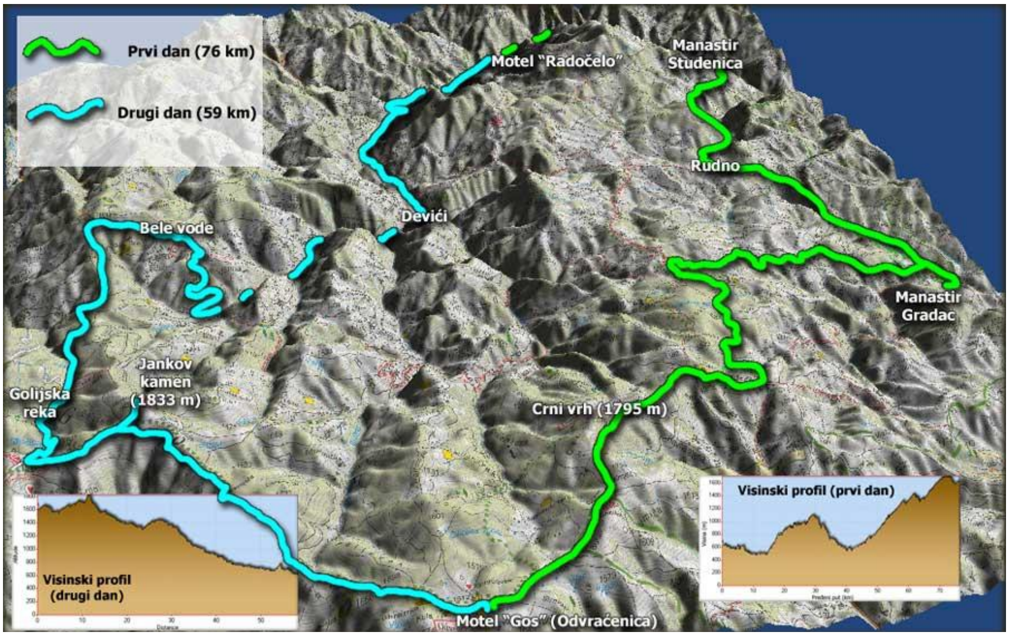
For the development of tourism on Golija the anthropogenic tourist values also play an important part, which in this area are represented by monumental and ethnographic tourist values. The elements of this complex date back from a different time and represent the development of historical, economic-political and cultural events. Medieval monuments of a sacral architecture as well as many monasteries are important forencouraging cultural tourism in this area. At the foot of the Golija mountain, we found the breathtaking monasteries of Studenica, Gradac, Stari Ras and Sopoćani. The ethnographic tourist motives can be seen in the specific customs, culinary specialties, folklore and traditional dress. They are characterized by originality and authenticity and represent complementary tourist values.

5. The existing infrastructure on golija

The technical equipment of the mountains of Serbia represents an important factor in the development of sports-recreational tourism. It is a necessary part of the functioning of the overall tourist space. It is often considered a part of the general standard of functioning of various forms of services, necessary for the satisfaction of physiological and cultural needs of visitors. They include: ski slopes, ski lifts and all the other recreational facilities and tourist services. Along with the material factors, the technical equipment represents an important factor, not only for the development of tourism, but also for the overall social-economic development of a certain spatial whole. In the mountain areas of Golija there are numerous possibilities for the development of ski slopes.

Golija, as a mountain with large tourist potential in terms of infrastructure, is not properly equipped. One of the bigger shortcomings that is preventing Golija from becoming a tourist attraction are first of all the run-down roads which lead up to the mountain, the poor accommodation and lack of other facilities.

As we have previously mentioned, the mountain Golija is located at an elevation of 500m-1.833m. Its highest peak is Jankov kamen (1.833m), and the second highest one is Crni vrh (1.795m). For the past ten years much has been said on the development of this mountain and the inclusion of the state in the realization of numerous strategic plans regarding the building and reconstruction of various objects, such as ski slopes and ski lifts. In 2009, a strategic plan was devised based on which investment capital started being diverted to Golija, and it slowly gained recognition as a mountain center of Serbia. Today this mountain notes great development in terms of tourist infrastructure. Its slopes are suitable to the development of winter sports, sports-recreational tourism, especially around: Odvraćenica, Često vrelo, Šeremetovica, Ljute livade, Biser voda, Radočelo, Brusnik, Rudno, etc.



Map 2: The existing ski slopes on Golija, available at: https://www.google.rs/search?q=karte+ski+staza+na+goliji

At an elevation of approximately 850m, at the location of Dajići there is a ski slope, with a ski lift, meant for beginners and children. The slope has a terrain at an angle and is protected by the ski club Golija from Novi Pazar. Another interesting part of Golija which is suitable for winter sport is the area around the Golija river. Here we find a single track 2.300m long, at an elevation of 480m. It is a track of a middle level of difficulty. The two-seater ski-lift has a capacity of 1.200 skiers per hour. In 2007 the necessary provisions were made for the development of the “half pipe” discipline. The third and at the same time most suitable part of this mountain for a ski hill is the area around the peak Odvraćenica. To this day, on it we find ski tracks which are solely used for recreation and belong to the group of easy slopes. They include: Kula 1, Kula 2, Kula 3, Kula 4, Goveđi do and Sovićke kolibe. In addition to the recreational track, there is also one meant for teaching skiers, and that is the track Kula 5.

We can conclude that in the mountain area of Golija we should promote the development of outdoor activities, the preservation of nature, traditional, mountain centers, authenticity, etc. In this sort of ambient, with the development of adequate sports-recreational content, recreational tourism could develop, both for the local and foreign tourists. Golija is the youngest, most popular tourist center in Serbia and it is still being developed. At this point there is not much additional content and most of the infrastructure facilities are closed or open objects located around the hotel just outside of the location of Odvraćenica. They include basketball courts, volleyball, handball, football and tennis courts. In addition, there are parks with entertaining and recreational content for children and adults. In the vicinity of the Golijska reka hotel there are three courts (for basketball, football and handball). Near the Golija hotel there is a children’s amusement park, a small sports court (basketball, volleyball and handball).

6. The material base for the development of tourism on golija

The beginnings of the development of tourism in the mountain centers of Serbia are tied to the beginning of the 20th century. Even so, they are still characterized by a pronouncedly unfavorable material base. On this location there is basic tourist accommodation, but it cannot meet the needs of foreign tourists.

The accommodation capacity on the territory of the mountain of Golija is similar to that of the infrastructure objects. At its disposal, Golija has 300 first category beds (hotels, motels, rest areas) in the vicinity of the tourist centers of Odvraćenica, Studenica and1.000 beds in the private sector in the vicinity of the river Golija. The service industry in the function of the development of rural tourism is tasked with providing food for tourists with an offer suited to their needs (The strategy for the development of the mountain of Golija, 2009). This offer for the time being is quite unsatisfactory. These facilities are modest, both in terms of capacity and assortment, equipment and the amount of work force. Based on this we can conclude that the aforementioned capacities, that is, the overall accommodation capacity, as well as the tourist infrastructure is insufficient and inadequate for the area of Golija.

We can conclude that based on the equipment of the facilities in terms of infra- and superstructural objects, Golija is only in its initial phase of development. Its basic characteristics are the non-selectiveness and the inability to meet the demands of concrete demands. Thus, in any future plans for development and the affirmation of tourism on Golija, this category of tourist transactions should be given special attention.

7. Conclusion

Based on the indicated features and problems of the mountainous areas of Golija, this mountain possesses some of the most valuable natural, economic, cultural-historic and tourist values, and potential, of all the mountain centers of Serbia. Based on the resources and conditions for the development of tourism, forestry, agriculture, cattle herding, it belongs to the best hill-mountainous areas of country, irrespective of the fact that it is among the economically most underdeveloped ones.

In the further development of the tourism of Golija, we should focus on the complementary development of sports-recreational, country, mountain and eco tourism. “The complementary development include synchronicity in the construction of objects, enriching the offer, proliferation of the content made available during one’s stay, year-round business, permanent and well-thought out propaganda, avoidance of disloyal competition” (Stanković i sar. 2005). Several types of tourism which have the same conditions for development on this area can influence the “more complex tourist equipment and recognition of the fact that the area is suitable for promoting polyvalent year-long tourism”. At the same time, we must start from the initial understanding that the development of sports-recreational, rural and mountain tourism on Golija must begin with the “scientific verification of the facts that the aforementioned types of tourism should be developed only in such a manner and only to the extent that they bring the local community appropriate economic benefit and social effects” (Stanković i sar. 2005).

The favorable geographical location of Golija, its proximity and the good traffic connection with major city centers in its surroundings, as well as the proximity of the already established mountain centers, offer the possibility of combining various forms of tourism. The possibility of successfully developing tourism in the area of Golija is influenced by well-preserved natural beauties, such as forests, the abundance of plant and animal life, and a climate suitable for the development of various forms of tourism. These and many other benefits which Golija offers can form a special tourist product, which in correlation with the specific ambient of life in rural areas can meet the demands of tourism of special interest.

The further development and affirmation of tourism on Golija is represented by the infra- and superstructure, especially ski slopes, ski lifts, as well as the appropriate material base. Considering the fact that Golija does not possess an adequate offer when it comes to these capacities, their erection is necessary, both in terms of infrastructure, as well as superstructural objects and additional objects. In addition, it is necessary to modernize the existing accommodation capacities and to build new service industry facilities, which would offer their services to the tourists who would like to spend time on Golija. In this way, on this area it would be possible to develop several types of tourism and enable a better tourist connection with the larger city centers.

The wealth of natural resources, cultural heritage, the existing and future provision of accommodation and service facilities, along with the development of mountain tourism, are especially important not only for attracting a larger number of tourists, but also for the future plans for the development of tourism in this area. The complementary development of sports-recreational, rural and mountain tourism, has influenced both the structure and the average length of the stay, as well as the enrichment of the content of available during a tourist's stay, not only content which relies on natural factors, but also content for tourists who spend their vacations participating in sports activities, recreational activities, cultural manifestations, eco-tourism…

The planned and focused development of tourism on the territory of Golija would emerge as the factor of the improvement of the economic and social situation of the local population. The most important measure for the encouragement of economic and social recovery of the area of Golija would be the if the project for the development of Golija were to be assigned national priority status, from which other measures for the improvement of protection and revitalization of Golija would emerge.

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DEM-BASED APPROACH OF WATERSHED DELINEATION IN VOJVODINA

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Abstract: In this paper, an attempt is made to see if freely available DEM can be used for delineation of watershed boundaries in a flat terrain. The presence of manmade structures and vegetation canopy, especially along rivers is the most affecting factor, beside a horizontal resolution of data. Correct watershed boundaries are determined in cases where the riparian vegetation is previously visually detected and flattened and where there is no or a little presence of canals.

Key words: Digital Elevation Model, watershed, drainage network, resolution, GIS

1. Introduction

The manual delineation of a watershed, based on a topographic map interpretation of relief which is presented with contour lines is a difficult task for flat terrains like it is a case with the most part of Vojvodina, northern autonomous province of Serbia. Geographic information system (GIS) as a major tool for geospatial analysis is able to define a watershed from a digital elevation model. This technique is an efficient method in comparison to interpretation from aerial photographs or topographic maps. For accurate delineation, the quality of grid based DEM is vital and it depends on horizontal resolution and vertical accuracy.

Study area covers approximately 21,500 km^2. The biggest river is Danube followed by its tributaries Sava and Tisa.

2. Meterials and methods

In a lack of freely available highly accurate digital terrain models, we were forced to use digital elevation model for hydrological modelling. The drawback of DEM for the purpose of watershed delineation in flat areas is the presence of artificial structures and vegetation canopy. Currently best freely available topographic data is a result of NASA’s Shuttle Radar Topography

Mission (SRTM). This land mapping took place in 2000. The first publicly available remote sensing data was in 3 arc second resolution but in 2015 became available data at a horizontal resolution of 1 arc second (approximately 30m at the equator). This highest resolution data was used for watershed extraction.

Tools used for watershed extraction was TauDEM (Terrain Analysis Using Digital Elevation Models). Those open source algorithms, which work as a plug-in for QGIS, are capable to analyse hydrological information from DEM. Despite few other software packages were able to do watershed delineation, like ArcHydro, HEC-GeoHMS and PCRaster, TauDEM was chosen because it offers D-infinity method, which provide improved computation of flow directions and watershed delineation (Zhang, Chu 2015). D-infinity method defines flow direction as an angle in radians toward the steepest downward slope, unlike the D8 method, which determines the flow direction in eight discrete horizontal angles toward the one of adjacent cell. Tarboton (1997) who developed D-infinity method at Utah State University is also one of the authors of this software package.

One of the biggest difficulties linked to geography of the study area is a presence of a large number of irrigation canals, regulated rivers and canalized streams with total length of Danube-Tisa-Danube canal system of 929 km (Gavrilović, Dukić 2002). For that reason, some of the most visible canals are visually detected and flattened because levees and thick vegetation along them performed as a barrier (Figure 1). In original data, canals and surrounding area made the flow direction perpendicular to them (Figure 2).

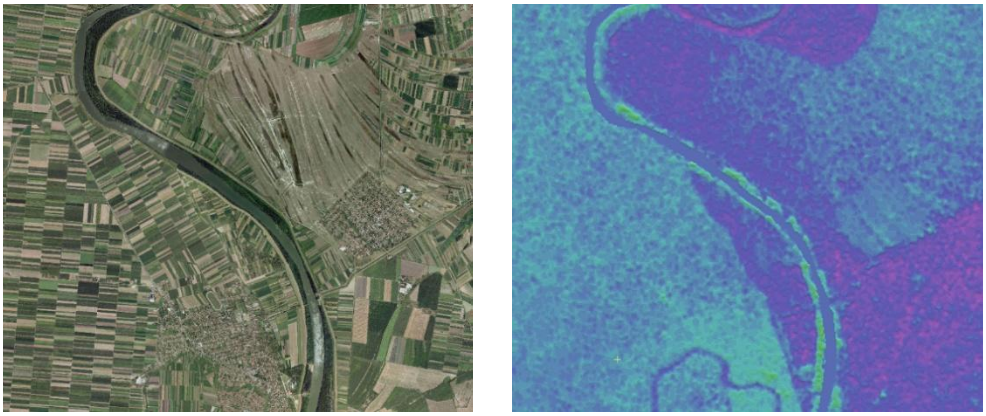

Figure 1 – Linearly distributed vegetation seen in the ortho mosaic (left) (Republic Geodetic Authority of Serbia) and in the SRTM DEM as a bright green area along the river (right)

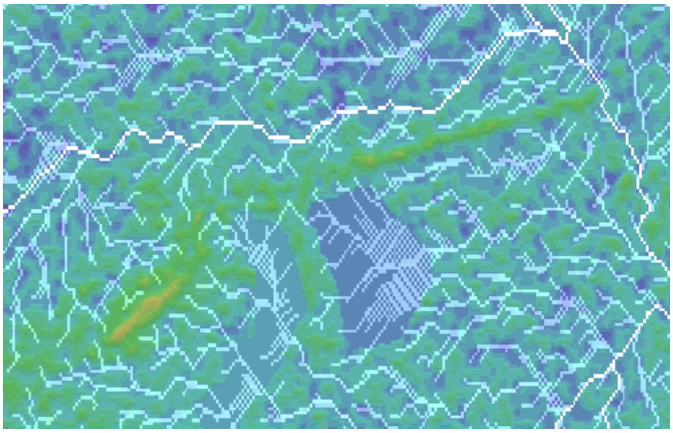

Figure 2 – Overlay of the SRTM DEM which shows a canal running southeast to northwest (light green and yellow area) and flow lines running from the canal (white and pale color)

Flattening of this kind of irregularities is done in software package Geomatica 2016 (Figure 3). Terrain along canals shown in Figure 4 are flatten and DEM was prepared for watershed extraction.

The first step of watershed extraction is making of hydrologically correct DEM. It is obtained by removing pits from the model using the flooding approach. In that way all sinks are eliminated thus creating conditions to compute flow directions. After positioning confluences of study rivers, upstream contributing areas are extracted.

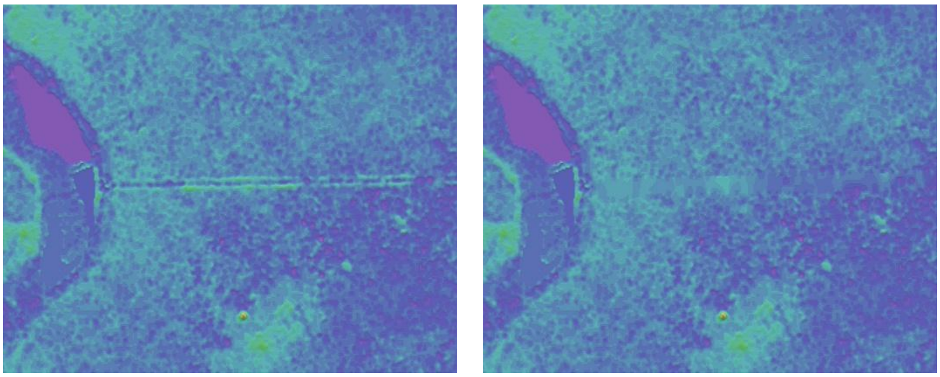

Figure 3 – Example of elevated terrain along the canal (left) and the same area after flattening (right)

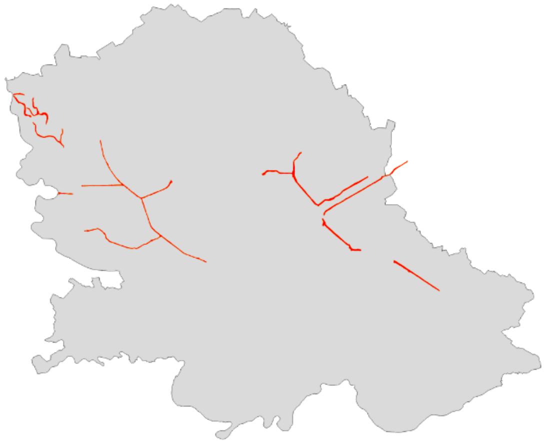

Figure 4 – Map of Vojvodina with canals where the flattening was performed

3. Results

In order to determine the reliability of this method (precision and accuracy) and applicability of freely available DEM, some of the Vojvodina rivers are selected: Jegrička, Karaš, Kereš, Krivaja, Nera, Zlatica, Čik, Brzava, Begej, Tamiš and Tisa. Their watershed areas are presented in Table 1. Watersheds of Jegrička, Kereš, Krivaja, Zlatica, Čik and Begej are subwatersheds of the Tisa river.

Table 1 – Watershed area of study rivers in Vojvodina

River	Jegrička	Karaš	Kereš	Krivaja	Nera	Zlatica	Čik	Brzava	Begej	Tamiš	Tisa
Watershed area in km^2	871	183	350	926	96	740	579	181	244	4,087	8,512

The Jegrička river basin (Figure 5) has an east-west extent of about 68 km. It accounts major parts of municipalities of Bačka Palanka, Bački Petrovac and Temerin, central part of Žabalj, southern part of Vrbas and northern part of Novi Sad municipality. The watershed boundary run from Savino Selo to the east, going between Bačko Dobro polje and Zmajevo, in north of Sirig, Temerin and Gospođinci, in south of Čurug and Taraš down to the mouth of the river. Southern border goes from the mouth of the river to southwest and then west, in south of Žabalj, Gospođinci and Bački Jarak, and in north of Novi Sad and Rumenka, including of Bački Petrovac, Maglić and Gajdobra.

The Karaš river basin (Figure 6) lies partly in northern part of Bela Crkva and far southeastern part of Vršac municipality. The only town within its boundaries is Jasenovo. It is located a few kilometers to the north of Bela Crkva and Vračev Gaj, and to the northeast of Grebenac.

The Kereš river basin (Figure 7) drains about 350 square kilometers in the utmost northern part of Vojvodina and Tisa river basin in Serbia. It occupies northern part of Subotica municipality and central part of Kanjiža municipality. Within its boundaries lakes Palić and Ludoš are located with areas of 5.4 km^2 and 3.3 km^2 respectively.

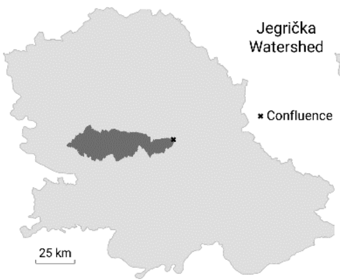

Figure 5 – Jegrička watershed

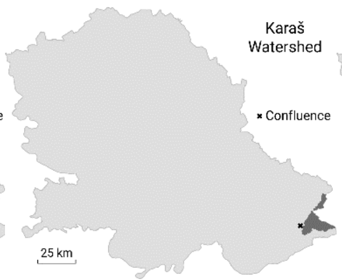

Figure 6 – Karaš watershed

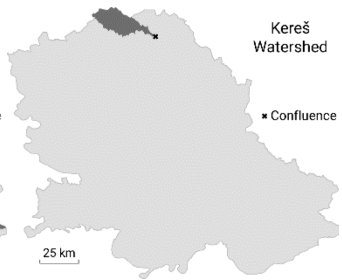

Figure 7 – Kereš watershed

The Krivaja river basin (Figure 8) is oriented to the south and southeast. It accounts western parts of Subotica and Bačka Topola municipalities, central part of Mali Iđoš municipality, a small part of Kula and northern part of Srbobran municipality. Besides Bačka Topola, Mali Iđoš and Srbobran within this river basin boundaries are few more towns: Bajmok, Đurđin, Pačir, Stara Moravica, Karađorđevo, Bajša, Lipar, Lovćenac and Feketić.

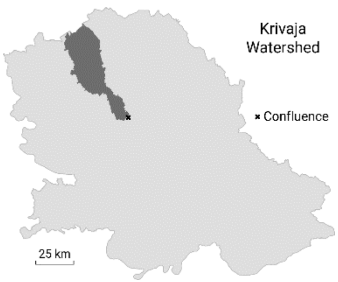

Figure 8 – Krivaja watershed

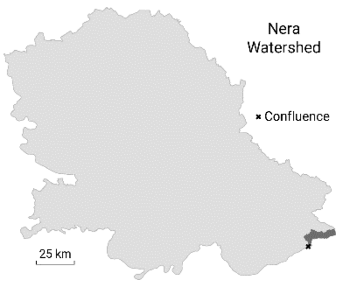

Figure 9 – Nera watershed

Figure 10 – Zlatica watershed

The Nera watershed (Figure 9) drains only southeastern part of Bela Crkva municipality. There are a couple of lakes in south of city of Bela Crkva, and the 6 biggest ones have a total area of 1km^2.

Zlatica watershed (Figure 10) occupies central part of the Northern Banat district. Towns within it are: Krstur, Novi Kneževac, Banatsko Aranđelovo, Jazovo, Mokrin, Sajan, Iđoš, Kikinda and Nakovo.

The Čik watershed (Figure 11) drains to southeast and it is almost parallel to Krivaja watershed. The boundary line starts south of Subotica and goes to southeast including Bikovo, Čantavir, down to Tisa River and Bačko Petrovo Selo. From Bečej boundary tends to northwest to Novo Orahovo, Novi and Stari Žednik, ending with Hungarian border. Bačka Topola stays outside its boundary.

The Brzava River is a tributary of the Tamiš River. The obtained watershed does not correspond to real one. Towns within obtained watershed (Figure 12) are: Samoš, Jarkovac, Sečanj and a part of Boka.

The Begej river basin (Figure 13) is situated in Middle Banat district in the area of Belo Blato, Stajićevo, Lukićevo, Ečka, Mužlja, northern part of Perlez and southern part of Zrenjanin.

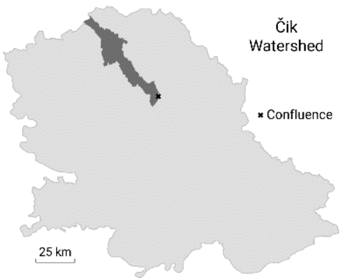

Figure 11 – Čik watershed

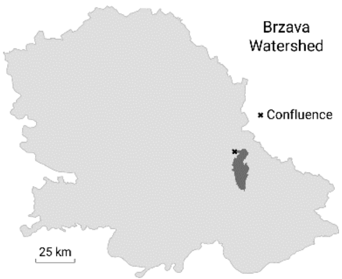

Figure 12 – Brzava watershed

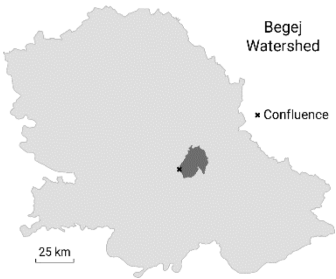

Figure 13 – Begej watershed

The Tamiš (Figure 14) river is a tributary of the Danube River. Its river basin occupies northern part of Southern Banat district, eastern part of Middle Banat district, small part of southeast of Northern Banat district and northern half of Vojvodinas' part of Belgrade district. The boundary line runs from Nakovo to Kikinda, then turns south to Torda. From Torda it tends to southwest towards Elemir leaving it outside the watershed. Boundary line runs across northern Zrenjanin and eastern part of Lukićevo, leaving Mužlja, Ečka, Stajićevo, Belo Blato and Perlez outside of the boundaries of watershed area. The confluence is in the southwestern part of the basin. In that part Baranda, Opovo, Sefkerin, Padinska Skela are situated. The boundary line crosses Debeljača and Kovačica tending to east and ending with Romanian border. Padina, Vladimirovci and the biggest part of Deliblato sands stays outside its boundary. Alibunar, Banatski Karlovac, Nikolinci, Izbište, Vršac and Veliko središte are located inside of the Tamiš drainage area.

The Tisa river basin (Figure 15) occupies Northern Bačka district, eastern half of Western Bačka district, northern half of Southern Bačka district, western part of Middle Banat district and most of the Northern Banat district, except its eastern part. The north watershed boundary line follows the Serbia state border between Bajmok and Nakovo. From Nakovo it goes to southwest to Kikinda and then to south to Torda, Zrenjanin and down to the mouth to the Tisa river, containing Bašaid, Melenci, Elemir, Aradac, Mužlja, Lukićevo, Ečka, Stajićevo, Belo Blato, Perlez and Knićanin. From the mouth of the Tisa River the boundary runs to the west, passing between Mošorin and Šajkaš, between Đurđevo and Kać, having on the north Žabalj, Temerin, Bački Jarak, Bački Petrovac, and on the south Novi Sad, Futog and Bačka Palanka. Reaching the Bački Petrovac, boundary line passes on to the northwest, between Gajdobra on the north and Nova Gajdobra to the south, having on the east Selenča, Odžaci, Srpski Miletić, Doroslovo, Stapar and Sombor. From Sombor line goes to northeast to Svetozar Miletić and Bajmok.

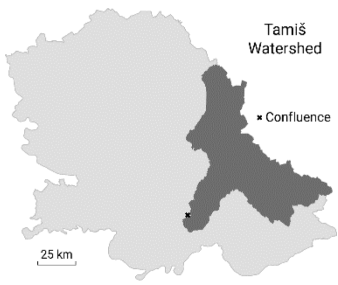

Figure 14 – Tamiš watershed

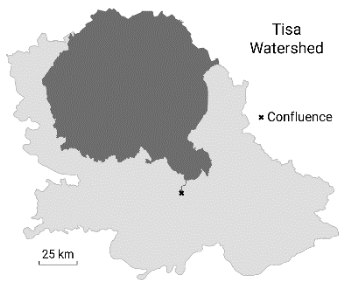

Figure 15 – Tisa watershed

4. Discussion and conclusions

Remote sensing and GIS provide variety of techniques for terrain and watershed modelling. Those DEM based models depend on spatial resolution, height precision, amount of noise contained within images, terrain nature and as it was shown here, the presence of manmade structures and vegetation canopy. Even in a highly accurate DEM, manmade structures and river embankments as well as vegetation near rivers could lead to errors in river networks, watershed boundaries and drainage directions.

After the raised areas along selected canals being flatten, flow lines was not perpendicular to canal anymore. In that way, flow lines started to follow the direction of canals or freely spreading over them from one side to another. Detecting of this sort of barriers around canals or rivers and their flattening was not so difficult but it is time consuming. Terrain flattening was only performed on selected canals. Determining of all areas of this kind exceeds the framework of this article.

According to results of this study, flattening of canals surrounding area was not sufficient for making a proper watershed delineation. There are a lot of river embankments and vegetation along them that simulate water barriers not allowing a water to flow into the river. The only way of using of SRTM DEM for watershed delineation is with previous thorough examination of those barriers and their elimination by flattening them. Built-up areas and treetops within watersheds have much less influence on river basin determination if they are located in the center and not by the edge.

DEM-based approach of watershed delineation performed well on previously edited parts of basins where canals were been flattened. This error correction method was not employed on rivers with riparian vegetation. This was the biggest source of errors in water basins with such rivers, for example with Tisa river tributaries. Water basins of Čik, Jegrička, Zlatica, Begej and Tamiš, drain at a single point joining Tisa river as its tributaries, but some of their parts are parallel to Tisa river flow line. Beside of this parts Čik and Jegrička watersheds are well delineated as well as watersheds of Nera, Karaš, Kereš and Krivaja. A big part of a Begej watershed was taken by Tamiš watershed. The terrain in this area is extremely plain so the DEM noise and present buildings and vegetation drive the Begej flow line network to southeast, to Tamiš. Tisa watershed is also lacking this part of Begej watershed. Brzava watershed was not been able to be well detected for the same reason as the Begej watershed.

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DEMOGRAPHIC AND FUNCTIONAL DETERMINANTS OF THE DEVELOPMENT OF BRENICA VILLAGE (THE CITY OF NIŠ)

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Abstract: The subject matter of this paper's research is the rural settlement of Brenica, which is located in the sphere of influence of the City of Niš. Based on the relevant quantitative indicators, main types of population movement and the reached degree of the population's demographic age were defined. Beside intense demographic changes, the settlement is also characterized by functional changes, so a series of analytic measures was used to determine the settlement's functional capacity and the settlement's functional self-sufficiency. The functional type of this settlement was defined through the analysis of these parameters. An intense functional transformation of the settlement was identified, along with the workforce transfer from agrarian to service-providing activities. Possibilities for the village revitalization were found in favourable natural conditions for fruit growing and winegrowing. The fact that a large number of households still own agricultural holdings implies that there is a possibility for the population to work in agriculture as an additional activity.

Key words: Brenica village, population, functional development, revitalization

1. Introduction

Contemporary trends of demographic and economic processes identified on the territory of the Republic of Serbia have also been noticed on the territory of the City of Niš. Due to intense industrialization and urbanization happening in the second half of the 20th century, a series of demographic, economic, sociological and other changes occurred in cities but also in rural settlements. At the same time, there was an economic and demographic development of the city, which distinguished itself as the pole of growth and development, whereas on the other hand, depopulation in the rural settlements occurred as a result of a constant population decline. For that reason, it is necessary to analyze demographic and functional development components for both cities and rural settlements.

The subject matter of the research is the village of Brenica (the City of Niš). The author chose to examine the reached degree of demographic development and functional capacity of the village itself by using a series of parameters. Beside such a defined goal, through the analysis of the spatial components and demographic processes in the village, the aim was to recognize the developmental potential of the village and possibilities of its exploitation, with the specific intention of identifying possible ways of the village revitalization.

The rural settlement of Brenica is characterized by a specific geospatial position. The village is located in the sphere of influence of the City of Niš, to which it administratively belongs. It is located at the northern edge of the Niš Basin, alongside both valleys of the Brenica River (the right creek of the Nišava River), 8m away from the downtown. The first official records on the village were obtained by the Turkish Census from 1454/1455, when the village had only 7 households (Enciklopedija Niša, 1995, p. 12). Nowadays the village has 522 inhabitants and is categorized as a smaller rural settlement.

2. Material and methods

Statistical and quantitative methods were used for the purposes of this paper. The first phase of this work included forming a wide range of statistical indicators. Various types of publications issued by the Statistical Office of the Republic of Serbia were used: census books, vital statistics books, special editions and others. This phase was defined as desk research and the base of necessary data was formed and then analyzed. Determining the reached stage of the settlement's demographic development was done through the analysis of the total population movement (natural and migratory) and through defining the demographic age stage. The method developed by Friganović M. (1978 and 2001, p 49) was used for defining the types of population movement. Each population can be classified into one out of 8 types according to the ratio between the component percentage of natural and migratory movements (more about the method in Friganović M. (1978) and Friganović M. (2001).

Table 1. Types of population movement (Source: Friganovic M., 2001.)

Types of population movement			
Immigration types		Emigration types	
I1	Immigration trend	E1	Emigration trend
I2	Regeneration due to immigration	E2	Depopulation trend
I3	Weak regeneration due to immigration	E3	Extreme depopulation trend
I4	Very weak regeneration due to immigration	E4	Extinction trend

For the determination of the achieved level of aging, we used technique that is widely spread in Serbian demographic and geographic scientific community, first shown in (RZS 1993, p 168). Based on the population percentage of 4 age groups (youth, young middle-aged, old middle-aged and old population), the aging index and the average population age, every population can be classified into one out of seven stages of demographic age: 1. Early demographic age, 2. Demographic youth, 3. Demographic maturity, 4. Threshold of demographic ageing, 5. Demographic old age, 6. Deep demographic old age, 7. The deepest demographic old age.

Functional typology of the settlement is based on the conception of the economic basis, i.e. this conception is based on the relationship of certain economic activities to the other activities in the village (Grčić M., 1999, p. 7). In this way, each settlement can be defined as: 1. Agrarian, 2. Agro-industrial, 3. Agrarian and service-providing, 4. Industrial, 5. Industrial-agrarian, 6. Industrial and service-providing, 7. Service-providing, 8. Service-providing and agrarian, 9. Service-providing and industrial (Tošić D., 1999, p. 262).

The level of functional capacity of the settlement could be expressed through the calculation of functional self-sufficiency of the settlement.

$$F1 = \frac{Z}{A} \qquad , \qquad F2 = \frac{T}{S}$$

According to that:

Z – Number of employees

A – Total number of the active population

T – Number of employed people in commerce, hospitality industry and tourism

S – Total number of population (Grčić M., 1999, p. 13)

Using comparative review of demographic and functional indicators, we tried to identify the basic factors of demographic dynamics and economic development of this rural settlement.

3. Characteristics of demographic development

Demographic dynamics of certain population is under the influence of a large number of factors. Natural and migratory population movement influence the population number directly, whereas the socio-economic, cultural, environmental conditions of life as well as the ethno-psychological population characteristics can be regarded as indirect factors.

The village of Brenica is located in the sphere of influence of the City of Niš, whose demographic development has also had a great impact on the demographic picture of this rural settlement. The settlement itself is defined as an area of noticeable depopulation because the population number has continuously been decreasing. During the observed 50-year period, the population number has decreased for more than 30%. The changes in household number show opposite trends, where an increase in household number was recorded until 2002, after which there was a decrease. The process of household nucleation is the result of accepting the contemporary sociological dogmas, which imply an independent lifestyle of young married couples. The average household size is reduced to almost a half, in comparison to 1961, and follows the trends of an average household size in the rural settlements on the territory of the City of Niš, which on average amounts to 3.17 (Radivojević, et al. 2014, p. 5).

Table 2. Changes of some demographic indicators in Brenica village (Source: * Population Census data)

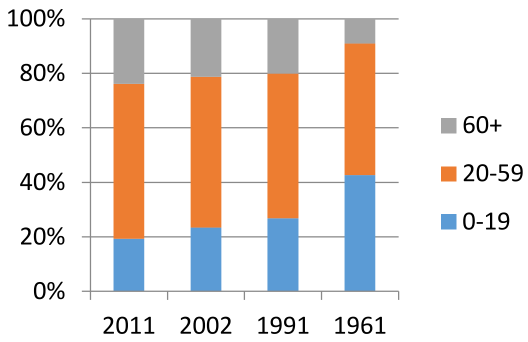
Year	No. of inhabitants	Change index	No. of households	Average size of households
1961.	773	100	131	5.9
1971.	634	82.2	131	4.84
1981.	596	77.1	139	4.29
1991.	600	77.6	142	4.22
2002.	555	71.8	171	3.25
2011.	522	67.53	144	3.62

The constant interconnection of influences between natural and migratory population movement determine the type of population. Five 10-year periods were observed. The birth rates were positive during the 1981-1991 period, after which there was a drastic decrease. During the 1961-1971 period, the natural growth of Brenica population increased approximately 5‰. The next 10-year period was characterized by slightly lower birth rates, around 4‰, while the highest rates of the natural growth were recorded during the 1981-1991 period, when the rates were around 7‰. After that period, due to negative changes in the age structure, a decrease in an average natural growth rate occurred ranging from - 4,5‰ during the 1991-2002 period, to below - 7 ‰ after 2002. During the entire observed period, the rates of migration balance were negative.

During the 1961-1971 period, the population of the village of Brenica is defined as an emigration population type E3 with the trend of extreme depopulation. This type of population movement has the characteristics of positive natural growth and a negative total population movement, causing the birth rates to be lower than the rates of the total change in the population number. During the next decade, the process of emigration continued, with the positive natural growth rates so that the population belongs to the same type.

The population number of Brenica slightly increased during the 1981-1991 period, while the natural growth rates were positive. Such a trend defined the area as emigratory and belonging to the type E1. The process of the population number decrease was again intensified during the period after 1991, which together with negative rates of natural population movement brought about the most unfavorable demographic situation in the village, declaring Brenica as a settlement of the type E4, which is characterized by the trend of extinction.

The process of population ageing was taking place at the same time as negative movement trends. Low birth rates as well as extended lifespan brought about an increase in the percentage of the elderly population contingent at the expense of the young. The percent of the people older than 60 was 9% out of the total population number in 1961, while in 2011 this contingent amounted to as much as 24%. Negative birth rates as well as emigration of the young population to the city brought about intense changes in the percentage of the young population. The people up to 20 years of age suffered the greatest changes. The percent of this age contingent was reduced from 42.7%, as it was in 1961, to only 19.3% in 2011.



Graph 1. Age structure of Brenica settlement in period 1961. – 2011. Source: Author's calculation based on Population Census data*

The analytic parameter most effectively used to track changes in a certain population's age structure is the ageing index, which shows the ratio between the elderly and young population. It is considered that the ageing process has started when the value of the ageing index exceeds 0.4 (Rančić M., 1980, p. 190). If the values of the ageing index exceed the limit of 1.00, it is considered that the ageing process is extremely difficult, almost impossible, to prevent (Živić D., Pokos N., 2005, p. 211).

The ageing index was 0.21 in 1961, which together with other representative parameters set the population of Brenica apart as demographically mature (the 3rd stage). The intense ageing process is reflected in the value of the ageing index which was 0.75 in 1991. Even over this period, the population was in the 5th stage of demographic age, and therefore declared as demographically old. The ageing process continued even during the last decade of the 20thcentury, and at the very beginning of the new millennium the ageing index value rose to 0.97. The population in this period was characterized by deep demographic old age (the 6th stage). The latest census from 2011. showed that the population entered the deepest demographic old age, which represents the 7th and the last stage of demographic ageing. The maximal value of the ageing index in this period was recorded to be 1.25.

The demographic dynamics of Brenica population undoubtedly shows an extremely regressive population type with a small percentage of the young and a high percentage of the elderly population. The decreased percentage of fertile women represents a special problem. According to the latest census, this population contingent makes up only 44% out of the total female population, and displays tendencies of further decline. Taking all into account, we can conclude that the projections of natality will record extremely negative values.

4. Functional determinants of development

Brenica village with its 522 inhabitants and with no significant production capacities is characterized by a limited and very low functional capacity. As in the majority of rural settlements, external functions are poorly developed.

According to the methodology of the Statistical Office of the Republic of Serbia, all inhabited places are divided into urban and others, and according to it, Brenica village is categorized as “other” settlement. Still, the urbanity and rurality degree can be calculated based on 3 criteria: the percent of agricultural population in total population, the percent of households with no agricultural holding, and the percent of the employed persons in the total active population.

Table 3. Settlement typology according to the degree of urbanization Source: (Tošić D., 1999, p. 245)

Urbanisation degree	Agricultural population in total population	Households without agricultural holding in total no. of households	Employed persons in the active population
Urban	≤ 10 %	≥ 70 %	≥ 70 %
More Urbanized	≤ 15	≥ 20%	≥ 70%
Less Urbanized	≤ 30	≥ 10 %	≥ 50%
On the threshold of urbanity	Satisfies two of the three conditions		
Rural	doesn't satisfy two or all three conditions		

With the total of 17% of agricultural population in the total population, 35% of households with no agricultural holding, and 67.6% of the employed individuals in the total active population, Brenica can be set apart as a settlement on the threshold of urbanity.

An intense functional transformation of the settlement was identified during the 1971-2002 period. In the first post-war period, the settlement had characteristics of a typically agrarian settlement with the dominant agricultural function. In the second half of the 20th century, the process of intense industrialization occurred on the territory of the City of Niš, which brought about the transfer of workforce from the primary to the secondary and the tertiary sector of economic activities. Brenica village is under the direct sphere of influence of the City of Niš, which, being the pole of concentration, attracts daily a great number of workforce who commute from the village. In 2002, the majority of the villagers were employed in the secondary and tertiary sectors which defined the village as an industrial and service-providing settlement.

Table 4. Functional typology of Brenica village according to the structure of active population based on sectors of economic activity. P – primary sector of economic activity; S – secondary sector; T – tertiary sector; Q – quaternary sector (Source: Author's calculation)

	Total of the employed population	P	%	S	%	T + Q	%	Functional type
1971	386	254	65,80	83	21,50	44	11,4	1. Agrarian
2002	190	31	16,32	87	45,79	68	35,79	6. Industrial - service-providing

Although the majority of the active population are employed in the production and service-providing sector, a great number of households with agricultural holding have been identified, which undoubtedly shows that the population is engaged in agriculture as an additional activity.

According to the degree of functional self-sufficiency, Grčić M. (1999) identifies the following types of settlements:

- self-sufficient ($F1 \geq 75$; $F2 \geq 6$)
- partly self-sufficient ($75 \geq F1 \geq 50$; $F2 \geq 4$)
- partly dependent settlements ($50 \geq F1 \geq 25$; $F2 \geq 2$)
- completely dependent settlements($F1 \leq 25$; $F2 \leq 2$)

The fact that the values for the examined settlement are: F1= 67,62; F2= 4,32 classifies it as partly self-sufficient. However, the lack of production capacities in the village point to certain elements of the settlement's dependence.

Beside the residential and work functions, public and service-providing functions as well as infrastructure objects are of a great importance for demographic, economic and social development for every settlement. As Tošić D. and Nevenić M. (2005, p. 173) state, the organization and distribution of the entities of the public and social infrastructure is dependent on the Law on Public Service. The main principle which has to be applied is that the primary education service, health protection service and veterinary services have to be available to all citizens under approximately equal conditions.

The road infrastructure of the village is poorly developed. The connection with the city is poor, especially during the winter months when the local buses run only to Kamenica village, forcing Brenica villagers to walk 2 km to the nearest bus stop. The number of the bus departures is reduced to 11 on working days, while the number of departures on Sunday is only 3. Within the framework of the planned infrastructure project for road construction of the northern Niš rural circle, at the end of 2015, the villages of Brenica and Hum were connected via a new asphalt road. This only partially solved the problem of the village's connection with the City, since there is still no a bus route running on this road. Through the realization of the entire project of the construction of the northern Niš rural circle road, 6 rural settlements will be connected, from Hum through Brenica to Malča, which would greatly contribute to the traffic availability of this area.

Energetic infrastructure, water supply, sewerage and sanitation system are underdeveloped. Water is supplied via the local autonomous system for water supply. A special problem for the villagers is the non-existence of wastewater treatment system. Although there is a plan to connect the settlement to one of the city's wastewater collection system, the high price of the construction of such an infrastructure system does not allow for its realization. There is no an organized system for collection and separation of waste in the village, which leads to negative environmental implications. A few smaller dumps have been identified on the village's territory, mainly located in the riverbed of the Brenica River, by the road and in deserted furrowed fields.

Primary education (the first four years) takes place in the separate class of the Primary School "Stevan Sinđelić" from Kamenica. After the completion of the fourth year, the pupils continue their education in the central primary school in Kamenica. The school had only 16 pupils encompassing all four years in 2002 (Stamenković S., p. 60). The number of pupils did not significantly change even over the last decade when it was around 20, counting the preschoolers too.

Health system is not developed, there is no ambulance station, while a medical team comes a few times a year, just to check the health of the senior villagers. The village has neither a pharmacy nor a veterinary clinic. The nearest health center is located in Kamenica village and is open 3 days a week. By organizing mobile medical teams who would come to the village regularly, once or twice a week, the villagers' daily lives would be made easier to a great extent.

There is one shop and one sports bar in the village. The lack of administration and management functions is a special problem, because the post office, the local office, and the police station have not been working in the village for a long time now.

By analyzing the existing functions in the rural settlements, Simonović Đ. and Ribar M. (1993.), identified 6 types of rural settlements: 1) primary rural settlements, 2) villages with village center, 3) community centers of rural settlements, 4) tourist or spa settlements, 5) rural settlements – municipality center, 6) suburban rural settlements. When applying this typology, Brenica village can be classified as a primary rural settlement due to the lack of functions, where only work and residential functions are developed to a significant extent.

5. Conclusion

The rural settlement of Brenica underwent significant changes in the 20th century. Depopulation was recorded during the entire observed period, which together with the age structure characteristics points to an extremely regressive population. The village population belongs to the type E4, which is characterized by a complete depopulation i.e. extinction. The percentage of the young population is constantly being reduced, which results in great socio-economic problems in the village. The percent of fertile women is also decreasing, which points to the birth rates continuing to be low over the next period.

The intense process of demographic changes in the village was followed by a functional transformation. The village completed a development journey from a typically agrarian to an industrial and service-providing settlement. As there are no important industrial complexes, we come to the conclusion that the majority of the economically active population is comprised of daily commuters who work in the City of Niš. The functional capacities of the settlement are small, and the village is characterized by the functions of residence and work, while other functions are present to a lesser extent. Poor sanitation, water supply and public and social infrastructure represent other problems.

The development potentials of the village are numerous, but a dominant factor to be emphasized is the auspiciousness of the village's micro position. A slight slanted terrain with a very favourable exposition gives great possibilities for the development of winegrowing and fruit growing. The village territory belongs to a once-famous winegrowing region of Matejevac. The agricultural census from 2012 shows that the number of households with agricultural holdings is growing, which points to the fact that the population works in agriculture as an additional activity. It is precisely in this that we should look for possibilities for the village revitalization. Subsidies and improvement of road infrastructure could prevent a complete emigration to the city and in such a way create a stable contingent of daily commuters. It is exactly this population group interacting with the city on a daily basis that has a possibility of revitalizing agricultural activities as additional ones and making extra profit by doing so. By encouraging alliances between agricultural producers and forming rural cooperatives a simpler placement of agricultural products would be enabled. Along with regulation of spatial and environmental problems, these measures should be a basis for further potential revitalization of the settlement itself, which would create a small suburban settlement of mixed economy and functions, whose inhabitants would interact with the city on a daily basis.

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ECONOMIC ASPECTS OF DEMOGRAPHIC TRENDS IN THE MUNICIPALITY OF TRGOVIŠTE

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Abstract: The paper is a result of the necessity to provide a review of the demographic changes of the border region in the South of the Republic of Serbia; more precisely, the changes in the municipality of Trgoviste whose social development during the 20th and at the beginning of the 21st century evolved in difficult social economic and historical conditions. Long-term demographic changes characterizing the mountain region of Pcinja led to a very unfavourable social development partially conditioned by a drastic reduction of the population at the end of the 20th and the beginning of the 21st century, emptying some rural areas as well as reducing the fertility potential of the entire region. The authors have analyzed the demographic problems in Trgoviste based on the statistical indicators of the Republic Institute for Statistics and empirical material from the field thus providing a special reference to the social development of Pcinja and a realistic assessment that the sustainability of life and work in the investigated area can only be ensured by investing in human resources and the exploitation of natural resources within the limits of sustainability. The authors' general opinion is that the importance of taking certain measures and the urgency of solving demographic problems in this border region by the relevant institutions and the country as a whole has to be kept in perspective so that this border region in the South of Serbia can become more demographically and socially vital.

Key words: demographic structure, households, statistics, social development, Trgoviste.

1. Introduction

While natural resources are objectively provided, the optimum usage of labour and expert potential (i.e. population) represents a subjective assumption of progress. The total resource of the population capable of working, qualified and professionally skilled is in essence the basic indicator of the economic development of every society. The theoretical and practical experiences of highly developed countries clearly point to a conclusion that modernizing today's production comes from knowledge as an important strategic development resource. On the other hand, every environment is characterized by demographic specifics with either a positive or a negative effect. To be precise, on the territory of Serbia, beside the already known structures of the population, further important ones are ethnic composition, religion, health aspect, international relations, etc.

The importance of the population in the complex process of a country's economic development is multiple, complex and multidimensional. Any population with a range of its own specific characteristics (structures) is a product of the environment features which it is developing in; it is not a phenomenon which is developing outside social, economic, cultural, traditional and other influences of a given environment. The population and its structures are very significant for the volume, structure and the pace of the process of manufacturing, i.e. economic development. It is both the manufacturer and the consumer as it defines the scope and the structure of society's needs with its demographic, economic, social and other characteristics.

2. The globalization of demographic changes within the development strategy

Estimations indicate that 5 million people lived on Earth six thousand years B.C. A million years had to pass for the number to rise from two and a half million to 5 million. Almost eight thousand years later, around 1650 A.D., the population numbered 500 million. Two centuries had to pass for the number to double. Then (by 1930) the population doubled in 80 years. And today, only 37 years are needed for the population to double. Developing countries have made up almost 20% of the population growth percentage during the last few decades. (Golubović, 2004., p.56)

The population factor is always taken into account in every phase of formulating the strategy of economic development. The important ones are, above all, amplitude and dynamics of population, age and gender structure, regional distribution, migrations, ethnic composition, complete historical background, analysis of the populations' capability for labour, real employment, while types of information which are related to the health status of the population, degree of urbanization, etc. are also important.(Stefanović, 1998.,p.45)

A particularly intensive relationship between social economic and demographic development has been established with the appearance of the industrial revolution. From then on, the overall production has increased and the population has changed radically. These radical changes emerge as a process of demographic transition in which mortality and birth rates decline leading to a new model of biological renewal of the human race. In addition, in this process of demographic transition, other population structures appear, such as biological, economic and social. These are important characteristics of the development of population and because of that the process of demographic transition is a reliable indicator of this development. Following the course of demographic transition, more precisely, its consequences on the size, the structure and the way of biological renewal of populations, actually implies following the development of population itself.

Modern industry is an extraordinary and unrepeatable event in our history and so is the population growth caused by this event. In the period after the industrial revolution, demographic changes came to terms. They became more landscape-oriented, clearer and easier to notice and follow. No other epoch in the economic history is similar to it. The improvement of human life and inventions in the area of medical sciences reduced mortality and extended human life so that population increased faster than it did before. At the same time, birth rates dropped, although a bit slower, and thus the way of reproduction of the population adjusted to the process of creating an industrialized society. Simultaneously, new demographic structures appeared, among which economic and social ones were compatible with those in economy.

The last quarter of the 18th century was the beginning of the demographic transition and it first happened in the western European countries, then the USA and Japan. How long this population transition of the entire Earth will last is hard to say. That process depends on the advancement of industrialization in undeveloped areas. Herman Kahn, with the researchers from Hudson Institute, USA, says that the demographic transition of the world will last around 400 years and that it will end around the year 2175. (Kahn, 1982. ,p. 28). According to them, it is a period of great transformation in which the world population will drastically increase, change the ways of its reproduction and form new structures.

It can be said with certainty that the demographic transformation of the world will be a long-term process with many uncertainties. Two centuries have already passed since the beginning of this process in the countries of the West and it cannot be said that it has been completed. Mortality rates have dropped in these countries and yet the reduction has been very slow so it is very likely that this process has been stabilized unlike the changes under the influence of the aging population. This is not the case with birth rates which are still dropping although having been part of the process for around 150 years. This tendency of birth rates is very typical and now it actually represents the basic characteristic of demographic transition. Dropping constantly, birth rates have already gone below mortality rates in some industrialized countries. This is a very steady movement and it is prominent enough to be taken as a reliable foundation for a new understanding of demographic transition. It is no longer reasonable to describe it as a process which has stabilized the biological reproduction of the population at low rates of birth and death. The nature and the real meaning of demographic transition should be investigated in a much wider context, which is related to the essential questions of survival and development of the industrial civilization. (Bošnjović, 1990, p.45)

3. The interdependence of demographic changes and economic development

There are more and more economists investigating the problems of population and are trying to explain the influence of the population on long-term economic movements, all within the boundaries of the theory of economic development. In these studies, the emphasis is on determining the connection between the quantitative and qualitative population development and the tempo of the economic development growth. This is of particular interest for undeveloped countries and developing countries characterized by a high population growth, insufficient economic accumulation and, most of all, an unequal regional development because of which their production can barely increase in proportion with the population growth which is why the national income growth and the population growth rates are identical. Therefore, the problem in these countries includes the matter of complete employment because in circumstances marked by a low labour force development, i.e. insufficient economic development, a great percentage of the working population is unemployed. On the other hand, a limiting factor of economic and thus regional development as well as unemployment is the rather unfavourable qualification structure determined by a low level of education of the entire population, the lack of work habits and skills, a relatively low degree of technical skills and experience, especially when labour potential in villages is concerned.

Furthermore, the population is both a producer and as a consumer, which is not the case with other factors determining the scope and structure of national income. That is why population has a dual significance for the economy of a country. Population in the role of the producer (work potential) participates in the creation of a newly formed value, the national income. Namely, one part of the total population – the working population – along with the object of work and the tools used for it represents the basic element of material production and overall economic activities. In addition, the economic development, regional development and all social activities depend on the size of the working population which a country has at its disposal. Conversely, the involvement of the working population, i.e. working potential in the increase of income may not be equal during all the epochs of economic development. On a lower level of economic development, the working potential is the decisive factor that contributes to the increase of the national income. Later, on a higher level of development, the increase of income depends on other factors more whereas it depends less on the working potential, i.e. the professionals.

As a consumer, the population does not only participate in the final distribution of the national income (personal spending) but also stimulates the production with its demand, making certain requests concerning scope and quality, that is, it determines the limits of the internal market.

Another characteristic of population, which is connected to the character and level of economic development, is the natural population migration. Research from the last few decades has shown that with the rise of the level of economic development, the rate of population growth has dropped, which means that regions of a country with a higher level of economic development have a lower rate of population growth. A lower level of economic development is accompanied by a higher rate of population growth and a resulting agrarian overpopulation. A separate problem resulting from the population growth, i.e. its rate, is the relationship of this rate expressed as the difference between the birth and death rates towards each of these two mentioned rates. Namely, countries with a high income per capita also have a high birth and death rate, which in turn conditions an unfavourable age structure, which negatively reflects on the economic development. However, this does not mean that in these countries a higher rate of population growth puts a lock on economic development, especially if it is considered as part of the long-term economic development. Quite on the contrary, in countries with a higher level of economic development, it is not just the birth rate that is low, but also the death rate also contributing to a favourable age structure, i.e. extending the work life of the working population. (Gligorijević, 2002, p.18).

The correlation between population and economic development is seen in the fact that population growth and its age structure basically determine the total work potential, whilst the tempo and course of development affect the scope of utilization of the work age population causing appropriate economic and social changes in the population structure. The age structure of the population is closely related to the process of population reproduction and is especially important for the forming of the labour force as well as for the relationship between the active and the dependent population.

Changes in the economic social structure of the population in recent years have born the mark of economic processes that have been in development at that time. Some of the most important changes in the economic structure of the population have been the absolute and relative decrease of agricultural population and the transfer of agricultural to the non-agricultural population. The speed of this process represents an important indicator of the level and tempo of economic development of a certain region. If the tempo of economic development is more intense, so will the increase in participation of the agricultural in the total population be faster, i.e. the migration of population from the village to the city, i.e. from the primary to the secondary and tertiary sector, will be faster.

Namely, the great migration of the population from the village to the city and the inability of economy to absorb the given corpus of the working population have caused an extremely increased rate of population migrations.The demographic emigrations out of rural, mountainous and border regions on one hand, and the excessive concentration of people in large city centres on the other hand, have a multiple negative effect on the overall economic development.

The historical aspect of the process of population development shows several stages of development characterized by certain relationships between the components of natural population changes (birth and death rate), the specific development trends of these components and the adequate changes in various society structures. One of the dominant modern theories which show population development as a development process with conditioned stages and developing closely related to the stages of social economic development is the theory of demographic transition. This theory is based on two important premises:

a) That it is a historical process under the direct influence of the factor of social economic development,

b) That the demographic transition includes changes in the birth rate, death rate and natural growth as well as changes in demographic and economic social structures of society.

Beside economic changes, as the basic and leading factor of transformations, demographic transitions can enter the maturity zone much earlier than there might be the real conditions for it. It is a sort of phenomenon that is characteristic for the model of rapid social economic development. Demographic and social processes, though depending on economic transformations, still gain great intensity and a sort of personal turbulence which drives them constantly forward. A discrepancy appears between the progress of material production forces on one side and social and demographic transitions on the other. The model of rapid social economic transformations always leads to this type of situation, i.e. from an intensive to an anticipated demographic transition. Great caution is necessary in order to avoid the imbalance between developed social and demographic structures and less developed natural basics of not just a country, but its regions as well. (Bošnjović, 1990., p.93).

It is not difficult to prove the anticipative course of demographic transition, or in other words, its faster movement in comparison to the economic development, if by that we start from the growth of population, as a reliable indicator. It represents a general expression of important demographic changes and it is under the direct influence of social and economic factors.The relationship between the death and the birth rate as related to the level of economic development also confirms that demographic transitions have an anticipatory character.

The transformation of the distinctive population structures also confirms that the demographic transition has an anticipative course. In this respect, three structures are significant: the agricultural and the non-agricultural population, the rural and the urban population and the educated population. During demographic transitions, these structures change significantly. They are also directly related to economic development and are conditioned by it, but they have a reversed influence as well. As a rule, the growth of the agricultural, the urban and the educated population depends on the growth of work productivity. In turn, these categories affect the further progress of work productivity.

The anticipative demographic transition is not an occurrence that should just be acknowledged and then left alone to proceed following its own course. It is neither neutral nor innocent and it is more than just an amazing event. When it occurs, it brings along certain risks. This is understandable because the anticipative demographic transition is a product of an abnormal relation from which unavoidable adverse consequences arise. Another serious consequence is when the relationship between the economic development and the process of population transformation is disturbed.

4. Demographic changes in Trgoviste

4.1 About Trgoviste

The municipality of Trgoviste, an area of 370 km^2, is located in the Southeast of the Republic of Serbia, among the municipalities of Bosilegrad, Vranje and Bujanovac and rather close to the border with Macedonia. The region is a typical rural and mountainous terrain surrounded by mountains and highlands. These are: Bela Voda, Dukat, Cupino brdo, Kozjak, etc. The ratio between the lowest and highest altitude is 520 m – 1,828 m (the difference is 1,308 m). The terrain, ground structure, and the mixed Aegean-Vardar and continental mountain climate have influenced the various flora and fauna. The centre of the municipality, the small town of Trgoviste, is located on the confluence of the rivers Tripusnica, Kozjedolska and Lesnicka, producing the river Pcinja that flows into the river Vardar. Its coordinates are 43º 33' N and 22º 17' S. According to the last 2011-census, the population is 5,226. In the close vicinity of Trgoviste, there are some monumental shapes of rock mass, probably unique on the territory of Serbia and even in the

Balkans and Europe as they resemble Djavolja Varo by their shape. This place is known as „Vrazji kamen“and on its peak, the Church of Virgin Mary is located, which dates back to the 14th century. Of special significance is also the vicinity of the Prohor Pcinjski monastery with its religious and memorial significance. The municipality of Trgoviste is connected to the Corridor X by the regional road R-125 which goes down the valley of the river Pcinja towards Bosilegrad. Near Trgoviste, the regional road R-238 branches and goes towards Kriva Palanka (FYROM) where no border crossing point has been opened yet.

The municipality of Trgoviste is located in the Southeast of the Republic of Serbia in the Pcinja District. It borders the municipalities of Bosilegrad, Vranje and Bujanovac and with the country of Macedonia in the length of 47 km.

The road network of the municipality of Trgoviste includes 455 km of roads out of which only 51 km is paved, thus being modern. There are no highways, regional roads include only 87 km of the entire length out of which only a bit more than a half are paved and the local roads include 368 km with only 4 km of modern roads. It is easy to conclude that the qualitative dimension of the road infrastructure is far below the level of the one in Serbia and below the level of the district.

Otherwise, out of the entire road network of Serbia, Trgoviste constitutes only one percent and the roads of the district a bit more than 16%. In the structure of roads of the municipality itself, even 81% belongs to local roads (most of all the districts in eastern and south-eastern Serbia), and then 19% to the regional roads, whilst there are no highways. Of all the roads only 11% are modern. Also, in the road network of the district, paved roads of the municipality of Trgoviste constitute 5.5%, regional 15%, and the local 18%.

The administrative, cultural and economic centre of the municipality is the small town of Trgoviste. It is located on the confluence of the rivers Tripusnica, Kozjedolska and Lesnicka, producing the river Pcinja, which flows into the river Vardar.

The municipality Trgoviste belongs to the group of the 40 least developed municipalities in the Republic of Serbia. It is away from the main railway and road traffic and it is characterized by a high rate of depopulation. The municipality is connected to Corridor 10 via regional roads which lead through the municipalities of Bosilegrad and Kriva Palanka (the border crossing has still not been opened).

4.2. A review of indicators pointing at the development of demographic changes

Demographic changes in Trgoviste have occurred simultaneously with the demographic changes in the surrounding area, now labelled as the Pcinja District, but also with many other populated regions in Serbia, especially the ones close to borders with other countries. (Veselinović, 2010.,p.293). Thus in 1948, Serbia had 6,527,573 inhabitants, the Pcinja district 209,232 of which 15,368 people were living in Trgoviste. A total of 3.2% of the entire Serbian population was living in the Pcinja District of which a total of 7.3% in Trgoviste. According to the 2011-census, 7,120,660 people were living in Serbia, which is 593,087 people, or 9.1% more than in 1948. However, in comparison to other census years, except in 1953, the number of inhabitants decreased. In the Pcinja District, there are 157,717 people, i.e. 2.23%, that is fewer, and in Trgoviste there are 5,145 people or 3.2%, which is more than half as many as in 1948. An obvious conclusion to be derived from this is that negative demographic changes (migrations, low or negative birth rates, higher death rated, demographic emigration, fewer marriages, more divorces, etc.) have been prominent in this area.(Petrović, 2012, p.261). In the district, there are 65 people per square kilometre whereas in Trgoviste there are only 15. It can easily be concluded what the consequences to the economic development, the security, the border cooperation as well as other issues are. Already the census in 1961 indicated that the population rate was dropping and this trend has been persistent until today. Therefore, the number of people living in Trgoviste, in the period from 1948 to 2011, has dropped to 10,223 people, or 66%, at an annual rate of 1.73, which means that 173 people vanished per year. On the other hand, the Pcinja District has been marked by some positive changes due to the fact that it is close to Vranje, Bujanovac and Presevo. When observing the movements of people in a mass of 1000 inhabitants in the period from 1948 to 2002, an increase of 3.2% can be noticed in the Pcinja district and a decrease of 5.9% in Trgoviste. In other words, the demographic changes are ominous.

As far as the components and the typology of population growth are concerned, the entire post-war period is characterized by a low or negative population growth and a prominent migration movement. (Djordjević, 2011, p.417). In the period from 1963 to 2002, in the Pcinja District, different directions of demographic movements were realized. An increase of population growth by 30 thousand people, but a negative migration total of about 90 thousand people can be noticed. The birth rate is a dominant component of population growth in the municipalities of Bujanovac, Vranje and Presevo while in Vladicin Han, Surdulica, Bosilegrad and Trgoviste it is the migration total. Only in the period from 1991 to 2002, the population rate in Trgoviste decreased by 748 inhabitants, a total of 89 based on the death rate and 659 based on migrations. Similarly, in the period from 1963 to 2002, the population rate in Trgoviste decreased by 7,636 inhabitants despite the birth rate totalling 2,479 people because migrations resulted in 10,115 people leaving the town.

Similar to these changes, the population density in Trgoviste in 1948 was 42 and in 2002 it was only 17 people per square kilometre. In 1965, this number was 59; therefore, more positive. (Krstić, 2007, p.234).

In border regions that are not developed, as is the case with Trgoviste, an important indicator of demographic changes is the agricultural population density. On a territory of one hundred hectares of agricultural territory in 1971, there were 35.7 people (65.5 in the District), in 1991 there were only 9.1 (27.4 in the District) and in 2002 there were only a modest and dangerously few of 6 people and 12.8 in the District. If only fertile soil is taken as an important condition for the agricultural development of the area, these figures are as follows: 108.4 in Trgoviste, 134 in the District, in 1991, 48.7 and 82.9 respectively, and in 2002, an extremely negative trend can be noticed in Trgoviste.

The number of children born alive is a vital demographic parameter of every nation, city and inhabited area. Thus in 1963, in the Pcinja District, 5,380 children were born of which only 448 in Trgoviste, marking a modest 8.3 %. In 2001, in Trgoviste, only 56 children, or 1.6 % were born as opposed to 3,588 in the District. During the entire period, the negative demographic trend in Trgoviste was being increased, i.e. it was much more intense than in other inhabited areas not only in the Pcinja District, but also beyond. Today the situation is even worse. However, an interesting fact to mention is that the death rate in Trgoviste in 1963 was 32.0 whereas in the District it was 24.0. In 2001, this relationship was drastically changed with 7.9 in Trgoviste and 13.8 in the District.

When observing the aspect of fertility, thanks to Bujanovac and Presevo, the Pcinja District does not have such a negative tendency as it is the case in Trgoviste. Thus in 1971, a fertility rate of 2.83 in the District and in

2002 a rate of 2.34 could be marked. This same indicator during the same period in Trgoviste is 2.62 and 1.57 respectively. On the other hand, the reproduction rate of the inhabitants in the same period was 130.4 % and 111.4 %, while in Trgoviste it was only 120.7 % and 74.8 %.

As expected, the negative image of demographic changes is further enhanced due to the death rate. In 1963, in the Republic of Serbia, it was 9.0, in the district 9.2 and in Trgoviste 10.1. In 2001, in Serbia, this rate was 13.1, in the District 9.6 and in Trgoviste even 11.6. The most frequent cause of death were cardio-vascular and various oncology diseases. The death rate of new-borns was also higher in these regions so that there is a double negative trend – fewer children were born, while more of those that were born died.

The presented indicator of demographic changes, the birth rate, also indicates a deep concern for the demographic future of this area. Without people any story about a future development is pointless. Thus in 1963, the birth rate was 10.2 per mill in Serbia, 14.8 in the Pcinja District and 21.9 in Trgoviste. In 2001, this indicator was -3.3 per mill in Serbia, a growth of 4.2 in the District (due to Bujanovac, Presevo and Vranje) and -3.5 in Trgoviste. An interesting fact to point out is that during this period, all other districts in Southeast Serbia marked a negative birth rate (the Districts Nis, Toplica, Jablanica and Pirot).

The nationality structure in 1961 in Trgoviste was 99.6 % of Serbs (69.5 % in the District) and in 2002, it was 98.5 % of Serbs (64.6 % in the District). The other two large nationalities participating in the national structure are Bulgarians and Albanians.

The activity rate of the population in 1961 was 45.1 % and in 2002 it was 53.9 %, which follows the decreasing population rate. Furthermore, the activity rate of males was 56.9 % and in 2002 it was 58.7 % whereas the activity rate of females was 34 % and 48.6 % respectively. As far as the sector of different businesses is concerned, during this period, more than 90 % of the inhabitants were involved in the primary industrial sector (much more than in the district) while in 2002, the involvement was more than a third (much less than in the District). During this year, the secondary sector is more prominent.

A very important aspect of this area is the deagrarization, i.e. agrarian population transforming into non-agrarian. In 1961, the agricultural population in the Republic of Serbia amounted to 56.1 %, in the Pcinja District 67.1 % and in Trgoviste 85.1 %. Many years later, in 2002, the agricultural population amounted to 10.4 % in the Republic, 9.9 % in the District and 19.8 % in Trgoviste. Furthermore, it should be pointed out that the dynamics of the process of deagrarization differed in the various periods from census to census as well as in the areas of the Pcinja District and the populated parts of Trgoviste. Similarly, it should be noted that this process had a decisive influence on the developmental trends in the entire region.

Without any further analysis, it should be pointed out that the percentage of illiterate people in Trgoviste decreased from 44.1 % in 1961 to 11.8 % in 2002. However, today, just as earlier, the largest number of illiterate people can be found in the age group ranging from 35 to 64 years. On the other hand, the participation of inhabitants with a higher education degree was increased from 0.5 % in 1981 to 1.3 % in 2002. In the Republic of Serbia and the Pcinja District, this percentage is considerably higher. Yet it should not be forgotten, that mainly younger and more educated people left Trgoviste.

A very interesting rate can be noticed in the employment dynamics in this area. In 1963, the number of employed people was 306 in Trgoviste and in 2001 it was 1784. But when this indicator of economic development is observed in a mass of 1000 people, the number of employed was 22 whereas in 2002 it was increased to 251. At the same time, this number was 165 in the Republic and 83 in the District, while 246 and 202 in 2002 respectively. This is much more than in the previous case. This is one of the rare examples of a positive demographic development. However, it is a result of a negative trend in the total number of inhabitants, migrations, changes in the demographic structure, etc. As far as the sector of employment is concerned, the employment rate was higher in the primary sector in this period than in the secondary sector. Nevertheless, it has to be pointed out that the number in the tertiary sector is respectable. An interesting fact is that the number of employed people in the industrial and the private sector was growing. The number of employed women increased from a modest 6.3 % in 1961 to 48.5 % in 2001. However, unemployment can be noticed as well but it is much more prominent in Trgoviste. In 2002, 91 in 1000 people were unemployed, which is lower than in the Republic. Still, the category of first-employment seekers is dominant whereby the number of people with higher education degrees and qualifications is increased in the unemployment structure.

4.3. The current demographic situation in Trgoviste (Field research conducted in 2015)

During the last ten years, 280 babies were born in Trgoviste, 397 people died, 212 marriages were contracted, and 22 were divorced. Only in 2012, 23 babies were born, but 29 people died. These data also indicate that the negative demographic movement in this area continues.

Data collected in 2012 indicate that the population structure includes 350 people up to 15 years old and 320 from 15 to 28 years old. This clearly indicates a negative trend in the population structure as far as age is concerned. The number of single people up to 20 years in 480, and from 20 to 39 years it is 450, while the number of singles above 40 is 100. These data once again confirm the relatively gloomy prognosis of the demographic future in this area. On the other hand, the number of those widowed by the age of 39 is 120 and of those widowed after the age of 40 is 1000. The average age in the villages is 60; the number of adults is 1150 whereas there are 46 children at pre-school age.

As far as the education structure is concerned, it should be noted that 300 people have finished only 4 years of elementary school, 250 a complete elementary school education, 280 two or three years of secondary education, 140 a complete secondary education, 45 a higher education and 35 a university education. This is one of the rare indicators that the negative demographic trends can be stopped if migrations are prevented. As far as the professional structure is concerned, it should be pointed out that there are 10 teachers, 15 educators, 8 doctors, 15 lawyers, 5 agricultural professionals, 1 veterinarian, and 26 other types of professionals, 33 technicians and nurses as well as 107 people of various other technical professions. Another type of professional structure indicates that there are 480 farmers in Trgoviste, 280 agricultural workers, 150 industrial workers, 27 administrative workers and 10 workers in the restaurant business.

On 25 August 2012, the total number of unemployed people was 1104. 450 among them have completed the first level of education (elementary school), 20 the second level (second year of secondary school), 372 the third (third year of secondary school), 223 the fourth (complete secondary education), 30 the sixth (higher education) and 12 the seventh level of education (university degree). 980 people are employed in the public sector and 150 in the private sector. 400 people are employed in the industrial sector. The number of people with benefits and social aid is 84, while 200 people are using the national kitchen. 262 are receiving aid from the Red Cross. The negative consequences of the transition have not missed Trgoviste so that 320 people have been laid off. The most prominent number of dependants can be found in the structure of housewives and students at elementary, secondary and tertiary level. A total of 180 are incapable of employment.

The industrial activities mainly present in Trgoviste include work in the agricultural sector so that it can be said that almost all the inhabitants in one way or the other are engaged in agriculture. In Trgoviste, 8 people are employed in the sector of hunting and forestry, 120 in the mining industry, 60 in the processing industry, 500 in the construction business, 100 in the trading sector, 2 in the area of auto mechanics, 18 in the hotel and restaurant business, 4 in transport, 180 in the administration and defence system, 80 in the health sector and 20 people are abroad. It should be noted that in the structure of the non-agricultural population, 380 people are permanently employed, 500 people have their own incomes, 150 people are dependants and 100 people have returned from a foreign country. As far as the unemployed are concerned, 15 people have a university degree, 18 a higher education degree, 400 a secondary education degree and 280 an elementary education degree. Also interesting is the structure of retired people. 280 people receive a pension in the agricultural sector, 450 people in the social sector, 600 people in the industrial sector and 35 people receive a foreign pension.

The structure of employed people according to their employment status can be described as follows: 980 people work in the public sector, 18 people own their own private companies, 120 people are employed in the private sector and 400 people are individual agricultural workers. As far as the economic status of employed people is concerned, 780 people are employees, 18 people are employers, 120 people work in their own companies and 680 people have no incomes. The average personal income of the active population is 27,000.00 Dinars.

As far as the structure of households is concerned, 20 households are agricultural, 120 are mixed and 360 are non-agricultural. On the other hand, there are 300 households with only one member, 10 households with couples without children, 300 households with one family, 60 households with two families and 40 households with three or more families. As far as the size of the households is concerned, 300 households consist of only one member, 310 of two members, 80 of three members, 10 of four members and 10 of five members. These facts also illustrate the difficult demographic situation in Trgoviste. Obviously, households with only one member or two members make up the majority. What is more, the members of these households are rather old. Furthermore, it is very indicative that 100 households do not own any land, 38 households own up to half a hectare of land, 30 households own 0.5 to 3 hectares of land and 10 households own 3 to 5 hectares of land.

These statistic indicators illustrate that there are many problems to be solved in the demographic sphere of Trgoviste. However, only a few factors indicate improvement which is why this border area is categorized as one that needs the help of the state in order to mitigate the effects of these problems at least to some extent.(Petrović, 2012, p.256.).

5. Conclusion

A more and more common belief is that the efficiency of economic development may not be based on devices, but on the working (human) potential. People with good skills can accomplish more successful results even with modest resources assuming that they are motivated and stimulated. However, a precondition is that proper management of resources instead of people is introduced. A real escape from inherited obstacles, alienation in the work process, misconceptions and manipulation, various types of addiction, political volunteering, scientific confrontation, one-sided professional tyranny and organized lack of knowledge is possible only in a democratic and economically developed society.

Creative human forces have always managed to channel processes of economic development via knowledge developing thus themselves as well. Already in ancient Greece, in the framework of philosophy, man was in the centre of attention (this was the time when the following saying of Protagoras' was coined – "Man is the measure of all things"), man's health was taken care of (Hippocrates' medicine) and especially the defence and protection of people was developed (Pericles' strategy). (Brekić, 1983, p.118). Other democratic civilizations have been announcing and developing human virtues until today. Therefore, the level of manifold development of working people – resources, has become a decisive factor and determining element of economic development.

As far as Trgoviste is concerned, the above mentioned speaks in favour of the thesis that the regional development of Serbia is a priority in economic political orientation because a large territory will lose its population as the most important factor of industrial activity. This will most certainly have a certain impact on the development of the Pcinja District. Therefore, not only the security aspect but natural resources as well should be taken into account as they represent a solid assumption that a certain economic development may be realized in this area.

6. Acknowledgement

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STATISTICAL ANALYSIS OF ANNUAL WATER DISCHARGE OF JABLANICA AND TOPLICA RIVERS

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Abstract: The rivers of Jablanica and Toplica are left tributaries of the Južna Morava. Their catchment area comprises left of the west half of the Južna Morava basin. Regionally-wise, it represents Topličko-Jablanička micro-region, which is a part of meso-region of Southern Pomoravlje. The paper discusses the data on discharge from the hydrological station Pečenjevce (on Jablanica river), which is located 3 km from the confluence with the Južna Morava and hydrological station Pepeljevac (on Toplica river), located at 69.5 km from the confluence with the Južna Morava. The data used for the analysis of flow are taken from the Hydrological Yearbook RHSS and cover the period 1950-2012 (Jablanica) and the period 1951-2012 (Toplica). The evidenced statistically significant changes in annual water discharge were examined using the following non-parametric tests: Pettit test, Standard Normal Homogeneity test, Buishand range test, von Neumann test and Mann Kendall test.

The results showed that on the river Jablanica there is a declining trend in water discharge while non-parametric tests: Pettit test, Standard Normal Homogeneity test, Buishand range test show that the change-point in average annual water discharge data occurred in 1987 and 1982. On other hand, on river Toplica is not established trend changes in annual water discharge or change-point.

Key words: discharge, trend, statistical homogenity tests, Jablanica, Toplica

1. Introduction

The rivers of Jablanica and Toplica are left tributaries of the Južna Morava. Their catchment area comprises left of the west half of the Južna Morava basin. Regionally-wise, it represents Topličko-Jablanička micro-region, which is a part of meso-region of Južno Pomoravlje. This micro-region comprises only of the basins of the Jablanica and the Toplica, where the basins of Veternica and the Pusta river are joined to the Jablanica.

Topličko-Jablanička micro-region extends on the surface of 4172 km^2. It is bounded by Kosovsko Pomoravlje in the south, Jastrebac and the Rasina in the north, Južno Pomoravlje in the east, whereas it is bounded by Ibar-Kopaonik area in the west (Marković, 1966; 1995).

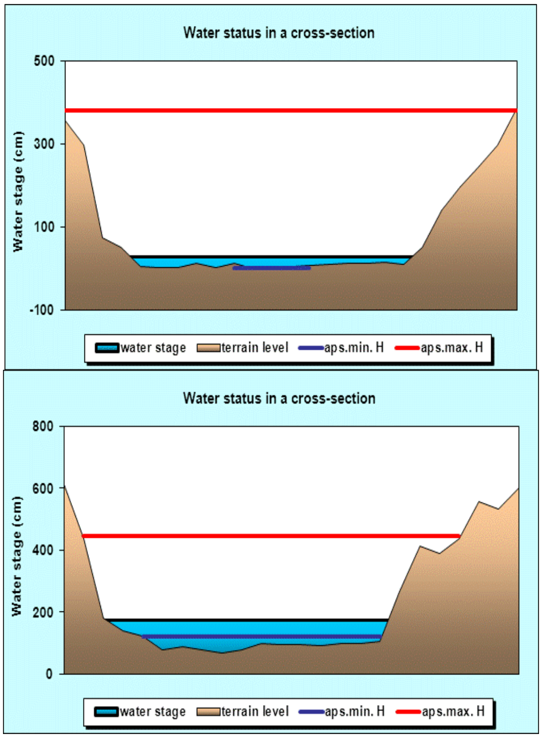

Figure 1- The shape of the cross section of the river Jablanica at hydrological station Pečenjevce (left); and Toplica River at the hydrological station Pepeljevac (right) (Source: RHSS)

The river of Jablanica emerges from the Banjska and Tularska river which join at the village of Maćedonce at sea level of 375 m. It is 75.3 km long, while it is 94.8 km long from the spring of the Banjska river, its longer constituent. The Jablanica flows into the Južna Morava 3 km downstream from Pečenjevce (Gavrilović, Dukić, 2013). This study examines the data on the discharge from hydrological station Pečenjevce, which is situated 3 kilometers from the confluence of the Jablanica. The surface of the basin on the Pečenjevce profile is 891 km at 205.82 m sea level. The data used for analysis comprise the period from 1950 to 2012. The data for the first and the second month of 1990 were interpolated on the basis of the Južna Morava discharge, the station Korvingrad. The surface of the Jablanica basin is

909.74 km^2. The basin is asymmetric. The upper part of the basin, up to Lebane is of serrated, almost circular shape, while the lower part is elongated and narrow, mostly in the direction of southwest - northeast. It completely belongs to Serbian-Macedonian mass. It is bounded by the mountain of Goljak in the south and southeast which separates the basin of Jablanica from Kosovsko Pomoravlje. In the east, the Kukavica and the Poljanica separate it towards the basin of Veternica. There is the mountain of Radan in the southwest which separates it from the basin of the Toplica and Kosanica, as well as the branches of Radan towards the north, northeast and the basin of the Pusta river. In the east and northeast, the basin is broadly open towards Bošnjačko field, the west part of Leskovac basin and the valley of the Južna Morava.

The river of Toplica emerges from several rivulets on the eastern slopes of Kopaonik, the biggest of which are the Lukovska river and the Đerekaruša river, which are joined at the village of Merćez. The Toplica is 130 km long, with basin surface of 2180 km^2. It is the biggest left tributary of the Južna Morava in which it flows into at Korvingrad (Gavrilović, Dukić, 2013). This study examines the data on the discharge from the hydrological station Pepeljevac, which is situated 69.5 km from the confluence of the Toplica. The surface of the basin on the profile is 986 km^2, at 329.9 m sea level. The data used for the analysis comprise the period from 1951 to 2012.

The basin of the Toplica can be divided into three parts: the upper Toplica, upstream from Kuršumlija, the middle or even Toplica and the lower Toplica with the village of Dobrič (Marković, 1966). The valley of the Toplica is composite; it consists of several expansions and gorges. Up to Kuršumlija the Toplica runs through deep and narrow valley, it is prone to flooding, with frequent rapids and whirlpools. From Kuršumlija the valley is broader and shallower. From the village of Pločnik the valley of the Toplica becomes broader and shallower than its upstream part. At Prokuplje its valley is gorge-like, while downstream it enters the spacious and flat Dobrič. The basin of the river is symmetrical, because the right and left tributaries are approximately equally long (Stanojević, 2001). The relief of the Toplica basin belongs to Serbian-Macedonian mass, the oldest part of the continent of the Balkan Peninsula and Dinaric zone of folded mountains. It was formed in the time of Alpine orogenesis. Topličko-kosanička basin with its rim was formed in the middle of Oligo-Miocene. It is situated between the mountains of Mali and Veliki Jastrebac in the north, Kopaonik and Požar in the west, Prolomske mountains, Sokolovica, Arbanaške mountains, Vidojevica and Pasjača in the southwest and west (Rudić, 1978).

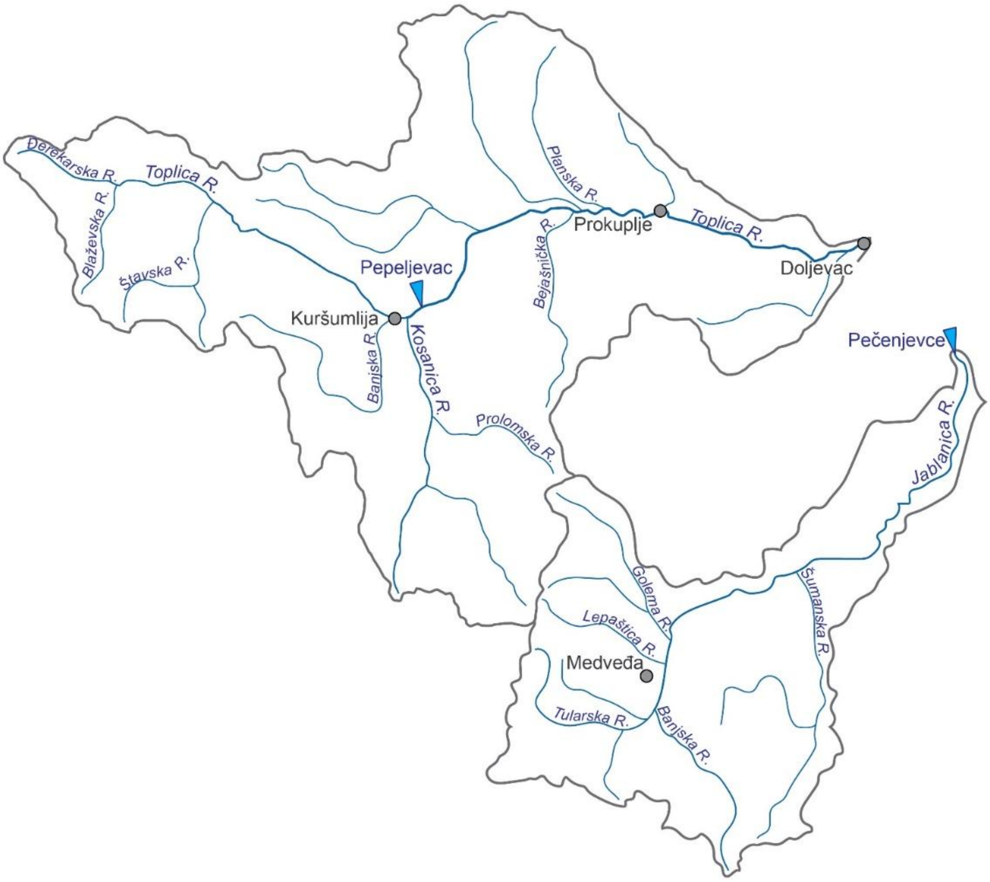

Figure 2– Map of catchment areas of Jablanica and Toplica rivers

The Toplica has a very unstable water regime. The highest discharge occurs in March and April, when the discharge is more than doubled because of snow melting from the surrounding mountains, while the lowest discharge occurs in August and September, when there is often less than 1 m^3/s flowing through its river-bed. The whole territory of the Toplica is much drained in that period, its tributaries almost dry out, which leads to the problems in water supply of the settlement (Rudić, 1978).

The Jablanica has a very unstable water regime, too, although it has a large basin. It is distinguished by high fluctuations in the discharge during year, where there is a shorter period of high waters and a longer period of low waters (below 1 m^3/s)(Rakićević, 1972). The Jablanica is also the longest river that dries up in Serbia. It was the reason to examine in this study if there is a trend of discharge and a breaking point in data series on discharge on both rivers and when the breaking point occurs.

2. Methodology

Test methods have been used to test and to identify general trends in annual water discharge in Jablanica and Toplica rivers in Serbia. Such an analysis involved the following statistical tests: Pettitt's test, Standard normal homogenety test (SNHT), Buishand range test (BR), von Neumann test and Menn Kendall test. Under alternative hypothesis, SNHT, BR test, and Pettitt test assume the series consisted of break in the mean and considered as inhomogeneous (Radivojević et al., 2015). These tests are capable to detect the year where break occurs. Meanwhile von Neumann test is not able to give information on the year break because the test assumes the series is not randomly distributed under alternative hypothesis (Neumann, von, 1941). The results of the Pettitt, Buishard range, and a SNHT tests goal to annual discharge data series show that the change points were detected in Jablanica river 1987 and 1982.

The Pettitt's test is a non-parametric test, meaning that its application requires no assumption about the distribution of data. This test provides assessment of the null hypothesis H_0 implying that the data are homogeneous throughout the period of observation, i. e. that the data have been obtained from a single or several distributions with the same location parameter (average values). The alternative hypothesis, implies presence of a non-accidental component among data causing a shift of the location parameter at a particular moment. Aside from providing for a data homogeneity check, the Pettitt's test also determines if the alternative hypothesis happens to be accepted the change-point when a shift of the location parameter occurred (Pettitt, 1979).

The SNHT homogeneity test is a statistical test which also checks if the data originate from the same population with the same distribution or indicate presence of a significant difference in the location parameter between the data before and after a specific change-point tc bringing an increase or decrease of the value of the observed feature. The null hypothesis in this test H0 implies that the data are homogeneous, i. e. that they originate from the same population, while the alternative hypothesis H1 implies presence of a significant difference in the location parameter in the period before and after the moment tc. The SNHT test determines the moment of change of the location parameter (Radivojević et al., 2015).

The Buishand range test is also a non-parametric test checking presence of a change-point in the given data marking a change of the location parameter (average values) distribution. The null hypothesis implies data homogeneity in terms of the location parameter, i. e. absence of a change regarding the said parameter over time. The alternative hypothesis implies presence of a change-point involving an increase or decrease of the average value of the observed feature (Buishand, 1982).

The von Neumann test also tests the null hypothesis implying data homogeneity in terms of the location parameter and absence of its change over the period of observation, as opposed to the alternative hypothesis implying presence of the moment when the change of the location parameter occurs. If the alternative hypothesis is accepted, the von Neumann test cannot pinpoint the moment marking the change of the location parameter (Neumann von, 1941).

Mann-Kendall test is a nonparametric test which identifies the trend of the series on the basis of comparing relative magnitudes in data change (Stojković, 2015; Stojković et. al., 2015; Kendall, 1975). This test was used to determine the trend of the discharge of both rivers.

Program package "R" was used for the interpolation. Coefficients of interpolation polynome were calculated with the condition of maximization of the determination coefficient R2.

For the application of the mentioned tests, Microsoft Office Excel 2007 and its XLStat were used.

3. Results and discussion

On the basis of the observed sample, the following descriptive average annual indicators of the river Jablanica was obtained for the period 1950-2012 (Table 1); of the river Toplica for the period 1951-2012 (Table 2).

Table 1– Basic indicators of water discharge and the specific runoff of the river Jablanica on the hydrological station Pečenjevce

Period	**N**	**F [km^2]**	**Q_{max} [m^3/s]**	**Q_{min} [m^3/s]**	**Q_{avg} [m^3/s]**	**σ**	**c_v**	**q [l/s /km^2]**
1950-2012	63	891	200	0	4,39	8,59	1,96	4,92

The Jablanica discharge (Pečenjevce station) in the measuring period from 1950 to 2012 according to Mann-Kendall test shows a significant decreasing trend with significance threshold of α = 0.001 (Figure 3). Parameters of linear regression of median line of the trend of annual values are as follows: A = - 4,77×10^{-2}, B=5,*60* (Martić Bursać, 2015).

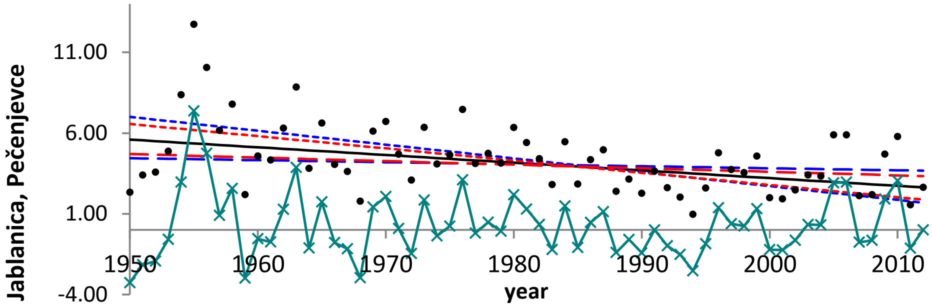

Figure 3- Trend of the annual water discharge of the river Jablanica (Pečenjevce) for the period 1950-2012 (Martić Bursać, 2015)

Table 2– Basic indicators of water discharge and specific runoff on the river Toplica on the hydrological station Pepeljevac

period	N	F [km^2]	Q_{max} [m^3/s]	Q_{min} [m^3/s]	Q_{avg} [m^3/s]	σ	c_v	q [l/s /km^2]
1951- 2012	62	986	275	0,09	7,07	10,38	1,47	7,17

Mann-Kendall test determined that there is no statistically significant trend of the Toplica discharge on the observed profile Pepeljevac in the given period (Martić Bursać, 2015).

Table 3. Pettitt's test results

	Jablanica	**Toplica**
K	590.0000	227.0000
t	1987	1963
p-value (Two-tailed)	0.0007	0.4930
alpha	0.05	0.05

Table 3 and Fig 4. show the results of the Pettitt's test. Regarding the data it can be concluded that there was a change-point when the annual water discharge decreased. This test indicates that the change point in average annual water discharge data occurred in 1987 for river Jablanica. On river Toplica is not established change-point in annual water discharge.

The results of the SNHT test are shown in table 4. The significance of the SNHT test leads to a conclusion that average annual water discharge in the observed period are homogeneous in terms of the location parameter. This test identifies 1982 as the year when a decrease in water discharge in Jablanica occurred. This can also be noticed in the following fig.5.

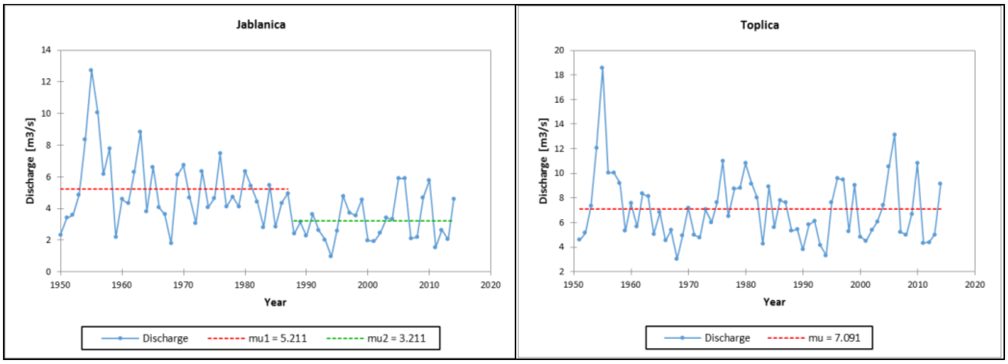

Figure 4. Pettit test for Jablanica (left side) and Toplica river (right side)

Table 4. Standard normal homogenity test (SNHT) for Jablanica and Toplica rivers

	Jablanica	Toplica
T0	14.3044	7.8726
t	1982	1958
p-value (Two-tailed)	0.0374	0.1086
alpha	0.05	0.05

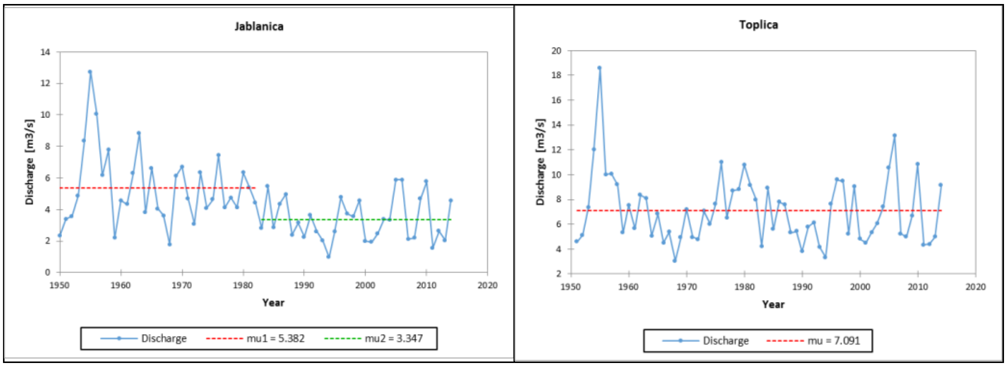

Figure 5. Standard normal homogenity test (SNHT) for Jablanica (left side) and Toplica river (right side)

Table 5. Buishand's test

	Jablanica	Toplica
Q	15.3630	7.4822
t	1982	1958
p-value (Two-tailed)	0.0003	0.2617
alpha	0.05	0.05

With regard to the test significance p <0.001 which is smaller than the significance level a =0.05, the alternative hypothesis is accepted, i. e. it can be concluded that there is a change-point marking occurrence of the change in average water discharge for river Jablanica. The Buishand test identifies 1982 as a moment when annual discharge decrease occurred in Jablanica river. Figure 6. shows this change in a graphical form.

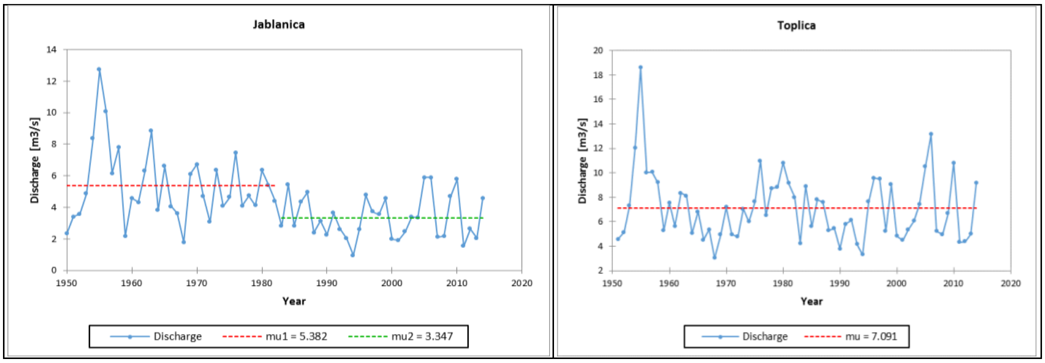

Figure 6. Buishand's test for Jablanica (left side) and Toplica river (right side)

Table 6. von Neumann's test for Jablanica and Toplica river

	Jablanica	Toplica
N	1.0676	1.2134
p-value (Two-tailed)	0.0001	0.0009
alpha	0.05	0.05

So, the results of the von Neumann test of homogenity, call for acceptance of the alternative hypothesis, i. e. lead to a conclusion that in the series of average annual water discharge there is a change-point regarding the location parameter in both rivers. The results are shown in table 6.

The analysis of annual water discharge recorded over 50-year period for the hydrological stations on rivers Jablanica and Toplica on the basis of used statistical tests, it can be concluded that there is a change-point marking occurrence of a decrease in average water discharge in Jablanica river. Neither trend of change, nor a change-point in the discharge data were determined for river Toplica.

The results obtained should be applied in the improving of the model for predicting river discharge, which is very important for water management and agriculture, but also for the society as a whole.

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ESTIMATION OF THE QUALITY OF WATER (CONCENTRATION OF NITRITE, NITRATE, PHOSPHATE, AMMONIAC, SULFATE AND CHLORIDE) IN THE LAKE CRNO JEZERO AT THE DURMITOR MT. FROM 2010 TO 2014

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Abstract: The Lake Crno jezero is the largest and the most prominent lake on the Durmitor Mountain and is the second largest mountainous lake in Montenegro by surface area. By its natural and overall potentials Durmitor represents the pretty rare area in Montenegro that is practically lack of anthropogenic influence. The goal of this paper is to present and take into consideration the quality of lake water within the period 2010 to 2014. Comparative analysis of concentrations of nitrate, nitrite, phosphate, ammoniac, sulfate and chloride in the lake with proposed values by the Law on waters (Official gazette of Montenegro, no. 27/07) was performed, taking into consideration the existing regulative that has importance for better understanding of determined concentrations and their impact.

Key words: environmental protection, Crno jezero Lake, nitrate, nitrite, phosphate, ammoniac, sulfate, chloride

1. Introduction

The first scientific and systematized data on lakes at the Durmitor mountain gave Jovan Cvijić: “Where slopes of the massif meet the surface carved inside rocks and bordered with moraines occurs the deepest lake basin in the area of the Durmitor: lake Crno jezero with depth of 48m“(Cvijić J. 1924).

All lakes at the Durmitor Mountain are in general with chemically and bacteriological safe waters. Lakes display normal thermal stratification during summer and inverse during winter, when are snow covered (Stanković S. 1995).

The lake Crno jezero is the largest and the most famous lake at the Durmitor Mountain, and is the second mountainous lake by surface area in Montenegro. It is situated beneath the giant Međed, where the strong spring

Čelina appears in spring, when a snow starts to melt. The lake consists actually of two aquatic regions, Lake Malo and Lake Veliko jezero, which are separated by narrow land form known as “struga”. The length of lake (including both basins) is 1155 m, and the maximal width is 810 m. The lake has the surface area of 515 m2. It is placed at the 1418 m a.s.l. The Lake Malo jezero is 49.1 meter deep, and the Lake Veliko jezero is 24.5 meters deep. Temperature of water in summer exceeds 22°C, thus being a very pleasant for swimming (Cerović B. 1979, https://durmitor.wordpress.com/nacionalni-park/jezera/).

Comparative analysis of concentrations of nitrate, nitrite, phosphate, ammoniac, sulfate and chloride in the lake Crno jezero at the Durmitor Mt., was performed utilizing data of the Institute for hydrometeorology and seismology of Montenegro.

2. Methods of study

The Institute for hydrometeorology and seismology of Montenegro (http://www.meteo.co.me), Department for the quality of water in Montenegro performs four series of measurement for the period June-October. This is a period of low water level, and the highest pollution as well as the highest use of water particularly for bath. All measurements and monitoring of the water quality take part in the Laboratory for the analyzing a water quality, which is accredited for sampling and testing according to the standard MEST EN ISO/IEC 17025:2011.

The appropriate analytical techniques: volumetric, electrochemical, gravimetric, spectrophotometric, flame photometry and membrane filtration methods are use for the assessment of physicochemical, microbiological and saprobiological parameters. Analytical procedure encloses two steps: field-work and the laboratory. This should incorporate a carefully notification and recording of meteorological and hydrodynamic parameters as well as organoleptic properties, a general appearance of water and the location of sampling point.

This paper takes into consideration results of studies performed in the Lake Crno jezero over raft from 2010-2014. Activities of the Section for monitoring and assessing water and air quality determine the Law of hydrometeorological activities ("Official gazette of Montenegro", no. 026/10 from 07.05.2010; 040/11 from 08.08.2011 and 030/12 from 08.06.2012);

Law on waters ("Official gazette of Montenegro", no.27/07); Act on organization and way of work of the state governance ("Official gazette of Montenegro", no. 5/12) as well as by another national rules. Activities of the Section are adjusted with the program of the World meteorological organization (WMO). Analysis of qualitative properties of water regarding the presence of mineral compounds of nitrogen (N), chlorine (Cl), sulfate (SO_4), and phosphorous (P) were performed in aim to determine a class of surface waters, their categories and quality in respect to recommended quality level, which has been defined by the Act on categorization of waters in Montenegro ("Official gazette of Montenegro", no. 2/07).

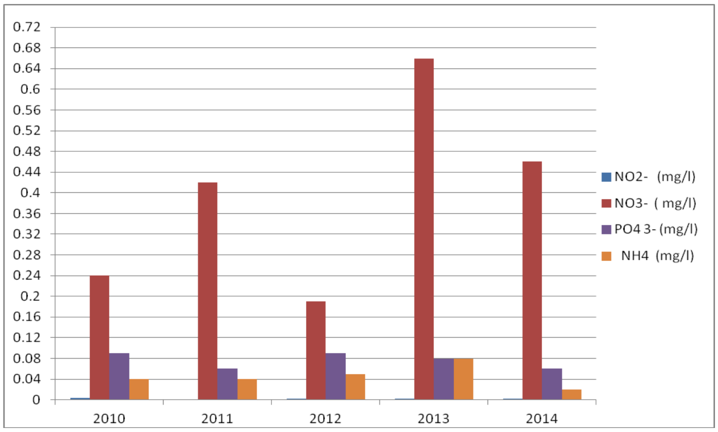
3. Obtained results

The maximal allowed quantities (MAQ) according to the Act on categorization of waters in Montenegro (Off. Gaz. of MNE, no. 2/07) determine a various classes. For the class "A" is it a 10 mg/l of nitrate, nitrite from 0.00 to 0.002 mg/l, phosphate 0.01 mg/l, ammoniac 0.00 mg/l, and for chloride is 10 mg/l. For the class A1, the MAQ of nitrate is 20mg/l, nitrite 0.003 mg/l, phosphate 0.02 mg/l, chloride 20 mg/l, sulfate 20 mg/l. For the class A2 recommended concentrations of nitrate is 25 mg/l, nitrite 0.005 mg/l, phosphate 0,05 mg/l, chloride 40 mg/l, and sulfate 50mg/l. In the class A3 is nitrate 50 mg/l, nitrite 0.02 mg/l, phosphate 0.10 mg/l, chloride 200 mg/l, and sulfate 200 mg/l. Obtained results were taken in consideration in agreement with the existed laws and sub laws acts: Act on categorization of waters in Montenegro (Off. Gaz. of MNE, no. 2/07), the Law of hydrometeorological activities (Off. Gaz. of MNE, no. 26/10), the Law on waters (Off. Gaz. of MNE, no.27/07), and Act on organization and way of work of the state governance (Off. Gaz. of MNE, no. 5/12). It was estimated for the observed period that the Lake Crno jezero considers to A1 class in water quality, although with a discrepancy. Identified concentrations of nitrite, nitrate, phosphate and ammoniac are given in the Table 1, while for chloride and sulfate results are in the Table 2.

It could be concluded that according to the obtained results for concentrations of nitrate and nitrite (table 1) and to the Act on categorization of waters in Montenegro (Off. Gaz. of MNE, no. 2/07) the lake Crno jezero corresponds to classes A and A1. The highest concentration of nitrate was recorded in 2010, while the lowest concentration was in 2012. The latter is almost four times less than the maximal value. Maximal amount of nitrite was recorded in 2013, whereas the lowest value, actually lack of it, fits to 2011.

Table 1. Concentrations of nitrite, nitrate, phosphate and ammoniac in mg/l from 2010 to 2014 measured from raft on the Lake Crno jezero

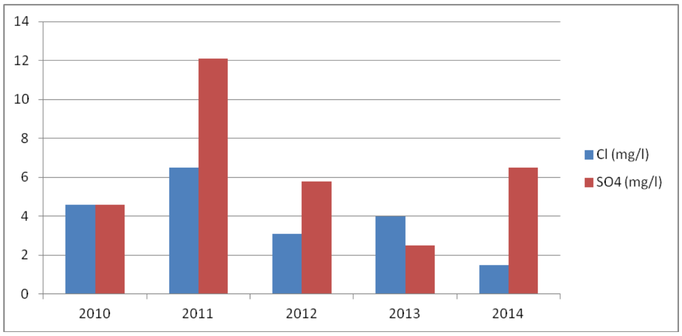
	2010.	2011.	2012.	2013.	2014.
NO_2^- (mg/l)	0.003	0.000	0.002	0.002	0.002
NO_3^- (mg/l)	0.24	0.42	0.19	0.66	0.46
PO_4^{3-} (mg/l)	0.09	0.06	0.09	0.08	0.06
NH_4 (mg/l)	0.04	0.04	0.05	0.08	0.02



Graphic 1. Graphical presentation of results from the table 1.

Table 2. Concentrations of chloride and sulfate in mg/l from 2010 to 2014 measured from raft on the Lake Crno jezero

	2010.	2011.	2012.	2013.	2014.
Cl (mg/l)	4.6	6.5	3.1	4.0	1.5
SO_4 (mg/l)	4.6	12.1	5.8	2.5	6.5



Graphic 2. Graphical presentation of results from the table 2.

Maximal amount of nitrite was in 2013, and the lowest in 2011 when nitrites were practically absent. Mentioned discrepancy is related for concentrations of phosphate and ammoniac that correspond water samples to a class A3. The reason for it is most probably sampling from shallow depths, which is commonly populated by grasses. The highest concentration of phosphate was recorded in 2010 and in 2012, while the lowest values were in 2011 and 2014. Maximal amount of ammoniac was measured in 2013, and the lowest, yet four times smaller in the next 2014. The data given in the table 2 reflects that the amounts of sulfate and chloride are within the recommended range MAQ during the period of observation. According to the "Act on categorization of waters in Montenegro" (Off. Gaz. of MNE, no. 2/07) these quantities classify water to the class A. Maximal values for both was recorded in 2011. Minimal quantity of chloride was recorded in 2014, whereas for sulfate it was the year 2013 (almost five times smaller than the maximal measured concentrations in given period).

Water from the Lake Crno jezero may be used for breeding of precious fish species (salmonids). This possibility classifies water to S class, which fulfills al requirements regarding quality of the class A1. In term of bathing is water of class K1 meaning really excellent for it.

4. Conclusion

According to the above noted facts water from the Lake Crno jezero corresponds to A1SK1 classes. Concentrations of nitrite, nitrate, phosphate, ammoniac, sulfate and chloride measured from raft, are variable throughout a year but remain within the MAQ range, which is proposed by the Act on categorization of waters in Montenegro" (Off. Gaz. of MNE, no. 2/07). Variable concentrations could be explained by sampling a shallow-depth waters, which are often grasses populated. Additionally, the influence of a natural process, such as the presence of evergreen trees and their physiologic products, along with the anthropogenic influence caused by numerous visitors, fishermen and swimmers should not be excluded.

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Zakon o hidrometeorološkim poslovima ("Službeni list Crne Gore", br. 026/10 od 07.05.2010, 040/11 od 08.08.2011, 030/12 od 08.06.2012)

Zakon o vodama (Sl.l.CG br.27/07),

https://durmitor.wordpress.com/nacionalni-park/jezera/

http://www.meteo.co.me

FIELD WORK AS A WAY OF IMPROVING THE UNIVERSITY TEACHING OF GEOGRAPHY

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Abstract: Field work is very important, because it makes it easier for students to understand the laws and processes of generalization. A teacher is an important factor in this kind of improvement of university teaching of geography. The quality and effectiveness of this kind of teaching depends on his/hers didactic preparedness and capability for field work. In addition, it is necessary to bear in mind the intellectual maturity of the students. This is very important because the field work with the "unskilled" teachers can be turned into a mere formality, and classes will remain verbal and inefficient. In that case, field work isn't the source and foundation of knowledge of the outside world. Department of Regional Geography, at the Faculty of Geography, pays great attention to improving the teaching quality. One of the aspects is the field work. Department of Regional geography has continued to nurture excursions - field work, as one of the important aspects of quality improvement.

Key words: geography, field work, opinions of students, university, improvement, quality

1. Introduction

Geographers are constantly emphasizing that the observation is the oldest method of learning about geographic reality. Teaching geography is most evident when it occurs in the contemporary "geographical laboratories" - the geographical area. Geography should be taught outdoor, in the field, not in the classrooms, as it is usually the case. The didactic idea which has long been proclaimed is that objective reality, with richness of its manifestations and changes, is the basic source of human knowledge. The most important element of obvious field work is organized, conscious and planned observation of objects and phenomena. Students should be trained for such observation during their education at universities. The theoretical knowledge allows us to determine which of the many visible features of the observed object or process have greater importance. For that reason field work is very important for students of geography, because it makes it easier to understand the facts and processes of generalization. The teacher is also an important factor in this kind of improvement of university teaching of geography. The quality and effectiveness of this kind of teaching largely depends on his didactic readiness and capability for field work. In addition, it is necessary to bear in mind the intellectual maturity and level of development of students. This is very important because the field work with the "unskilled" teachers can be turned into a mere formality, and classes will become more verbal and inefficient. In that case, field work becomes an end in itself rather than a means, the source and foundation of knowledge of the outside world.

2. Field work teaching at the Department of Regional Geography, University of Belgrade – Faculty of Geography

Department of Regional Geography at the Faculty of Geography in Belgrade pays great attention to improving the teaching quality of regionalgeographic subjects. One of the aspects of improvment is field work teaching, which is performed as a one-day or multi-day excursions. During the shorter field works (usually one day) students visit Deliblato sands, DjavoljaVaros, Fruska Gora and Radjevina. This kind of field work is carried out for the undergraduate studentson third and forth year of Geography, and more recently for the third year students of Spatial Planning. Three and five day excursions are realized in the area of StariVlah and Raska in southwest Serbia (the third year students of Geography and the second year students of Turismology) and in the area of Prokletije and Durmitor in Montenegro (for the fourth year students of Geography).

Field work represents an efficient means for the education of future geographers. Accordingly, those who want to be successful geographers must see real objects and processes in nature, such as those who are preparing to be physicists or chemists must perform experiments in laboratories. Field work should contribute to proper and comprehensive understanding of the geographical phenomenon, and especially to awaken student interest for the development of these phenomena. Borivoje Z. Milojević pointed out: "Once awakened interest will mean striving for continuous improvement, and this will create an expert in geography who will always be ready to respond to all those tasks, which are required of him" (Milojević, 1950). And after 65 years after these statements, we can rightfully ask what is the position of geographers in modern science.

In order to geography to take its rightful place in the education system (and we have to ask ourselves where is geography in the middle of the second decade of the 21st century) continuous improvement of teachers is a necessity. By constantly improving the quality of teachers we are improving the teaching of geography. In this way the geography would gain importance in general education, which it deserves. One of the aspects of the implementation is to improve the quality of teaching, primarily the quality of field work. However, the big issue for this kind of work are abilities and qualifications of teaching staff at universities, and staff which are employed in elementary schools and high schools.

The author of this work, remembers several one-day excursion, which were organized by professors from the Department of Regional Geography (prof. KosovkaRistic and prof. MiloradVasovic, prof. DusanGavrilovic from the Department of physical geography and prof. MilutinLjesevic). These excursion were held in the area of Banat sands, Šumadija, Zapadna Morava valley, Novi Sad, Pinosava plateau etc.

After these field works the author of this paper has truly realized the true meaning of geography. The author then made the decision to take the students on field trips as often as possible.

The teaching staff at the Department for Regional Geography, which was succeeded by professors who have retired during the period 1990 - 1995, has sought to implement a one-day and multi-day field trips (as far as the material conditions allowed). The greatest satisfaction for professor, the author of this paper, is to hear the positive comments made after the field work, because then she really realizes that her beliefs and decisions, even from her student days, have a real confirmation.

Department of Regional geography has continued to nurture excursions - field works, as one of the important aspects of improving the quality of teaching of regional geographic subjects. However, in the period from 1978 - 1995 the field work were not carried out. Until 1978, field works were carried out by prof. Jovan Dj. Markovic, prof. MiloradVasovic, prof. Dragan Rodic and prof. KosovkaRistić. Some generations went to Slovenia and Istria, and then using Adriatic road to Dubrovnik and Popovopolje in Herzegovina. Excursion in 1978 carried out by prof. Jovan Dj. Markovic (participants were also prof. VujadinRudic and assistant Dragica Zivkovic) was realized in the area of Durmitor, Niksicpolje, Skadar depression (Podgorica), via Cetinje and Kotor to Dubrovnik. Then the students visited Popovopolje, Trebinje, Bileca, Foca, Uzice and Belgrade. Over 100 students participated in this field work. The participant of this field work was the author of this text and this field work was crucial to define her scientific work in the field of regional geography. The realization of field works was not interrupted despite the economic problems that the country faced and the socio-political developments in the last decade of the 20th century. Unfortunately, there was only a decrease in the number of days from eight to seven, and then finally five days of excursion. We can responsibly say that this is a short period, and that the professors of the Department, as well as faculty management should be more involved in finding financial resources for the implementation of this kind of teaching. Students themselves pay all the cost of field works. Therefore, we can rightly wonder, whether this society is so poor that it doesn't have funds to finance this important segment of teaching which is necessary for future geographers. Such an attitude toward field work for all students of geography, arises the following question: can someone become a professor of chemistry or physics, without working in laboratories and conducting experiments?

Since the 1995 Department of Regional geography, after the discontinuation, has organized multi-day excursions (in accredited curriculum called fieldwork), for students of the third and fourth year of Geography and second year of Turismology. Students of the third year of Geography have three-day field work realized in the area of StariVlah and Raska, including visits of the Pester plateau - KarajukicaBunare. Sjenica and Uvac canyon. The field work is carried out with the involvement of local geographers and historians.

After the discontinuation, multiday field trips for forth year students of Geography have been carried out for 22 years. Field work is carried out by prof. Mile Pavlovic and prof. MilutinLješević and the former assistants of the Department (prof. Mirjana Gajic, prof. Snežana Vujadinović and prof. Dejan Sabic). Field work is implemented on the territory of Durmitor, Niksicpolje and the Montenegrin coast (Bay of Kotor, Ulcinj coast and Skadar Lake). The field work was carried out with a large number of students (sometimes up to 120), which may burden the quality of teaching, because they couldn't all be actively involved. However, experience shows the great interest of students for this kind of teaching in geography. Field work is the main event, which they will remember after studies. They found particularly interesting the cruising in Bay of Kotor, by school boat from Hydrological Institute from Kumbor.

In the last ten years fieldwork for the fourth year students of Geography is still performed in the area of Durmitor and Prokletije. The organizer is the Department of Regional geography and it is implemented under the leadership of prof. Mile Pavlovic and assistant Filip Krstic. And this fieldtrip causes a lot of interest among students and almost all students are included. Contribution to the quality of field work give colleagues - professors, and also graduate geographers from the area. These are, first of all, prof. Slobodan Kasalica and prof. Miroslav Doderovic from the Faculty of Philosophy in Niksic, and prof. Marko Knezevic, a retired professor.

In order to improve university teaching, a survey was conducted among the students on how to improve the teaching of geography. Students from the following institutions were involved in the survey: University of Belgrade – Faculty of Geography, University of KosovskaMitrovica – Faculty of Science, University of Niš - Department of Geography, Faculty of Sciences, and University of Belgrade - Faculty of security studies. In the table below are the questions to which the students responded and the survey results are very interesting: 81.7% of students at the Faculty of Geography in Belgrade believes that the organization of field work the best form to improve teaching, 95% have such an opinion in KosovskaMitrovica, 80.0% at the Department of Geography in Nis and at the Faculty of Security studies (Pavlović et. al., 2014).

Table 1 – Results of the student's survey on ways to improve university teaching (in %) Source: Pavlović et al., 2014

Institution / Ways of improving university teaching	University of Belgrade – Faculty of Geography	University of Priština - Faculty of Science and Mathematics	Universiy of Niš - Faculty of Sciences and Mathematics	University of Belgrade – Faculty of security studies
A) Good organized lectures	16,3	5,0	13,3	15,0
B) Interest of professor for teaching	2,0	0,0	6,7	5,0
B) Organization of field work	81,7	95,0	80,0	80,0

On the basis of the surveyed students, 82.3% of respondents said that the quality of the teaching process can be raised to a higher level by organizing field work, while only 4.0% said that the teacher lecture can improve the quality of teaching. The results are very important for the professors in the Department of Regional geography. The aim of this survey was to point out the attitudes and perceptions of students in the fourth year of Geography and based on their opinions to be more involved in the implementation of field work as a form of improving university teaching of geography.

3. Conclusion

Field work has been an important part of the curriculum throughout the 20^{th} century. One of the reasons for neglecting field work was insufficient training of the professor for performing such way of teaching, but also lack of motive and enthusiasm. The importance and role that professor of geography has are perhaps best illustrated by the following wordsof Borivoje Z. Milojevic: “If something is need to be done by tomorrow afternoon, do it today! None one day should past, without writing a couple of sentences or reading a few pages. The door of your office should always be opened for your student and associates, particularly for ones abroad (Pavlovic, 2016).

These spoken words should make all geographers think and reexamine themselves. Without this kind of work, we are deeply convinced that there will be no well organized teaching of geography and no good geographers. All this is reflected in the level of university teaching and the status that geography has in the educational system.

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