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THEMATIC PROCEEDINGS
II

UNIVERSITY OF KRAGUJEVAC
FACULTY OF HOTEL MANAGEMENT AND TOURISM IN VRNJAČKA BANJA

SOIL EROSION, CHANGES OF LAND USE AND MIGRATION TRENDS - IMPACT ON TOURISM DEVELOPMENT

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Abstract

Sustainable tourism can be simply defined as `tourism that takes full account of its current and future economic, social and environmental impacts, addressing the needs of visitors, the industry, the environment and host communities`. Sustainability principles refer to the environmental, economic, and socio-cultural aspects of tourism development. A suitable balance must be established between these three dimensions to guarantee its long-term sustainability (UNEP and UNWTO, 2005). The paper presents a comparative analysis of ecological and sociodemographic components: land use changes, intensity of erosion, population, household and settlement size (in the area of Vranje Valley in the period from 1953 to 2016). According to the erosion maps produced using the erosion potential method by prof. Gavrilović, the mean coefficient of erosion (Z_{mean}) of the study area amounted to 0.76 (intensive erosion processes) in 1953, while it was 0.34 (slight erosion processes) in 2016. Along with erosion control works, the observed changes have caused a decrease in the intensity of erosion in the last 60 years.

Keywords: *intensity of erosion, land use, socio-demographic factors, sustainable tourism, Vranje Valley*
JEL classification: $Q_{24}, Q_{25}, R_{14}, R_{20}$

Introduction

Soil erosion is considered to be one of the most common forms of land degradation that can greatly affect the environment. In recent years,

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erosion has been increasingly recognized as a threat that causes loss of soil, water quality deterioration and many other adverse effects. Since prevention is the best way to address these problems, planning, conservation and management of degraded areas are of vital importance (Perović et al. 2016). Human-induced erosion typically occurs in the regions with intensive agricultural production and other human activities such as mining and construction or intensive deforestation. The planning of soil conservation measures requires knowledge of the factors that cause the loss of soil. It makes the first step in the soil erosion control (Perovic et al. 2013).

The region of Vranje Valley was the central point from which the highest intensity erosion processes developed during the 1950s. Devastating torrential streams endangered human lives, as well as the Belgrade-Skopje-Thessaloniki motorway and railway, plough land, etc (Braunović, 2013). The study of the change in the intensity of erosion processes revealed the causes of its abatement in the period 1953-2016.

The pattern of land use, accompanied with the study of weather and climate conditions, topography, geological composition, bedrock and distribution of the observed erosion processes, was one of the key factors in the identification and mapping of erosion process. By using land and other natural resources for the purpose of social and economic development, man may either disturb and endanger the naturally-established balance or preserve and improve it. Therefore, the land use, as a significant anthropogenic factor of erosion, represents the focal interest of the study. The paper presents the study of the change in land use in the region of Vranje Valley in the period from 1953 to 2016 and the ways socio-demographic changes affected the intensity of erosion processes.

Study area

Vranje Valley is situated in the south-east of Serbia. In administrative terms, the Vranje Valley region belongs to the municipalities of Vladičin Han, Surdulica, Vranje and Bujanovac. It is 45 km in length stretching from Vladičin Han to Bujanovac in the NE-SW direction (Figures 1 & 2). It is averagely 5km in width, but its form is mostly indefinite. In the north, it reaches its maximum width in the area between Vladičin Han and Surdulica (15 km), whereas in the south the maximum width is between Gornji Vrtogoš and the village of Klenike (20 km). It covers an area of 1,302.16 km^2. Torrential watersheds account for 1,240.45 km^2 (95%) of the total surface area, whereas the remaining 61.71 km^2 represent the area beyond the watershed (built up area of Surdulica, Vranje and Bujanovac, the road network and watercourses). The brim consists of older rocks, but the bed is covered with neogene sediments (Braunović & Ratknić, 2012a).

Figure 1: *Study area*

Figure 2: *Map of municipalities and cadastral municipalities*

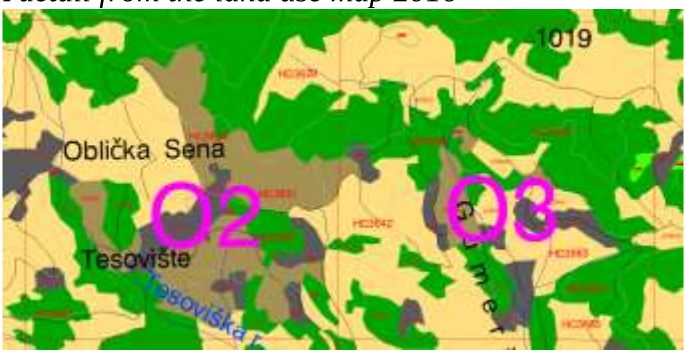
Source: *Original*

Methodology

The available topographic maps, field mapping data and satellite images of the study area were processed in order to define the land use pattern in 2012. The structure of the area was determined by using homogeneous plots, within which productive and non-productive areas were identified. Productive areas comprised forests, degraded forests, meadows and pastures, degraded meadows and pastures, high-mountain meadows and pastures, plough land, vineyards, orchards, house yards and gardens. Non-productive areas included gullies, rocky grounds, gravel, road networks, waterways and the construction zone of settlements. Based on the above-mentioned categories, there are 4100 homogenous plots within the study area. This classification was then used to draw up a digital map of land use that formed the basis for the mapping of erosion (Figure 3). We studied the state of erosion in two reference periods: in 1953 and in 2012.

The 1953 coefficient of erosion was determined according to the available digitalized map of erosion. The values of *Z* erosion coefficient were calculated by Prof Gavrilović's methodology (Gavrilović, 1972) using land survey data (mapping of excessive and intensive erosion processes), data on bedrock, soil, climate and distribution of vegetation for each homogeneous plot. The intensity and spatial distribution of erosion processes were determined in 2012 based on a 1:50 000 digital map of erosion (Braunović, 2013). The map was further improved in 2016 with the results of field research and the data from thematic maps (topographic, geological, soil, land use, etc.) and satellite images. Regarding the socio-demographic context, we studied the changes in the population trends, household numbers and population density based on the available census data for the period from 1948 to 2011 (Ratknić & Braunović, 2013). Data were collected and analyzed for 165 settlements (Statistical Office of the Republic of Serbia, 2014a; Statistical Office of the Republic of Serbia, 2014b). We further studied and determined the number and the size of settlements, population by municipalities as well as the changes in the population size of the settlements with the altitude.

Figure 3: *A detail from the land use map 2016*



Source: *Original*

Results and discussion

The length of the South Morava's main stream in the Vladičin Han–Bujanovac section is 47 km (Table 1). The hydrographic network is well-developed, with 73 tributaries flowing into the South Morava in this section: 36 torrential tributaries on the right bank and 37 on the left bank (rivers, streams, gullies and dry watercourses). The largest tributary of the South Morava in this area is the Vrla River with 217.76 km^2 of watershed area.

Table 1: *Hydrographic and topographic characteristics*

Parameter	**Vranje Valley**
Watershed surface area - F (km^2)	1302.16
Main stream length - L (km)	47.00
Watershed circumference (km)	189.96
Most upstream point of the main stream - K_v (m a.s.l.)	394.5
Most downstream point of the main stream - K_u (m a.s.l.)	324.0
Stream winding coefficient - K_k	0.80
Number of stream tributaries - B_r	73
Average slope in the section - I_p (%)	0.15
Mean area width- $S_š$ (km)	27.76
Total length of hydrographic network-ΣL (km)	572.50
Hydrographic network density - G ($km \cdot km^{-2}$)	0.47
Watershed asymmetry coefficient - a	0.64
Highest watershed altitude (m a.s.l.)	1,923.00
Mean watershed altitude - N_{sr} (m a.s.l..)	804.30
Mean watershed altitude difference - D (m)	480.30

Source: *Original*

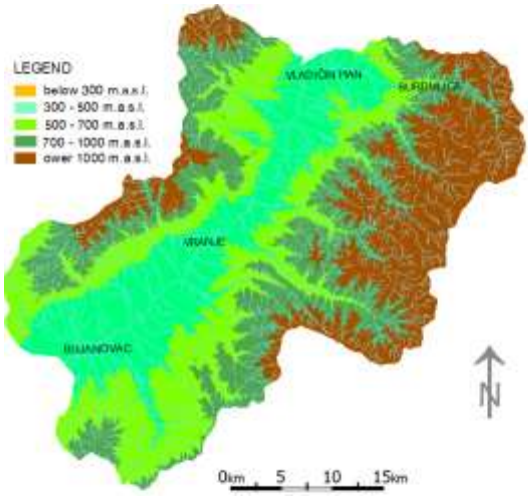
The second largest watershed tributary is the Vranjsko Banjska River. The remaining two rivers, belonging to the class of tributaries with the surface area over 100 km^2 are the Kozarska and Trnovačka River. The tributaries with the watershed area of 50-100 km^2 are the Džepska, Jelašnička, Korbevačka, Tibuška, Trnovačka and Krševička Rivers.

Figure 4: *The Map of hydrographic network*

Source: *Original*

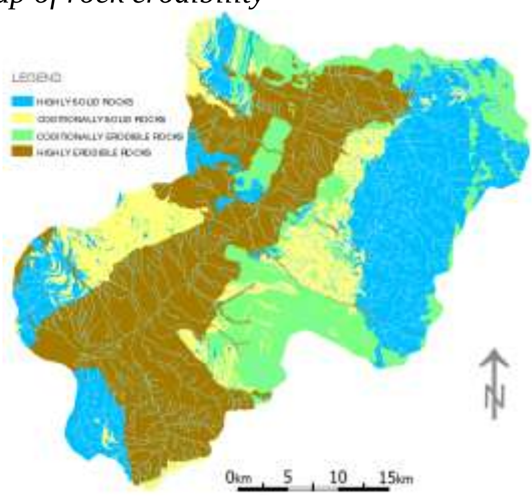
There are 15 watershed tributaries with the watershed area of 20-50 km^2, the largest among which are Preobraženska, Trebešinska and Jovačka River (Figure 4). The slope inclinations of the watershed tributaries are significantly above the average and range from 3 to 20 % (Figure 5). All tributaries in the watershed area have typical torrent characteristics: developed spring areas, large slopes in the upper and central streams, lower stream slopes of 1-3 %, with clearly distinct or highly developed fans.

Figure 5: *Altitudinal zonation*



Source: *Original*

Figure 6: *The map of rock erodibility*



Source: *Original*

The research area is at 300 to 1923 meters above sea level, with each altitude zone (300-500, 500-700, 700-1000 and >1000 m a.s.l.) covering 25% of the surface area.

Natural characteristics of the area (climate, topography, soil, bedrock, developed hydrographic network, degraded forests) favor the development of erosion processes (Braunović, 2013). Highly solid rocks account for 23%, conditionally solid rocks for 12%, conditionally erodible for 25%, and highly erodible for 40% of the total area. The areas potentially at risk of erosion exceed the stable areas, and account for about 65% of the area of Vranje Valley (Figure 6).

The land use pattern for 1953 was defined based on the available data from 'The record of torrents of the South Morava River's right and left tributaries in the Vladičin Han-Bujanovac section, The Register of torrent watersheds and slopes`, 1964. By means of synthesizing the above-mentioned data, it was determined that forests accounted for 33.19%, plough land for 32.80%, meadows and pastures for 7.39%, orchards for 1.46%, house yards and gardens for 0.43 % of the total watershed surface area, that is, productive areas constituted 75.27% of the study area. In 1953, barren land accounted for 22.38% of the watershed, that is, over 1/5 of the study area (Braunović & Ratknić, 2012b). When the share of the areas denoted by the term 'outside the watershed area' (built up areas, asphalted roads and watercourses) is added to the barren land share in the total surface area, it may be concluded that non-productive areas occupied 24.73% or one quarter of the Vranje Valley surface area (Table 2).

Table 2: *Land use in Vranje Valley (1953)*

Land use	**Surface area ha**	**Representation %**
Forests	43,225	33.19
Meadow and pastures	9,623	7.39
Plough land	42,715	32.80
Orchards	1,896	1.46
House yards and gardens	560	0.43
Productive areas	98,019	75.27
Barren land	29,138	22.38
Outside the watershed area	3,059	2.35
Non-productive areas	32,197	24.73
Total	130,216	100.00

Source: *Braunović, 2013*

In 2016, the productive area in the region of Vranje Valley accounted for 96% of the study area. Forests covered 47% of the area, whereas degraded forests, located around the settlements, accounted for 3.6% (oak stands). Tree pruning for animal fodder was still practiced, although in small areas. Meadows and pastures covered 21% of the area, 5% of which were degraded pastures, while high mountain meadows and pastures constituted 9%. Plough land covered 21% of the area, and it stretched along the South Morava River and the lower streams of its larger tributaries (Figure 7). Very small areas of plough land were found on higher altitudes and steep slopes. Non-productive areas accounted for 3.8% of the total surface area (Table 3). Barren land was recorded on 307 ha, 53ha of which were covered with gullies (Žuta voda, the Trnovačka river basin, the Muhovska river, the surroundings of Veliki Trnovac).

Table 3: *Land use in Vranje Valley (2016)*

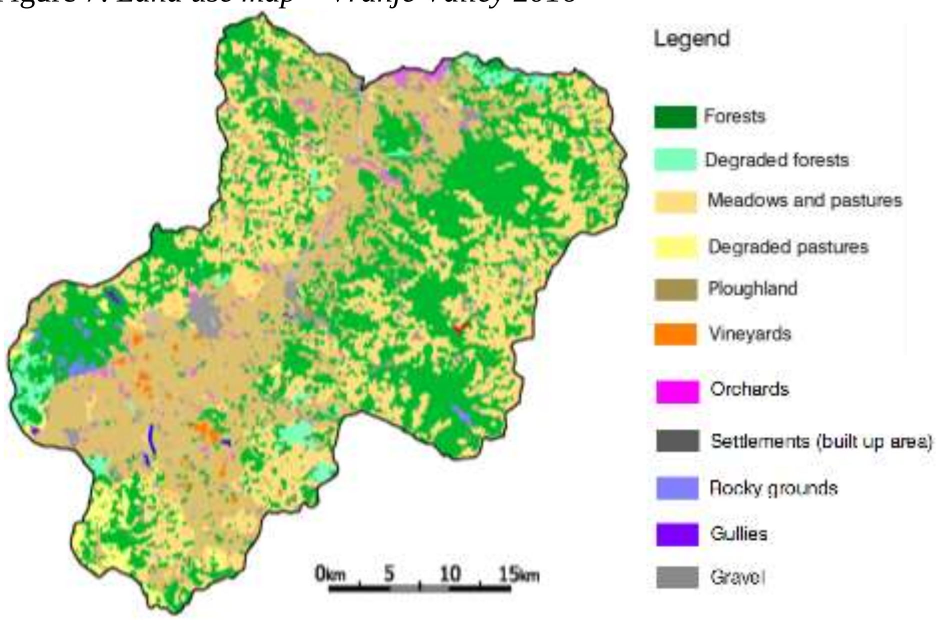
Land use	**Surface area (ha)**	**Share (%)**
Forests	58,456.61	96.41
Degraded forests	2,177.52	3.59
Forests	60,634.13	46.56
Meadow and pastures	23,828.97	85.75
Degraded pastures	1,358.08	4.89
High mountain meadows and pastures	2,601.88	9.36
Meadows and pastures	27,788.93	21.34
Plough land	28,069.24	21.55
Vineyards	1,121.67	0.86
Orchards	2,001.01	1.54
House yards and gardens	5,669.73	4.35
Productive areas	125,284.71	96.20
Settlements (built up area)	3,052.93	2.34
Gullies	52.99	0.04
Rocky grounds	208.31	0.17
Gravel	45.68	0.04
Road network and watercourses	1,572.00	1.21
Non-productive areas	4,931.91	3.80
Total	130,216.62	100.00

Source: *Original*

The share of plough land in the study area decreased in the period from 1953 to 2016. In comparison to 1953, forests recorded an increase of 13.4%, resulting in the present afforestation level of 46%. Non-productive areas decreased by nearly 21% in the same period. The share of plough land in the total surface area decreased, i.e. plough land was abandoned and naturally ’transferred’ to the category of meadows and pastures, the share of which increased by 14%.

Based on the land use map drawn up in 2012, it can be determined that the productive area constitutes 96.20%, whereas the non-productive area accounts for 3.8% of the Vranje Valley region. In addition to its primary purpose, the land use map was used as the basis for drawing up of an erosion map. Vranje Valley comprises 165 cadastral municipalities (Surdulica 22, Vladičin Han 30, Vranje 80 and Bujanovac 33). The last census data (2011) for Bujanovac could not be used because they were given at the level of the whole municipality. According to the 2002 census (Table 4), the area had a population of 151,670. Vranje (population of 73,944), Surdulica (10,888), Vladičin Han (8,030), Vranjska Banja (5,347) and Bujanovac (12,011 - 2002 data) have the status of urban settlements. Urban settlements have 110,220 inhabitants, which makes about 67% of the total population. A total of 19,597 inhabitants live in 11 rural settlements with a population over 1,000.

Figure 7: *Land use map – Vranje Valley 2016*



Source: *Original*

Table 4: *Population by census years and municipalities*

Municipality	Number of CM	Population by census years							
		1948	1953	1961	1971	1981	1991	2002	2011
Surdulica	22	15132	17901	17591	18109	19624	20395	19256	18380
Vladičin Han	30	15345	16001	15738	16218	17776	19196	19086	17687
Vranje	80	48388	51173	54841	63160	75571	80778	84004	99532
Bujanovac	33	20841	22185	23630	26915	29929	33137	29324	-
Total	165	99706	107260	111800	124402	142900	153506	151670	135599

The study settlements were classified according to their population in 5 categories:

1. Villages with a population below 100 (with an increase from 4 villages with 336 inhabitants in 1953 to 65 villages with 2,761 inhabitants in 2011).
2. Villages with a population from 101 to 300 (with a decrease from 50 villages with 10,452 inhabitants in 1953 to 38 villages with 6,541 inhabitants in 2011).
3. Settlements with a population from 301 to 500 (with a decrease from 47 settlements with 18,797 inhabitants in 1953 to 22 settlements with 8,779 inhabitants in 2011).
4. Medium-sized settlements with a population from 501 to 1000 (with a decrease from 44 settlements with 30,334 inhabitants in 1953 to 24 settlements with 17,025 inhabitants in 2011).
5. Large rural and urban settlements with a population over 1000 (with a decrease from 20 settlements with 47,428 inhabitants in 1953 to 16 settlements with 129,817 inhabitants in 2011) (Table 5).

Figure 8: *The village of Kaćarci, 2016*

Source: *Original*

Table 5: *Changes in the population and settlement number*

Population	1953		1971		2011	
	Number of settlements	Population	Number of settlements	Population	Number of settlements	Population
Municipality of Vladičin Han						
below100	0	0	0	0	11	507
101-300	9	2122	12	2360	9	1519
301-500	7	2668	8	3529	3	1096
501-1000	12	8305	8	5308	3	2388
> 1000	2	2906	2	5021	4	12177
Total	30	16001	30	16218	30	17687
Municipality of Surdulica						
below 100	0	0	0	0	11	466
101-300	2	380	6	1108	3	556
301-500	8	3388	9	3254	1	390
501-1000	6	3879	7	4611	3	2254
> 1000	6	10254	3	9136	4	14714
Total	22	17901	22	18109	22	18380
Municipality of Vranje						
below 100	2	166	5	396	36	1446
101-300	29	6066	36	7402	15	2369
301-500	22	8690	17	6665	13	5326
501-1000	19	12689	16	10663	11	7600
> 1000	8	23649	6	38034	5	82791
Total	80	51260	80	63160	80	99532
Municipality of Bujanovac						
below 100	2	170	2	164	7	342
101-300	10	1884	10	1818	11	2097
301-500	10	4051	9	3310	5	1967
501-1000	7	5461	7	4763	7	4783
> 1000	4	10619	5	16860	3	20135
Total	33	22185	33	26915	26	29324
VRANJE VALLEY						
below 100	4	336	7	560	65	2761
101-300	50	10452	64	12688	38	6541
301-500	47	18797	43	16758	22	8779
501-1000	44	30334	38	25345	24	17025
> 1000	20	47428	16	69051	16	129817
Total	165	107347	168	124402	165	164923

Source: *Original*

In 1948, a total of 49% of the population in the municipality of Surdulica lived in the altitude zones of 300-500 m (19%) and 500-700 m (30%), while 51% of the population lived in the zones of 700-1000 m (32%) and over 1000 m (19%). In 1971, the population was still increasing in the zones of 300-700 m, but decreasing in the settlements over 700 m a.s.l.

According to the 2002 census, the largest population growth compared to 1948 was recorded in the zone of 500-700 m (2.43 times), and the largest population decrease in the zone above 1000 m (as much as 12.4 times). According to population projections for 2021, the zone above 1000 meters above sea level will be depopulated (Braunović & Ratknić, 2010).

The aim of the study was to determine the changes in the number and size of the settlements and the reducing trend in the population per municipality. Table 5 clearly shows a reducing trend in the population number and in the number of larger settlements (over 300) and an increasing trend in the number of settlements with the population below 300, especially below 100. The total number of inhabitants in the settlements with a population below 100 has increased with the increase in the number of settlements of this size.

The settlements with the population over 1,000 inhabitants have also recorded an increase in the number of inhabitants (urban areas).

Table 6. Altitudinal distribution of settlements and population

Altitude zones (m a.s.l.)	Number of settlements	Population							
		1948	1953	1961	1971	1981	1991	2002	2011
below 100	1	11252	13465	17999	28613	44094	51215	55052	73944
300-500	72	48075	50492	51948	56093	63088	71127	69021	40924
500-700	38	17160	18584	18782	19301	20530	20429	19095	14300
700-1000	35	14260	15058	13865	12338	9985	7631	6620	4755
>1000	19	8959	9661	9206	8057	5203	3104	1882	1136
Total	165	99706	107260	111800	124402	142900	153506	151670	-

Source: Original

Table 7. Population size of the settlements by altitude

Altitude	Population below 100			101-300			301-500			501-1000			more than 1000		
	1953	1971	2011	1953	1971	2011	1953	1971	2011	1953	1971	2011	1953	1971	2011
< 300	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
300-500	0	0	8	18	22	18	18	17	16	26	22	18	10	11	12
500-700	2	3	18	17	20	11	8	6	4	7	7	3	4	2	2
700-1000	2	2	21	9	16	9	16	11	2	6	5	2	2	1	1
> 1000	1	2	18	5	5	0	5	8	1	6	3	0	2	1	0
Total	5	7	65	49	63	38	47	42	23	45	37	23	19	16	16

Source: Original

Most of the settlements are located in the altitude zone of 300-500 m (72 settlements), followed by the zone of 500-700 m (38 settlements) and 700-1000 (35 settlements). There are 19 settlements in the altitude zone over 1000 m, and 1 in the zone below 300 m. Altitudinal distribution of settlements and population is shown in Table 6.

Population size of settlements by altitude zones explains the strong settlement depopulation and fragmentation both in space and in time. There is an obvious decrease in the number of settlements with a population of 301-500. They accounted for 43% in 1953, 35% in 1971 and 22% in 2011 (Table 7) of the total number.

Figure 9: *Population in 1953*

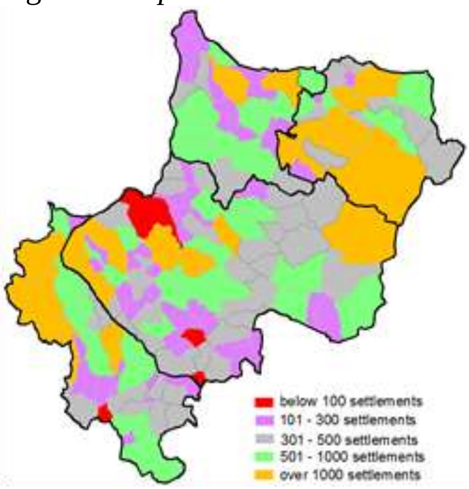
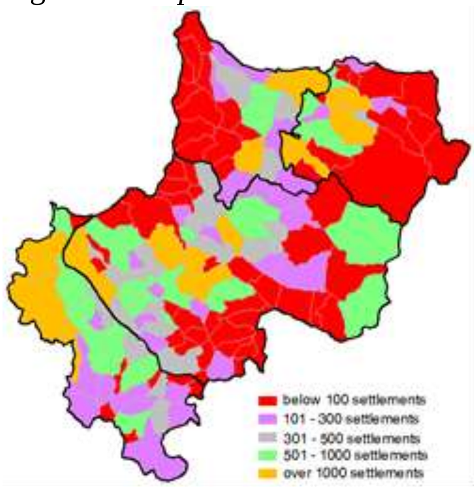


Figure 10: *Population in 2011*



The population reduction occurs in all altitude zones, but it is strongest in the zones over 1000 m, 700-1000 m and 500-700 m. Further reduction occurs in the number of settlements with a population of 501-1000 which accounted for 42% of the total number of settlements in 1953, 38% in 1971 and 20% in 2011. Here again the reduction occurs in all altitude zones and it is most pronounced in the zones above 500 m. The reduction in the number of settlements with a population over 1,000 is slightly less pronounced, except in the zone above 1000 m which had 2 settlements in 1953 and none in 2011 and in the zone of 700-1000 m which had 2 settlements of this size in 1953 and 1 in 2011 (Figure 9 & 10).

On the other hand, there is a significant increase in the number of small settlements. The most significant increase is in the number of settlements with a population below 100. There were 5 settlements with less than 100 inhabitants in 1953, 7 in 1971, and even 65 in 2011. The most significant changes occur in the altitude zones over 700 m.

The state of erosion in 1953 and 2016

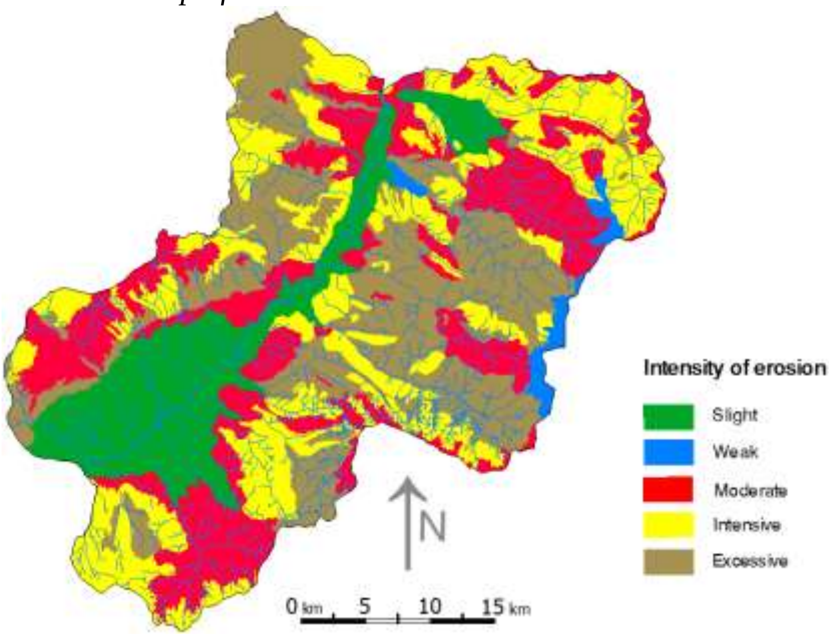
The conducted digitization and measurements of the area under the represented categories of erosion (based on the 1953 erosion map of Vranje Valley) revealed that the study area was affected by erosion processes of all intensities of destructiveness - from weak surface erosion on gentle slopes to excessive surface and deep erosion on steeper terrains. The review of the areas by the intensity of erosion in 1953 is given in Table 8. According to the mean coefficient of erosion, the catchment was generally affected by intensive processes of erosion (Table 8; Figure 11).

Table 8: *The areas by the intensity of erosion in 1953 and 2016*

Categories of destructiveness	**Intensity of erosion**	**Z_{mean}**	**Share in the total area**			
			1953		**2016**	
			(km^2)	**%**	**(km^2)**	**%**
I	Excessive	1.25	355.44	28.44	3.11	0,25
II	Intensive	0.85	411.90	31.45	15.44	1,24
III	Moderate	0.55	306.43	25.51	115.34	9,30
IV	Weak	0.30	19.50	1.87	657.25	52,98
V	Slight	0.10	209.04	12.73	449.32	36,22
Total		0,76	1302.16	100.00	129180.7	100.00

Source: *Original*

Figure 11: *The map of erosion in 1953*

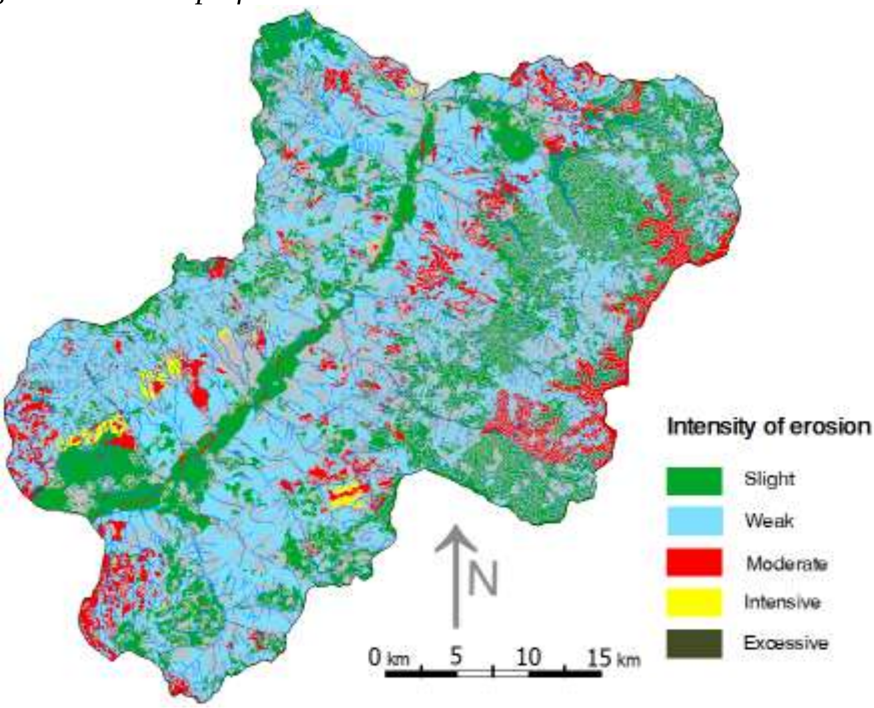


Source: *Original*

Erosion processes of different intensity affected 1240.45 km^2 (95.26%) of the Vranje Valley surface area in 2016, while there was no erosion on 61.71 km^2 (4.74%). The mean coefficient of erosion in the area of Vranje Valley is Z_{mean}=0.34, confirming the prevailing effects of weak erosion processes (Table 8; Figure 12). The coefficient of erosion in this area ranges from Z_{mean} = 0.29 (part of the immediate basin of South Morava River basin which belongs to Vranje Valley) to Z_{mean} = 0.84 (Tibuška River Basin).

This area has recently experienced an increase in the number of forest fires, 98% of which have been directly or indirectly related to human activity. The fire-affected sites in the areas susceptible to erosion can increase the risk of soil loss and flooding due to the absence of vegetation cover and changes in the soil structure (Ratknić & Braunović, 2015).

Figure 12: *The map of erosion in 2016*



Source: *Original*

Apart from forest fires, landslides, *etc*., road erosion (dirt roads in the hilly and mountainous areas) also occurs and calls for direct and indirect involvement of people (paving, protection, maintenance, proper use, *etc*).

Figure 13: *Road map(Vranje Valley)*

Source: *Original*

Figure 14: *Landslide and damaged road*

Photo: *The Basin Vranjsko banjska rivers 2015*

Conclusions

Indirect anthropogenic impacts (depopulation and population ageing) have resulted from the industrialization and urbanization of the area. Depopulation of rural settlements has reduced the share of arable land, meadows and pastures. It has further decreased the number of livestock and turned large areas into the grass. Non-productive areas decreased by 2.17% in the same period, while the forests increased by 17.6%. Direct human impact - changes in land use, effectively implemented erosion control works and the prevention measures applied in the period from 1955-to 1990, together with the above factors, have reduced the intensity of erosion in this area. The changes have been most pronounced in the zones above 600 m a.s.l., which is the zone of intensive village depopulation.

The conditions are still suitable for the development of erosion processes: non-resistant and impermeable bedrock, great altitude differences, frequent short and heavy rains, forest fires, degraded vegetation cover, tree pruning for fodder, irrational use of agricultural land, unfinished erosion control works, *etc*.

When planning the development of this impoverished part of Serbia through tourism, one should primarily preserve the stability of the ecosystem, increase the share of protected areas under different protection regimes, invest in the road network and use the agricultural and forest land in a sustainable manner.

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