

Corrigendum to “Challenges of Soil Resource Protection:  
A Case Study from Sitnica River Basin (Kosovo)”  
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The authors regret that the corresponding author was mistakenly tagged in the original article. The proper corresponding author is shown above.

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## Challenges of Soil Resource Protection: A Case Study from Sitnica River Basin (Kosovo)

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### ABSTRACT

The soil resources in Kosovo are facing challenges due to different human activities. Urbanization, along with economic growth, has further worsened the shortage of soil resources in Kosovo. In the last 20 years, Kosovo has undergone some social, political and economical changes which have made the population to migrate toward plains, where new settlements are formed, and other are extended. Soil resources are important for Kosovo's inhabitants, who are mainly focused on agriculture. Most of the Kosovo's terrain is mountainous, which means nearly half of the area is not suitable for agriculture. The Sitnica River basin lies mostly in Kosovo Plain where soils are characterized by high fertility with a great potential for agricultural development. The vicinity parts of the river basin lie in the hilly mountainous areas where soils have low fertility. Good natural conditions have made the River Basin the most densely populated area in Kosovo. Rapid extension of urban and rural settlements changed the land cover; agricultural lands were excluded from primary use, and the agricultural capacity is reduced with the increasing number of settlements on lands with high quality. Sitnica River basin was faced with uncontrolled urbanization, followed by the degradation of agricultural lands and land use changes, where floods occur in some cases or the flood risk is increased. In this case study, the Sitnica River basin will be analysed based on terrain morphology, soil and other natural resources, land use changes and will be a contribution towards sustainable urbanization of settlements in order to preserve soil resources.

**Keywords:** soil resources, land use, degradation, zoning, urbanization, sustainable development, Sitnica River basin.

### INTRODUCTION

Humans live close to and depend on the soil. It is one of the most scarce and vulnerable human resources and is one upon which, both deliberately and inadvertently, humans have had major impact [Richter, 2007]. The urban population, like all over the world, is growing rapidly in Kosovo as well. Globally, more people live in urban areas than in rural ones, with 54% of the world's population residing in urban areas in 2014. In 1950, about 30% of the world's population was urban, and by 2050 66% of the world's population is projected to be urban. The rural population of the world has grown slowly since 1950 and is expected to reach its peak in a few years. The global rural population is now close to 3.4 billion and is expected to decline to 3.2 billion by 2050 [United

Nations 2014]. Even in Kosovo, the population – especially the urban population – has grown in the last five decades. Until the 1960s the changes were small, but later, the changes were enormous for a small country. In 1953, the urban population in Kosovo was 15.6%, in 1981 it was 32.4%, in 1991 about 36%, and today it reaches 45% of the total population. In 1948 the number of the urban population was 71,000, while in 1991, it grew to 730,000. In the period 1953-1981, the urban population increased to 388,300 or 307%, while in the years of 1953-1991, it was about 600,000 or 480%. Today, about 45% of Kosovo's population lives in cities, which is 8% below the world level. The housing area and its funds increase in villages and cities. In Kosovo's urban settlements, the number of flats grew from 21,000 in 1951 to 88,000 in 1981, and has doubled today

[Kosovo Agency of Statistics 2013]. The socio-economic changes in the settlement of Kosovo led to migration toward plains where most of the cities are located. The number of population in hilly and mountainous areas is declining and the dominant migration is towards the agricultural lands in the periphery of the existing dense settlements which are extended in flat areas. Land use planning in the Sitnica River basin, and in general throughout Kosovo were not fully implemented. As a result, the primary destination of agricultural lands is changed into construction sites. Additionally, the largest coal mine in Kosovo is located in the centre of Sitnica River Basin. In the past, the periphery of settlements (cities and villages) included transition zone between the urban landscape and natural habitats. Today, periphery of villages is being extended rapidly in construction sites. Thus, urbanization has led to changes in land cover. On the other hand, improper planning has influenced the major transformations in agricultural soils, particularly near the main road to the area.

## LITERATURE REVIEW

Agricultural lands in the periphery of the cities serve as transition zones from natural and rural habitats to urban landscapes. They serve as a supplier of vital ecosystem elements such as food, clean air, soil and water to the urban areas and as buffer zones to diminish the negative effects of the urban systems on the natural environment [Doygun, 2009].

Expansion of urban, suburban, and exurban development into agricultural landscapes and other rural settings has prompted much public concern over land use. Alarming estimates of the loss of farmland have been suggested, as have startling visions of extensive idling of farmland in anticipation of future urban development or because of intolerable spillover effects from the nearby urban development. In order to sustain this concern over declining agriculture in urban regions of the country, there appears to be an association between the increases in population and losses of farmland [BERRY, 1978]. The growth and urbanization of the global human population over the last 50 years has resulted in the rapid increase in the total share of global population on the one hand, and the unprecedented spatial expansion of a number of cities, on the other. While

the world's megacities (i.e., those estimated to have more than 10 million inhabitants) offer striking examples of the environmental challenges that accompany urbanization, environmental degradation has not been avoided by cities of any size [Hardoy, Mitlin, Satterthwaite, & Hardy, 2001]. The rapid and random expansion of urban centers has caused changes on land cover. Forests and water catchment areas are faced with the threat of a dense settlement [Archer, 1989], [Mount, 1995]. The agricultural capacity is reduced due to urban sprawl on high quality agricultural land [Kim, Kobayashi, & Mizuno, 2003]. Indeed, the impact of urban activities of cities of all sizes on the local, regional, and global scale environmental trends is increasing [Millennium Ecosystem Assessment, 2005]. The growth of the number of population is affected in Kosovo settlements, and also the extension of settlements. Thus, most of the settlements are concentrated on plain areas, the effects of urbanization had more impact on most fertile soils of Sitnica basin. Soils have received an increased attention. The impact of urbanization on the agricultural land became an academic concern during the 1950s [Bogue, 1956]. By the late 1960s, Gilbert was able to put together a comprehensive study of the impact of cities on various environmental resources, and included an entire chapter on soils. [Gilbert, 1989]. During the 1990s, the literature on urbanization and its impact on soils expanded significantly. The direct effects of urbanization and population decentralization involve, of course, the conversion of land from rural to urban uses [Berry, 1978].

Two important reasons why cities are becoming the driving forces in environmental trends involve the increasing share of the global population that resides in urban areas and the increased intensity of activities that these populations bring to cities [Marcotullio, Braimoh, & Onishi, 2008]. The world recently hit a level of 50% urbanization and the United Nations [United Nations, 2001] predicts that the share of urban population will increase to 60% over the next 30 years.

The land use plans in the Sitnica River basin, and throughout Kosovo in general are not fully implemented, so as a result, agricultural lands have changed the primary destination, and became construction sites. The destination change of soils has influenced the development of other processes, such reduction of soil resources, erosion, local climate, etc. The number of population and settlements in the hilly and mountainous

areas is declining. Precisely, these inhabitants are migrating toward plains with high fertile soils. In this case, the number of inhabitants in plain settlements increased, whereas the existing settlements were extended. In the past, the periphery of settlements (cities and villages) have been the transition space between the urban landscape and natural habitats, while today, periphery of settlements is being extended at a rapid pace into construction space. Thus, urbanization has led to the changes in land cover. Improper planning has affected large agricultural lands, especially near the main roads of the basin.

In order to protect the land from uncontrolled extension of settlements and urban infrastructures, in the concept of sustainable development, it is necessary to create a zoning system or define future development. "Zoning is a system that regulates the type and intensity of land use development that occurs within a community. In order to create a zoning system, a local government divides the municipality into districts and regulates the construction and use of buildings within it. The regulations may differ among one another, but within each individual district, the regulations must be uniform. A zoning system enables the community its future growth to conform to a set of goals and policies that reflect the community's vision for itself. For example, a municipality that sets a goal to strengthen the central business district would likely create a zone in its downtown into which only such intensive commercial uses would be allowed. Similarly, a community that chooses to remain rural might create a zone that allows minimal development, and then place a significant proportion of its land within this zone. Agricultural zoning is a specialized form of zoning used by communities that seek to preserve their agricultural base. It reflects a community-wide policy that farmland is a valuable resource that should be preserved to ensure the continued production of agricultural commodities. The purpose of agricultural zoning is to protect farmland from incompatible uses, which would adversely affect the long-term economic viability of the area within the region" [Kruft 2001]. The main objective of zoning should consist in rational land use in accordance with sustainable development principles [Riddell, 2004]. These principles are comprehensively investigated in Williams [2010], Guy and Marvin [1999], Jenks et al. [1996], Holden [2004], Hoyer and Holden [2003, 2001], McLaren [1992] and Banister [1992], who

discuss this process as an interaction between social and technical solutions for sustainable cities.

Urbanisation leads to the conversion of a natural landscape to an urban area and intensifies the competition between different land-use practices in space and time having direct and indirect types of influence on soil resources and food security [Ramadani 2013]. In addition to the impact on construction, the agricultural land fund is reduced by coal surface exploitation and coal combustion for energy production, where significant areas of productive soils are degraded by pollution [Bytyqi, Ramadani 2018]. The construction density is one of the most important factors and criteria for urban development, protection of agricultural land and the sustainable development of settlements. Many studies emphasise a strong correlation between the urban density and sustainability, especially in relation to transport with numerous benefits. Sustainable settlements are developed based on certain important criteria: high density and integrated land use [Newman, Kenworthy, 1989; Næss, 2012; Van der Waals, 2000; Burton, 2001; Gordon and Richardson, 1997; Thinh et al., 2002; Kenworthy, 2006]; Jacobs, 2002; Rudolf et al., 2017; Acioly, 2000; Dagmar et al., 2017; Riddell, 2004]. Good management would also yield results for resource conservation for future generations.

## STUDY AREA

Sitnica River flows in the central part of Kosovo Plain (Figure 1). The river basin (without two main tributaries: Llapi River and Drenica River) has an area of 1,489 km<sup>2</sup> (13.6% of the Kosovo territory) (Figure 2). The geology of basin mostly involves rocks of the Pliocene and Quaternary age which are represented by sand, gravel and silt, sandy and silty deposits with lignite strata. The south-eastern part of the basin is formed by epidote, sericitic schist, metacarbonatic rocks, marbles and carbonate flysch. The eastern part is represented by limestone, marbles, serpentines, andesite, trachyte and metamorphic rocks. In the west, at mount Golesh (1,018 m) there are ultrabasic massifs, in Çicavica (1,091 m) sedimentary – volcanic series. In the northeast, in area of Trepça geological complex there are volcanic-sedimentary series, latite, and pyroclastic rocks. The basin is characterized by a continental climate,



Figure 1. Location of Kosovo in Europe (V. Bytyqi)

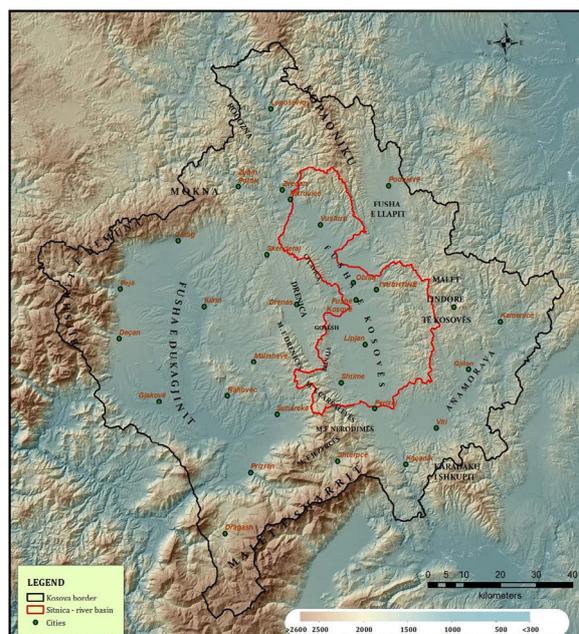


Figure 2. Location of Sitnica River basin in Kosovo (V. Bytyqi)

where the lower part of the basin is crossed by 10°C isotherm, while the average rainfall amounts to 678 mm.

Most of the River basin consists of flat topography (central part), while the periphery is hilly-mountainous. The basin is inclined towards Sitnica River which flows northward to Ibër River, and finally to Black Sea. The average altitude of River basin is 695 meters, and lies between 470-1,377 m. The Carraleva and Nerodima mountains are located southwest; in the south, there is a small watershed divides where the river bifurcation of Nerodimja is created. In the southeast and east there are

Eastern Mountains of Kosovo, with the height of 1000 meters. In the west, the basin is closed by the mountain of Çiçavica (1,091 meters), while in the northeast the mountain of Kopanik (Figure 2).

The rivers flow toward Sitnica River, which belongs to the Black Sea watershed. In terms of soils, Sitnica basin has different types of soils, such as vertisols (27.9 %), dark grey in compact layers of rocks (33.3 %), dark reddish (11.6 %), alluvial soils (11.3 %), etc.

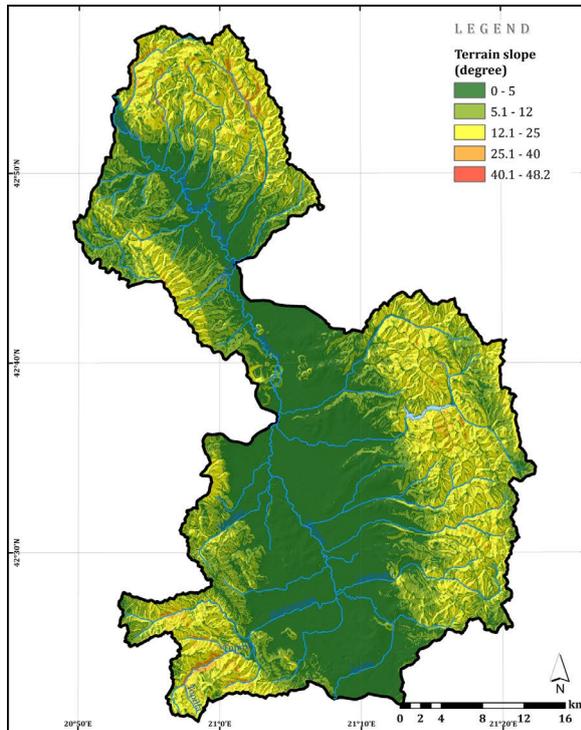
The boundary of land use and crop production is not only determined by latitude, but also by relief, rainfall and distance of water bodies (seas and oceans), aspect of relief [Ramadani, 2013]. The slope of topography plays an important role in the creation of the soil. According to slope criteria, soils are classified into 5 categories [Bognar, 1991]. Thus, in Sitnica River basin (Figure 3, Table 2) most of the slopes are suitable for agriculture (the slopes under 5 degrees). These slopes occupy 47.3% of the Sitnica River basin. The slopes that are relatively suitable for agriculture, which are exposed to the risk from erosion (5-12 degrees), encompass 28.4% of total surface. In turn, the slopes over 12 degrees with restrictive categories including the slopes useful for agriculture through terrace, and the slopes useful for forestry encompass 24.3% of the surfaces in Sitnica basin.

Table 1. Types of soils in Sitnica River basin

Description	Area (ha)	%
Alluvial soils	16892.5	11.3
Diluvium soils	2168.8	1.5
Meadow soils	6322.1	4.2
Mineral-swampy soil	580.3	0.4
Vertisol	41505.6	27.9
Dark clay soils	2614.5	1.8
Dark reddish soils	17331.7	11.6
Pseudogley	5275.0	3.5
Rendzina	1930.1	1.3
Dark grey soils	49627.0	33.3
Terra rosa	1330.0	0.9
Ranker	3326.0	2.2
<b>Sum</b>	<b>148903.6</b>	<b>100.0</b>

**Table 2.** Slope categories and their area in Sitnica River basin

Slope (degree)	Description	Area (ha)	%
< 5	Slopes suitable for agriculture	70434.0	47.3%
5 – 12	Slopes relatively suitable for agriculture with the existence of risk from erosion	42218.9	28.4%
12 – 25	Restrictive category of slopes for the most important agricultural use	34043.6	22.9%
25 – 40	Slopes useful for agriculture through terrace	2202.4	1.5%
> 40	Slopes useful only for forestry	5.2	0.0%

**Figure 3.** Slope map of Sitnica River basin (V. Bytyqi)

On the basis of the data presented on the map, the basin is characterized by fertile soil where most of them lies in the plain, with an altitude under 800 meters, where the slopes of the terrain are below 12 degrees, which in fact represents the high fertile soils. Humans are the main factor for the destiny of soils for certain activities. However, they are also the main factor exerting pressure on soil resources worldwide, including Sitnica River basin. The population in this area is increasing steadily. The destination of internal migrations includes plain areas, especially in Sitnica river basin. Thus, according to the census of 2011, the basin's population was 413,915 inhabitants, with average density of 278 inh/km<sup>2</sup>, i.e. four times greater than the average for Kosovo. Migration processes have led to extension of existing settlements, where most of them are in plain areas.

## DATA AND METHODS

In order to make a relationship with migration, settlement extension and land use changes, a lot of thematic maps (morphological, slope, climate, soil, geologic) were used. The aerial images of different years were used to analyse the recent changes in Sitnica River basin. The population was counted by the censuses from the past, and the latest data are from the population census conducted in Kosovo in 2011. Furthermore, the gathered data were structured, processed and analysed to produce the final results of the paper. The statistical methods used in the GIS software also helped to increase the analysis processes for the land use patterns in this area. Vector layers were prepared, aerial images were used and information on the field were collected. Digital data provides information on expanding settlements, operators, and expanding infrastructure, including the spatial component. The gathered data were then systemized and structured to fit and be used in the appropriate software for further analyses. Lastly, the legal framework was reviewed, an analysis was carried out, and causes were interpreted, which led to the results of the research.

## RESULTS AND DISCUSSION

Sitnica River basin is one of the densely populated agricultural areas in Kosovo. It is characterized by a continental climate, with flat terrain and fertile land, once regarded as the main basis for the development of agriculture in Kosovo. In the second half of the 20<sup>th</sup> century, due to coal reserves (lignite) power plants began to be built in this part of Kosovo. The process of energy production requires the removal of overburden soil and coal extraction. Thus, capacity building infrastructure in the most fertile soils of Kosovo began to lose. Today, the human impact can be observed in Sitnica River basin, not only in connection with the construction of industrial and communication

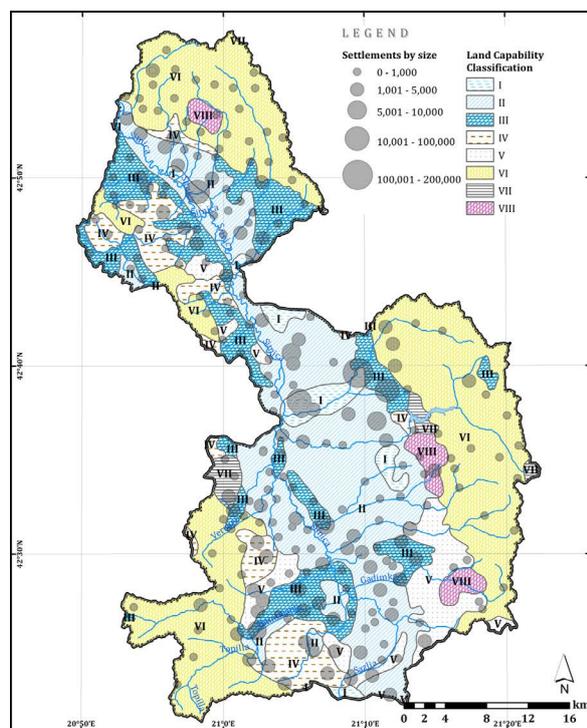
**Table 3.** Land capability classification in Sitnica River basin

Class	Land Capability Classification	Area (ha)	%	Area (ha)
I	Perfect land for growing crops	4,855.3	3.3	79,568.5 (53.4%)
II	Have some limitations that reduce the choice of plants and require moderate conservation practices	42,562.7	28.5	
III	Same as II but require special and intense conservation practices	20,325.9	13.7	
IV	Very severe limitations that restrict plant choice and require careful management	11,824.6	7.9	
V	Cannot be tilled, therefore it's used for pasture, timber or wildlife.	10,007.3	6.7	69,335.1 (46.6%)
VI	Same as V	54,065.0	36.3	
VII	Woodland and wildlife use	2,053.7	1.4	
VIII	Recreation, wildlife, aesthetic uses only	3,209.1	2.2	
Sum:		148,903.6	100	

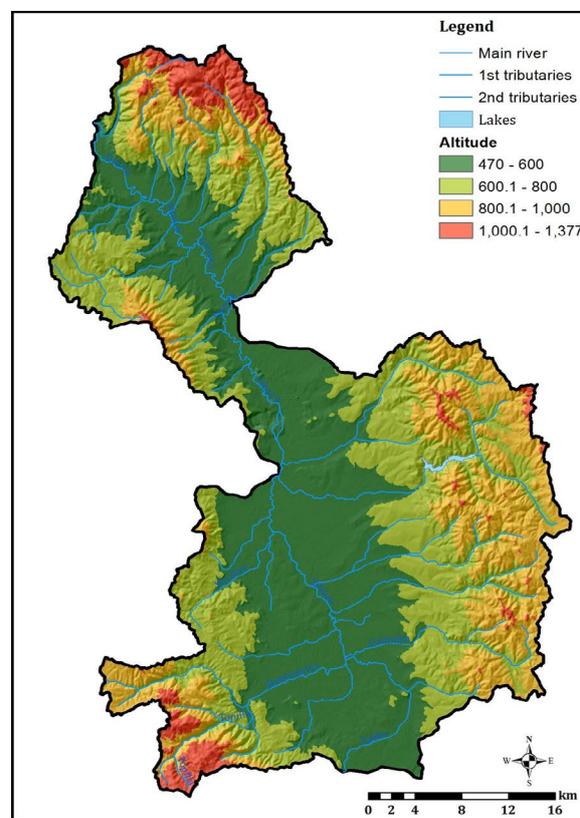
infrastructure, but also with the extension of settlements. In this way, natural landscapes were gradually transformed to urban landscapes.

In Sitnica River basin (Figure 4, Table 3), out of the total area, 79,568.5 ha (53.4 %) correspond to the soils from I- IV category which are considered agriculture land [Law no. 02/L-26]. From this category of agriculture land, II category of soils (area with some limitations that reduce the choice of plants and conservation practices require moderate) are 28.6% (42,562.7 ha); III category which requires intensive use practices are 13.7%; IV category which requires careful management are 7.9%. On the basis of land capability classification, soils of I category

are 3.3% (4,855.3 ha). The rest of the soil resources belong to category V-VIII, which cannot be used for agricultural production. These soils (69,335.1 ha, 46.6%) can be used for other purposes, such as: forestry, meadows, recreation, wildlife, aesthetic use, etc. Most of these soils are situated above 800 meters of altitude, where the slopes of the surface are over 12 degrees. Nowadays, these soils are used for meadows, forestry, wildlife development, etc. these areas are considered with small density of population, which means less impact on soils.



**Figure 4.** Land capability classification map of Sitnica River basin (V. Bytyqi)



**Figure 5.** Morphographic map of Sitnica River basin (V. Bytyqi)

The settlements in Sitnica River basin, also in Kosovo are very early and date to prehistoric periods. Currently, in Sitnica River basin (Table 4) there are 238 settlements located between 470 m and 1,167 m. The average density of settlements is 16 per 100 km<sup>2</sup>, which is larger than Kosovo's average. Greater density of settlements is found in the area under 600 m altitude, where 135 settlements are located, with average density of 21.9 settlements per 100 km<sup>2</sup> (average area of settlements is 45.5 hectare), while in the elevation over 800 meters, the average density of settlements is 9/100 km<sup>2</sup> (Figure 6, Table 4).

The figures indicated that the most of settlements and population are found in the high fertile soils of Sitnica River basin (Land capability class I-IV). At these elevations (<600 m), there are 81.3% of the population of the basin, which in fact includes 41.3% of the total Sitnica River basin area. According to the census data of 2011,

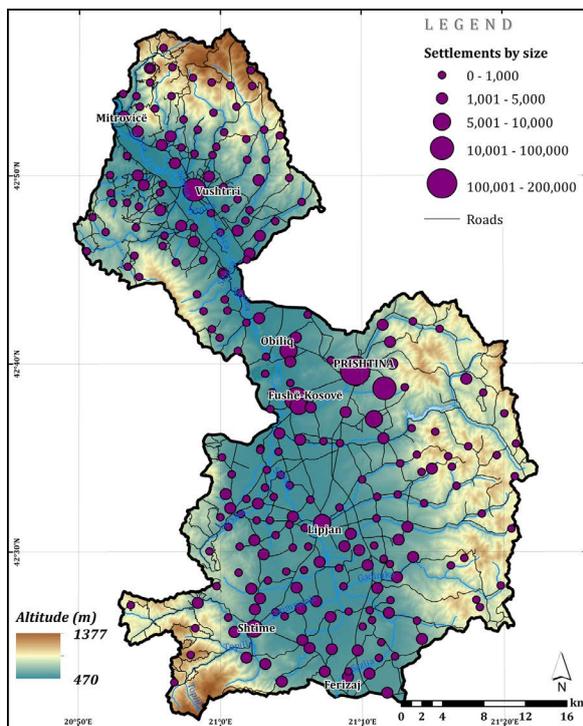
547 inhabitants per square km live in Sitnica River basin, which is three times greater than Kosovo's average population density.

With the extension of settlements, agricultural areas are reduced. Today, greater density of infrastructure is concentrated in the lower parts of basin. In general, the total basin area of Sitnica River (1,489 km<sup>2</sup>), physical structures built by human activities are 9.65% (14,362 hectares) of total area. Most of the sites built by human activity are the settlements which cover an area of 9.2%. The rest include: airports, industrial facilities, landfills, roads, railways, etc. (Table 5). Additionally, the extension of rural areas through the construction of individual houses, and the parcelization of agricultural land are fairly common. In this case, the soils are lost permanently, but the development of intensive agriculture is stopped or reduced.

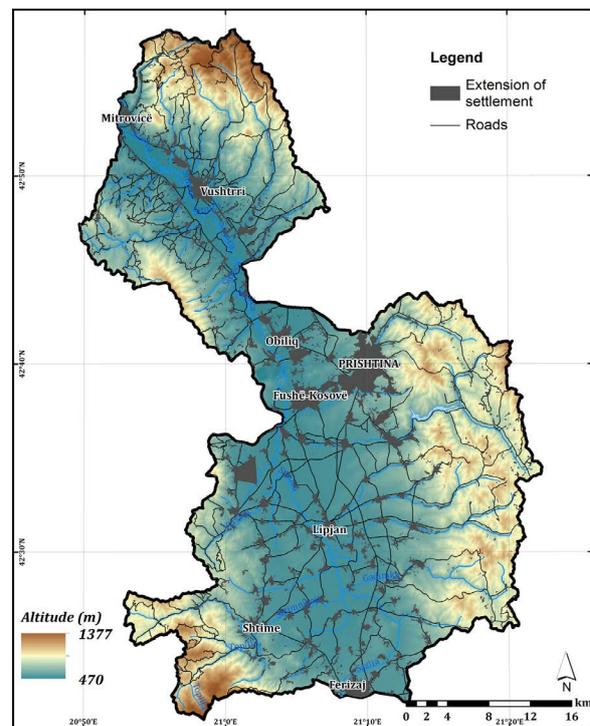
The majority of rural and urban settlements do not possess urban plans or in many cases they

**Table 4.** Demographic characteristics of Sitnica River basin

Altitude (m)	Area (km <sup>2</sup> )	% of area	Nr. settlement	Population (2011)	% of population	Density (inh.km <sup>2</sup> )
< 600	615.3	41.3%	135	336,653	81.3%	547
600 – 800	500.5	33.6%	69	70,496	17.0%	141
800 - 1000	297.2	20.0%	27	6,071	1.5%	20
1000 - 1377	76.1	5.1%	7	695	0.2%	9
	1,489.04	100%	238	413,915	100%	179



**Figure 6.** The distribution of settlements by altitude (V. Bytyqi)



**Figure 7.** Area covered with urbanization process in Sitnica River Basin (V. Bytyqi)

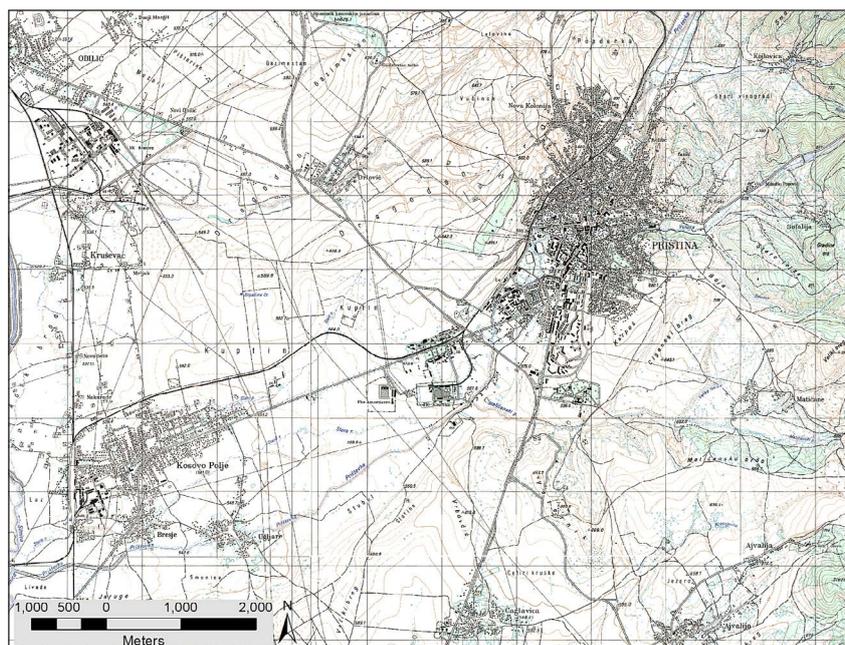
**Table 5.** Area covered by human activity

Human activity	Area (ha)	%
Settlements	13,696.99	9.20%
Airport Pristina	457.61	0.31%
Waste disposal	10.88	0.01%
Power plants	165.92	0.11%
Military	27.47	0.02%
Others	3.96	0.00%
Sum:	14,362.82	9.65%
Total area of basin:	148,903.58	100.00%

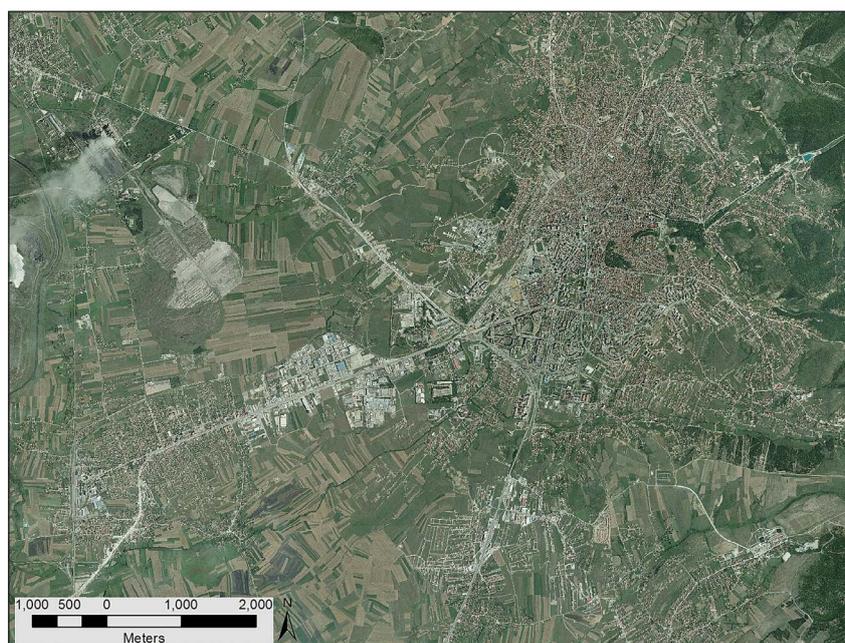
were not implemented. Settlements, particularly rural ones are extended without any criterion, always at the expense of agricultural land.

Even in Kosovo's Spatial Plan [MMPH, 2010], one of the main goals is the preservation of agricultural land. On the basis of the statistics, the agricultural land per capita in Kosovo is very small (under EU standards) that in the future may not provide the necessary agricultural production.

Other negative phenomena are associated with the process of urbanization. Thus, in the



**Figure 8.** The city of Pristina and its surroundings during the 70-s. (Kosovo topographic map)



**Figure 9.** The city of Pristina and its surroundings in 2018 (Kosovo Cadastral Agency)

1970 (based on topographic maps) (the largest city of Kosovo) Prishtevka river flows in the city of Pristina; today, the river is completely covered. Besides the reduction of agricultural land, the extension of settlements infrastructure affects their local climate. Therefore, the highest temperatures today in settlements are observed in summers, particularly in larger cities.

## CONCLUSIONS

Sitnica River basin is known for highly fertile soils and as one of the main areas of agricultural development in Kosovo. More than half of the area of the Sitnica basin is characterized by appropriate relief and very smooth slope. Sitnica basin is characterized by high population density and settlements which are evident due to suitable physical and geographical conditions.

As a result of the urbanization process in Sitnica River basin, the following phenomena are observed: the largest concentration of population in urban areas, near the main cities (capital and large industrial cities), horizontal extension of urban settlements, and unplanned extension of rural settlements.

Additionally, there are certain negative effects of urban extension exerted on high fertile soils, including: permanent loss of agricultural land through extension of settlements, development of commercial activities and construction of necessary infrastructure (especially along the main roads), airport extension, building of industrial capacities and auxiliary facilities. In some cases (April 2014), floods occurred in many villages of Sitnica river basin. They resulted not only from the large amount of rainfall, but also due to improper spatial planning. In the River basin, there are regional inequalities between hilly-mountainous areas and plains, which was one of the driving force for the migration of population toward plain especially near existing urban centers. In the context of settlements distribution is found a disproportional between hilly-mountainous areas and plains, where a large concentration of settlements – which is above average for whole Kosovo – is found in gentle slopes terrain. With the aim of protecting and preserving soil resources, the process of urbanization should take into consideration the small fund of soils resources that owns Kosovo. This fund, despite the small surface, should serve as a basis for the development of agriculture in Kosovo.

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