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THE IMPACT OF RELIEF ON LAND COVER AND LAND USE OF THE LLAP RIVER BASIN

Shpejtim Bulliqi[1], Leutrim Krasniqi [2]*, Florim Isufi[3]

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Abstract: Based on the dialectical principle, an attempt was made to analyze in details the impact of relief on land cover and land use. To achieve this objective, the Llap river basin was chosen. The Llap river basin lies in the north-eastern part of Kosovo, which is discerned as a morphological whole with particular physical-geographic elements. Since the past, relief was a factor with direct and indirect impact on land cover and especially on land use. The essential part of the analysis was the correlation of the geomorphometric parameters (altitude and slope) with land cover and land use. For calculating these parameters, a digital elevation model of 12 m / pixel was downloaded from the Alaska Satellite Facility. On the other hand, the CORINE Land Cover 2012 data from the European Environment Agency (EEA) were used for land cover. The completion of the analysis was done in that form for each category of geomorphometric parameters was compared with land cover and land use. It is evident that relief has influenced the Llap basin, both in the extent of settlements and in the activities that human develop on this land.

1. Introduction

Relief on its forms has been always the object of study, admiration, curiosity and practical analysis for people all over the world. Relief study it has great importance for the recognition of the geographic environment as a whole, which with parameters and morphology influences the creation of natural conditions (climatic, hydrographic, plants and animals) (Kristo, 1971). According to Goudie (2006), the relief can be defined as: "altitude difference in a predetermined area". Geomorphometry, which is defined by Chorley et al. (1957) as a science "which treats the geometry of landscape" that attempts to describe quantitatively forms the

[1] University of Prishtina "Hasan Prishtina", Kosovo, shpejtim.bulliqi@uni-pr.edu
[2] University of Prishtina "Hasan Prishtina", Kosovo, leutrimkrasniqi14@yahoo.com, corresponding autor
[3] University of Prishtina "Hasan Prishtina", Kosovo, florim.isufi@uni-pr.edu,

Earth's surface. Tobler (2000) argues that it is a modern, analytical-mapping approach to mirror topography through computer manipulation. It is said that the basin represents the "basic geomorphic unit" (Chorley, 1969; Leopold et al., 1964). The basin can be thought of as an open system that receives energy from the atmosphere and the sun on its surface and releases energy through water and sediments mainly through the estuary (Zăvoianu, 1985). From this, the authors determined to make this analysis within the Llap basin.

Land cover and land use are characterized by the biophysical and economic features of the Earth's surface (Prakasam, 2012). Land cover describes vegetation and artificial constructions covering the Earth's surface, while land use refers to human economic activities on Earth (Burgess and Pairman, 1997). The knowledge of the area relief is also essential for the implementation of spatial policy or developing planning documents (Salata and Prus, 2012). The concept of sustainable development imposes a requirement for such space leadership that all components of the human environment are balanced while at the same moment considering the natural circumstances for optimal use of space (Kryk 2010; Staniak 2009). Land?form is also a very important factor affecting human activities and rational utilization of space in the process of planning and space management (Prus and Salata, 2014). It is evident that relief has influenced the Llap basin, both in the extent of settlements and in the activities that human develop on this land. More specifically, the authors were seeking the answer to a question on how land cover and land use varies depending on the altitude and slope.

2. Material and methods

The analysis is based on the interrelation of geomorphometric parameters with land cover and land use. Initially, a digital elevation model with a precision of 12 m / pixel was downloaded from the Alaska Satellite Facility - https://www.asf.alaska.edu. Two basic parameters were included in the analysis: altitude and slope. The altitude was categorized at certain intervals. While for calculating the slope we used the method by Skidmore (1989). On the other hand, CORINE Land Cover 2012 data from the European Environment Agency (EEA) - http://www.eea.europa.eu were used for land cover. The completion of the analysis was done in that form for each category of morphometric parameters was compared with land cover and land use. The utilization of GIS and Remote Sensing techniques greatly contributed to the achievement of the foreseen objectives, which are powerful and flexible tools for manipulating and analyzing spatial information.

3. Study area

The Llap river basin (Fig 1.) lies in the north-eastern part of Kosovo, which is discerned as a morphological whole with particular physical-geographic elements. In terms of morphology, it belongs to the four units: Kopaonik mountains in the northwestern part, Eastern Kosovo Mountains in the southeastern part, Llap's plain in the center and Kosovo plain in the southwest (Bulliqi, 2006).

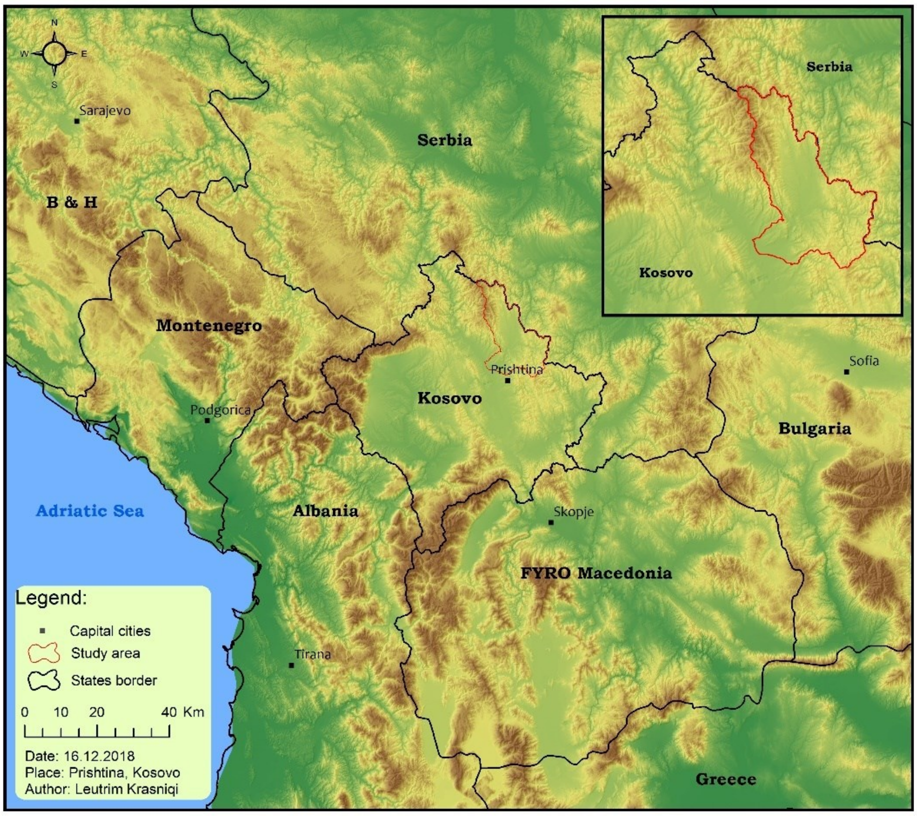

Fig 1. Geographical position of study area in Kosovo

The basin is prolonged in the north-south direction with a length of 49.30 km, while in the west-east direction it has a width of 26.60 km. The surface area of the basin is 942.1 km^2, while the perimeter length is 203.4 km. The hydrological artery that flows through this basin is the Llap river (Fig 2.), while it flows into the Sitnica river (which belongs to the Black Sea basin). In the center of the Llap plain lies the city of Podujeva, as the important nucleus for most of the settlements of the basin, as many as 77 of this municipality. Apart from the municipality of Podujeva, on this basin are partly located the municipalities of Prishtina, Obiliq, Vushtrri, and Mitrovica.

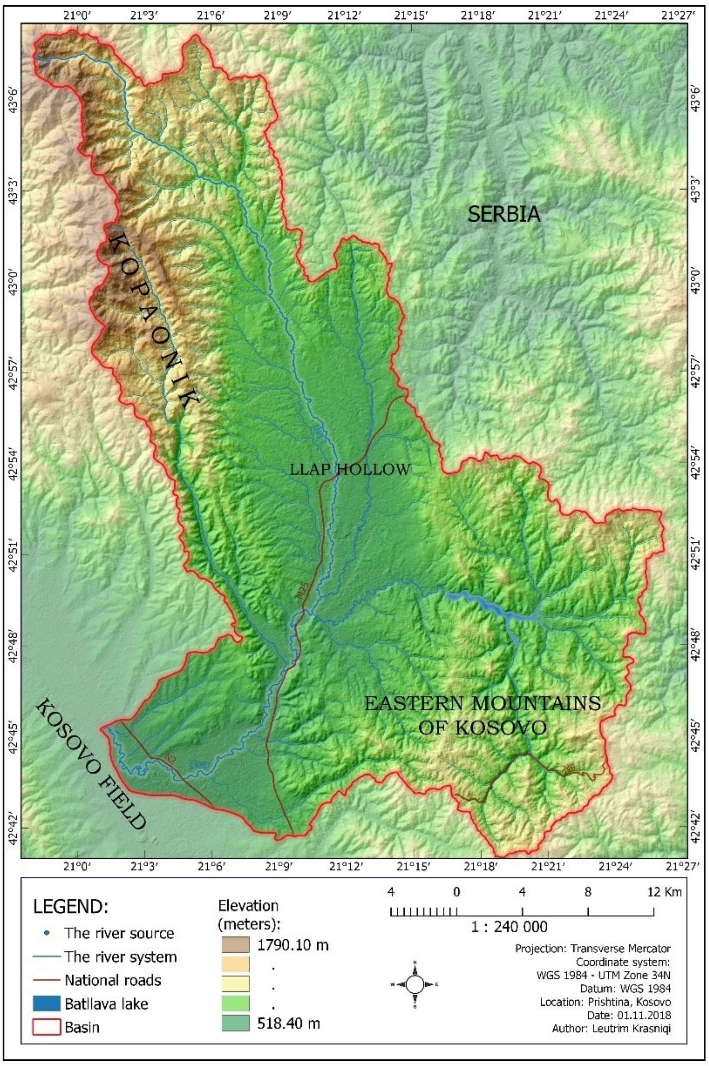

Fig 2. Geographical position of the basin

The lithostratigraphic compositions are represented by different formations in terms of composition (structure, texture, mineralogical composition, etc.) and their age (ICMM, 2006). The oldest rocks belong to the upper paleozoic, represented by mica schist and gneisses. From the Triassic period, there are fragments of serpentinites. Jurassic is represented by metamorphic rocks: filite, gneisses, basalt; and cretaceous formations of conglomerates, limestones, flysch, etc. Cenozoic is represented by neogenic formations such as conglomerates, sand, etc. The morpho-tectonic and morphological aspect has conditioned the basin to have a minimum altitude of 518.10 m and a maximum of 1790.10 m. Hilly-mountainous relief dominates at about 40% of the area and the low relief for our conditions up to 700 m lies about 35 % of the basin area.

In the Llap basin dominates the shallow brown soil on schists at around 61.8% of the total area of the basin. Wide extents have alluvial and diluvial soils associated with the main river valleys.

Whereas, smaller representations within the basin have reddish-brwon sandy-loamy soil (ICMM, 2006).

Llap basin is characterized by a population of 114 702 inhabitants lying over 110 settlements (one urban and the other rural settlements), (Kosovo Census Data 2011). The density of population varies depending on the altitude. In altitude up to 700 m is the largest population density of about 104 inhabitants/km².

Tab 1. The lying of population on the basin

Municipalities	Area - km^2	Population by municipality	Settlements	Population by settlements
Podujevë	630.22	88 499	77	88499
Prishtinë	213.27	198 897	20	15155
Mitrovicë	44.93	71 909	2	146
Obiliq	30.43	21 549	6	5184
Vushtrri	23.25	69 870	5	5718
	942.10		110	114702

The paper aims at a land use analysis presented at CORINE Land Cover 2012.

5. Results

According to the dialectical principle, all processes that occur in nature are in co-relation to each other. It is understandable that the relief with land cover and land use has this report. The author Pushka (2008) claims that no process develops solely and under the influence of oneself but in relation to other processes and reciprocal variability. In the development of these processes, there are certain rules that need to be discovered and interpreted. The discovery of these rules, and especially the relief, implies the discovery of these causes that determine the land cover and land use on this basin. Analysis of CLC 2012 for the Llap basin in correlation with the morphometric parameters made it possible to investigate the forms of land cover in respective altitude and slope intervals. To see more precisely the land cover on the basin, the following table is presented in three levels with 14 classes.

Table 2. Corine Land Cover classes, 2012 database

Level 1	Level 2	Code	Level 3	Area-km²
Artificial surfaces	Urban fabric	112	Discontinuous urban fabric	17.07
	Industrial, commercial and transport units	121	Industrial or commercial units	0.48
	Mine, dump and construction sites	133	Construction sites	0.07
Agricultural areas	Arable land	211	Non-irrigated arable land	129.95
	Pastures	231	Pastures	6.48
	Heterogeneous agricultural areas	242	Complex cultivation patterns	103.81
		243	Land principally occupied by agriculture, natural vegetation	129.22
Forest and semi natural areas	Forests	311	Broad-leaved forest	432.7
		312	Coniferous forest	1.88
		313	Mixed forest	4.22
	Scrub and/or herbaceous vegetation associations	321	Natural grasslands	36.73
		324	Transitional woodland-shrub	67.61
	Open spaces with little or no vegetation	333	Sparsely vegetated areas	9.64
Water bodies	Inland waters	512	Water bodies	3.18

5.1. Land cover and land use on altitude

Artificial surfaces cover the land of 17.62 km² or 1.86% within the basin and they lie within the altitude of 518m to 700m. The nature of the developments of the last decades has conditioned the expansion of the artificial cover, these enlargements are noticed mainly in the Llap plain and a part in the Kosovo plain.

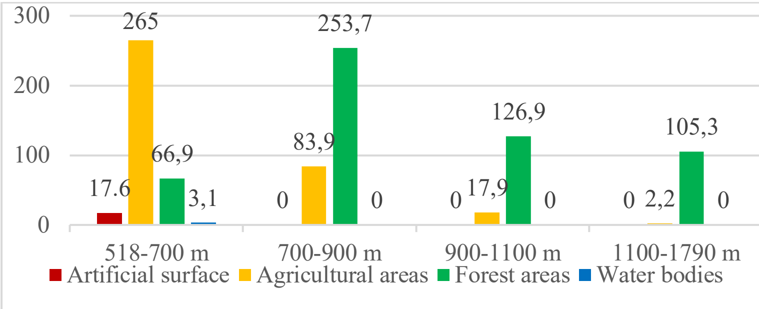

Fig 3. Land cover of the Llap basin on altitude

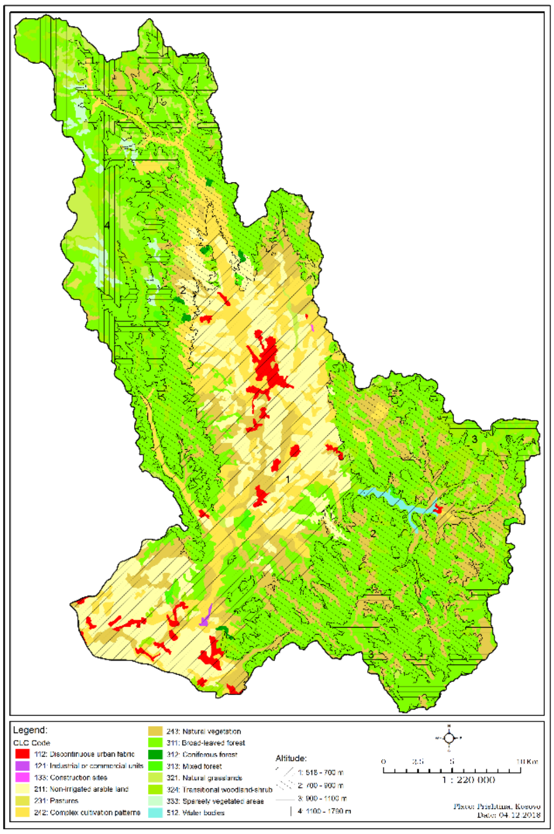

Fig 4. Land cover of the Llap basin on altitude

At the third level, we have the participation of coverage: non-continuous urban space, industrial or commercial units, and construction sites. The agricultural areas that represent the primary sector of food production in the total area of the basin lies with 369.46 km², respectively with the participation of 39.17%. At an altitude of 518-700 m, the agricultural area has the largest land cover of 265 km² or 71.72%, separated by non-irrigated arable land and complex cultivation patterns. With increasing altitude of 1100 - 1790m reduced presence of agricultural areas under non-irrigated arable land with only 2.2 km² (only found agricultural areas with natural vegetation).

In the area of arable land cultivate different types of agricultural crops from which cereals dominate, then rank fruits and vegetables. Forests and semi-natural areas have the largest lying on the mountains of Kopaonik and Gollaku with 552.78 km² or 58.6%. Forests are noticeably increased in their presence with increasing altitude. At the altitude of 518-700 m, they lying to an area of 66.9 km² or 12.10%, while at the altitude above 900 m, there is a significant increase in surface area of 232 km² or 41.96%. At the most detailed level, distinguish: broad-leaved forest mainly covering low relief, followed by coniferous forest, while high relief is covered by natural grasslands, transitional woodland-shrub, as well as sparsely vegetated areas. Water bodies have a symbolic impact on this basin due to their small area only 3.18 km² (0.33%), that lie to the altitude of 518-700 m.

5.2. Land cover and land use on slope

The slope of the terrain is one of the determinant factors in human activities. If we take and analyze the slope of the terrain in the Llap basin, we can conclude that territories with up to 5° slope are covered with the artificial surface with an extension of 13.42 km² or 76.16%. With the slope of the terrain up to 12°, lies the rest of artificial surfaces with about 4.2 km² or 23.83% participation. These areas are largely dominated by settlements that are expanding by covering productive agricultural land. The appropriate agricultural areas, respectively suitable agriculture territories with a slope of 0-12°, have a relatively broad lying with the involvement of 321 km² on the total area of the basin or 87%.

With slope rise above 12°, due to unsuitable conditions, these areas are reduced to 47.9 km² (12.35%). Agricultural areas are reduced even more with the slope of the terrain, so in the territories with a slope of 25-40° lies only 2.3 km², while over 40° slope terrain we do not have any agricultural area. Areas used for agriculture are mainly planted with wheat, maize, potatoes, and other products. Adequate agro-climatic conditions enabled the cultivation of raspberry plants at the last time (449.94 hectares in 2016 according to USAID). On land cover of forests and semi-natural areas, the slope of the terrain has had a clear impact. On sloping terrain up to 5° forest areas cover about 33.6 km² (6.07%), while up to 12° slope

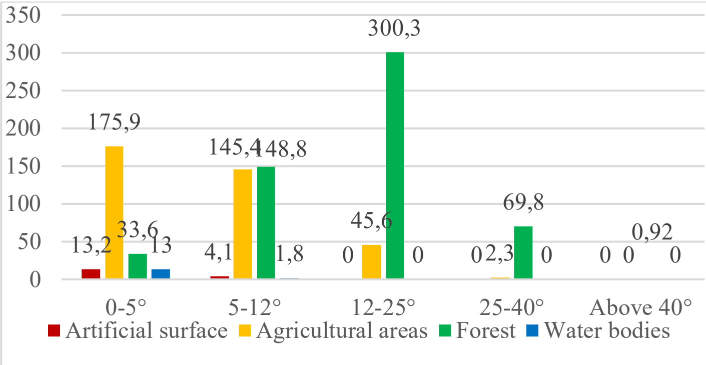

Fig 5. Land cover of the Llap basin on slope

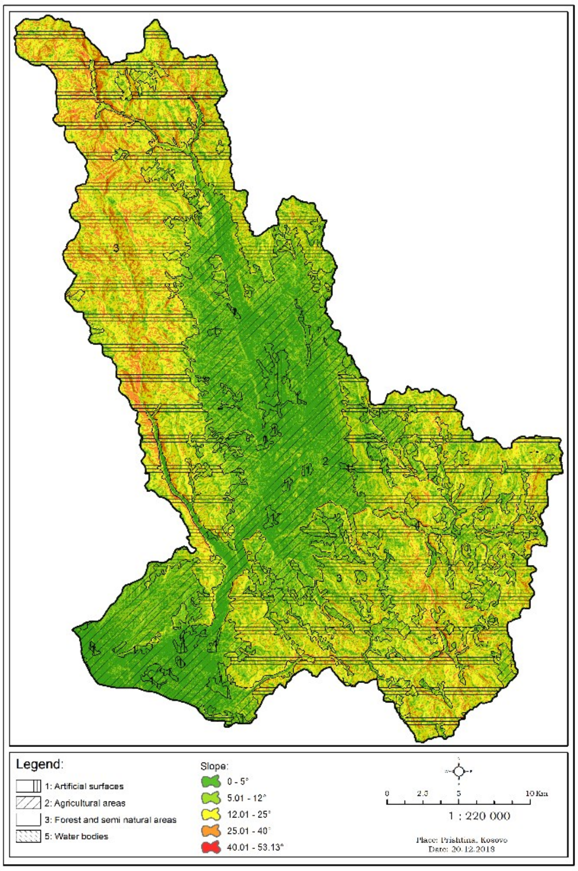

Fig 6. Land cover of the Llap basin on slope

forest areas expand to about 148.8 km² (26.88%). Territories with a slope of 12-25°, are dominant with forest areas with lying of 346.24 km² or 54.26%. While on slope of over 40°, we have only cover of forests as well as bare vegetation zones. Forests on this basin are mainly used for forestry, livestock, and tourism.

Conclusion

With the synthesis of all analyzes made, we came to the conclusion that the relief was one of the determining factors in land cover and land use in the Llap basin. Correlation analysis of geomorphometric parameters (altitude and slope) with land cover and land use enabled the achievement of results that fulfill our hypothesis.

From these analyses we noticed that: relief with altitude up to 700 m is dominated by agricultural areas and settlements, while with the increase of the altitude especially above 1000 m these surfaces are reduced. Forests up to altitude 700 m have a small lying on the basin, but with the rise of the altitude over 700 m and above 1000 m dominate with their cover and use. The slope of the relief as one of the main parameters has had an effect on the extent of settlements to a large scale up to 5°. The presence of settlements is up to 12° but in a small area. In the context of agricultural land use, the largest extent is under 12° of the slope. Agricultural areas are reduced more by increasing the slope of the terrain, so in the territories with a slope of 25-40° lie on a small surface, while over 40° slope the terrain does not have any agricultural area. On the slope of the terrain up to 12° because of human activity, there are fewer forest areas, but over 12° dominate the forests. The slope over 40° is covered by forests and there are occasional terrains without vegetation.

Finally, we realized that the relief had a special role in the nature and intensity of the land cover, and especially of land use on this basin. This research constitutes a basic premise for the rational use of land, as well as making the right decisions for land use in the future.

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