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Modeling of Soil Erosion Intensity and Estimation of Soil Erosion Risk in Upper Part of Shkumbini Watershed in Albania

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Abstract

Because of favourable natural factors and strong human impact over environment during centuries, area of the Republic of Albania is characterized with high soil erosion rate. In last decades, faster economic growth of the country and lack of soil resources, fresh water, forests etc., reinforce the need for soil protection and soil conservation. That increases the interest for erosion research, especially in the areas highly affected by soil erosion. One of those areas is catchments of river Shkumbini, which is in turn a major river in the Republic of Albania. As a result of very suitable characteristics (soft rocks, sandy soils, steep slopes, climate, sparse vegetation, anthropogenic influence) upper part of its catchments has very high soil erosion rate. Soil erosion and associated nonpoint pollution pose critical problems affecting the economic welfare, food security, and public health of Albania. Each year nearly 60 million tons of sediment are deposited by Albanian rivers into the Adriatic Sea. The objectives of this paper is to quantify the magnitude of soil erosion and its effects on water quality at three levels of intensity—site-specific, watershed, and nation as a whole and to identify high-risk areas for immediate soil erosion control using a geographic information system.

Keywords: soil erosion, land use, environmental conservation

1. Introduction

Shkumbini basin with an area of about 2450 km^2 and is traversed by the Shkumbini river and its branches. Shkumbini River ranks among the most important rivers of the Albania. It has a total length of 181 km and is a major river in the Shkumbini basin.

Shkumbini was formed by the merger of two small streams, which flow from the eastern slopes of Vallamares and western slopes of the Kamje mountains. During its flow towards Quksit and then through Librazhdi, Elbasan, Peqin and until near the Rrogozhina, several streams of different sizes join with Shkumbini river.

Most of the watershed extended in mountainous regions. Annual precipitation vary on 900 - 2200 mm where the intensity is higher in mountainous areas. The average flow of the Shkumbini river is 61.5 m^3/sek, and flow ratio Max / Min is 13,2 The mineralization of the river water is 317 mg / l and is represented mainly by bicarbonates [6].

Water flow erodes soil particles transport them to another location and deposited as a sediment. It is a natural process that removes fertile soil from the crop land [8]. Soil erosion we can decrease by the vegetation, but recently it is increasing due to anthropogenic activities like deforestation for urbanization, industrialization and overgrazing.

Shkumbini river is one of the rivers with the highest erosive activity in our country. Erosion risk in Shkumbini Watershed is consider Low in 35,4 % of basin area and high/very high in 17.1 % of basin area [4]. Solid materials transported by the river are about 36 kg/sec (Murashe) until to 180 kg/sec in Rogozhine. Materials transported in suspension grow from 4,1 tons/ha/year up to 28.7 tons/ha/year, respectively upstream and downstream of the river [7].

2. Materials and Methods

This study is based on data from erosion studies in AUT processed with Corine model[1]. Data on

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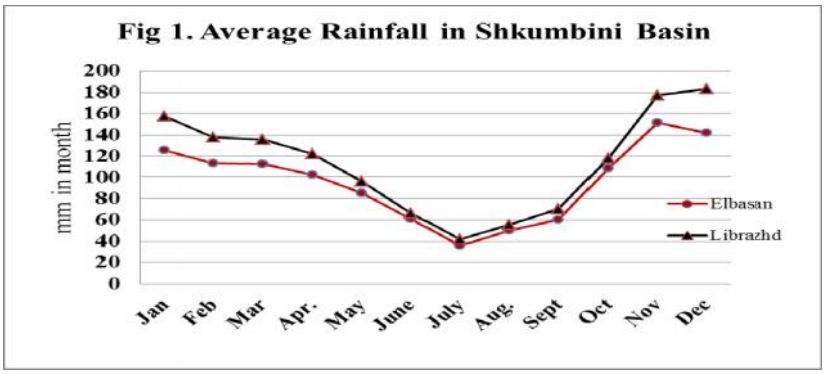
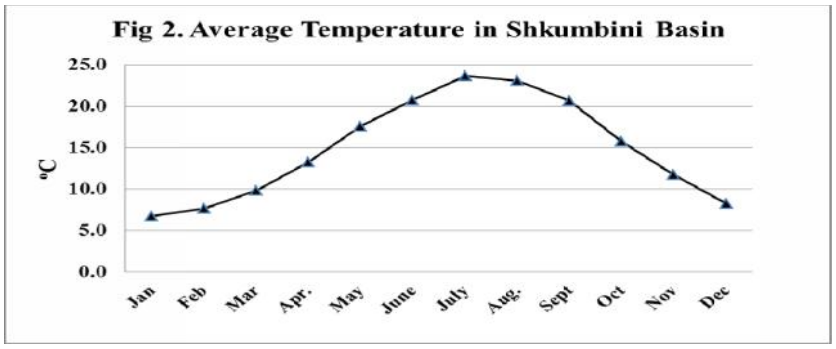
climatic conditions, soil properties and slope in the Shkumbini basin are obtained from the AUT database.

3. Results and Discussions

Climatic conditions in the Shkumbini Basin

As one of the basic factors causing erosion can mention the climatic characteristics of the region, especially precipitation.The intensity and distribution of rainfall are the main factors that determine climate potential of the eroding process [1; 10] in a given region. In Figures 1 and 2 we have given distributions of monthly precipitation and average temperatures from meteorological stations of Librazhdi and Elbasan that dominate the river watershed and where the first dominates the upper part river and the second central part of the river.

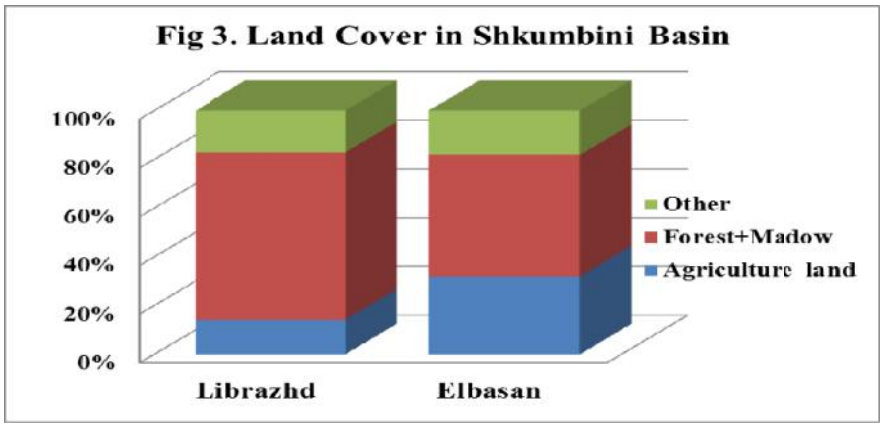




The data from these two stations are used to assess climate as a factor for the intensity of erosion in the Shkumbini basin

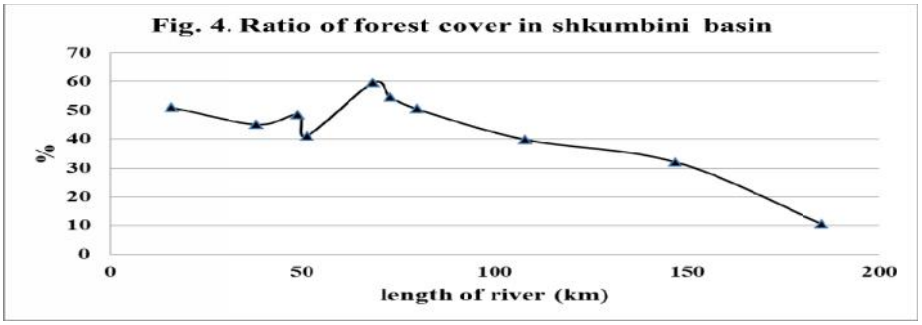
Land Cover in the Shkumbini Basin

Another important factor that determines the actual erosion is land cover. [1] [10] Land in the Shkumbini Basin is covered by of forests, shrubs, pasture and farmland [7]. In Figure 3 we have categories of land cover and rates versus total area. The data show that there is an apparent reduction of a forest and pasture surfaces when pass from the upper to the lower part of the Shkumbini river.



This is clearly expressed and presented in Figure 4. The data presented show for a report that has area of forest and pasture in relation to the total area of the watershed.

In the upper part of the river we have a good land cover which is about 60% with forest and pastures. While in the lower part of the river forests and pastures cover only 20-40% of total area.

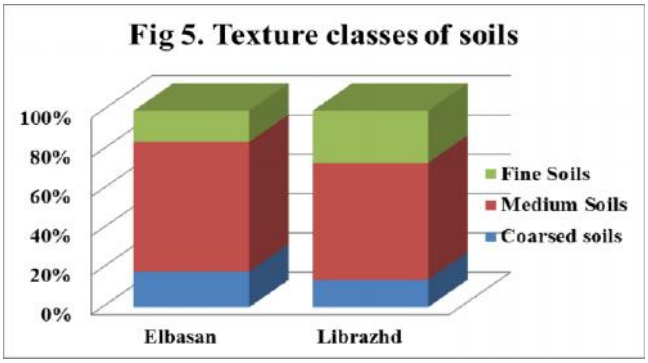


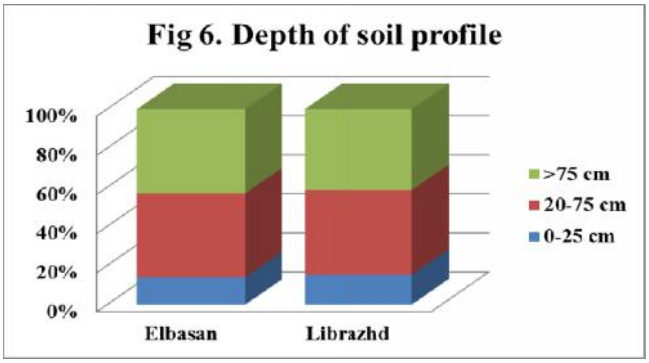
Soil Properties in the Shkumbini Basin.

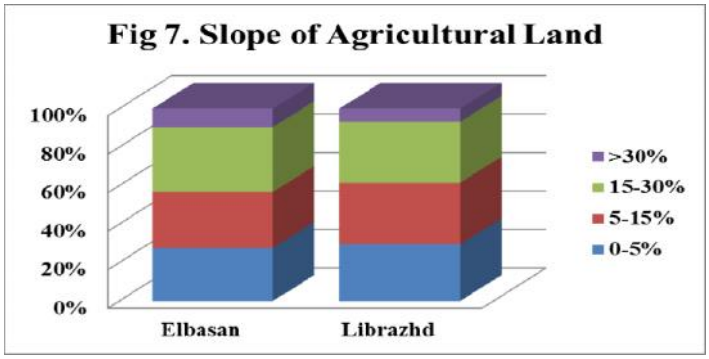
Other factors important to determine the potential of the region to have a low erosion and high ground are the soil properties as texture, depth of soil profile and slope of the terrain [1].

In particular,the slope is very important element in the process of erosion risk assessment in Albania area [5].

The three indicators for Shkumbini basin are presented in Figure 5, 6 and 7. As can be seen, these three indicators tend to promote erosion in moderate up to high level.







The Potential for Erosion in the Shkumbini Basin.

To assess the potential erosion factors in Shkumbini basin we used the CORINE Assessment Model for Soil erosion risk [1; 2; 3].

An assessment of the Erosovity index and Soil erodibility index for climatic factors and soil properties in upper and central part of Shkumbini watershed is given in Tables 1 and 2.

Table 1. Erosivity index in Shkumbini Basin

No	Region	Fournier index	Bagnouls-Gaussen index	Erosivity index	
				Range	Class/Description
1	**Librazhd**	4.0	2.0	8	**3 (High)**
2	**Elbasan**	3.0	2.0	6	**2 (Moderate)**

Erosivity index shows that climatic factors in the upper part of the Skumbini river tend to support a higher erosion. While in the central part of the river climatic factors have a moderate role to stimulate erosion.

Soil erodibility index indicates that soil properties have a low potential to reduce soil erosion. In all regions there is a tendency for higher erosion. Only in the limited area of agricultural land (5-10%) may have a moderate index, but the distribution of factors in a detailed spatial model is not object of this paper.

Table 2. Soil erodibility index in Shkumbini Basin

No	Region	Classes of soil characteristics			Soil erodibility index	
		Soil texture	Soil depth	Stoniness	Value	Index /Description
1	**Librazhd**	1.87	1.74	**2**	6.51	**3 (**High)
2	**Elbasan**	2.02	1.71	**2**	6.91	**3 (**High**)**

Including in the assessment and the steepness of the terrain and the land cover we evaluated actual soil erosion risk in uper and central part of the Shkumbini basin.

The data are presented in Table 3. High risk of erosion exists in about 27% of the region and it becomes much more intense when pass from upper to central part of Shkumbini basin.

The main factor which increases the risk of erosion is reducing surfaces with forests and pastures.

Table 3. Actual soil erosion risk in Shkumbini basin

No	Region	Actual soil erosion risk (Ha)					
		Low		Moderate		High	
		Ha	%	Ha	%	Ha	%
1	**Librazhd**	0	0	90325	81.7	20264	18.3
2	**Elbasan**	0	0	83417	64.9	45203	35.1
	Total			**173742**	**72.6**	**65467**	**27.4**

Crop Cover and Erosion in Agricultural Land.

Risk of erosion on agricultural lands in the Shkumbini basin is really high. The data of current risk assessment of erosion (Table 4) show that in the area of central part of the river (Elbasan) 72.4% of agricultural lands are under a high risk of erosion. The main factor that determines this high risk is a distribution of agricultural lands in steep terrain. In this region 72% of agricultural land have slopes over 5% and 25% of agricultural lands have slopes over 25%.

Table 4. Actual soil erosion risk in agriculture land of Shkumbini Basin

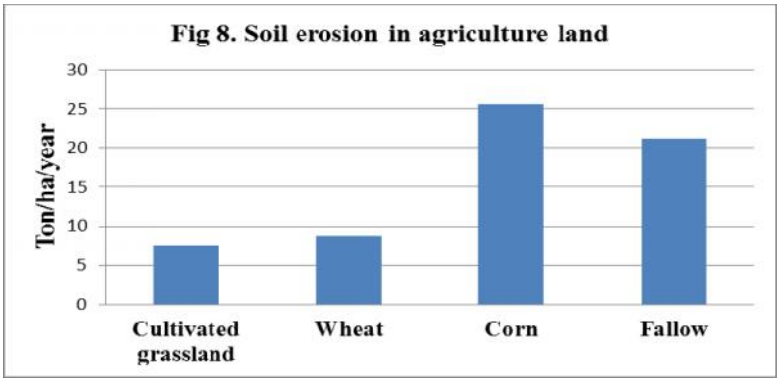
No	Region	Potential soil erosion risk (Ha)					
		Low		Moderate		High	
		Ha	%	Ha	%	Ha	%
1	**Librazhd**	0	0	14164	**91,6**	1297	**8,4**
2	**Elbasan**	0	0	11145	**27,6**	29305	**72,4**

Therefore it is very important that the protection of soil erosion in this region take place in the spotlight.

Crop cover (C factor) is less significant when land use and land cover area comprises maximum percentage of natural vegetation and plantation crops. The value of which ranges from '0' in water bodies to slightly greater than '1' in barren land. [8] In this region to evaluate the intensity of erosion of agricultural land we have measured the amount of eroded soil erosion using some crop cover. Data from this experiment I have given in Table 5 and Figure 8. We can see clear that the good land cover (Cultivated grassland and wheat) reduces erosion compared with bare soils in a range 50-70%.

Table 5. Actual soil erosion in agriculture land of Shkumbini Basin

	Ton/ha/year		
	2009	2010	Average
Cultivated grassland	7.5	8.92	8.21
Wheat	8.8	13.87	11.34
Corn	25.6	26.08	25.84
Fallow	21.2	23.04	22.12
	15.8	**17.98**	**16.89**



4. Conclusions

Actual soil erosion risk is expected to be in moderate level on 75% of the Shkumbini basin area and in high level on 25% of the basin area.

Actual Soil erosion risk in agricultural soils is very high. in the central part of the river, 72.4% of agricultural lands are under a high risk of erosion

Using of cereals, perennial grasses and legumes can reduce erosion in agricultural land in range 50 – 70 %.

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