Modern Environmental Science and Engineering (ISSN 2333-2581)
June 2020, Volume 6, No. 6, pp. 715-721
Doi: 10.15341/mese(2333-2581)/06.06.2020/010
Academic Star Publishing Company, 2020
www.academicstar.us

Some Aspects of the Assessment of the Erosion Rate in the Ulza Basin as a Function of Land Use in Forest Areas in This Region

Enea Malaj
Indipendent Expert, Tirana, Albania

Abstract: The overall objective of the study was to evaluate the extent of soil erosion in relation to topography and vegetation in the Ulza basin to provide quantitative data on actual land loss and its trend, which can be used in land use planning and land conservation in this area. Specific objectives were: Determine the amount of land currently lost by water erosion and estimate the trend of loss in the study area. Determine the cost instead of soil erosion in the Ulza basin. To analyze the relationship between land erosion and land use in the project area. Raise awareness among farmers, water users, national and local authorities of the importance of applying best management practices and payment for environmental services for the economy and ecology of the area. The field work has focused on performing soil layer deposition measurements at erosion monitoring stations, in order to evaluate the degree of erosion by land use categories by man. Based on the results of the measurements, we aim to draw conclusions on effective measures to prevent this phenomenon.

Key words: forest lands, soil erosion, man and erosion, economic losses, sustainable, management of forest ecosystems

1. Introduction

Erosion is a major threat to soil resources in Albania, and may impair their ability to deliver a range of ecosystem goods and services. Therefore, accurate data on soil loss are required, especially in the light of predicted changes in climate patterns, notably frequency, seasonal distribution and intensity of precipitation. Rates of soil loss differ between soil types and a variety of landscapes and must be compared with natural rates of soil formation which can be used as a basis for setting tolerable soil erosion levels. A modified definition of tolerable soil erosion is proposed as “any actual soil erosion rate at which a deterioration or loss of one or more soil functions does not occur”, actual soil erosion being “the total amount of soil lost by all recognised erosion types”. The causes of accelerated soil erosion are influenced by a number of factors (Morgan, 2005) and the most significant are: soil erodibility or susceptibility to erosive forces, as determined by soil physical, chemical and biological properties (Czarnes et al., 2000; Doerr et al., 2000, Allton, 2006; Shakesby and Doerr, 2006); erosivity or energy of the eroding agent, e.g. rainfall, overland flow or wind (Morgan et al., 1986; Knighton, 1998); slope characteristics (Meyer et al., 1975; D’Souza and Morgan, 1976; Wischmeier and Smith, 1978); land cover use and management (Gyssels et al., 2005; Zhang et.al., 2007).

Soil erosion is a natural process, occurring over geological time, and most concerns about erosion are related to accelerated erosion, where the natural rate has been significantly increased by human action. Soil erosion is considered as one of the major threats to European soils, particularly in the Mediterranean areas

Corresponding author: Enea Malaj, Msc in Forestry Engineering; research area/interest: erosion level study. E-mail: eneamalaj94@gmail.com.

(Communication on Soil Protection — "Towards a Thematic Strategy for Soil Protection", CEC, 2002). In order to effectively formulate mitigation strategies and implement conservation measurements to counteract soil erosion, it is essential to identify the hotspots and rating them based on the risk level. There are numerous studies identifying various factors contributing to erosion where land cover change and land use are factors which strongly are affected by the mankind determining the susceptibility to erosion. Moreover the conventional cultivation practices especially in the agriculture lands which have a direct impact in the soil erosion may be modified and mitigating their effect in a short period due to the application of the best cultivation practices and crops planting. Thus soil erosion is considered as the major form of soil degradation in Albania inducing severe limitations to sustainable agriculture land use, pasture and forest management. The average rate of soil formation in Europe is estimated at about 1.4 t/ha/year (Verheijen et al., 2009, quoted by Panagos et al. 2010). Therefore, any soil loss more than 1.4 t/ha/year can be considered irreversible. In Albania soil loss ranged from 20 to 70 t/ha (WB, 2007) and these data may happen in individual storms in extreme events (Morgan, 1992). The Ulza watershed is prone to soil erosion and this phenomenon has caused irreversible consequences in the landscape. Erosion phenomenon is induced by the combination of various factors. These factors are grouped together in several groups: climate factors (precipitation, rainfall intensity, rainfall duration and distribution, wind); soil factors (soil type, soil moisture, humus, litter layer, soil chemical compounds, bedrock); topographic factors; watershed slope, watershed area, aspect, elevation, vegetation cover; hydrographical factors; creeks density, water flow length; human factors; land use factors. Ulza watershed provides a wide combination of these factors because of the specific characteristics of this entity. Our aim is the analysis of such factor's combination on soil loss and sediment and the estimation of the erosion quantity depending on the land use in the Ulza watershed. In order to have a clear evidence about the erosion and soil loss in the Ulza watershed the experimental sample plots are located in various types of land cover and usage. By raising the number of experimental sample plots and making a distribution in all types of land use and possible combinations of such factors we aim to increase the accuracy of data about soil loss. Monitoring of soil loss using runoff plots is considered cost-effective allowing direct linkages between land use, current management practices and their impacts on runoff and soil erosion. Identification of the problems on land management practices especially on agriculture and pasture will serve to take appropriate preventive measures to reduce soil loss by improving management practices.

2. Purpose of the Study

2.1 General Purpose

The overall purpose of the study was to evaluate the degree of soil erosion in relation to topography and vegetation in the Ulza basin to provide quantitative data on actual land loss and its trend, which can be used in land use planning and land conservation in this area.

2.2 Specific Objectives

- Determine the amount of land currently lost by aquatic erosion and estimate the trend of loss in the study area.
- Determine the cost instead of soil erosion in the Ulza basin.
- To analyze the relationship between land erosion and land use in the project area.
- Raise awareness among farmers, water users, national and local authorities of the importance of applying best management practices and payment for environmental services for the economy and ecology of the area.

2.3 Study Hypothesis

The study hypothesis is that current land use

practices have a significant impact on surface runoff and land loss in the Ulza basin.

3. Methodology

3.1 Experimental Plots

For surface erosion and source monitoring we will use approximately 100 m² of erosion test surfaces (50 experimental plots). Some criteria were used to select experimental plots such as: Type of land; Ground slope (in 4 classes 0-20%, 21-40%, 41-60%, > 60%); Type of land cover based on the CORINE classification (forests, pastures, agricultural land, plantations, orchards, bare soil, temporary forests, pastures with extensive vegetation damaged); Land clearing; Land use; Climatic position; The length of the slope. For each experimental location a small meteorological station is established equipped with thermometer and rain gauge for collecting data about temperature and precipitation. Soil erosion is a process based on the type of terrain, the type of soil, rainfall intensity, form of land cover/ use and practices of management (Renard and Foster, 1983). Since the Ulza catchment is characterized by a very complex landscape configuratio, the RUSLE model was used in this study. The Revised Universal Soil Loss Equation (RUSLE) equation model enabled gross erosion (the sum of rill erosion and inter-rill erosion) to be estimated (Renard et al. 2011). This equation is given as:

$$A = R*K*LS*P*C$$

where

A: annual soil loss (t ha−1 year−1),

R: rainfall erosivity factor (MJ mm ha−1 h−1 y^{-1}),

K: soil erodibility factor (t ha h or (ha MJ mm)$^{-1}$),

LS: slope-length factor

C: land use/cover factor

P: support practice factor.

We also did the calculation of mean soil loss for each combination of land use and slope and we found that degraded forests have the highest values of soil loss, followed by plantation.

Soil quality will be monitored in respect to pH, humus and nutrient contents. The soil and sediment analyses will be performed in the Soil Labs in the Agricultural University of Tirana. The chemical analysis will be carry out using standard methods given in Table 2 (Fig. 1).

Table 1 Mean value of soil loss for each combination of land use and slope.

Inclination (%)	Land use						
	Forest (F)	Degraded Forests (DF)	Agric. Land (A)	Orchard/ Plantation (O)	Pasture (P)	Degraded land (B)	Overgrazed pasture (OP)
0-20	0.61		2.21	3.27	2.45	2.32	
21-40	2.06	4.00	13.73	8.50	2.91	31.13	3.26
41-60	5.35	21.78		9.6			9.6
over 61	8.62			12.5			11.6
Average	4.16	12.9	8.00	8.5	2.7	16.7	8.2

Table 2 Methods and standards used for chemical compound analysis.

Nr.	Analysis designation	Methods
1	pH water/salt	EN 15933:2010,
2	Humus	ISO 14235:1998/2010
3	Phosphorous	Mehlich 3-Extrable Elements Soil Analysis
4	Potassium	Mehlich 3-Extrable Elements Soil Analysis
5	Nitrogen	S SH EN 14672: 2005

Fig. 1 Laboratory soil sediment analysis.

4. Results and Discussions

We collected our results for a 10 month monitoring period starting from February to December 2016. Our measurements for each sample plot are measured in millilitre and were converted in volume unit per 1 ha unit area. The results of our study are presented in the Table 3. The table show that existence of a common trend in sediment yield which shows that soil loss is decreasing from bare land to forest land. This value highlight the importance of vegetation or forest cover to reduce the soil loss. Our calculations showed that the

Table 3 Sediments extracted from different classes of land use for 10 months.

Land use	Sediment volume (dm^3/ha)
Bare land	38.3
Arable land	16.41
Plantation	14.95
Overgrazed meadow/pasture	6.92
Not grazed meadow/pasture	5.25
Forest	3.48

total land loss for year was 723 192.5 tons, while the average value of land loss was about 6.2 tons/ha for year.

The economic loss caused by soil erosion was determined using the Replacement method (Eswaran et al. 2001). For this purpose, data on the amount of sediment eroded at the Ulza basin and the nutrient content (NPK) of the sediments were used. The economic loss (EL) is calculated by the formula:

$$EL = LN * PN$$

where:

LN = Loss of plant nutrients (s)

PN = Market Price for Plant Nutrients (US $/t).

$$PN = PF/NF$$

where:

PF = Market price of fertilizers (US $/t).

NF = Nutrient content in 1ton of fertilizer (s)

To assess the degree of soil degradation by erosion by land use types, some properties of eroded soils were compared with those of non-eroded soils considered as reference. Comparison of values of land properties with reference land data shows that the degree of land degradation is higher than depositions.

Loss of land affects the condition of agricultural land and their productivity. A significant amount of chemical constituents are removed annually from the watercourse, reducing the productivity of agricultural land. To increase the productivity of agricultural land, farmers are using different fertilizers every year to replace the chemical components removed by water leakage and soil erosion. Information gathered from farmers shows that the amount of each fertilizer used is increasing year by year. The value of the economic loss from erosion is approximately US $ 13.21 million and can be considered as an additional cost for agricultural production in the study area (Fig. 2).

Table 4 Annual loss of nutrients from soils in Ulza watershed.

Land use class	N	P	K
	Tonne		
Forest	1103.58	215.65	2159.09
Pasture	717.02	155.52	1123.38
Agriculture land	83.80	16.88	253.01
Bare land	0.36	0.11	1.01
Orchard/plantation	9.86	1.52	17.64
Degraded forests	1603.71	303.02	3550.42
Total	3518.32	692.69	7104.56

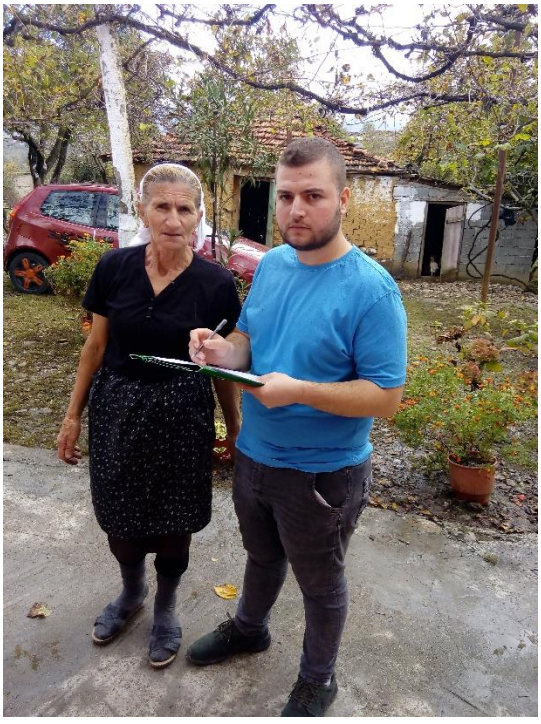

Fig. 2 a) Interviews with farmers. b) Final presentation of the project.

5. Recommendations

5.1 Improving the Current Situation Will Require Taking Action

Planting with forest seedlings of surfaces, which are bare and under the direct action of the process of surface erosion; Cultivation of pastures with perennial vegetation to make erosion less active and to use them effectively; Discipline forest cutting under the relevant law; Completion of hydrotechnical constructions; Improvement of field lands, rehabilitation of drainage and irrigation works; Construction of dams on the sides of streams that receive large tracts of land every year during the rainy season; Construction of sewage system; Providing services for the collection and transportation of urban waste that would limit their illegal dumping; Keeping the environment clean from without criteria developments of businesses and manufacturing activities. This problem is exacerbated by the lack of measures by the local government to discipline them; Awareness raising campaign for community residents on a clean and well-maintained environment; It should be emphasized that collaboration between researchers, local decision makers and the community will greatly facilitate the improvement of the situation despite the lack of necessary financial means today, so it is important to secure these funds; More friendly relationships and mutual respect between nature and inhabitants should be established, as well as future generations, who will have greater demands on the environment in which they work and live.

References

[1] H. Eswaran, R. Lal and P. F. Reich, Land degradation: An overview, in: Bridges E. M., I. D. Hannam, L. R. Oldeman, F. W. T. Pening de Vries, S. J. Scherr, and S. Sompatpanit (Eds.), *Responses to Land Degradation*: *Proc. 2nd. International Conference on Land Degradation and Desertification*, Khon Kaen, Thailand. Oxford Press, New Delhi, India, 2001.

[2] V. A. de. Oliveira, C. R. de. Mello, M. F. da Durães and A. M. Silva, Soil erosion vulnerability in the Verde River Basin, Southern Minas Gerais, *Ciênc. Agrotec., Lavras*, 38 (2014) (3) 262-269.

[3] G. B. Tesfahunegn and P. L. G. Vlek, Assessing sediment-nutrient export rate and soil degradation in Mai-Negus Catchment, Northern Ethiopia, *ISRN Soil Science*, 2013, Article ID 748561, available online at: http://dx.doi.org/10.1155/2013/748561.

[4] The Academy of Sciences of the Republic of Albania, *The Physical Geography of Albania*, Vol. II, 1991, p.

490.

[5] Academy of Sciences of the Republic of Albania, *Climate of Albania*, 1991.

[6] K. E. Allton, Interactions between soil microbial communities, erodibility and tillage practices, PhD thesis, Cranfield University, Cranfield, 2006, p. 224.

[7] S. Beskow, C. R. Mello. and L. D. Norton, Soil erosion prediction in the Grande River Basin, Brazil using distributed modeling, *Catena* 79 (2009) (1) 49-59.