021 Study of Erosion Plots in the Middle Mountain of Nepal using USLE

Iwate University, United Graduate Course Ghimire, S.K
Hirosaki University, Faculty of Agriculture and Life Science Higaki, D.

1. Background

Soil erosion is a world wide environmental problem. It results in degradation of land, pollution of water bodies and sedimentation of reservoirs. Soil erosion is a complex process comprising of detachment and transport of topsoil as a result of rainfall. In the field of erosion dynamics, erosion estimation and prediction has become a great challenge for the concerned professionals in spite of huge attempts made so far. A widely used and the most comprehensive erosion prediction equation is Universal Soil Loss Equation (USLE), which was developed by Wischmeier and Smith in 1958. In this paper, it is attempted to evaluate the applicability of the USLE in context of Nepal, demonstrating the results of its application in three erosion plots, two under agriculture and one degraded bare land.

In brief, USLE is an empirical equation representing the relationship between average annual soil loss and rainfall erosivity, soil, topography and land-use. It is given by the equation: $Y= R.K.L.S.C.P$ where, Y is the mean annual soil loss, R is the rainfall erosivity factor and it is the product of kinetic energy of the storm and the maximum 30-min intensity. K is soil erodibility factor which is obtained from a Nomograph designed to compute this index for the use in USLE where it is correlated with the amount of silt and very fine sand (0.002 - 0.1 mm), Organic matter, soil structure and permeability. The factors of slope length (L) and slope steepness (S) are combined in a single index which expresses the ratio of soil loss under a given slope steepness and slope length to the soil loss from the standard condition of a 5 degree slope, 22m long, for which LS=1. C is the crop management factor that represents the ratio of soil loss under a given crop to that from bare soil. P is the conservation practice factor that takes account of erosion control practices for protection of agricultural land such as contouring, terracing and strip cropping.

2. Description of Study area

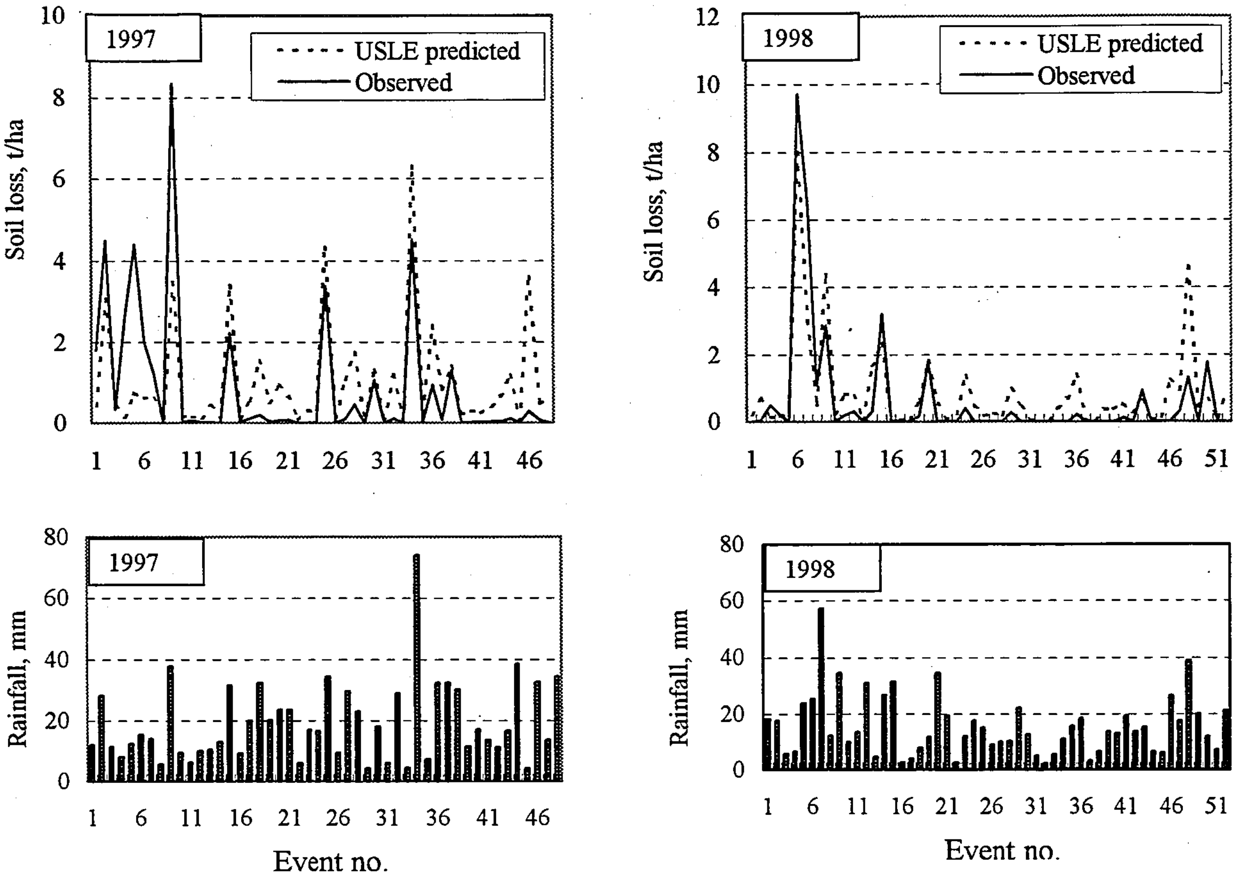
Three erosion plots were selected in Jhikhu Khola watershed, which lies in the middle mountain region in central Nepal. The study plots and their characteristics are given in the Table 1.

Table 1. Land use and topography of study plots

S.N.	Name	Elevation (m)	Land use	Size (m x m)	Area (m^2)	Slope (degree)
1	Bela1	1320	Cultivated	13.6 x 4.5	61.8	20.4
2	Bela2	1345	Cultivated	20.4 x 4.8	101.6	18
3	Kubinde	1010	Degraded	20.6 x 5.0	103.5	15

3. Computation by USLE and results

Two approaches are applied in the computation: erosion from individual rainfall events and long-term annual average erosion. Erosion losses from individual rainfall events estimated by USLE and observed ones are shown in Figures 1a,b and c,d.(in case of Kubinde). Figure 2 shows the annual average soil losses computed by USLE and corresponding observed values. The figures indicate wide variations in measured and predicted values. Overall trend is that USLE underestimated the soil losses from the higher rainfall events and overestimated those from smaller ones. USLE underestimated the annual soil losses from Bela1 and Bela2 with relative errors 37 and 19% respectively, however it overestimated in case of Kubinde plot within relative error of 28 % .



Figures 1a,b and c,d. Comparisons between USLE predicted and measured soil losses from individual rainfall events in Kubinde in 1997 and 1998 respectively.

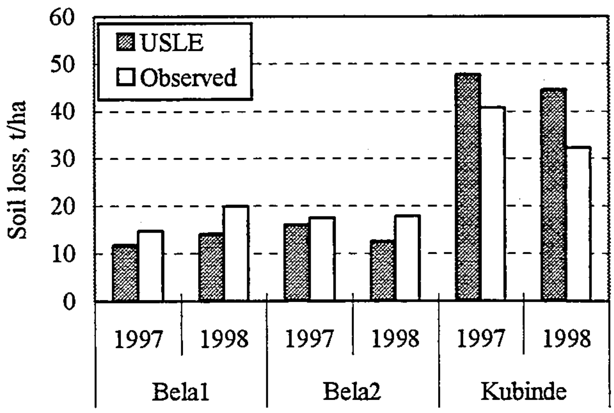


Figure 2. Comparison between USLE and observed annual soil losses.

There might be a number of reasons for the discrepancies in the measured and predicted values of soil losses. But the trend of underestimation from bigger rainfalls and overestimation from smaller ones is important to notice, because it is prevalent in all the erosion plot-years. Also, the rainfall patterns are such that, during the first half period of the rainy season (i.e. up to event 26) the frequency of higher rainfall is more than during the second half period. It is more evident in case of Bela. Consequently, the underestimation is manifested in the first half period and overestimation in the later. This trend can be explained by the seasonal changes in USLE factors. Because crop factor-C is not changing much after the full growth of canopy, and erosion control and topographic factors virtually remain constant, the only erodibility factor-K may have remarkable seasonal variation which has been assumed constant in the analysis. The K factor should be lesser in the later part of the rainfall period because the soil tends to be more saturated leading to decrease in permeability.

Although USLE could not satisfactorily predict the event wise erosion losses, its importance cannot be overlooked in estimating long-term erosion loss because in the field of erosion control, it is important to provide good comparative estimates than to attempt to provide accurate absolute values of erosion rates.