Peer Reviewed International Research Journal of Geography
Maharashtra Bhugolshastra Sanshodhan Patrika
ISSN : 0971-6785 {Impact Factor 3.687 (IIFS)} Vol. 35, No.1, Jan-Jun. 2018.pp 93-97

ESTIMATION OF SOIL LOSS BY USING STELIK SOIL LOSS EQUATION, A CASE STUDY OF MUTHA VALLEY CATCHMENT, PUNE DISTRICT, WESTERN MAHARASHTRA.

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Abstract

Soil loss due to water is a environmental problem in number of heavy rainfall areas. Its damage has harmful impacts not only on agriculture but also on economy of countries like India. The purpose of this study is to estimation of soil loss due to soil erosion by water using GIS tools and Stehlik's soil loss equation in Mutha Valley catchment, Pune District. Stehlik's soil loss equation is a model to predict soil loss from agricultural lands. It is based on climatic factor i.e. rainfall pattern (R factor), petrological factor (G factor), Soil erodibilty (P factor), slope length or topography (L factor) slope steepness (S Factor) and vegetation cover (O factor).The result of the research is that high potential soil loss area is an area with severe slope, poor vegetation, sandy soil and no water and soil conservation practices. Therefore, this combination of Stehlik's soil loss equation and GIS can be useful for decision makers to establish appropriate strategies of soil and water conservation in the Mutha Valley Catchment. The study stated that the area under above 40 to 50kg/sq.m./per year needs to be urgent application of conservation measures and sustainable management in the study area.

Key words:- *Mutha Valley Catchment, GIS, Stehlik's soil loss equation, soil loss estimation, R factor, G factor, P factor, L factor, S Factor and O factor.*

1. Introduction

Soil loss processes are site specific and differ in kind, intensity and aerial coverage of the affected area. Soil degradation and erosion are insidious processes, not readily apparent to farmers until the effects are severe and irreversible and a threat to long term soil productivity. Erosion and degradation not only decrease land productivity, but can also result in major downstream or off-site damage than on-site damage. Deforestation, wastelands and indiscriminate usage of cultivable lands have collectively induced soil loss resulted in ecological imbalances. Soil loss, generally associated with agricultural practices in tropical and semi-arid countries, leads to decline in soil fertility, brings on a series of negative impacts of environmental problems, and has become a threat to sustainable agricultural production and water quality.

Thus, soil loss is one of the most critical environmental hazards of modern times. Vast areas of land now being cultivated may be rendered economically unproductive if the erosion of soil continues unabated. Information on the factors leading to soil erosion can be used as a perspective for the development of appropriate land use plan (Kumar et.al., 2014).

Because of serious impact of soil erosion, many researchers have worked in this specific field using GIS and models to assess and predict the soil loss caused by water erosion. Thus, the emergence of various models which differ by complexity such as Universal Soil Loss Equation (USLE) (Wischmeier and Smith, 1978) or Revised Universal Soil Loss Equation (RUSLE) (Renard et al., 1997), Stehlik's soil loss equation (1975). Despite the considerable number of erosion model, Stehlik's soil loss equation is accepted and is considered as the most used to predict soil loss in small drainage areas.

In the Mutha valley Catchment, after the construction of Temghar dam, majority of families moved to the villages relocated on the middle slopes of the hill ranges. They cut down forest area for agriculture or for domestic use. The vegetation cover is also removed for construction of roads for Lavasa city and real estate. This has naturally caused serious deforestation with result that the siltation at a rate more than estimated has threatened the life of the Dam. High rainfall, steep slopes, barren land and infertile nature of the soil due to high surface runoff are primary constraints and these have been compounded by large scale shifts in agricultural practices and deforestation that have been led to soil erosion. The study stated that the area under above 40 to 50kg/sq.m./per year needs to be urgent application of conservation measures and sustainable management in the study area.

2. Study Area:

The area selected for the present study is a source region of Mutha watershed located in the Mulshi and Haveli Taluka of Pune District. The total geographical area is 133 sq.km. and has latitudinal extent from 18°23'43” N to 18°28'50” N and longitudinal extent from 73°27'04” E to 73°41'17” E.(Figure 1).The Mutha river is a fifth order drainage basin and flows in west-north-west to east-south-east direction respectively. The entire part of the study area falls within the Upper Bhima catchment area, which is an important tributary of Krishna River.

The climate of the study area is of tropical monsoonal type characterized by the well defined seasons like summer, rainy and winter seasons.

The study area experiences tropical type of climate with monsoonal rains from the south-west monsoon winds. The average annual rainfall in the study area is 1395.14 mm. Figure 2 introduce rainfall variation in the study area

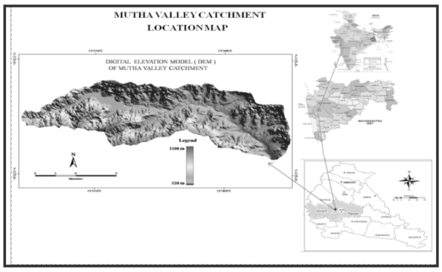


Fig 1. Location map of the Mutha Valley.

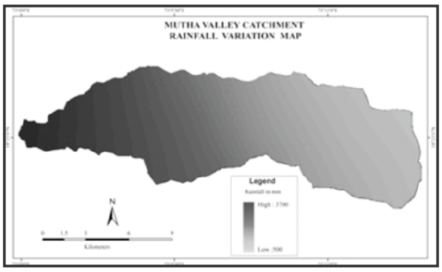


Fig.2 Rainfall Distibution map

1. Stehlik's Method

A method was developed by Stehlik (1975) for predicting the annual rate of soil erosion in Czechoslovakia. It uses the

$$X = D.G.P.S.L.O$$

Where,

X = the mean annual soil loss (mm/y-1)

D= Climatic

3.1 D Factor:-

This is the climatic factor and is expressed in terms of the mean precipitation falling at intensities (mm/min) equal to a greater than $\sqrt{5t}$. Where 't' is the duration of rainfall min.

$$D = 0.0014 X (R) - 0.38$$

Where, R = Mean annual precipitation.

3.2 G Factor:-

This is petrological factor and assess rocks type according to the permeability of weathered debris. The variation of petrological factor between 0.7 to 1.4 suggest high, moderate slight and low permeability. The texture of the rocks is derived from the textural analysis of debris samples. The entire study area is covered by basaltic flows, which are commonly referred to as Deccan traps. There are two types of basaltic flows occurred viz. the pahoehoe flows and aa flows. The pahoehoe flows weathers easily & gives rise to mature type of topography with smooth hill slopes & conical peaks. The product of weathering includes sub-rounded fragments. The 'aa' flows have different resistance to weathering. The basalt dense rock is very resistant; while the breccia part breaks down easily.

3.3 P Factor:-

Soil erodibilty is strongly dependent on the nature of soil, parent material, texture, structure, organic matter content, porosity, catena and many more. Generally, soils become of low erodibility if the silt content is low, regardless of corresponding high content in the sand and clay fractions (Rahaman et.al., 2015). In the present study area, the soil texture map was prepared from soil survey data.

This expresses the erodibility of the soil based on the % of particles smaller than 0.1 mm in size and the organic content. The soil data helps in determining the percentage of clay as well as organic matter (humus content). This shows distribution of % of clay in the region.

The variation in humus content is between 0.5% and 1.9 % while the % clay throughout the region ranges from below 10% to 50%.

3.4 S Factor:-

On steep slopes, the rate of soil erosion is high because the flow velocity is high, and causes showering and cutting of soil. This rate of soil erosion increases due to splash, as splashed particles on steep slopes are thrown to larger distances down the slope on an inclined plane and the damage due to raindrop impact is greater on soil crust. Hence slope factor plays an important role in soil erosion.

This expresses slope steepness according to relationship,

$$S = 0.25 + 0.106s + 0.0028s2$$

Where, 's' is the slope in percent.

This factor is computed for each and every grid considering the % slope map prepared for the area.

3.5 L Factor:-

The L factor expresses the effect of local topography on soil erosion rate, combining effects of slope length (L) and slope steepness (S). There is a direct relationship between the slope length and runoff, that is, longer the slope length the greater the amount of cumulative runoff. Also the steeper the slope of the land the higher the velocities of the runoff which contribute to erosion. (Rahman et.al., 2015)

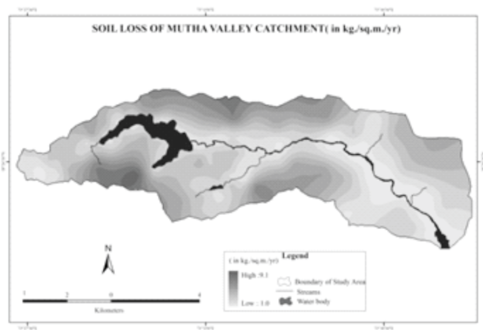
The slope length factor is calculated with the help of tanø values of respective grids in the area, for that measure the minimum distance between maximum and minimum contour was considered.

3.6 O Factor:-

Vegetation cover in contact with the surface protects the soil from raindrop splash and erosion by flowing water or runoff. 'O' factor is vegetation factor and dependent upon the % cover of the area and calculated with the help of digitized landuse and land cover map. The information is placed in respective grids so as to ascertain the % vegetation cover of the area. % vegetation cover less than 20% considered as degraded forest cover.

2. Result

In present study, calculation of Soil Erosion using Stehlik's soil loss equation based on Sub watershed level. The Mutha valley catchment divided in to 29 five sub basin. Figure-3 a and b.



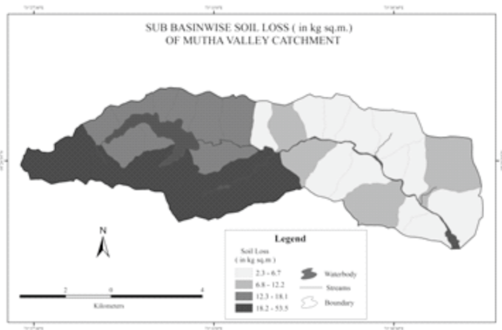


Fig. 3 a) Soil loss estimation in Mutha Valley Catchment   Fig. 3 b) Sub basinwise Soil loss in Mutha Valley Catchment

As per the different class group category given by the Rambabu & Narayan for erosion by water in India is given in Table 1. Different classes of soil erosion by water in India (Ref- Rambabu &Narayan)

Sr.no	**Soil erosion class group**	**Soil erosion range(kg/sq.m/year)**
1	Slight	0-5
2	Moderate	5-10
3	High	10 -20
4	Very High	20 -40
5	Severe	40 -80
6	Very Severe	>80

The soil losses estimated using Stehlik's soil loss equation has been carried out for Mutha valley Catchment. After calculation of the six parameters of Stehlik's soil loss equation for the all 29 sub watersheds, it is found that three sub watersheds coded as are subjected to severe and very high conditions of erosion (given in Table-1) and needs some watershed treatment to control the high rate of erosion. Eight sub watersheds are subjected to high conditions of erosion. Four sub watersheds are subjected to moderate and eleven sub watersheds are experiencing low or slight erosion.

1. Conclusion

In this study, we have used a simple methodology to show that in a GIS environment the Stehlik's soil loss equation can be applied to determine soil loss on a local scale. Since water is one of the responsible factors which causes soil erosion, measures aimed at preventing soil erosion by water are also water conservation measures. Reducing soil erosion by water generally involves the following measures

i) For controlling and guiding runoff, Runoff can be captured and stored for use or allowed to soak into the soil. Dry wells, soil amendment and rain gardens are used to infiltrate water into the soil.

ii) Reducing the impact of water on soil,The crop remains can provide an excellent soil cover after harvest, improve soil water intake by preventing soil surface sealing due to rain drop impact, and consequently, reduce impact of water on soil.

iii) Allowing for greater infiltration by slowing down water flows,

iv) Improving soil structure.

v) Farmers should be encouraged to adopt the techniques of Agriculture of conservation such as crop rotation, contour farming, fertilization and no-till farming.

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