Estimation of Soil Erosion using RUSLE Method in Tiruvallur District

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Abstract. Remote Sensing (RS) and Geographic Information Systems (GIS) these technologies are used for various purposes and natural resources. GIS and RS are pixel based and are used as a spatial modeling method to forecast erosion. RUSLE is one of the methods developed to estimate the erosion. RUSLE is the tool used to forecast erosion from five parameters. This study will give you that how much soil erosion happening in Tiruvallur district. By using the Geo informatics techniques, we can be able to find out the soil erosion in an easy way and by using the data like LIS III satellite images and LANDSAT imagery data by using this we can able to predict the soil erosion in Tiruvallur district.

Keywords: Remote Sensing (RS), Geographic Information Systems (GIS), RUSLE, Soil Conservation, Five Parameters

1. Introduction
My area is Tiruvallur district in Tamil Nadu. In this district hilly terrain occupies an area of mostly 68% and the average rainfall is (1104mm), therefore it is a risk of soil erosion and also for natural disasters is high [1]. There are many procedures and different methods research soil erosion, But presently the application of geographic information systems (GIS) integrated modeling approach in soil erosion is a powerful tool and it is very helpful to analyze the data and soil erosion in a very short span of time, very easy to estimation and design the soil map in a very short manner. [7] There are many ways to find the soil erosion; one way to find is Revised Universal Soil Loss Equation (RUSLE) [2]. Using this method, we can able to find out the different factors to calculate the soil erosion. Soil loss rate can be calculated by measurement of annual rainfall, slope, crop cover and practice erosion control factors. By using the RUSLE method, we can find out the soil erosion by using all parameters shown in equation 1.

\[ A = R \times K \times LS \times C \times P \] (1)

Where:
- \( R \) = Rainfall erosivity factor (MJ.mm/ha/yr)
- \( K \) = Soil erosion factor (ton.ha.h / MJ.ha.mm)
- \( LS \) = slope and slope steepness factor
- \( C \) = Cover Management factor
- \( P \) = practice factor
- \( A \) = loss of soil (ton/ha/yr).

2. Study Area
The total area of the Tiruvallur district is about 3422 sq.km. This is the study area as shown in Figure 1 and it has a mixture of urban and rural characteristics. In this area we can find more hilly areas. There are three revenue divisions which come under this district viz, Tiruttani and Ponneri. The coordinates of Tiruvallur district is 12°15' and 13°15' North and 79°15' and 80°20' East.

Figure 1: Study area

3. Data Used to Find the Factors
   - The average rainfall data for many years of some meteorological stations in the region From Tiruvallur district [9].
   - Soil map
   - Topographical map
   - Satellite Images which will downloaded from bhuwan and earthexplorer.usgs.gov.[10]

4. Methodology
   Soil erosion modeling [3] is based on RUSLE equation, integrated with the open source GIS equation using with GRASS GIS and QGIS software is the primary method of this research. Using the data and QGIS and by using this software and input data; GRASS GIS software. By using these we can able to find out the five parameters [4] to find the soil erosion as explained in Figure 2.

Figure 2: Proposed system
5. Determining of Rusle Factors
The RUSLE is a series of mathematical equations resulting in estimated annual soil depletion due to soil erosion. In this method we can find out the five parameters and the values by using the RUSLE method [5].

5.1. Rainfall Erosivity Factor (R)
Rainfall data collected from different meteorological stations and 10 years data from Tiruvallur district and these input data can be used to interpolate rainfall map for the entire data. The rainfall map can used to evaluate the erosion caused by rainfall factor which is shown in Figure 3. To find out R factor we can take average on rainfall data which is collected before equation 2.

\[ R = 79 + 0.363R_N \]  

Where, \( R_N \) = Average rainfall (mm)

To find out the average annual rainfall data we need at least 10 years rainfall data [6]. There are fifteen rainfall gauge stations are present in my study area. R factor values are applied for the rainfall erosivity map. The erosion factor value should from 286.5 to 325.3 MJ ha/mm/hr/yr [8].

![Rainfall erosivity factor](image)

**Figure 3: Rainfall erosivity factor**

5.2. Soil Erodibility Factor (K)
K Factor depends on the types of soil, soil texture and weather. The soil map for study area obtained from the Tiruvallur district in Tamil Nadu [9]. The importance of this element is influenced by the soil's capacity for infiltration and structural stability [10]. So, execute the K values between 1.0 to 0.01 with optimum values for heavy silt or very fine soils Sand Start K factor value is calculated from standard plot by measuring the sand, Soil and other particles [11]. The quality of organic matter and the permeability value for soil texture available in the study area are taken from literature [12].

5.3. Slope and Steepness Factor (LS)
This factor depends upon the surface soil on the sheet and rill erosion. These LS factor needs the DEM data to find out the slope length and steepness factor [13]. This factor is used to estimate loss of soil ratio. The standardized 9 per cent length of 22.13 m Slope under conditions otherwise similar. The slope and steepness factor of Thiruvallur district is shown in Figure 4. The slope length was calculated by using the equation;

\[ L = 0.4 \times S_P + 40 \]
5.4. Cropping Factor (C)
It is the most important factor in RUSLE method for the cover-management impact along with the P factor. It is the most easily changed single factor, and the most commonly considered factor in the development of a conservation plan [14]. The C factor value should from 0 to 0.5 and it is depicted in Figure 5.

5.5. Practice Factor (P)
It is the factor which is used to control the water runoff and reduce soil loss. This factor varies from 0 to 1, where the maximum importance for areas without conservation activities is given. The P factor value is usually predict by the agriculture process and terrain slope. The key conservation approach in the present study area is the use of bonds across the agricultural practices [15].

6. Results and Discussions
R factor value obtained from proposed methodology is given in Table 1 and generated rainfall erosivity factor map. In the study area two major types of soils are found namely clay and sandy. K factor value obtained from proposed methodology is given in Table and generated soil erodibility factor map. LS factor map generates based on equation stated above. The total Geographical area of Tiruvallur district is 3423 KM². The agriculture land occupies about 43.61% of total area.
### Table 1: K value factor

| Parameter                        | S. No. | Classes             | Value  |
|---------------------------------|--------|---------------------|--------|
| Rainfall gauge stations R factor value | 1      | Tiruvallur (1104)   | 1616.3 |
| K Factor Value Soil             | 1      | Clay loam           | 0.320  |
| Texture K Value                 | 2      | Sandy Loam          | 0.120  |
| C Factor Value Land             | 1      | Agriculture Land    | 0.450  |
| Cover Classes C – Factor        | 2      | Tree clad area      | 0.001  |
|                                 | 3      | Forest              | 0.090  |
|                                 | 4      | Waste Land          | 0.400  |

7. Conclusion
While several scholars have researched different facets of soil erosion, little attention has been paid to the temporal routes of soil depletion and landscape changes. By using the remote sensing technology, it is easy to find out the soil erosion and it will also save time. Despite numerous attempts to measure the degree of soil degradation, the emphasis was mainly on small-scale implementation, such as suburban rates. We can use RUSLE method as to find the soil erosion different factors and through this we can easily find the erosion. Soil erosion is a worldwide problem when it comes to the hilly areas and we need to predict the erosion happening. GIS techniques and remote sensing techniques used to estimate the soil loss. It has capable of estimating the erosion in different factors. Ultimately in this paper we will estimate the soil erosion in different factors by using the GIS techniques.

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