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# MICRO WATERSHEDS PRIORITIZATION ON THE BASIS OF SOIL EROSION MODELLING USING GEOSPATIAL TECHNOLOGIES

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## ABSTRACT

This paper aims to represents the assessment of soil erosion for the study area and micro-watersheds prioritization based on soil erosion severity and propose best agricultural practices to reduce soil loss. For the present study area, universal soil loss equation is used to determine the average yearly soil loss. USLE is the product of five factors such as rainfall erosivity factor, soil permeability factor, slope length factor, cover management and conservation practice factor. The data required for the present study have been taken from the concerned departments. For present study area 77 micro watersheds were generated using digital elevation model (DEM) data. The main criteria for generating micro watersheds are flow direction and stream order. The mean annual soil loss according to each micro watershed in the hanwada basin having area of 235.58 sq kms area was calculated as 0.635 tons/ha/year. The evaluation of soil loss by using geospatial technologies is to deliver rapid information and allow farmers to take good recommendations about soil conservation.

**KEY WORDS:** micro watersheds, geospatial technologies & priority

## INTRODUCTION

Soil erosion is the profound environment complication as it erodes the top layer of soil which have high levels of rich nutrients. The annual soil erosion in is estimated about 5334 metric tonnes due to various conditions (Narayan and babu 1983). Instability of atmosphere, rise of temperatures and unusual times of heavy precipitation in unusual amounts that leads to the erosion of soil in excessive amounts. Heavy winds, overgrazing of cattle, and deforestation like several factors are essential sources of soil erosion. Due to the heavy blowing wind, the depletion of topsoil usually occurs where the soil not covered upon vegetation. As a reason of intense development of urbanization forests are destroyed. In this distortion process of huge areas, the topsoil will relocate results in soil erosion. Environmental issues like rising of sedimentation of rivers and reservoirs which will result in shortening the life span and storage capacities caused mainly by the soil erosion [1]. Management of soil loss depends upon both the factors affecting as well as the methods for regulating these factors to safeguard the resource [2]. Based on the USLE (universal soil loss equation) investigation is done, it is one of the efficient technique for soil loss management and assessment of soil erosion for various land uses [3]. The rate of soil erosion is booming due to the human exercises. Erosion in large amounts results in reduction of agricultural productivity and loss of rich nutrients. Various models were refined to assess the soil erosion during past few years such as WEPP (Water Erosion Prediction and Planning), WATSED (Watershed Model) and USLE (Universal Soil Loss Equation) [4].USLE and sediment yield method are bounteously used for the micro watersheds prioritization based on the mean annual soil loss [5].Geospatial technologies gives correct appeal of universal soil loss equation for micro watersheds [6]. Both cover management and conservation practice factors values are evaluated using buffer zone calculator [7]. Soil erosion reduce the production of crops and increases the sedimentation in rivers and dams and reduce their retention space [8]. The geospatial technologies are of most use in personation and listing of micro watersheds on account of soil loss [9]. Two versions of universal soil loss equations were revised USLE and modifies USLE used. To evaluate the soil loss, RUSLE deals with complex field areas where as MUSLE deals with peak flow rate and runoff [10]. Crop management factor values are different for each landuse classes and it differs for categories of forest class such as tropical and deciduous forests. It also varies from waste land, scrub land and grassland [11]. The most largely used equation is universal soil loss equation because it represents standard results for the assessment of soil loss [12]. Revised universal soil loss equation include advanced scientific technology gives rise to RUSLE2. RUSLE has more advantageous than USLE when compared to the evaluation of soil loss, crop varieties and agricultural practices [13]. The use of geospatial technologies is to provide rapid information and evaluate the soil erosion at larger areas [14]. Based on mean of annual soil loss, prioritization of micro watersheds and by using universal soil loss equation to propose best agricultural practices for micro watersheds [15].

## STUDY AREA DESCRIPTION

For the present study Hanwada Mandal of Mahbubnagar district was chosen as study area, Telangana state, India. (Fig 1.1). The geographical location of the hanwada Mandal is 16.7333 degrees North latitude and 77.9333 degrees East longitude. It has an average elevation of 520 meters (1676ft). Hanwada Mandal covers an area of 235.38 square kilometers. The soil textural class of hanwada is clay loamy. The nearest town to hanwada is Mahbubnagar which is 10 kilometers away. The annual rainfall of hanwada in the year 2018-2019 is 456.1 mm. 680.9 mm was average annual rainfall in for the past 10 years. Annual rainfall in the year 2018-2019 is less, when compared to the past ten years annual rainfall.

The majority of the land in the study area is covered with by crop land, which comprises of 9645 hectares (54.26 % of total area).The next major land cover is scrub land-open which occupies an area of 3763 hectares (19.05% of the total area).This is followed by forest constitute of 1893 hectares (11.65 % of total area).The water bodies include (9.70 % of total area). The lowest land cover is built up area which is 1186 hectares (5.34 % of total area).

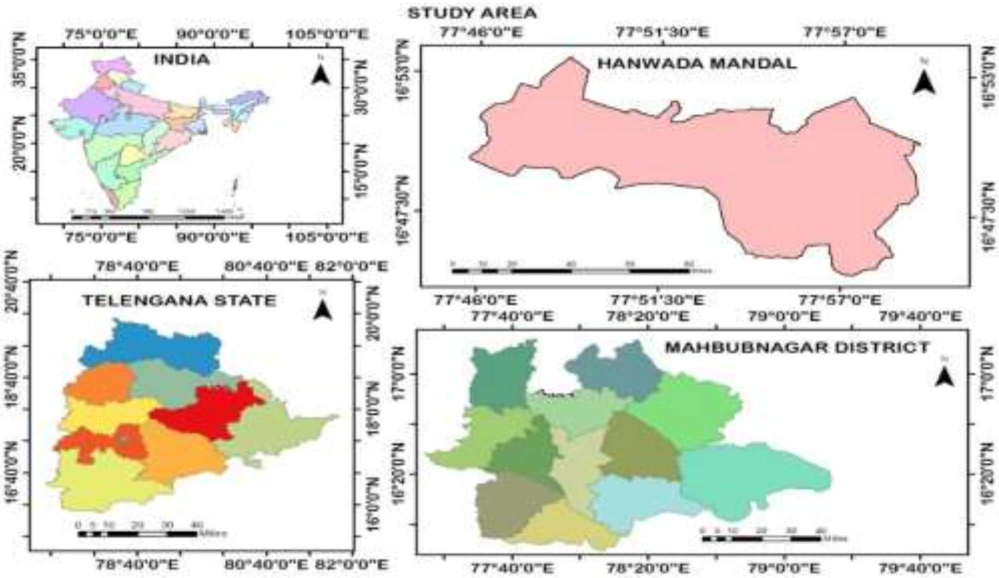



**Fig 1.1 Location of the study area**

**Data used**

The rainfall data were collected from the Telangana state development planning society (TSDPS). The soil map of the study area was taken from the Telangana state remote sensing application Centre (TRAC). SRMT DEM (Digital Elevation Model) was download from USGS site to generate slope map. The sentinel-2 images of the study area were download from United States geological survey (USGS) for preparation of LULC map (Land use/Land cover) of different classes using supervised classification.

## METHODOLOGY

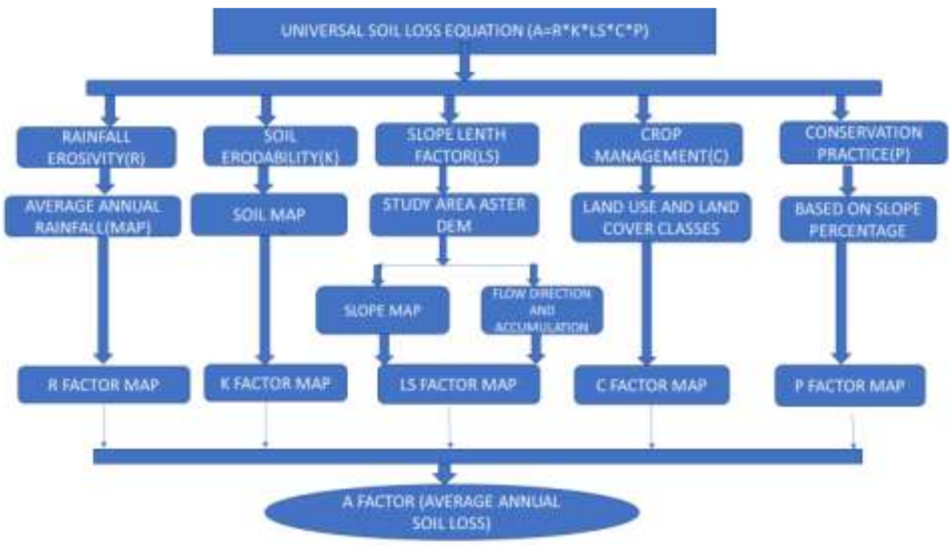
### Universal soil loss equation (USLE)

USLE is utilized for calculating the mean of the annual soil loss, as a multiplication of five erosion factors. The regulation of sediment yield and deposition are the limitations of this model. The equation for calculating the mean annual soil loss is evaluate as shown below

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

Where; A is average annual soil loss (t/ha/yr.)
R is rainfall erosivity factor (MJ-mm/ha/h/yr.)
K is soil erodibility factor (t-ha-h/ha/MJ/mm)
LS is slope length factor

C is cover management factor
P is conservation practice factor




**Flow chart representing universal soil loss equation factors**

**Rainfall erosivity factor (R)**

The rainfall data of Hanwada Mandal is taken from positioned rain gauges were used for average annual rainfall, to calculate the R factor and to generate R factor map. There are several methods that can be used to find out R factor, among them Singh et al, 1981 suggested following formula to determine R factor using average yearly rainfall. This method is the only method which can be adopted for the places like India.

$$R=79+0.363*MAP$$

Where MAP is mean annual precipitation

**Soil erodibility factor (K)**

The K factor exhibits the susceptibility of soil. Soil map is used to determine the K factor. For this study area soil map was taken from the Telangana state remote sensing application Centre. Soil map includes soil properties like soil texture, soil structure, organic matter, and silt percentage and soil permeability. For the properties of the soil like texture of soil, soil structure and soil permeability will process different values of K factor. Otherwise, laboratory tests carried out on soils to determine the properties of soil of that area. Wischmeier et al. (1971) promote the formula to determine the K factor based on soil properties. Equation to calculate K factor is shown below

$100A = 2.1M^{1.14} (10^{-4}) (12 - X) + 3.25 (Y -2) +2.5(Z-3)$

where, A= soil erodibility factor
M= silt percentage
X=organic matter
Y= soil structure
Z= soil permeability

**Slope length factor (LS)**

Slope length factor (LS) is determined by length of the slope and gradient independently. There are different formulas to represent the slope length factor, among that best formula for integrating with geo spatial technologies. In this study area, the method proposed by Moore and Bruch (1985) to calculate the slope length using DEM data is evaluate shown below

LS = (Flow accumulation * cell size / 22.13) ^0.4 *(sin B /0.0896) ^1.3

Cell size same as pixels side, B is slope angle in degrees, digital elevation model data (DEM) is used to find out the slope and flow accumulation. By substituting these parameters in the above formula to calculate the LS factor.

**Cover management factor (c factor)**

The c factor used to respective usefulness for soil and vegetative management system by preventing soil loss. For the identified crops, C factor is defined as the ratio of soil loss. Depending on the land cover classes for the present study area Cover management factor values varies from 0 to 1. The larger C factor represents corresponding land cover classes results in more erosion.

**Conservation practice factor (p)**

The P factor is defined as the effects of agricultural practices that will decrease the amount and rate of water runoff and then decrease the soil loss. According to the slope percentages P factor values were considered, for present study area. Due to the slope percentage, values of P factor varies from 0 to 1. Where 0 indicates erosion impedance and 1 indicates no erosion impedance.

**RESULTS:**

**Generation of Maps**

**Rainfall erosivity factor (R)**

In study area, R factor is evaluated on the mean annual precipitation data over a time of ten years (2009-2019) from Telangana state development planning society. The mean annual precipitation data over a period of ten years collected from dual rain gauge stations in the study region have been interpolated in the inverse distance weightage tool (IDW) in the arc map 10.2.2. Substitute the mean annual precipitation in the formula R=79+0.363*MAR through raster calculator in the arc map to produce R factor map. The R factor values differs from 281.617 to 326.165. R factor map was generated using arc map was shown in the figure A.

**Soil Erodibility factor (K)**

K factor values were obtained through soil map. Soil map includes soil properties like soil texture, soil structure, organic matter, silt percentage, soil permeability. The K factor value is varying for the different properties of soils like texture of soil, soil structure and soil permeability etc. Present study area soil map was obtained from the Telangana state remote sensing application Centre. By taking soil erodibility constant values from the soil map to generate K factor map in arc map 10.2.2. Figure A represents the K factor map.

**Slope length factor (LS)**

Slope length factor also contributes to soil erodibility. LS factor was determined from the digital elevation model (DEM) data downloaded from the United States Geological Survey. By using dem data, generate slope map in degrees in the arc map 10.2.2. The maps representing flow direction and accumulation were prepared using hydrological tools in the ArcMap 10.2.2. Substitute these maps in the formula to generate LS factor map. The LS factor map was made using Arc map ranges from 0 to 33.65 was shown in the figure A.

**Cover Management factor (C)**

For present study area, land use and land cover classification map was prepared using sentinel-2 satellite images. Land use and land cover was obtained through supervised classification. The classification results show five land use land cover classes include agriculture, water bodies, waste lands, forest and built up area .C factor values for different land use classes taken from previous studies. The c factor values taken for present study region was represented in the table 1. By using c factor values, c factor map was generated using arc map10.2.2 and cover management values ranging from 0.002 to 1 was represented in the figure A.

| **Land use land cover** | **C -factor** |
|---|---|
| Agriculture land | 0.18 |
| Water bodies | 1 |

| | |
|---|---|
| Scrub lands | 0.28 |
| Forest | 0.004 |
| Built up area | 0.002 |

**Table 1**: C factor values for each land use and land cover class

**Conservation practice factor (p)**

The P factor is defined as the impacts of agricultural practices that will decrease the value and rate of water runoff and then decrease the soil loss. Best agricultural methods are contour tillage, terrace system and strip cropping. P factor differs from 0 to 1 based on t slope percentage. Where 0 indicates erosion impedance and 1 indicates no erosion impedance. The p factor values were taken according to the different types of agricultural management practices and slope percentage. For the present study area P factor values according to the slope percentage was show in the table2. By using p factor values, conservation practice factor map was generated using ArcMap 10.2.2 and p factor ranges from 0.5 to 1 was shown in figure A.

| **Slope percentage** | **P factor** |
|---|---|
| 0-7 | 0.50 |
| 7-11.3 | 0.60 |
| 11.3-17.6 | 0.80 |
| 17.6-26.8 | 0.90 |
| >26.8 | 1 |

**Table 2**: P factor values for different slope percentages

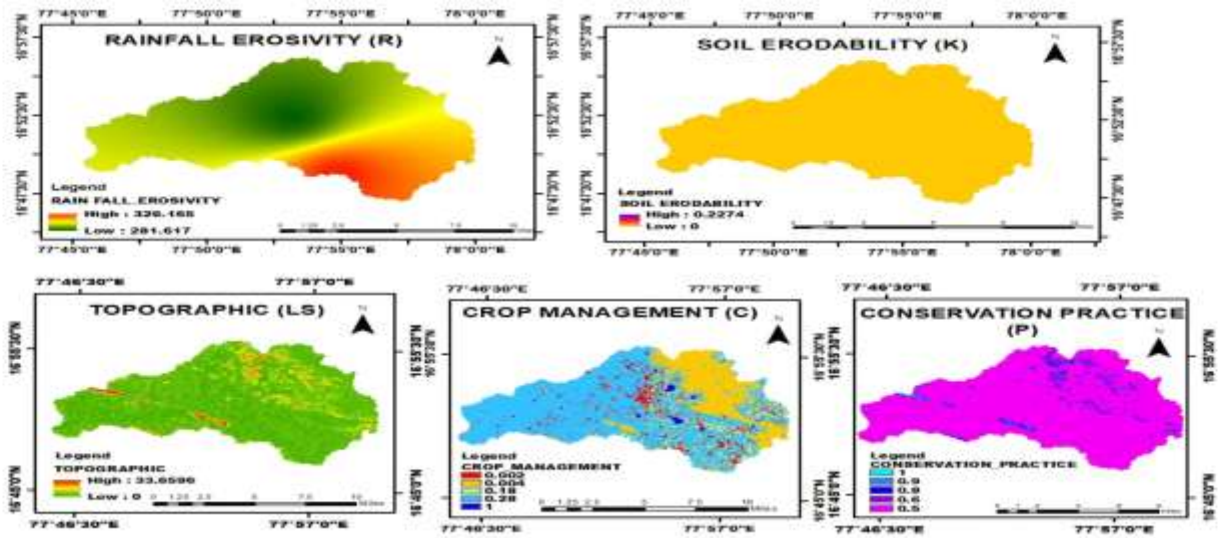



**Figure A: maps of USLE factors (R K LS C P)**

**Mean Annual soil loss and prioritization of micro watersheds**

Mean yearly soil loss for micro watersheds were estimated by the product of the five usle factors (R K LS C P). All the factors are multiplied by using raster calculator tool in the arc map 10.2.2 to get mean annual loss of study area was shown in the figure B. The soil loss map was overlaid with the 77 micro watersheds of hanwada basin to get soil loss of individual micro watershed. The soil loss rate (tons/hectare/year) of each micro watershed was calculated as division of loss of soil of each watershed (tones/year) to the area of each micro watershed (hectares). The soil loss classification divided into three categories they are slight, average and high based on the soil loss severity and area of micro watersheds. The differentiation of each micro watershed according to the soil loss severity was prepared in the arc map 10.2.2 was shown in the figure B. Among all the 77 micro watersheds ,3 micro watersheds fall under high erosion category, 14 falls under average erosion category and remaining all the micro watersheds are slight erosion category. Prominence of micro watersheds were given on the standards of mean yearly soil loss (tons/ha/year) for each micro watershed. By taking the huge speculation in the development planning of micro watersheds, it is subsequent to organize the ventures on priority basis for attaining profitable outcomes.

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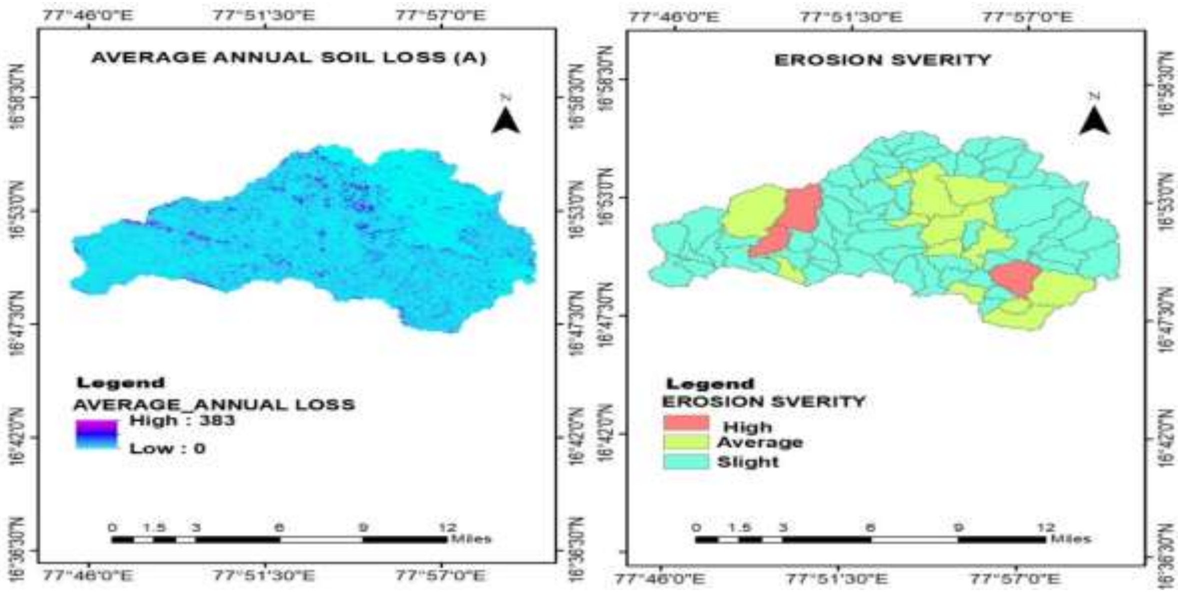


**Figure B: Mean annual soil loss map and MW wise erosion severity map**

## CONCLUSION:

This research estimates the mean yearly soil loss of Hanwada basin using universal soil loss equation and the loss of soil of each micro watershed was calculated and prominenece of micro watersheds was given on the basis of mean yearly soil loss. Mean yearly soil loss of each micro watershed was 0.635 tons/hac/year. The evaluation of soil loss by using geospatial technologies with field observations is to deliver rapid information and allow farmers to take good recommendations about soil conservation. The use of geospatial technologies is to give rapid information in less and more accuracy outcomes in soil erosion. The soil erosion severity of micro watersheds comes under average and high class need to have best agricultural practices to control soil erosion. By taking the huge speculation in the development planning of micro watersheds, it is subsequent to organize the ventures on priority basis for attaining profitable outcomes. Agricultural methods suggested for micro watersheds in Hanwada basin are contour farming, terracing, afforestation, reduced tillage, terracing and check dams.

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