ESTIMATION OF RUNOFF AND SOIL LOSS USING REMOTE SENSING AND GIS TECHNIQUES-A CASE STUDY OF DHANSIRI WATERSHED IN ASSAM

A Dissertation submitted in
Partial Fulfilment of the Requirement for the Award of the Degree of

MASTERS OF TECHNOLOGY
In
CIVIL ENGINEERING
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DECLARATION

I hereby declare that the work presented in the project report “ESTIMATION OF RUNOFF AND SOIL LOSS USING REMOTE SENSING AND GIS TECHNIQUES: A CASE OF DHANSIRI WATERSHED IN ASSAM” in partial fulfillment of the requirement for the award of the degree of “MASTER OF TECHNOLOGY” in Civil Engineering (with specialization in Water Resource Engineering), submitted in the Department of Civil Engineering, Assam Engineering College, Jalukbari, Guwahati – 13 under Assam Science & Technology University, is a real record of my work carried out in the said college under the supervision of Dr. Utpal Kr. Misra, Professor, Department of Civil Engineering, Assam Engineering College, Jalukbari, Guwahati – 13.

Do hereby declare that this project report is solemnly done by me and is my effort and that no part of it has been plagiarized without citation.

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This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

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CHAPTER 1
INTRODUCTION

1.1 GENERAL:

The Dhansiri watershed, located in Assam, India, is a vital hydrological system that supports diverse ecosystems, agriculture, and livelihoods. Characterized by intense monsoonal rainfall and diverse topography, the watershed faces significant challenges, including soil erosion, land degradation, and seasonal flooding. These issues not only impact agricultural productivity but also contribute to sedimentation in rivers and downstream areas. Understanding the interactions between rainfall, runoff, and soil erosion is crucial to managing these challenges effectively. Modern technologies, such as remote sensing and Geographic Information System (GIS), offer powerful tools to analyze these processes and develop strategies for sustainable watershed management.

Rainfall-runoff modeling and soil erosion assessment are essential components of hydrological studies, providing insights into water flow dynamics and erosion hotspots within a watershed. The Revised Universal Soil Loss Equation (RUSLE**)**, combined with spatial data from remote sensing, enables precise estimation of soil loss, while GIS aids in mapping erosion-prone areas. Such analyses are especially relevant for the Dhansiri watershed, where deforestation and shifting cultivation practices exacerbate soil loss. By integrating these techniques, researchers can identify high-risk zones, prioritize conservation efforts, and enhance flood mitigation strategies, ensuring the long-term sustainability of the region's natural resources and livelihoods.

This study focuses on modeling rainfall-runoff and soil erosion in the Dhansiri watershed using remote sensing and GIS techniques. By quantifying soil loss and runoff, the research aims to provide actionable insights for watershed management. The findings will inform strategies to combat soil erosion, reduce flood risk, and enhance agricultural productivity. Given the ecological and socio-economic importance of the Dhansiri watershed, this study addresses a critical need for sustainable land and water resource management in the region, while also contributing to the broader understanding of hydrological and erosion processes in tropical watersheds.

1.2 OBJECTIVES OF THE STUDY

The objective of the project study is given below:

1. To estimate soil loss of Dhansiri watershed in Assam using RUSLE.
2. To analyze the impact of land cover change on sheet erosion.
3. To simulate the runoff of Dhansiri river using HEC-HMS rainfall-runoff model.

CHAPTER 2
LITERATURE REVIEW

Jaiswal *et al*., (1999) examined remote sensing technology for the changes in land use and land cover over a 30-year period in a section of Madhya Pradesh's Shahdol district's Gohparu block. Maps of land usage and land cover were created by visually interpreting data from two time periods from remote sensing. It was discovered that 14 percent of the area had turned into wasteland, while the loss of vegetation cover was estimated to be 22 percent. It was discovered that the overall rate of change throughout this time was 1.8 percent every year.

Shalaby and Tateishi (2007) mapped land cover changes along Egypt's northwestern coast using maximum likelihood supervised classification and post- classification change detection algorithms using landsat data collected in 1987 and 2001, respectively. On each of the two images' six reflecting bands, a supervised classification was carried out using ground truth data. Using auxiliary data, observable interpretation, and expert knowledge of the area through GIS, the categorization results were significantly improved. These modifications to the land cover led to deterioration of the vegetation and water logging in a section of the study area.

Wischmeier & Smith, (1978) (Kinnell, 2010) developed the most popular models for calculating long-term average yearly soil loss and for planning soil and water conservation are the Universal Soil Loss Equation (USLE) and its revised version., i.e. Revised Universal Soil Loss Equation (RUSLE).

Beskow et al., (2009) combined USLE and GIS in order to calculate probable soil loss from the Grande River Basin in Brazil (6273 Km2). The ability to identify the region's most vulnerable to water erosion was made possible by their results, which demonstrated sufficient precision.

Biswas and Pani (2015) combined the Revised Universal Soil Loss Equation model with geographic information systems. The GIS platform's overlay of the factors for soil erodibility, length of slope, steepness of slope, management of cover, and support and conservation techniques leads to a significant amount of soil loss in the research region. High soil loss in the basin's upstream region is closely related to the LS and K factors as well as the drainage density. The capacity of reservoirs has been reduced in both dead and living storage space as a result of soil loss in the upper catchment areas. The influence of soil erosion on plateau fringe areas is concluded, and estimating soil loss is a crucial component of effective land use planning and development plans.

Obiero et.al., (2022) adopted empirical models like RUSLE in which Soil erosion can be measured using an easy-to-use, comprehensive methodology offered by. Remote sensing and geographic information system (GIS) integration are also strong points of the RUSLE paradigm. This article gives a broad summary of the RUSLE model's developmental milestones for assessing soil loss. The RUSLE model's parameterization has been adequately evaluated, with special attention paid to the difficulties and achievements encountered in the development of each individual factor. According to the review, various equations have been created by scientists to model the five elements of the RUSLE model. It was discovered that the creation of such equations takes into account the various variations that represent the soil erosion process.

Dutta et.al., (2021) The paper presents a comprehensive analysis of soil erosion dynamics in the Subansiri river region of Assam, India, utilizing the Revised Universal Soil Loss Equation (RUSLE) model. It effectively highlights the significant issue of soil erosion exacerbated by human activities and land degradation. The study reveals alarming soil loss rates, estimating approximately 20 million tons annually, with a detailed categorization of erosion severity across different regions. The findings underscore the critical need for effective soil conservation practices to enhance water quality and mitigate flood risks, making a valuable contribution to sustainable agricultural practices in the area.

Ghosh et.al, (2022) The paper presents a comprehensive study on soil erosion in the Mayurakshi River Basin, utilizing the Revised Universal Soil Loss Equation (RUSLE) integrated with Geographic Information Systems (GIS) and remote sensing techniques. It highlights the significant issue of soil erosion, which contributes to nutrient loss and water quality degradation, particularly in developing countries like India. The study estimates an alarming annual soil loss of approximately 4.63 million tons, categorizing the basin into various risk classes for soil erosion. The authors emphasize the importance of using advanced modeling techniques for effective soil management and conservation planning, making a valuable contribution to environmental resource management.

Vanlalchhuanga et.al, (2022) This paper presents a comprehensive study on soil erosion in the Mahadevpur block of Arunachal Pradesh, utilizing the RUSLE method alongside remote sensing and GIS technologies. The authors effectively demonstrate the fragile nature of the soil and ecosystem in the North Eastern Himalayan ranges, highlighting that 37.10% of the area experiences very slight soil loss, while 7.0% faces extremely severe erosion. The integration of Sentinel 2 data and ALOS digital elevation model (DEM) for mapping various factors contributing to soil erosion is commendable. Overall, the study provides valuable insights for resource planning and conservation measures in the region.

Halder et.al, (2021) The paper presents a comprehensive study on soil loss estimation in the Shilabati river basin, utilizing the Revised Universal Soil Loss Equation integrated with remote sensing and GIS techniques. It highlights the critical issue of soil erosion in a semi-arid region of West Bengal, India, where anthropogenic activities and natural factors contribute significantly to soil degradation. The study estimates soil loss ranging from 40.079 to 677.93 t/ha/year and emphasizes the importance of prioritizing conservation measures in the most affected sub-basins. The use of empirical equations to calculate the Sediment Delivery Ratio adds depth to the analysis, making it a valuable resource for watershed management.

Patil (2018) The paper "Spatial Techniques for Soil Erosion Estimation: Remote Sensing and GIS Approach" addresses the critical issue of soil erosion, which poses significant threats to agricultural productivity and ecological balance. It highlights the importance of assessing soil erosion risks for effective land evaluation, particularly in regions where erosion is prevalent. The authors discuss various erosion models that simulate complex interactions affecting erosion rates, emphasizing the challenges of generating spatial input data through conventional methods. The integration of Remote Sensing (RS) and Geographic Information System (GIS) technologies is presented as a cost-effective solution to enhance soil erosion modeling, making it more comprehensive and robust.

CHAPTER 3
DESCRIPTION OF THE STUDY AREA

3.1 INTRODUCTION

The Brahmaputra River, one of Asia's largest rivers, flows through Tibet, India, and Bangladesh, supporting a vast basin of ecological and economic significance. In Assam, it traverses the fertile plains, receiving numerous tributaries from both its north and south banks. Among its significant south bank tributaries is the Dhansiri River, originating in the Laisang Peak of Nagaland at an elevation of approximately 1,500 meters and flowing through the Golaghat and Karbi Anglong districts before joining the Brahmaputra near Dhansirimukh

The Dhansiri River has a catchment area characterized by dense forests in the upper reaches and cultivated lands in the lower stretches. It is primarily rain-fed, with its flow significantly influenced by the monsoons. The river carries a substantial runoff load due to heavy rainfall, deforestation, and shifting cultivation practices in its catchment areas. This makes it an important focus for soil erosion and rainfall-runoff modeling, providing insights into the region's hydrological behavior and land degradation challenges.

The stretch of the Dhansiri river lying within Assam is chosen as the study area for the current study taking into consideration the land and data issues. The total length of the Dhansiri River is 392 km. The Dhansiri River- Chathe River is designated as National Waterway 31(NW31) with a stretch of 110 km within Assam. The watershed of the Dhansiri River was clipped against Assam. Fig 3.1 shows the geographical location of the Dhansiri watershed and fig 3.2 shows the study area of Dhansiri watershed in Assam.

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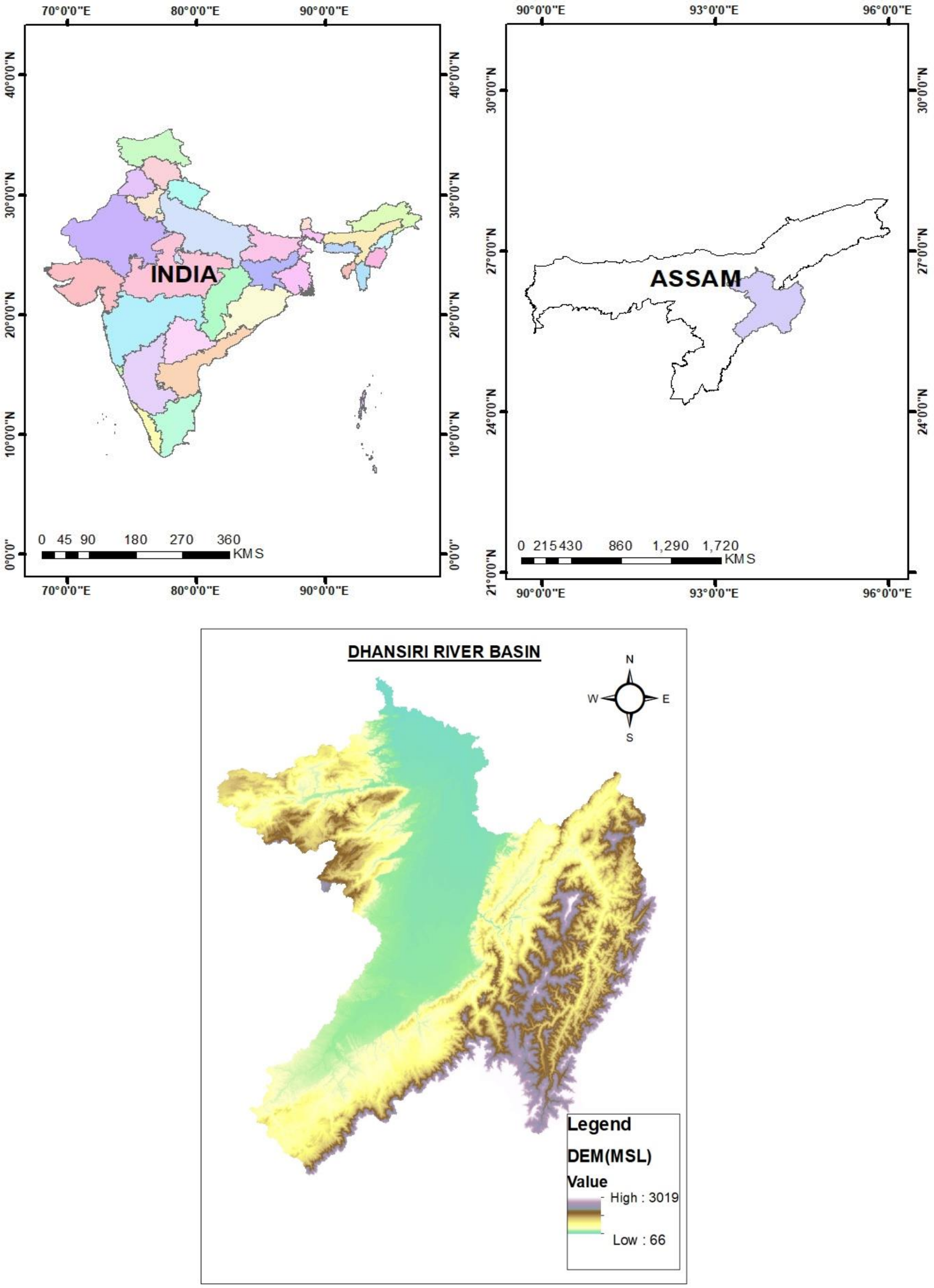

Fig 3.1 Geographical location of Dhansiri Watershed

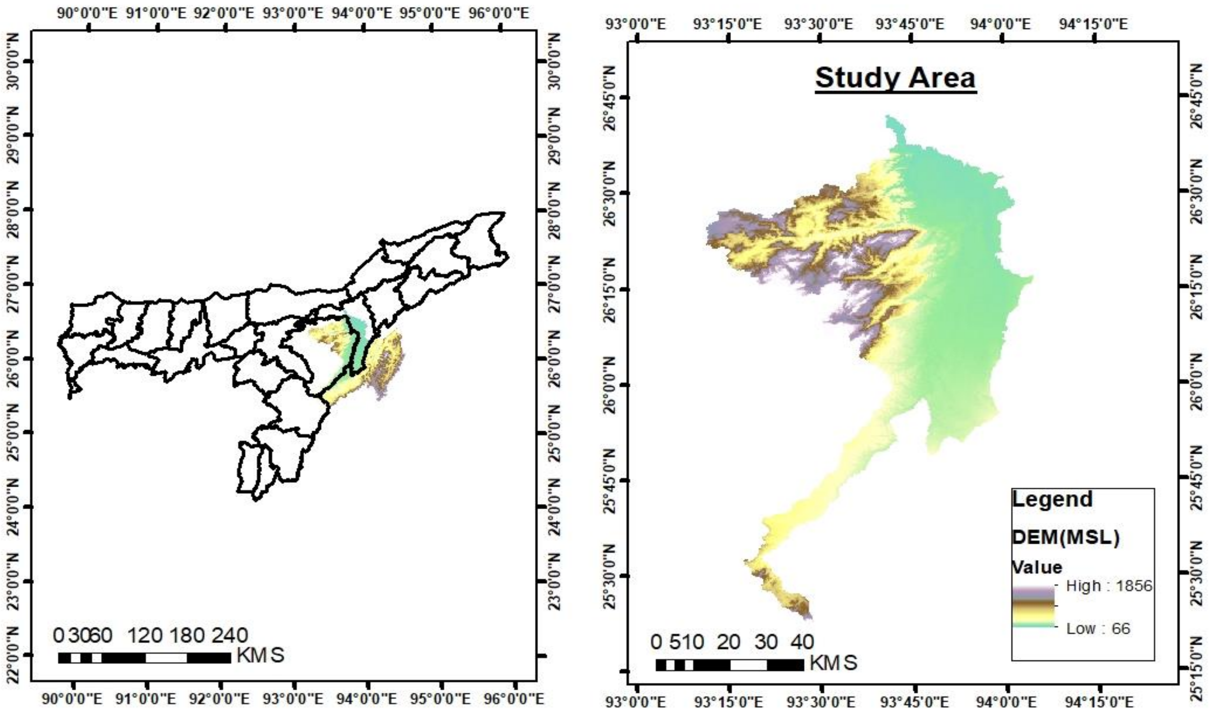

Fig 3.2 Geographical Location of Study Area

3.2 Land Use

The part of the watershed that lies within Assam is focused in this study. The part that lies in Assam is mostly flat and having some hilly areas in Karbi Anglong District. A large area of the watershed is covered by forest. Fig 3.3 shows the LULC map for the year 2024

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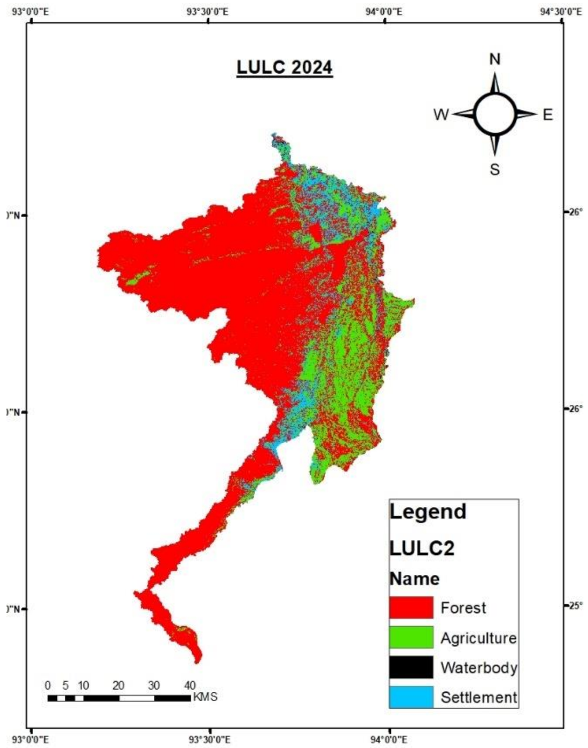

Fig 3.3 LULC 2024

Table 3.1 LULC classes and their approx. percentages

Sl No.	Land Use type	Approx. Area (km^2)	Area (%)
1	Forest	2970.62	68
2	Agriculture	786.34	18
3	Waterbody	218.42	5
4	Settlement	393.17	9

Table 3.1 shows the areas of the LULC classes their percentages.

3.3 Soil Characteristics

The lower Dhansiri River basin comprises of unconsolidated sediments of recent to sub-recent age overlain by alluvial deposits of the Pleistocene age occurring along the foothills. The soil map of the study area is shown in Fig 3.4. The soil characteristics were classified with the help of mwswat 2012.

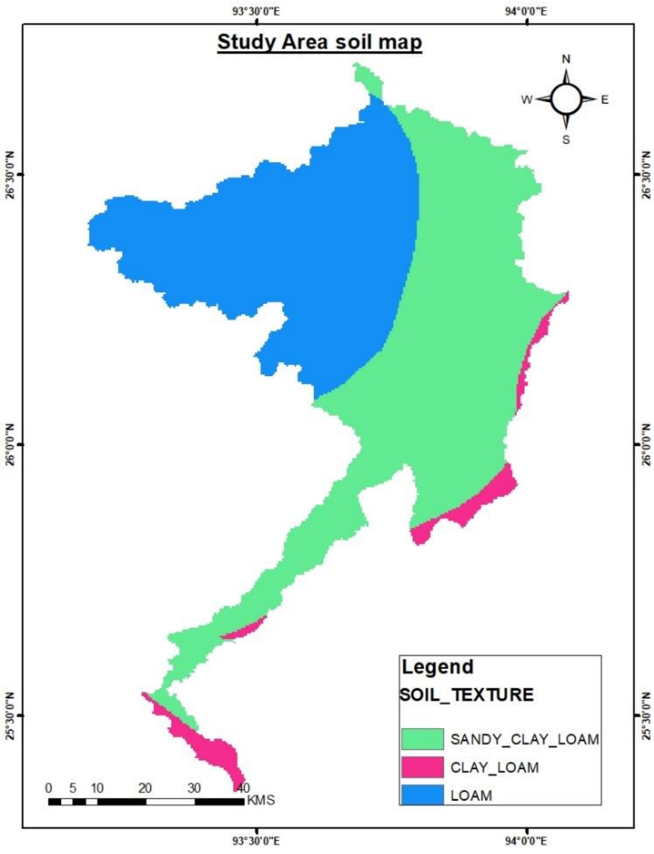

Fig 3.4: Study Area soil map

3.4 Topography

The elevation of Dhansiri watershed varies from 66 m to 3019 m. Due to the presence of mountaneous regions the variation of slope in this area is large. The slope varies from 0 degree to

75.1287 degree.

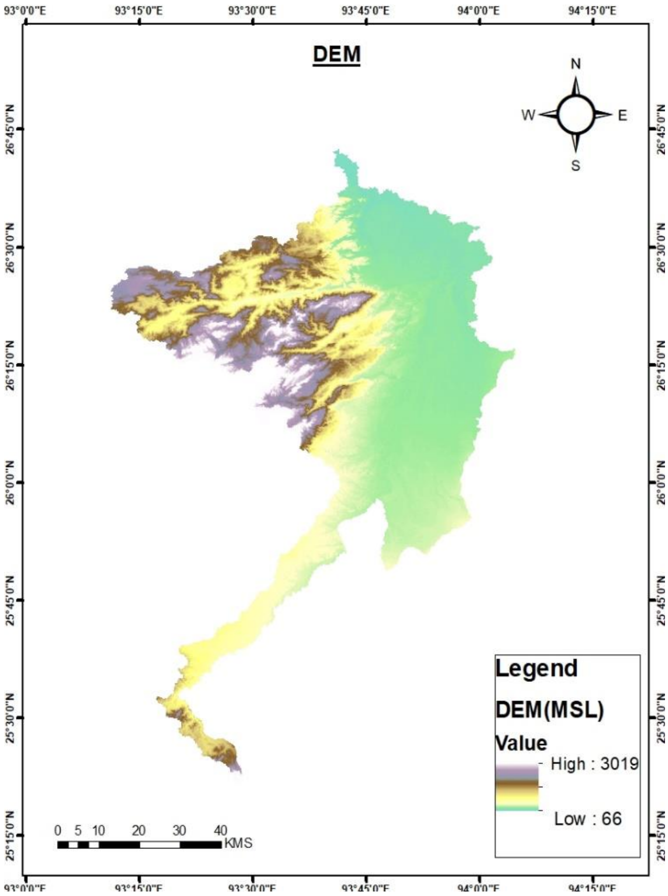

Fig 3.5: Study Area DEM

3.5 Climate

The river basin falling within south-west monsoonal regime, receives a mean monsoon rainfall of 1158.10 mm and the average annual rainfall in the basin is 1805.60 mm. The monsoonal rainfall causes heavy landslides in the mountainous upper catchment areas and flash floods in the lower part of the basin.

CHAPTER 4
METHODOLOGY

4.1 Introduction

The rate of soil loss from an area is strongly dependent upon its soil, vegetation, topographic and climatic characteristics. These factors are usually vary significantly within the various parts of a watershed. Therefore, the watershed needs to be discretised into smaller homogeneous units before making computations for soil loss. A grid-based discretization is known as the most reasonable procedure (Kothyari and Jain, 1997). The cell size to be used for discretization should be small enough so that a grid cell encompasses a hydrologically homogeneous area (Jain and Kothyari, 2000). The use of Geographical Information System (GIS) methodology is suitable for the quantification of heterogeneity in the topographic and drainage features of a catchment (Shamsi, 1996). Methods such as the USLE and RUSLE have been found to produce realistic estimates of soil loss over areas of small size (Wischmeier & Smith, 1978; Renard et al. 1997). So, in the present study, the quantitative empirical model RUSLE has been applied by integrating with a Geographical Information System (GIS) and remote sensing approaches to predict soil loss rates.

4.2 Revised Universal Soil Loss Equation

The Universal Soil Loss Equation (USLE) determines soil loss at any given point as a function of rainfall energy and intensity, soil erodibility, slope length, slope gradient, soil cover, and conservation practices (Wischmeier and Smith 1978). The Revised Universal Soil Loss Equation (RUSLE) has the same form as the USLE, but includes revisions for slope length and slope gradient calculations, more elaborate calculations for soil cover and conservation practices (Renard et al. 1997). However, RUSLE can estimate only annual average soil loss from rill and interill erosion caused by rainfall splash and overland flow, but not from gully and channel erosion (Renard et al., 1997). Therefore, GIS methods are used to partition the areas into overland and channel types to estimate the soil loss in individual grid cells of overland areas.

The RUSLE method is expressed as

A=R*K*L*S*C*P…………………………………………………………………………………..(4.1)

Where

A= Computed spatial average soil loss and temporal average soil loss per unit of area, expressed in the units selected for K and for the period selected for R, expressed in $ton.acre^{-1}.yr^{-1}$ or $ton.ha^{-1}.yr^{-1}$.

R = rainfall-runoff erosivity factor, the rainfall erosion index plus a factor for any significant runoff from snowmelt.

K = soil erodibility factor - the soil-loss rate per erosion index unit for a specified soil as measured on a standard plot, which is defined as a 72.6 ft (22.13 m) length of uniform 9% slope in continuous clean-tilled fallow.

L = slope length factor, the ratio of soil loss from the field slope length to soil loss from a 72.6 ft (22.13 m) length under identical conditions.

S = slope length factor, the ratio of soil loss from the field slope length to soil loss from a 72.6 ft (22.13 m) length under identical conditions.

C = cover-management factor, the ratio of soil loss from an area with specified cover and management to soil loss from an identical area in tilled continuous fallow.

P = support practice factor, the ratio of soil loss with a support practice like contouring, strip-cropping, or terracing to soil loss with straight-row farming up and down the slope.

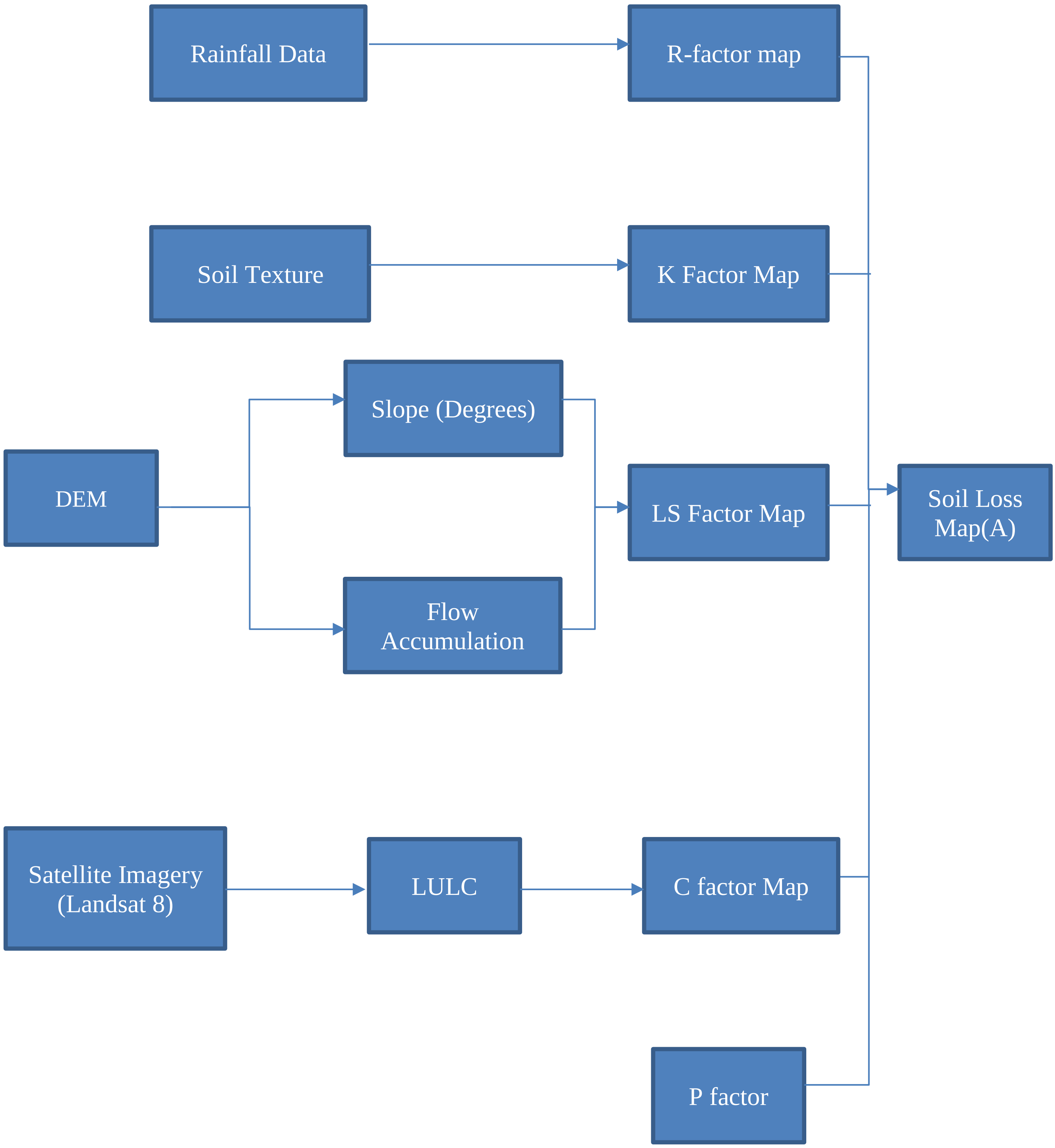

Fig 4.1 Flowchart of RUSLE

4.2.1 Rainfall Runoff Erosivity Factor (R)

The rainfall erosivity factor (R) describes the erosivity of rainfall in an area based on the rainfall amount, intensity and reflects the effect of rainfall intensity on soil erosion. It quantifies the effect of raindrop impact and explains the amount and rate of runoff associate with Rainfall erosivity (R). The value of rainfall erosivity factor used in RUSLE must quantify the effect of raindrop impact and must also reflect the amount and rate of runoff likely to be associated with the rainfall. The rainfall erosivity factor is often determined from rainfall intensity if such data are available. In 1986, Morgan as multiplied the mean yearly rainfall by 0.5 as a general constant.

$$R = P * 0.5 \quad \ldots\ldots(4.2)$$

Where, P = the available mean annual rainfall data.

Morgan and Davidson (1991) used this model once more in Ivory Coast and Burkina Faso for their study. Joshi et al. (2016) employed this model in India for their research in the north of Pune, Maharashtra. Dahe and Borate (2015) also used this approach on Maharashtra's Kaas Plateau.

Singh (1981) created a different R factor model, which is as follows:

$$R=79+0.363\ AAP \quad \ldots\ldots(4.3)$$

Where,

R=Rainfall erosivity factor,

AAP is the average annual precipitation in mm.

4.2.2 Soil Erodibility Factor (K)

The ease with which soil is separated by splash during rainfall, by surface movement, or by both is referred to as soil erodibility. The soil-erodibility factor (K), also known as soil erodibility, measures the combined impact of rainfall, runoff, and infiltration on soil loss. The influence of soil characteristics on soil loss during storm occurrences on upland areas is taken into consideration by the soil-erodibility factor (K) in RUSLE.The rate of soil loss per rainfall erosion index unit [ton. acre. h(hundreds of acre. ft-ton. in)$^{-1}$] as measured on a unit plot is known as the soil erodibility factor (K). The unit plot is 72.6 feet (22.1 meters) long, slopes at 9%, and has been continually left in a clean-tilled fallow condition with tillage done both uphill and downhill (Wischrneier and Smith 1978). For situations when the silt fraction does not exceed 70%, the nomograph can be approximated algebraically using (Wischmeier and Smith 1978).

$$K= [2.1 - 10\text{-}4(12\text{-}OM)\ M1.14+3.25(s\text{-}2) +2.5(p\text{-}3)] / 100 \quad \ldots\ldots(4.4)$$

OM = Percent Organic Matter where

M is the product of the major fractions of particle sizes. (percentage of modified silt, or the 0.002-0.1 mm size fraction)

s = Structure classes

p = Permeability of the soil

K is represented as $ton.acre^{-1}$ per erosion index unit using ton.acre.h (hundreds of acre.ft-ton.inch) units that are usual in the United States. Its SI unit is expressed in $t.ha.h.ha^{-1}\,MJ^{-1}mm^{-1}$

There is also an Equation for estimating K-factor values given by Wiliams (1995)

$K= f_{csand}*f_{cl-si}*f_{orgc}*f_{hisand}$ ……………………………………………………………….....(4.5)

where,

f_{csand}: a factor, that lowers the k indicator in soils with high coarse-sand contents and higher for soils with little sand;

f_{cl-si}: gives low erodibility factors for soils with high clay-to-silt ratios;

f_{orgc}: reduces K values in soils with high organic carbon content, while;

f_{hisand}: lowers K values for soils with extremely high sand content

$$f_{csand} = \{0.2+0.3*EXP[-0.256*m_s*(1-\frac{m_{silt}}{100})]\}$$

$$f_{cl-si}=\left(\frac{m_{silt}}{mc+m_{silt}}\right)^{0.3}$$

$$f_{orgc}=\left(1-\frac{0.25*org\ C}{orgC+\exp[3.72-2.95*orgC]}\right)$$

$$f_{hisand} = (1 - \frac{0.7*\left(1-\frac{m_s}{100}\right)}{\left(1-\frac{m_s}{100}\right) + \exp[-5.51+22.9*(\left(1-\frac{m_s}{100}\right)}$$

where:

m_s– the sand fraction content (0.05-2.00 mm diameter) [%];

m_{silt} – the silt fraction content (0.002-0.05 mm diameter) [%];

m_C– the clay fraction content (<0.002 mm diameter) [%];

orgC – the organic carbon (SOC) content [%].

The equation 4.5 was used to prepare the Soil Erodibility Factor (K) map for our study area. The K factor is a number that ranges from 0 to 1, with values closer to 0 being less susceptible to soil erosion.

4.2.3 Slope length and Steepness Factor(LS)

L factor and S factor are usually considered together to combine the effect of slope and slope length, which basically reflects the terrain on a given site. In this study an approach developed by Moore and Burch (1986) is used to compute LS factor. Moore and Burch (1986) proposed a unit stream power based physical LS factor.

According to them if the USLE is to be applied to real-world catchments, whether they are large or small, then it is recommended that the length-slope factor derived from unit stream power theory be used rather than the original Equation given by (Wischmeier and Smith 1978). This allows a greater range of topographic attributes (slope, slope length, and catchment convergence) and rilling to be explicitly accounted for within the soil loss calculations (Moore and Burch, 1986).

$$LS = (\frac{Slope\ Length}{22.13})^{0.4} * (\frac{\sin\theta}{0.0896})^{1.3}$$

Where,

Slope Length = Floe accumulation * cell resolution (DEM) and θ is “ Slope in Degrees”.

Flow accumulation can be derived from DEM using spatial analyst tool in ArcGIS. At first the DEM has to be filled and then flow direction has to be performed. Using Flow Direction as an input Flow Accumulation can be derived in ArcGIS. Slope angle θ, for each grid can be found by using the Spatial Analyst tool in ArcGIS.

To compute LS Factor using DEM in Arc Map following steps were used:

1. Calculate Fill sinks
2. Calculate flow Direction using Fill sinks data as the input raster
3. Calculate flow accumulation using flow direction data as the input raster
4. Calculate slope of watershed in degree using DEM (Digital Elevation Model) as the input layer(Arc Map ⟶ spatial Analyst Tools ⟶ Surface ⟶ Slope)

5. Write the LS-factor formula below in Arc Map ⟶ spatial Analyst Tools ⟶ Map Algebra ⟶ Raster Calculator

4.2.4 Cover Management Factor (C)

The next crucial element that regulates the risk of soil erosion is vegetation cover. The cover and management (C) factor reflect the effect of LULC, cropping and management practices on the rate of soil erosion, and it is the ratio of soil loss from land covered by vegetation. The cover management element in the Revised Universal Soil Loss Equation takes into account the impact of vegetation cover. According to Wischmeier and Smith (1978), it is the proportion of soil loss from land that has been farmed under certain conditions to the same loss from clean-tilled, continuous fallow. According to Oliveria et al. (2015) b and Wischmeier & Smith (1978), this factor is a non-dimensional number between zero and one that indicates a rainfall erosivity- weighted ratio of soil loss from land under specified, vegetated conditions to the analogous loss from continuous bare fallow.

Rao (1981) then used the USDA-SCS (1972) idea to determine the cover management factor in the context of India. This idea was applied by Tirkey et al. (2013) to the Daltonganj watershed in the Palamu district of Jharkhand. This table was adopted by Chatterjee et al. (2014) for the Upper Subarnarekha River Basin in Jharkhand. The model was utilized by Joshi et al. (2016) for their investigation in the Maharashtrian region of Pune. The C-values were used in the present study proposed by Kim et al., (2005).

4.2.5 Support Practice Factor

Support practice indicates the rate of soil loss according to the various cultivated lands on the earth. There are contour farming, strip cropping and terrace as a method and as an important factor that can control the erosion.

CHAPTER 5
RESULTS & DISCUSSION

5.1 Delineation of Watershed

The delineation of watershed was done in ArcMap 10.4. Shutter Radar Topography Mission (SRTM) Digital Elevation Model of 30m x 30m was used which was downloaded from https://earthexplorer.usgs.gov. Fig 5.1 shows the website along with the tiles within which the area of study lies.

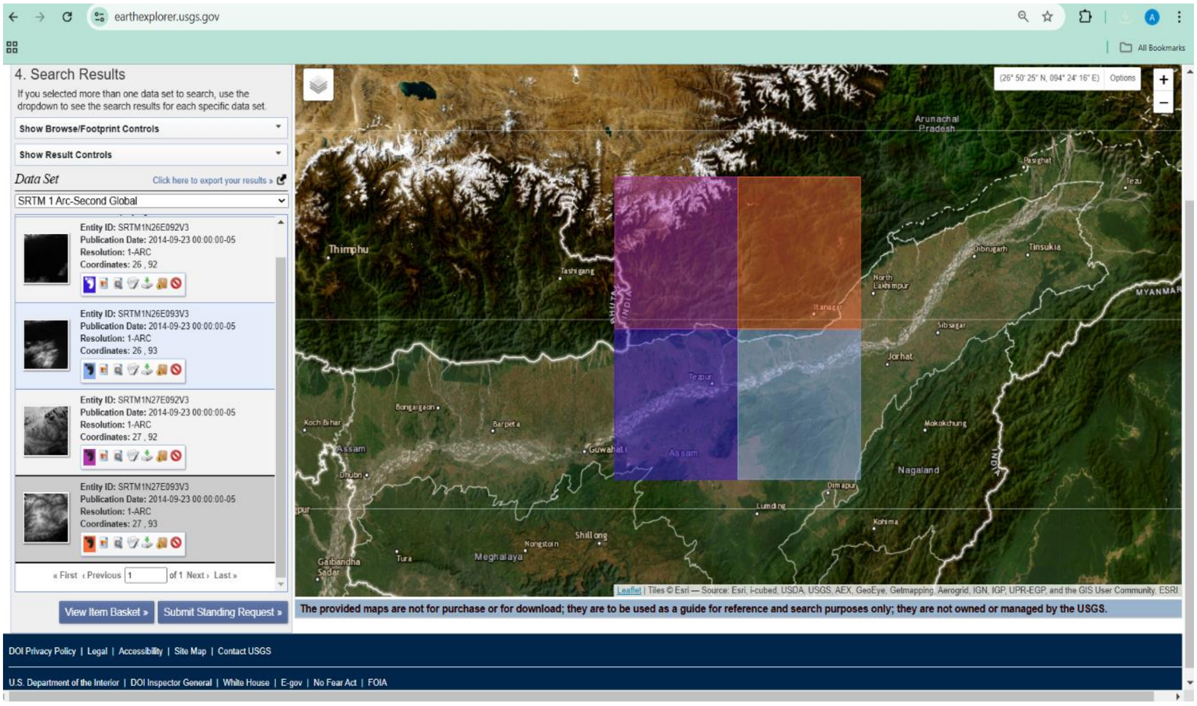

Fig 5.1 DEM download from USGS Earth Explorer

The DEM downloaded is then imported in ArcMap 10.4. Since there are multiple tiles covering the study area. Therefore, the tiles are mosaiced using the “Mosaic to New Raster” tool in ArcGIS. Fig 5.2 shows a moment during the mosaic process.

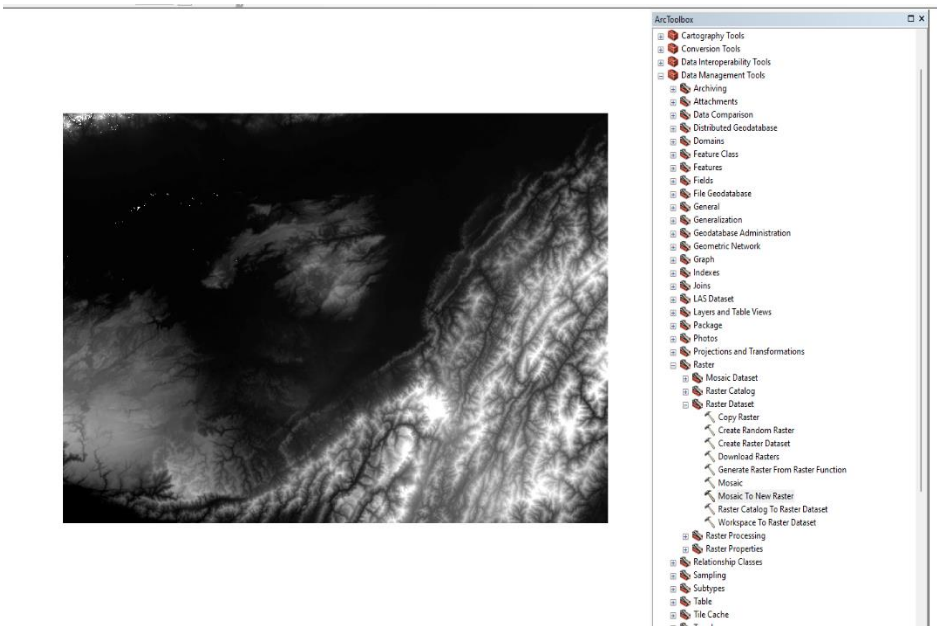

Fig 5.2 Mosaic to new Raster tool

After mosaicking, the next step is to fill the DEM as it will remove the sinks and allow the water to flow downhill, which is necessary to proceed further in our study. Fig 5.3 shows the “fill” command in ArcGIS’s Arc Toolbox.

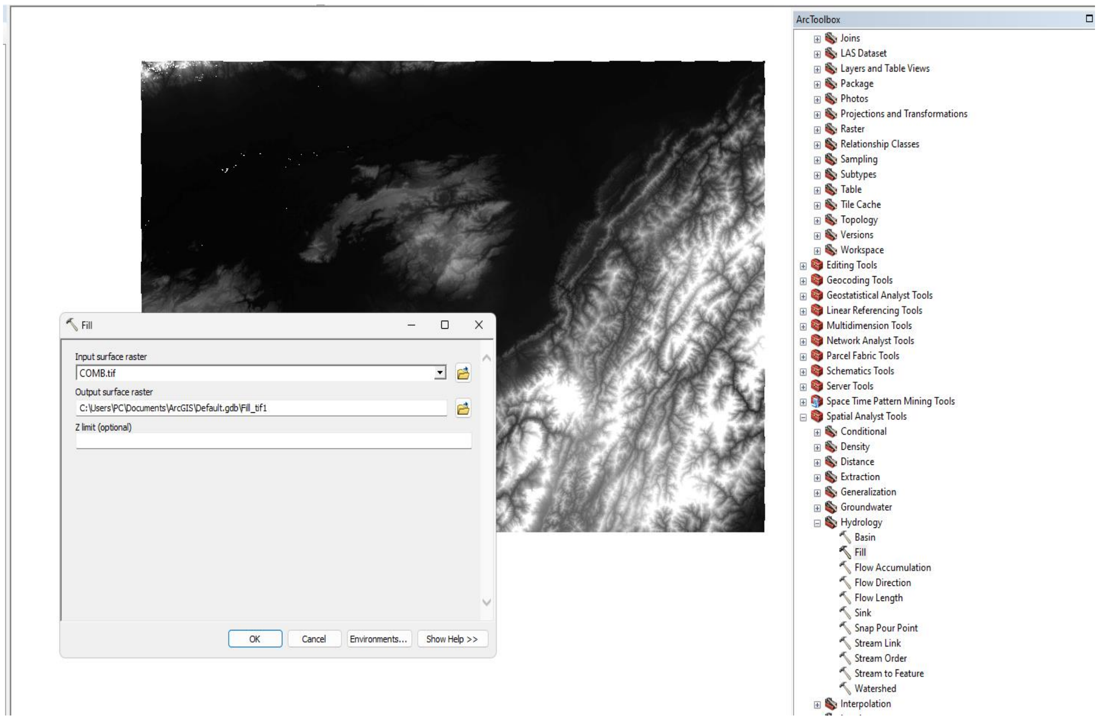

Fig 5.3 Using fill command in ArcGIS

The next step after fill is to identify the flow direction. For this, the “Flow Direction” tool in ArcGIS is used. The Flow Direction tool in ArcGIS is important because it helps determine the direction of water flow, which can be used to delineate the watershed.Fig 5.4 shows the “Flow Direction command in ArcGIS’s Arc Toolbox.

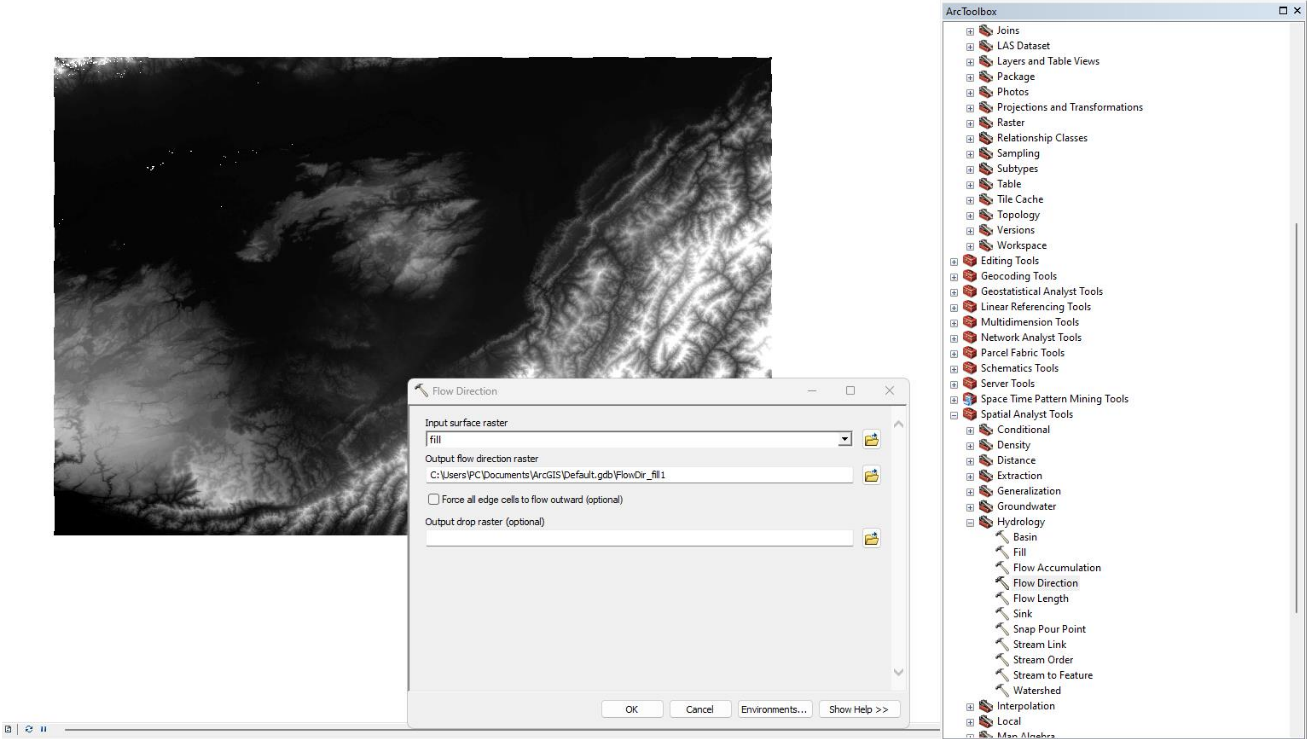

Fig 5.4 Flow Direction command in ArcToolBox

Fig 5.5 shows the Flow Direction Raster for the input DEM.

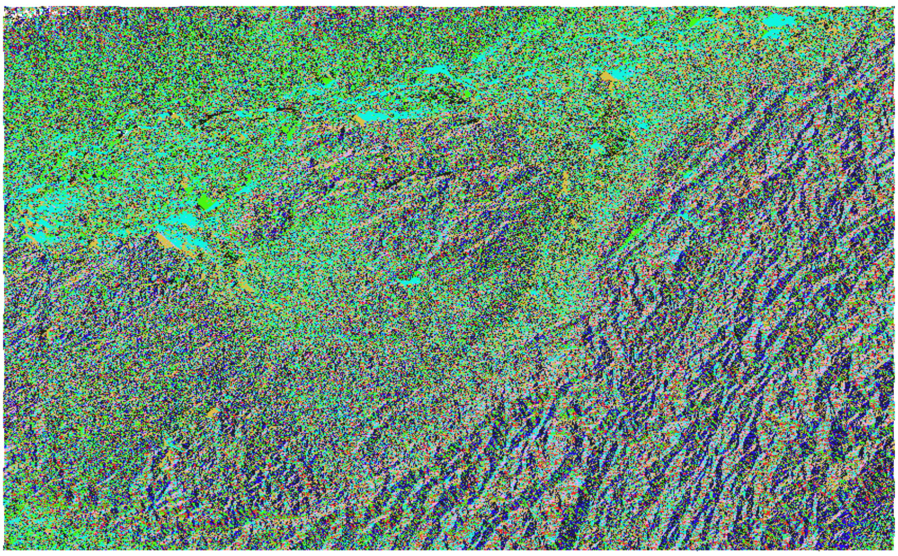

Fig 5.5 Flow Direction Raster

After flow direction, the next step is to perform flow accumulation. The Flow Accumulation tool calculates accumulated flow as the accumulated weight of all cells flowing into each downslope cell

(a)

in the output raster. If no weight raster is provided, a weight of 1 is applied to each cell, and the value of cells in the output raster is the number of cells that flow into each cell. Fig 5.6 (a) shows the flow accumulation command in ArcToolBox and (b) shows the flow accumulation raster.

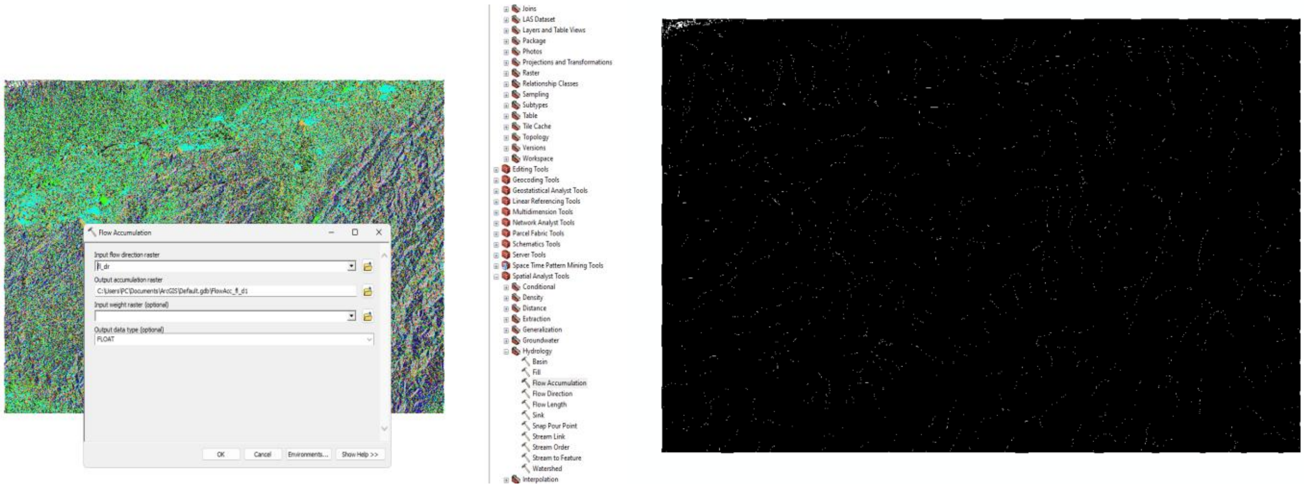

Fig 5.6 (a) Flow Accumulation command in Arc Toolbox; (b) Flow accumulation raster

After flow accumulation the next step is to identify the outlet point. Then we go to “Watershed” (Fig 5.7) and delineate the watershed by adding the outlet point shapefile as pour point data.

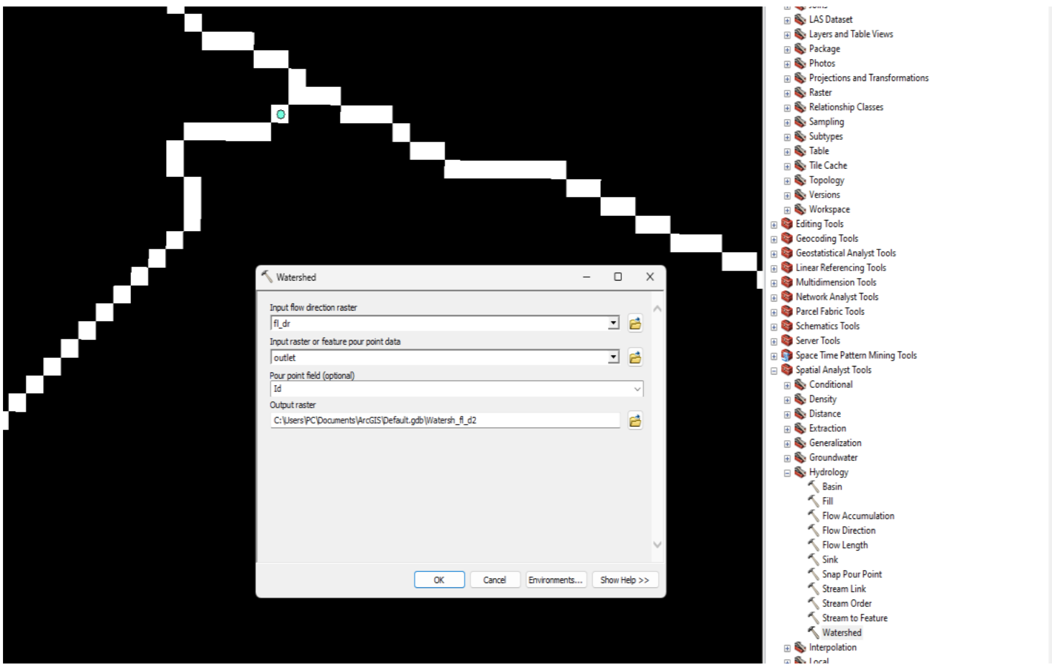

Fig 5.7 Watershed command and adding outlet data

Then we obtain the watershed as shown in fig 5.8.

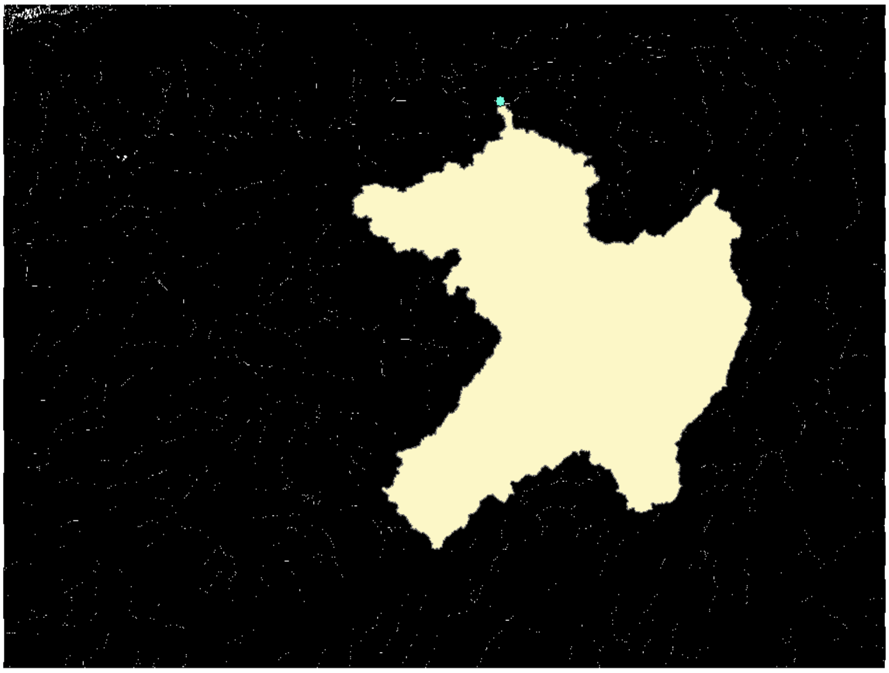

Fig 5.8 Delineation of watershed

After delineation, the study area was clipped against the part that lies within Assam. This is illustrated in fig 3.2 of Chapter 3 :Description of Study Area.

5.2 Land Use Land Cover

The Land Use Land Cover Map for the study area was prepared by using Landsat-8 images downloaded from USGS Earth Explorer. After downloading the Landsat image was clipped against the study area. Fig 5.9 shows the clipped image. The composite bands of 5, 4, 3 were used for the images.

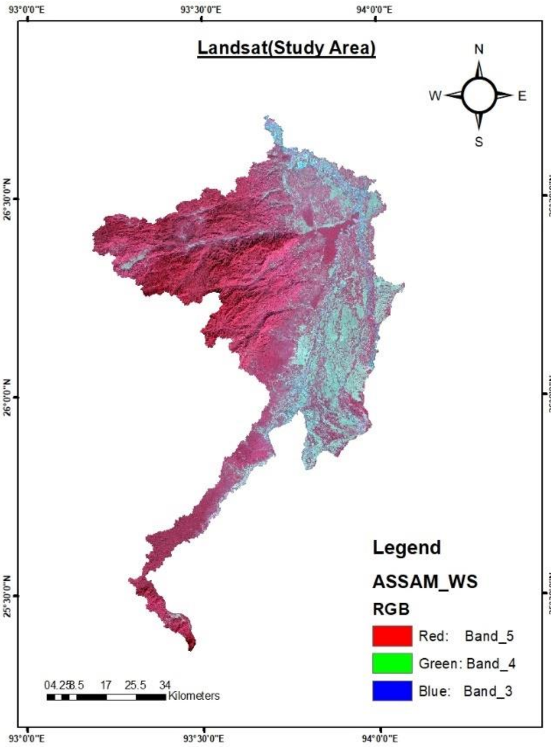

Fig 5.9 Clipped study area from Landsat Image

After that, using supervised classification the study area was classified for different classes and a Landuse-Landcover (LULC) map for the year of 2024 was prepared in ArcGIS. Fig 5.10 shows the LULC map of the study area for the year 2024.

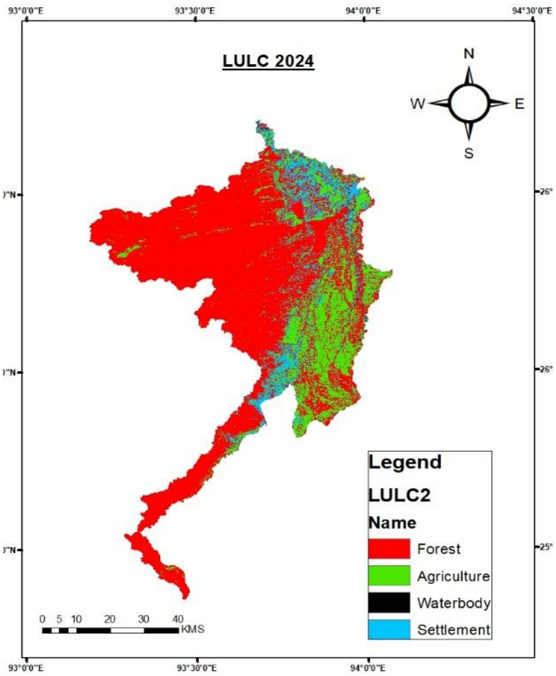

Fig 5.10 LULC map (2024)

The Landuse classification and the areas of each class is shown in table 3.1 in Chapter 3: Description of Study Area.

5.3 Soil Erodibility Factor (K)

The ease with which soil is separated by splash during rainfall, by surface movement, or by both is referred to as soil erodibility. The soil-erodibility factor (K), also known as soil erodibility, measures the combined impact of rainfall, runoff, and infiltration on soil loss. The influence of soil characteristics on soil loss during storm occurrences on upland areas is taken into consideration by the soil-erodibility factor (K) in RUSLE. The soil erodibilty factor(K) map is shown in fig 5.11.

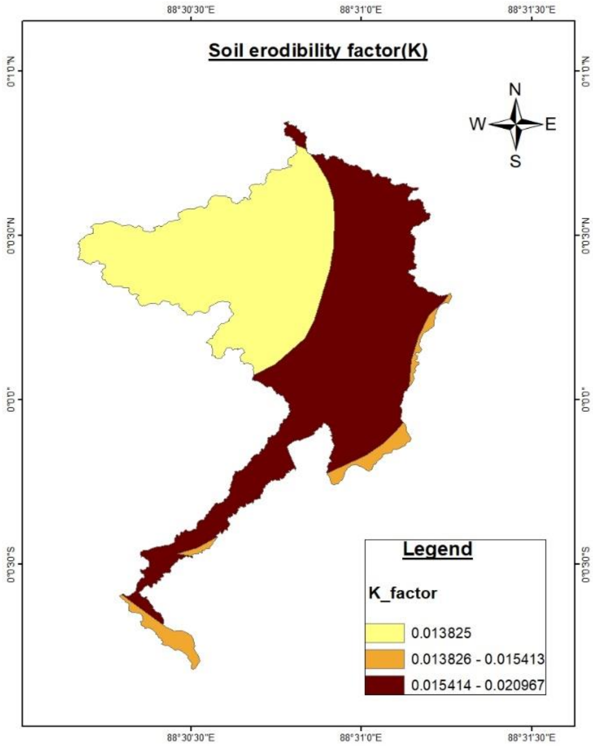

Fig 5.11 Soil erodibility map (K)

5.4 Slope length and Steepness factor (LS)

L factor and S factor are usually considered together to combine the effect of slope and slope length, which basically reflects the terrain on a given site. In this study an approach developed by Moore and Burch (1986) is used to compute LS factor. Moore and Burch (1986) proposed a unit stream power based physical LS factor. Fig 5.12 shows the LS factor map for the study area.

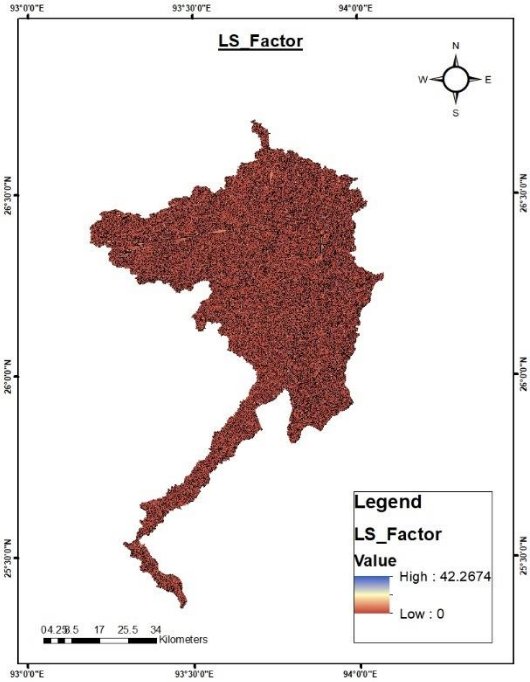

Fig 5.12 Slope length and Steepness Factor (LS) Map

5.5 Cover Management Factor

The cover management factor was first created by USDA-SCS (1972) using water bodies, agricultural land, sparse vegetation, dense vegetation, barren land, and built-up land . The USDA-SCS (1972) equation was updated by Wischmeier and Smith (1978a,b), who increased the variation in land cover for the C factor.

Table 5.2 Land use-land cover class and respective C-factor

Sl No	Classes	Approx. Area (Km^2)	Percentage Distribution (%)	C factor
		2024	2024	
1)	Waterbody	218.42	5	0
2)	Forest	2970.62	68	0.003
3)	Crops	786.34	18	0.63
4)	Built Area/Settlement	393.17	9	0.8

In this study, the Cover Management Factor was calculated using cloud-free Landsat 8 satellite. The study area has been classified into four land use classes. Cover management factor was assigned different land use patterns using the values given in Table 5.2. C-factors were allocated after calculating the area related to each land use land cover class for the year 2024. (Table 5.2). Using land use land cover map and C-factor value, the cover management factor (C) factor map was prepared. Fig 5.2 shows the C-factor map for the study area.

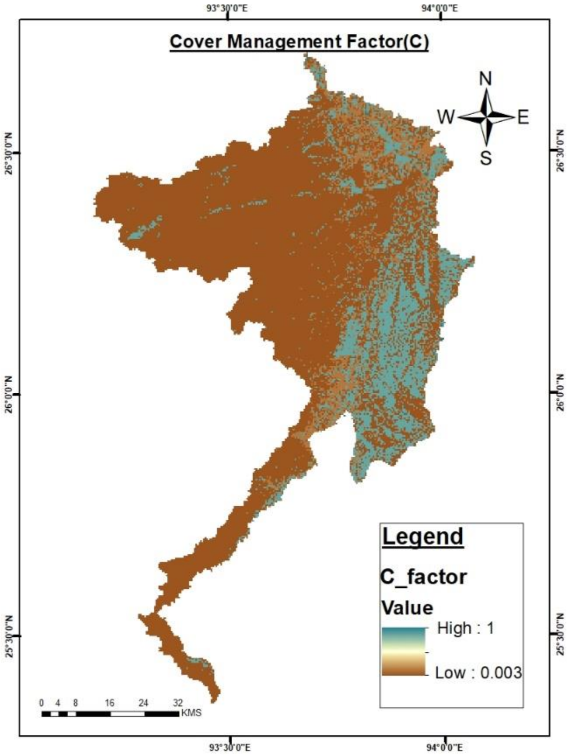

Fig 5.13 Cover Management Factor (C) with LULC for 2024

According to Fig 5.2, the watershed's C-factor values range from 0.003 to 1. The study determined the C-factor, results as thickly vegetated areas have low C values and are less likely to erode.

5.6 Support Practice Factor

The support practice factor (P) in RUSLE is the ratio of soil loss with a specific support practice to the corresponding loss with upslope and downslope tillage. These practices principally affect erosion by modifying the flow pattern, grade or direction of surface runoff and by reducing the amount and rate of runoff (Renard et al., 1997). The values of P-factor ranges from 0 to 1, in which the highest value is assigned to areas with no conservation practices and the minimum values correspond to built-up land and plantation area with strip and contour cropping. For this study the maximum value of 1 was considered as there is no known conservation practice present in the watershed.

CHAPTER 7
CONCLUSION

- The Land Use Land cover map for the year of 2024 shows that the class of forest occupies the largest area of 2970.62 km^2 at a percentage distribution of 68%. At the same time, the class of waterbody occupies a very small area of 218.42 km^2 at a percentage distribution of 5%.
- From the soil map, it can be found that the study area soil consists of three soil textures namely Sandy_Clay_Loam, Clay_Loam and Loam. From this soil map, the soil erodibility factor(K) map was also determined. The K-factor values were found to be the range of (0.013825-0.020967) t. ha.h./ha.MJ.mm. The low values of K indicates that the soil in the study area are less susceptible to erosion.
- From the Slope length and Steepness (LS) factor map it can be seen the LS factor varies from 0 to 42.674. Lower values appear to be scattered in the plain region of the basin where the slope length and steepness is low. It shows that the LS factor is large in hilly or places with high elevations and low in areas with low elevations.
- From the cover management factor(C) map, it can be seen that the C-factor values varies from 0.003 to 1 within the study area.

CHAPTER 8
FUTURE WORK

- To find R factor for the study area using rainfall data(to be collected).
- The annual soil loss from the watershed will be found using RUSLE.
- LULC map for the study area for the last 20 years at an interval of 5 years will be studied to determine the impact of land cover change soil loss.
- To simulate rainfall-runoff modelling

CHAPTER 8
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