Case Study
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SOIL EROSION RISK ESTIMATION BY USING SEMI EMPIRICAL RUSLE MODEL: A CASE STUDY OF NUN WATERSHED, UTTARAKHAND

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ABSTRACT

Day by day numerous population pressure on land and due industrialization there is a vigorous increase of temperature increase in atmosphere, acid rain along with Deforestation definitely degrade the quality the of land. It should have to evaluate the land for estimate the quality of soil and find out the nutrition status as well as the soil health. The present study with the help of Geographic Information System (GIS) platform to estimation erosion risk following Revised Soil Loss Erosion Model (RUSLE). The physiographic soil map has been prepared through visual interpretation of LISS-4 satellite image from which soil erodibility factor is derived. The Digital Elevation Model (DEM) prepared from the contour line derived from toposheet and GPS survey. In the model (Slope Length) LS factor was derived from the DEM. Crop Cover and Support Practices Map (C and P) factor derived from the LULC map.it has been found that 15.90 % under very high category erosion, 5.49 % high erosion,7.03 % under moderate high erosion, 8.54 % under moderate erosion,11.69 % under low erosion, and 51.36 % under very low erosional prone area.

Keywords: Dem, Erosion, Gis, Rusle, Vigorous

1. INTRODUCTION

The soil is a natural skin of the earth body which contain mineral and organic constituents, differentiated into different horizons of variable physical, chemical also biological characteristic such as dept, texture, structure, colour, mineral content etc.

The LULC change analysis has been prepared with the help of out using Resource sat LISS III and LANDSAT-8 OLI satellite data. Saha et al. (1992) Discussed about the erosion prone area of Sukhna Lake catchment, north India using IRS 1D LISS for land use/ land cover mapping with a classification accuracy of 83 percent Shirmali et al. (2002). Universal soil loss erosion model has been used to estimate the average rate of soil erosion for different combination of crop practice system which associate with different types of soil, climate, relief, slope Jain and Kothyari (2000) Demonstrated that Remote Sensing and GIS and technique can be integrated with USLE successfully and effectively for prediction of soil loss erosion Wischmeier and Smith (1965) Study of the ground water impact on soil erosion CGWB (2009) various types of parameters like land use land cover, Physiographic unit map, slope and texture map has been prepared for soil erosion Bhattacharya (1997)

Evaluate the physiographic and metamorphic characteristic to ensure sustainable land use to predict the land degradation. Bhushan and Khera (2002) GIS technology to predict the annual soil erosion rates 56 tonnes/ha/yr. fall under highest category, which has been seen basically rain fed cultivated areas, which is affected by slop and relief. The lowest soil erosion bellow 1 tone/ha/yr. are found under dense forest. Shrestha (1997)

1.1. STUDY AREA

The study area is located in Dehradun district of Uttarakhand. The Nun Watershed is located between 300 20' 12" N to 300 27' 52" N latitude and 770 56' 05" E to 780 08' 55" E longitude. The study area covered with a terrace agriculture, dense Sal Forest, mixed forest, dense scrub, degraded forest, open forest, open scrub, orchards etc. The climate of the study area is like moderate temperature with cool winter of its absolute location near foothill of Himalaya.

Figure 1

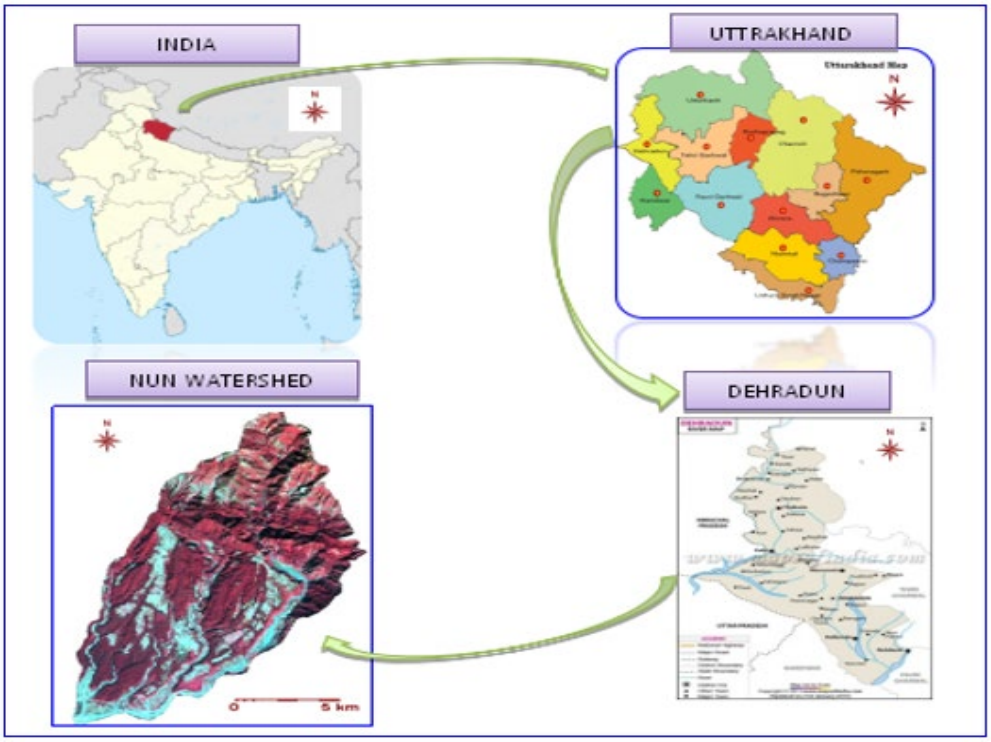


Figure 1 Location map of the Study area

2. MATERIALS AND METHODS

The required data has been taken from different sources as like rainfall data of 25 year has been collected from District Administration of Dehradun. And rest of the data details has been given below Table 1 and Table 2

Table 1

Table 1 Satellite data of the Study area

LISS-IV images	Date	Path No.	Row No.
1	17-OCT,2020	96	49
2	7-OCT,2020	96	50

Table 2

Table 2 Topographical sheet of the Study area

SL. NO.	Toposheet No.	Scale
1	53F/15	1:50000
2	53J/3	1:50000

Following are the steps of methodology which objectives these are preparation of LULC MAP, Physiographic map, Slope map, Digital soil map, slope length factor map, crop cover and support practice factor map and finally prepare soil erosion risk map.

Figure 2

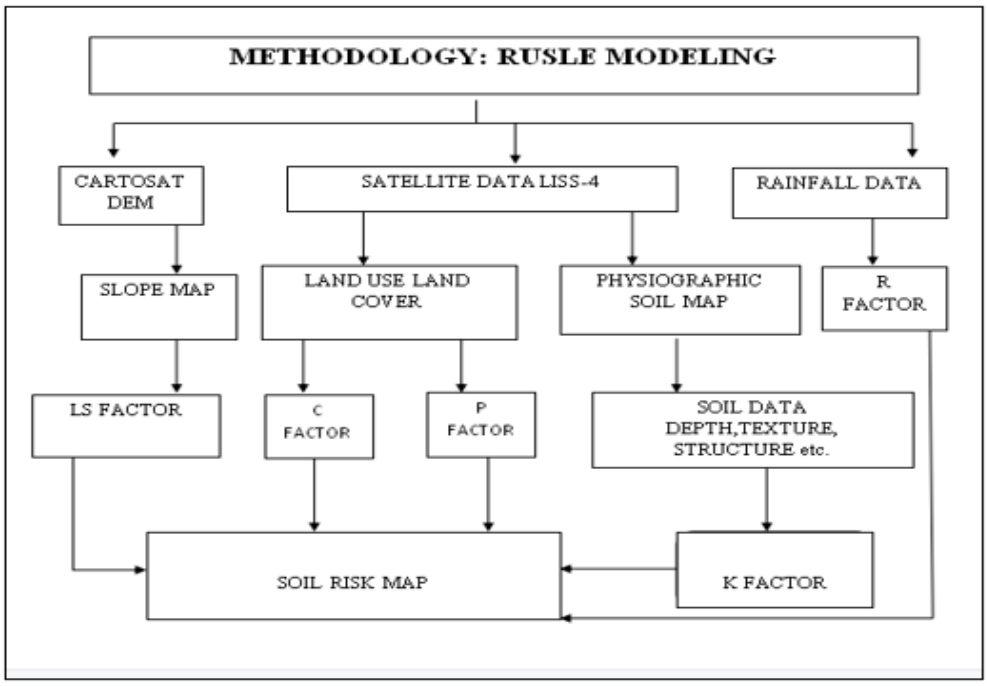


Figure 2 Methodology for revised soil loss erosion model

3. RESULTS AND DISCUSSIONS

Physiographic Soil Map

In physiographic map physiographic units are divided into fifteen parts. These units are divided on the basis of slope steepness. The watershed falls under the hills

and river terraces. Each unit have its own characteristics on the basis of soil, vegetation, and slope. The total area of the physiographic unit is 8819.51 hectare and each units have different area.

Table 3

Table 3 Physiographic Unit and percentage of area

Physiographic unit	PH Unit	Area (ha.)	Area (%)
Steep Himalayas (scrub)	H1	471.6225	5.54
Steep Himalayas (agriculture)	H2	677.755	7.96
Steep Himalayas (dense forest)	H3	19.9675	0.23
Upper piedmont (scrub)	UP1	724.6125	8.51
Upper piedmont (dense forest)	UP2	838.86	9.85
Upper piedmont (agriculture)	UP3	24.735	0.29
Middle piedmont (scrub)	MP1	64.6175	0.76
Middle piedmont (dense forest)	MP2	707.3375	8.3
Middle piedmont (agriculture)	MP3	283.5775	3.33
Middle piedmont (orchard)	MP4	751.9075	8.83
Lower piedmont (dense forest)	LP1	164.3175	1.93
Lower piedmont (agriculture)	LP2	1894.1275	22.24
Lower piedmont (current fallow)	LP3	471.6225	5.54
Residual hill	R1	677.755	7.96
River terrace	R2	19.9675	0.23
River	R3	724.6125	8.51
Total		8517.395	100

Figure 3

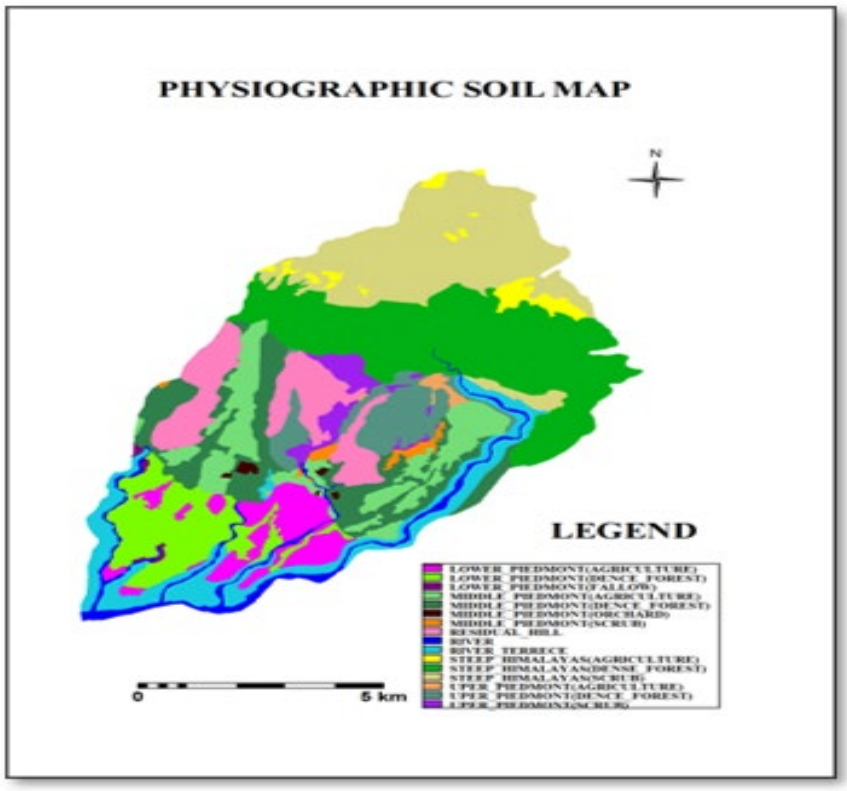


Figure 3 Physiographic Soil Map

Table 4

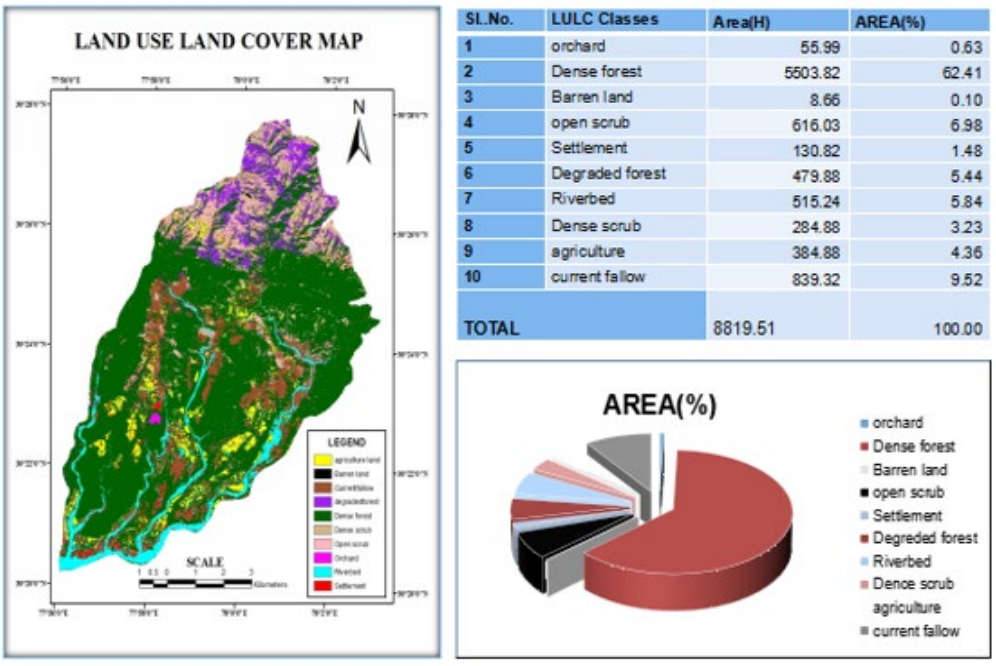
Table 4 Physiographic Unit wise Soil properties

Sl. No.	PH unit	Slope (%)	Drainage	Surface Stones	Texture	Erosion	pH	EC
1	H11	15-25	Excessive	40-75	Sl	E1/e2	4.95	0.032
2	H12	15-25	Excessive	40-75	Sl	E2/e3	5.24	0.063
3	H13	60-70	Excessive	40-75	Sl	E2	5.31	0.041
4	P11	15-Oct	Well	15-40	Sil	E1	5.66	0.066
5	P12	10-Jul	Excessive	15-40	Sl	E2/e3	5.49	0.094
6	P13	7-May	Moderate	<15	L	E1	5.77	0.062
7	P21	8-May	Well	<15	Sil	E2	5.63	0.05
8	P22	2-Jan	Well	<15	Sil	E1	5.42	0.04
9	P23	3-Feb	Well	<15	Sil	E1	4.87	0.04
10	P24	8-May	Well	<15	L	E1	5.85	0.086
11	P31	8-May	Well	<15	Sil	E2/e3	5.61	0.073
12	P32	5-Mar	Well	<15	Sil	E1	5.42	0.061

3.1. LAND USE LAND COVER

The major land use land cover of the study area is orchard, dense forest, barran land, open scrub, settlement, degraded forest forest, riverbed, dense scrub, agriculture, current fellow. The total area of the study region is 8819.51 ha. Agriculture area covered with 62.41 % whereas open scrub covered with 6 percentage.

Figure 4



Sl.No.	LULC Classes	Area(H)	AREA(%)
1	orchard	55.99	0.63
2	Dense forest	5503.82	62.41
3	Barren land	8.66	0.10
4	open scrub	616.03	6.98
5	Settlement	130.82	1.48
6	Degraded forest	479.88	5.44
7	Riverbed	515.24	5.84
8	Dense scrub	284.88	3.23
9	agriculture	384.88	4.36
10	current fallow	839.32	9.52
TOTAL		8819.51	100.00

Figure 4 Landuse Landcover map of the study area

3.2. SLOPE FACTOR

Slope map was prepared using Digital Elevation Model. Slope was used for calculating LS factor. The digital elevation map (DEM) prepared with the help of

Contour map. In the model LS factor was derived from the DEM. The slope of the watershed lies between gentle slope to very steep slope.

Figure 5

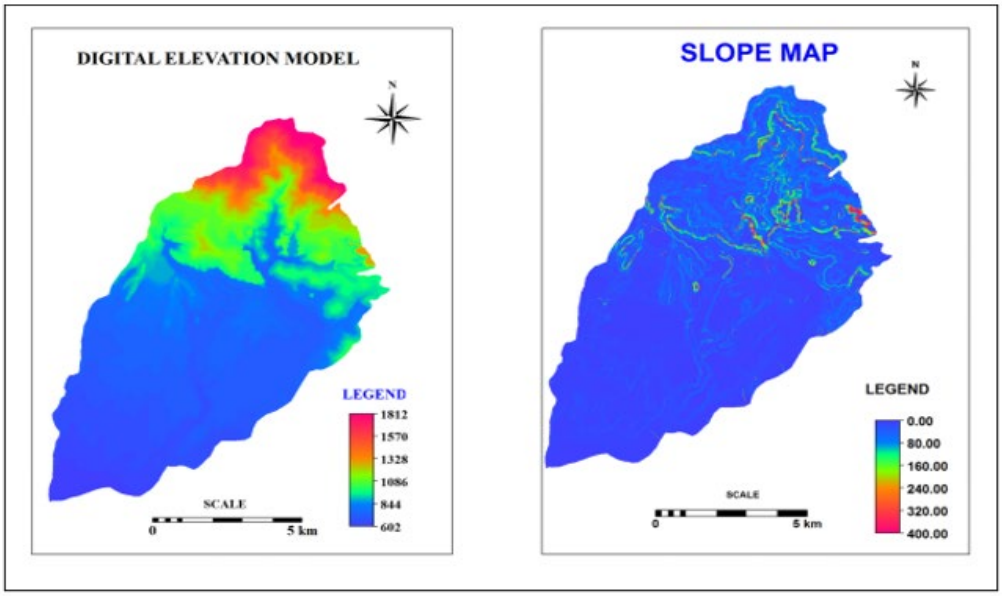


Figure 5 Slope of study area in percentage

3.3. RAINFALL EROSIVITY FACTOR

Rainfall Erosivity factor has been calculated with the average rainfall of the twenty-five years. twenty-five-year average rainfall is 2051.4mm. The equation, is calculating the rainfall Erosivity, is-

R= 81.5+0.375*X (where, X= mean annual rainfall)

R= 81.5+0.375*2051.4

Figure 6

Month	Rainfall(mm)
January	46.9
February	54.9
March	52.4
April	21.2
May	54.2
June	230.2
July	630.7
August	627.4
September	261.4
October	32
November	10.9
December	2.8

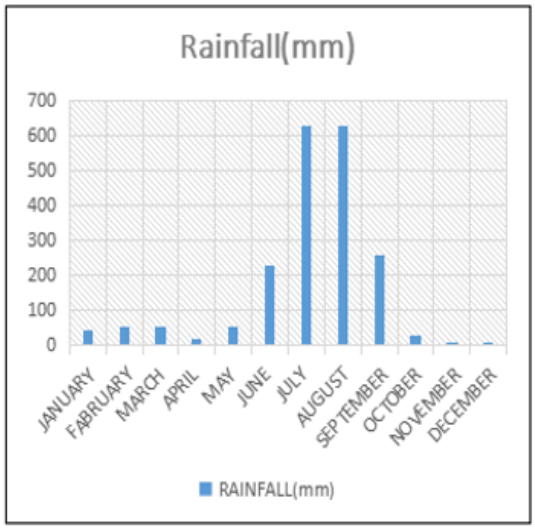


Figure 6 Monthly rainfall data

3.4. COVER AND MANAGEMENT PRACTICE AND SUPPORT PRACTICE FACTOR

There are ten Landuse and Landcover classes have been found in the study area. LULC analysis showed that dense forest covered 62.40 %, degraded forest covered 5.44%, agricultural land covered 4.36%, dense scrub covered 3.23 %, open scrub covered 6.98 %, riverbed 5.84 %, and C and P factor derived from the LULC map. The C value varies from between 0.004-1 and the P value varies between 0.3 -1.

Table 5

Table 5 C and P value of land use and land cover

Unit	C Value	P value
Orchards	0.01	0.4
Dense Forest	0.004	0.8
Barren Land	1	1
Open Scrub	0.8	0.8
Settlement	0	0
Degraded Forest	0.04	0.8
Riverbed	0	0
Dense Scrub	0.08	0.8
Agriculture	0.2	0.3
Crop II	0.3	0.3

Figure 7

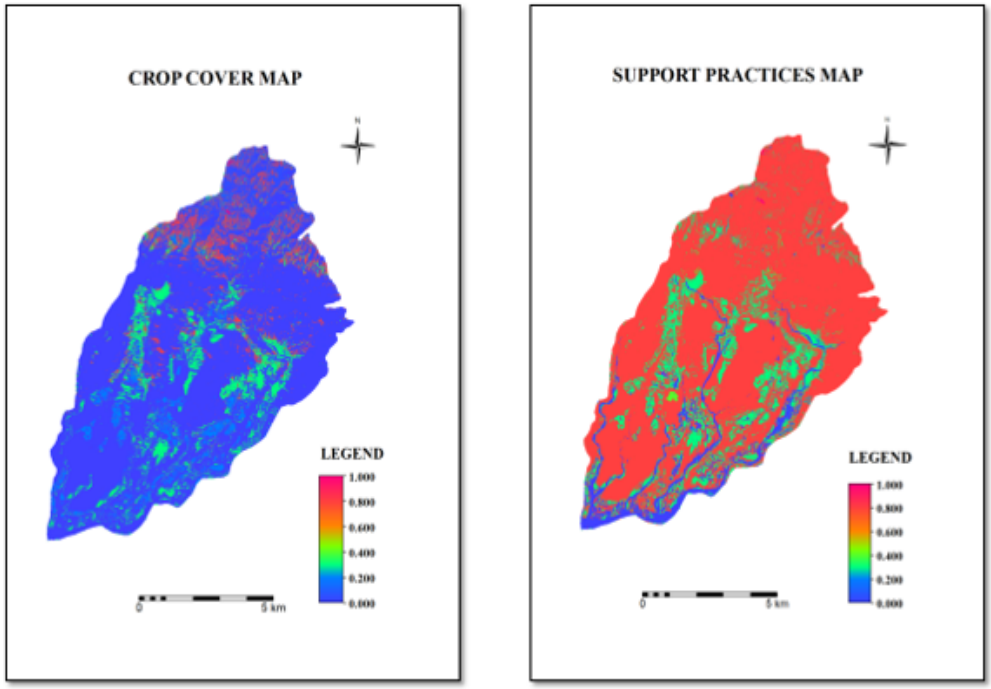


Figure 7 Crop Cover and Support Practices Map

3.5. ESTIMATION OF SOIL EROSION

RUSLE soil erosion risk map has been prepared after generated of all parameter map. The formula to generate the soil erosion risk is as below:

A= R * K* L* S* C *P

it has been found that 15.90 % under very high category erosion, 5.49 % high erosion,7.03 % under moderate high erosion, 8.54 % under moderate erosion,11.69 % under low erosion, and 51.36 % under very low erosional prone area. ion.

Table 6

Table 6

Classes	Soil Loss(tons/ha/yr.)	Area (ha)	Area (%)
Very Low	0-10	4253.1	51.36
Low	25-Oct	967.842	11.69
Moderate	25-50	706.885	8.54
Moderate high	50-100	581.745	7.03
High	100-200	454.537	5.49
Very high	>200	1316.897	15.9
Total		**8281.07**	**100**

Figure 8

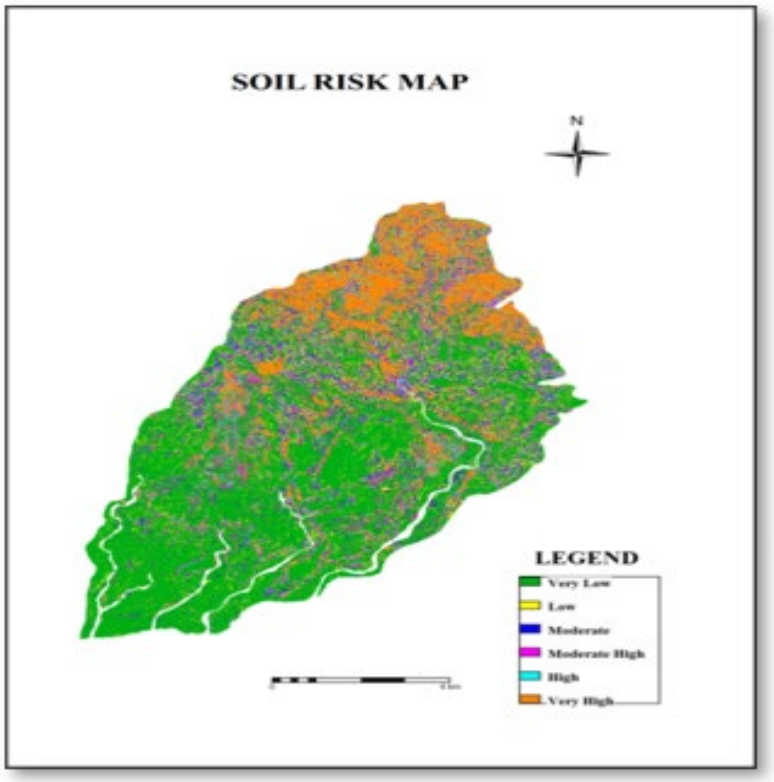


Figure 8 Areal extent of Soil Risk in Nun watershed

Figure 9

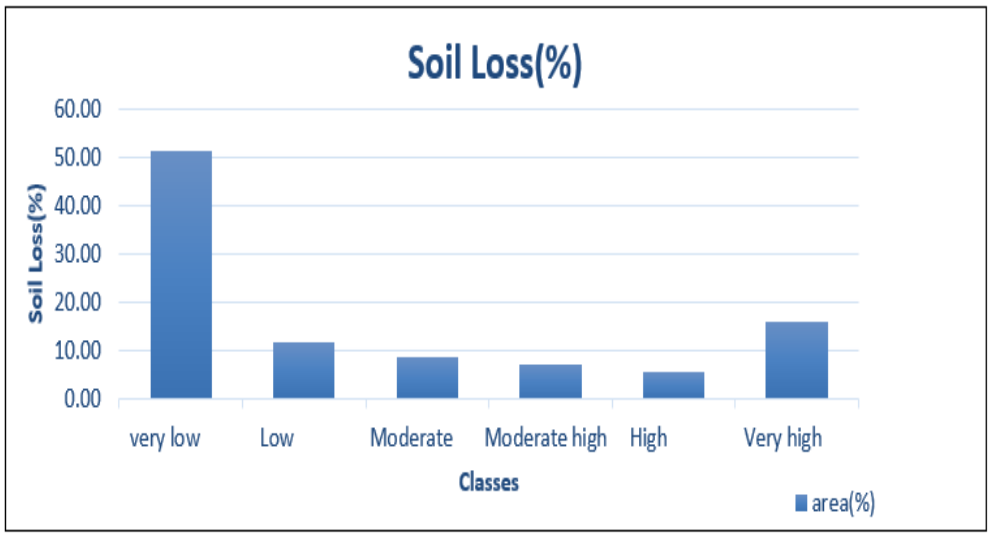


Figure 9 category of aerial extent of Soil Risk in Nun watershed

4. CONCLUSIONS AND RECOMMENDATIONS

The study area situated in Dehradun district Uttarakhand with objectives of estimation of soil risk are in the Nun watershed using Remote Sensing and GIS techniques. Remote sensing weight age overlay analysis is used to estimation the soil loss. The soil loss risk map which shown that total soil loss of the study area is 25-50 tons/ha/yr. the high erosion area found on high degree of slope along with high intensity of rainfall. The soil loss of low land or plane area is countable because of unsustainable Landuse pattern. Major findings are -

1) Average soil loss of the Nun watershed is 25-50 tons/ha/yr.
2) Major cause of soil erosion is high degree of slope, high intensity of rainfall and deforestation.
3) Highest soil loss area has been found on scrub land, fallow, barren land.
4) Lowest soil loss area has been found on dense forest.

CONFLICT OF INTERESTS

None.

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None.

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