International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-11 Issue-2, July 2022

Assessment of Soil Erosion and Reservoir Sedimentation in Nira River basin in Maharashtra, India

Vijay S. Ghogare, Rakesh K. Jain, Deepa A. Joshi, Shivaji G. Patil

***Abstract:** Safeguarding the water resources from soil erosion is a big challenge due to its nature and scale, which arises from the issues like intensification of agriculture, damage to land classes and other similar activities. Revised Universal Soil Loss Equation (RUSLE) with Geoinformatics is utilised for estimation of soil erosion. Sedimentation occurs due to the floods, change in climatic conditions like a global warning, change in cropping patterns and changing patterns of land use land cover, agricultural practices, deforestation, etc. and mainly causes cropping of such issues. Reservoir sedimentation is now a becoming a serious threat not only to safety of dams and but also becoming a serious social, economical and environmental problem. Sedimentation and its effects on dam are occurring all over the world. More than 2327 dams out of total 5264 dams in India are constructed before 1980, so there is urgent need to control the sedimentation process and also urgent need to minimize the operational problem of dam and its health hazards. It is further needed to assess the loss of water storage and its impacts on irrigation as well as other social and economical issues. According to the analysis in this study, 43.70 Ha-m/100 sq. km/year of rate of siltation is occurred during the period considered in the said study. As per the results from the analysis conducted in present study, the soil erosion in Nira River Basin is 43.70 Ha-m/100 sq. km/year, which is responsible for siltation in Bhatgar and Vir Reservoir. The result shows that the overall accuracy of RUSLE method is quite higher with 95.53% as compared to government analysis. Therefore, analysis reveals that RUSLE Model is more accurate and reliable for soil erosion analysis for similar type of study.*

***Keywords:** Erosion, Sedimentation, Reservoir, Soil.*

I. INTRODUCTION

Agricultural land is degrading due to soil erosion and became a global issue of loss of valuable top cover of soil, more runoff due to more non-permeable sub-soil and less water availability to agricultural products. Therefore, soil erosion and sedimentation estimation becomes key issue for best management practices for water resources. In India, soil erosion has become a serious issue and affecting the sectors like agricultural, reservoir siltation, soil degradation, etc. There are four existing major dams in the Nira River Basin viz. Vir, Bhatghar, Nira-Devghar, Gunjavani dam. Nira Canal system irrigates more than 45000 acres of lands falling under Drought Prone Areas Programme (DPAP) areas in Pune, Satara and Solapur district. Soil erosion occurring in the study area is directly affecting water storage capacity of the reservoirs constructed in this basin. Due to deforestation, destruction of natural vegetation, landslides, construction of roads and other development activities, topographical changes in the lands by land owners / farmers, hills and slope cutting by villagers, soil erosion is occurring on large scale and it leads to the sedimentation in reservoirs and ultimately resulting in reduction of the storage capacities of reservoirs.

Manuscript received on 06 June 2022 | Revised Manuscript received on 08 June 2022 | Manuscript Accepted on 15 July 2022 | Manuscript published on 30 July 2022.

* Correspondence Author

Vijay S. Ghogare*, Research Scholar, Department of Civil Engineering, Dr. D. Y. Patil Institute of Technology, SPPU, Pune (Maharashtra), India. Email: vijayghogare90@gmail.com

Rakesh K. Jain, Department of Civil Engineering, Dr. D. Y. Patil Institute of Technology, SPPU, Pune (Maharashtra), India. Email: jainrb20@gmail.com

Deepa A. Joshi, Department of Civil Engineering, Dr. D. Y. Patil Institute of Technology, SPPU, Pune (Maharashtra), India. Email: hodcivil.dit@dypvp.edu.in

Shivaji G. Patil, Department of Civil Engineering, Dr. D. Y. Patil Institute of Technology, SPPU, Pune (Maharashtra), India. Email: dr.shivajigpatil@gmail.com

II. LITERATURE REVIEW

Erosion is a geological process mostly occurring naturally and ending in displacement of soil particles, generally by water or some times by wind and moving the eroded particles from one place to another place. Terrain characteristics like slope, shape, etc. are influencing the soil erosion process. As the terrain slope increases, the runoff obviously increases and thus infiltration gets reduced (Renschler et al., 1999) [3]. To infer on the extent and volume of soil erosion, an assessment is always required so that appropriate remedies for proper management could be find out for a region with similar conditions (Kothyari et al., 1994) [7]. USLE is used on large scale as empirical model for assessing the soil erosion, which is developed by (Wischmeier and Smith). For assessing soil erosion potential by conventional methods is costly and also taking more time. Therefore, for estimation of soil erosion, there is a need to make the analysis comprehensive and also to encompass the field data and data acquired by RS and GIS technique seems to be path finder for detail research in soil erosion issues (Fernandez et al., 2003; Gitas et al., 2009; Xu et al., 2009) [4][10]. It is revealed by (Jain et al., 2001 and Dabral et al., 2008) [5][6] that the rainfall is causing for the sensitivity of soil erosion rate. However, the advantages of using annual rainfall include its ready availability, ease of computation and greater regional consistency of the exponent (Shinde et al., 2010) [8].

III. STUDY AREA AND DATA

The Nira River Basin falls under Western Ghats region of India, having an area of 6892 sq. km. as shown [Figure [1] & [2].

The Nira River originates in Sahyadri Hill range near Shirgaon village (Tal. Bhor, Dist. Pune) at an altitude of 623 m above MSL and flows toward the south-east and has flourished agrarian zone with high populated riverbanks. The Nira River is a major tributary of Bhima River. The study area has diversified physiographic setup with a complex geological structure. The monsoon is the dominant climate in the study area.

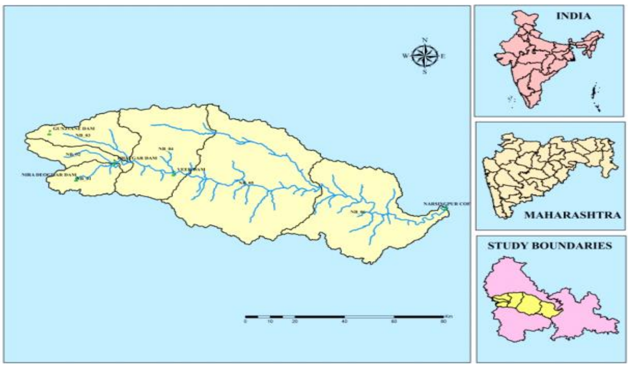

Fig. 1: Location Map of the Study Area

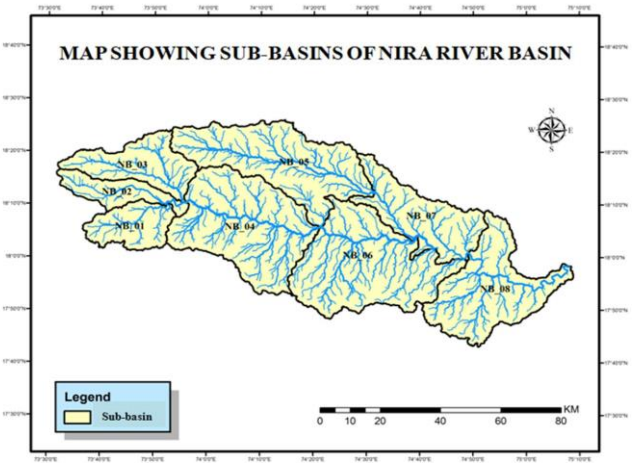

Fig. 2: Sub-basin map of the Study Area

Soil erosion and sediment study needs to collect and process huge database. It includes 16 toposheets to the scale of 1:50000, which are procured from Survey of India. River flow and weather data are procured from various rain gauge and weather stations located in Nira River basin and river flood data are procured from River Gauge Station at Ambheghar, Tal. Bhor, Dist. Pune and Sarati, Tal. Malshiras, Dist. Solapur, LISS-III spatial data downloaded from Bhuvan website and rainfall data procured from IMD and Hydrology Division, Nashik, Water Resources Department, Govt. of Maharashtra.

Table 1: Requirement of Data

Sr. No.	Type of data	Data source	Data description
1	DEM	NRSCs' website https://bhuvan.nrsc.gov.in	DEM (30 m resolution)
2	Satellite imagery	NRSCs' website https://bhuvan.nrsc.gov.in	LISS 3 Imagery (23.5 m resolution & year 2013)
3	Soil	NBSSLUP	Soil Texture Map
4	Rainfall	IMD	Rainfall data for 1996 to 2013

Soils

Soil properties are vital for soil erosion analysis and estimation of soil loss and sedimentation, and are classified in different classes as per their respective physical characteristics.

Meteorological conditions

Observed data from meteorological stations in the catchment of Nira River Basin are collected from different sources for hydrological parameters like temperature, evaporation, wind direction and wind speed, etc., as shown typically for few RG stations [Table 2].

Table 2: Meteorological Parameters

Source: WRD, Govt. of Maharashtra and Central Water

Sr. No.	Name of RG Station	Location Dist./ Taluka	Wind speed (m/sec)	Wind Direction	Atmospheric pressure (hpa)	Temp. (ºC)	Humidity (%)	Solar radiation (w/m^2)
1	Sakhar	Pune/ Velhe	934.8	1.59	219	33.4	22.1	1180
2	Nazare	Pune/ Purandar	935.2	1.71	351	37.1	8.5	997
3	Late	Pune/ Baramati	950.1	0.79	342	38.2	7.8	973
4	Malshiras	Solapur/ Malshiras	947.3	1.43	322	36.9	6.5	696

Commission, Govt. of India

In Nira River Basin, rainfall and runoff data are collected from Water Resource Department, Government of Maharashtra, Central Water Commission (CWC), Govt. of India, New Delhi and Indian Meteorological Department, Government of India. Rainfall varies from one location to other and therefore the Weighted Average Rainfall (WAR) is worked out by Treason Polygon method. The average annual rainfall data, for 23 years (1991-2014), collected from the various rain gauge stations are as shown [Table 3].

Table 3: Rainfall Stations of Nira River Basin

Sr. No.	Location of Rain Gauge Station	Rainfall at dam	Rainfall in catchment	Average Rainfall (mm)
1	Bhatgar dam, Bhor, Pune	1000	6250	1000
2	Vir dam, Khandala, Satara	508	1066	508
3	Sarati, Malshiras, Solapur	761	945	761

Source: WRD, Govt. of Maharashtra and Central Water Commission, Govt. of India

Hydrological data are collected from observation station at Sarati, Tal. Malshiras, Dist. Solapur, to ascertain the availability of water. River gauging data for the period from 1972 to 2008 are collected from CWC and by using these data, annual flows of river gauging station are worked out from data for 36 years. Rational method for surface runoff estimation has been adopted and sub basin wise runoff has been calculated.

Table 4: Runoff for Nira River Sub-basins

Retrieval Number: 100.1/ijrte.B70890711222
DOI: 10.35940/ijrte.B7089.0711222
Journal Website: www.ijrte.org

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

Nira Sub-Basin No.	I	Area (sq. km)	A = Area (Hect.)	C value	A*C	Q
1	11.05	690	69000	0.3	20700	635.37
2	11.82	682	68200	0.22	15004	492.36
3	11.88	768	76800	0.4	30720	1013.76
4	15.55	705	70500	0.3	21150	913.56
5	11.79	824	82400	0.3	24720	809.58
6	15.84	579	57900	0.5	28950	1273.8
7	12.7	776	77600	0.4	31040	1095.02
8	19.69	734	73400	0.3	22020	1204.37

Reservoirs in Nira River Basin

Yelwadi River and Gunjawani River are main tributaries of Nira River. Besides Major dams as mentioned in [Table 5], number of minor irrigation dams & small bandhara are constructed in Nira River Basin. Average annual rainfall in the catchment of Bhatghar, Vir and Nira Devghar varies from 1200 mm to 2000 mm and upper part of Nira River Basin lies at altitudes ranging from 1200 to 1500 m. Heavy storms occurred in the area of Nira River Basin during the year 2005 and 2019.

Table 5: Major dams constructed in Nira River Basin

Sr. No.	Name of Dam	Year of Construction	Type of Dam (Purpose)	Full Reservoir Level (m.)	Catchment area (sq. km)	Live Storage (Million Cum)
1	Bhatgar	1928	Irrigation & hydropower	623.28	340	665.57
2	Vir	1967	Irrigation & Hydropower	579.85	1756	266.40
3	Nira Deoghar	2005	Irrigation & hydropower	667.100	115	332.12
4	Gunjawani	2017	Irrigation & hydropower	727.20	50	104.48
5	Nazare	1974	Irrigation	677.02	-	16.638

Source: WRD, Govt. of Maharashtra

IV. METHODOLOGY

All over the earth problems persist through the geologic ages which are related with soil erosion, movement and siltation in water bodies. Due to increasing interventions of humans with the environment the situation is worsening in recent times. It becomes necessary to work out the quantum of soil erosion and also sediment yields in the reservoirs in Nira River Basin. Therefore, remote sensing satellite image, cover management practices, soil properties data, etc. are used alongwith RUSLE model to prepare a map showing land use land cover. An advantage of use of RUSLE model is that its parameters could be integrated with other data in GIS environment. To identify the scale of soil erosion risk in Nira River Basin, RUSLE model alongwith RS and Geoinformatics is used. The methodology used is represented in the form of chart [Figure 3].

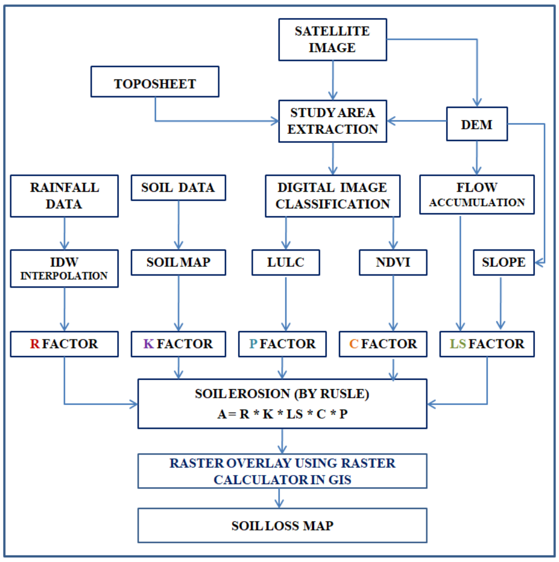

Fig. 3: Flowchart showing Overall Methodology

V. RESULTS

RUSLE Parameters for Soil Erosion Estimation

RUSLE model is very useful and hence it is widely applied in the studies field for various management practices. Nira River Basin is delineated using toposheets (Scale 1:50,000) procured from Survey of India (SOI). Various influential rain gauge stations in the study area are mapped and used to extract the study area from LISS-3 satellite image and DEM (Digital Elevation Model). RUSLE model has basic assumption that the sediment flow controls the deposition and detachment (Kim, 2006). Using RUSLE model the soil erosion potential on the slopes of terrain is worked out by Eq. (1) (Wischmeier and Smith, 1978).

$$A = R * K * LS * C * P \quad \ldots\ldots\ldots (1)$$

Where,

A = gross soil loss,
R = rainfall erosivity factor,
K = soil erodibility factor,
L = slope length factor,
S = slope steepness factor,
C = cover or crop management factor and
P = conservation practice factor.

Rainfall erosivity (R) factor

Rainfall erosivity(R) factor, which depends on the intensity of rainfall and causes erosion of soil, needs data of precipitation continuously for working out its output (Wischmeier and Smith, 1978) [9]. The studies conducted in the past shows that the soil erosion from cultivated agricultural lands is connected directly to rainfall intensity. Monthly rainfall data are utilised to work out the R factor using Eq. (2).

$$R = \sum_{1}^{12} 1.735 \times 10^{(1.5 \log_{10} (Pi/P) - 0.08188)} \quad \ldots\ldots\ldots (2)$$

Where,

R = rainfall erositivity factor,
Pi = monthly rainfall and
P = annual rainfall.

Retrieval Number: 100.1/ijrte.B70890711222
DOI: 10.35940/ijrte.B7089.0711222
Journal Website: www.ijrte.org

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

To estimate R factor, rainfall quantities are obtained from the records of rain gauge stations on daily, monthly and annual basis. The point data of weather stations was interpolated using IWD interpolation technique.

R-factor map indicates the effect of spatial autocorrelation on the distribution of rainfall erodibility. R-factor calculated as shown [Table 1]. Rainfall erosivity was determined by analyzing the rainfall data. For a long time, average annual rainfall is being taken into consideration for R-factor by many researchers. Low erosivity can be observed in an area having nearly slope region and the soil particles were protected by water ponding from the eroded region by the rainfall. Annual average rainfall data of 35 years are used as input to work out R-factor by Eq. (3).

R = 79 + 0.363*RN

Where, RN is average annual rainfall (in mm).

Table 6: Estimated R-Factor values

Nira Sub-Basin No.	Area (sq. km.)	Avg. Rainfall (RN) (mm)	R-Factor
NB-1	375	4144.01	1583.30
NB-2	305	1969.51	793.93
NB-3	542	2923.36	1140.20
NB-4	1351	1998.00	804.27
NB-5	1210	568.42	285.14
NB-6	1394	523.74	269.12
NB-7	712	534.67	273.09
NB-8	1003	525.27	269.67

Inverse Distance Weightage (IDW) interpolation is used in GIS environment to estimate average annual rainfall distributed spatially in Nira River Basin. As per observations, the highest rainfall occurred in Nira Sub-basin 1 and the lowest rainfall is occurred in Nira Sub-basin 6. From the rainfall map Rainfall Erosivity (R) Factor map is generated using GIS tool, as shown [Figure 5].

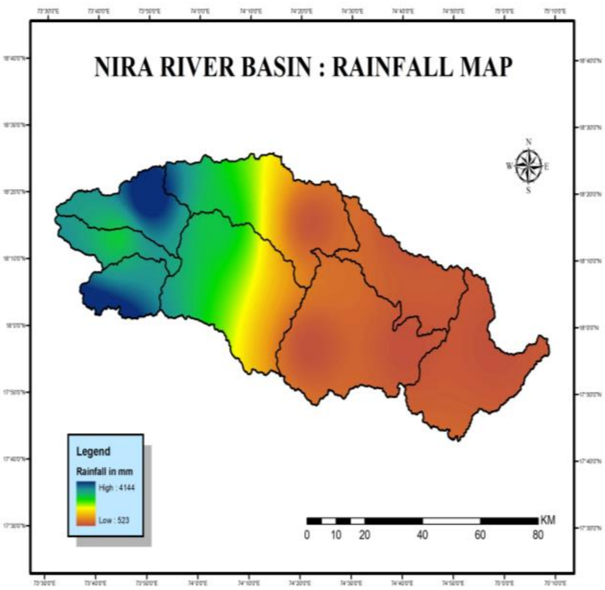

Fig. 4: Rainfall Map of the Study Area

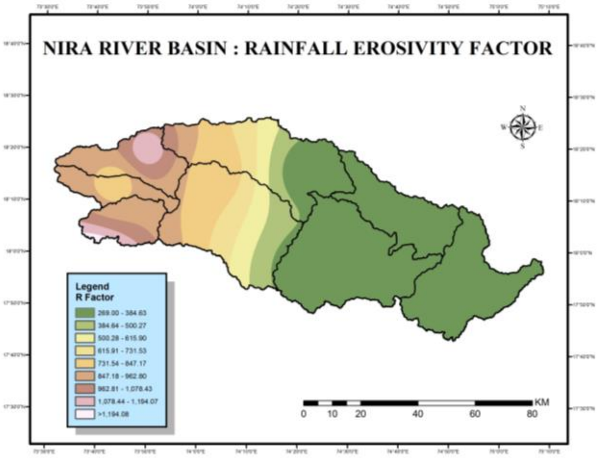

Fig. 5: Rainfall Erosivity factor Map

Soil erodibility factor (K)

Soil erodibility factor (K) represents susceptibility of soil or surface material to erosion and transportability of the sediment and it is estimated using soil texture characteristics. The soil characteristics such as natural resistance susceptible, soil texture, grain size and organic content are responsible for the soil erosivity. Six soil types are considered [Table 6]. K-factor affects the infiltration capability and structural stability of soil. Minimum susceptibility for soil erosion is nil; whereas 1 is for maximum susceptibility due to water, where K-factor is measured in the scale range from 0 to 1. Values of K-factor for different soil textures are defined by Stewart et al (1975) as shown [Table 7].

Table 7: K-factor values

Sr. No.	Textural class	Organic matter content (%)
1	Fine sand	0.14
2	Loamy sand	0.10
3	Slit loam	0.24
4	Clay loam	0.25
5	Silty Clay	0.23
6	Sandy loam	0.24

The study area consists of 6 types of soil having different physical properties. Based on the characteristics of each type of soil such as texture, antecedent moisture content the soil erodibility value is assigned to them. The map for soil classification is reclassified with the values of K-factor for each soil class [Figure 6]. The K-factor is a numerical value, which varies from 0 to 1, in which soil erodibility values closer to 0 are less prone to soil erosion.

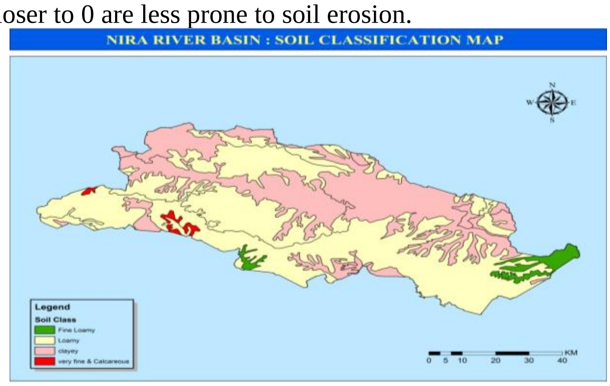

Fig. 6: Soil classification map

Retrieval Number: 100.1/ijrte.B70890711222
DOI: 10.35940/ijrte.B7089.0711222
Journal Website: www.ijrte.org

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

Fig. 7: Map for Soil erodibility factor (K)

[Figure 7] reveals that the K-factor depending on soil class, textural properties and soil permeability code changes from 0.14 to 0.33. In RUSLE model K-factor represents the rate at which different soils will erode.

Topographic factor (LS)

Topographic factor is nothing but the ratio of soil loss under given condition that at site having standard slope steepness and slope length, which are considered as two factors of it. Steeper the slope, the greater is the erosion (Wischmeier and Smith, 1978). The slope (%) map is generated from DEM for the study area as shown [Fig. 8]. The ratio of soil loss is given by Eq. (A).

$LS = (X/22.13)^y * (0.065 + 0.045\ S + 0.0065 * S^2)$ …. (A)

Where,

X = Slope Length (m or km)

S = Slope Gradient (%)

Digital Elevation Model (DEM) of Nira River Basin derived slope value and even DEM derived the value of X and S.

$LS = [Qa\ (\text{Flow accumulation}) * M\ (\text{Cell value}/22.13)]^y * (0.065 + 0.045\ S + 0.0065 * S^2)$…… (B)

Stream lengths worked out, stream order wise, using Eq. (B) and are shown in Table 8.

Table 8: Stream order wise Stream Lengths

Nira Sub-basin No.	Stream Order wise Stream Length (in km)				
	1	2	3	4	5
NB-01	199.75	116.03	60.66	4.35	8.32
NB-02	260.39	80.92	46.44	26.60	0
NB-03	126.95	129.95	103.80	79.99	49.80
NB-04	190.00	141.52	23.38	38.67	0.92
NB-05	281.57	174.11	48.07	12.4	29.8
NB-06	155.87	95.16	33.96	25.20	9.99
NB-07	220.97	147.94	54.04	0	27.32
NB-08	220.40	162.95	4.46	21.49	61.25

Table 9: LS factor values

Sr. No.	Nira Sub-basin No.	Area (sq. km)	Avg. Rainfall (mm)	LS-Factor
1	NB-1	375	4144.01	1.63
2	NB-2	305	1969.51	1.49
3	NB-3	542	2923.36	1.10
4	NB-4	1351	1998.0	0.75
5	NB-5	1210	568.42	0.20
6	NB-6	1394	523.74	0.19
7	NB-7	712	534.67	0.19
8	NB-8	1003	525.27	0.20
	Total =	6892		

Moreover, the (%) slopes are worked out from the DEM using tools available in ArcGIS software. [Figure 9] shows the study area, which reveals that the slope length factor varies from the lowest 0 to 74.12. The study area in the hilly region was indicated by the topographic factors which indicate the higher occurrence of soil erosion.

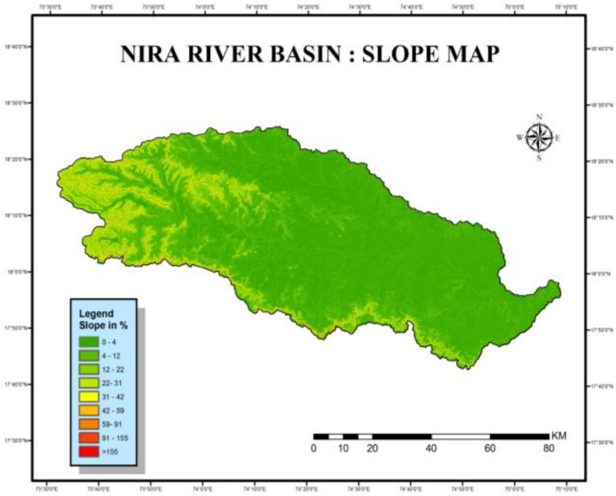

Fig. 8: Slope (%) map of the study area

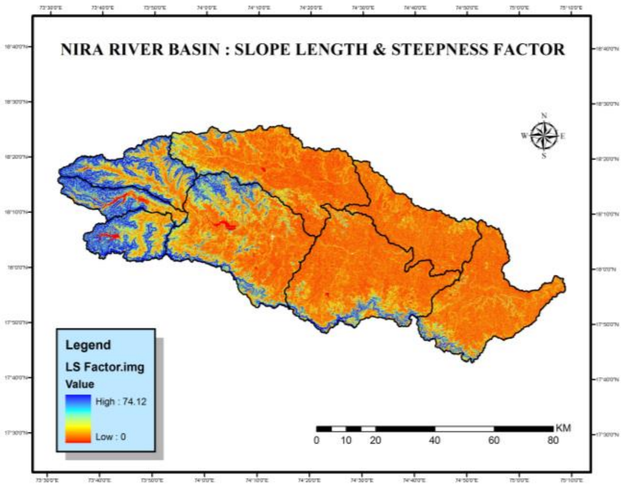

Fig. 9: Map for topographical factor (LS)

Crop or Cover management factor (C)

The C-factor values plays significant and important role in crop or cover management. LULC map (Figure 10) is used to prepare the crop management (C) factor map (Figure 11) of Nira River Basin, which is classified in seven classes, viz. natural vegetation, barren land, water body, residential area, agriculture land, open scrub land and fallow land. C-values considered in this study are as suggested by (Kim et al., 2005).

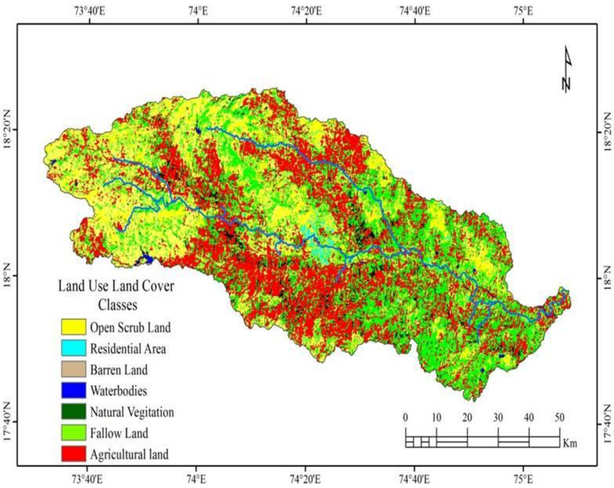

Fig. 10: LULC Classification map

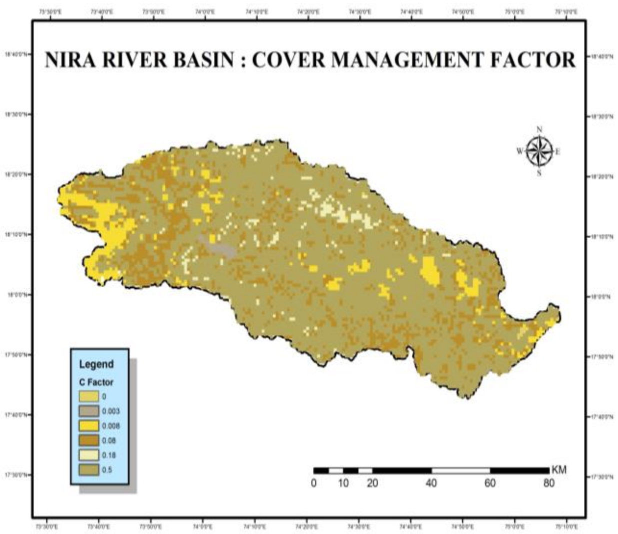

Fig. 11: Cover management (C) factor map

Table 10: Cover management factor (C)

Sr. No.	LULC class	Area (sq. km)	% of Total area	C values
1	Agricultural Land	2531	36.73	0.630
2	Fallow land	1329	19.28	0.300
3	Natural Vegetation	565	8.1	0.500
4	Barren land	2244	32.57	0.180
5	Water bodies	37	0.53	0.003
6	Open Scrub Land	33	0.47	0.600
7	Residential Area (Built Up Land)	153	2.22	0.090

Conservation practice (P) factor

Conservation practice (P) factor is used to recognise the beneficial impacts of conservation practices. Reduction in soil loss due to runoff by the various factors like contouring, velocity of runoff, etc. on the soil is specified by the P-factor, which is controlled by such support practices. The area having no management practice has been assigned as highest value whereas the built-up land is assigned as the minimum value, means P-factor is in the rage from 0 to 1 [Table 11] and using this **C**onservation practice (P) factor map is generated as shown [Figure 12].

Table 11: Conservation practice factor (P)

Sr. No.	LULC class	Area (sq. km)	% of Total area	C values
1	Agricultural Land	2531	36.73	0.630
2	Fallow land	1329	19.28	0.300
3	Natural Vegetation	565	8.1	0.500
4	Barren land	2244	32.57	0.180
5	Water bodies	37	0.53	0.003
6	Open Scrub Land	33	0.47	0.600
7	Residential Area (Built Up Land)	153	2.22	0.090

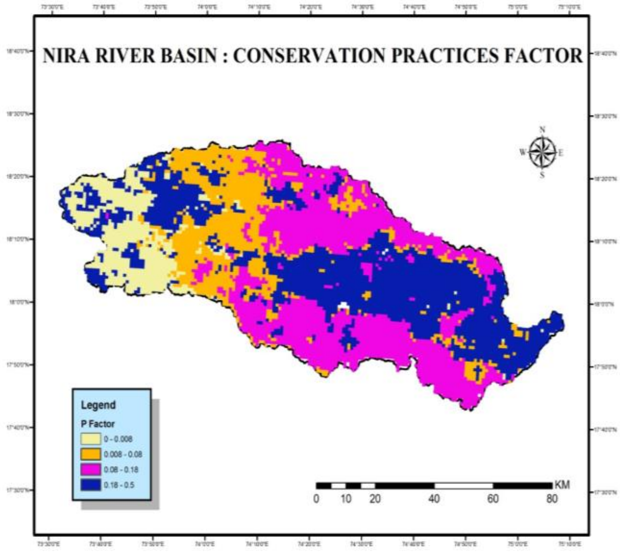

Figure 12: Conservation practices factor (P)

Assessing the rate of soil erosion

The classified image is given with C-factor values as shown in (Table 12) to prepare a C-factor map.

Table 12: Soil Loss Estimation for Nira River Basin

Sr. No.	Soil Erosion category	Soil Loss categories	Area (sq. Km)	Area (%)
1	Very Low erosion	Less Than 1	3132.14	45.44
2	Low erosion	1-2	2604.63	37.78
3	Moderate erosion	2-6	1061.23	15.39
4	High erosion	6-8	79.00	1.14
5	Very High erosion	>8	15.00	0.21
		Total	6892	100

Rainfall erosivity factor (R)

The estimated R-factor value ranges from 613 to 1366 as shown in [Table 6].

Soil erodibility factor (K)

The K-factor values ranges from 0.14 to 0.24. If the K-factor value of soils is lower, then those soils have lesser permeability and lower moisture content.

Retrieval Number: 100.1/ijrte.B70890711222
DOI: 10.35940/ijrte.B7089.0711222
Journal Website: www.ijrte.org

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

Topographic factor (LS)

Erosion process is influenced by the topographic (LS) factor. As the flow accumulation and slope increases, the value of topographic factor (LS) increases in a range of 0.19 to 1.63.

Crop or Cover management factor (C)

LULC map is prepared using collected data [Table 10] and C-factor map is generated as shown [Figure 11].

Conservation practice factor (P)

P-factor values are ranging from 0.08 to 0.50 and the area having no management practice has been assigned as highest value whereas the built-up land is assigned as the minimum value.

Potential annual soil erosion estimation

Annual soil erosion worked out using RUSLE model and Geoinformatics is 43.70 Tonnes/Hectare/Year against measured average annual sediment load of 40.94 Tonnes/Year, occurred during the water years 2007-2013, as per Govt. reports. It is observed that due to less number of check dams constructed across Nira River Basin and its tributaries soil loss was occurring on large scale. However, number of check dams were constructed after the year 2007 in the Nira River Basin, which helped to control and reduce the quantum of soil erosion and thereby sedimentation too. Prospective soil loss is classified in five classes viz. very low, low, moderate, high and very high erosion as shown in [Table 12].

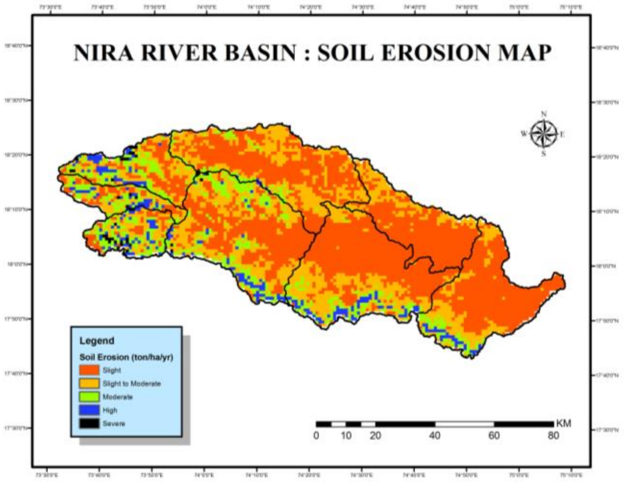

Fig. 13: Soil Erosion (Loss) Map

Table 16: Annual Soil Erosion for different factors

Sub-Basin No.	Area (sq. km)	Factor					Annual So Erosion (T/Ha/Yr
		R	K	LS	C	P	
NB_1	375	1583.3	0.24	1.63	0.008	0.008	0.039
NB_2	305	793.93	0.25	1.49	0.08	0.08	1.892
NB_3	542	1140.2	0.2	1.1	0.08	0.3	6.020
NB_4	1351	804.27	0.24	0.7	0.5	0.5	33.779
NB_5	1210	285.14	0.23	0.2	0.06	0.5	0.393
NB_6	1394	269.12	0.26	0.19	0.03	0.5	0.199
NB_7	712	273.09	0.24	0.34	0.03	0.5	0.334
NB_8	1003	269.67	0.24	0.43	0.03	0.5	0.417
Total	6892					Total	43.07

Result shows that the estimated soil loss worked out to 43.07 Tonnes/Hectare/Year in the Nira River Basin. It is revealed that GIS is a efficient tool in assessing soil erosion. It is evident from the [Table 12] that the soil loss category of less than 4 (t ha-1 year-1) has occupied a little less than three-fourth of the total study area i.e. 83.22 %, whereas soil loss category of 4-8 (t ha-1 year-1) comprised nearly about 15.39 % of total area and soil loss category of more than 8 (t ha-1 year-1) has occupied about 1.35 % area, which has witnessed the possibility of severe soil loss in Nira River Basin. [Figure 13] shows that the areas under steep slope although under dense vegetation have also witnessed higher soil loss potentiality. As per the results obtained through the study for Sedimentation Survey of Bhatgar and Vir Reservoir carried out by Water Resources Department, Govt. of Maharashtra and Maharashtra Engineering Research Institute (MERI), Nashik, Government of Maharashtra, it is observed that the Nira River Basin is the responsible factor for siltation in Bhatgar and Vir Reservoir. Using 80 years data, the average rate of silting for Bhatghar Reservoir is 0.201 % per annum and for Vir Reservoir it is 0.276 % per annum. Hence, this amount of siltation represents the greater quantity of soil erosion in Nira River Basin. According to the analysis in this study, 43.7 Ha-m/100 sq. km/year of rate of siltation is occurred during the period considered in the said study. As per analysis in the abovementioned study, the average annual soil erosion in Nira River Basin is 43.07 Tonnes/Hectare/Year, which is responsible for siltation in Bhatgar and Vir Reservoir, which are situated in Nira River Basin. The result shows that the overall accuracy of RUSLE method is quite higher with 99.53% as compared to government analysis. Therefore, analysis reveals that RUSLE Model is much more accurate and reliable for soil erosion analysis for the present study.

VI. CONCLUSIONS

1. The soil erosion estimated using RUSLE Model and GIS techniques and the spatial distribution of soil at the Nira River Basin is successfully demarcated.
2. The soil erosion loss map is categorized into five soil erosion risk classes. As per the results, approximately 5736.57 sq. km of the study area (i.e. 83.22%) is at low risk of erosion and 1061.23 sq. km of the study area (i.e. 15.39%) is under a moderate risk category for erosion. This trend was closely linked to the fallow land.
3. The high probability of erosion is observed with 94 sq. km of total area of analysis (Table 16).
4. The map derived for estimated soil loss can be used for forecasting soil erosion and also for remedial conservation measurements and for effectively tracking the soil loss.

RECOMMENDATIONS

1. The local farmers should follow methods of soil conservation and protection in their own farms. The farmers shall adopt good management practices by various options such as farming with plantation strip and the contour cropping region for minimizing the soil loss.
2. In addition, local planners and decision-makers shall

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

help to implement natural resource management programs to minimize the soil loss in farms and ultimately to minimise siltation into the dams within study area and thereby avoid loss in valuable storage capacity of these dams.

REFERENCES

1. B. A. Stewart, W. H. Wischmeier & D. A. Woolhiser, "Control of water pollution from cropland", Vol. 1 & "A manual for guideline development, Vol. 2; an overview" U.S. Dep. Agriculture, (1975) ARS-H-5-1 and ARS-H-5-2.
2. C. Fernandez, J. Q. Wu, D. Q. McCool & C. O. Stockle, "Estimating water erosion and sediment yield with GIS, RUSLE and SEDD" Journal of Soil and Water Conservation, Vol. 58, Issue 3 (2003) Page No. 128-136.
3. C. S. Renschler, C. Mannaerts & B. Diekkrüger, "Evaluating spatial and temporal variability in soil erosion risk - rainfall erosivity and soil loss ratios in Andalusia, Spain" Catena, Vol. 34 (1999) Page No. 209-225. [CrossRef]
4. Loannis Z. Gitas, Kostas Douros, Chara Minakou, George N. Silleos & Christos G. Karydas, "Multi-temporal soil erosion risk assessment in N. Chalkidiki using a modified USLE raster model EARSeL" eProceedings, Vol. 8 (2009) Page No. 40-52.
5. P. P. Dabral, N. Baithuri & A. Pandey, "Soil erosion assessment in a hilly catchment of North Eastern India using USLE, GIS and remote sensing", Water Resources Management, Vol. 22, Issue 12 (2008) Page No. 1783-1798. [CrossRef]
6. S. K. Jain, S. Kumar & J. Varghese, "Estimation of soil erosion for a Himalayan watershed using GIS technique", Water Resources Management, Vol.15, Issue 1 (2001) Page No. 41-54. [CrossRef]
7. U. C. Kothyari, A. K. Tewari & R. Singh, "Prediction of sediment yield" Journal of Irrigation and Drainage Engineering, ASCE, Vol. 120, Issue 6 (1994) Page No. 1122-1131. [CrossRef]
8. Vipul Shinde, K.N. Tiwari, Manjushree Singh, "Prioritization of micro watersheds on the basis of soil erosion hazard using remote sensing and geographic information system" International Journal of Water Resources and Environmental Engineering, Vol. 2, Issue 3 (2010) Page No. 130-136.
9. W. H. Wischmeier & D. D. Smith, "Predicting Rainfall Erosion Losses: A Guide to Conservation Planning", Agriculture Handbook, U.S. Department of Agriculture, Washington DC, Vol. 537 (1978) Page No. 58.
10. Y. Q. Xu, J. Peng, X. M. Shao, "Assessment of soil erosion using RUSLE and GIS: a case study of the Maotiao River watershed, Guizhou Province, China" Journal of Environmental Geology, Vol. 56 (2009) Page No. 1643-1652. [CrossRef]

AUTHORS PROFILE

Vijay S. Ghogare, Research Scholar Deptt. of Civil Engineering, Dr. D. Y. Patil Institute of Technology, Pune, Maharashtra, India. Savitribai Phule Pune University, Pune. Professional Membership: IEI, 2 Publications vijayghogare90@gmail.com

Dr. Rakesh K. Jain, Ph. D. (Civil Engg.), Deptt. of Civil Engineering, Dr. D. Y. Patil Institute of Technology, Pune, Maharashtra, India. Savitribai Phule Pune University, Pune. Professional Membership: ISTE, IEI, 48 Publications

Dr. Deepa A. Joshi, Ph. D. (Civil Engg,), Deptt. of Civil Engineering, Dr. D. Y. Patil Institute of Technology, Pune, Maharashtra, India. Savitribai Phule Pune University, Pune. Professional Membership: ISTE, IEI, 40 Publications. ravindraklad5@gmail.com

Dr. Shivaji Govind Patil, Ph. D. (Civil Engg,), M. Tech. (Civil), LL. B., MBA, B. Journ., Executive Engineer, MIDC, Pune. Membership: IE (India), ISRS. 8 Publications, dr.shivajigpatil@gmail.com

Retrieval Number: 100.1/ijrte.B70890711222
DOI: 10.35940/ijrte.B7089.0711222
Journal Website: www.ijrte.org

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)