International Journal of Engineering Science Invention Research & Development; Vol. IV, Issue II, AUGUST 2017
www.ijesird.com, E-ISSN: 2349-6185

ASSESMENT OF SOIL LOSS IN WYRA WATERSHED USING REMOTE SENSING AND GIS

Ankala Mani Deepika[1], P. Sridhar[2]
[1]*M.Tech (Geoinformatics) Student,* [2]*Assistant Professor in Geoinformatics, Civil Engineering department, SVECW, BVRM.*

,*ABSTRACT-* Soil Erosion is one of the biggest ecological problems in and around the world. In the present study, GIS based study is used to assessment of soil erosion using USLE (Universal soil loss equation) method. The method is applied to Wyra reservoir catchment area for the assessment of soil loss. Using GIS techniques created R- factor, K Factor, LS factor, C factor, P factor maps. Using GIS software tools, Raster calculator in spatial analyst used to generated Soil erosion map of the study area. The results showed that, 0-5 t/ha/year is 480.42 square kilometers, 5-10 t/ha/year is 13.41 sq kms and greater than 10 is found to be 29.36 sq kms. Most of the reservoir catchment area is found to be slight to moderate erosion. In this context the catchment area is required some of the conservation structures. The GIS software and remote sensing tools are proved that accurately assessed the soil erosion of the wyra catchment area.

KEYWORDS: **USLE, Raster calculator, reclassification, DEM, Contours, spatial analyst.**

1.0 INTRODUCTION

Accelerated soil erosion is a serious concern worldwide, and it is difficult to assess its economic and environmental impacts accurately because of its extent, magnitude, rate, and complex processes associated with it (Lal, 1994). The several human activities, such as faulty agricultural practices, deforstration, shifting cultivation, resulting in accelerated erosion. Soil erosion from cultivated areas is typically higher than that from uncultivated areas (Brown, 1984). In India, a total of 1,75,0000 km^2 of land out of the total area of 3,28,0000 km^2 is prone to soil erosion. Thus Active erosion caused by water and wind alone accounts for 150 Mha of land, which amounts to a loss of about 5.3 Mt of subsoil per year. In addition, remaining 25Mha land have been degraded due to ravine, guillies, shifting cultivation, salinity, alkalinity, and water logging (Reddy 1999). Soil erosion can pose a great concern to the environment because cultivated areas can act as a pathway for transporting nutrients, especially phosphorus attached to sediment particles, to river systems (Ouyang and Bartholic, 1997). Soil erosion is a physical process with considerable variation globally in its severity and frequency, where and when erosion occurs is also strongly influenced by social, economic, political, and institutional factors (Morgan). When soil particles are detached from its original place, the eroded material transported as sediment by flowing water. The transported soil particles deposited at distant place where the velocity of water reduces. The sediment deposition in reservoirs, drainages or some distant plane area. Due to the possible on-site deposition of soil materials due to changes in topography, vegetation, and soil characteristics, soil loss is usually less than soil erosion. Thus, sediment yield is used to refer to the amount of eroded material that is actually transported from a plot, field, channel, or watershed (Renard et al., 1997). Modeling provides a quantitative and consistent approach for estimating the soil erosion and sediment yield under a wide range of conditions (Pandey et al. 2007). A number of mathematical models, Physical process based models and empirical equations are developed to estimate the soil loss. Last 30 years most of the researchers are using famous an empirical equation USLE, for estimating the soil loss. The model computing long term average of sheet and rill erosion per year wise. Main draw back of this model is cannot consider the gully erosion. Nevertheless, the researchers are using USLE as basic equation to develop a new model for assessing and computing the average Sediment yield for year. The model requires parameters of DEM (Digital Elevation Model), Weather data, Soil, Land use, Land cover information. Sediment yield calculation for Indian catchments are generally made from any of the equations proposed by Khosla (1953), Dhruvanarayana and Rambabu (1983) and Garde et al. (1983). The Garde is proposed an equation for estimate the sediment yield for watershed or basin level. To compute sediment yield using Gardes equation, requires the watershed area, Annual runoff, Precipitation data of all raingauges, Stream slope, Drainage density, Vegitative cover of the watershed or basin. For compute the annual runoff , requires annual temperatures, vegetative cover factor of the watershed or basin. For compute the vegetative cover factor requires multi temporal satellite sensor data. The multi temporal data categorize, capture and process spatial mapping of Land use / land cover, changes of Landuse / Land cover of the watershed. In this study, it has been planned to develop a GIS and RemoteSensing based spatial model using USLE model for assessing soil erosion prone areas in Wyra watershed, located in the Khammam district of Telangana state. The various steps for the implementation of USLE model under GIS environment have been automated by developing computer programs of Arc GIS 9.3 software.

2.0 STUDY AREA

Wyra is a Mandal in Khammam District of Telangana State, India. Wyra Mandal Head Quarters is Wyratown . It belongs to Telangana region .Wyra is belongs to Khammam revenue divison . It is located 32 KM towards East from District head quarters Khammam.
Wyra Mandal is bounded by by Bonakal Mandal towards South ,Thallada Mandal towards North , Konijerla Mandal towards North , Kallur Mandal towards East . PalwanchaCity , Khammam City, Jaggaiahpet City, Kodad City are the nearby Cities to Wyra.
Wyra consist of 30 Villages and 21 Panchayats .Poosalapadu is the smallest Village and Somavaram is the biggest Village. It is in the 103m elevation(altitude).
Khammam ,Amaravathi , Nagarjunakonda (NagarjunaSagar Dam) , Vijayawada (Bezawada) , Bhadrachalam are the near by Important tourist destinations to see. Telugu is the Local Language here. Also People Speaks Urdu . Total population of Wyra Mandal is 51,205 living in 12,639 Houses, Spread across total 30 villages and 21 panchayats . Males are 25,984 and Females are 25,221. It is too Hot in summer. Wyra summer highest day temperature is in between 35 °C to 48 °C.Average temperatures of January is 26 °C , February is 26 °C , March is 30 °C , April is 33 °C, May is 37 °C, June is 32 °C.

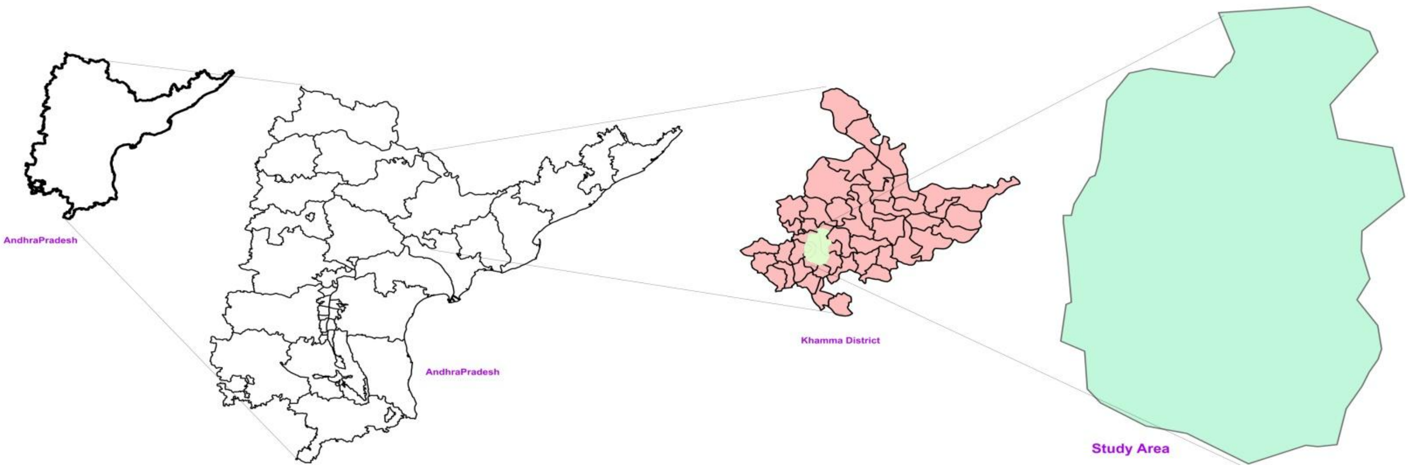


Fig .1: Location Map of The Study Area.

3.0 METHODOLOGY:

Estimate soil loss of wyra watershed using USLE equation, to suit Indian condition some of the parameters were modified.

A = R*K*L*S*C*P ………………. (1)

Where,

A = compound soil loss (MT/ha/year);
R = rainfall-runoff erosivity factor (MJ.mm.ha-1.hr-1);
K = soil erodabilityfactor (MT.ha.hr.ha-1.MJ-1.mm-1);
L = slope length factor (dimensionless);
S = slope steepness factor (dimensionless);
C = cover management factor (dimensionless); and
P = supporting practice factor (dimensionless).

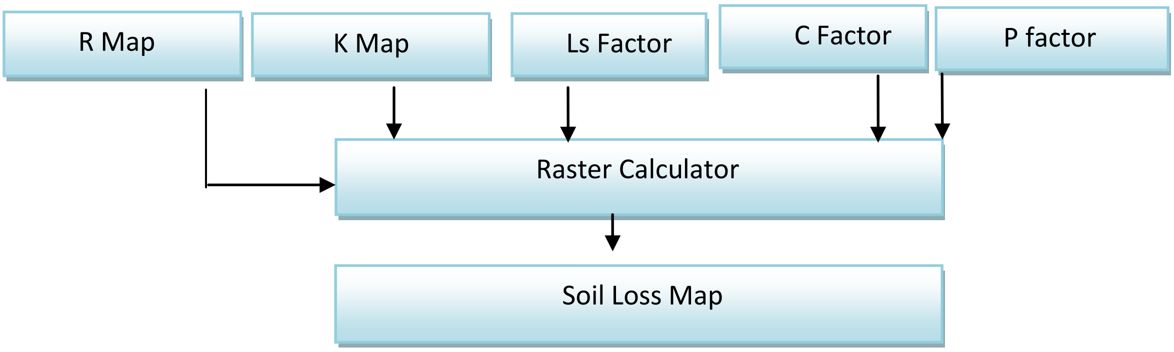


Fig.2: Flow chart of Methodology

3.1 R- FACTOR

In this study the R factor is computed by Singh et al (1981) proposed equations have been used. R-Factor using R= 79+0.363*P where P is mean annual rainfall. wyara watershed has six rain gauge stations. Station wise R factor computed and listed in Table.1.Station wise values computed and added in each rain gauge station wise. Interpolation method (IDW) in GIS used to know effective R factor of each station wise.

Table.1 Station wise R factors

S.NO	Rain gauge station Name	Mean Annual Rainfall in mm	R=79+0.363*P (mm)
1	Wyra	932.00	417.31
2	Julurpad	1201.28	515.06
3	Kamepalle	1071.14	467.82
4	Thallada	930.15	416.64
5	Khammam	895.05	324.90
6	Enkuru	1182.14	508.11

Station wise Rain gauges showed in the fig.3. R factor map showed in fig. 4.

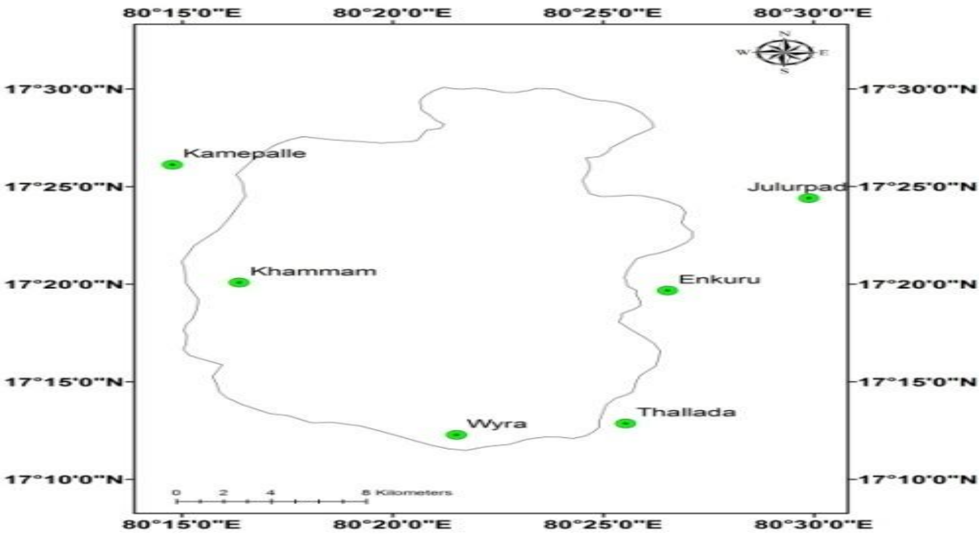


Fig.3 Rain gauge Location map

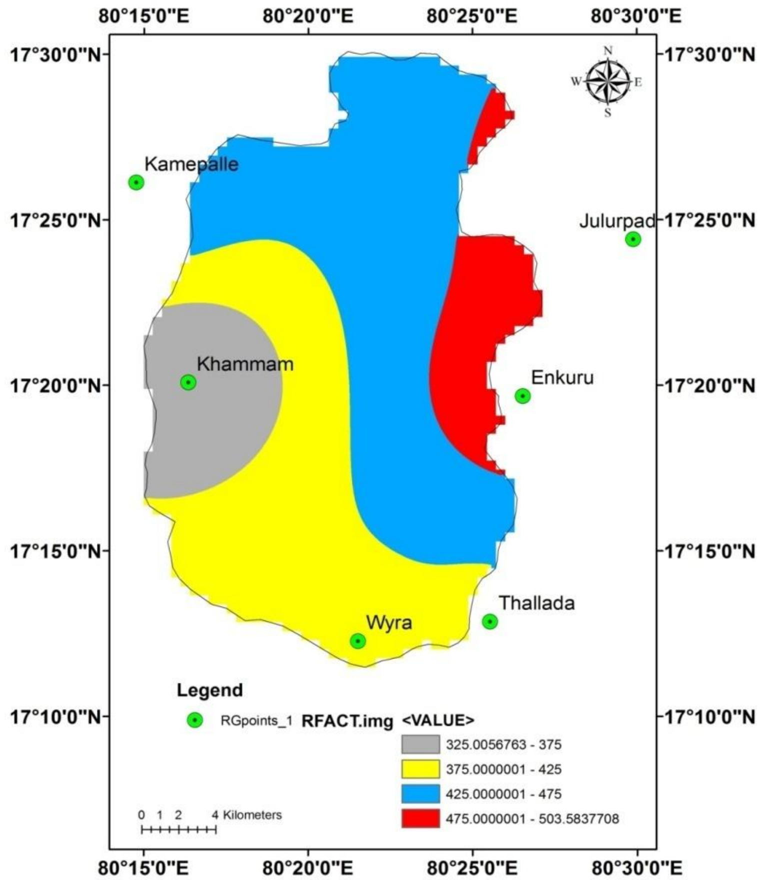


Fig. 4 Spatial distribution of R Factor map.

3.2 SOIL ERODABILITY MAP (K):

The soil Erodability factor (K-factor) is a quantitative description of the inherent Erodability of a particular soil. presently ,The soil map was collected from National Bureau of Soil Survey and Land Use, Nagpur which was prepared on a scale 1:100,000. The collected soil maps were scanned and registered with tic points and rectified. Further, the rectified maps were projected. All individual projected maps were finally merged as a single layer. Later, the delineated study area map of sub basin was overlaid on projected soil map and finally, soil map pertaining to the study area was thus extracted in GIS environment. Boundaries of different soil textures were digitized in ARC GIS and the polygons representing soil classes. Table. 2 listed soil description of the study area. Fig.5 showed spatial distribution of soil map of the study area.

Fig.6 shows soil erodablity map of the study area.

Table 2: Soil description of the study area.

MAP UNIT	DESCRIPTION
2	Moderately deep well drained, gravelly loam soils with low AWC,on undulating lands,severely eroded; associated with: Moderately deep, well drained, gravelly clay soils.
11	Moderately shallow, well drained, gravelly loam soils with low AWC, on very gently sloping plains, moderately eroded; associated with: Moderately shallow, well drained, gravelly clay soils.
12	Moderately shallow, well drained, gravelly loam, calcareous soils with low AWC, on very gently sloping plains, slightly eroded: associated with: Moderately deep, well drained,loamy soils.
90	Deep, well drained, clayey soils with high AWC, on rolling lands, slightly eroded; associated with: deep, well drained, loamy, calcareous soils.
96	Deep, Moderately well drained, clayey soils with high AWC, on nearly level valleys, slightly eroded; associated with: deep, moderately well drained, clayey soils
106	Rock out crops on hills and ridges; associated with ; Very shallow, somewhat excessively drained, gravelly clay soils with very low AWC, moderately eroded.
110	Moderately deep, well drained, loamy soils with medium AWC ,on nearly level interhill valleys, slightly eroded; associated with: Deep, well drained, clayey soils with high AWC.

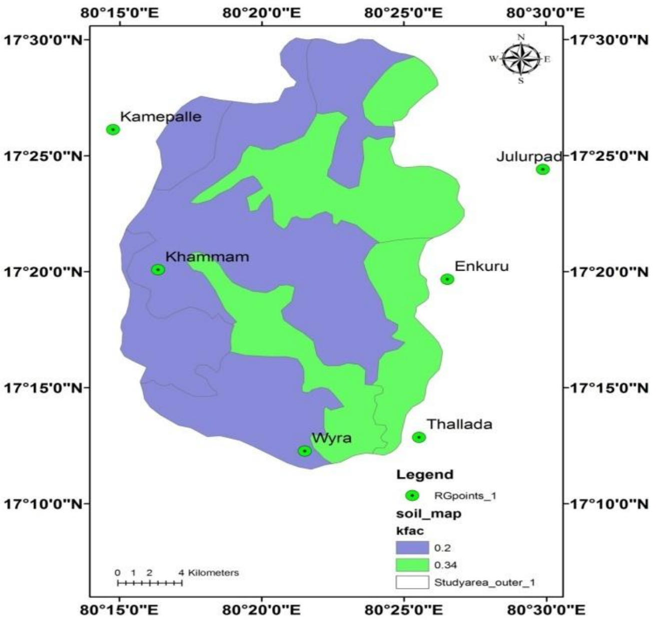
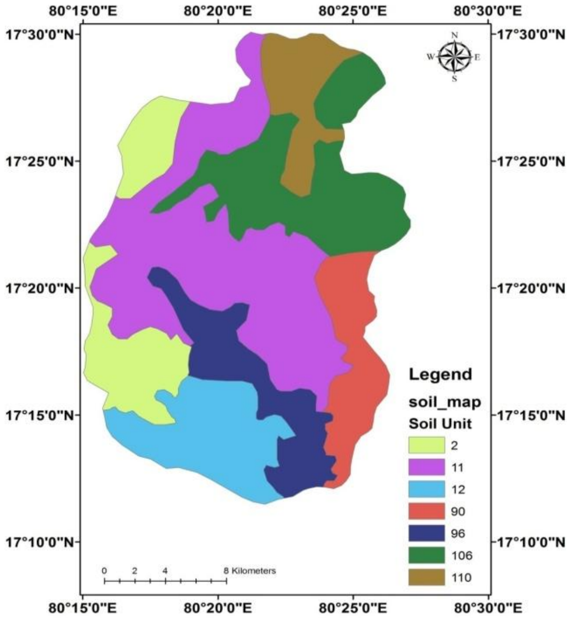


Fig.6 Soil Erodability factor map of the study area



. Fig. 5 Soil Map of the study area.

The soil units taxonomy for map units 2, 11 and 12 of the study area is Gravelly Loam, 90 and 96 are clayey soils. Using the soil taxonomy information the K – factor values directly obtained from different researchers done for the same study area. The values are showed in the Table. 3.

Table 3: Soil Erodability values for (K- Factor) of the study area.

S.NO	K factor
1	0.2
2	0.34

3.3 SLOPE LENGTH FACTOR MAP

Slope length map to be computed from Digital Elevation map. Digitized all contour lines from toposheet and added all contours elevation information. Using 3D analyst tool in GIS software created TIN model and then converted into DEM Map of the study area. After Creation of DEM, the data set have the slight errors it can be sinks or peaks. Using Hydrology tools in spatial analyst created error free DEM or Dipressionless DEM of the study area.

To compute slope length of the study area the following equation were used in Raster calculator.

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

Where …………(L) Slope length in meters

(S) Slope steepness in %

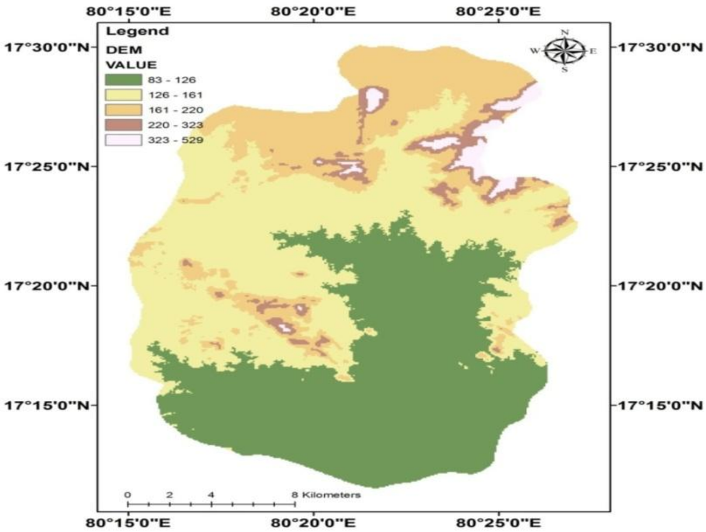


Fig. 7 DEM of the study area.

3.4 CROP MANAGEMENT FACTOR

C Factor means the crop and vegetation factor. Preventing soil loss can identify to determine the soil and crop management. The C factor is a ratio comparing the soil loss from land under a specific crop and management system to the corresponding loss from continuously fallow and tilled land. Based on the land use/cover classified image of watershed, similar ecosystems were searched on different bibliographical sources and therefore assigned to the ones existing in study area. The search was oriented to those areas with similar geographical settings. C factor ranges from 1 to approximately 0, where higher values indicate no over effect and soil loss comparable to that from a bare fallow, while lower C means a very strong cover effect resulting in no erosion (Erencin, 2000). for the study are of Wyra water shed crop factor C listed below table. 4.

Table 4. C- Factor For study area.

S.NO	Description	C-FACTOR
1	Forest	0.002
2	Kharif	0.18
3	Rabi	0.18
4	Decedious Forest	0.002
5	Double crop	0.18
6	Reservoir	0

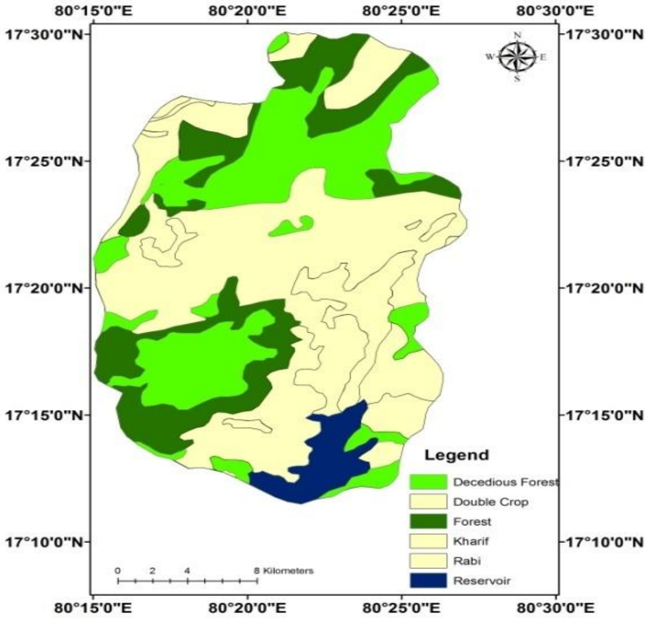


Fig.8 LULC map of the study area.

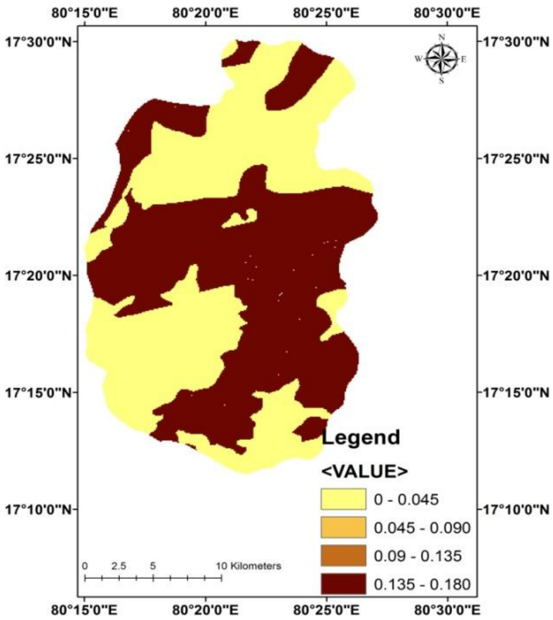


Fig.9 Crop Management (C) Factor Map.

3.5 EROSION CONTROL MANAGEMENT FACTOR MAP (P):

P is the support practice factor. It reflects the effects of practices that will reduce the amount and rate of the water runoff and thus reduce the amount of erosion. The P factor represents the ratio of soil loss by a support practice to that of straight-row farming up and down the slope. The most commonly used supporting cropland practices are cross slope cultivation, contour farming and strip-cropping.

P factor indicates the rate of soil loss according to the various cultivated lands on the earth. There are contour, cropping and terrace as its methods and it is important factor that can control the erosion. P values range from 0 to 1, whereby the value 0 represents a very good manmade erosion resistance facility and the value 1 no manmade resistance erosion facility. In the study area there were some agricultural support practices, such as contour farmland and terraced farmland.

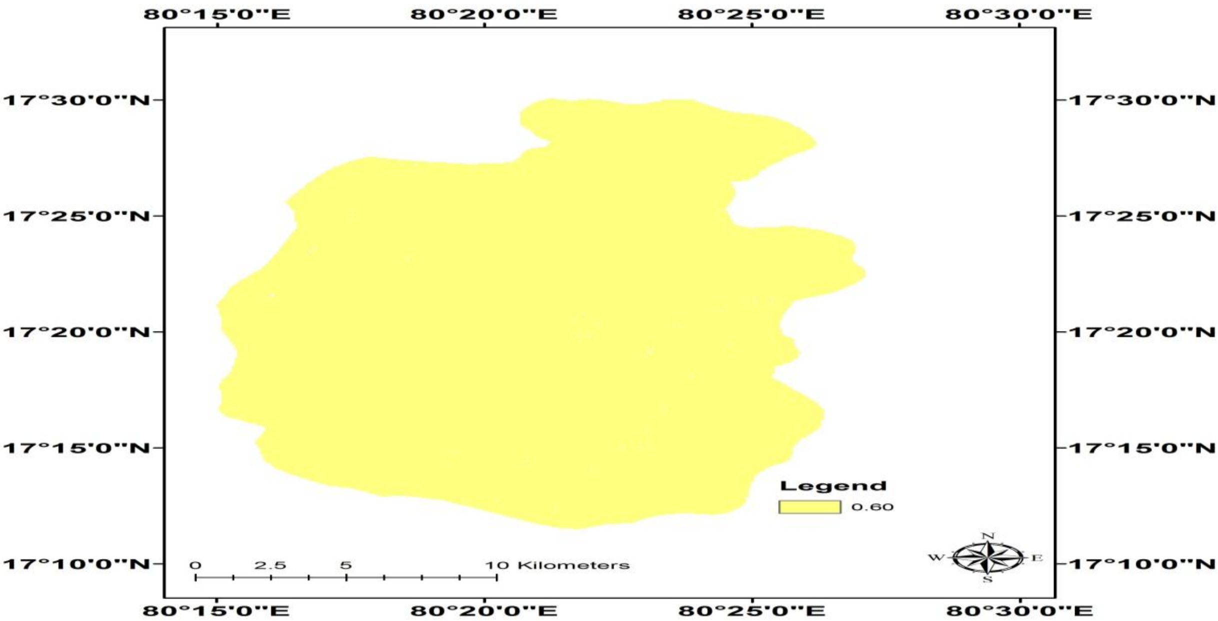


Fig: 10 Erosion Control Management Factor Map.

Table. 5 Management factors used in the study area

S.NO	Description	P-FACTOR
1	Forest	0.6
2	Kharif	0.6
3	Rabi	0.6
4	Deciduous Forest	0.6
5	Double crop	0.6
6	Reservoir	0.6

4.0 RESULTS

Raster calculator used to compute soil loss assessment map of the study area showed in the fig.11. The Inputs are computed in raster calculator is R factor map x K Factor map x Slope length map x Crop management factor map x Management factor map. using these factors in the tool, generates the soil loss estimation of the studyarea which is showed in the fig .11the total study area is 523.19 sq kms. The soil erosion is divided into three classes 1) slight 0.-5 t/ha/year 2) Moderate 5-10 t/ha/year 3) Moderately severe > 10 t/ha/year. the area of each classified and presented in to table. 6.

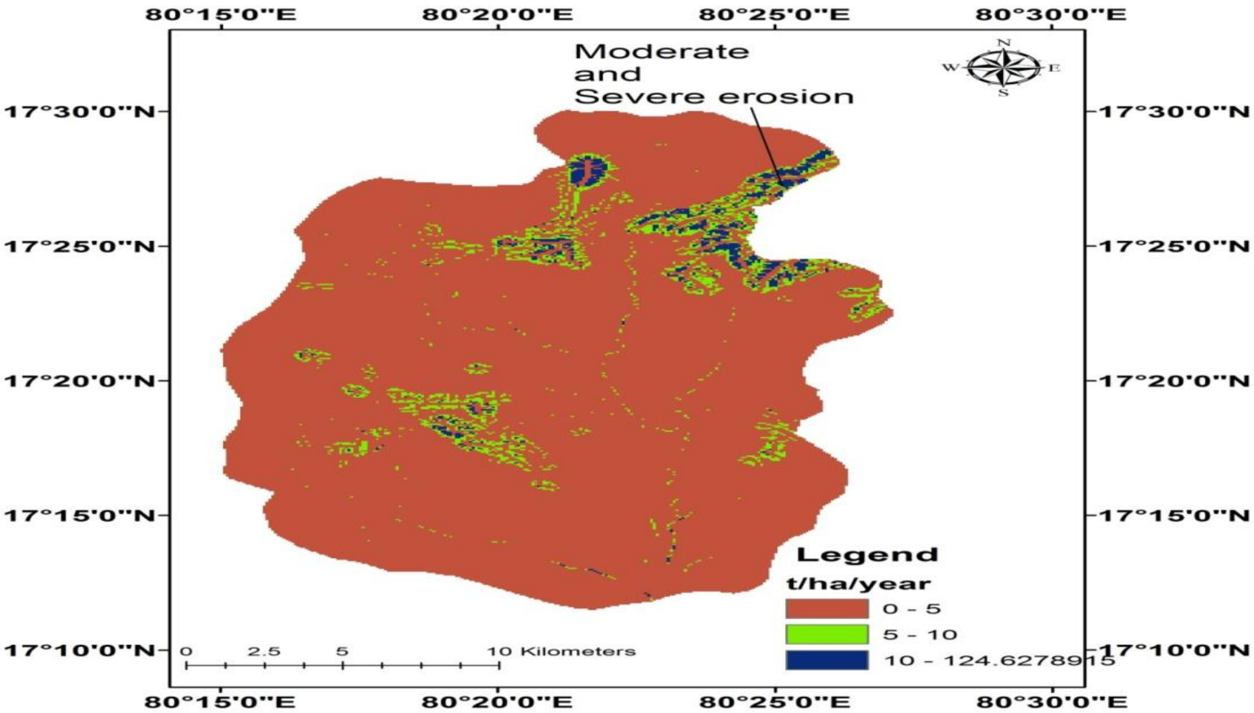


Fig.11 Soil loss assessment of the study area.

Table. 6 Erosion intensity of the study area.

S.no	Erosion Class	Rate of erosion	Area in sq kms
1	Slight	0-5	480.42
2	Moderate	5-10	13.41
3	Moderately severe	>10	29.36

5.0 CONCLUSIONS

Creation of database through conventional methods is time consuming, tedious and is difficult to handle Modern techniques such as remote sensing and GIS are very useful tools for generation of information about thematic maps. Therefore various thematic layers representing different factors of USLE were generated and overlaid in GIS framework to compute the spatially distributed average annual soil erosion map for the Wyra reservoir catchment area. The study revealed that area covered under slight, moderate, soil loss potential zones are 91.8 %, 2.56%, 5.65%, respectively. The average annual soil loss map will definitely be helpful in identification of priority areas for implementation of soil conservation measures and effective checking of soil loss. The mean soil rate is estimated to be >10 ton/hectare/year respectively under potential conditions respectively. To reduce the soil erosion intensity, required the soil conservation measures with in the watershed. Geographical information systems are very useful to identification and location of the soil conservation measures spatially.

References

1. A. N. Khosla, ―*Silting of Reservoirs*‖, CBI & P, New Delhi. 1953.
2. Brown LR (1984). *Conserving soils. In: Brown LR* (ed.) State of the World, New York, Norton, pp. 53-75.

3. D. V. V. Narayan and R. Babu, "*Estimation of Soil Ero- sion in India*," Journal of Irrigation and Drainage Engi- neering, Vol. 109, No. 4, 1983, pp. 419-431.
4. Lal R (1994). *Soil erosion by wind and water: problems and prospects*. In: Lal R (ed.) Soil Erosion Research Methods (Second edition). Soil and Water Conservation Society (Delray Beach: St. Lucie Press).
5. Ouyang, D., Bartholic, J., 1997. *Predicting sediment delivery ratio in Saginaw Bay watershed*. Proceedings of the 22nd National Association of Environmental Professionals Conference. May 19–23, 1997, Orlando, FL, pp. 659–671.
6. Pandey A. chowdary VM, Mal BC (2007) *Identification of critical erosion prone areas in the small agricultural watershed using USLE, GIS and Remotesensing* . Water Resource Manage 21:729-746. doi:10.1007/s11269-006-9061.
7. Reddy MS (1999) Theme paper on "*water vision 2050*". Indian water resources Society, Roorkee, pp 51-53.
8. Renard, K.G., Foster, G.R., Weesies, G.A., McCool, D.K., Yoder, D.C., 1997. *Predicting soil erosion by water: a guide to conservation planning with the revised soil loss equation* (RUSLE). U.S. Dept. of Agriculture, Agric.Handbook No. 703.