ESTIMATION OF SEDIMENT YIELD OF A CATCHMENT USING USLE WITH ARCGIS MAPPING

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CERTIFICATE

I hereby certify that the Project Dissertation titled **"Estimation of Sediment Yield of a catchment using USLE with arcGIS mapping"** which is submitted by **BHANU KUMAR,** Roll number **2K18/HFE/019** of M.Tech (**HWRE**), Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of Master of Technology, is record of the project work carried out by the student under my supervision. To the best of my knowledge this work has not been submitted in part or fully for any Degree or Diploma to this University or elsewhere.

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ABSTRACT

One of the most serious issues in India is soil erosion. For a specific duration, it is extremely hard to measure exact soil erosion. On the basis of watershed, numerous tests and hypothetical strategies have been inferred for erosion estimation. For my very river channel of Orissa, India, the strategies include GIS which is utilized for the calculation of residue yield. In this technique, spatial information of Ong catchment is segregated in individual characterized units/cells to analyze features of the catchment. In every unit, net erosion is determined utilizing the Universal Soil Loss Equation (USLE) by deciding different boundaries of unit. The Ong catchment at lower Mahanadi locale is chosen here for the study as the ease of accessibility of desired information at different areas inside watershed zone. Ong catchment has a zone of 5128 km^2 of the lower Mahanadi district. By utilizing the factors of USLE, net soil erosion is steered for inference of transport limit residue by the help of different maps obtained through arcGIS. The maps portray the measure of silt through a specific lattice in spatial space, the pixel estimation demonstrates the residue yield at the watershed outlet. By investigation of information of Ong catchment with the technique of Universal Soil Loss Equation, the yearly residue yield of Ong catchment gives great concurrence, being not exactly ± 32% error. Largest sediment yield acquired at Salebhata (Gauging station), which is equivalent to 24.3 ton/hectare/yr.

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CHAPTER 1
INTRODUCTION

1.1 GENERAL

Soil erosion is cycle wherein includes separation, transport of residue caused due to raindrop and shear power of running water where dregs is confined from surface of soil. Progression of water the eliminated silt, moves to downward, despite of the fact that there is a limited quantity of residue move happens to downward slope by raindrop. Soil disintegration thought is fundamental for arranging watershed improvement works. Because of dregs disintegration, it has been acknowledged that some basic issues brought up in horticulture, land debasement which causes climatic change. Disintegration diminishes not just capacity to downstream bowls yet in addition crumbles the proficiency of the watershed. By and large definite assessment of dregs transport sums rely upon assessment of overland streams. Sedimentation yield is characterized to be measured silt amount going through the outlet from watershed. Over half of the Pasturelands and almost of cultivating lands of the world experience the ill effects of the same (Pimentel et al. 1995). It is educated that, all inclusive, around 60 million ha of fruitfull land is being lost every year because of simply erosion and related elements (Dudal 1981). It is assessed that close of 1,964.4 MH all out land region currently corrupted (UNEP 1997). Amongst it, around 1,903 MH and 548.3 MH land territorial issues because of water and twist individually. In our country, Land debasement by soil disintegration is a serious issue with water and soil misfortunes of the fundamental drivers for residue inflow to the bowl and cause abatement quality of water. Disintegration of soil firmly impacts the strength of living beings. By observing the significant of assessment, disintegration of soil numerous analysts working in this field. Not only withstanding the improvement of genuinely based soil disintegration scope and silt transport conditions, dregs gauges at a shed zone or locale are accomplished principally through straightforward exploratory models as insufficient information requiredto use of truly based models Assessment of soil disintegration and dregs yield, need of some basic models are generally utilized for their effortlessness and ease.

A portion of the models is there usually utilized to process soil disintegration, for example, Erosion Productivity Impact Calculator, known as EPIC, which may not be possible to duplicate it by USLE/RUSLE for the genuine image to disintegrate measure they depending for factors figured to aligned based perceptions, it has been broadly applied everywhere on the world for the most part to ease of the the modl detailing its effectively accessibility to informational collection (Barsch et al., 2002; Jain and Kothyari, 2001; Jain et al., 2001). Wischmier and Smith,1978 shows to USLE modl gives good outcomes to assess soil disintegration at plotting scale. To arise to an occurrence of catchment, the portion to disintegrated soil stored in catchment before to spread to the outlest of catchment. Soil disintegration in any case, determined by USLE can be coordinated to utilizing the hypothesis of silt conveyance by appropriate strategy .Both soil disintegration and transport of residue measures, spatially fluctuates due to the spatial variety. These kind of irregularity has invigorated the utilizing to information serious disseminated strategy to assess disintegration of catchment to silt to zone with homogeneous qualities and steady precipitate conveyance (Young et al., 1987; Beven, 1989). Land and soil use, watershed, utilize of GIS strategy is appropriate. These methods works by discretizig the catchment to little lattice units which to utilized to the calculate such physical attributes of a cells for example slant, land uses and soil kind. By knowing to qualities in lattice shell, disintegration of soil and affidavit in case of diverse sub-regions to the catchment zone can be contemplated. Both decipher and tested models dependent on GIS have been to demonstrate soil losses. Numerous specialists additionally utilized experimental connection to Delivery Ratio and catchment territory so as figuring out silt load. Jain et al. (2003) said to computation of silt yield for the catchment of HAHARO at upper Damodar valley. Residue release relation created was, utilizing every single day info for assessing of residue yield by the trial relationship, various geological boundaries, for eg, use of land and geology were produced utilizing Geographic Information System (GIS) strategy. He additionally made to use exploratory condition for appraise silt conveyance part so as to declare residue yield for catchment outlet. By making use of GIS, Remote Sensing (RS) with USLE to identify the core disintegration inclining territories in watershed for position reasoning. Here, theory assess soil yield by utilizing the USLE boundary for appraising precipitation put together disintegration with respect to Catchment of Ong of Salebhata measuring station.

1.1.1 SOIL EROSION

Water and wind current are the reason for disintegration of soil from the surface happening and it is called soil disintegration. Almost both, stream of water is far more liable from the disintegration in which cycle incorporates separation, transport and testimony of single residue particles through impact of raindropping, streaming of water. Disintegration is one of the primary issues in horticulture and common assets the executives. Erosion causes decline in the particles of the soil profitability, dirtis the streams and inturn fills the repositories (Fangmeier et al. 2006). Our actions, for example, development of streets, parkways, and dams, control chips away at channels and waterways, mining, and urbanizing ordinarily quickens is cycle of disintegration, transportion, and sedimenting.

In fig. 1, shows the cycle of the soil disintegration and also sedimentation occurring and the cycle of disintegration happens at the point, where downpour falls on the ground, resulting in the expulsion of particles of soil. Results to flimsy overland we know as sheet disintegration/ interrill disintegration in which eliminated particles are horizontally shipped into the rivulets. (Foster and Meyar 1977).

Through stream inside rivulets the majority in the down side slope residue transportation happens. Stream disintegration also happens when water from disintegration of sheets joins passing via little channels which as we all know is the common type of surface disintegration.

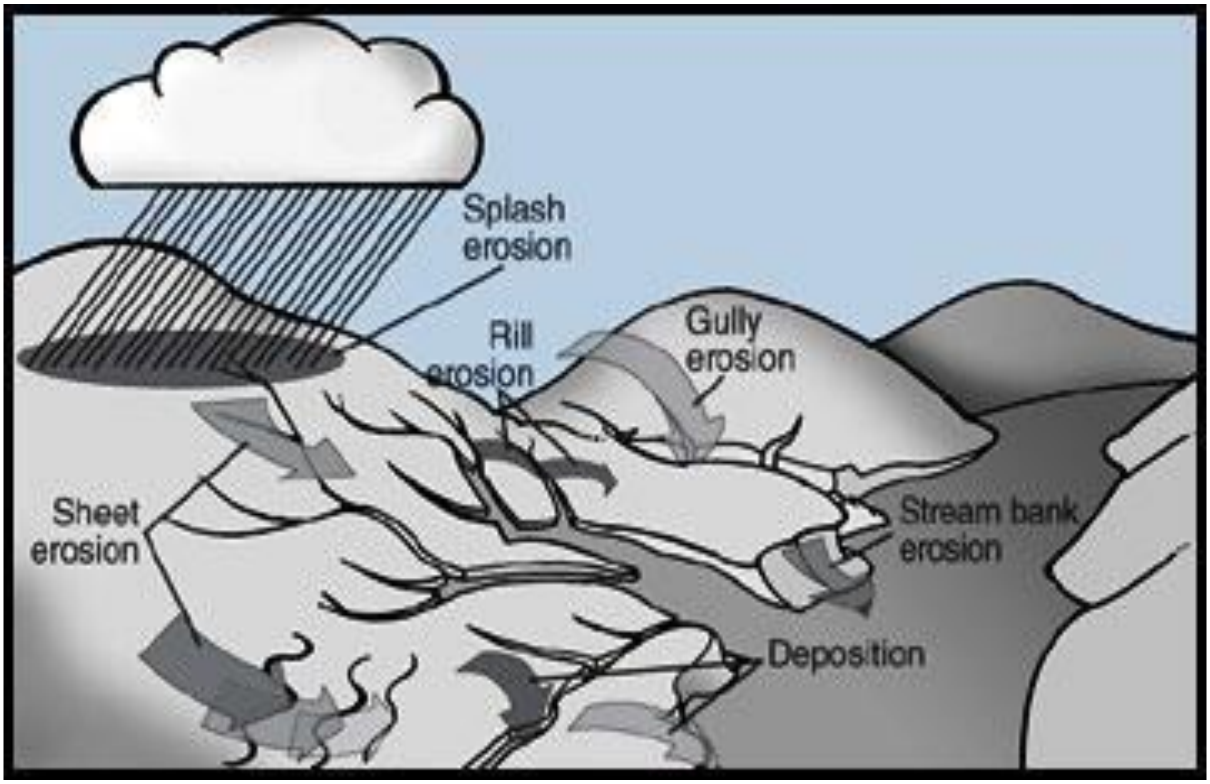


Figure 1 Soil Erosion Process

In this Figure 1, it plainly shows that, rivulets bit by bit join to shape bigger channels and results to gorge disintegration which is comparable as brook disintegration yet bigger in scale. Disintegration of stream channel, resulting from concentrated water in which structures inside to rivulets and crevasses to causes expulsion in residue from streambed and banks of stream. At point when the calculation of transported limit is less than the isolate limit of soil, than just the movable aggregate will be conveyed to down side and the rest is be stored through the section.

1.2 AIM

General target aims to estimate disintegration of soil rates utilizing the model of Universal Soil Loss Equation and ArcGIS Mapping 10.3 at the Basin of Ong River, Orissa. Some particular goals are:

1. To examine the numerical models utilized for the assessment of sediment yield.

2 Analyse rate of soil loss of the catchment utilizing the precipitation data, DEMs, Soil Type and Land Cover Map data of the Cartchment.

3. Identification and stating the geographical coordinates of the severely affected areas to erosion lying in the basin of river with the help of GIS and Remote Sensing.

1.3 OUTLINE OF THESIS

Chapter 1: Introduction with works of annual erosion estimation of by USLE parameters on river basins.

Chapter 2: Description of the previous research works done in relation to soil erosion using USLE parameters.

Chapter 3: Describing the availability of data, location of the study area and its characteristics.

Chapter 4: Describes usage of arcGIS as a supporting tool in delineation of different kinds of maps needed for estimation, and briefly describe about the procedure used to estimate the result.

Chapter 5: Results obtained from the USLE model.

Chapter 6: Summary and conclusion of the results on Ong river basin.

CHAPTER 2
LITERATURE REVIEW

1. Narayana and Babu et al., (1983) The completed work on Soil disintegration issue of India. Without precise evaluations of absolute disintegration in the nation, this paper presents a cycle to show up at a first gauge of soil disintegration, dregs heaps of streams and sedimentation in stores. In this investigation, existing yearly soil misfortune information for 20 diverse land asset districts of the nation residue heaps of certain waterways, and precipitation erosivity for 36 stream basin and 17 catchments of significant stores were used and measurable relapse conditions are produced for determining dregs yield. Utilizing these phrasings and comparing estimations of territory, precipitation, precipitation erosivity and surface spillover, yearly estimations of absolute dregs heaps of streams, silt statement in supplies, and residue lost for all time into the ocean are assessed. As indicated by this gauge, which is treated as a first guess, soil disintegration is occurring at the pace of 16.35 ton/ha/annum which is more than the passable estimation of 4.5-11.2 ton/ha. About 29% of the absolute disintegrated soil is lost for all time to the ocean. A modest amount of it is kept in supplies. The staying 61% is separated from one spot to the next.
2. Kothiyari et al., (1996) They completed work on the issue of soil disintegration which is overwhelming over around 53 % of the absolute land region of India. The locales of high disintegration incorporate the seriously dissolved gullied land along the banks of the waterways Yamuna, Chambal and Mahi and other west streaming waterways in western Indian states. Moreover the Himalayan and lower Himalayan areas have been extraordinarily influenced by soil disintegration because of concentrated deforestation, enormous scope street development, mining and development on steep slants. Reviews of existing huge and medium-sized Indian supplies have demonstrated that in any event six huge repositories (stockpiling > 100 Mm3) and three medium-sized stores (stockpiling 20-100 Mm3) have just lost over 25% of their abilities. In the current paper numerous information identified with disintegration and sedimentation issues in India were

introduced. Subjective examination of these information is likewise attempted to recognize the potential reasons for concentrated disintegration and sedimentation. A portion of the potential medicinal measures are quickly examined.

3. Subramanian et al., (1996) They completed work on data gathered on dregs transport in Indian waterways. It shows the significant commitment which Indian waterways make to the aggregate sum of residue conveyed to the sea at a worldwide scale, yet additionally features the enormous fleeting and spatial inconstancy of riverine silt transport in the Indian sub-landmass. This fluctuation is clear not just in the amount of the silt shipped yet additionally in the size and mineralogical highlights of the dregs loads.
4. Adinarayana et al., (1996) They did take a shot at another method of presenting "Coordinated Resources Units" (IRUs) to the Sediment Yield Index (SYI) model of the All India Soil and Land Use Survey, so as to recognize intense hydrological units over a huge bowl, which was tried in a seepage bowl of the Western Ghats rugged zone which gets weighty precipitation. The IRUs, amassed from coordinated investigation, incorporate the different bowl assets of soils, slants, seepage and the dynamic land-use design. The IRU has been utilized as the vital unit for doling out the erosivity and mobility estimations of the segregated material in the SYI model for inferring need classes for sub-bowls. The critical variety in SYI values calls for preservation arranging in instances of high and high need sub-bowls. A treatment-situated land-use arranging plan, utilizing Geographical Information Systems, was additionally figured for maintainable improvement of the bowl. On the off chance that the proposed organic building rehearses were utilized on the need sub-bowls, there would be less disintegration and subsequently huge ventures to control disintegration, or more terrible, to restore the influenced lands, could be decreased. The IRU approach, likewise useful in observing the dynamic parts of the basin and for rethinking to be.
5. Kothyari and Jain et al., (1997) They did deal with strategy which was created in the current examination for the assurance of the dregs yield from a catchment utilizing a GIS. The strategy includes spatial disaggregation of the catchment into cells having uniform soil disintegration highlights. The surface disintegration from each of the discretized cells is directed to the catchment outlet utilizing the idea of silt conveyance proportion, which

is characterized as an element of the territory of a cell secured by backwoods. The silt yield of the catchment was characterized as the whole of the residue conveyed by every one of the cells. The spatial discretization of the catchment and the inference of the physical boundaries identified with disintegration in the cells are performed through a GIS strategy utilizing the Integrated Land and Water Information Systems (ILWIS) bundle.

6. Jain and Kumar and Varghese et al., (2001) They completed work on the delicate environment of the Himalayas has been an expanding reason for stress to biologists and water assets planners. The lofty slants in the Himalayas alongside depleted woods spread, just as high seismicity have been principle factors in soil disintegration and sedimentation in stream comes to. Assessment of soil disintegration is an absolute necessity if sufficient arrangement is to be made in the plan for protection of structures to balance the sick impacts of sedimentation during their age. In the current examination, two various soil disintegration models, for example the Morgan model and Universal Soil Loss Equation (USLE) model, have been utilized to assess soil disintegration from a Himalayan watershed. Boundaries basic for the two models were produced utilizing distant detecting and auxiliary information in GIS mode. The dirt disintegration surveyed by Morgan model is in the request for 2200 t km^{-2} yr^{-1} and is inside the cutoff points announced for this locale. The dirt disintegration evaluated by USLE gives a higher rate. Hence, for the current investigation the Morgan model stretches, for zone situated in sloping territory, genuinely great outcomes.
7. Wayne, Mahmoudzadeh and Myers et al., (2002) They did take a shot at Sedimentation overviews of dams in little sandstone seepage bowls close to Sydney, Australia, show that land use is the main factor for deciding silt yields and soil misfortune rates. Developed bowls yield a normal residue yield of 7.1 t/ha/year while touched field and timberland/forest bowls move midpoints of just 3.3 and 3.1 t/ha/year, separately. However, these yields are high by Australian guidelines. Silt moves from touched field and timberland/forest bowls are comparative on the grounds that the backwoods/forest bowls are likewise munched. Dam dregs are upgraded in earth and natural issue in contrast with topsoil's. Ravines and bank disintegration are not dynamic geomorphic

measures in the seepage bowls examined with the goal that the deliberate residue yields could be truly related to soil misfortune rates controlled by observational soil misfortune conditions, Modified Universal Soil Loss Equation (MUSLE), Soil misfortune and Revised Universal Soil Loss Equation (RUSLE), which don't represent chasm and channel disintegration. These conditions correctly anticipated the deliberate dregs yields, with MUSLE being the most exact. In spite of the fact that Soil misfortune is the main exact condition to utilize Australian information, MUSLE accomplished somewhat better, notwithstanding being a fundamental form of the Universal Soil Loss Equation (USLE) that is utilized for instructing. RUSLE forecasts of soil misfortune rates were additionally firmly related with estimated residue yields.

8. Singh et al., (2002) They did chip away at Mathematical displaying of watershed hydrology, which was utilized to address a wide range of natural and water assets issues. A recorded perspective of hydrologic demonstrating is given, and new developments and difficulties in watershed models were talked about. Model structure, normalization, and information preparing have gotten a lot of thought, while model approval, mistake multiplication, and examinations of uncertainty, danger, and dependability have not been treated as completely. At long last, a few comments are made concerning the future viewpoint for watershed hydrology displaying.

9. Dutta and Bhattarai et al., (2006) They completed work on a GIS-based strategy, which was applied for the assurance of soil disintegration and dregs yield in a little watershed in Mun River bowl, Thailand. These strategy includes spatial breakdown of the catchment into homogenous network cells to catch the catchment heterogeneity. The net soil disintegration in every cell was planned utilizing Universal Soil Loss Equation (USLE) via cautiously deciding its different boundaries. Sediment conveyance proportion was utilized to course surface disintegration from each of the discretized cells to the catchment outlet. The arrangement of dregs conveyance from matrix cells to the catchment outlet is connoted by the geographical qualities of the cells. The consequence of DEM goal on dregs yield was inspected utilizing two distinct goals of DEM. The spatial discretization of the catchment and deduction of the physical boundaries identified with disintegration in the cell are cultivated through GIS Strategies.

10. Pandey, Chowdary and Mal et al., (2006) They dealt with Karso watershed of Hazaribagh, Jharkhand State, India was arranged into 200 × 200 network cells and normal yearly silt yields were estimated for every framework cell of the watershed to distinguish the basic disintegration inclined territories of watershed for positioning reason. Normal yearly silt yield information on framework premise was proposed utilizing Universal Soil Loss Equation (USLE). When all is said in done, a significant limitation in the utilization of hydrological models has been their powerlessness to deal with the a lot of information that portray the heterogeneity of the natural system. Remote sensing (RS) technology provides the vital spatial and temporal information on some of these parameters. Thus, the Arc Info 7.2 GIS software and RS (ERDAS IMAGINE 8.4 image processing software) provided spatial input data to the erosion model, while the USLE was used to predict the spatial distribution of the sediment yield on grid basis. The deviation of assessed sediment yield from the observed values in the range of 1.37 to 13.85 percent specifies accurate estimation of sediment yield from the watershed.

11. Gebhardt and Jackson (2007) completed their work by the use of Modified Universal Soil Loss Equation (MUSLE), identified with normal yearly silt yield on 14 little rangeland waste bowls by subbing normal yearly spillover and an aligned plan release for the overflow and pinnacle stream terms separately in MUSLE. The goal was to decide whether a plan release can be endorsed to empower the equation, in the structure, utilized for yearly silt yield gauges to little waste bowls.

12. Arekhi and Shabani et al., (2010) They did deal with Modified Universal Soil Loss Equation (MUSLE) application concentrate so as to appraise the dregs yield of the Kengir watershed in Iyvan City, Ilam Province, Iran. The overflow factor of MUSLE was processed utilizing the deliberate estimations of spillover and pinnacle pace of overflow at outlet of the watershed. Geological factor(LS) and yield the executives factor(C) are resolved utilizing geographic data framework (GIS) and field-based overview of land use/land spread. The preservation practice factor (P) was gotten from the writing. Silt yield at the outlet of the examination watershed is reproduced for six tempest occasions spread throughout the year 2000 and approved with the deliberate qualities. The high

coefficient was utilized for assurance esteem (0.99), which shows that MUSLE model dregs yield expectations are agreeable for handy purposes.

13. Parveen and Kumar et al., (2012) They did deal with Soil disintegration which is issue for the zones of rural movement where soil disintegration prompts diminished horticultural profitability as well as lessens water accessibility. Widespread Soil Loss Equation (USLE) is the most mainstream observationally based model utilized all around the world for disintegration expectation and control. Far off detecting and GIS methods have become important devices uniquely while evaluating disintegration at bigger scopes due to the measure of information required and the surrounding region inclusion. The current investigation presents a piece of Chotanagpur level with moving geology, with a high danger of soil disintegration. In the current investigation an exertion has been made to evaluate the yearly soil misfortune in Upper South Koel bowl utilizing Universal Soil Loss Equation (USLE) in GIS structure. Such data can be of immense assistance in recognizing need territories for execution of disintegration control measures. The dirt disintegration rate was resolved as a component of land geology, soil surface, land use/land spread, precipitation erosivity, and yield the executives and practice in the watershed utilizing the Universal Soil Loss Equation (for Indian conditions), distant detecting symbolism, and GIS methods.
14. Ahmad and Verma et al., (2013) They completed work on Assessment of soil disintegration. Various parametric models was created to gauge soil disintegration at seepage bowls, yet Universal Soil Loss Equation, prevalently known as USLE model is most generally utilized exact recipe for assessing yearly soil misfortune from agrarian bowls. With the development of Remote Sensing method it gets conceivable to quantify hydrologic boundaries on spatial scales while Geographic Information System coordinates the spatial explanatory usefulness for spatially conveyed information. In the current paper the utilization of USLE model and GIS, for soil misfortune assessment has been introduced for the Tandula repository catchment region on Tanudula River at Balod Tehsil of Durg locale of Chhattisgarh State, India.

CHAPTER 3

STUDY AREA AND DATA COLLECTION

3.1 INTRODUCTION

Section contains concise depiction checking at Salebhata station of Ong Catchment alongside informational index needed consider disintegration of basin of sedimentation. Disintegration demonstrating, geography, precipitation, in which type of soil and land use are additionally examined quickly in below mentioned part.

3.2 STUDY AREA

Examination zone covers Salebhata gauging station in the Ong catchment of Orissa. The 4 locale in Orissa specifically, Balangir, Bargarh, Nuapada and Sonpur are covered in the study. The coordinates of the Waterway Basin are in longitude of 82˚34ˈ23.71ˈˈ E and 83˚49ˈ10.11ˈˈ E and latitude of 20˚44ˈ20.56ˈˈ N and 20˚52ˈ28.21ˈˈ N.

Ong River is the direct feeder to the Mahanadi stream basin and is arranged in the district Balangir, Orissa. Complete region of Ong catchment is roughly about 5,128 Km^2 which completes over Orissa at Tel Waterway joins Mahanadi in Sambalpur, 11 Kms upstream of Sonpur. Typical yearly precipitation in basin is 1,400 mm and it shift ranging 1,600 mm in the east and 900 mm in the west 75% of the yearly precipitation of Orissa occurs in the four rainstorm long stretches of the months namely June, July, August and September. Figure 2 (on the next page) shows the area of Mahanadi Basin in Orissa. It gives us the overview of the location of Ong catchment in Orissa and in turn in India.

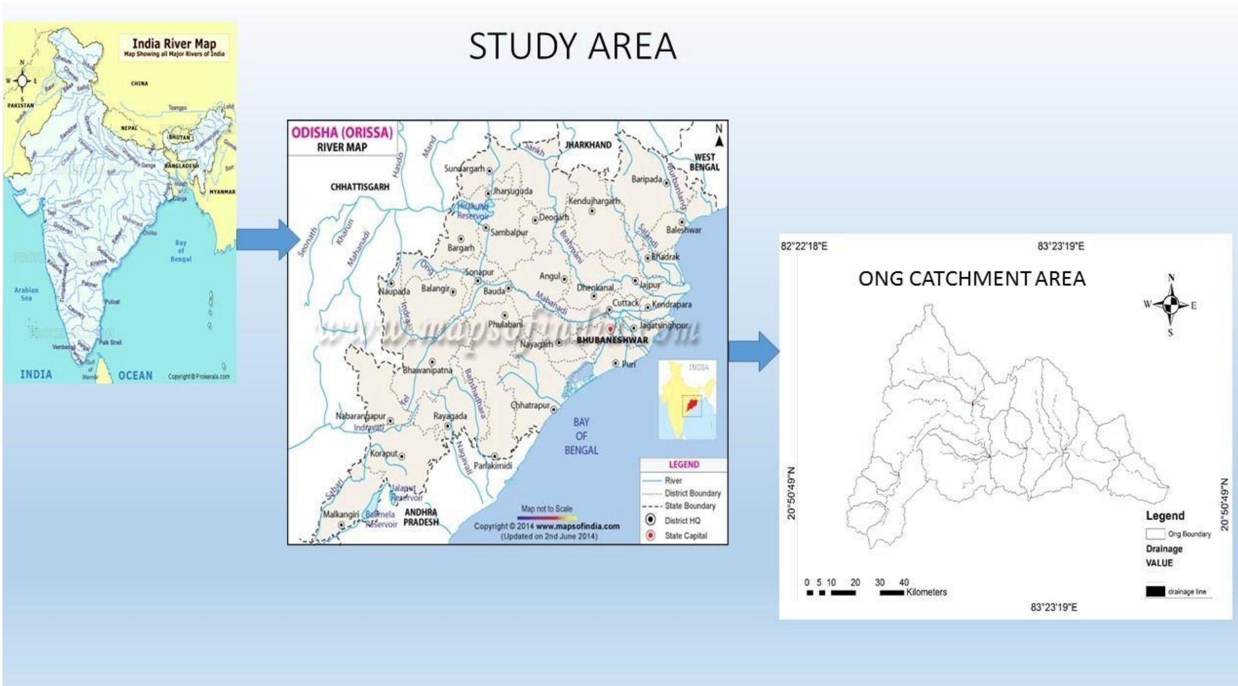


Figure 2 Area of Mahanadi Basin in Orissa (Source: researchgate.net)

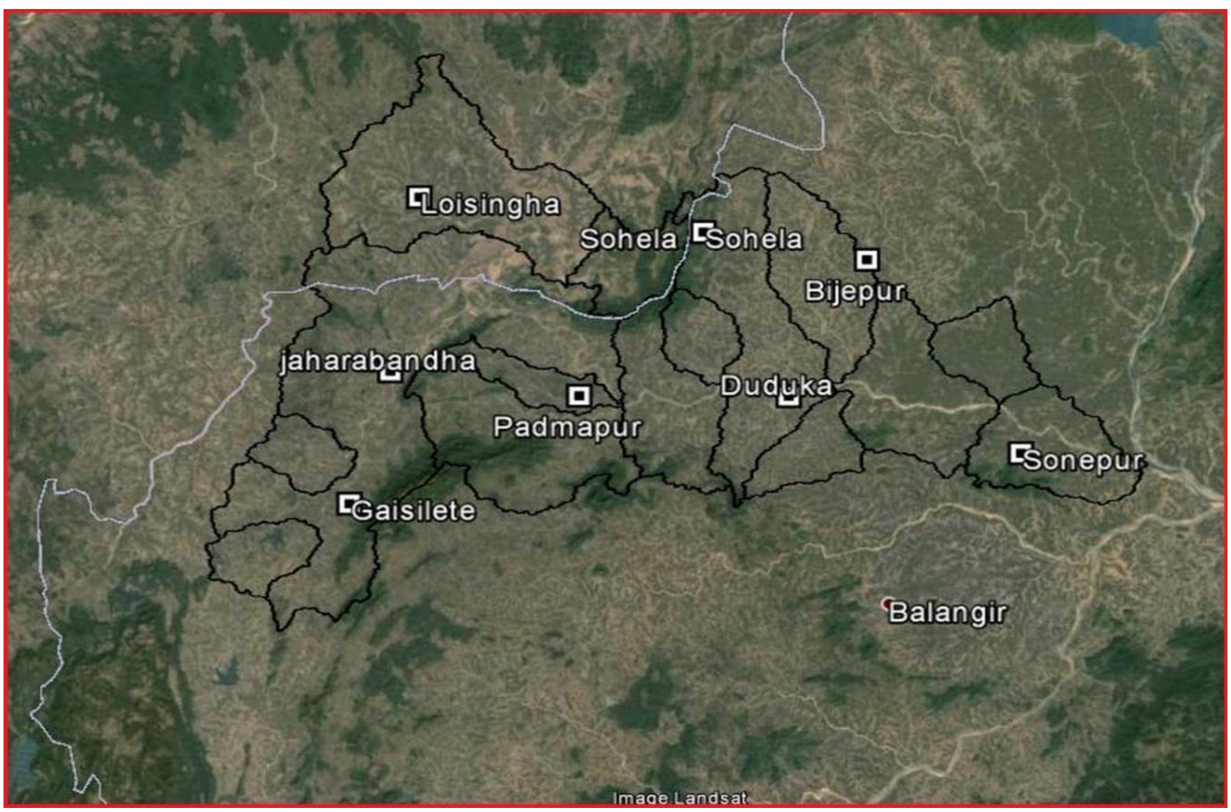


Figure 3 Synoptic View of the catchment (Source: link.springer.com)

Figure 3 gives a synoptic view of location of the eight down slope check stations closer to the investigation zone in the Ong Catchment of Mahanadi Basin. The characteristics of the catchment are mentioned below:

1. Geography

The geography of the territory has a bumpy geography. From mean ocean level, the height ranges from (103 to 1005)m with high incline in the region. There are undulating uneven plots in the complete territory with encircling slopes in the eastern sides.

2. Use of Land

Almost 25.38% of the all out topographical region of the area is secured with thick woods. The significant backwoods results of the area the leaves of Sal and Wood. The satisfactory development essentially situated in the waterway valley. The terrains which are not useful are available in patches. Right now backwoods spread is normally diminishing because of snappy expansion of mine zones in the vicinity of the basin. Soil in the catchment is blend of black and red soil.

3. Agriculture

In this catchment region rice is essentially rural yield, around there antagonistic atmosphere land utilized example, and variable precipitation and light surface soil, the editing example of the area mostly rely upon precipitation.

4. Soil

Figure 4 presents the catchment region of the soil can be characterized into two gatherings dependent on the soil development to be specific leftover and the soil which got carried away or can say transported. Under red rock, upper basin is accumulated, along with red soil. Focal area of stream basin goes red and dark top soils, though the bottom basin gathered under red topsoil and lateritic soils. Clayey soil is in the delta region of the Catchment.

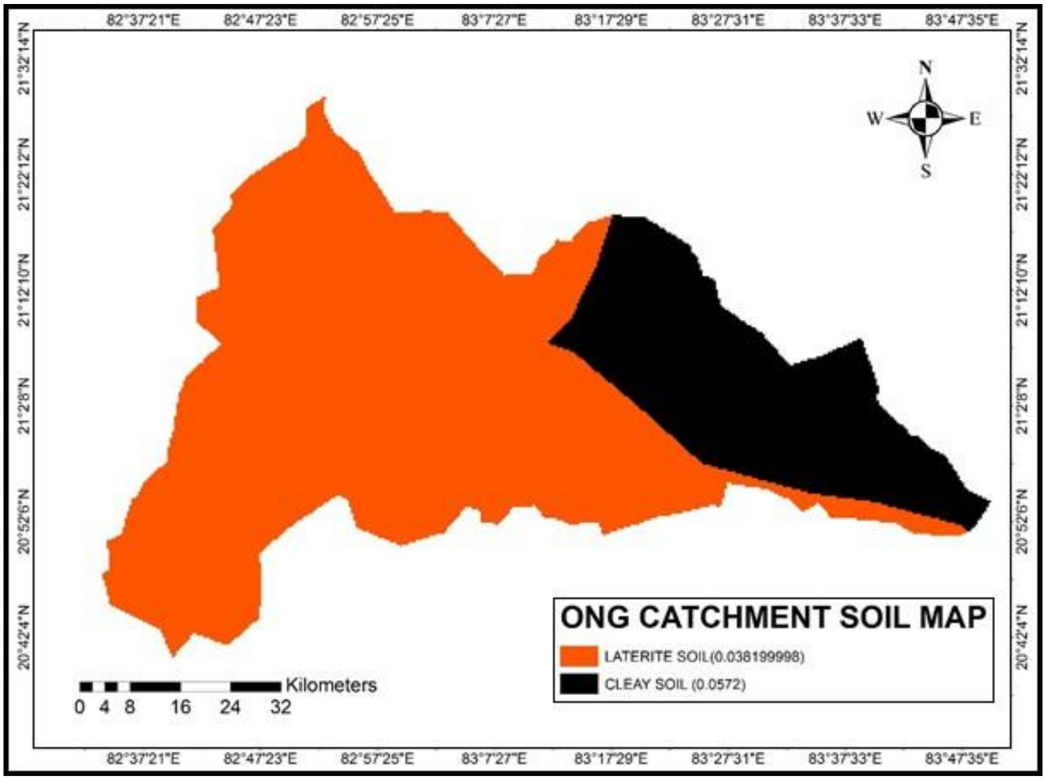


Figure 4 Soil Map of Ong Catchment

5. Available Minerals

Among the four catchment zones namely Sonepur, Naupada, Bargarh and Balangir, in which two regions involves in a significant area in mineral guide. Bauxite, Manganese, Graphite, Galena, Lime Stone, Gem Stone dolomite, mica, zinc and lead copper. Fundamentally Iron-metal and manganese-mineral stores are accessible around the examination region. In view of these minerals numerous little and medium ventures are built up around the investigation region.

6. Temperature

The temperature ranging in the catchment zone is mostly tropical. The atmosphere around region is sorted by domineeringly high summer with most extreme humid weather.. Temperature starts to expanding rapidly accomplishing the greatest during the long stretch of May. Throughout the late spring, it rises up to 42°C. The atmosphere turns out to be more soothing with the appearance of the storm around June and stays the same up to the furthest limit of October. In the period of December, it is most minimal for example around 12°C. Rarely, even drops down to 6°C.

3.3 DATA COLLECTION AND ANALYSIS

Various kinds of data is needed to find the sediment yield using USLE, as rainfall, flow data. Sediment yield, DEM, land cover map, described below:

3.3.1 Rainfall Data

June to September is the storm season of Orissa. Yearly precipitation of catchment zone is almost 1400mm with 80% of the yearly precipitation happens during Monsoon Season. In the season, precipitation is high. For the current examination daily precipitation information were gathered from eight downpour check stations closer to the investigation zone which.

The following are the selected check stations for the analysis:

Bijepur, Gaisilte, Sohela, padampur, Jaharbandha, Duduka, Losingha and Sonepur.

Accessible precipitation information was from June 2006 to September 2010 (Source: Orissa Rainfall Monitoring Deptt.).

From the gathered information obviously precipitation during January to May is right around zero. Normal precipitation was determined through technique Thiessen Polygon or Isohyetal strategy can be applied. Reason being, no downpour check station present in zone.

Table 1 presents the area and the accessible precipitation recorded in long periods of the precipitation check stations in the ONG Catchment.

Table 1 Average Rainfall Data in the different regions of the Ong Catchment

STATION	DISTRICT	Longitude (degree)	Latitude (degree)	Starting (Date)	Last (Date)	Precipitation mm/yr
Sohela	Bargarh	83.396	21.189	01/1/2006	01/9/2010	1300
Bijpur	Bargarh	83.071	21.087	01/1/2006	01/9/2010	1500
Gaesilite	Bargarh	83.812	20.089	01/1/2006	01/9/2010	1300
Jaharabndh	Bargarh	82.803	21.026	01/1/2006	01/9/2010	1500
Padmpur	Bargarh	83.070	21.112	01/1/2006	01/9/2010	1300
Dudooka	Balangir	83.38	20.891	01/1/2006	01/9/2010	1500
Losingha	Balangir	83.518	20.777	01/1/2006	01/9/2010	1400
Sonpur	Sonpur	83.802	20.923	01/1/2006	01/9/2010	1500

3.3.2 Flow Data

Normal month to month stream information is gathered from India-Wris of checking station, Salebhata from month of June to October (2006-2010). Table 2 show the month to month release information on Salebhata measuring station separately. Gathered information, clearly states that the release during August of 2006 is most extreme and October of 2010, listed in Table 2.

Table 2 Average Monthly discharge data

Year/Month	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER
2006	45.55	204.85	1002.25	121.68	12.33
2007	160.69	173.68	97.93	221.056	63.304
2008	150.14	28.18	266.84	422.88	14.11
2009	140.31	575.78	165.11	71.63	26.02
2010	150.04	96.16	106.77	135.9	21.88

3.3.3 SEDIMENT YIELD DATA

In Ong catchment, the important investigation is sediment yield which gathered from India-Wris. Examination assessed silt yields at already selected measuring station of the Catchment. Examination dependedent on yearly residue yield assessed at the checking station of Salebhta in Ong catchment. The watched sediment yield information is gathered from India-Wris (period 2006 to 2010). In Table 3, it is the collected data for the sediment yield of the Ong catchment. Unit is tons of residues per square kilometer of the watershed region every single year.

Table 3 Sediment Yield Data

YEAR	SEDIMENT YIELD (ton/year)
2006	7344.82
2007	6554.23
2008	5468.58
2009	4828.96
2010	4629.29

The accompanying datasets are utilized to ascertain the erosion:

1. Digital Elevation Model (DEM)
2. Average Annual precipitation information
3. Average Annual release information
4. Land spread sorts map
5. Soil sorts map
6. Sediment yield reports of the Basin

3.3.4 Digital Elevation Model (DEM)

It's a 3-D graphical representation of elevation data of the particular region which tells about the terrain of that particular region A DEM can be utilized to arrange diverse basin qualities, for example, seepage region, rise, slant steepness, inclination length, and streams, as in figure 5.

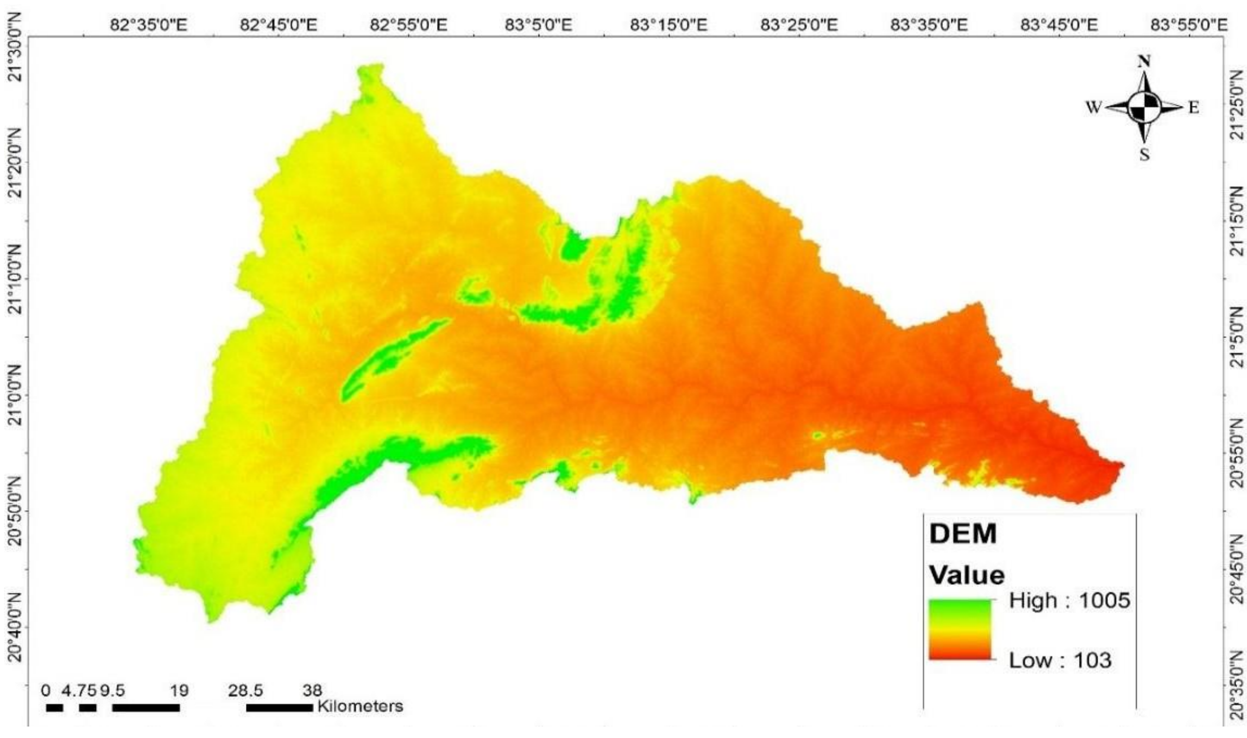


Figure 5 Representation of DEM of Ong catchment

3.3.5 Land Cover Map

Here, spread data/Map gathered from AWiFs (Advanced wide field sensor) satellite sensor of almost 10 to 12 pictures with 30 m spatial goal were utilized with the end goal of order that included 11 to 12 principle classification of land classes with various blended classes are as as per the following:

1. Urban Areas
2. Orchards/Fruit Trees,
3. Irrigated Agricultural land,
4. Rain Fed Agricultural Lands,
6. Natural Forests,
7. Rangeland, with
8. Barren grounds,
9. Marsh/Swamp Areas,
10. Water Bodies

Provided map by AWiFs is utilized in assurance in this examination. Figure 6 states the land spread characterization guide of the Ong catchment. In this examination Land spread valuation and distinguishing are fundamental for supportability to characteristic assets.

It also gives description of lands arrangement of Ong catchment inferred to directed picture grouping of territories having all the boundaries grouped based on shading as introduced by NRS (Public Far-off Detecting Foundation).

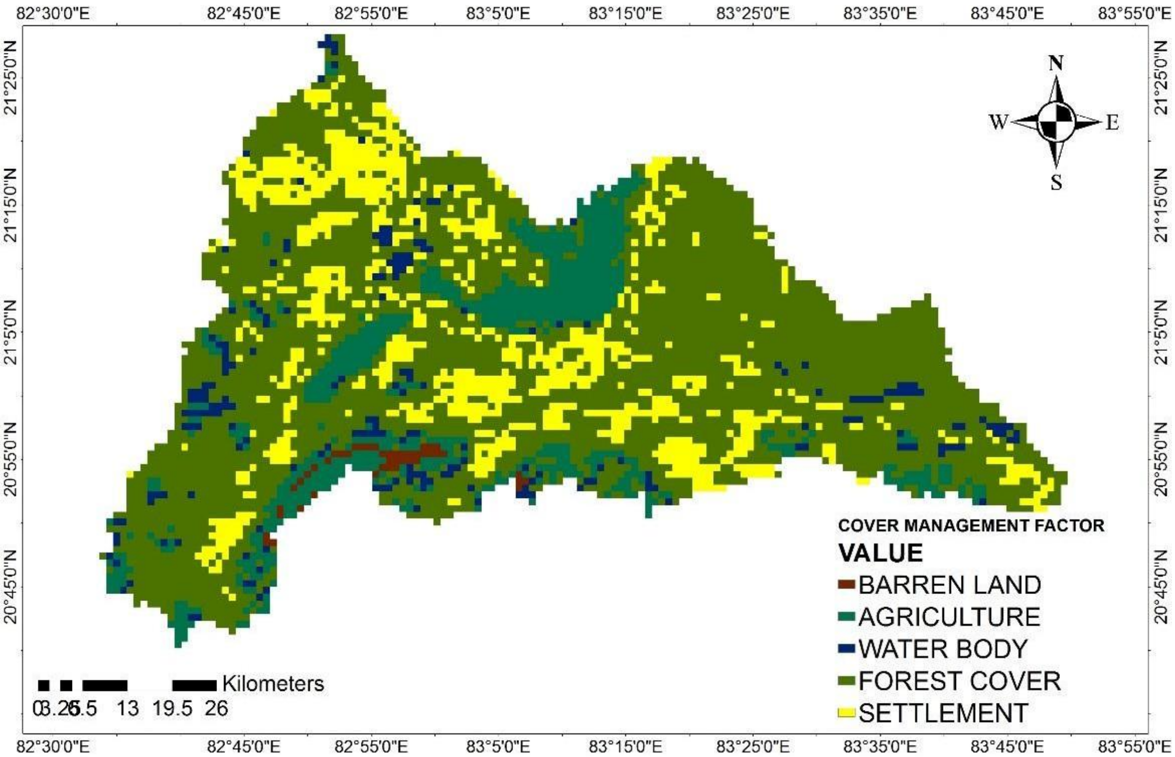


Figure 6 Land Arrangment of Ong Catchment

Portrayal and informational collections with geography, normal yearly precipitation, types of soil, land use spread, and residue yield study information for the Ong catchment. Information needed to dissect, to gauge the factor of USLE procedure disintegration factors. Chapter introduces how to use this data to find the factors of USLE. the utilization of these information. Geography information DEM is utilized to appraise the incline length (L) and slant steepness (S) factors. Precipitation of a year is utilized to register the precipitation overflow erosivity factors (R). Soil type map of vectorized character is changed into raster information with 30m matrix unit size to figure the dirt erodibility factor (K). For the spread administration factor (C).

CHAPTER 4

METHODOLOGY

4.1 INTRODUCTION

Methods to assess yearly normal soil loss rate utilizing model of USLE are been explained in this part. Segment 4.1 tells the fundamental ideas in USLE boundary assessment. Section 4.1.1 till Section 4.1.5 spreads assessment and sensibility investigation of the 5 parameters utilized in the model. Synopsis and conversation of the aftereffects of the parameters utilized in erosion of the soil assessment is explained in 4.2.

USLE Parameters:

Soil erosion is brought about by effect of raindrop and surface overflow. Broadly used in gauging erosion misfortune, evaluate the disintegration of soil hazard, manage improvement and protection plans so as to control disintegration under various land-spread conditions. The hidden supposition in the USLE is that separation and testimony are constrained by the residue content of the stream. The disintegration cycle isn't only cause dependent; moreover, it is restricted by the transport limit of the stream. At the point when the residue load arrives at the transporting limit of the stream, separation cannot occur anymore. All of 3, USLE, MUSLE and RUSLE gauge normal yearly erosion of soil. Here, **USLE equation** is utilized appeared in Eqn. 4.1., (Source: Procedure to use USLE, Ministry of Agriculture, Food and Rural Affairs, Ontario)

$$\mathbf{A = R \times K \times LS \times C \times P} \qquad \text{(Eq. 4-1)}$$

Where,

1. A = Calculated Aerage Yearly soil erosion anticipated, fleeting normal soil loss per unit of region. SI unit of ‘A’ is tonnes per hectare (tons per acre) per year.

2. R = Rainfall and Runoff factor
3. K = Soil Erodibility factor. (Tonnes per hecatare/ tons per acre).
4. L = Slope length factor.

   Characterized as the horizontal length from the inception of overland stream to where either slant inclination diminishes enough that the overflow gets moved in a characterized channel.

5. S = Slope steepness factor.

   Characterized as the proportion of soil misfortune from the field inclination to that from 9 % slant under in any case of indistinguishable condition

6. C = Cover the management factor.

   Characterized as the normal proportion of soil erosion from land under indicated conditions to soil loss from clean surface /without vegetation.

7. P = Support Practice Factor.

   Characterized as proportion of soil loss with a particular help practice to comparing soil loss with upslope and down slope culturing, or preparation of land for growing crop.

The above mentioned factors of USLE are described below:

4.1.1 R Factor (Rainfall Run-off Factor)

It is factual portrayal for conceivable precipitation to disintegrate soil, one of the prime info boundaries to display USLE. R factor is characterized to draw out normal result of the all out precipitation vitality (E30) and the greatest 30 min precipitation force in storm occasions (Wischmeier and Smith 1978; Renard et al., 1997). By and large, utilized month to month, occasional and yearly precipitation information to appraise the R factor. Rainfall erosivity assessment utilizing precipitation information for various downpour check station in Ong waterway bowl, for example, Padmapur, Bijepur, Duduka, Jharbandha, Loishinga, Gaisilete, Sohela, Sonepur. Following condition was produced in the region of Damodar valley, Jharkhand, Ram Babu et al. (Jain et. al 2004). As in downward Mahanadi stream bowl, Orissa being close to DamodarValley that's why it is to be used in the current condition.

$$\mathbf{R = 81.5 + 0.38R_N\ (340 \leq R_N \leq 3500\ mm)} \qquad \text{(Eqn 4.2)}$$

here, Normal yearly precipitation (in mm), represented as R_N.

Current investigation, Eqn 4.2 utilized in computation of yearly estimations of 'R' by supplanting R_N with real watched yearly precipitation of year. Renard and Freimund (1994) assessed 'R' factor were utilized for the information point of basin. Every information guide spatial introduction is needed along with the basin toward making a similar lattice unit size, same to other topical guides as DEM mapping, Soil type mapping, Land use mapping and Topographical guide. Consequently,

1. Normal yearly precipitation, R factor to every information is embedded into ArcGIS and by spatial method introduced utilizing Kriging method there in arcGIS, compartment of Spatial Analyst tool.
2. Kriging'^s method is a typical method utilized in understudies for numerous investigations over globe for addition of accessible information focuses. Method depends to mathematical model which incorporate auto-correlation, mathematical connections in b/w the deliberate information focuses.
3. As an outcome, Geo – statistical methods are equipped for delivering a gauge surface as well as give some proportion of the conviction or precision of the forecasts.

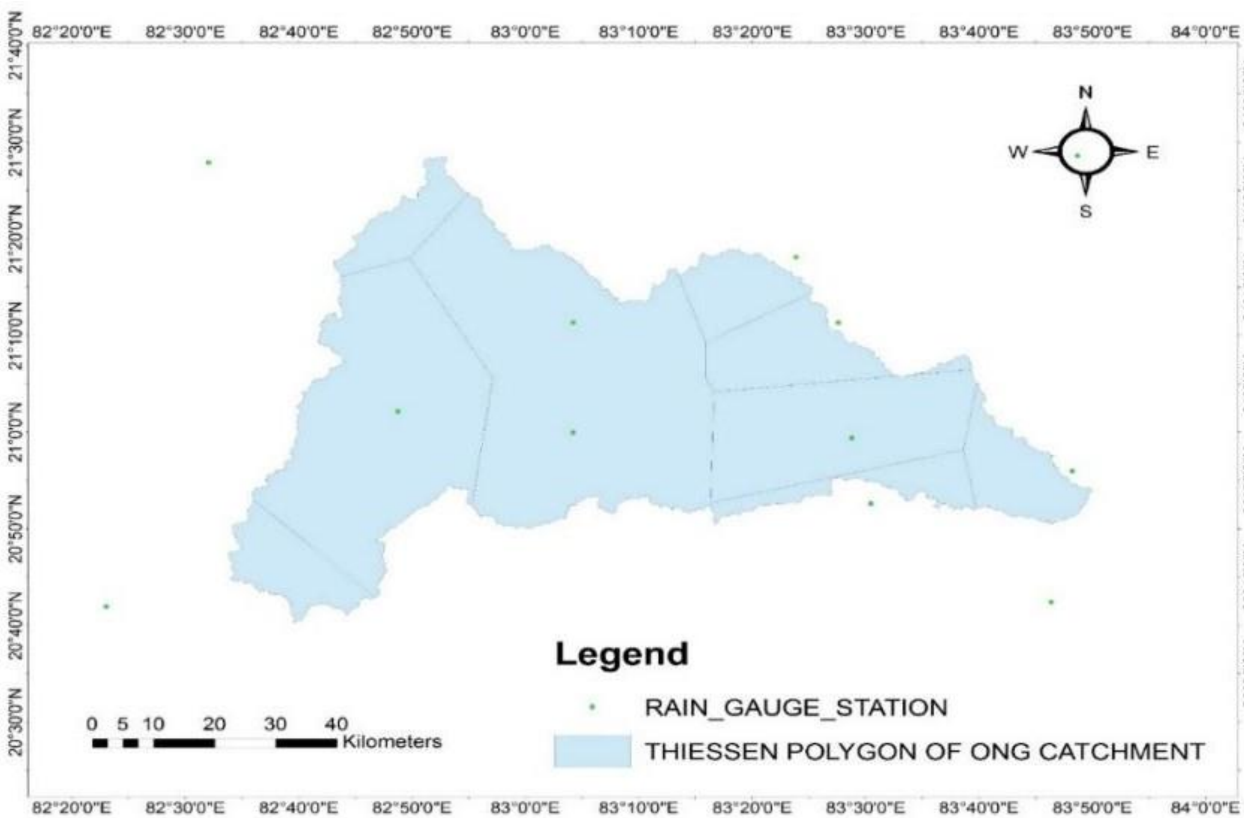


Figure 7 Rainfall Map (Thiessen Polygon Method)

To find the R factor utilizing Arc GIS mapping:

Region of the Ong catchment, separated into 8 locale, on the basis basis of Thiessen polygon. At that point measuring stations present, on locale as represented in Figure 7 and yearly downpour fall summation value is registered. At that point downpour erosivity factor determined with utilizing above condition for field adding machine, which is there in quality table for polygon document of arcGIS.

Table 4, R factor is spoken, keeping in view, 8 measuring stations and precipitation information for 8 checking stations. Color coding ranges between light brown (high erosivity factor) to grey (low erosivity factor). It is seen that erosivity factor here is similar for Sohela and Padampur.

Table 4 Rainfall Runoff Erosivity Factor, 2006

S.NO	STATION NAME	DISTRICT	R FACTOR
1.	Jharbanda	Baragarh	728.075
2.	Sonpur	Sonpur	889.266
3.	Sohela	Balangir	721.075
4.	Padampur	Baragarh	721.078
5.	Bijpur	Baragarh	808.201
6.	Gaesilite	Baragrh	709.25
7.	Loisinga	Balangir	420.08
8.	Dudooka	Balangir	740.34

Figure 8 (on next page), Rainfall erosivity factor determined for Ong catchment region utilizing ArcGIS. The shading ranges from grey to light brown (grey being low and light brown being high). Districts with similar shading area has similar Erosivity.

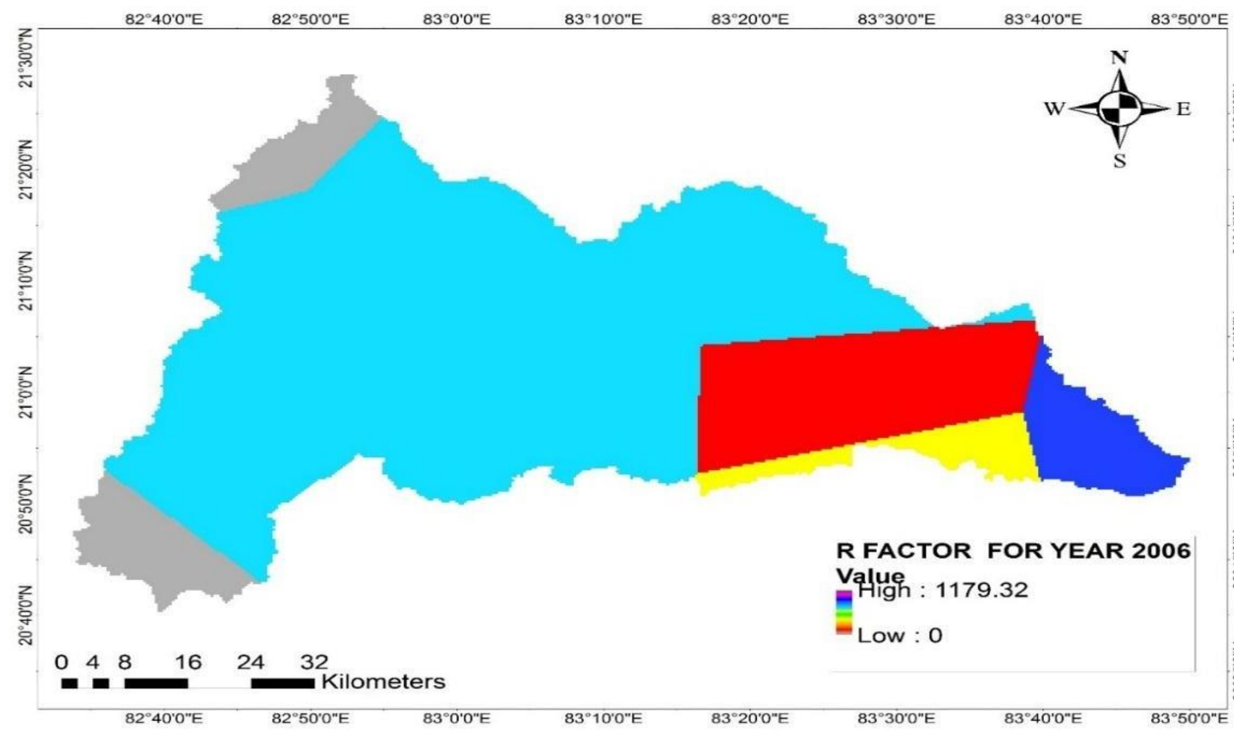


Figure 8 (R) Factor for 2006

By Table 5, R factor describes 8 measuring stations for the year 2007. These factors are figured from various precipitation information and for the following 8 checking station. It can be clearly inferred from the table that for Sohela and Sonepur, R factor is similar.

Table 5 Rainfall Runoff Erosivity Factor, 2007

S.NO	STATION NAME	DISTRICT	R FACTOR
1.	Jharbandh	Baragarh	608.56
2.	Sonpur	Sonpur	650.54
3.	Sohela	Balangir	650.56
4.	Padampur	Baragarh	708.56
5.	Bijpur	Baragarh	730.56
6.	Gaesilite	Baragrh	858.25
7.	Loisinga	Balangir	732.18
8.	Dudooka	Balangir	915.21

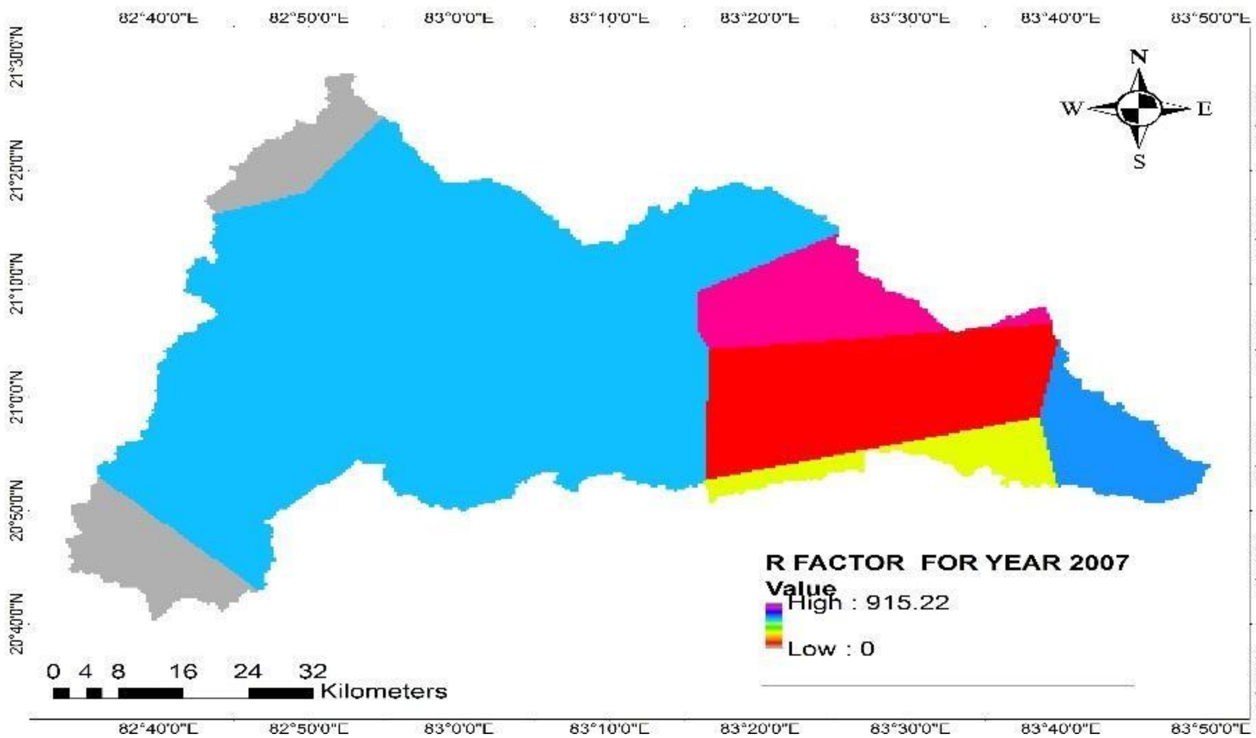


Figure 9 (R) Map for 2007

Fig. 9 presents R Factor obtained for year 2007. Here, Sohela and Sonepur have same erosivity.

In the Table 6, Rainfall runoff erosivity factor is spoken to for eight measuring stations. The factor is figured from various precipitation information, and for following 8 checking station, seen that R factor is most extreme for Duduka and least for Jharbanda.

Table 6 Rainfall Runoff Erosivity Factor, 2008

S.NO	STATION NAME	DISTRICT	R FACTOR
1.	Jharbndha	Baragarh	496.84
2.	Sonpur	Sonpur	524.53
3.	Sohela	Balangir	724.08
4.	Padampur	Baragarh	557.64
5.	Bijpur	Baragarh	604.75
6.	Gaesilite	Baragar	858.22
7.	Loisinga	Balangir	677.22
8.	Dudooka	Balangir	940.35

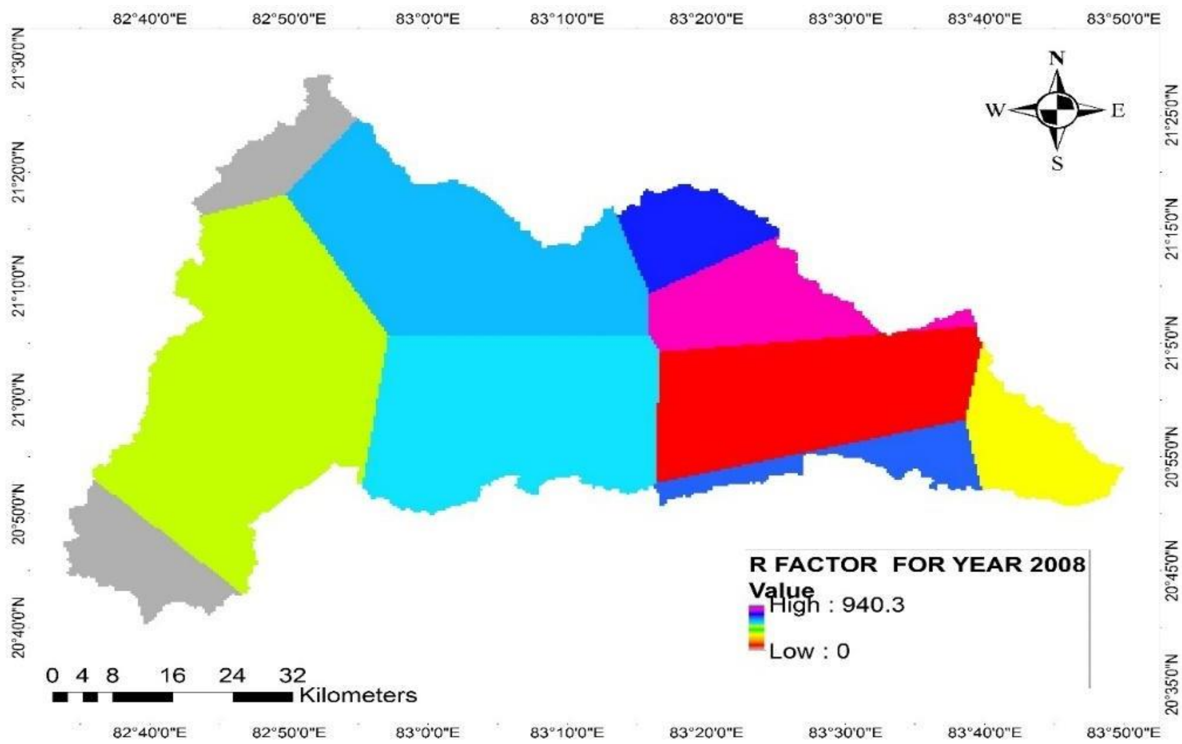


Figure 10 (R) Map for 2008

By Table 7, R factor is spoken for following mentioned 8 measuring stations. The R factor, figured by various precipitation information of checking station. R is most extreme for Duduka and least for Loisingha.

Table 7 Rainfall Runoff Erosivity Factor, 2009

S.No.	STATION NAME	DISTRICT	R FACTOR
1.	Jharbandh	Baragarh	504.82
2.	Sonpur	Sonpur	638.53
3.	Sohela	Balangir	601.72
4.	Padampur	Baragarh	615.77
5.	Bijpur	Baragarh	514.32
6.	Gaesilite	Baragarh	592.92
7.	Loisinga	Balangir	497.6
8.	Dudooka	Balangir	852.52

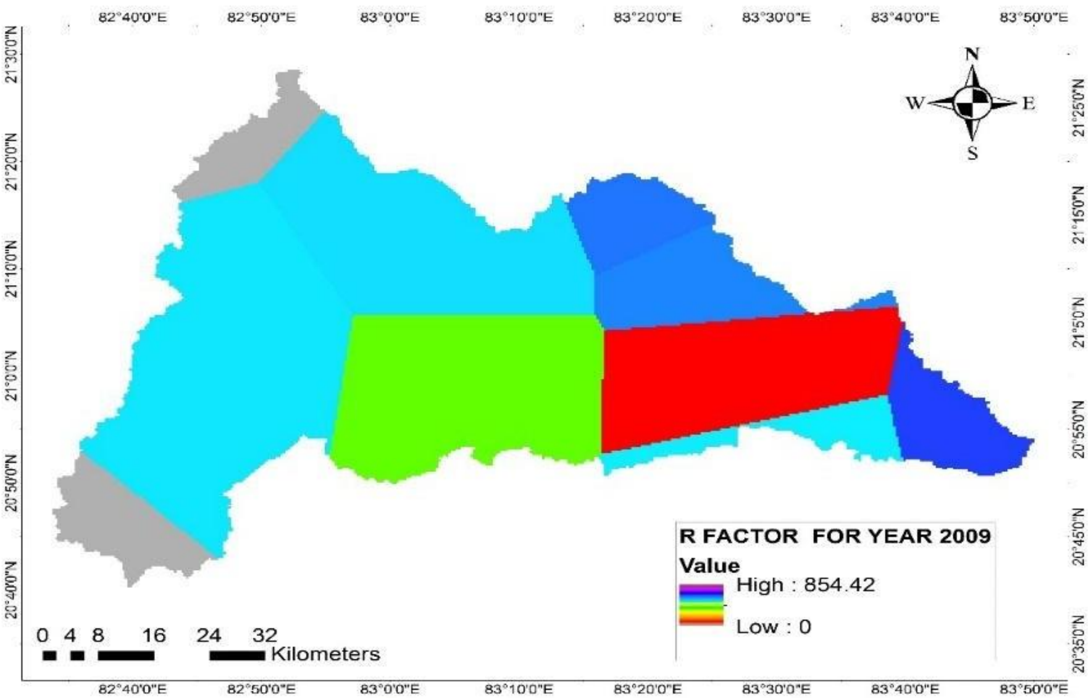


Figure 11 (R) map for 2009

In Figure 11, Rainfall erosivity factor determined utilizing arcGIS mapping, range being grey to light brown (grey for low and light brown for high erosivity). The district with similar erosivity has same R. Table 8, Rainfall Runoff Erosivity factor is spoken to for eight measuring stations. The factor is figured from precipitation information for below mentioned checking stations. It is clear from the table that R is high for Padampur and low for Loisingha.

Table 8 Rainfall Runoff Erosivity factor, 2010

S.NO	STATION NAME	DISTRICT	R FACTOR
1.	Jharbandh	Baragarh	354.42
2.	Sonpur	Sonepur	491.14
3.	Sohela	Balangir	475.32
4.	Padampur	Baragarh	528.88
5.	Bijpur	Baragarh	515.96
6.	Gaesilite	Baragarh	479.36
7.	Loisinga	Balangir	321.66
8.	Dudooka	Balangir	470.734

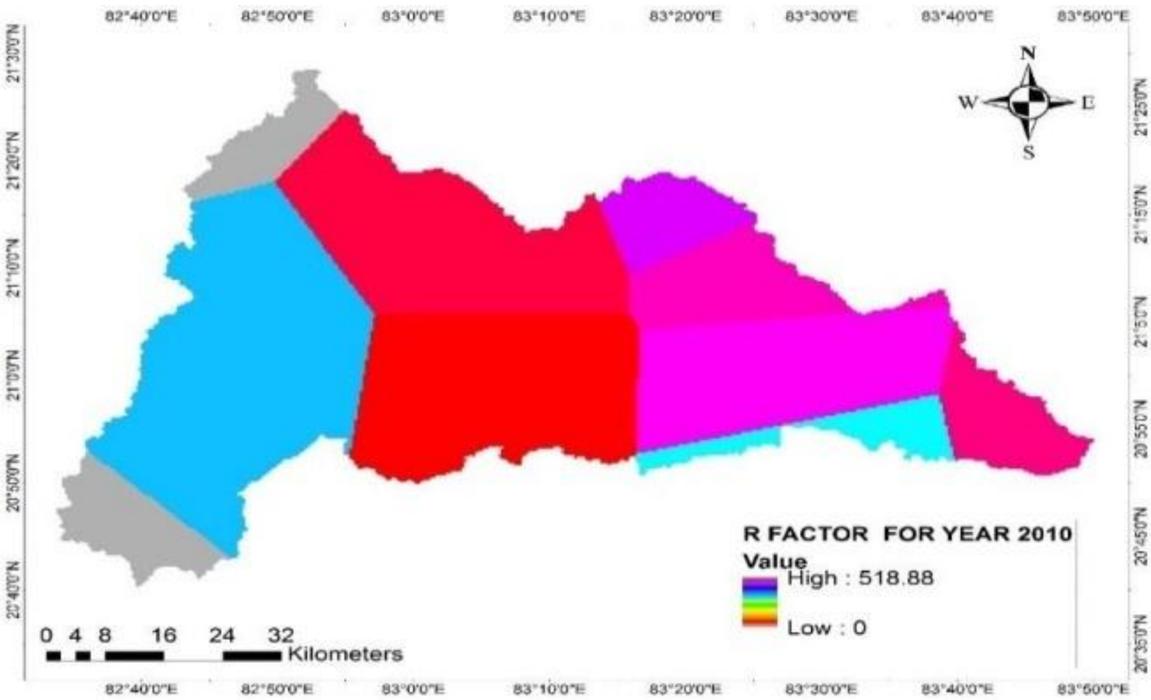


Figure 12 (R) map for 2010

Figure 12 represents the rainfall erosivity obtained for Ong Basin using arcGIS. Range of color code being grey to light brown (grey for low and light brown for high). Here, all regions have different Erosivity factor.

4.1.2 Soil Erodility Factor (K)

'K' is related as for consolidated impact for precipitation, overflow, and penetration through soil lost. Represents impacts of properties of soil on soil misfortune at storm occasions to territories upland (Renard 1997). In viable sense, it is a lumped boundary speaking to incorporated connection in between yearly normal disintegration, response to disintegration, hydrological measures. In a specific soil, 'K' is the pace of disintegration/ unit disintegration file got by unit plot sufficiently little to eliminate through by ordinary culturing activity.

The accompanying technique to discover the ‘K’:

1. Download soil map from the computerized guide of soil of world from World food and Farming Association (FAO), United Nations Version 3.6.

2. The soil map of the world is fit as a fiddle and has all the soil information in it.

3. By utilizing shape record for the catchment credits through guide of the world is to be extricated by arcGIS tool, called cutting tool.

4. FAO soil information used to esteem appointed to separate soil. In light of esteem document of the catchment is changed over to raster picture.

‘K’ ranges as an incentive from 0.02 - 0.6 (Goldman and Jackson 1986). Substance have low K, 0.05 – 0.15, primarily because of resistance from separation. Surface being primary influencing factor. Surface soils, being courser, for example, soils having low K that runs between 0.05-0.2. Because of less surface spillover brought through by unnecessary penetration despite the fact that these soil are handily confined.

If there should arise an occurrence of cut topsoil soil, for example, medium surface soils, having moderate value of K which commonly go through 0.25 to 0.4 because of moderate defenselessness in separation and medium overflow. Soils with greatest residue contents being generally erodible everything being equal. Effectively independent, will in general outside and deliver high paces of spillover. K esteems for these kind of soils will in general be more noteworthy than 0.4. Natural issue content declines erodibility, lessen powerlessness of the dirt to separation, and builds penetration rates, which thus diminishes overflow and disintegration.

‘K’ Factor is related by consolidated impact of precipitation, overflow, penetration soil misfortune. Represents impact properties of soil on soil loss in storm occasions.

Fig 13 represents the aftereffects of ‘K’ in the Basin. Qualities run from (0.038 – 0.057), 0.038 for or Laterite, 0.057 gives clay soil. (Jain et. al)

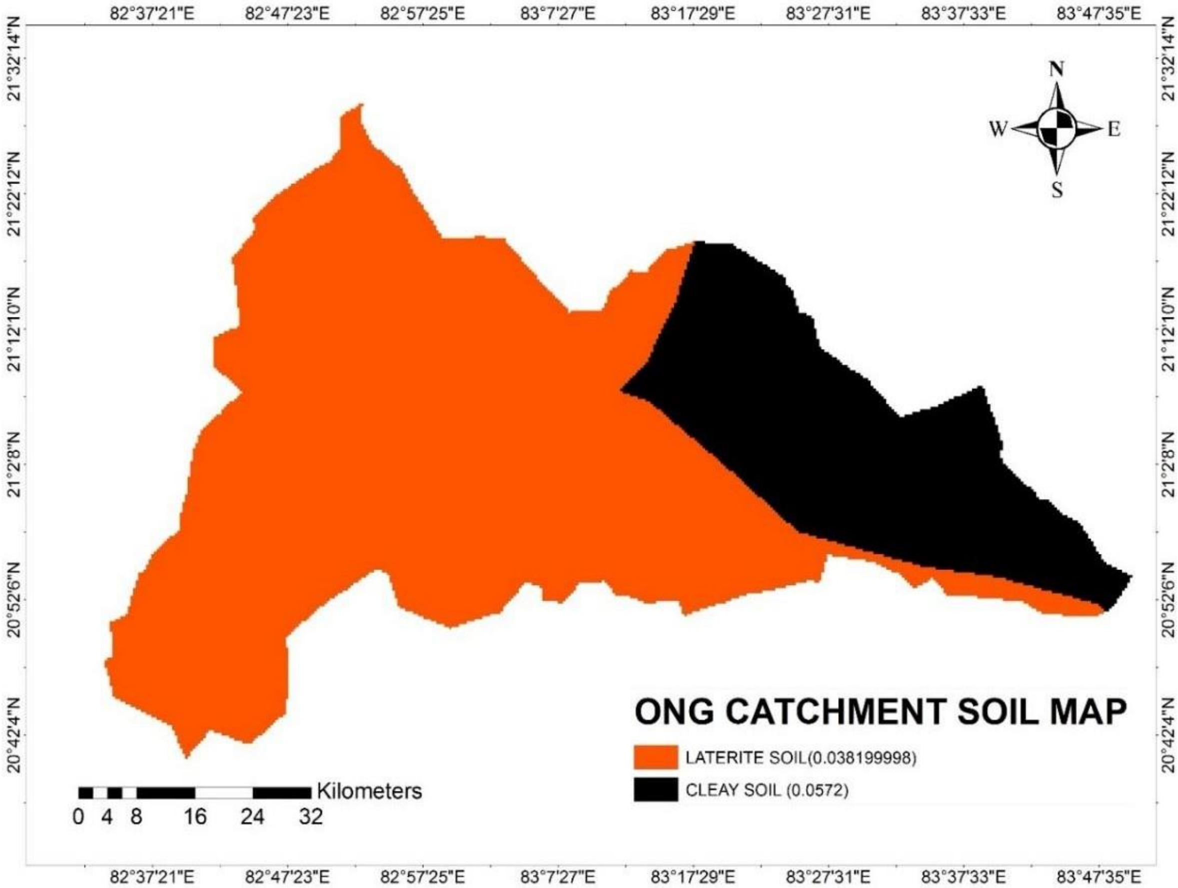


Figure 13 Soil Erosibility map for Ong Catchment

4.1.3 Slope Length and Slope Steepness Factor (LS):

After effect for geology on disintegration represented as the LS – factor of USLE, and joins impacts for an incline length factor, ‘L’ and slant steepness factor, ‘S’. Realized that expansion of slant length ‘L’, brings about increment to disintegration of soil per unit territory because of expanding in collection of surface overflow down slope heading. With expansion of ‘S’, speed and disintegration of soil spillover additionally increments. Slope length (L) is characterized as the length which is being additionally measured be proportion of the soil misfortune from the slant length from the field to soil loss from a 22.3m long plot under indistinguishable conditions.

Figure 14 represents slope based on percent rise inferred from flow direction toolbar of

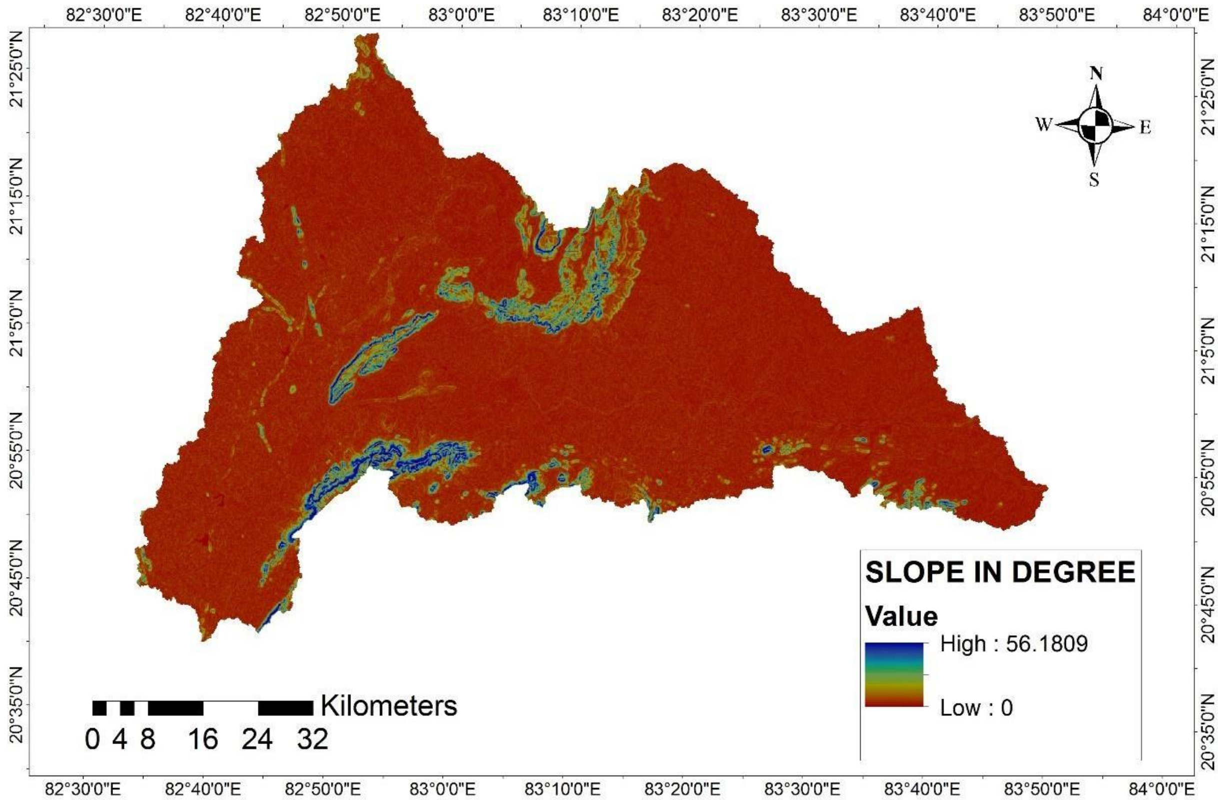


Figure 14 Slope Map for ONG Catchment

hydrology, in Spatial Analyst Toolbox of ArcGIS for count of slope from DEM of Ong Catchment. Accompanying technique to ascertain the L-S factor:

1. Download the DEM of the zone of catchment from Catrosat1, Bhuvan, ISRO.
2. Precised region of catchment is to be removed in the collected data through Ong shape file.
3. Incline degree is determined utilizing surface apparatus of arcGIS of spatial examination.
4. By utilizing hydrology tool compartment of arcGIS under spatial expert segment, flow bearing and stream gathering is done.
5. Then, LS is found through utilizing articulation in raster number cruncher under guide variable based math in spatial expert tool kit.
6. The last LS figure is found by separating previous LS figure with 100.
7. Range of the slope to be found: 0 – 90.

Here, Figure 15 Represent stream gathering of Ong catchment. It was registered from stream course raster picture by utilizing stream heading tool arcGIS investigator tool kit. Dark shading of picture signifies no stream amassing and the while high stream aggregation.

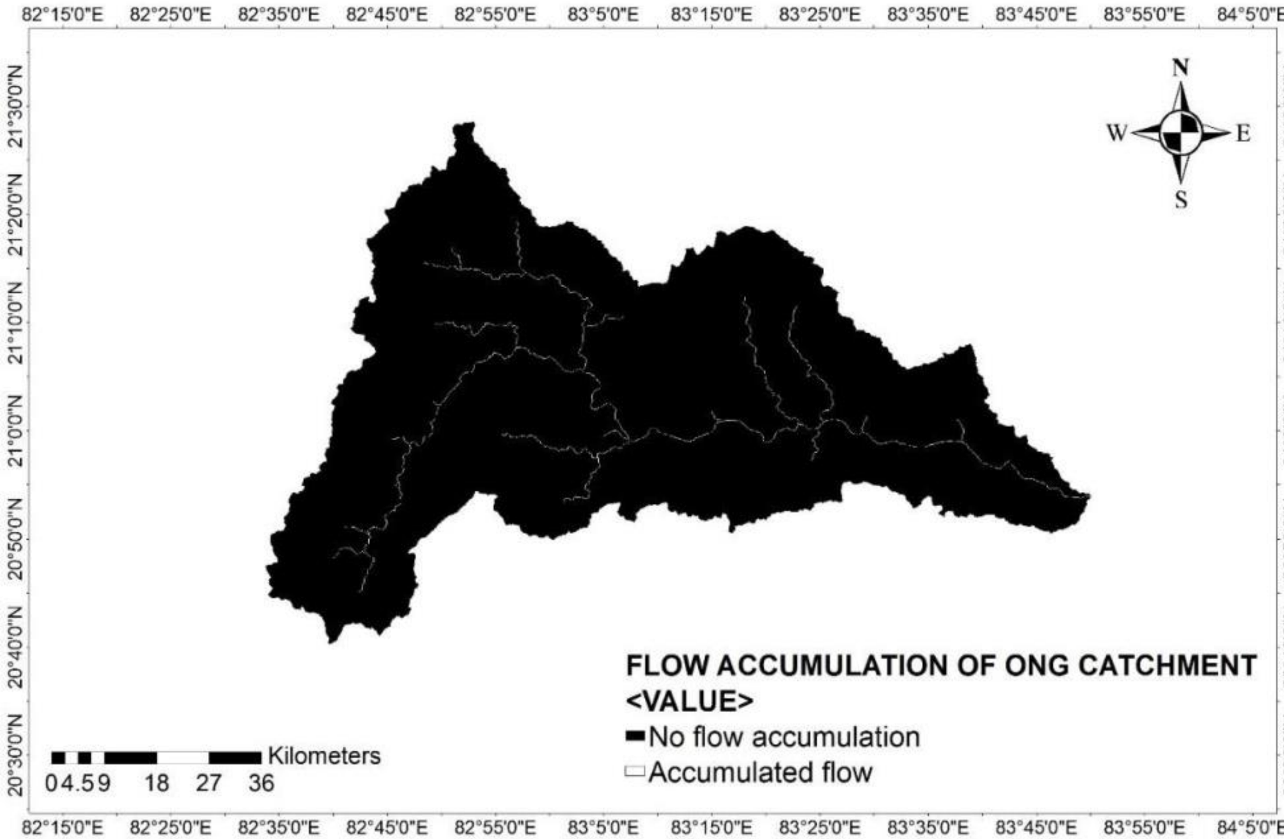


Figure 15 Flow Accumulation diagram of ONG catchment

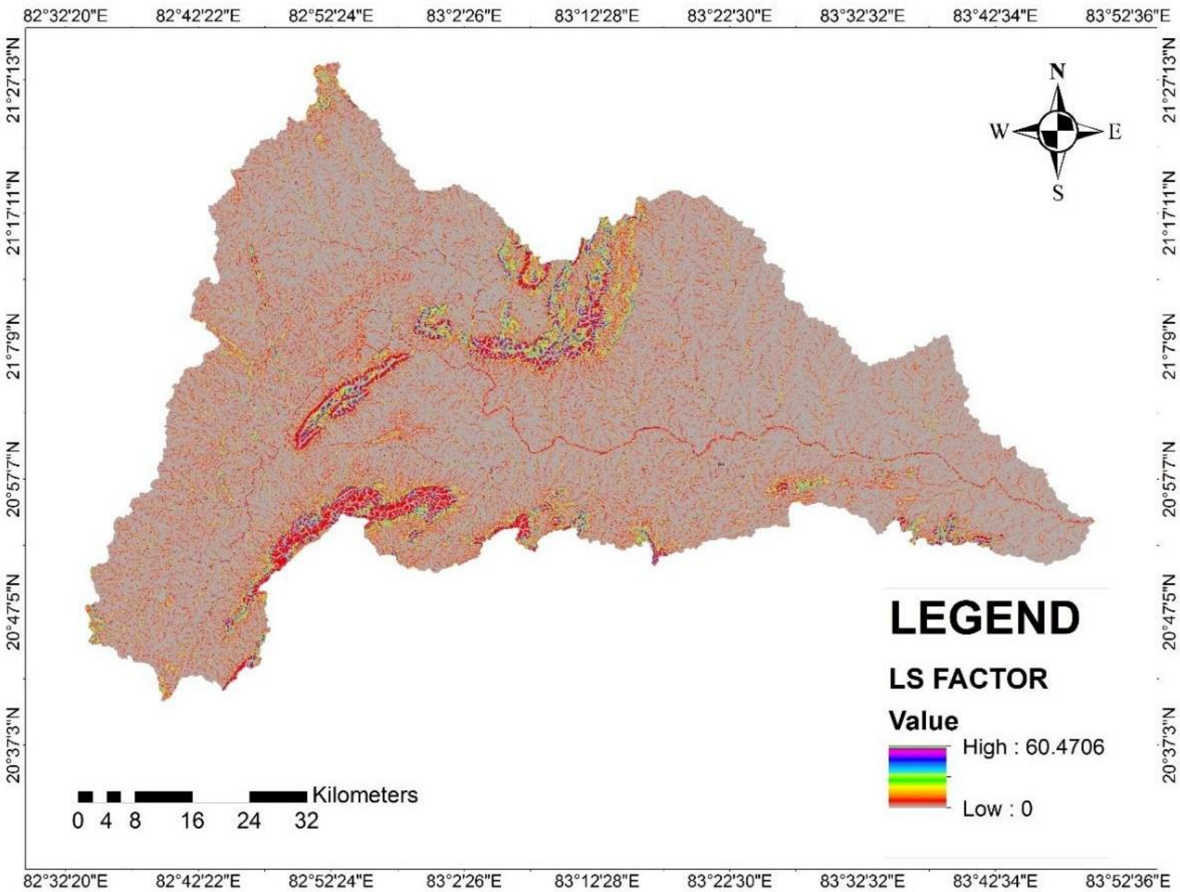


Figure 16 LS Factor Map of Ong Catchment

Results of LS values are represented in Figure 16 ranging from minimum 0 and maximum of 60.4708 for Ong catchment.

4.1.4 Cover Management Factor 'C'

'C' Factor represents impact over cultivation, editing the board rehearses on disintegration rates characterized as proportion loss in specific location with predefined spread compared to standard unit.

Amount in defensive front to yields or cultivation for surfaces of land impacts dirt disintegration value. 'C' is 1, when surfaces of land consistent exposed decrepit with 0 vegetation inclusion lower, when there is >0, yield spread bringing about lower measure of soil disintegration. For thick and develop woods, the C value 0.001, no need to worry.

Steps to ascertain ‘C’:

1. 3 groups from AWiFs Advanced wide field sensor (Source: Bhuvan) changed over to composite band utilizing picture investigation apparatus.

2. The raster picture was separated by cover from the composite picture.

3. Then, test shading for each record was gotten by utilizing picture grouping instrument. Comparative shading test document was consolidated and names were appointed to various example record and a mark document was made.

4. Supervised picture order was completed utilizing most extreme probability arrangement in picture characterization instrument.

5. Then the ordered raster picture was changed over into polygon document.

6. Then the characteristics having same network code was blended utilizing proofreader device. In the wake of combining all the polygons having same network code esteems relegated through lattice codes. Determination of border region is done from the obtained polygons.

7. The polygon document was again changed over into raster picture on basis of obtained parameters estimation of C factor ranging (- 1 to 1).

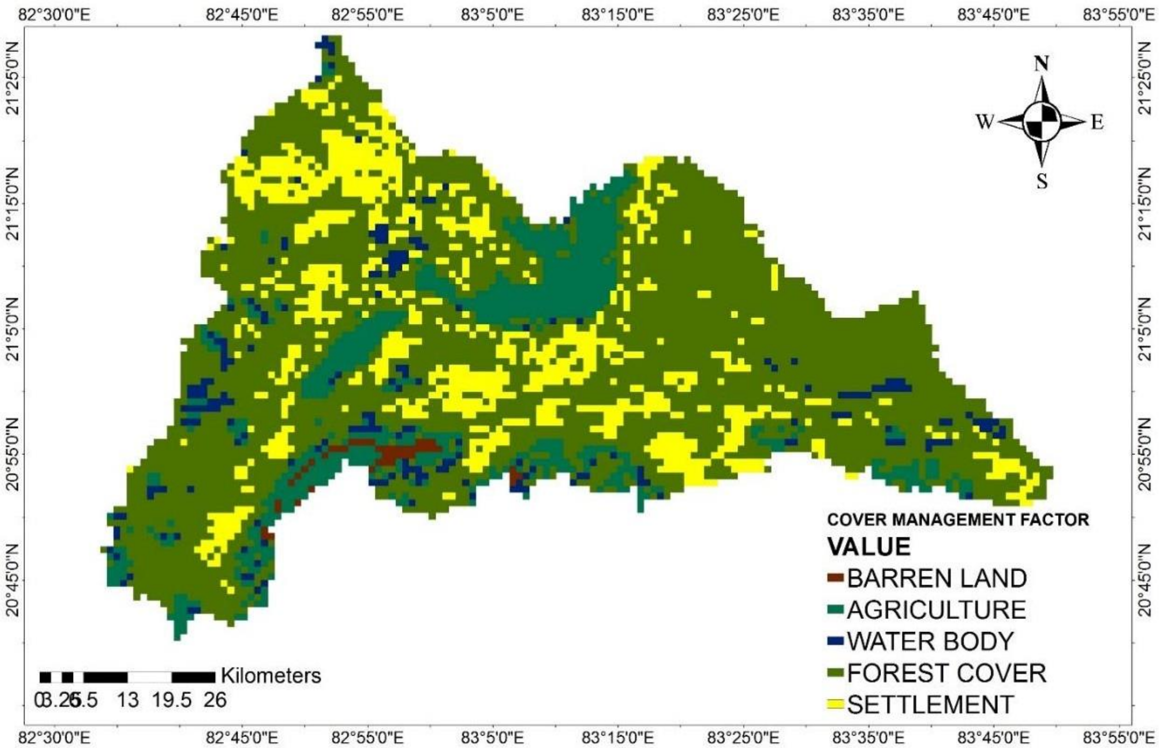


Figure 17 Cover Management Map of ONG Catchment

Figure 17 speaks to the land spread guide of Ong catchment, Mahanadi basin. Administered arrangement is completed by recognizing zones with barren land, agriculture, water body, forest cover, settlement. Source: (Jain et. al.2009), Table 9.

Table 9 Cover management Factor values

Type of land cover	Cover management factor values
Barren land	0.65
Agriculture	0.40
Water body	1
Forest cover	0.03
Settlement	0.80

4.1.5 Support Practice Factor (P)

'P' represents proportion of soil misfortune as a particular help relating soil misfortune with upside slope and downside slope culturing, basically impacts disintegration through changing stream examples, bearing of surface spillover diminish the sum and pace to overflow. 'P', for the cultivable grounds: forming, strip-trimming, terracing, and subsurface waste. While dry land territory, help practice factors being soil upsetting practices to result stockpiling of dampness with decrease in overflow.

'P', range (0 – 1), is proportionate to 1 if land is straightforwardly developed at incline, under 1 if embraced preservation practice decreases disintegration. Terracing and molding are normal being successful help rehearses at level of fields impacts of terracing reflected in the slope incline length and angle, since decreases slope slant length. Molding alters stream course causing spillover streaming of the slope slant instead of legitimately down- slope.

Accompanying method in finding the 'P' factor:

1. Download the DEM of the region from CATROSAT 1, Bhuvan, ISRO.
2. Precisely, catchment region which is desired is removed from downloaded Elevation Map by utilizing Ong shape document.
3. Rate incline is determined utilizing surface tool.
4. When renaming of incline map is done and same as of raster picture, it gets changed to polygon record. At the property table, in the arcGIS, code are blended. In the wake of combining all of the similar polygons with same framework.
5. The Raster image of the region is obtained on the basis of polygon record changed into raster.

CHAPTER 5

RESULTS AND DISCUSSION

5.1 INTRODUCTION

The parameters of Universal Soil Loss Equation have been found out in previous chapter. Here, all those parameters are used to calculate yearly average soil loss rate 'A' of Ong Catchment. From the Raster Images obtained, the areas prone to maximum erosion are identified and recognized with the help of their coordinates.

These are the following parameters of USLE:

1. Rainfall – Runoff Erosivity factor 'R'
2. Soil Erodibility Factor 'K'
3. Slope – Length and Slope Steepness Factor 'LS'
4. Cover Management Factor 'C'
5. Support Practice Factor 'P'

Estimation of Annual Average Soil Loss Rate (2006)

Values used mentioned as:

1. Rainfall Runoff Erosivity factor 'R':	420.99 ~ 1179.32mm
2. Soil Erodibility factor 'K':	0.037 ~ 0.054
3. Slope length factor & Slope Steepness Factor 'LS':	0 ~ 60.470
4. Cover Management Factor 'C':	0 ~ 1
5. Support Practice Factor 'P':	1.0

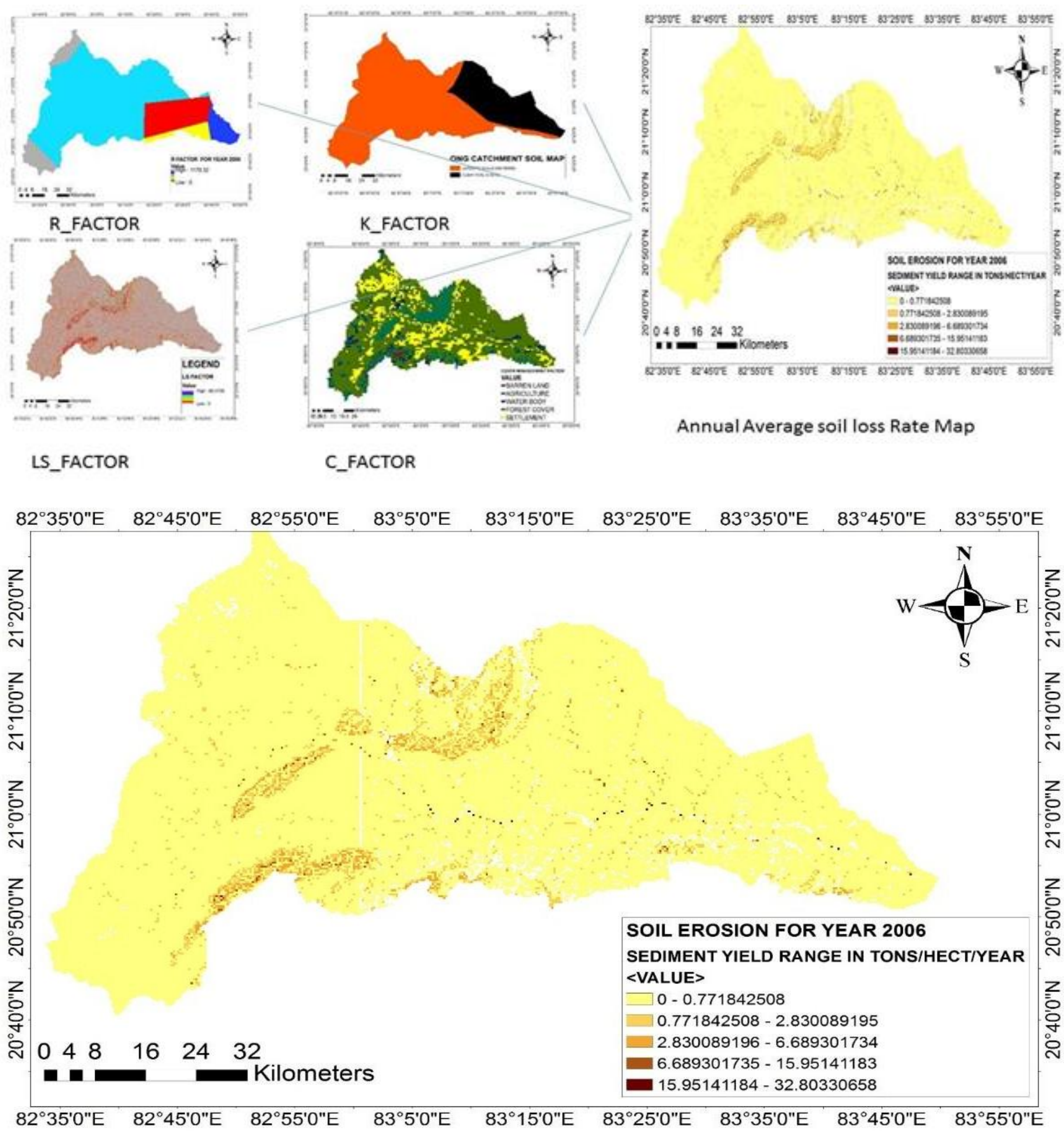


Figure 18 Representation of multiplication of all parameters of USLE to get Sediment Yield, year 2006.

Multiplication of the four parameters to get the annual average soil loss rate is shown in Figure 18. The raster images of the parameters obtained are multiplied using the raster calculator tool of arcGIS. For the year 2006, maximum value of the sediment yield obtained is 32.80 tons/ha/yr. The coordinates obtained for the regions with highest value of soil erosion are represented in Table 10. Coordinates are obtained through arcGIS identification tool and further identified by name using latlong.net website to know the name and respective district of coordinates.

Table 10 Maximum Erosion Prone areas of the Catchment in 2006

Latitude	Longitude	Erosion prone Area	Districts
20° 54' 8.9064" N	83° 47' 23.766" E	Mayurudan	Sonepur
20° 54' 26.0388" N	83° 39' 30.492" E	Loisinga	Balangir
21° 14' 40.2756" N	82° 56' 47.0976" E	Mundpadar	Sonepur
21° 3' 27.8424" N	82° 45' 47.5128" E	Jharbandha	Bargarh
20° 51' 10.44" N	82° 44' 35.736" E	Cherangaihain	Bargarh

Estimation of Annual Average Soil Loss Rate (2007)

Values used mentioned as:

1. Rainfall Runoff Erosivity Factor ‘R’: 532.18 ~ 915.22mm
2. Soil Erodibility Factor ‘K’: 0.037 ~ 0.054
3. Slope Length Factor & Slope Steepness Factor ‘LS’: 0 ~ 60.470
4. Cover Management Factor ‘C’: 0 ~ 1
5. Support Practice Factor ‘P’: 1.0

Multiplication of the four parameters to get the annual average soil loss rate is shown in Figure 19. The raster images of the parameters obtained are multiplied using the raster calculator tool of arcGIS. For the year 2007, maximum value of the sediment yield obtained is 25.82 tons/ha/yr.

Net Sediment Yield is 7710.86 tons/yr obtained by adding all pixel values while the value at the IndiaWris, comes to be 6554.23 tons/yr. 17.6% is the error obtained in the observed and calculated value.

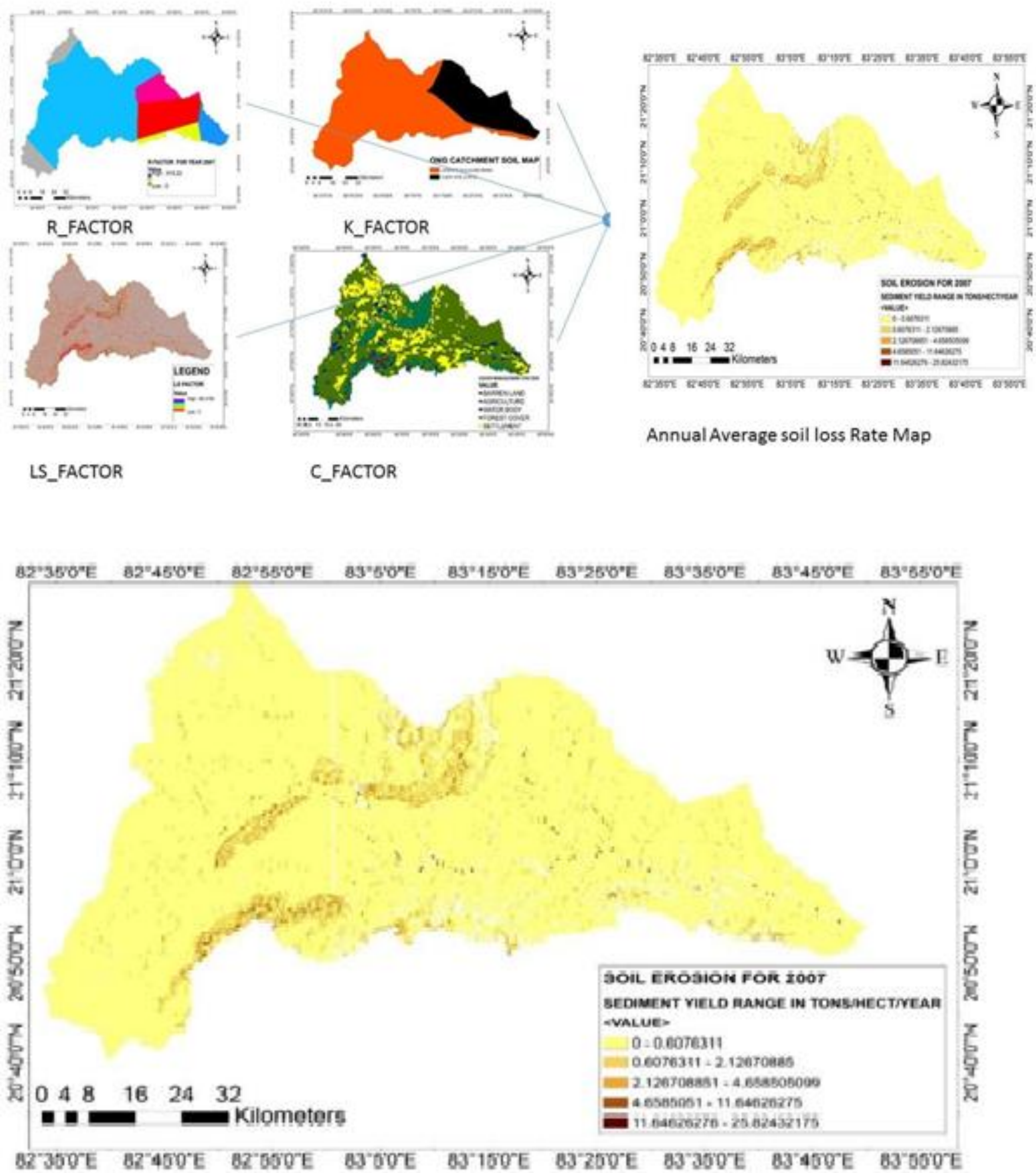


Figure 19 Representation of multiplication of all the parameters of USLE to getSediment Yield, year 2007.

The coordinates obtained for the regions with highest value of soil erosion are represented in Table 11 for the year 2007. Coordinates are obtained through arcGIS identification tool and further identified by name using latlong.net website to know the name and respective district of coordinates.

Table 11 Maximum erosion prone areas of the catchment in 2007

Latitude	Longitude	Erosion prone Area	Districts
20° 54' 10.548" N	83° 47' 23.5536" E	Mayurudan	Sonepur
21° 4' 53.94" N	83° 24' 53.5428" E	Balangir	Balangir
20° 51' 55.2024" N	82° 49' 0.0336" E	Chhetgaon	Bargarh
20° 43' 42.6036" N	82° 46' 6.9996" E	Baddakala	Balangir

Estimation of Annual Average Soil Loss Rate (2008)

Values used mentioned as:

1. Rainfall Runoff Erosivity Factor 'R': 496.84 ~ 940.3mm
2. Soil Erodibility Factor 'K': 0.037 ~ 0.054
3. Slope Length Factor & Slope Steepness Factor 'LS': 0 ~ 60.470
4. Cover Management Factor 'C': 0 ~ 1
5. Support Practice Factor 'P': 1.0

Multiplication of the four parameters to get the annual average soil loss rate is shown in Figure 20. The raster images of the parameters obtained are multiplied using the raster calculator tool of arcGIS. For the year 2008, maximum value of the sediment yield obtained is 26.15 tons/ha/yr. Net Sediment Yield is 7291.44 tons/yr obtained by adding all pixel values while the value at the IndiaWrs is 5468.58 ton/yr. 33.3% is the error obtained in the observed and calculated value.

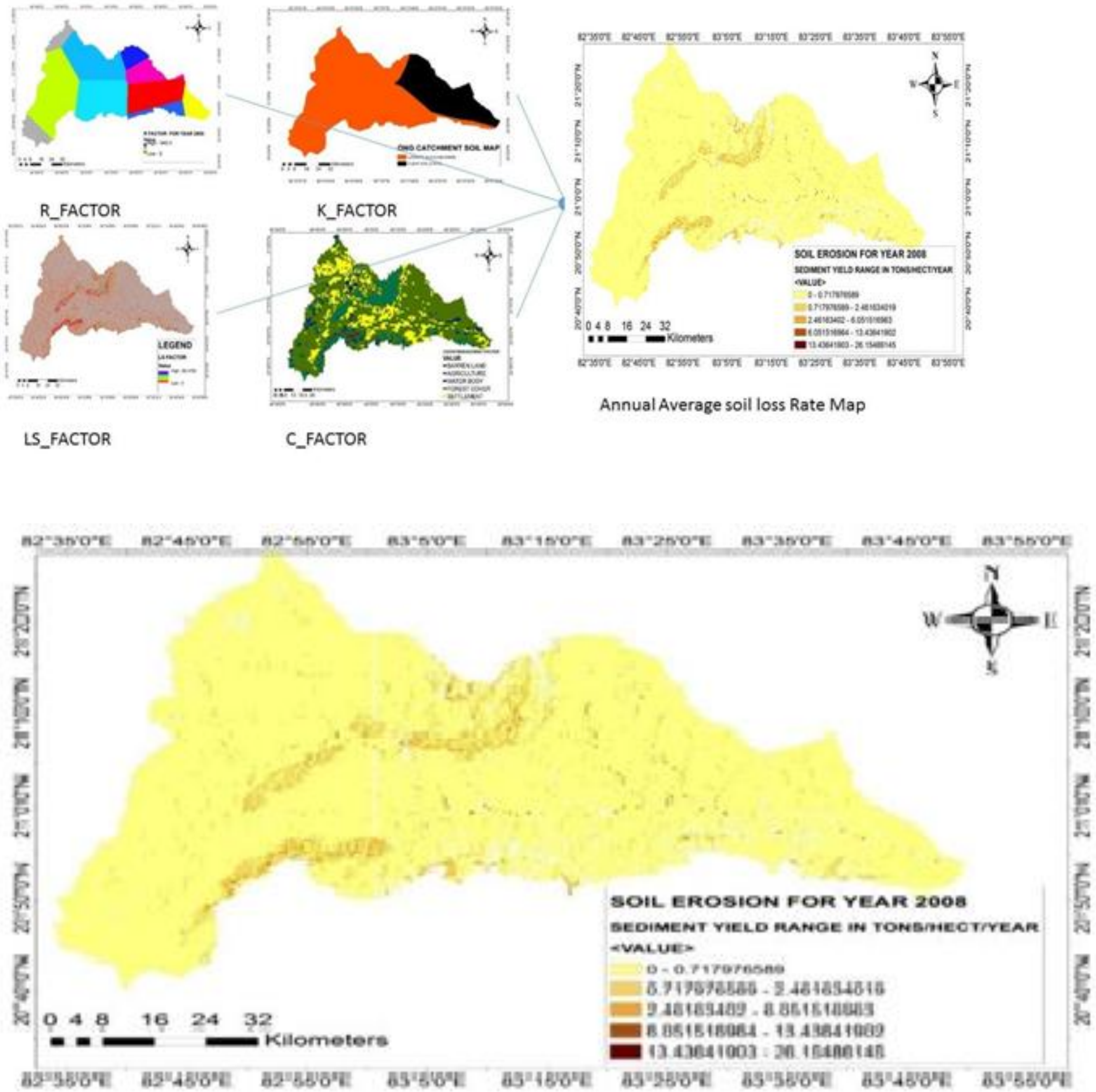


Figure 20 Representation of multiplication of all factors of USLE to get Sediment Yield, year 2008.

The coordinates obtained for the regions with highest value of soil erosion in year 2008 are represented in Table 12. Coordinates are obtained through arcGIS identification tool and further identified by name using latlong.net website to know the name and respective district of coordinates.

Table 12 Maximum erosion prone areas of the Catchment in 2008.

Latitude	Longitude	Erosion prone Area	Districts
21° 2' 49.65" N	82° 50' 8.5632" E	Turla	Bargarh
20° 59' 18.9276" N	83° 8' 37.0104" E	Kansar	Bargarh
21° 6' 11.8116" N	83° 9' 12.9888" E	Gyan	Bargarh
21° 16' 47.4132" N	83° 15' 28.17" E	Jhar	Bargarh
20° 52' 27.7536" N	83° 39' 44.4132" E	Badimunda	Balangir

Estimation of Annual Average Soil Loss Rate (2009)

Values used mentioned as:

1. Rainfall Runoff Erosivity Factor ‘R’: 496.84 ~ 940.30mm
2. Soil Erodibility Factor ‘K’: 0.037 ~ 0.054
3. Slope Length Factor & Slope Steepness Factor ‘LS’: 0 ~ 60.47
4. Cover Management Factor ‘C’: 0 ~ 1
5. Support Practice Factor ‘P’: 1

Multiplication of the four parameters to get the annual average soil loss rate is shown in Figure 21. The raster images of the parameters obtained are multiplied using the raster calculator tool of arcGIS. For the year 2009, maximum value of the sediment yield obtained is 23.67 tons/ha/yr. Net Sediment Yield is 6382.75 tons/yr obtained by adding all pixel values while the value obtained from the India-Wris is 4828.96 tons/yr. 26.97% is the error obtained in the observed and calculated value.

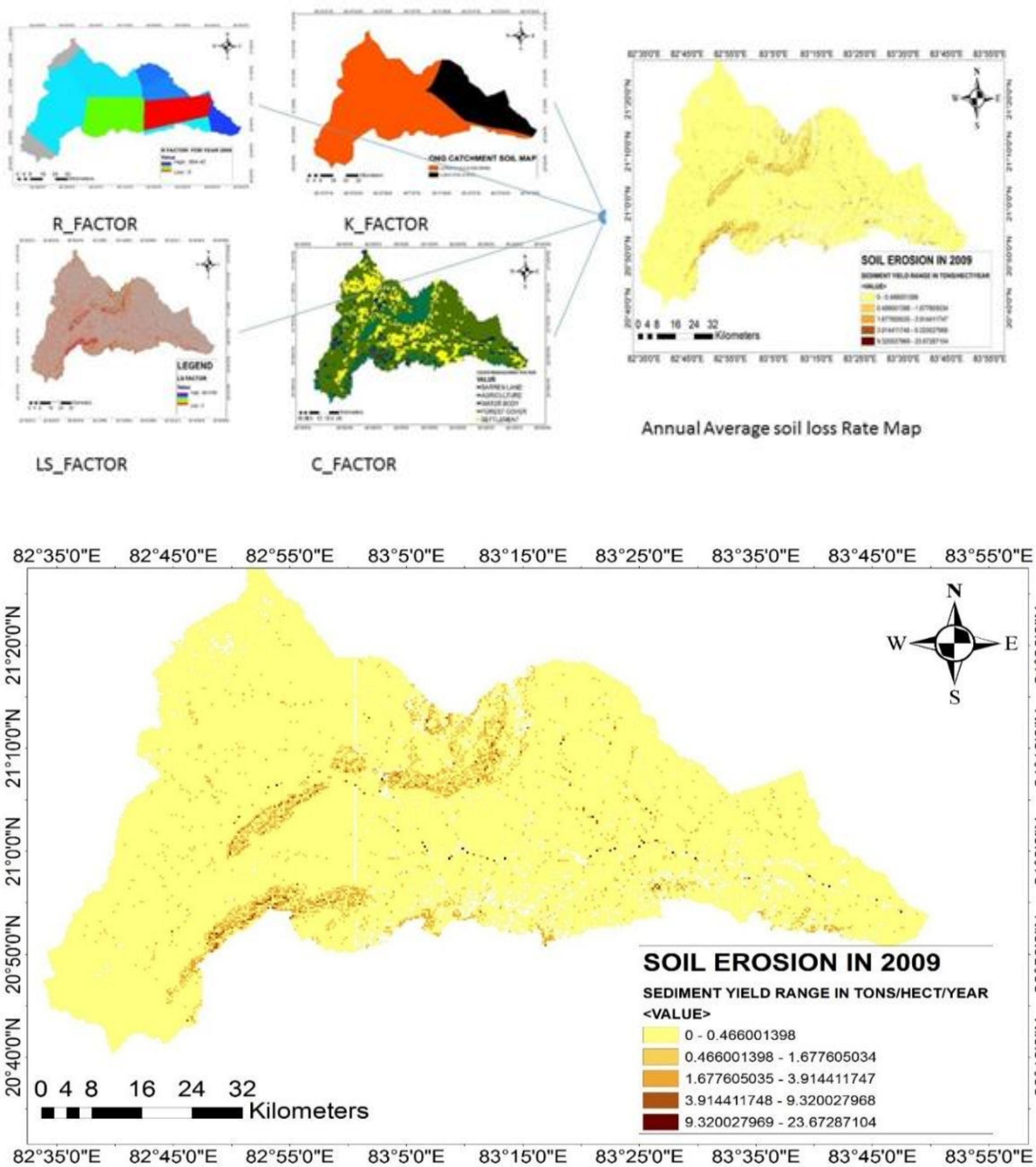


Figure 21 Representation of multiplication of parameters of USLE to get Sediment Yield, year 2009.

The coordinates obtained for the regions with highest value of soil erosion in year 2008 are represented in Table 13. Coordinates are obtained through arcGIS identification tool and further identified by name using latlong.net website to know the name and respective district of coordinates.

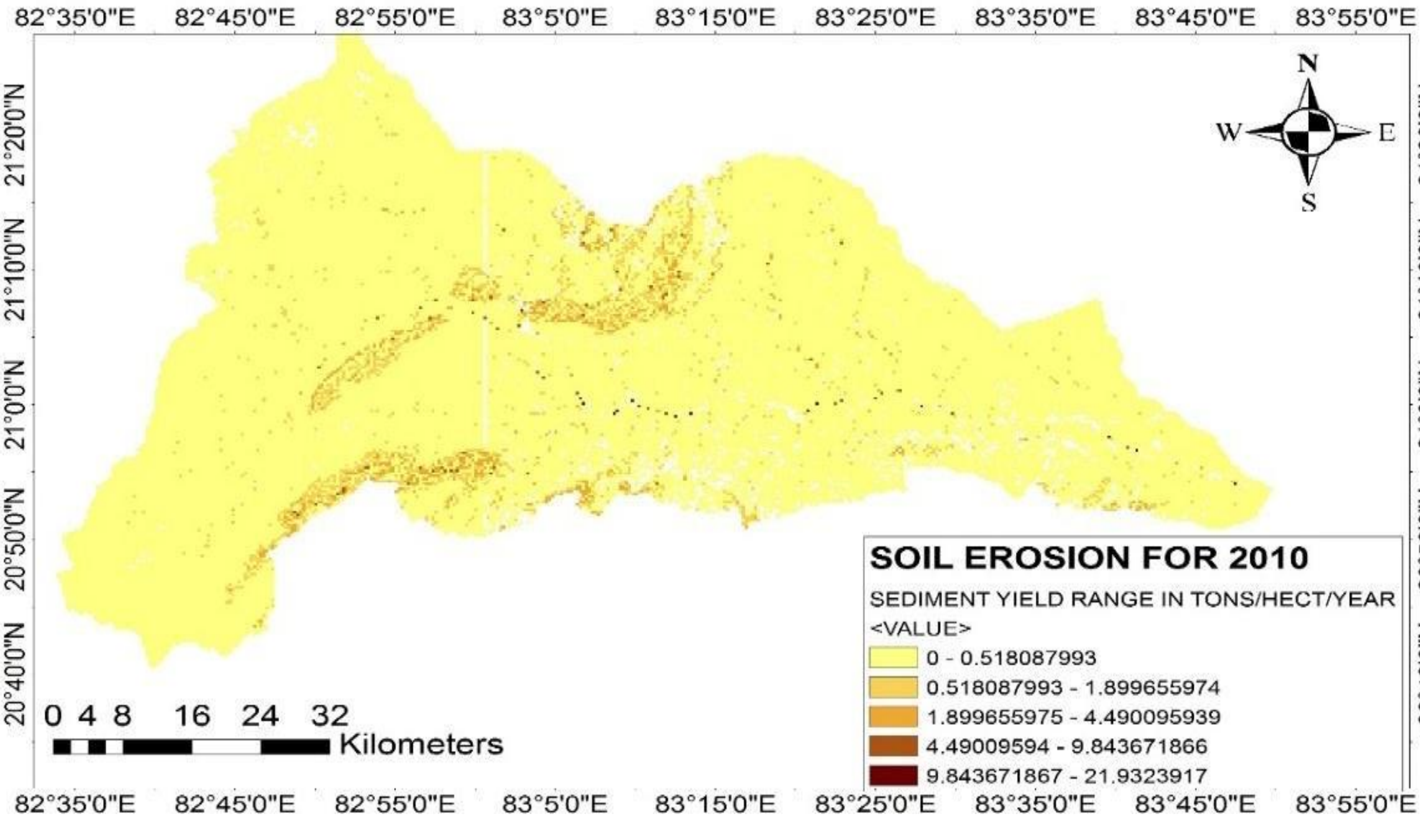
Table 13 Maximum Erosion Prone Area of the Catchment in 2009.

Latitude	Longitude	Erosion prone area	Districts
20° 48' 44.1" N	82° 42' 53.9064" E	Makhanamunda	Bargarh
20° 46' 15.9096" N	82° 44' 47.7204" E	Temrimal	Bargarh
21° 6' 32.0256" N	82° 57' 33.6564" E	Padamapur	Bargarh
20° 55' 24.2148" N	83° 45' 15.0624" E	Kudopali	Bargarh
21° 14' 9.7944" N	83° 7' 6.2112" E	Beheramala	Sonepur

Estimation of Annual Average Soil Loss Rate (2010)

Values used mentioned as:

1. Rainfall Runoff Erosivity Factor ‘R’: 321.66 ~ 508mm
2. Soil Erodibility Factor ‘K’: 0.037 ~ 0.054
3. Slope Length Factor & Slope Steepness Factor ‘LS’: 0 ~ 60.47
4. Cover Management Factor ‘C’: 0 ~ 1
5. Support Practice Factor ‘P’: 1



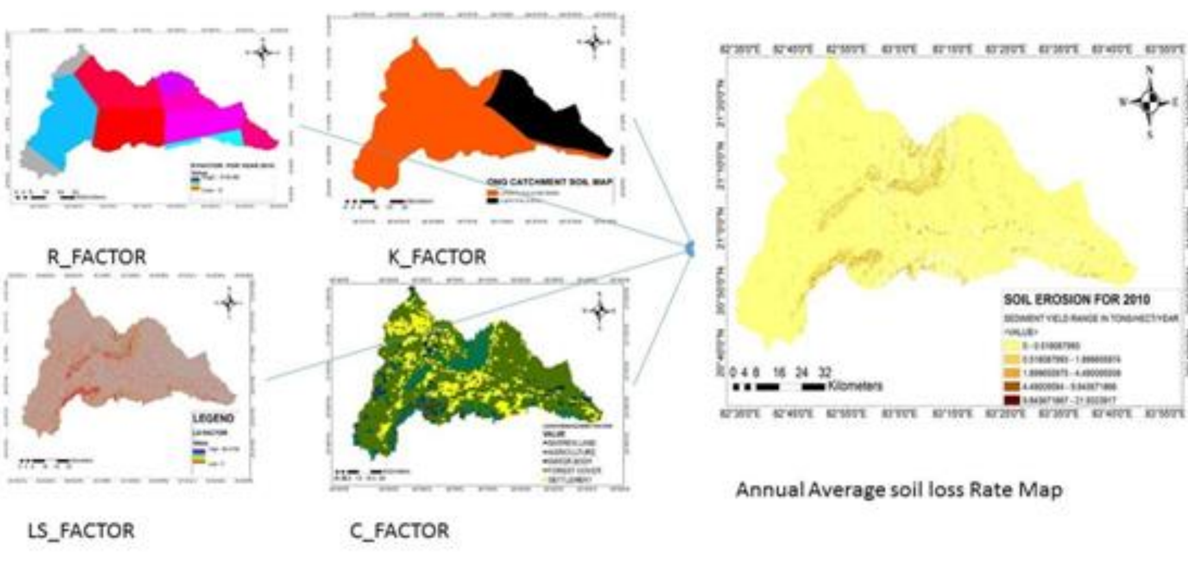


Figure 22 Representation of multiplication of all the parameters of USLE to get Sediment Yield, year 2010.

Multiplication of the four parameters to get the annual average soil loss rate is shown in Figure 22. The raster images of the parameters obtained are multiplied using the raster calculator tool of arcGIS. For the year 2010, maximum value of the sediment yield obtained is 21.93 tons/ha/yr. Net Sediment Yield is 5510.30 tons/yr obtained by adding all pixel values while the value at the IndiaWris is 4629.29 ton/yr. 19.02% is the error obtained in the observed and calculated value.

The coordinates obtained for the regions with highest value of soil erosion in year 2008 are represented in Table 14. Coordinates are obtained through arcGIS identification tool and further identified by name using latlong.net website to know the name and respective district of coordinates.

Table 14 Maximum Erosion Prone areas of the Catchment in 2010.

Latitude	Longitude	Erosion Prone Area	Districts
21° 6' 50.508" N	83° 4' 17.0616" E	Saraikela	Bargarh
21° 2' 1.824" N	83° 4' 17.0616" E	Binka	Subarnapur
20° 57' 41.0328" N	83° 11' 20.292" E	Semelunda	Bargarh
21° 12' 51.516" N	83° 6' 42.876" E	Sonepur	Sonepur

FINAL RESULT COMPARISON OF ACTUAL AND COMPUTED SEDIMENT YIELD RESULT OF THE ONG CATCHMENT FOR THE YEARS 2006 – 2010.

Table 15 Comparison of Actual and Computed Result of the Catchment for years 2006-2010.

Year	GAUGING STATION	Actual sediment yield (tons/year)	Computed sediment yield (tons/year)	Variation in Actual and computed Sediment Yield (tons/year)	ERROR(%)
2006	Salebhata	7344.82	9067.69	1722.87	23.45
2007	Salebhata	6554.23	7710.86	1156.63	17.64
2008	Salebhata	5468.58	7291.44	1822.86	33.3
2009	Salebhata	4828.96	6382.75	1553.79	32.17
2010	Salebhata	4629.29	5510.25	880.96	19.03

CHAPTER 6
SUMMARY AND CONCLUSION

In Orissa, there climatic and topographic condition increases process to sedimentation and erosion, by water erosion continues being a serious issue. By the study done here, objective primarily is to generate maps and awareness about the maximum prone areas. The information which can be used for future prediction also and preventing of soil erosion as far as possible in Ong catchment.

ArcGIS v.10.3 with USLE model is used for the overall estimation of spatial distribution of soil rate under various land uses of catchment, to generate DEM, which is further used to extract/ delineate different parameters required for estimation.

Conclusions specifically related to the results of the USLE model application at the Ong catchment are summarized below:

1. ‘A’, for Ong Catchmet, found out to be as per the USLE model through arcGIS v.10.3 is 7192.60 ton/year, from 2006 – 2010.
2. Some conclusions can be drawn from the spatial distribution of soil erosion rates of the catchment as around 70% of the average annual soil rates are in the tolerable range of soil loss (0.5 tons/acre/year). Whereas, eastern part of basin is less prone to erosion as compared to western part.
3. The maximum variation b/w the observed and computed value of ‘A’ is lesser than (< 34%) and the erosion prone areas are identified and mentioned.
4. Laterite soil and Clayey soil are the major soil types of the Ong catchment, Orissa.

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