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Research Paper

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Impact of Land Use and Land Cover changes on Land Degradation in Agar Watershed (Maniyari Basin), Chhattisgarh

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Abstract — Land degradation is one of a hazardous agricultural problem which enormously effect on food grain production as well as soil quality. It caused significant economic damage and posed harm to the environment. The loss of soil and nutrients costs the nation over $200 million per year. The one and only significant type of land degradation that has long been a hindrance to the nation's economy and people's well-being is soil degradation. Only from the country's highlands do soil erosion and nutrient depletion cause significant economic losses, amounting to 10%–11% of agricultural GNP. The country's average annual rate of soil erosion is 16.35 tons per hectare or 5334 million tons annually, which varied according to the relief, land use land cover, slope, rainfall etc. Across the nation, changes in land usage and land cover as well as degradation are happening alarmingly quickly. This increased rate of soil erosion in Chhattisgarh was significantly influenced by the change in land use types. Agricultural land exhibited a steadily rising tendency, displacing grasslands and forests. A incredibly high rate of soil erosion and a decrease in the amount of arable land are both results of the country's population growth. This study article's goal is to examine how modifications in landuse Landcover have affected land degradation across Maniyari basin.

Keywords — Land Degradation, Soil Erosion, Landuse Landcover, Geographical Information System

I. INTRODUCTION

Globally, land is being degraded quickly. Healthy land resources and thriving ecosystems are required to provide food security for a growing global population. But because of the way we now farm, soils are eroding up to 100 times quicker than they are being replenished by natural processes.

Landuse Landcover change (LULC) is affected by human activities and natural modification of the land surface [10, 16, 15]. The natural ecosystem is being severely impacted by the growth of cultivated area at the expense of native plants. [13] This ongoing growth of cultivated land is a significant contributor to land degradation, which poses a larger risk to soil fertility. Several studies have estimated how much LULC has affected global soil resources in general and Ethiopian soil resources in particular. [2, 3, 11] Recent studies in Ethiopia's Blue Nile valley and central highlands have found that agricultural land is expanding into wooded areas, which is the main driver of environmental change and degradation that will probably have an impact in the future. [1, 6, 15] One of the main causes of LULC changes, according to studies conducted in several areas of the Blue Nile basin, is population density, which has also increased the risk of erosion. [9].The natural environment is changing due to a number of persistent and intricate causes that are fueled by socioeconomic, political, and regime changes. [9, 10] When it comes to land uses, the effects of climate change and variability are seen over a long period of time, but when it comes to soil loss, the effects of human land alteration are realized much more quickly. [13]

II. STUDY AREA

The Maniyari River basin is a part of Shivnath catchment (Part of Mahanadi). The river maniyari rises from Satpura Maikal range situated in central plateau. So, the Maniyari River flows through all the three ideal stages of life cycle like hilly, Pleatue and plain. The study area covered three districts namely Kabirdham, Mungeli and Bilaspur. Summer temperatures peak at 43º C, with a mild winter temperature of 11ºC. And the average annual rainfall is 1128.34 mm, which is less than the 1292 mm average rainfall in Chhattisgarh. **Figure 1** depicts the research region.

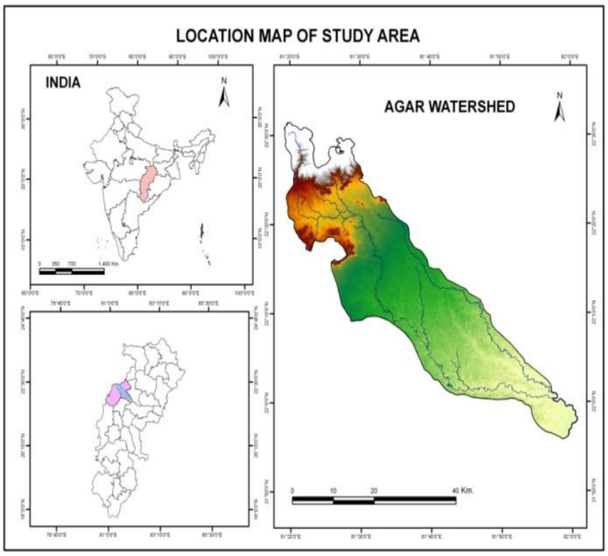

Figure 1: Location map of the study area

III. DATA AND METHODOLOGY

Data base is one of the prime raw materials to finish a work. Both primary and secondary database has been used to prepared Landuse Land cover map and Land Degradation map as well as soil erosion (RUSLE) map has been prepared and to find out the correlation between improper Landuse and Land Degradation. [5] And secondary data like topographical sheet, Sentinal 2 satellite imagery with the resolution of 10 m. and Aster DEM with a resolution with 30 m. has been collected from survey of India and USGS Earth Explorer respectively. All of the primary and secondary data sources are included in Table 1.

The methodology flow chart has been given bellow the Figure 2.

Table 1: Sources of data

Data types	Data sources	Details
Soil Sample	Field Survey	Top soil
Topo sheet	Survey of India	64F-06 to 16, 13 and 16, 64J03 and 04, 64K01
Satellite imageries	NRSC, ISRO	Sentinal 2 (30 m)

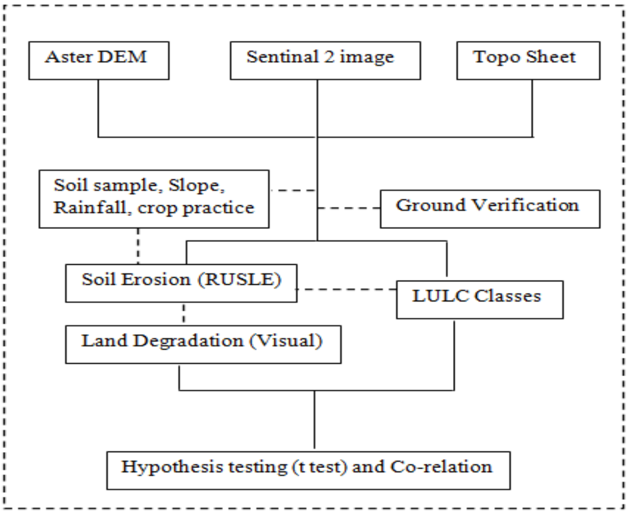

Figure 2: Flow chart Methodology

3.1 SOIL SAMPLING:

Thirty two soil samples has been collected to study the Land degradation as well verified the physical land degradation which has been prepared with the help of Sentinal 2 satellite images and Aster DEM for sheet and Gully erosion. Soil sample has been collected on the basis of Land Physiographic unit as well grid sampling.

There are four physiographic unit has been identified to collected the soil samples with the help of Digital Elevation Model and Topographical Sheet. These are Hilly, Upper plateau, lower plateau and Plain. The soil sample map is shown in Figure 3.

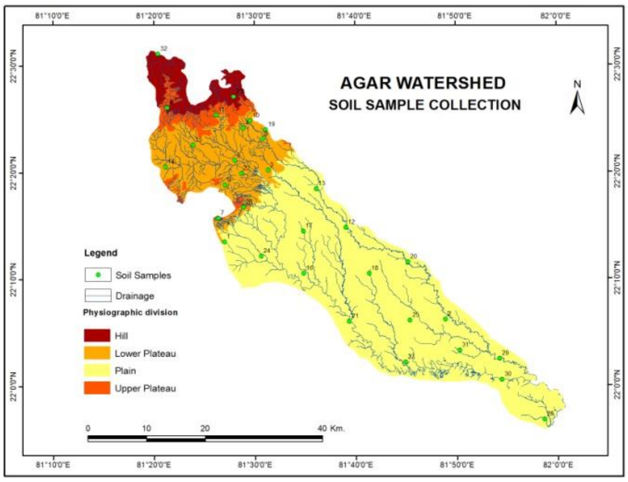

Figure 3: Soil sampling site map

Table 2: Soil sample Analysis Results

Samples	Latitude	Longitude	pH	EC	OC (%)	N (kg/ha)	P(kg/ha)	K (kg/ha)	Depth (Cm)
1	22.22	81.43	7.6	0.26	0.75	125.44	16.12	230.49	45
2	22.10	81.78	7.2	0.15	0.85	137.98	19.71	174.608	41
3	22.33	81.52	7.1	0.2	0.7	158	16.2	138.78	40
4	22.40	81.48	6.8	0.3	0.7	162	17.25	142.56	30
5	22.38	81.51	5.8	0.4	0.8	125.38	18.25	128.21	30

6	22.53	81.60	5.5	0.44	0.4	175.9	19.06	315.1	30
7	22.28	81.48	7.3	0.25	0.03	351	10.75	358	26
8	22.35	81.48	7.3	0.5	0.21	188	8.96	302	33
9	22.41	81.98	7.6	0.76	0.47	175	8.96	425	32
10	22.42	81.50	7.7	0.3	0.31	351	12.03	302	32
11	22.42	81.98	6.8	0.55	0.82	236.2	20.51	281.79	28
12	22.25	81.65	6.9	0.84	0.37	200	9.86	380	48
13	22.31	81.60	6.2	0.34	0.46	225	5.3	313	52
14	22.39	81.51	7.4	0.57	0.4	439	13.75	380	40
15	22.39	81.51	7.2	0.26	0.32	363	10.31	324	41
16	22.20	81.58	7.2	0.46	0.3	376	9.86	481	54
17	22.20	81.58	7	0.5	0.57	238	13.44	504	40
18	22.18	81.69	6.2	0.78	0.53	338	10.75	352	75
19	22.39	81.52	7.3	0.81	0.31	250	6.87	492	25
20	22.19	81.75	7.6	0.61	0.2	225	8.06	369	42
21	22.11	81.66	6.9	0.94	0.32	288	7.17	380	56
22	22.33	81.48	6.7	0.72	0.31	288	15.23	459	29
23	22.45	81.48	7.6	0.8	0.47	175	7.17	257	26
24	22.20	81.50	6.8	0.32	0.22	357	7.17	291	48
25	22.10	81.76	7.5	0.45	0.31	301	9.86	481	56
26	22.28	81.48	7.2	0.79	0.12	476	11.65	459	35
27	22.10	81.76	7.3	0.97	0.18	376	12.54	436	58
28	22.00	81.95	6.7	0.83	0.18	401	13.44	492	60
29	22.04	81.90	6.7	0.62	0.17	144.1	7.15	351	48
30	22.01	81.91	7.53	0.36	0.96	255.3	33.96	318.5	72
31	22.03	81.83	6.6	0.2	1.47	328.4	6.26	86.68	45
32	22.26	81.43	6.5	0.6	0.27	188	8.96	190	24

IV. RESULTS AND DISCUSSION

4.1 LANDUSE LANDCOVER ANALYSIS

Landuse Landcover of the study area has been prepared using remote sensing data such as Sentinal 2 imagery with the help of visual image interpretation techniques (2020) in Arc GIS platform. The classification had done using eight land use land cover classes these are Water body, barren land, Agriculture Land, Scrubland, Forest and Built up land. After classification the classified image has been verified using the Ground truth verification through GPS. To assess the classification accuracy, post classification matrix has been prepared which shows 82 percent of overall accuracy and 80 percent of producer accuracy where as 87 percent of user accuracy. [7]

LULC class wise area and percentage of are shown in below the table. It has been found that 76 % of the area has been covered by agriculture within that 65 % are agriculture without bund.

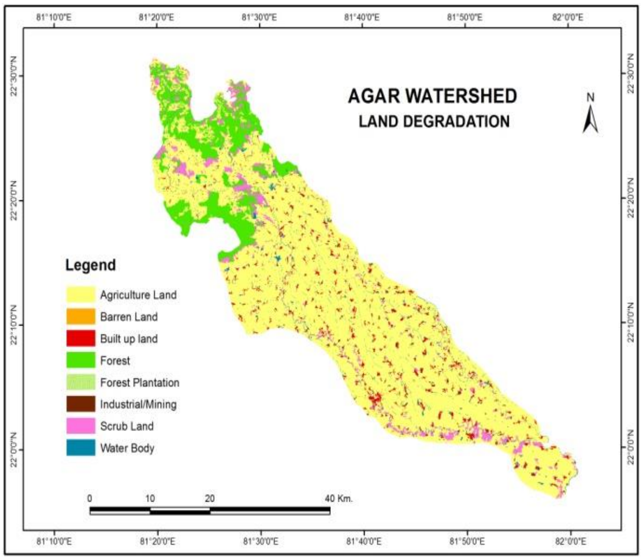

Figure 4: Landuse Land cover map of the study area

Table 3: LULC classes and their area

LULC Classes	Area (Sq km)	Area (%)
Agriculture land	1015.75	76.26
Built up land	44.79	3.36
Forest land	159.98	12.01
Barren land	0.40	0.10
Industrial/Mining	0.72	0.05
Scrub Land	75.93	5.70
Water Body	34.71	2.61

4.2 NORMALIZED DIFFERENCE VEGETATION INDEX (NDVI)

The difference between Red and Near-infrared (NIR) spectral reflection of native vegetation is described by the NDVI, a dimensionless index. NDVI indicates the vegetation cover which can denote the degradation which implies on land. [17] Forest area and core agriculture area has been appeared in high NDVI index where as barren land, scrub land and grassland areas are appeared very low NDVI values. Where the NDVI values are high the land degradation and soil erosion also vary high.

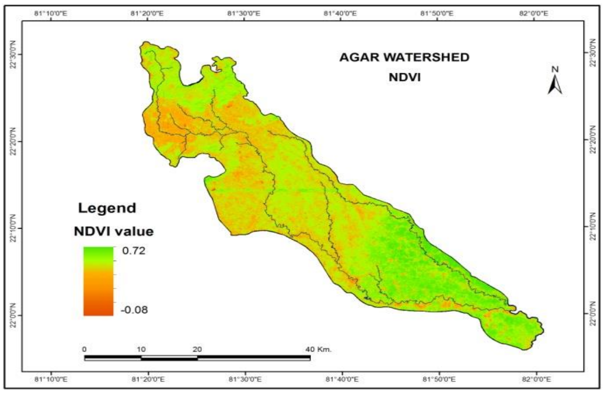

Figure 5: NDVI of the study area

4.3 LAND DEGRADATION SURVEILLANCE

A negative environmental process called land degradation can be increased up by human activity. In this study area some area of agricultural without bund or management practice also affected by sheet erosion and scrub land, barren land are affected by land degradation or soil erosion. Visual land degradation has been prepared on the basis of satellite imagery and field observation. Soil erosion has been prepared on the basis of RUSLE model.

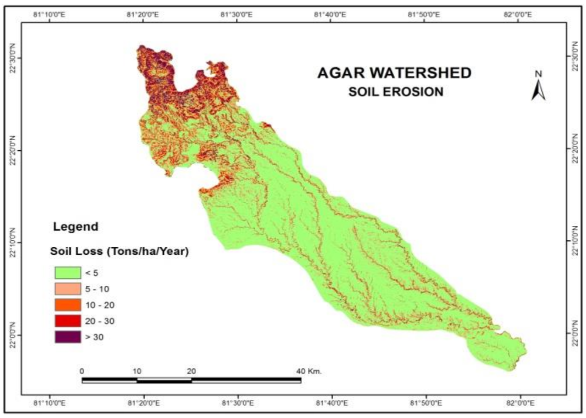

Figure 6: Soil Erosion of the study area

United state Department of Agriculture (USDA) revised Soil Loss Erosion Model (RUSLE), which is used to indicate the soil loss using various aspect of land.

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

A = average annual soil loss per unit area,
R = Factor of rainfall erosivity
K =Factor of soil erodibility
L = Factor of slope length
S = Factor of slope steepness
C = cover and management factor
P = = Factor of support and conservation practices

So here C and P (which can access from Land use Land cover) are one of the major factors to determine the soil erosion.

When the soil's chemical or physical composition has been negatively changed, soil degradation occurs. Acidification, salinization, organic matter loss, compaction, nutrient depletion, structural deterioration, topsoil loss, gully erosion, and chemical contamination are a few examples of soil degradation. Loss of topsoil with low Organic carbon (OC), Nitrogen (N) nutrient depletion, sheet and gully erosion are the most prevalent types of soil degradation found in Agar watershed.

The topsoil quality of plateau and hilly area of the watershed are already deficient in Nitrogen due to parent material but also due to land degradation and soil erosion the nutrient and organic carbon also bifurcated and annihilate to the downward.

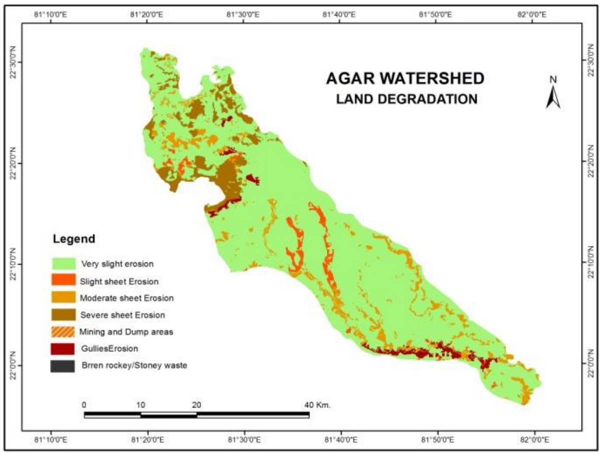

Figure 7: Visual Land degradation map

LULC classes wise weightage value assigned according to the cover and management factor and support and conservation practices factor shown in table 3.

Table 3: LULC wise assign weightage value for potential land degradation

Land Uses	LULC weightages	Land Degradation (tons/ha/year)
Agriculture with bund	**0.18**	**4**

Barren Land	**0.5**	**25**
Built up land	**0.03**	**1**
Forest	**0.01**	**2**
Forest scrub	0.016	1
Mining	1	40
Scrub Land	0.014	7
Agriculture without bund	0.4	15
Total	2.15	95
mean	0.2687	11.875
SD	0.3517	14.106
t test	2.3265	
Df	14	
P value	0.05 (95%)	

T hypothesis testing is done with the help of two variable LULC and Land Degradation. Calculated t value (-2.3265) more than the table value (2.15), so there is a level of significance has been found between improper land uses and Land Degradation.

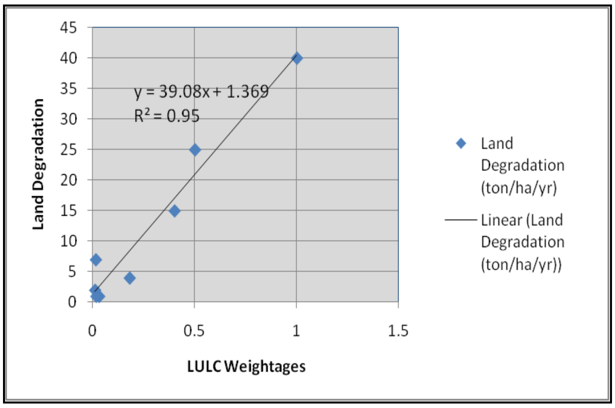

Figure 8: Relationship between LULC and Land Degradation

There is a positive co relation has been observed between improper land use and land degradation, where the weightage value (0-1) based on factor C and D is high also the land degradation value (Ton/ha/Year) is also is high.

V. CONCLUSION

Since land degradation isn't a static process, it requires strategies that can take into account its spatial and temporal changes. [12] Since land degradation affects the quality of the soil and water, public health, and biodiversity, it cannot be addressed as a standalone issue. A crucial factor in promoting a sustainable land management system is a better understanding of the mechanisms underlying LULCCs. Monitoring LULCCs at a regional level in this context is extremely important for identifying regions that are threatened by land degradation and where mitigation measures should be implemented. [4] In this present study some types of land uses which highly influences the land degradation as well as soil quality such as unsuitable crop practice and scrub land mining dump, agriculture without bund should necessary for monitoring and management.

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CONFLICT OF INTEREST

The authors declare no competing interests.

REFERENCES

[1] W. Bewket & G. Sterk "Dynamics in land cover and its effect on stream flow in the Chemoga watershed, Blue Nile basin, Ethiopia". *Hydrological Processes: An International Journal*, *19*(**2),** pp. **445-458**, 2005.

[2] P. Borrelli, D. A. Robinson, L. R. Fleischer, E. Lugato, C. Ballabio, C. Alewell & P. Panagos, "An assessment of the global impact of 21st century land use change on soil erosion". *Nature communications*, Vol. *8*(**1)**, pp. **1-13, 2017.**

[3] O. Cerdan, G. Govers, Y. Le Bissonnais, K. Van Oost, J. Poesen, N. Saby & T. Dostal, "Rates and spatial variations of soil erosion in Europe: A study based on erosion plot data". *Geomorphology*, vol. **122(1-2),** pp. **167-177, 2010.**

[4] M. D'Angelo, G. Enne, S. Madrau, S. Percich, F. Previtali, G. Pulina, and C. Zucca "Mitigating land degradation in Mediterranean agrosilvo-pastoral systems: a GIS-based approach". *Catena* Vol. **40**, pp. **37–49, 2000.**

[5] FAO "Land Degradation Assessment in Dry lands (LADA) Project - The linkages between global, national and local scale work in LADA. Beijing, **22-24 January 2007.**

[6] Fisseha, G., Gebrekidan, H., Kibret, K., Yitaferu, B., & Bedadi, B. (2011). Analysis of land use/land cover changes in the Debre-Mewi watershed at the upper catchment of the Blue Nile Basin, North West Ethiopia. *J. Biodivers. Environ. Sci*, Vol. **1(6),** pp**. 184-198, 2011.**

[7] G. Forkuor and O. Cofie, "Dynamics of Land-Use and Land-Cover Change in Freetown, Sierra Leone and Its Effects on Urban and Peri-Urban agriculture a remote sensing approach", *International Journal of Remote Sensing*, Vol. **32**: **4**, pp. **1017 - 1037**, **2011.**

[8] E. E. Hassen, & M. Assen, "Land use/cover dynamics and its drivers in Gelda catchment, Lake Tana watershed, Ethiopia. *Environmental Systems Research*, Vol. **6(1), 1-13, 2018.**

[9] N. Haregeweyn, A. Tsunekawa, J. Poesen, M. Tsubo, D. T. Meshesha, A. A. Fenta, & E. Adgo, "Comprehensive assessment of soil erosion risk for better land use planning in river basins: Case study of the Upper Blue Nile River. *Science of the Total Environment*, Vol. **574,** pp. **95-108, 2017**.

[10] E. F. Lambin, H. J Geist & E. Lepers "Dynamics of land-use and land-cover change in tropical regions", *Annual review of environment and resources*, Vol. **28(1),** pp. **205-241, 2003.**

[11] S. M. Oduori, S. Musse, and N. Gomes. "Environmental study of degradation in the Sool plateau and Gebi valley: Sanaag region of northern Somalia", *Horn Relief*, 2006

[12] L. Salvati, S. Bajocco "Land sensitivity to desertification across Italy: past, present, and future". *Applied Geography*, Vol. **31(1)** pp. **223–231, 2011.**

[13] T. Tolessa, C. Dechassa, B. Simane, B. Alamerew & M. Kidane, "Land use/land cover dynamics in response to various driving forces in Didessa sub-basin, Ethiopia", *GeoJournal*, Vol. **85(3),** pp. **747-760, 2020.**

[14] M. T. Taye, P. Willems, & P. Block "Implications of climate change on hydrological extremes in the Blue Nile basin: a review. Journal of Hydrology", *Regional Studies*, Vol. **4**, pp.**280-293, 2015.**
[15] T. Tolessa, F. Senbeta, & M. Kidane, "The impact of land use/land cover change on ecosystem services in the central highlands of Ethiopia" *Ecosystem services*, Vol. **23,** pp. **47-54, 2017.**
[16] R. D. Van Remortel, M. E. Hamilton, & R. J. Hickey, "Estimating the LS factor for RUSLE through iterative slope length processing of digital elevation data within Arclnfo grid". Cartography, Vol. **30(1),** pp. **27-35, 2001.**
[17] J. Weier and D. Herring, "Measuring Vegetation (NDVI & EVI). *NASA Earth Observatory, Washington DC, USA,* **2000**.

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