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Morphological Changes on Gungata River Watershed due to Anthropogenic Interferences, a part of the Upper Rihand Basin, Chhattisgarh

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ABSTRACT: The main aims of this research are to identify the morphological changes and development of the Gungata River watershed due to the rapid growth and effects of anthropogenic activities. The natural origin of rivers is sensitive to anthropogenic interference which causes a change in channel morphological characteristics. Human activities have revamped the river geomorphology and made limitless anthropogenic geomorphic features. These features have remarkable characteristics which have sometimes been misbalanced with landscapes produced by natural processes. Modern techniques like remote sensing and GIS were used to identification of morphological changes and their historical comparison etc. High-resolution satellite imagery (LISS-I 5m.), Digital Elevation Model (CARTO DEM 30m) were used to analyze the anthropogenic geomorphic features which provide different opportunities for a better understanding of landscape processes. This research paper has been shown how anthropogenic activities interference with the morphological changes of the Gungata river watershed.

KEYWORDS: Anthropogenic, Digital Elevation Model, Digital Elevation Model, Geomorphology, GIS, Remote sensing.

INTRODUCTION

The different constructional works are associated with soil materials which extraction from the river bed. This is the significant cause of adverse changes in the geomorphologic characteristics of the river. Since the early civilization, human activities are always intervened in the natural water flow and characteristics of a river. These are to manage the water resources and to protect against flooding or to make passage along or across the river easier. From the late 20th Century, modern civilization greatly depends on rivers, and most of the rapid construction works of dams, barrages, and bridges, there has been raised some environmental concern (Maurya. U.S. 2008). After started industrialization humans have rapidly changed the environment over time by cutting forests, cultivating the land, irrigating and exploiting the mineral resources, etc. Through these very complex actions, human has become active agent, who transforms, directly or indirectly, reality. On the other hand, he is a passive morphological agent, who assists, reacts, and adapts himself to the conditions created by the natural environment. Under certain circumstances, human has proved to be a strong geomorphological agent, even more, efficient than the natural processes in modeling the landforms (Billi and Rinaldi 1997). The main purpose of monitoring morphological changes is one of the significant studies in geomorphological process analysis. This is also one of the interesting areas of study when natural resources are associated with anthropogenic activities. Most of the riverbank erosion and bed scouring is general and is believed, by many, to have been aggravated in recent times in response to increased human activities (Sharma et. al., 2010; Afrin et al., 2018)

The settlements are those sites where humans reside, engage in agricultural production, and are other economic activities. The inhabitant locations are selected for generation to generation. People live in those places which associate with the natural, cultural, and social environment (Yang et al. 2015). The Investigation of the spatial distribution and pattern of settlements are most significant for several aspects, to geographical, morphological, territorial, and cultural researches of human-environment interactions (Liu et. al. 2013). The identification and emphasis of anthropogenic topographies can widely improve the understanding of the mechanisms for quantifying changes to landscape systems in the context of the anthropogenic epoch (Jordan et. al. 2016). The man-environment interaction explains how the peoples adapted to the prevailing environment and brought to modify them in the environment to suitability their demands. It is being determined that the geomorphological study of rivers necessity to be properly documented and analyzed. The various characteristics of each river must be understood and analyzed that the response of the rivers is different from each other. The man-made structures on river beds may be anticipated and preventive measures as considered necessary may be planned (Maurya. U.S.2013). The impact of floods on river dynamics remains largely unclear since flooding in the Ganges system is also believed to be one of the major drivers of channel degradation (Jain et. al., 2012). The development of remote sensing (RS)

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and Geographic Information System (GIS) is improved the satellite imagery interpretation and The Digital Elevation Model (DEM) analysis. These techniques are helped to determine the location of settlement and associate features. The Distribution of Rural Settlements about Land Form Factors in Low Hilly Land on the Loess Plateau (Jiao et. al. 2013), Characteristics of landscape pattern and spatial distribution of rural settlements (Li et. al. 2014), the terrain differential characteristics of rural residents (Ma et. al. 2016).

The natural morphological features are being modified or changed by anthropogenic activities and utilized in different land use. One of the crucial issues is how the different land surfaces are interpreted. It should be determined with the help of different modern techniques and run the modeling. The main purpose should be to identify the relationships between land uses and morphological transformations which changed by human activities. The Geosciences are advancing towards empirical knowledge and theoretical frameworks that integrate both the natural resources and sociocultural forces that are now among the leading shapers of Earth's surface processes (Tarolli et. al. 2019). The rapid growth of population and the constant demand for natural resources affects the environment as well as Geomorphology. Different human activities are found on the river bed to fulfill their requirements. Sand mining is one of these which continuous supply to constructional work. The over-extraction of sand mining in river beds also led to changes in the environment as well as the morphological shape of the drainage system (Mandal B. et. al. 2020).

STUDY AREA

The study has been investigating in Gungata River a tributary of Rihand River. The Gungata watershed is a part of the upper Rihand basin, located south of the Rihand River. The Rihand River is the tributary of Son River which is also a tributary of the Ganga River. The present study area is part of the surguja and Surajpur districts, Chhattisgarh in India. Total 834.11 km^2 areas are covered by the Gungata watershed. The extension of the watershed is 22°45'55.45" N to 23°8'40.38" N latitude and 83°5'7.48" E to 83°23'25.6" E longitude. The maximum and minimum elevation of the watershed is 1105m and 478 m respectively. The slope of the study area is very high in hilly areas and low on plain surfaces. The range of the slope is 0° to 57°. Overall, the height gradient follows a South-Northwest direction (higher in the south, lower in the northwestern side). Figure number 1 is representing the location map of the Gungata River watershed.

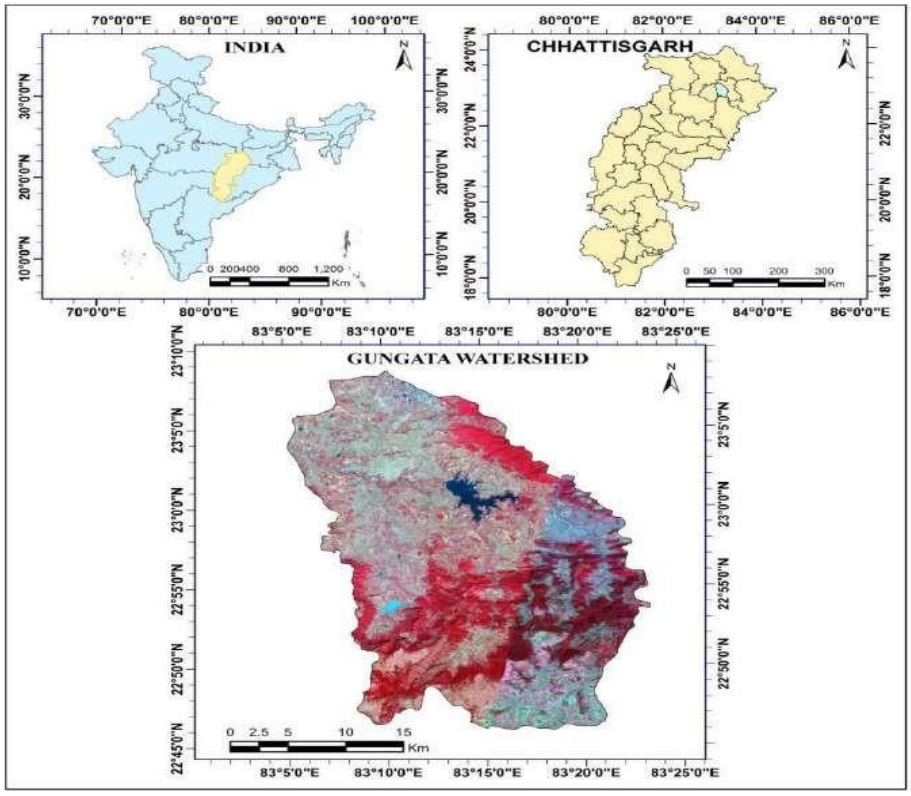

Figure No. 1: Location Map of Gungata River Watershed

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DATA AND METHODS

The main purpose of this research is to identify the effects of anthropogenic activities on the Gungata River and the morphological changes. The basic information about the research area has been collected through field surveys and the use of satellite imagery. Initially, the watershed boundary has been delineated by Topographical sheets and CARTO DEM 30m. Geographic Information Systems (GIS) has been played a vital role to analyze the (LISS IV 5m and Google imagery 0.5m) satellite imagery.

RESULTS AND DISCUSSION

The various types of anthropogenic activities likely, the building of river bridges, barrages, dams, house construction, and sand mining have been. These man-made constructions are obstructing natural water flow. A huge amount of water has been lifted from the river for irrigation; industry, construction, drinking, domestic purpose, etc. Those are the main causes of changes and modification of channel morphological characteristics which include the channel depths; water discharge, river environment, etc. How the anthropogenic geomorphic features have been changed historically is shown in figure number 2.

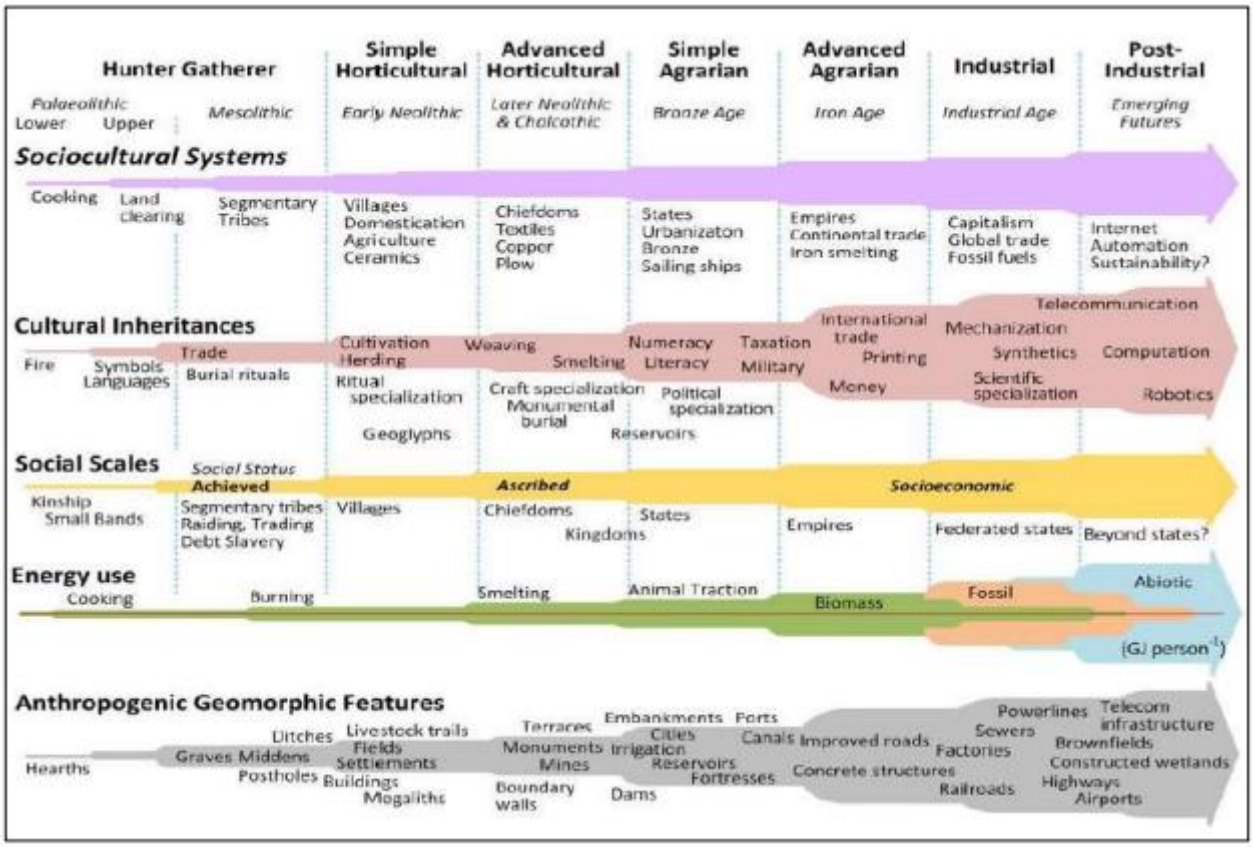

Figure No. 2. A conceptual diagram is representing the long-term changes in sociocultural systems, cultural inheritances, societal scale, energy resource uses, and anthropogenic geomorphic features. Different societies combine different sets of anthropogenic geomorphic features, including both pre-existing and novel, to produce their sociocultural across landscapes (this figure expanded by Ellis, 2015, Figure 3 and Ellis et al., 2018, Figure 1).

Landuse Class

Landuse is one of the important parts of the result and discussion. In this research area, more than 52% area is used for agricultural purposes. Agricultural activities are suitable for those places where morphologically plain surface, soil properties, and water supply are available. The hilly area mainly mainpat plateau is covered by moderate to dense forests (36%). This hill area is totally inaccessible to human activities due under-protected by Government. Others land surfaces are covered by scrub land, wasteland, water bodies, mining, and buildup. The various types' of human activities were found in different Land use areas which are mentioned in figure number 3.

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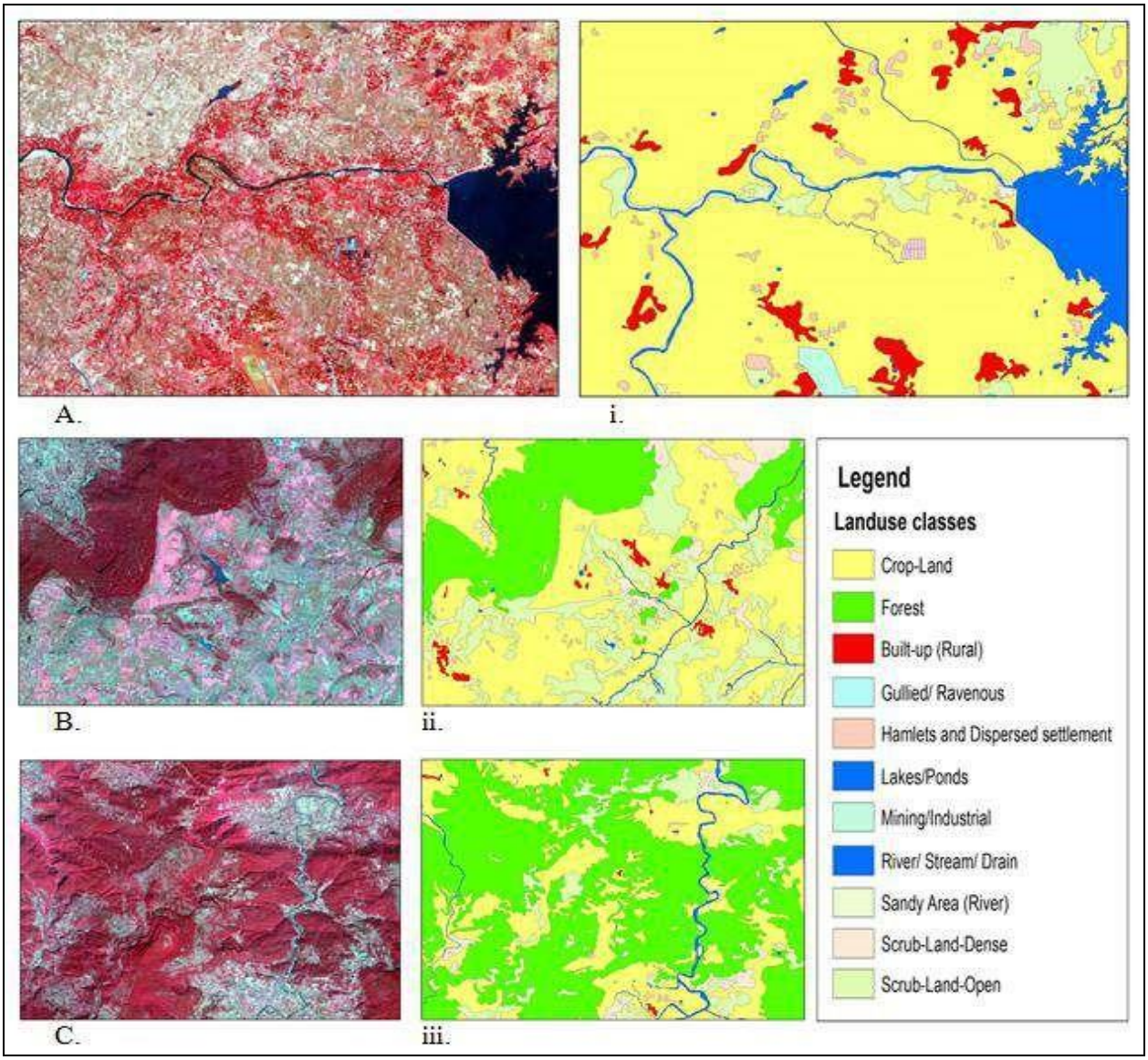

Figure No. 3. The satellite imagery is presented in different parts of the Gungata river watershed A. plain area, B. hilltop of Mainpat Plateau, and C. hilly area. The various Land use and Land cover map are presented i.Cropland, ii. Agricultural land use on hilltop and iii. Forest area in hilly part.

Effect of Slope and Curvature

Three-dimensional models (3D) from satellite imagery (CARTO DEM 30m) were analyzed for map interpretation. The digital elevation model (DEM) has consisted of a matrix of digital numbers. The digital data from a DEM is mostly performed in visual form to place it understandable to humans. The modern techniques, Geographic Information Systems (GIS), were used for the analysis of the morphometric condition of the study are area. Evans (1980) has been described the digital terrain model (DTM) surface as approximated to the bivariate quadratic function. The formula is given below:

$$Z = ax^2 + by^2 + cxy + dx + ey + f \quad (1)$$

Where: x, y, and z are local coordinates, and a to f are quadratic coefficients.

From such a surface, it is possible to compute the first (slope, Eq. (2)) and second (curvature, Eq. (5)) derivative. Slope (Fig. 5) is calculated as:

$$\text{Slope} = \arctan \sqrt{d2 + e^2} \quad (2)$$

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Where d and e are coefficients from Eq. s (1).

The formulating of Curvature is the second derivative of the land surface. It is also referred to as the change rates of the slope gradient or direction (Wilson and Gallant 2000), and it was emphasized to the convex and concave elements in the landscape. Evans (1980) was proposed two measures of the curvature, maximum and minimum, and Wood (1996) testified that only the resolution of the DTM and the neighboring cells relevant to these parameters and further defined as

$$\text{Curvature}_{max} = k*g\ (-a-b+\sqrt{(a-b)^2+c^2}) \quad (3)$$

$$\text{Curvature}_{min} = k*g\ (-a-b-\sqrt{(a-b)^2+c^2}) \quad (4)$$

Where a, b and c are quadratic coefficients from Eq. (1), g is the grid resolution of the DTM (2 m) and k is the size of the moving window.

From Eq. (3) and (4), mean curvature (Figure number 4.) can be defined as:

$$\text{Curvaturemean} = \frac{\text{curvaturemax}+\text{curvaturemin}}{2} \quad (5)$$

The natural slopes of the landscape are altered by humans in several ways. Most of which changed due to human demands. Based on the mathematical formulation it's found that the natural slopes areas are present low correlations within the neighborhood. The causes are those originally irregular, while the artificial land surfaces which are mostly affected by human activities to fulfill their needs and has been found self-similarity with surroundings. The mean Curvature maps for the three different parts of study areas are shown in figure number 4.

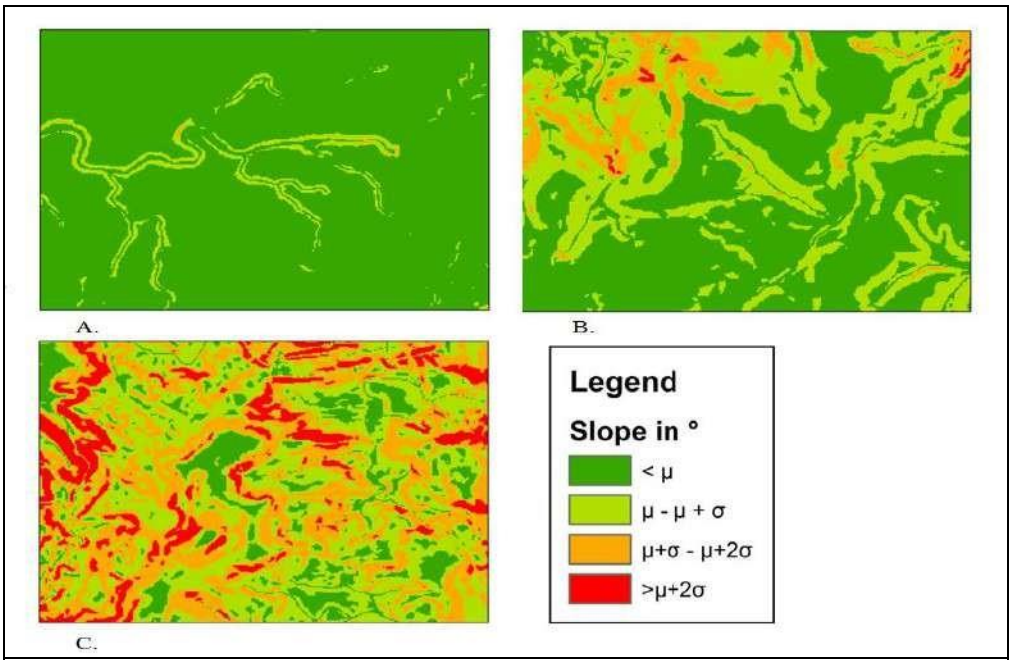

Figure No. 4. The Mean Curvature maps for the three different parts of study areas: A. plain area, B. hilltop of Mainpat Plateau and C. hilly area. Mean curvature is presented in multicolored according to the value from 1 to 2 times interval of standard deviation (σ) from the mean (μ)

Effect of Dams, Barrages or Reservoirs on River Morphology

The main purposes of the construction of the Barrages and dams across the river are to provide irrigational facilities in the agricultural fields, especially in the dry seasons. Water supply from Barrages and dams has played a huge role in agricultural production as well as in power generation. Besides that, it also plays an important role to control floods during the high discharge of rainwater. But sometimes the barrage also has made negative impacts on river characters. These impacts are also quiet effects in upstream and downstream segments of the barrage. So many barrages, reservoirs, and dams have been established on the Gungata

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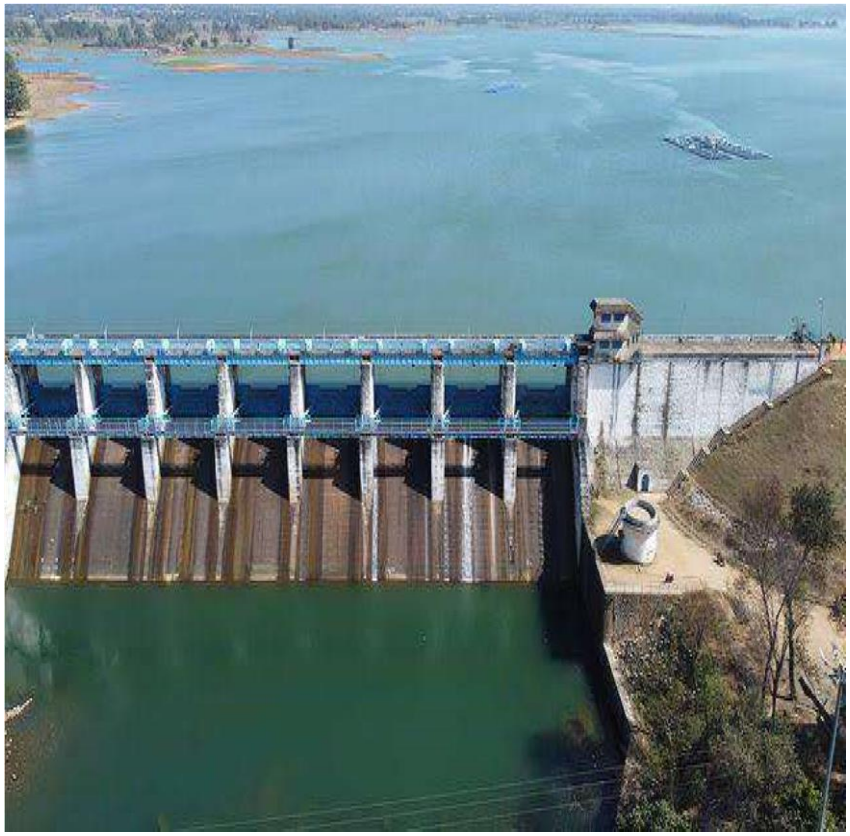
River those are given below in Table number 1. The special-temporal satellite imageries and field photographs of Ghungutta dam are represented in figure number 5.

Table No. 1. List of important dam, reservoir and large sized tank

Name	District	River name	Length in km	Width in km	F.R.L. in m	Live Capacity at F.R.L. in M.Cum.
Ghungutta Dam	Surguja	Gungata River	3.2	1.4	581.0	62.05
Bada Dameli Reservoir	Surguja	Lotha River	1.7	0.8	116.0	04.15
Puta Reservoir	Surguja	Lotha River	0.38	0.28	-	-

A.

B.



C.

Figure No. 5. A. Satellite imagery of Ghunghutta Dam before construction (2000), B. Satellite imagery of Ghunghutta Dam (November 2020), and C. field photographs.

Effect of Sand extraction from the River bed

Although mining is as old as the manufacture of stone tools and leaves clear geomorphic signatures, it occupies a relatively small surface area worldwide (Tarolli and Sofia, 2016). The mining activities have been driven by a wide variety of objectives which include obtaining materials for making items such as tools, utensils, weapons, ornaments, decoration, and currency (Timberlake, 2017). The rivers are the most important life-supporting system of natural flora and fauna. Most of the sand is used in constructive works which are mainly extracted from river water for human subsistence. The diverse nature of sand uses in concrete work in building sites, roads construction, making of various sizes of bricks, glasses industries, even fill in deep space, reclamations to replace eroded coastline, etc. Sands of river streams have no substitute for use as a building material in reinforced concrete cement.

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Mostly the rapid growth of urbanization is the major cause for sand demand and is responsible for unsustainable extraction of sand from dried river beds (Mandal B. et. al. 2020).

The extraction of sand from the Gungata River bed near Krishanapur and Ranpur village is going on for a long period of time. Figure number 7 is showing the different management strategies of sand mining on streaming and off streaming mining. The extraction material from river bed may trigger changes in many factors governing the fluvial processes, misbalanced the natural sediment deposition, and alter the erosion level and siltation patterns.

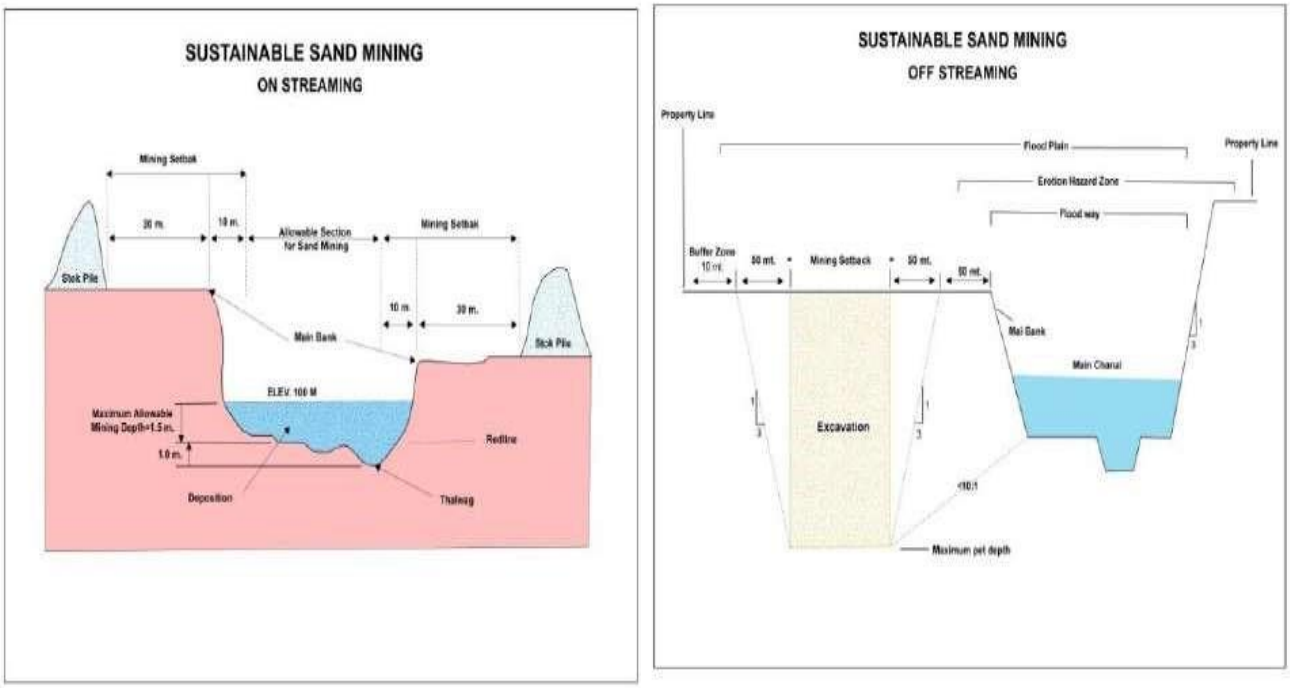

Figure No. 6. Management strategies of sand mining (on streaming and off streaming mining).

Dandy Bolton Equation

Dandy Bolton equation is one of the important formulas that is broadly used to calculate the sedimentary yield in the river bed. This equation is help to measure the sediment yields in a local area for watershed planning. The different structures of lithological, physiographical division, topographical features, types of climatic condition, drainage pattern, soil properties, local plants, Anthropogenic activities are mainly influenced by equations. Dandy Bolton equation analyzed the combined influence of surface runoff and watershed area on sediment yield to predict the sediment yield.

(Q < 2 inches)

$$S = 1280*(Q)\ 0.46*\{1.43-0.26\ \text{Log}\ (A)\}\ F\ldots1$$

For runoff more than 2 inches (Q > 2 inches)

$$S = 1958*(e-\ 0.055*Q)*\{1.43-0.26\ \text{Log}\ (A)\}\ F\ldots2$$

Where: S = Sediment yield (tons/sq. km/yr.) Q = Mean Annual runoff (inches) A = Net drainage area in sq. km Gungata watershed falling in (2) equations due to high annual runoff. Replenishment of sand around = Sediment yield = 22.98 M. tons/km2/yr.

The sand mining extracting area (164000 $m^{2)}$ is representing the Gungata river watershed. Thus, a huge amount of sand has been extracted every year in the river bed. The anthropologically high influence on the river bed leads to a change in the shape of the channel. Extraction of sand from the Gungata River bed (near Krishanapur and Ranpur village) and changing the channel water flow are mentioned in figure number 7.

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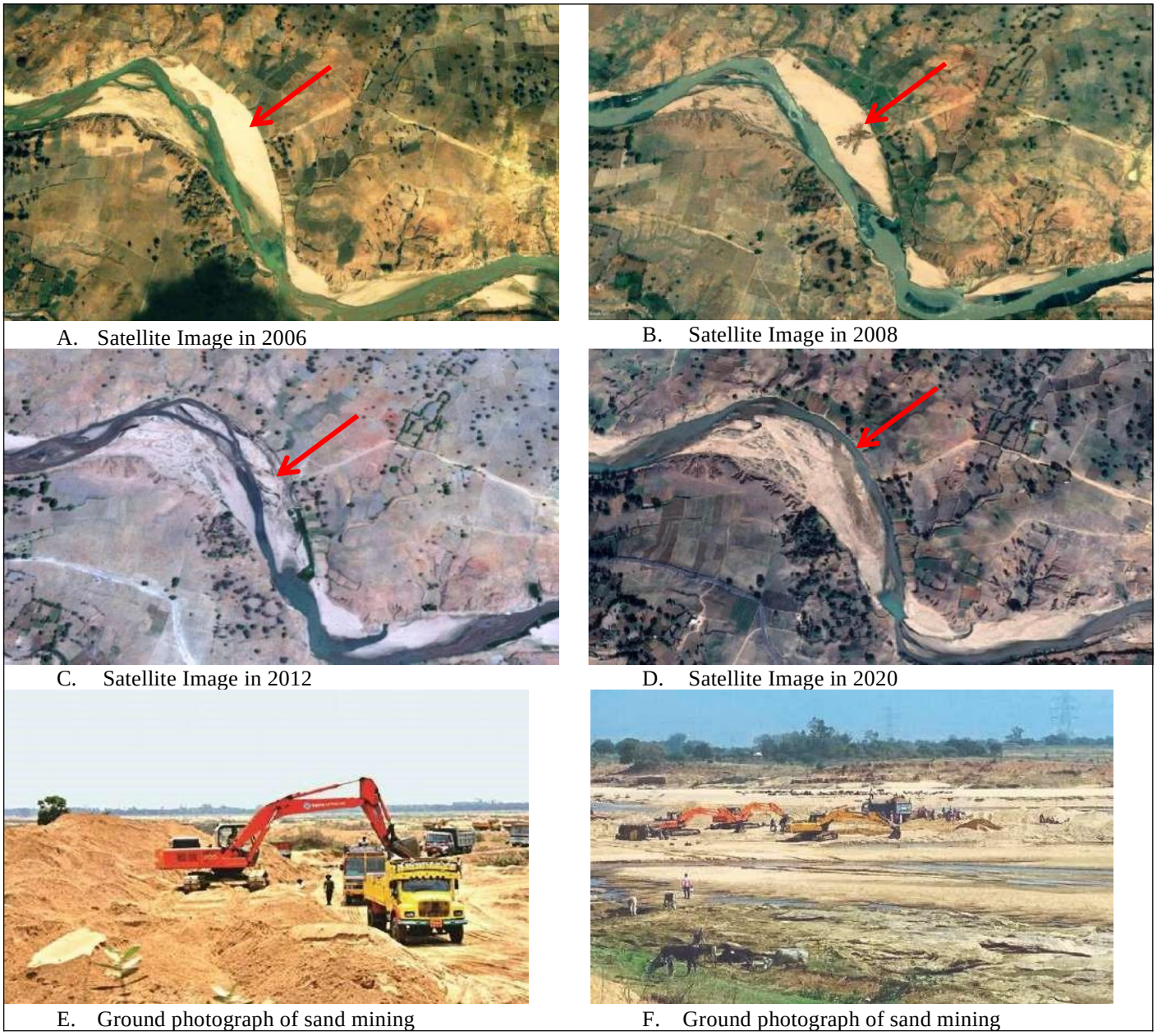

A. Satellite Image in 2006 B. Satellite Image in 2008

C. Satellite Image in 2012 D. Satellite Image in 2020

E. Ground photograph of sand mining F. Ground photograph of sand mining

Figure No. 7. Extraction of Sand and has been changed the water flow in river bed.

Effect of constructional works within the river and riverbank

The different sizes of buildings and multi-story buildings have been constructed on the Gungata river bank. Hard materials like stone, sand are used for this construction purpose. In a meandering shape of a stream, erosion takes place on one bank and deposition on the other bank. This fluvial process is governed by running water velocity during monsoon season (Herget et al., 2007) The Human Impact on the channel morphology is mostly found in the bridge's construction sites. The bridge and paved bank of the river has played a significant role in the river environment and river morphological features. The water flow in a river, sedimentation, and wave regulation is largely affected by the bridge on the river. So many bridges have been constructed on the Gungata River. Most

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of the changes were found in Ambikapur city which is the headquarters of the Surguja district of Chhattishgarh. The small river bed near Ambikapur city has been shifted due to the extension of the city area which is pointed out in figure number 8.

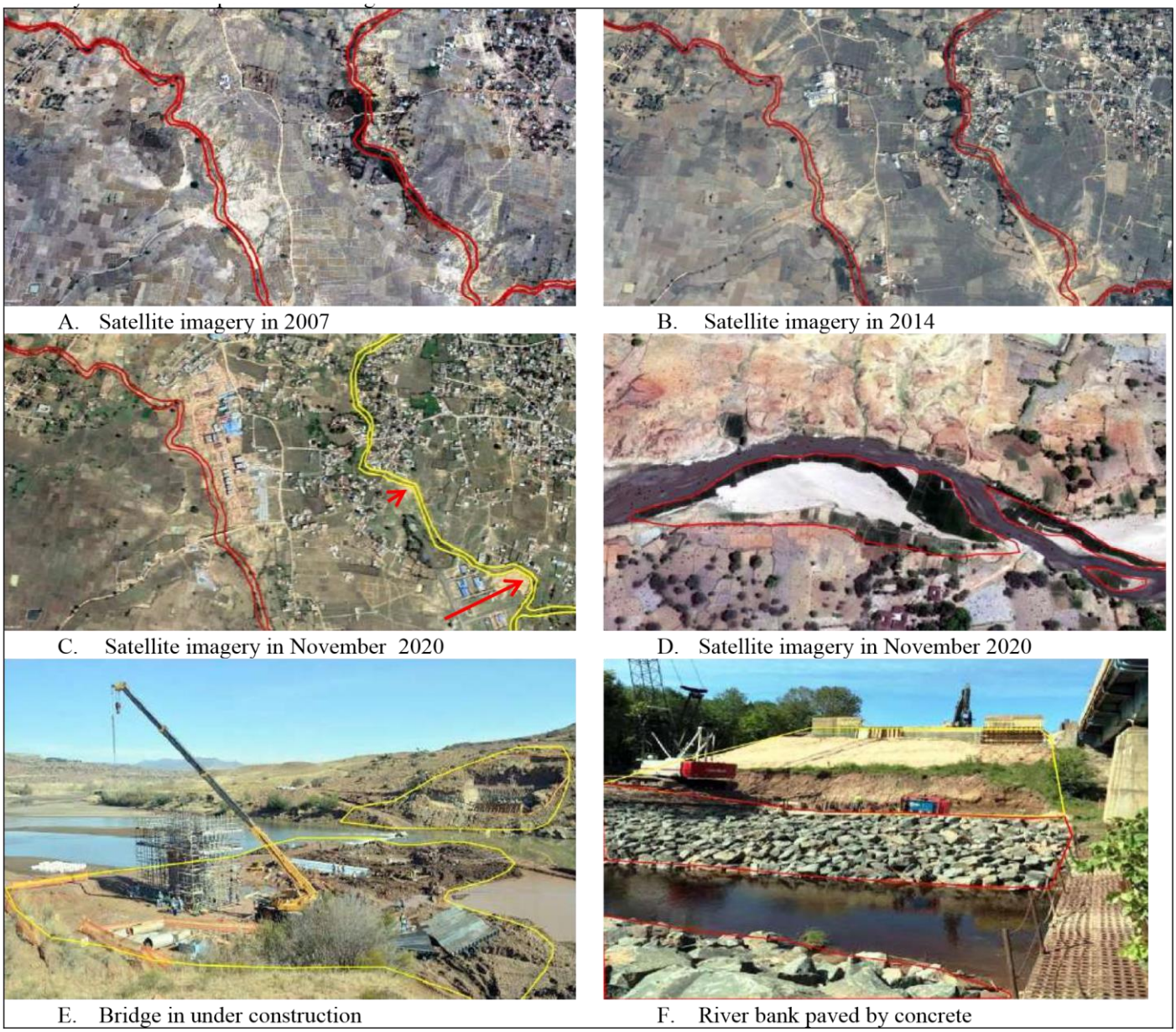

Figure No. 8. The figures (A. to C.) are representing the shift of the river bed by human constructional work, D. Agricultural activities on the river bed, E. under construction of the bridge, and obstacle the natural water flow and F. Yellow line is Upper and red line is Lower segment of construction.

CONCLUSION

The present study has been discussed above and shows the significant impact of human activities and intervention on natural channel morphological characteristics. Now human activities are transforming the natural geomorphology of landscapes to their own needs. In this study, various anthropogenic activities have been found in Ghunghutta dam, Bara Dameli reservoir, Puta reservoir, and so many other constructional works. Those activities have been played a vital role in landscape development. On other hand have been changes in the natural river morphology due to excessive storage of the water in those reservoirs. Also, it has been seen the cross-

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section profile of rivers which are broadened simultaneously from time to time. The speed of river water and transportation of sediment materials are affected due to lateral erosion as well as mining work. As a result of these changes by man, nature sometimes has a mocking effect on human life. This research paper has been showing how anthropogenic activities interference with the morphological changes of the Gungata river watershed.

REFERENCES

1. Afrin, N, Habiba, U, Das, R. R. Auyon, S. T. & Islam, M. A. (2018). Impact and Vulnerability Assessment on Climate Change of Jessore and Mymensingh Districts in Bangladesh. Progressive Agriculture, 29, 320-335.
2. Billi, P. Rinaldi, M. (1997), Human impact on sediment yield and channel dynamics in the Arno River basin (central Italy), Human Impact on Erosion and Sedimentation (Proceedings of Rabat Symposium S6, April 1997), IAHS publ.no. 245.
3. Chen, J. Li, K. Chang, K.J. Sofia, G. and Tarolli, P.(2015). Open-pit mining geomorphic feature characterization. Int. J. Appl. Earth Obs. Geoinf, 42, pp.76–86.
4. Ellis EC (2015) Ecology in an anthropogenic biosphere. Ecological Monographs 85(3), pp. 287–331.
5. Ellis, EC.Magliocca NR Stevens CJ (2018) Evolving the Anthropocene: Linking multi-level selection with long-term social-ecological change. Sustainability Science 13(1): 119–128.
6. Jain, V, Tandon, S. K. & Sinha, R. (2012). Application of Modern Geomorphic Concepts for Understanding the Spatio-Temporal Complexity of the Large Ganga River Dispersal System. Current Science India, 103, 1300-1319.
7. Jiao B, Shi P, Liu C, et al. (2013). The Distribution of Rural Settlements in Relation to Land Form Factors in Low Hilly Land on the Loess Plateau. Resources Science 35(8): 1719- 1727.
8. Jordan, H.; Hamilton, K.; Lawley, R.; Price, S.J. Anthropogenic contribution to the geological and geomorphological record: A case study from great Yarmouth, Norfolk, UK. Geomorphology 2016, 253, 534–546.
9. Li S, Zhang Y, Yan X (2014) Characteristics of landscape pattern and spatial distribution of rural settlements in Zhuxi Country. Research of Soil & Water Conservation 04: 203-207+218. https://doi.org/10.13869/j.cnki.rswc.2014.04.040.
10. Liu Y, Yang R, Yuheng L I (2013) Potential of land consolidation of hollowed villages under different urbanization scenarios in China. Journal of Geographical Sciences 23(3): 503-512. https://doi.org/10.1007/s11442-013-1024-8.
11. Mandal, B., Bej, D. and Baghmar, N. K., (2021) Environmental impact and Management of sand Mining: A case study of Kangsabati River Watershed, West Bengal Using Remote Sensing and GIS Technique, International Journal of Technology Research and Management, vol. 8, (8), pp. 1-9
12. Ma S, Liu J, Zhao Z, et al. (2016) Research on the terrain differential characteristics of rural residents in Fuping County, Hebei Province. Research of Soil & Water Conservation (06): 327-332.
13. Maurya. U.S. (2013) M. Sc. Dissertation, University of Lucknow (Uttar Pradesh, India, 2008).
14. Maurya. U.S. (2013) International Journal of Geology, Earth & Environmental Sciences, 2013, 3, 2, 90-96.
15. Sharma, B. Amarasinghe, U. Zueliang C., de Condappa D., Shah, T. Mukherji, A. Bharati, I, Ambili, G. Quershi, A. Pant, D, Xenarios, S, Singh, R. and Smakhtin, V. (2010). The Indus and the Ganges: River Basins under Extreme Pressure. Water International, 35, 493-521
16. Timberlake, S. (2017). New ideas on the exploitation of copper, tin, gold, and lead ores in Bronze Age Britain: The mining, smelting, and movement of metal. Materials and Manufacturing Processes 32(7–8): 709–727.
17. Wood, J. (1996). The geomorphological characterization of digital elevation models. Ph.D. Thesis, University of Leicester.

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