

Spatio-Temporal Changes in The Fluvio-Geomorphological Environment of The *Diara* of Bhagalpur, Bihar in The Middle Course of Ganges: A Geomorphological Analysis

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Abstract - Ganges, the holy river to the Indians, is not only known for her uncountable blessings and foundation of Indian civilization but for sculpturing distinct and unique physical features also. The main course of Ganges has passed and passing over three main agrarian states of India i.e. U.P., Bihar and W.B. and the entire meandering middle course accompanied by enumerable floodplain generating tributaries and distributaries possessed by the state Bihar. The naturally gifted soils of the floodplains are often compared to the gold as those foster millions or billions of people, generations after generations in India directly or indirectly. Even, Ganges is often called by the 'son/daughter of the soil' of Bihar as *Ganga Maiya* i.e. mother to all north Indians. Particularly, the *Diara* part of the Bhagalpur district in Bihar is noted for a permanent disputed one. Keeping the disputed administrative matters aside, it will be worthier to study the fluvio-geomorphological set up and spatio-temporal changes of the course of the Ganges in *Diara* region of Bhagalpur district in Bihar. This geographic article has mainly focused on different unique fluvio-geomorphological aspects of Bhagalpur *Diara* and its impact on the socio-economic status since last two decades.

Keywords: Diara, Fluvio-geomorphological environment, bil, palaeo channel, relict, shoal deposit, floodplain.

I. INTRODUCTION

The entire north Bihar enclosed within the Kosi River and Ganges is known as *Diara*. It is the most prominent and unique landscape architected and sculptured through the fluvio-geomorphological activities by Ganges in its middle course in Bihar for thousands of years. The study area stretches from 86°59'00"E to 87°07'00"E longitudes and from 25°17'00"N to 25°22'30"N latitudes and situated along the left bank of Ganges and in the region, south of Kosi River. The study area includes the villages like – Jaimangaltola, Chhoti Parbatta, Jagatpur, Barka Parbatta, Rajandih, Phulikia, Raghunitola, Ismailpur and Binaua etc.

Unfortunately, since the formation of the very small to very large fertile shoal deposits along Ganges form decade after decade due to the continuous depositional activities by Ganges here, the newly but temporarily or permanently built land-areas formed or forming by the fluvial activities which were supposed to be the region of agriculturally or economically prosperous one in Bihar, has become a region of unresolved disputed region. The continuous shifting of the Ganges and Kosi River along with their tributaries and distributaries also change the physical scenario here and the intangible depositional and erosional land areas become a major reason behind the age-old disputed area.

Objectives:

To find out the locational significance of the Diara-land of Bhagalpur district of Bihar, India.

To acquire, calculate the quantitative as well as qualitative data and to analyze the data obtained from the field survey and through satellite imageries of the region of interest.

To compare the spatio-temporal changes in the fluvio-geomorphological attributes of this area since 1970s to 2014.

To analyze the impact of the changing fluvio-geomorphological environment of Diara-land in Bhagalpur district.

II. METHODOLOGY

✓ Pre-Phase:

Literature Review – Mainly scholarly articles in books and journals have been gone through to collect previously published authenticated report about the problem area. Secondary data has mainly been obtained from Census, 2011 and other government reports.

Collection of - Toposheet No.s – 72O/3 and 72K/15 with R.F. 1:50k and Satellite Imageries (IRS LISS-III, 2014) from <https://www.bhuban.nrs.c.gov.in>.

✓ **Phase of Data Processing:**

Geo-referencing the selected Toposheets (Raster layers) and digital processing of the different bands in the same CRS through Arc GIS and Qgis v3.4.

Digital Classification of the satellite imageries through supervised and unsupervised techniques.

Extraction of different physical and cultural attributes.

Calculating the number (point), Length (line), Area (polygon) of the vector layers.

✓ **Post-Phase:**

Comparing the fluvio-geomorphological data extracted both from Toposheets and Satellite Imageries of 2014 (IRS LISS-III images downloaded from <https://bhuvan.nrsc.gov.in>).

Analyzing and Interpreting the data to make them a secondary source (Through Mapping and articles) to the interdisciplinary research works where primary and secondary data are not available.

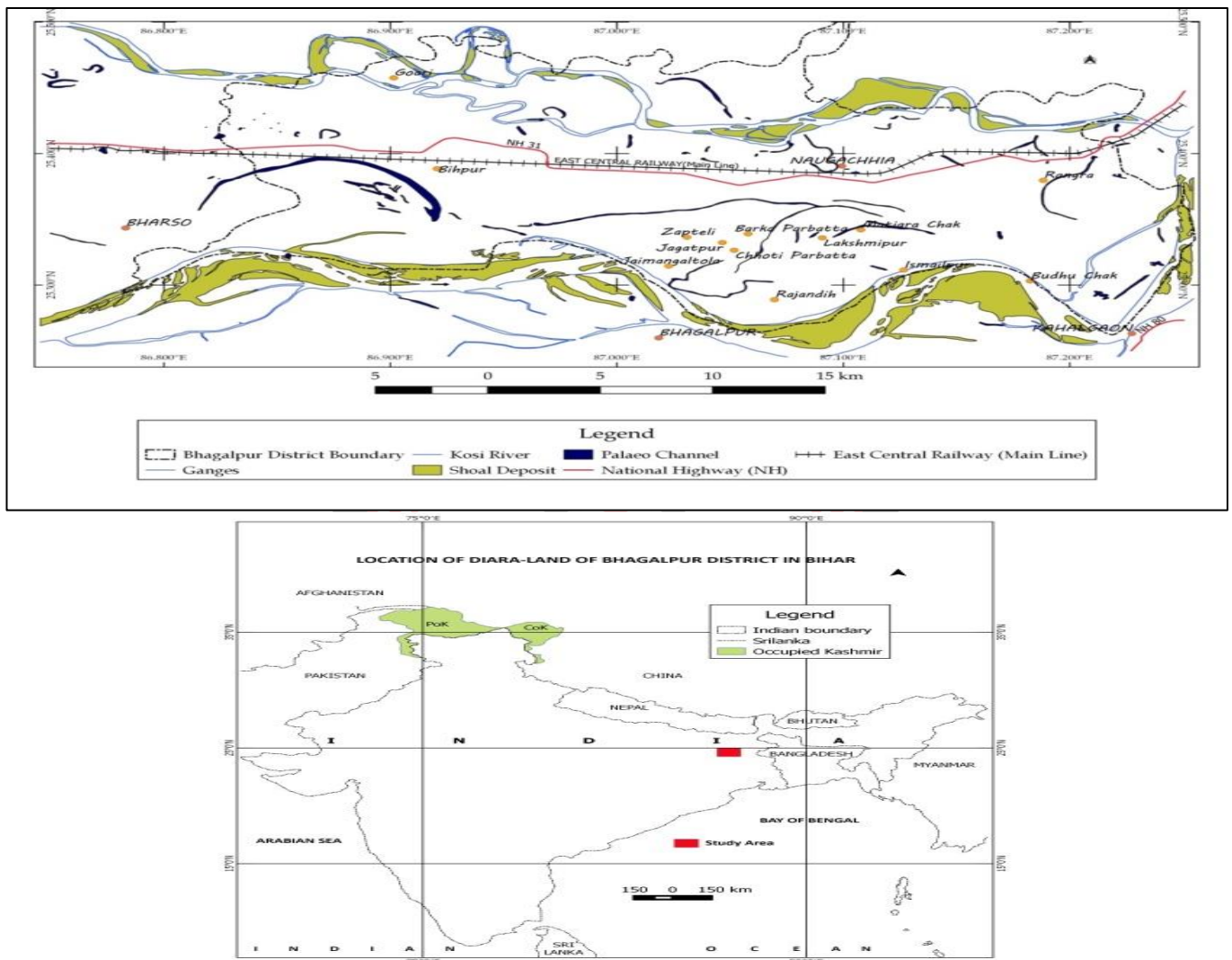


Fig.1: Location of the Diara-land Ganges and Kosi River in Bhagalpur district of Bihar, India.

Location of the study area: From Barhia to Pirpriya-Hussaina and from Munghyr to Toufir including the parts of Bhagalpur and Sahibganj, the length of the Diara is almost 250 km. Bihar alone possesses almost 900000 ha land area out of the total area of the Diara. The Ganges-Diara land (Fig.1) covers 240 km², Burhi-Gandak Diara land covers 230 km², Gandak-Diara land covers 1400 km², Kosi River-Diara land covers 1500 km² and ultimately Son-Diara land covers 1100 km² land area. The Ganges-Diara land is the most important in Bihar; and both the left and right banks of Ganges has plenty of arable lands.

III. FLUVIO-GEOMORPHOLOGICAL ENVIRONMENT

Before discussing the changing fluvio-geomorphological environment one must go through geological history and its control over the changing fluvio-geomorphological environment of the middle course of Ganges, particularly over the Diara in Bhagalpur district of Bihar. Earlier studies on geological set up of Bihar and adjacent regions in India clearly revealed the facts that a little change in the upper courses of the major rivers in India, creates a great impact on the middle course of the rivers origination particularly from Himalayas. Singh et al. (1998) showed that Ganga-Padma fault is controlling the flow direction of

Ganga River new Farakka, West Bengal. Similar controls were observed in the north Bihar Plains also. Arogyaswamy (1971) showed the significance of subsurface structure on the lateral migration of Kosi River. Agarwal and Bhoj (1992) also related the migration of Kosi River with the activation of subsurface faults in the Kosi River basin. Sinha (1996) suggested that most of the channel movement in this area viz. avulsions, cutoffs were caused by neotectonics and/or sedimentological readjustments. The bed of the Kosi River in Bihar is now at a higher level than the floodplain (Valdiya, 1987). It seems therefore that rapid subsidence combined with very high sedimentation rates has resulted in reduction in carrying capacity of channels in downstream reaches, which experience frequent and severe flooding.

The *Diara* of Bhagalpur is almost a flat land with a slope towards north-west. The Bhagalpur – *Diara* is located between 86°59'00"E up to 87°07'00"E longitudes and from 25°17'00"N to 25°22'30"N latitudes with an elevation of 30-32m height above MSL. This particular region is in the left bank of Ganges, southern part of Kosi River and east of Khagaria, west of Katihar district and north of Bhagalpur district. The Ganges flows from west to east having meandering and braided course. Most

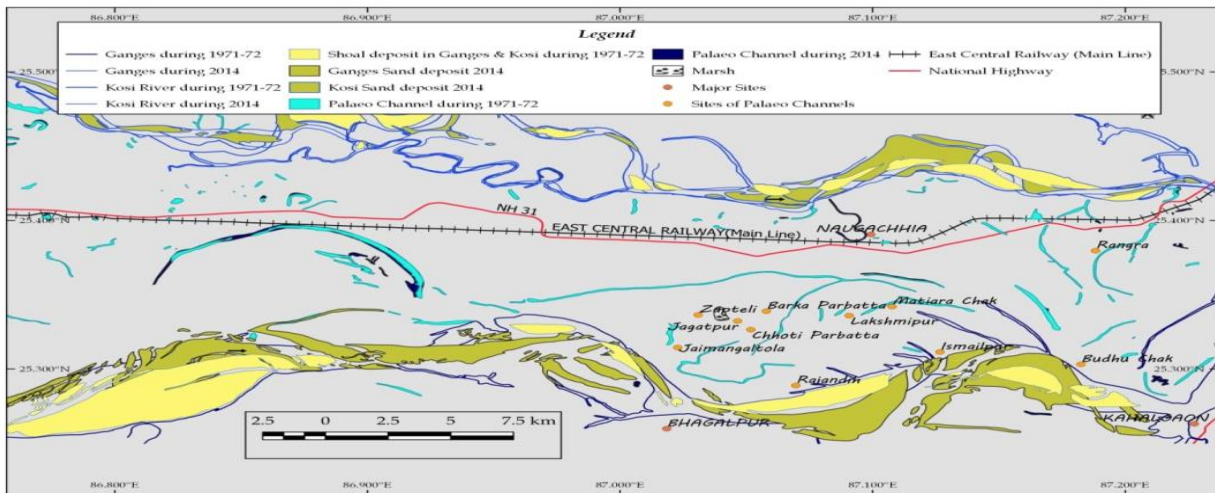


Fig.2: Spatio-temporal changes in the fluvio-geomorphological environment of Ganges and Kosi River since 1971-72 to 2014.

interesting feature of *Diara* is in the relicts or palaeo-channels of Ganges (Fig.2). These are found in parallel manner and the length of the impression increases off the bank of Ganges. Sometimes, fish-shaped and bird-shaped depressions have been noticed. The longest one is Kalbalia-Dhar having a length \pm 23.5 km. A lot of ox-bow lakes can be noticed which have made this region a unique one. This region is also having a lot of natural depressions and bil areas along with small dry segments of waterbodies, which show the previous original route of Ganges.

During the field study in 2001 after the flood-period, it was noticed that many depressions which were formed due to the scouring by the Ganges, were later remained scattered over the plain and had no connection with the main river. The remnants had various shapes like circular, semi-circular, crescent and by joining them the original route of Ganges could easily be identified. Even in recent times, few palaeo channels can be noticed just a few kilometers interval in this region. One of the relicts or palaeo-channels of Ganges here is Jahajwa-Dhar. From the analysis of the Toposheets of the year 1971-72 by SOI and the LISS-III satellite images of 2014 it has been noticed that Ganges and Kosi River have been decayed a lot during this period because the analysis tracked that the area under shoal deposit has increased from 65.87 km² (during 1971-72) to 103.26 km² (during 2014). On the other hand, a slight

change in area under the bils and palaeo channels in Bhagalpur *Diara* during this period (Fig.3). The area under bils and palaeo channel was about 16.68 km² during 1971-72 and 15.57 km² during 2014. Whereas, the length of the Ganges and Kosi River didn't change a lot (Ganges- 233.45 km and Kosi River- 211.47 km) during this time. These bils and palaeo channels have considerable impact on the land use pattern. Though number of remnants is increasing every year but many old depressions are now silted and turned to agricultural fields. During dry seasons these perennial palaeo channels use to support irrigation in the surrounding agricultural fields.

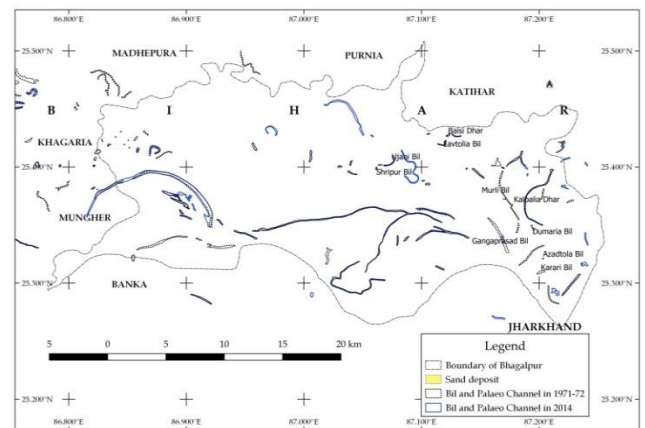


Fig.3 Spatio-temporal changes in Bil and Palaeo Channels from 1971-72 to 2014.

During the field survey it was noticed that the remnants are found every within few kilometers and almost equidistant to each other and the width of the remnants also varies less. Whenever flood takes place, these palaeo channels are joined with each other. Heavy deposition takes place covering the agricultural fields with sand, clay and silt. The relative height of the banks along Ganges here ranges between 4 m to 20 m. In relation to Ganges, the palaeo channels such as Kalbalia-Dhar, the relative height of the embankment is 2 m. Water remains almost throughout the year in these remnants. The relative height of the embankment of the Mar Ganga Nadi ranges between 2 m to 9 m. This easy availability of collecting irrigation water does not encourage shallow (STW) or deep tube-well (DTW) or bored-well irrigation here. Hence, recent analysis from the Toposheets and ISRO satellite imageries of this region revealed the facts that some shallow and deep tube-wells are being used by some localities here.

As the entire *Diara* of Bhagalpur is covered by new alluvial soil i.e. khaddar near the Ganges and laterite soils away from the Ganges valley; the fertility of the soil here is very high as the floodplain is renewed every year after post-flood period.

IV. FLOOD HAZARD IN DIARA-LAND OF BHAGALPUR

Natural hazards is a term indicating action of abrupt modifying natural events, such as floods, droughts, earthquakes, land-slides and anthropogenic hazards which are indicated by the term *technological hazards or environmental risk* (O.Riorden,1986). A hazard is defined as an expected damage, injury or death to people and property, subsequent to general distress and economic loss. A natural hazard is considered as problem of occurring in built areas, which people are not aware of its characteristics in order to cope with it (Pirazizy, 1992). As we all know that Ganges is the basis of economy of northern India. Wherever Ganga has passed on North India it became the basis of livelihood of millions of people. So many dams, barrages have been built to control flood, which inversely became a curse to the people our country. *Diara* is one of the most important flood prone areas of north of Bihar which is markedly different from other flood prone regions along the course of Ganga. Almost all the floods occurring in *Diara* were associated with the tale of monsoonal cyclonic rainfall. Till today the floods of 1971, 1975, 1978, 1997 and 1998 became remarkable from the human distress point of view. The depressional rainfall of 1978 and the devastating flood in consequence have created an all time record in the region so far as historical documents are available. Besides the changes of the river from time to time towards north and south the Ganga spilled over and breached embankments on both sides at various places in between the Kosi River and Ganga itself leaving behind a trail of woe and agony. Some of the worst affected places

were village Ramnagar, Binoba Nagar, Itmatpur, Phulkia, Kamlakund, Ramdiri, Raghunitola, Akawa, Buddhu Chak, Chhoti Parbatta, Barka Parbatta, Jagatpur, Ismailpur, etc. generally the water remained stagnated for 4-6 mts. deep in and around the *Diara* for several weeks. Almost all the villages ranging 10-12 Km. along the left bank of Ganga in *Diara* land were submerged (Fig.1). At the time of flood the previous impressions were filled by the excess water and joined with each other.

Shri Preetam Kumar Raju, local general physician of village Barka of Sahu Parbatta reported (in 2006) loss of 5,000-10,000 families in these villages during last five years and every year almost 5 Km. of area along the left bank of Ganga were eroded away by the river last year (2001). According to him, once this village was only 6 Km. away from the main Ganga which later shifted 13 Km. north of the main Ganga. Not only the Barka Parbatta but also a lot of villages have to change their original location in response to the destruction of the land caused by the flood every year. Nowadays, according to the villagers of Harijantola all the villages are shifting towards far north. The main causes identified by them were Kosi River Dam and the Farakka Barrage. According to them, before the construction of the Farakka Barrage the magnitude of the destruction during flood was lesser than that of the present days. Even the analysis of census report of 2011 of Bhagalpur district revealed the fact that more than 50% of the households do not have kitchen in the blocks along the Ganges in this region. This is due to the unreliability and uncertainty of flood situations during heavy monsoons in this region which generally cause havoc damage to the people living in Bhagalpur Diara.

Impact of annual floods in Diara-land of Bhagalpur from 1970s to 2014: The magnitude of land erosion by Ganga is so huge and disastrous during flood in *Diara* region that rescue teams or NGOs think twice to take risk to save the poor innocent villagers. At this time one can't see the other side of the Ganga. Due to increasing magnitude of flood occurrences in Diara-land and rapid decaying of the river beds of Ganges and Kosi River, maximum households do not prefer to set up permanent households here. From the Census Report (2011) it was also found that maximum households in Naughachhia (Fig.1) the Diara of Bhagalpur district in Bihar have least number of permanent households. The reason behind this may be the insecurity feeling of the local people of Diara as the Ganges become violent during any severe cyclonic conditions particularly during mid-monsoon period (July-August) and can swipe away their households within few hours. Side by side, the legally or illegally acquired shoal deposits along or within the bed of Ganges do maintain their areal coverage due to continuous shifting of the Kosi River and Ganges influenced by the changing discharge of the upper reaches directly or indirectly affected by the large dams and barrages built in their beds further to the north.

V. CONCLUSION

Shifting of river and spatial temporal changes in the length and areal coverage of the bils and palaeo channels are common natural phenomena in Bhagalpur Diara. Generations after generations of people of Diara in Bihar have made them well accustomed to the flood and bank erosion here. Besides Ganges and Kosi River carry and deposit huge amount new fine alluvium over the entire floodplain of Diara the result of which can easily be observed during post-flood conditions here. Even after havoc annual damages and loss of property, people worship these two rivers as their 'Maiya', the Mother Nature under whose nourishment the Govt. of Bihar produce huge amount of crops and cereals for which the Diara is famous till today.

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