

GEOMORPHOLOGICAL DESCRIPTION AND MICRO LANDSCAPE OF THE COURSES OF THE RIVER GANGA: A CASE STUDY AREA*

BY

Mukesh Kumar*

Research Scholar, Department of Geography, University of Allahabad, Prayagraj, India.

Abstract

The spatial and temporal changes in channel morphology of the Ganga River have been flowing in the southeast direction of the study area. The channel of the river Ganga is influenced by lateral erosion to alluvial soil. They have created river meandering and braided drainage patterns. Then the micro landscape affects the river Ganga and changes the channel pattern. A field survey was conducted on the primary sources of data with the help of personal interviews with the priest, boatman, shopkeeper, devotees, and local people in the river Ganga in the study area. They have illustrated the channel shape which is described as sinuosity, braiding and meandering. Braided ranges consist of two or more channels divided by bars or islands, with one channel usually being dominant. Natural landforms are formed by the hydraulic process with erosional and depositional force, the depositional landforms are found in the Ganga valley rather than erosional landforms. Here Bluffs, cliffs, riffles, pools and gullies are found in erosional landforms. The depositional plain is found on both river banks a large amount in the Ganga valley. The alluvial plains and water distributaries are deposited in the depositional landscape in the river Ganga. The Chunar fort is on the rocky bank of the river Ganga and from across the Ganga River stands on the rock, detached part of the Vindhya Range at an elevation of 85 m above sea level. This area has received much important knowledge by field surveying the channel pattern, the micro landscape, major Ghat and its importance to the human, social, and economic development of the river Ganga.

Key words: River morphology, Braided channel, Meandering channel, Bluff, Cliff, Riffle, Pool, Gully, Depositional plain, Embankment, Bridge, Agriculture land, Temple and Fort, River Ghat.

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* Correspondence Author: Mukesh Kumar

Introduction

The Ganga River is one of the major river systems in India. Gangetic plain covers a large portion of India. The river Ganga emerges from the Gangotri glacier, about 4,500 m above mean sea level in the Uttarakhand Himalayas and flows down to the Bay of Bengal covering a distance of 2,525 km. The sediment deposition creates many severe problems like the decrease of river depth due to riverbed siltation. The study of spatial and temporal changes in channel morphology of the Ganga River has been done keeping in mind the place named from Rampurghat to Chunar, flowing in the south-east direction of the study area. Between these places, it determines the distance of approximately 64 km

from Rampurghat, Ramgayaghat, Vindhyachal Dham, Mirzapur City, Pakka Ghat, Baria Ghat, Nar Ghat, Company Ghat, Bhogao Ghat, Newaria Ghat, Sindhaura Ghat and Chunar.

India's largest mythological sanctuary of the year - the holy river the Ganges satisfies the ruin of millions of Crores of people, who have been given the title of 'Ganga-Maa'. This has a variety of natural patterns and human representations in its lap as well as cultural heritage representation. Practical and technical suggestions have been given to reduce pollution including channel patterns, natural landscape, and man-made landscape, resources development and suggestions on land use & land cover, and social, cultural and religious activities. The profile of the Ganga River valley has also been built on the confluence of the bridge connecting Mirzapur city and Chilh Block, Bhatauli and Kachchhawa of the study area. The river Ganga is the lifeline of human beings. Looking at the ecological, social, and economic importance of the Ganges River and the small research work for the analysis and solutions of many problems related to Ganga valley, from Rampurghat to Chunar has been selected from a small area of Ganga valley.

In this study of the river Ganga, there have been many changes due to human and natural reasons which have to prevent to be beneficial for human habitation, somewhere fatal. Here the Ganga River valley has become shallow for two reasons - due to being a plane plume and another due to flooding the valley with depression load due to this, the flows of the river have decreased and the river produces excessive diversion through horizontal erosion which has resulted in many types of geo-environmental problems. In this part, under the Channel morphology –pool, riffles terraces and bars are formed in the Ganga River. The path of the river valley is influenced by cutting due to alluvial soil. In this part, the creation of the river meandering and braided drainage patterns.

The Study Area

The study region is a valley area of river Ganga between Rampurghat and Chunar. The area under study extends from 25°00' N to 25°2' N latitudes and from 82°30' E to 82°88' E longitudes. The actual length (channel length) of the river is 61km. long while the air length is only 45km. long. The width of the river course also is a major part right side and left side a small area covers the study region (on the left bank of the river in Sant Ravidas Nagar (Bhadohi), and the right bank of the river in Chunar, Mirzapur district. In the study region, the river adopts a naturally dynamic, highly ruinous, meandering plan form. The study region comprises the extreme southern part of Chhanbay block, Lalganj block, Marihan block, Rajgarh block, Chunar Tehsil, Pahari block development block of Mirzapur district; Extreme northern part of Kan block, Manjhawa block, Sikhar block, and some part of Bhadohi and Varanasi.

The direction of the flow of the river Ganges in the study area is almost northwest to southeast. Under which the flow of the river from Rampurghat to Chunar in the west to east. From the village of Rampurghat, the river Ganga turns into a large dip in the southeast near at right bank of Newaria village and the left bank of Mujahra Kalan. Many tributaries of the Ganga, come from the northeast and join the Ganges. During the monsoon period, the river Ganga becomes more elongated and many sub-channels unite together. In the study area, the south and east of the Ganga River are situated in Ram Gaya Ghat, Vindhyachal Dham, Mirzapur City, Bhatauli, Sindhaura Ghat and Chunar sub-urban respectively. On the left bank of the river, Ganga has located some parts of Bhadohi, Mirzapur, and Varanasi.

At present, many physical landscapes or physical patterns developed on the geomorphological surface are rapidly transforming in channel change of the river Ganga, main reasons are the many economic and cultural processes of the developing human.

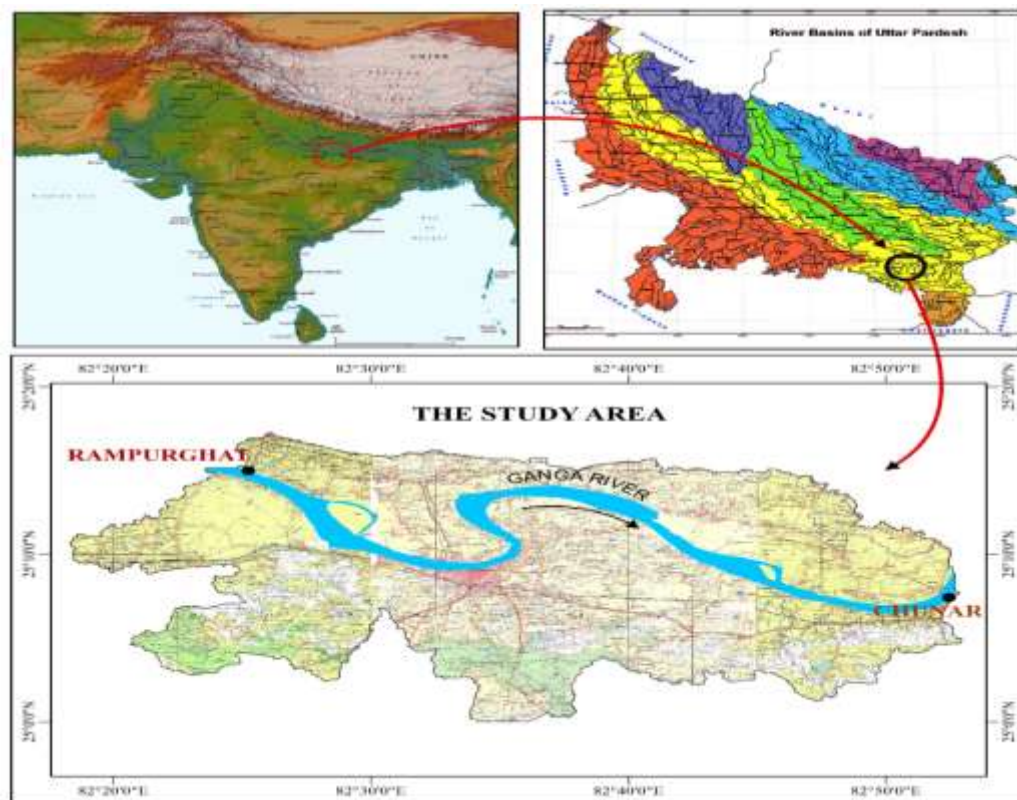


Figure: 1 Location map

Database and Research Methodology

The boundary of the Ganga River has been shown in Landsat imagery. All the topographical maps and satellite images were mosaiced and georeferenced with the help of ArcGIS version 10.7. After georeferencing of the toposheets, they are rectified and resampled into a Universal Transverse Mercator (UTM) projection WGS 1984, Zone 44 North. The whole streams of the Ganga River were extracted by digitizing with the help of the ArcGIS 10.7 environment using the ArcGIS Spatial Analyst extension and Arc hydro tool, available at <http://earthexplorer.usgs.gov> which is developed by USGS/NASA. After deciding on the study area in the different digital sources, that are needed to collect data in this fieldwork.

The main objective of the paper was to identify the geomorphological landscape and to access the present condition of the channel pattern of the morphology description. Secondary data were reviewed such as research papers, newspapers, articles, and magazines. A field survey was conducted to gather primary sources data with the help of personal interviews with the priest, boatman, shopkeeper, and devotees, who come here to take a holy dip in the river Ganga local people of the study area. Fieldwork enabled us to access the situation from a practical view.

Result and Discussion

Channel pattern denotes a mode of channel form modification in the flat plane which is additional but connected with transverse and lengthwise modes. An understanding of the river pattern provides a basis for understanding ancient fluvial deposits and inferring environments of deposition and it also

provides an empirical basis for determining past river morphology and palaeohydrologic. Alluvial channels flow from side-to-side self-deposited erodible sediments.

Such channels are self-formed through the inter-reliant adjustment of morphologic variables. These systems are characterized by a tendency to adjust towards equilibrium or regime. Channel Pattern is naturally related to alluvial channels. The channel pattern of the river is generally measured as straight, meandering and braided. Channel patterns are categorized by many geomorphologists in countless ways. For example, Leopold and Wolman (1957) divided alluvial channels into three basic patterns-meandering, braided and straight based on sinuosity.

Brice et, (1978) have illustrated the range of channel three basic types of channels which are characterized by degree; sinuosity, braiding and anabranching. They further perceived an extensive range in these three channels patterns as there is a high variety in the degree and character of sinuosity, braiding and a branching Brice, J.C. classified alluvial channels in 17 patterns. Schumm & Khan has classified alluvial channels based on sediment load types (viz. Suspended load, mixed load and bedload) into three major types e.g.-(1) Suspended sediment load channels, (2) mixed-load channels, and (3) bedload channels.

Table: 1 Classification of River channel pattern.

Type	Morphology	Sinuosity	Load-type	Erosive behaviour	Depositional behaviour	W/D ratio
Meandering channel	Single-channel (maybe inner point bar channels)	>1.05	Suspension or mixed load	Channel incision, meander widening	Point bar formation	<40
Braided Channel	Two or more channels with small islands	>1.30	Bedload	Channel widening	Channel aggradation, mid-channel bar	>40

SOURCE: M. Morisawa, (1985), S.A. Schumm, (1963b) and A.D. Miall, (1978).

Morisawa after amalgamating the classificatory schemes of Schumm and A.D. Miall presented a unified classification of alluvial channels in 1985, wherein 3 major categories of channel patterns have been identified based on morphological characteristics, sinuosity index, sediment load types, and erosive and depositional behaviour e.g. – (1) Straight channel (2) Meandering channel (3) Braided channel. Friend and Sinha have proposed a morphological classification of alluvial channel systems. The classification is established on sinuosity and braiding parameters. Braids, single channels and multi-channel are characterized into four groups. The further two types, single with low sinuosity (straight) and multi-channel with high sinuosity (anastomosing) are abundant less.

1. Meandering Channel pattern

The studies have been presenting that there is a better meander wavelength of sand and gravel transferring rivers than silt-clay transporting rivers. The rivers flow through the narrow path and go through the curved, and rough paths. Thus, the turning point in the river's path is called the Meandering River. There are two edges of the Meander; the stream of the river directly collapses on a concave

slope and further erosion. The regularity of bends is the result of the dominance of hydrodynamics factors whereas irregularity is caused by random topographical, sedimentological or artificial disturbances.



Figure: 2 Aerial photograph of valley meanders in bedrock cut by the Ganga River of the study area. (A) view of the meandering river, Mirzapur city, (B) view of the meandering river, Bhogao Ghat.

It may be concluded that the incident was due to special conditions. It is, on the other hand, true that meandering divisions are mainly common in areas everywhere fine silt or clay creates the dominant load, or where is a moderate gradient of the stream channel. the cliff is formed on the concave bank. On the other hand, the convex slope is deposited rather than erosion. The meandering channel takes on a curved path, like a screw yarn, and is likely to retain a meander form, but it is unknown whether the flow of water in the pattern causes meandering, or vice versa. While studying (Fig. A), a large meander makes the river Ganges in the middle of Vindhya Ghat from to Company Ghat. the left bank, further (Fig. B) it has come with the convex slope towards the right bank where the Mujahra Kalan and Bhogao Ghat is located. Apart from this, the river Ganges flows through many small and extinct routes from Rampurghat to Chunar.

2. Braiding channel pattern

When the amount of water decreases during the summer and due to the speed of flow of water, the river deposition begins to do more. As the sandy island starts to appear in the middle of the river's

stream and the river started flowing in many branches. This type of Channel is called the Braiding channel pattern. This type of representation is split into several areas of the study area.

Braided ranges consist of two or more channels divided by bars or islands, with one channel usually being dominant. They are considered by unstable bars and islands; temporal changes in their (bars and islands) locations, size and shape; everyday changes in banks and thalwegs with changes in discharge; high width/depth ratio less total channel widths of separated channels than the width of single-channel overhead the point of division; steep slopes and large bed loads. The Ganga River also forms a braided channel pattern (Fig. A) view of the braiding channel, near Ram Gaya Ghat, (Fig. B) view of braiding channel, Shastri bridge at Mirzapur city (Fig. C) near Bhatauli Ghat, (Fig. D) view of braiding channel near Chunar (Balu) Ghat. Where channels are intercrossed by inter-connecting channels forming sand bars and the Channel Islands. This channel pattern concerns maximum areas in the middle section of the study region.

3. Geomorphological description and Micro landscape of the river Ganga

The Ganga Valley can be divided into two forms of landforms of river valley located area.

3.1 Natural landscape

Natural landforms are formed by this type of hydraulic process by erosional and depositional works, the depositional landforms are found in the Ganga valley rather than erosional landforms. Because here the river Ganges is advancing towards maturity - "Bluffs, cliffs, riffles, pools and gully are found in erosional landforms."

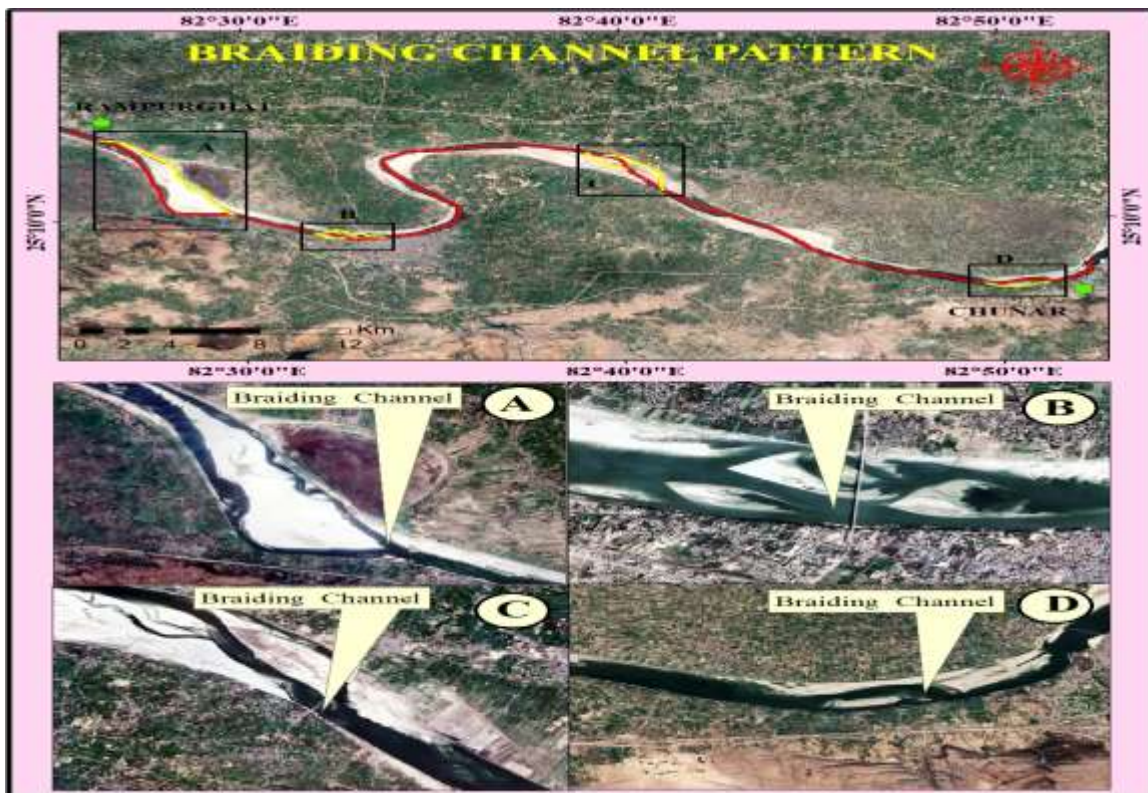


Figure: 3 Aerial photographs of valleys braiding pattern of Ganga River of the study area. (A) view of braiding channel, near Ram Gaya Ghat (B) view of braiding channel, Shastri bridge at Mirzapur city (C) near Bhatauli Ghat, (D) view of braiding channel near Chunar (Balu) Ghat.

Bluffs are found in the Ganga valley from Rampurghat to Chunar. It is found in the straight channel pattern. The result of erosion is found in the form of a slope that is temporary. Whose height was found from 2 - 3 feet to 6 - 7 feet during the study?



Plate: 1 Photograph of a river bluff in the Ganga River in the study area. (A) view of river Bluff, near Ram Gaya Ghat (B) view of river bluff at Vindhyachal Ghat.

River Cliffs are the interminable permanent or non-permanent sandstone banks of the river, whether they are permanent. In the study area during fieldwork on the river Ganga from Rampurghat to Chunar, it was found that there is a lack of river cliffs on the left bank in the Ganga valley at Chak Niranjana, Majhara, Chilh, Mujahara Kalan, Bhogao, Garauli, Kachchhawa, Ramgarh Kalan, and Misirpur. Then it was found on the right bank of the river Ganga in the study area at Jaunpa, Babura, Akorhi, Vindhyachal Ghat, Mirzapur City, Baisukhiya, Newaria, Ledu, Chauhanpatti, Dewahi, Sindhaura, and Chunar. The river cliff is found 3 km in length and 10-15 feet high at available many sections.



Plate: 2 Photographs of a river cliff in the Ganga River in the study area. (A) view of river cliff, near Pakka Ghat (B) view of river cliff at Company Ghat.

Riffle and pools: The pool is manufactured by erosion. A pool is an area of the stream that had greater depths and is slower. The stream where the water breaks over cobbles, gravel, and boulders or where the water surface is visibly broken. Riffle is a shallow and fast-moving section of a stream; they are areas with a fast current where the rock breaks the water surface. They are both seen in river streams,

riffles are the area of the stream that is the highest, shallowest point whereas pools are the lower dips of the stream.



Plate: 3 Aerial photographs of riffle and pool in the Ganga River of the study area. (A) aerial view of step-pool morphology near drainage outlet at Shastri bridge, (B) aerial view of the pool – riffle channel near drainage divides at Bhatauli bridge.

Rill and Gully's erosion is a lack of forests in the Ganga valley and the development of the rills, gully and the angle of elevation by the erosion of rainwater has developed. It flows about 22 km distance from Rampurghat to Mirzapur city and after this, it flows 12 km distance from Mirzapur city to Ledu town and continues to flow 30 km distance from Ledu town to Chunar.



Plate: 4 Photographs of the rill and gully in the Ganga River in the study area. (A) view of Modana nala, near Rampurghat (B) view of Ojhala nala near Mirzapur city, (C) view of Pahari nala near Vindhyachal Ghat.

The tributaries such as the Ojhala Nala, Khajuri Nala, Barhaiya Nala, Gguggha Nala, Machchharmala Nala, Gurkhauli Nala, Karnauti Nala, Durga Nala, and some streams such as Belwan Nadi, Hurray minor, right lower Khajuri canal, left lower Khajuri canal, Tarha minor and Pathanal minor come from Kaimur uplands, form dendritic to sub-dendritic drainage patterns while the tributaries originating over the Kaimur hills, make parallel patterns.

3.2 Depositional landscape

From the confluence of Rampurghat to Chunar, there is the primacy of deposited alluvial plains in Ganga valley. On the confined grounds of the Ganga River, on each side of the depositional plain, on

the north side of the Ganges River, there is a wide bound field, which is quite fertile and sandy and barren elsewhere. On which small shrubs are grown such that the small plants of scrubs, Dhatura, Acacia etc. and the southern shore have settled in Ram Gaya Ghat, Vindhyaachal Ghat, Mirzapur City, Bhogao Ghat, Kachchhawa, Chunar etc. From Mirzapur city to the Mujahra Kalan area, there is an expanse of wide floodplains on both sides of the river.

During the fieldwork, many sand islands are found in the Ganga valley from Rampurghat to Chunar. For those who see more in April and May months in the summer season, their size is uneven. The length is not fixed. Can be from 10 to 400 meters or smaller. In the study area, the depositional plain is found on both river banks a large amount in the Ganga valley. The alluvial plains and water distributaries are deposited in the depositional landscape in the river Ganga.



Plate: 5 Aerial photographs of depositional landscape in the Ganga River of the study area. (A) view of the depositional plain from Kewataveer to Bhatauli village Rampurghat (B) view of the sand bar from Rampurghat to Baisukhiya village. (C) view of dunes, near Ram Gaya Ghat.

3.3 Man-made Landforms

The man-made landform is the result of human economic and social work - the following major human formations were found in the Ganga Valley: Agriculture lands the studying in the Ganga Valley of the study area, has found in the fields along with the plains and multi-coloured the land, where the farmers can produce watermelon, melon, cucumber, local vegetables in their field with great efforts and reverence etc., which comes under growing agriculture because the number of small landholders is high. Small farmers are irrigating the river by the river and by using pots made from their fields. After finding the farmers that these plants are like children to them. They consider it money but a strange thing is that farmers are seen wearing sandals in their fields on sand island farms located.

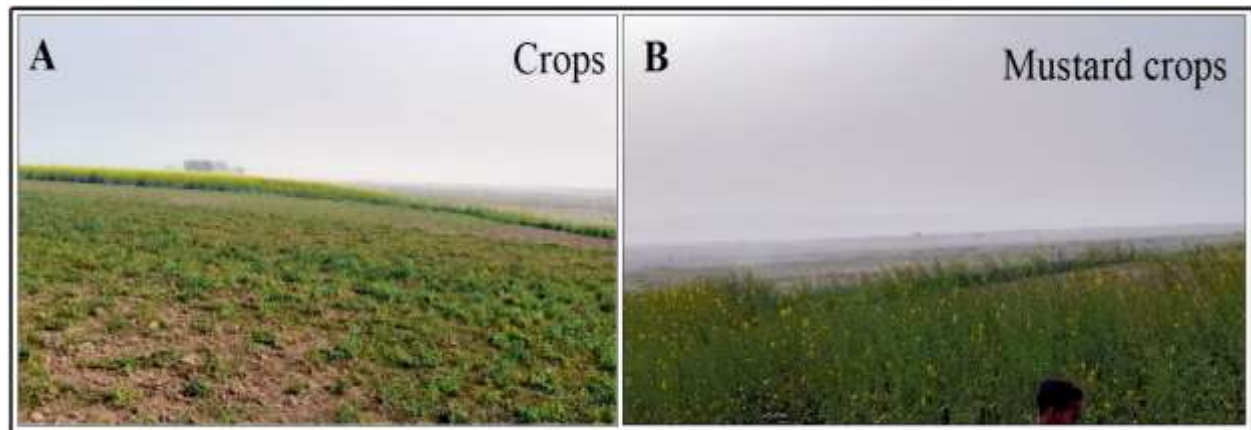


Plate: 6 Photographs of agricultural land in the Ganga valley of the study area. (A) view of wheat crops at Baisukhiya village (B) view of mustard crops at Kachchhawa village.

Bridge, from the study area, these bridges play an important role in ensuring social and cultural development as well as trade and commerce by working to connect one city to another city and a sub-region from one city. There are a total of two bridge views. The first is at the bridge junction, who connects the area of Chilh block and Mirzapur city. Here the bridge length is 1.5 km. and the second bridge is connecting the area of Kachchhawa village and Bhatauli village. The length of bridges is 1 km. Temple is situated on the right bank of the river Ganga. This temple is well known for old Kashi (like Varanasi) Bhogao Ghat. Here is a beautiful temple situated on the Ganga River, such as the lord of Shiva's temple situated on the bank is a huge temple that is a wonderful specimen of architecture. Here it is used for boating and other recreational activities. Cremation or funeral of dead bodies is done and it is also used for performing the last riots of the human being.



Plate: 7 Photographs of the bridge in the Ganga valley of the study area. (A) view of Shastri bridge connects Chilh block and Mirzapur city. (B) view of Bhatauli bridge connects Kachchhawa and Bhatauli village.



Plate: 8 Photographs of the temple in the study area. (A) view of Shree Trilochan Nath Mahadev temple at Mirzapur city. (B) view of Ancient Kashi Shiv temple at Bhogao Ghat.

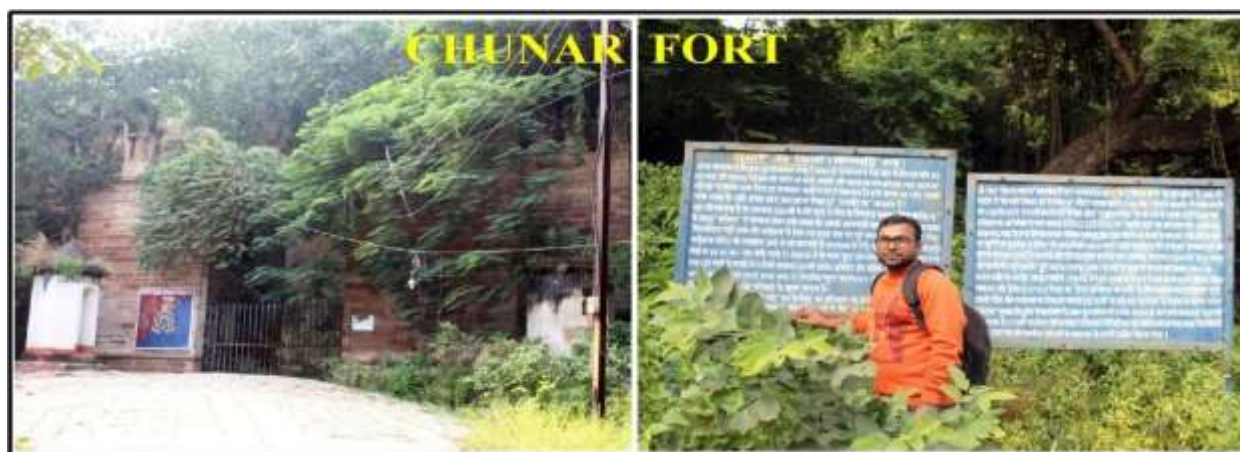


Plate: 9 Photographs of the Chunar fort of the study area. (A) view of the front picture of the fort of Chunar at Chunar city. (B) view of Archaeological signboard by tourism in Uttar Pradesh.

The Chunar fort is situated in Chunar city of the study area. The southern part of the fort is on the rocky bank of the river Ganga. Northview of the fort from across the Ganga River stand on a rock, detached part of the Vindhya Range. The fort of Chunar is situated on the bank of the river Ganga. The embankment: The Shastri bridge has been built 1-2 km length embankment to sandstone cover, which protects the northern part of the Mirzapur city from the floods of the river Ganga and the traffic continues to also play an important role. The strong cobbles and boulders on the north side of the Shastri bridge have been constructed, to save the rural and suburban areas from the effects of floods in the rainy season. River Ghats: The Ganga River has a special religious significance for the Hindu religious people. The religious, economic and social activities are seen, the Vindhyachal Ghat has situated as the biggest Ghat and other Ghats like Ram Gaya Ghat, Pakka Ghat, Bhogao Ghat, and Sindhaura Ghat. Each year. Cremation or funeral of dead bodies is done and it is also used for performing the last riots of a human being. During the Dushahara festival, hundreds of idols of the soil on the Durga Pooja, Ganesh Chaturthi and the river water are also polluted by the chemical colour used in colouring it. The major Ghat of the study area findings of the field survey was Rampur Ghat, Bhogao Ghat (Bhadohi), Ram Gaya Ghat, Vindhyachal Ghat, Chaubey Ghat, Pakka Ghat, Baria Ghat, Nar Ghat, Company Ghat and Chunar (Balu) Ghat of the study area.



Plate: 10 Photographs of the embankment of the study area. (A) view of the sandstone embankment at Mirzapur city. (B) view of embankment made by sand and stone at Chaubey Ghat.



Plate: 11 Photographs of the river Ghat to the study area. (A) view of Ram Gaya Ghat. (B) view of Vindhyachal Ghat. (C) view of Pakka Ghat at Mirzapur city. (D) view of Bhogao Ghat as a famous ancient old Kashi (The lord of Shiva temple).

Conclusions

In the study area, it has received much important and knowledgeable information by field surveying the channel pattern, the micro landscapes, and major Ghat in the Ganga valley. During the study has also understood and examined the practical side of the hypothetical knowledge. It also came to the knowledge that the ecological development of the Ganga River in reality and the importance of human, social, and economic development is important. There has been direct knowledge of many landmarks such as wave-cut of cliff, bluff, pool, rifle, bar, channel island, sand island etc. which often get

degraded. Crores of devotees come to cremation today, especially due to the special religious significance of the Ganga River, especially among the Hindus. Even today many people like to do cremation on the banks of the river. It was also seen how the children of poor households, like the sailors, tied dozens of magnets in the rope and dug the coins put by the devotees on the river. There are also several reasons for the pollution in the river Ganga. One important thing is changing, originally cultivated by local farmers and they work in their fields with great effort and courage. Thus, there is also the knowledge of increasing interference in social, cultural, economic and technical human beings.

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