Ganga Cultural Documentation
2020

VAISHALI DISTRICT

Natural Heritage Documentation

NAMAMI GANGE

National Mission for Clean Ganga

INTACH

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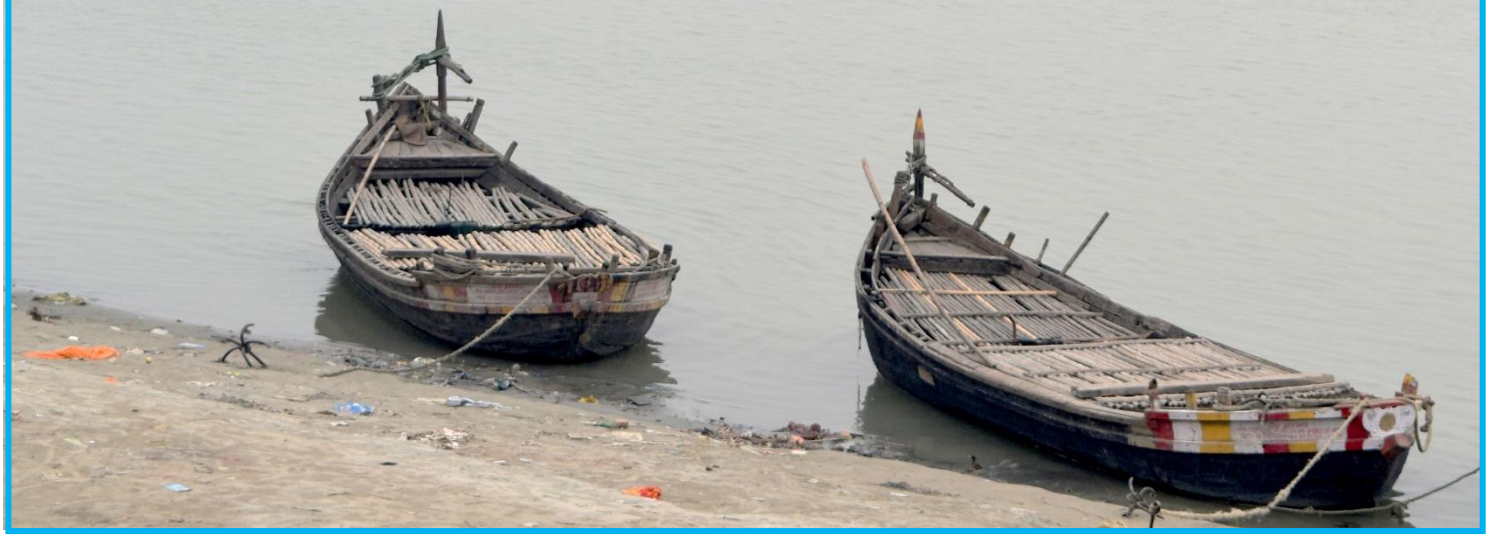

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December, 2020

Sponsored by :

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1.0 Introduction

1.1 Vaishali Distt. (25°41′N, 85°13′E / 25.68°N, 85.22°E) is one of the centrally located Distt.s of Bihar state having a very special place in history owing to the birth of the last Jain "*Thirthankara*" Lord Mahavir here. Another important reason is the last sermon delivered by Gautama Buddha after which he announced his *Parinirvana* (attainment of enlightenment) on this holy soil. Due to these reasons, numerous references of Vaishali can be found in various texts of Buddhism and Jainism which have preserved much information on Vaishali and the other Maha Janapadas. Based on the information found in these texts, Vaishali was established as a republic by the 6th century BC, prior to the birth of Gautama Buddha in 563 BC, making it the world's first republic (https://vaishali.nic.in/about-district/).

1.2 Until 1971, this Distt. was known as Hajipur sub-division under the erstwhile Muzaffarpur Distt. It acquired the status of a full-fledged Distt. on 2nd October, 1972 and has a current geographical area of 2,015.37 sq.km. It is bounded by the Muzaffarpur Distt. on the north, Patna Distt. on the south, Samastipur Distt. on the east and Saran Distt. on the west [Map 1]. The Distt. Is divided into three sub-divisions namely – Hajipur, Mahua and Mahnar which are further divided into sixteen developmental blocks.

1.3 The Distt. comprises of an extensive plain formed by the alluvium brought by the Ganga, the Gandak and other rivers which flow through it. It lies on the south of the Burhi Gandak and is bounded by the Ganga on the South and the Gandak on the south-west. The morphology of the area has been shaped mainly by processes of the river Gandak which has its origin in the Himalayan ranges in Nepal. Morphologically it can be classified into three broad categories (MSME, 2016):

a. Hazipur Surface: It is the oldest morpho-unit of the area comprising yellow brown to brownish-grey compact clay.
b. Vaishali Surface: It overlies the Hazipur surface. This surface comprises ashy grey silt, silty clay and has been found oover the eroded very gently sloping Hazipur surface.
c. Diara Surface: It is the lowest and youngest geomorphic unit which emerges from riverbed. The *diara* forms after the main channel has migrated and can also be called as the old riverbeds.

Map 1: Location Of Vaishali Distt.

1.4 The Distt. is characterized by a wide variety of soils which can be broadly grouped into two categories: 1) Entisols: also known as Balsundari, these are the younger alluvial soil with a light friable loam with a higher proportion of sand and silt. 2) Inceptisols: locally known as Mathivari these calcareous alluvial soils occur mostly in the central part and is richer in lime content and kanker than Balsundari soil ((CGWB, 2013). The climate of the Distt. is warm and temperate. Though both the summers and winters receive rain, the scales are tipped towards the summers with 270 mm. The average annual temperature is 25.4 ° C with annual average precipitation of 1000 mm. (Climate-data.org)

1.5 Vaishali Distt. is connected with Patna Distt. through the Mahatma Gandhi setu [Image 1] which was constructed in 1982 and served as the longest bridge in India till 2017 with the total length of 5.75 kms. Till today this bridge serves as an important connecting link for North Bihar with the rest of Bihar through the capital city of Patna with thousands of vehicles crossing it daily.

Image 1: Gandhi Setu Connecting Vaishali Distt. With Patna Distt.

2.0 Ganga River In Vaishali Distt.

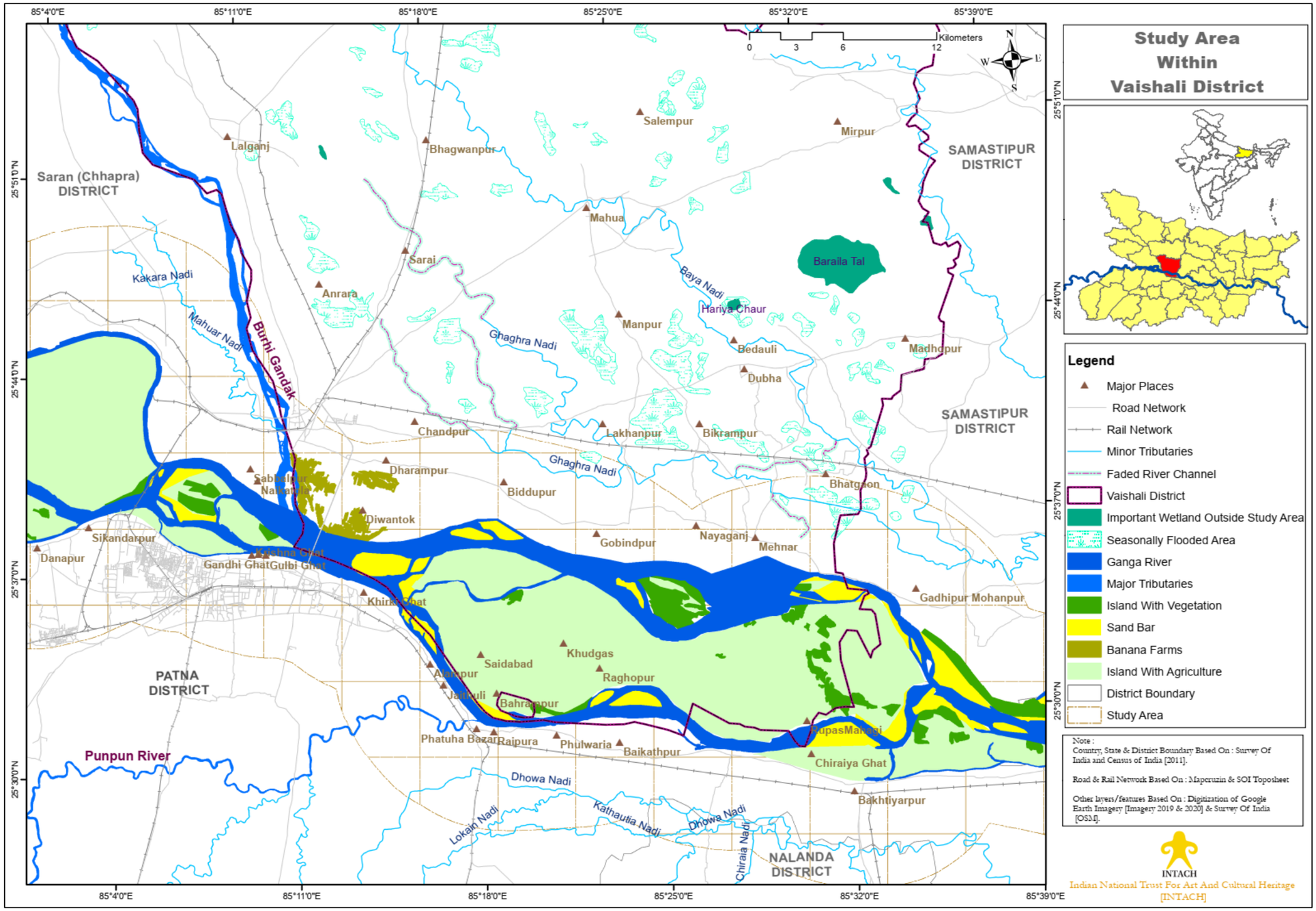
2.1 Ganga River enters Vaishali Distt. just after its confluence with Gandak river in Hajipur sub-division. It flows as a single stem till a little distance after Mahatma Gandhi setu and then is divided into two branches by Raghopur diara. Its left branch then flows alongside Nawa nagar, Bidupur, Chechar until Baba Ganninath Manidr in Hasanpur encompassing many sand bars and one or two small diaras which all form a part of Raghopur diara administrative block. During its flow throughout the Distt., the water levels keep changing with shallow in most parts and deep in some parts. However, most of the river stretch in this Distt. dries up during winters and summers exposing the sand resources which is frequently exploited by the locals [Image 2]. After traveling a distance of almost 40 kms, the river leaves Vaishali Distt. at Hasanpur to enter Samastipur Distt.

Image 2 : Dried Up Ganga River Bed As Observed Near Hajipur In Vaishali Distt. On 20th December, 2020

3.0 Methodology

3.1 Ganga River flows in Vaishali Distt. for 40 kms adjoining it mostly on the left bank. Hence, for carrying out the ground survey a 7 km of buffer zone on the left bank of Ganga River was selected encompassing a total area of 460 sq.km. The selected study area was further divided into grids of 5 × 5 km for field survey [Map 02]. Based on the secondary information analyzed and the features noted on Google Earth imagery, plan for the fieldwork was constituted to cover different elements of natural heritage in these grids. Special focus was laid on denoting the sites important for riparian biodiversity, riverine fishing, boat making communities, river and stream confluences, important water bodies and oxbow lakes. Furthermore, contacts were developed with various stakeholders including riparian & *Diara* communities in the Distt. for carrying out relevant interactions.

3.2 The field survey in Vaishali Distt. was undertaken from 14-24 December, 2020. The documentation and necessary permissions for the survey were taken from DM Office in Hajipur. During the survey, areas such as Hajipur, Bidupur, Gobindpur, Jadhua, Mahnar, Chechar and Hasanpur were visited where good quality pictures related to the study were collected using Nikon D3400 DSLR camera. The GPS locations were also collected using Garmin hand-held GPS and videography at the study sites was done using Sony Handycam. The plants observed in the survey were identified based on available handbooks and online databases while the birds observed in the survey were identified using Grimmett et al. (2011). The information on current status of Ganga river and changes from the past was obtained from detailed interactions with different stakeholders such as agriculture and cattle farmers, temple priests, village heads, fishermen, boatmen, etc.



Map 2: Study Area In Vaishali Distt.

4.0 Tributaries Of Ganga River

4.1 **Gandak River:** It is a left bank tributary of Ganga river and one of the major rivers in Nepal and India. Originating in Tibet near the northern Nepal border, it is known for a distinguishing deep gorge known as the Kali Gandaki Gorge between the mountains Dhaulagiri and Annapurna. The river is joined by Rahught Khola at Galeshwor at the south of the gorge, Myagdi Khola at Beni, Modi Khola near Kushma and Badigaad at Rudrabeni. A major tributary, Trishuli, at Devighat, joins Kali Gandaki just as the river exits the foothills of the Himalayas into the southern plains of Nepal. From Devighat, the river flows southwest and is called Narayani or Sapt Gandaki. The river then meanders back towards the southeast and enters India. After entering India, the river flows for an extended length of about 300 kms across the Gangetic plains of Bihar state. It finally merges with Ganga river near Hajipur in Vaishali Distt. [Image 3]. **This river serves as an important habitat for the Gangetic river dolphin and Ghariyals.** Map 3 depicts the Gandak river confluence in our study area along with other tributaries flowing in the Distt. **The course of the Ghagra river towards the end has been extinguished, a situation which needs to be addressed.**

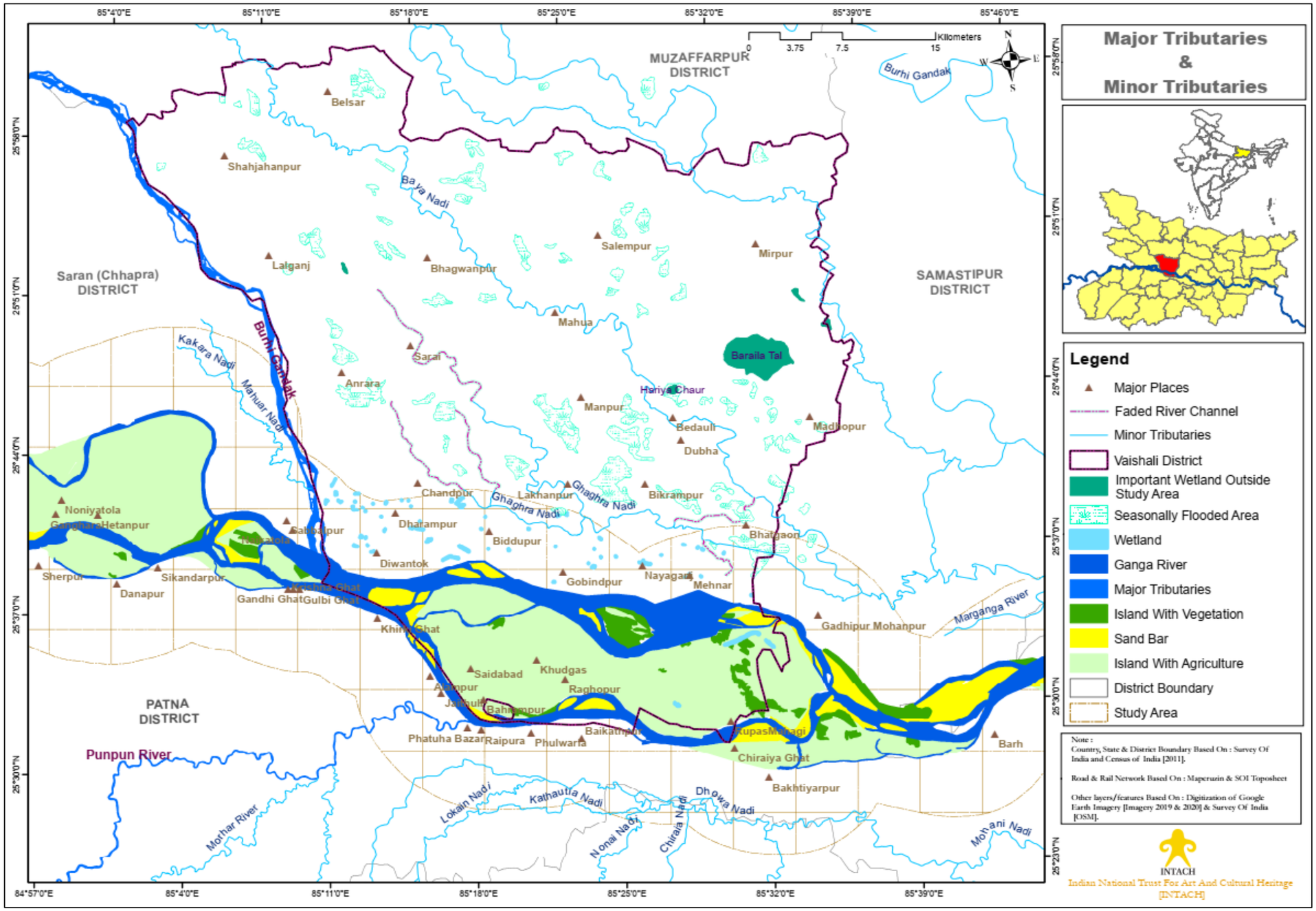
Image 3: Gandak River Near Hajipur In Vaishali

4.2 **Sacred Ghat on Gandak River Bank:** Located at a little distance from Gandak-Ganga confluence, Kaunhara Ghat is one of the main ghats in this region where cremation and worshipping have taken place for many centuries. This Ghat derives its name from a mythological legend according to which a fight between an elephant (*Gaja*) and a crocodile (*Graah*) took place at this site due to which people started asking *Kaun Haara* (meaning who lost). Lord Vishnu himself had to appear and intervene in this fight during which he killed the crocodile to give him instant salvation and saved life of the elephant. This legend is depicted at many places including the Ghat [Image 4] and has become an emblem for Hajipur railway station, Sonepur mela and other notable places nearby. Upon interaction with the locals including saints of the temples, all of them lamented the lack of sanitation and cleanliness and unavailability of facilities such as washrooms and dustbins which ultimately lead to the filth going into Gandak river.

Image 4: Kaunhara Ghat On Gandak River Bank

4.3 Located adjacent to Kaunhara Ghat is an 18th century-built temple which needs a special mention. This temple is known locally as 'Nepali temple' and was built by a commander of Nepali Army named Matbar Singh Thapa (Kumar, 2018). This temple is popular for its wooden artwork which mostly comprises of erotic scenes similar to that of Khajuraho [Image 5]. Once, a popular site for tourists, this temple is in a dilapidated condition due to negligence and might lose its entire structure if not paid attention to in coming time.

Image 5 : 18th Century Nepali Temple Near Kaunhara Ghat



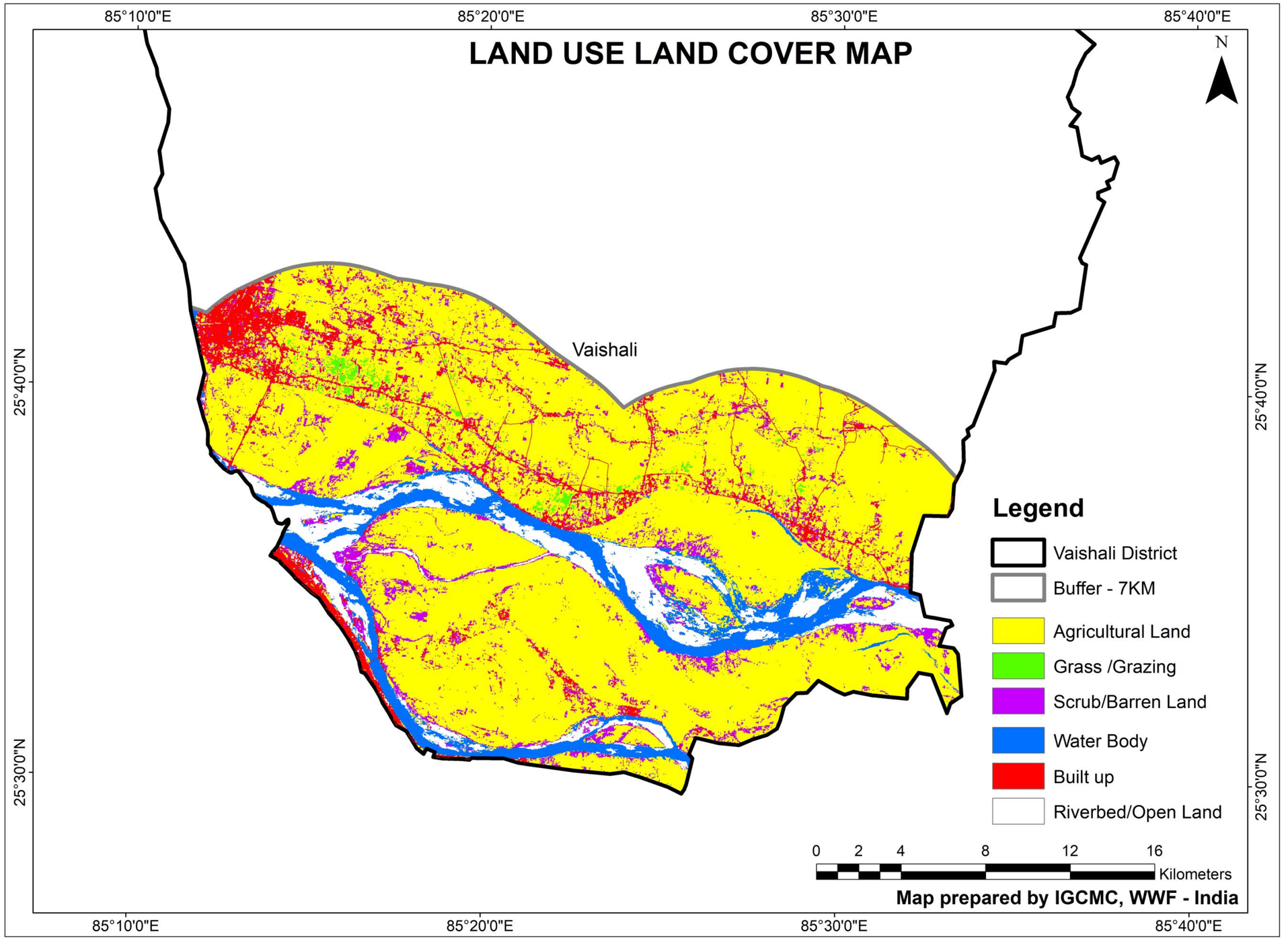
Map 3 : Major And Minor Tributaries Of Ganga River In The Study Region

5.0 Land Use/Land Cover

5.1 Land Use Land Cover (LULC) Map of the study corridor has been prepared from Landsat imagery. Using supervised classification system, 6 different classes were generated – agricultural land, grass/grazing, scrub/barren land, water bodies, built up area and river bed/open land. Agriculture being the principal source of income for residents of Vaishali Distt., the agricultural land cover was recorded to be 407.68 sq.km. which forms roughly 70% of the total study area. This also includes vast areas of Ganga river floodplain which are under extensive cultivation for various crops. The built-up area covering about 31.63 sq.km. in the study area mainly includes the towns of Hajipur, Bidupur, Chakaushan and Mahnar along with other small villages. The open land covering about 41.75 sq.km in the study area includes to a large extent the dried-up Ganga river bed in winter and summer seasons. The details of these classes in terms of area covered are presented in Table 1 and the land use of the Distt. is depicted in Map 4.

Table 1 : Land Use/Land Cover Details Of Study Region In Vaishali Distt.

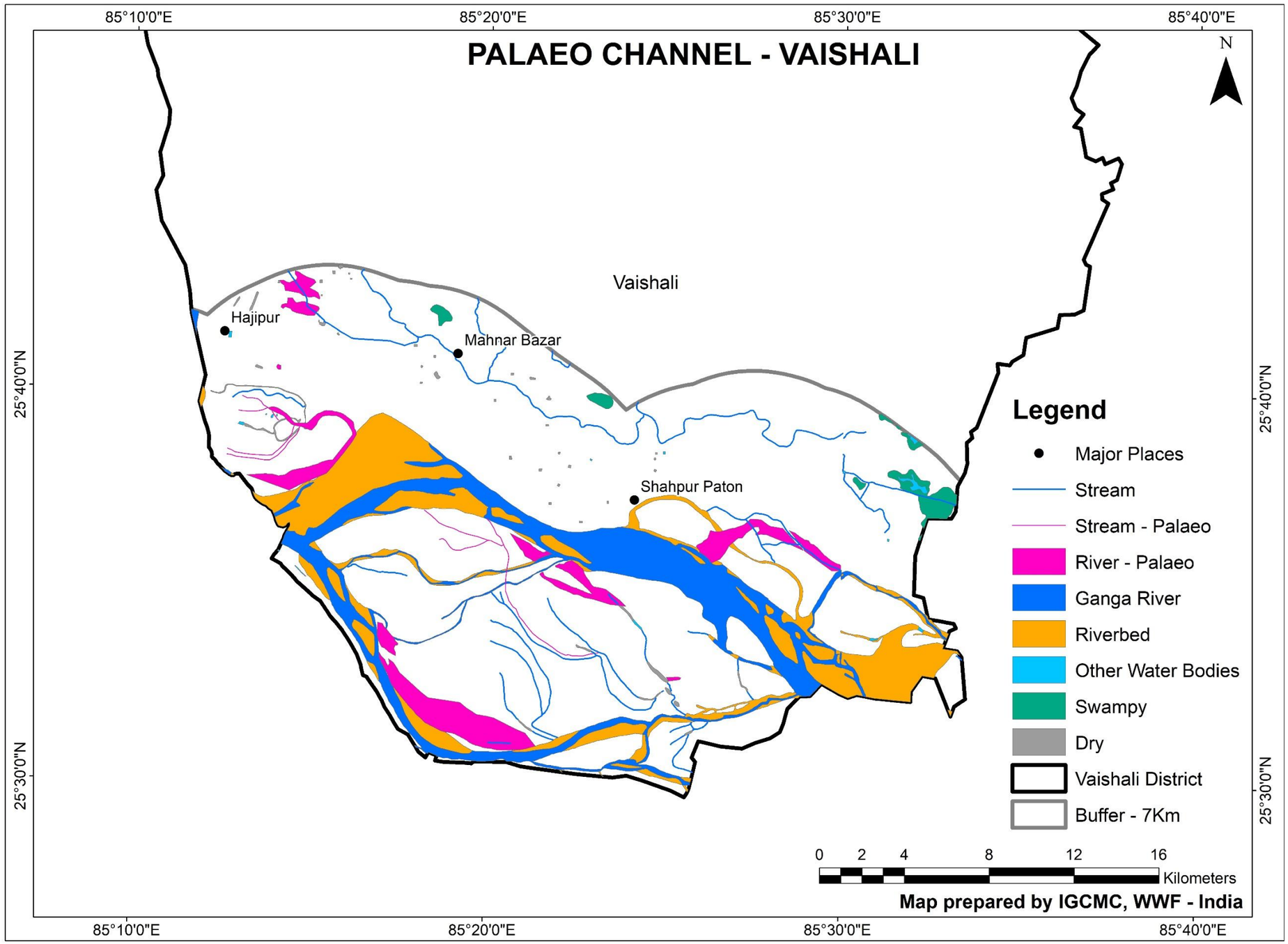
Vaishali Distt.			
Class	**Area (Ha)**	**Area (Sq.Km.)**	**Area (%)**
Agricultural Land	40768.000	407.680	70.311
Grass/Grazing	378.854	3.789	0.653
Scrub/Barren Land	4797.580	47.976	8.274
Water Body	4698.490	46.985	8.103
Built up	3163.500	31.635	5.456
River Bed/Open Land	4175.610	41.756	7.202
Total	**57982.034**	**579.820**	**100.000**



Map 4: Land Use/Land Cover Map Of Study Region In Vaishali Distt.

6.0 Palaeochannels Of Ganga River In Vaishali Distt.

6.1 Decline in natural flow of a River or stream decreases the sediment flushing ability of the Rivers. It may be a reason behind the disappearing of River channels in the Ganga River basin. Apart from that various other factors such as change in land use pattern, sand mining, agricultural practices and brick kilns may also lead to disappearance of streams and river channels in the region. These palaeochannels do not carry water during most of the year but may flow during flood events. Such abandoned and silted palaeochannels of the past can be mapped using the remote sensing techniques. Hence, based on the available satellite data and subsequent remote sensing analysis, Map 5 was prepared which depicts the various paleochannels in the study region of Vaishali Distt.



Map 5: Palaeochannels In The Study Region

7.0 Floodplain Of Ganga River In Vaishali Distt.

7.1 The active flood plain of a river is defined as an area on either side of the river channel with regular flooding on a periodic basis. Maintaining active flood plain of a river is critical for assuring equilibrium in ecosystem. The floodplains harbour rich biodiversity including riparian vegetation as well as many other groups of organisms which help in maintaining fertility of this region. Along with this, the floodplains have been of great cultural and economic importance with many early civilizations having risen in these fertile lands. As the rivers naturally meander through the landscape over a period of time, they deposit sand, silt and other soil forming materials in the floodplain region which make them ideal for agricultural production. Throughout history, people have learned to cultivate in the fertile floodplains and use their rich resources for sustaining livelihoods. Even today, in most of the riverine regions especially in India, the floodplains have been occupied by local farmers for carrying out their agricultural activities especially in the non-monsoon season. Ganga River floodplain is one such important floodplain in India which has been extensively utilized in almost all the districts, where it passes through, for agricultural purposes.

7.2 Vaishali Distt. falls under the North West Alluvial Plain Zone according to NARP (National Agricultural Research Project) with the major soils being sandy soil, coarse sandy loam soil, fine sandy loam soil, clayey soil and saline/calcareous soil. Agriculture is one of the major sources of income for the residents of the Distt. and it is benefitted by the fertile alluvium brought by Ganga river and its tributaries. Vast floodplain lands of Ganga river could be observed under cultivation throughout the Distt. with the major crops being wheat and mustard [Image 6]. Mustard crop is mainly grown for seed oil which forms an important part of the diet in this region. Apart from this, the fields also yield rich growth of vegetables such as cabbage, cauliflower, potato, onion, cucumber, Lal saag and parwal [Image 7]. In some areas, the crop cultivation could be observed upto the edge of the active flow channel of Ganga river indicating that the villagers expanded their fields till the current river channel. The details of some villages surveyed along with their floodplain agriculture produce is provided in Table 2.

Image 6 : Mustard And Potato Crops Cultivated In Maniarpur Village

Image 7 : Cauliflower Cultivation In Ganiari Village

Table 2 : Some Floodplain Villages Along With Their Agricultural Produce In Vaishali Distt.

Sr. No.	Village Name	Agricultural Produce
1.	Maniarpur	Mustard, Potato, Cabbage, Onion, Cauliflower
2.	Ganiari	Mustard, Cauliflower, Potato, Radish, Wheat
3.	Bidupur	Mustard, wheat, Parwal, Lal saag
4.	Sultanpur	Wheat, Mustard, Corn
5.	Nayagaon	Mustard, Cauliflower, Parwal, Lal Saag

7.3 **Floodplain Horticulture :** Banana is a major horticultural crop throughout Vaishali Distt. with huge lands under its cultivation including many fields situated on Ganga river bank [Image 8]. It forms a major source of farmer's income in this region owing to the good returns they get against investment on its plantation. Some of the major banana varieties cultivated in Vaishali are Chinia, Alpan, Battisa and Kothiya. Among these, the Chinia and Alpan varieties are known for their small, sweet and tasty banana fruits and are most commonly available in this region [Image 9]. Whereas the Kothiya variety is believed to be rich in Iron and other minerals due to which it is especially given to pregnant ladies and patients recovering from various ailments [Image 10]. The Battisa variety of banana is mainly used in its raw form as a vegetable as its ripened fruits are not found to be as tasty as the other varieties.

Image 8 : Banana Fields Along Ganga River Bank In Vaishali Distt.

Image 9 : Alpan Variety Of Banana

Image 10 : Kothiya Variety Of Banana

7.4 **Floodplain Grasses :** The two most common floodplain grass species found distributed throughout the study region are – *Saccharum spontaneum* L. and *Saccharum bengalense* Retz. (commonly known as *Kattha* or *Kaans*) [Image 11]. Both these grasses are tall, perennial grasses growing widespread in river bank and floodplain areas of Ganga in the study region. Upon interaction with the locals, it was found that these grasses in the dried form were commonly used for thatching roofs of huts and other temporary settlements throughout [Image 12].

Image 11: *Saccharum spontaneum* L. Growing On Ganga River Bank Near Madhurapur

Image 12: Dried *Saccharum* Grass Collected For Roof Thatching Near Sultanpur

8.0 Wetlands In Vaishali Distt.

8.1 Wetlands are one of the most productive and unique ecosystems. They help in maintaining the food web and provide habitat for the aquatic biodiversity. They also help in controlling floods, recharging groundwater, nutrient recycling, climate stabilization and carbon sequestration. According to the report prepared by Tare et al. (2012) about 402 wetlands are reported in Vaishali Distt. which include – lakes/ponds, oxbow lakes, riverine wetlands, waterlogged areas, rivers/streams, tanks or ponds and wetlands of smaller areas (<2.25 ha). However, in this study a total of 67 different wetlands are identified in the study region with the help of Google imagery and satellite data out of which some selected wetlands are discussed in this section. The list of identified wetlands is presented in Table 3. And their spatial distribution is depicted in Map 6.

Table 3 : List Of Wetlands Recorded In The Study Region

Sr. No.	Wetland Name	Coordinates		Area [in hectares]
		Latitude	Longitude	
01	01	25°41'47.22"N	85°12'37.28"E	3.0
02	02	25°41'19.76"N	85°12'41.49"E	3.67
03	03	25°41'1.89"N	85°12'11.83"E	2.83
04	04	25°41'0.60"N	85°12'47.68"E	0.72
05	05	25°40'56.79"N	85°12'52.93"E	1.18
06	06	25°41'14.36"N	85°13'37.18"E	0.63
07	07	25°41'14.41"N	85°13'45.75"E	0.43
08	08	25°40'32.69"N	85°13'32.86"E	5.63
09	09	25°38'56.88"N	85°13'24.24"E	3.30
10	10	25°40'54.97"N	85°13'33.76"E	0.82
11	11	25°40'42.26"N	85°13'26.80"E	0.57
12	12	25°40'45.67"N	85°14'24.72"E	0.45
13	13	25°40'37.21"N	85°13'54.12"E	0.74
14	14	25°40'24.30"N	85°14'0.55"E	0.66
15	15	25°40'45.00"N	85°15'1.09"E	1.80
16	16	25°40'31.99"N	85°16'11.48"E	0.31
17	17	25°40'6.27"N	85°14'44.83"E	0.40

18	18	25°39'21.32"N	85°13'41.88"E	1.33
19	19	25°39'19.65"N	85°13'45.78"E	0.58
20	20	25°39'17.19"N	85°13'56.10"E	0.63
21	21	25°38'56.60"N	85°13'59.38"E	0.62
22	22	25°38'37.99"N	85°14'10.82"E	1.36
23	23	25°39'30.74"N	85°14'49.96"E	0.45
24	24	25°39'33.62"N	85°14'52.82"E	0.24
25	25	25°40'48.71"N	85°15'46.59"E	0.23
26	26	25°40'46.82"N	85°16'5.85"E	0.36
27	27	25°39'47.51"N	85°16'32.69"E	0.37
28	28	25°39'28.23"N	85°16'26.63"E	9.19
29	29	25°38'57.66"N	85°16'54.55"E	5.10
30	30	25°38'10.31"N	85°17'52.35"E	11.7
31	31	25°38'22.91"N	85°18'38.34"E	11.1
32	32	25°40'38.43"N	85°18'7.93"E	2.98
33	33	25°40'30.26"N	85°18'20.65"E	0.79
34	34	25°40'20.60"N	85°18'33.16"E	6.50
35	35	25°40'23.94"N	85°18'40.27"E	1.0
36	36	25°40'36.81"N	85°18'29.46"E	3.32
37	37	25°40'42.73"N	85°18'39.57"E	0.55
38	Bidupur Pokhar	25°39'15.20"N	85°19'25.63"E	0.81
39	39	25°39'45.98"N	85°19'39.88"E	0.43
40	40	25°38'22.18"N	85°19'41.17"E	0.81
41	41	25°38'15.87"N	85°20'39.13"E	1.32
42	42	25°39'6.41"N	85°21'40.01"E	1.1
43	43	25°36'40.80"N	85°22'39.24"E	1.24
44	44	25°38'14.71"N	85°22'52.16"E	0.21
45	45	25°39'37.17"N	85°23'11.02"E	0.88
46	46	25°39'33.14"N	85°23'4.40"E	0.83
47	47	25°39'35.95"N	85°23'30.83"E	1.39
48	Chandrapura Pond	25°37'25.30"N	85°24'21.92"E	0.38
49	49	25°37'37.97"N	85°24'58.46"E	0.57
50	50	25°38'29.25"N	85°24'58.91"E	0.59

51	51	25°38'25.20"N	85°25'2.88"E	0.59
52	52	25°37'15.59"N	85°24'34.61"E	3.30
53	53	25°37'36.64"N	85°25'41.18"E	0.80
54	54	25°37'21.07"N	85°26'57.11"E	0.53
55	55	25°37'12.52"N	85°27'4.96"E	6.68
56	56	25°37'31.35"N	85°27'49.71"E	0.35
57	57	25°37'53.90"N	85°28'55.26"E	0.91
58	58	25°36'36.85"N	85°29'4.76"E	0.59
59	59	25°36'30.05"N	85°28'53.07"E	0.31
60	60	25°37'36.84"N	85°29'47.89"E	1.20
61	61	25°36'29.27"N	85°29'37.40"E	0.66
62	62	25°37'23.83"N	85°30'47.02"E	099
63	63	25°37'42.99"N	85°29'34.82"E	0.85
64	64	25°35'26.70"N	85°31'55.62"E	0.88
65	65	25°33'35.74"N	85°31'18.51"E	40.40
66	66	25°33'16.18"N	85°32'36.17"E	8.28
67	67	25°30'52.79"N	85°28'0.06"E	4.27

8.2 **Thana Mor ka Pokhara:** This pond is located near the Mahnar Bazar Main road [Image 13] and gets this local name owing to a road curve (mor/mod) that leads to the Mahnar Police station (locally known as Mahnar Thana). Upon interaction with a local resident, it was found that this water body was used for fish rearing until 30-40 years ago. However, due to some disputes among local residents over the use of this pond, gradually it was left neglected and continues to remain in a shabby condition today. Garbage dumping in and around this pond happens to be a major issue resulting in its sad state [Image 14].

Image 13 : Location Of Thana Mor Ka Pokhara [25°36'29.98"N, 85°28'53.47"E]

Image 14 : Thana Mor Ka Pokhara

8.3 **Nayagaon Pokhara:** This Pokhara is a government owned wetland located a few steps inside from the Mahnar main road in Nayagaon village [Image 15]. According to some local residents, this wetland is believed to be more than 200 years old and used to occupy a huge area which was encroached upon as time passed gradually reducing it to the present extent [Image 16]. Currently this pond has been given on lease to a local resident for rearing fish which mainly include silver carp (*Hypopthalmichthys molitrix*), naini (*Cirrhinus mrigala*), buari (*Wallago attu*) and katla (*Labeo catla*). The residents reiterated the need for checking illegal encroachments and garbage dumping in order to safeguard the wetland resources.

Image 15 : Location Of Nayagaon Pokhara [25°37'20.71"N, 85°26'57.42"E]

Image 16 : House Encroachment Seen In Nayagaon Pokhara

8.4 **Chandpura pond:** This pond is also situated adjacent to the Mahnar main road in Chandpura village [Image 17] of Vaishali Distt. It is about 50-60 years old and is used for fish rearing by some local residents. A small Ghat is also constructed on this pond where the Chhath puja rituals take place by the residents of this village [Image 18].

Image 17 : Location Of Chandpura Pond [25°37'25.14"N, 85°24'22.10"E]

Image 18 : Chandpura Pond

8.5 **Ismailpur Pokhara:** This is an old wetland located adjacent to Hajipur-Samastipur road in Ismailpur village [Image 19]. Some local residents reiterated this lake to be more than 300 years old believed to have been built by the then ruler of this land. A temple dedicated to the Sun God has been constructed by some local residents on one of the banks of this wetland along with a Ghat which is used principally during the Chhath puja. Barring the religious festivities, this pond has been leased out to a local villager for fish rearing which includes mainly katla (*Labeo catla*), buari (*Wallago attu*) and rohu (*Labeo rohita*) fish.

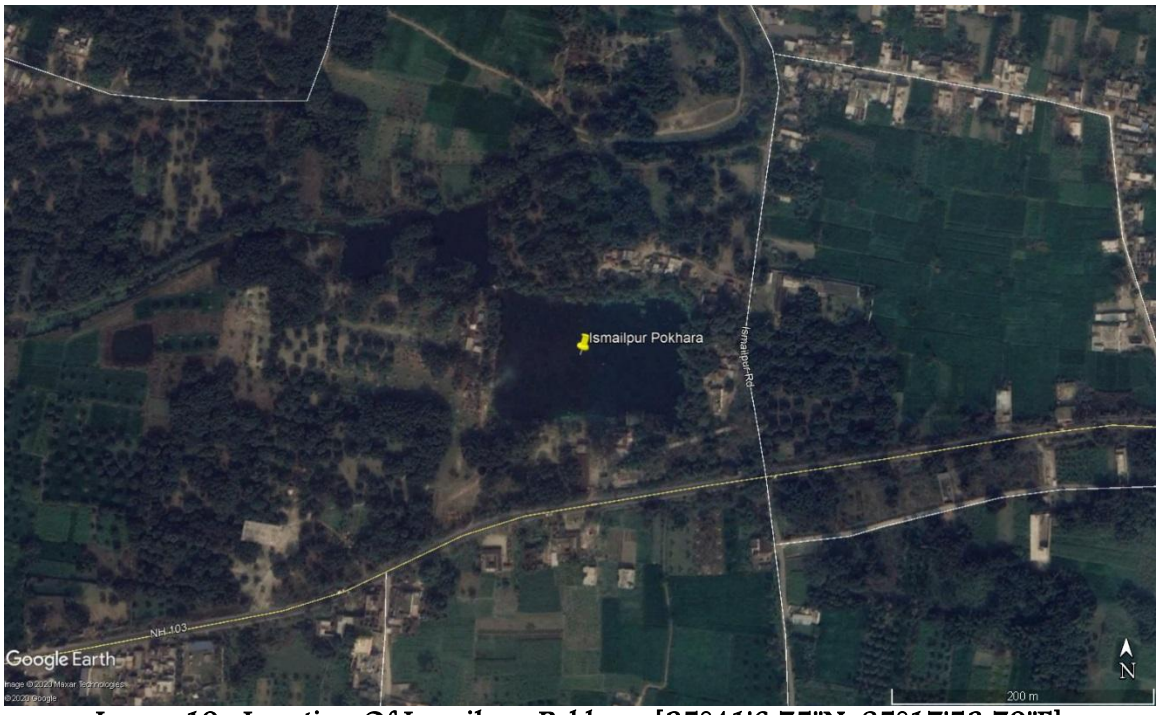


Image 19 : Location Of Ismailpur Pokhara [25°41'6.75"N, 85°17'53.79"E]

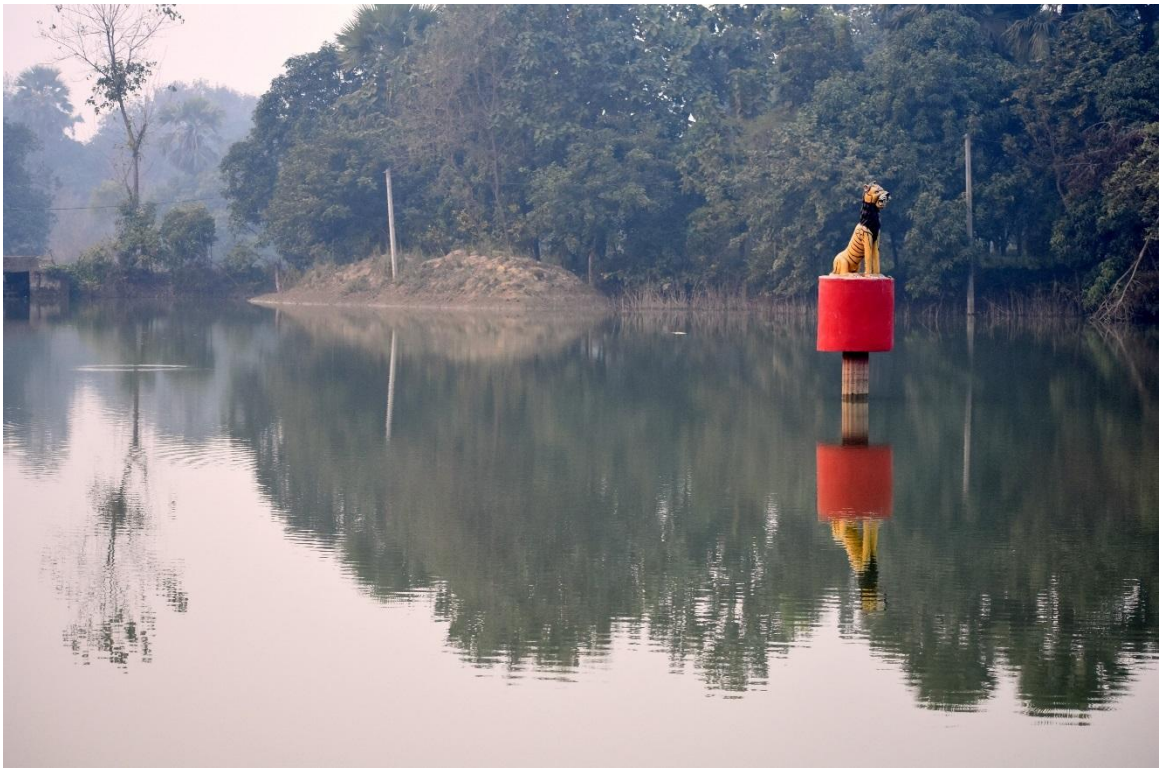
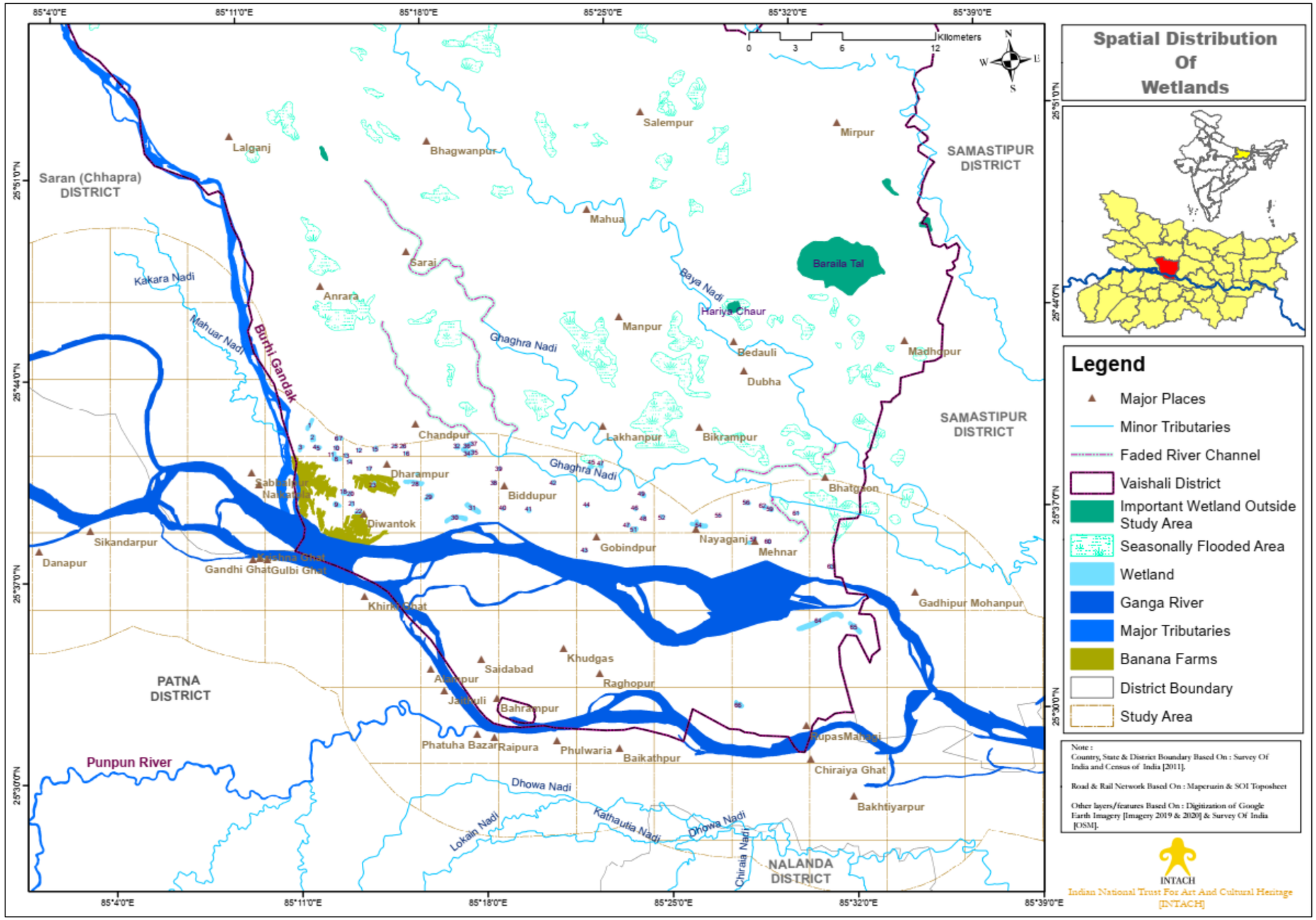


Image 20 : Ismailpur Pokhara



Map 6: Spatial Distribution Of Water Bodies In Vaishali Distt.

9.0 Riparian Flora Along Ganga River In Vaishali

9.1 The riparian areas, lying between the aquatic and the terrestrial habitats, serve as functional interfaces within the landscapes, mediating energy and matter between these two ecosystems. With dynamic environmental conditions and ecological processes, these areas tend to harbor rich biodiversity. A major component of this biodiversity is the plant communities growing along the river bank which are interacting with both terrestrial and aquatic ecosystems. The riparian vegetation is significant in the overall ecology and environmental aspects of the region owing to its important roles in soil conservation, harboring faunal diversity and providing livelihood resources (Groffman *et al.*, 1990; Castelle *et al.,* 1994).

9.2 Till some time ago, no proper systematic sampling had been undertaken or record had been maintained for the riparian plant diversity all along Ganga river. There are however, some scattered but significant works of Pallis (1934), Auden (1941), Sahai (1953), Gupta (1960), Bhattacharyya and Goel (1982), Groffman *et al.* (1990), Krishanmurti (1991), Castelle *et al.* (1994), Shyam (2008), Gangwar and Joshi (2006) and Gangwar and Gangwar (2011) which have explored the biodiversity of Ganga river basin. Also, a detailed study published in the form of a book titled – "The Ganga – A Scientific Study" edited by Krishnamurti (1991) documents 475 riparian plant species from Rishikesh to Chinasura. Some earlier researchers have reported the presence of 7 shrubs, 41 herbs, 6 grasses and 2 sedges along with a number of tree species from Buxar to Barh stretch of Ganga river during 1987-88 (Kumar, 2001).

9.3 The riparian vegetation in Vaishali district was sparse and comprised of few species of trees and herbaceous flora. In many areas throughout the Distt., agriculture was being practiced right upto the current flow of Ganga river which seemed to be a major reason for such low diversity, especially of the ground flora [Image 21]. Among the trees, Teak, Peepal and Tad were dominant in most sites with Peepal often being associated with local deities/temples. *Polygonum glabrum* was found to be growing in the river water on many bank sites. *Bambusa bambos* was also growing luxuriantly in many riparian villages which was used by the locals for setting up structures during various functions. Some of the notable riparian species recorded in the survey are presented in Images 22-24.

Table 4 : Riparian Plant Species Recorded In The Study Area

Sr. No.	Botanical Name	Common Name	Family	Habit
1.	*Acacia nilotic*a (L.) Delile	Babool	Fabaceae	Tree
2.	*Azadirachta indica* A. Juss.	Neem	Meliaceae	Tree
3.	*Bombax ceiba* L.	Semal	Bombacaceae	Tree
4.	*Borassus flabellifer* L.	Taad	Arecaceae	Tree
5.	*Dalbergia sissoo* DC.	Shisham	Fabaceae	Tree
6.	*Ficus benghalensis* L.	Banyan tree	Moraceae	Tree
7.	*Ficus religiosa* L.	Peepal	Moraceae	Tree
8.	*Mangifera indica* L.	Aam	Anacardiaceae	Tree
9.	*Phoenix dactylifera* L.	Khajur	Arecaceae	Tree
10.	*Tectona grandis* L.f.	Teak/Saagwan	Lamiaceae	Tree
11.	*Calotropis gigantea* (L.) Dryand.	Safed Aak	Apocynaceae	Shrub
12.	*Lantana camara* L.		Verbenaceae	Shrub
13.	*Polygonum glabrum* Willd.		Polygonaceae	Shrub
14.	*Croton bonplandianus* Baill.	Ban Tulsi	Euphoriaceae	Herb
15.	*Parthenium hysterophorus* L.	Congress grass	Asteraceae	Herb
16.	*Saccharum spontaneum* L.	Kans/Katha	Poaceae	Grass
17.	*Saccharum bengalense* Retz.		Poaceae	Grass
18.	*Bambusa bambos* (L.) Voss	Indian thorny bamboo	Poaceae	Bamboo Grass

Image 21 : Riparian Vegetation Interspersed With Mustard Cultivation At Mahnar Bada Ghat

Image 22 : *Borassus flabellifer* (Taad)

Image 23 : *Polygonum glabrum* (Common Marsh Buckweed)

Image 24 : *Croton bonplandianus* (Ban Tulsi)

10.0 Faunal Diversity In Vaishali Distt.

10.1 **Gangetic Dolphin :** The Gangetic River Dolphin is exclusively aquatic and piscivorus, occasionally found in small groups. It is one of the three freshwater dolphin species in the world and is distributed in the Ganga–Brahmaputra–Meghna and Sangu–Karnaphuli River systems in India, Nepal, and Bangladesh (Sinha & Kannan, 2014). It has been declared as the National Aquatic Animal by Govt. of India (Sinha & Kannan, 2014) and is classified as 'Endangered' in the IUCN Red List owing to the decrease in its population in the last 3-4 decades. A detailed census of this endangered species was conducted by a multi-institutional team in 2018 which revealed the occurrence of 300 dolphins in Ganga river stretch from Buxar to Mokama and 700 dolphins in Ganga river stretch from Mokama to Maniari in Bihar state (Ranjan, 2019). Similar survey of dolphins in Gandak river stretch of Bihar state highlighted the presence of 155 individuals which has decreased from 257 individuals recorded from the same stretch in 2009-10 (Singh, 2019).

10.2 Based on the local interactions, it was found that the dolphin sightings have decreased in the Ganga river stretch between Hajipur to Hasanpur which could be mainly attributed to the decrease in water depths and reduction in river flows. The locals also reiterated that increased use of large sized mechanized boats for sand mining and unchecked fishing activities in the region could also have impacted the dolphin populations. Only few sightings of dolphins could be made in the Ganga river near Hasanpur at the border of Vaishali-Samastipur Distts. Apart from this, significant dolphin population can be observed in the Gandak river stretch and Gandak-Ganga confluence in the Distt. according to the local residents.

10.2 **Gharial :** Indian Gharial (scientifically known as *Gavialis gangeticus*) is the only surviving member of an ancient family of crocodiles found to reside mainly in Indian sub-continent. It derives its popular name – *gharial* or *gavial* from the bulbous knob like protuberance on a breeding male's snout which resembles a 'Ghara' meaning an earthen pitcher (Saikia, 2012). This species is endemic to the Indian sub-continent and is considered to be 'Critically Endangered' in the IUCN Red List. Once distributed across several major river systems in India and neighboring countries, this species has seen an estimated 96-98% decline in its population owing and is now restricted to only few scattered locations in India and Nepal (Sinha, 2018). The presence of gharials was only recorded in the Gandak river stretch and near Gandak-Ganga confluence of Vaishali Distt. based on the sightings by respondents. They reiterated to have seen this crocodile often on sand bars and sometimes on the dried up river bank in this region.

10.3 **Turtles :** India is one of the world's hotspots for turtle diversity representing 29 species of tortoises and freshwater turtles among which 13 different species find their abode in the Ganga river system. These turtles play a significant role in the river by scavenging dead organic material and diseases fish, controlling fish population as predators and controlling aquatic plants and weeds (WII, 2017). Though there were no direct sightings of turtles in the survey, upon interacting with the fisherfolk in this region, following different species of turtles were known to occur in Ganga river – Indian softshell turtle (*Nilssonia gangetica*), Indian peacock softshell turtle (*Nilssonia hurum*) and Indian flapshell turtle (*Lissemys punctata*). The fisherfolk reiterated that sightings of turtles in the study region had decreased significantly in the last two-three decades.

10.4 **Nilgai :** The Nilgai antelope – *Boselaphus tragocamelus* is widely distributed throughout the country. However, due to prolonged breeding activity and lack of potential predators, the numbers of Nilgai have increased considerably and become locally overabundant in states of Gujarat, Bihar, Uttar Pradesh, Haryana, Punjab, Rajasthan, Madhya Pradesh and Delhi (Meena, 2017). In the due course of time, this species has been successful in adjusting to the human-altered landscapes and in many places have become serious pests of agricultural crops. During the survey, nilgai was spotted in various floodplain fields of the study region foraging on the crops [Image 25]. The farmers in this region often complained about the large-scale damage to agricultural produce caused by nilgai but despite this they claimed to never kill this animal. The villagers often enclosed their fields with mesh nets or wires or thorny plants to keep nilgai away and drive them awaywith the help of sticks and stones.

Image 25 : A Herd Of Nilgai Foraging In An Agriculture Field Near Bidupur

10.5 **Wild Boar :** The Indian wild boar (*Sus scrofa* L.) also known as the wild pig is one of the widespread animals throughout the world. In recent times, wild boar has become a regular menace for farmers as it generally causes damage right from planting till the maturity of the crop (Vasudeva Rao et al., 2015). The floodplain agriculture farmers in some villages such as Kaithaulia, Ganiari and Sultanpur complained about the menace caused by wild boars specially to crops such as potato. They claimed that the boars destroyed entire fields sometimes resulting in huge losses and even attacked small children or some local residents who tried to drive them away. Hence, in some cases the local villagers had to resort to killing these boars in order to safeguard themselves and their agriculture produce.

10.6 **Golden Jackal :** The golden jackal (*Canis aureus*) is a wolf-like canid that is native to Southeast Europe, Southwest Asia, South Asia, and regions of Southeast Asia. It is listed as of Least Concern in the IUCN Red List with their population trend increasing in the last couple of years owing to their widespread distribution, availability of shelter and food in good quantity and they being generalist foragers. Its presence in the study region was recorded based on the information provided by local residents in different villages.

10.7 **Avian diversity :** Vaishali Distt. has a rich diversity of avian species which is relatively understudied. During our field survey, the diversity of avian species was recorded using binoculars and identified using field guides (Salim Ali, 2012; Grimmett et al., 2016). The conservation status of the species was listed by using IUCN Red Data List. A total of 60 species of birds were sighted during the field visits in the study region of which 13 were wetland species. The remaining 47 were species of grassland and forest community including 3 species of raptors. Some of the notable birds in study region are depicted in Images 26-29. Based on the data collected, following observations were made:

- White throated kingfisher, Little Egret, Cattle Egret, and Indian Pond Heron were frequently sighted wetland bird species
- House Sparrow, Jungle Crow, Common Myna, Bank Myna, Common Pigeon, Black Drongo, Common Babbler, Eurasian Collared Dove, White Wagtail and White-browed Wagtail were the most common species present.
- Alexandrine Parakeet and River Lapwing which have been listed in Near Threatened category of IUCN's Red Data List were also sighted.

Table 5 : Avian Diversity In The Study Region

Sr. No.	Common Name	Scientific Name	Conservation Status
1	White throated Kingfisher	*Halcyon smyrnensis*	Least Concern
2	Cattle Egret	*Bubulcus ibis*	Least Concern
3	Little Egret	*Egretta garzetta*	Least Concern
4	Great Egret	*Ardea alba*	Least Concern
5	Indian Pond Heron	*Ardeola grayii*	Least Concern
6	Common Sandpiper	*Actitishy poleucos*	Least Concern
7	Asian Openbill	*Anastomus oscitans*	Least Concern
8	Little Cormorant	*Microcarbo niger*	Least Concern
9	Indian Cormorant	*Phalacrocorax fuscicollis*	Least Concern
10	White breasted -Waterhen	*Amaurornis phoenicurus*	Least Concern
11	Common Moorhen	*Gallinula chloropus*	Least Concern
12	Eurasian Coot	*Fulica atra*	Least Concern
13	**River Lapwing**	***Vanellus duvaucelii***	**Near Threatened**
14	Red-wattled Lapwing	*Vanellus indicus*	Least Concern
15	Black Drongo	*Dicrurus macrocercus*	Least Concern
16	Common Myna	*Acridotheres tristis*	Least Concern
17	Bank Myna	*Acridotheres ginginianus*	Least Concern
18	Asian Pied Starling	*Gracupica contra*	Least Concern
19	Paddyfield Pipit	*Anthus rufulus*	Least Concern
20	Common Stonechat	*Saxicola torquatus*	Least Concern
21	Jungle Babbler	*Turdoides striata*	Least Concern
22	Indian Bushlark	*Mirafra erythroptera*	Least Concern
23	Oriental Skylark	*Alauda gulgula*	Least Concern
24	Common Babbler	*Argya caudata*	Least Concern
25	White Wagtail	*Motacilla alba*	Least Concern
26	Grey Wagtail	*Motacilla cinerea*	Least Concern
27	White-browed Wagtail	*Motacilla maderaspatensis*	Least Concern
28	Yellow Wagtail	*Motacilla flava*	Least Concern
29	Indian Silverbill	*Euodice malabarica*	Least Concern
30	Asian Plain Martin	*Riparia chinensis*	Least Concern
31	Common Tailorbird	*Orthotomus sutorius*	Least Concern
32	**Alexandrine Parakeet**	***Palaeornis eupatria***	**Near Threatened**
33	Rose-ringed Parakeet	*Psittacula krameri*	Least Concern
34	Black-rumped Flameback	*Dinopium benghalense*	Least Concern

35	House Sparrow	*Passer domesticus*	Least Concern
36	Indian Jungle Crow	*Corvus culminatus*	Least Concern
37	House Crow	*Corvus splendens*	Least Concern
38	Oriental Magpie Robin	*Copsychus saularis*	Least Concern
39	Indian Robin	*Saxicoloides fulicatus*	Least Concern
40	Common Pigeon	*Columba livia*	Least Concern
41	Barn Swallow	*Hirundo rustica*	Least Concern
42	Asian Plain Martin	*Riparia chinensis*	Least Concern
43	Brown-headed Barbet	*Psilopogon zeylanicus*	Least Concern
44	Coppersmith Barbet	*Psilopogon haemacephalus*	Least Concern
45	Ashy Prina	*Prinia socialis*	Least Concern
46	Plain Prinia	*Prinia inornata*	Least Concern
47	Asian Koel	*Eudynamys scolopaceus*	Least Concern
48	Greater Coucal	*Centropus sinensis*	Least Concern
49	Red-whiskered Bulbul	*Pycnonotus jocosus*	Least Concern
50	Red-vented Bulul	*Pycnonotus cafer*	Least Concern
51	Shikra	*Accipiter badius*	Least Concern
52	Common Kaestral	*Falco tinnunculus*	Least Concern
53	Black-winged kite	*Elanus caeruleus*	Least Concern
54	Red Avadavat	*Amandava amandava*	Least Concern
55	Scaly-breasted Munia	*Lonchura punctulata*	Least Concern
56	Black-hooded Oriole	*Oriolus xanthornus*	Least Concern
57	Spotted Dove	*Spilopelia* chinesis	Least Concern
58	Eurasian Collared Dove	*Streptopelia decaocto*	Least Concern
59	Laughing Dove	*Spilopelia senegalensis*	Least concern
60	Zitting Cisticola	*Cisticola juncidis*	Least concern

Image 26 : Black Hooded Oriole

Image 27 : Black-Rumped Flameback

Image 28 : White-Breasted Kingfisher

Image 29 : Jungle Babbler

11.0 Ganga Riverine Islands/Diaras In Vaishali Distt.

11.1 The riverine fluvial islands are present in many major rivers and are defined as 'land masses within a river channel that are separated from the floodplain by water on all sides and exhibiting some kind of stability' [Osterkamp, 1998]. Such islands may not be permanent on the geologic time scale owing to the river meandering, climate change, etc. but can remain in place over decadal or century time scales and hence exhibit stability [Wyrick & Klingeman, 2011]. Many such islands are existent in the Ganga River stretch of throughout Bihar state which are locally referred to as *Diaras*. This term is derived from the word *Diya* (which means an earthen oil lamp) and has been coined for a land where a *Diya* is never lit [Udas *et al.*, 2018]. In local parlance in different parts of Bihar state, it symbolizes a village which is located outside the embankments of Ganga River floodplain. Some of the major *Diaras* surveyed in the study are described in this section.

11.2 The biggest *diara* in the Ganga River stretch of this Distt. is Raghopur Diara which measures about 30 kms long and 8-10 kms wide and is situated between the two bifurcated streams of Ganga River with Patna Distt. on the right bank (bordering lower Ganga stream) and Vaishali Distt. on the left bank bordering upper Ganga stream). This *diara* mainly consists of alluvial soil and every year it gets submerged during the floods in Ganga River. According to Census of India (2011), it is inhabited by 232,909 people spread across in villages such as Birpur, Paharpur, Fatehpur, Rampur, Jurawanpur and Shiv nagar to name a few. This *diara* is connected with Vaishali Distt. through pontoon bridges [Images 30] which is used by the natives to access this island along with use of boats. Apart from that a new permanent multi-lane river bridge is also being constructed to connect this *diara* with Vaishali and Patna [Image 31]. This project is estimated to be completed in the next few years which shall provide round the year connectivity as against the pontoon bridges which are removed during monsoons forcing many residents of this *diara* to abandon this place and move in nearby towns. **The *Diara* is officially recognized as a Community Development Block.**

Image 30 : A Pontoon Bridge Connecting Raghopur Diara With Vaishali Distt.

Image 31 : A New Bridge Being Constructed To Connect Raghopur Diara With Vaishali Distt.

11.3 Agriculture and fishing are the main sources of income for residents of this *diara*. The agriculture produce mainly includes wheat and mustard along with vegetables such as cauliflower, potato, gourd and parwal [Image 32]. According to some respondents, 'parwal' is a major vegetable grown on this *diara* as it is a popular consumption for villagers in this region. However, during monsoon many agriculture fields are inundated by the flood waters due to which people alternatively shift to fishing for fulfilling their food requirements and earning some income. Mostly dragnets and gillnets are used for catching fish with the help of small boats.

Image 32 : Wheat Fields With Mustard In The Backdrop On Raghopur *Diara*

11.5 Another roughly semi-circular shaped *diara* measuring about 3-4 kms long and 2 kms wide was observed near Sultanpur village in the distt [Image 33]. It was mainly used for agricultural purposes specially by the residents living on the river bank [Image 34]. They make use of small boats to cross the river water and reach *diara* for collecting the agricultural produce along with *Saccharum* grass for roof thatching.

Image 33 : Diara Near Sultanpur In Vaishali Distt.

Image 34 : Local Residents Practising Agriculture On The Diara

12.0 Fishing In Vaishali Distt.

12.1 Fish resources of Ganga river have been an important source of livelihood and food security for millions of people residing along its banks. Ganga river supports a diverse fish fauna with about 260 species reported for Indian waters (Sinha and Khan, 2001) among which about 35 species have been identified as having highest commercial value including carps (Cyprinidae), snakeheads (Channidae) and catfish (Siluriformes) (Islam et al., 2006). However, today these rich fish resources are threatened by various anthropogenic activities and resulting water pollution, accumulation of heavy metals, eutrophication, damming, alteration of hydrology and introduction of exotic species (Tripathi et al., 2017).

12.2 During the survey in Vaishali Distt., fishing from Ganga and Gandak rivers was found to be an important source of food and income second to agriculture. Many local residents, specially belonging to the Mallah community were involved in riverine fishing using small boats. The main fishing techniques used by them include fine mesh sized nets spread across the stream which are mostly made of plastic and available from nearby markets and rope-based drag nets some of which are made locally [Images 35 & 36]. Most of the fish caught by them are either sold directly in village markets or in bigger markets such as 'Jadhua Macchli Bazar' [Image 37] mainly during early morning time.

Image 35 : Fine-Sized Fishing Nets Spread Across The River Near Sultanpur

Image 36 : Fishermen Making Ropes For Drag Nets Near Mahnar

Image 37 : Selling Fish In Jadhua Macchli Bazar

12.3 Upon interaction, the fisherfolk expressed their concerns over the significant decrease in the fish catch and yield over the last few decades. According to them the most commonly caught fish in the study region included Buari (*Wallago attu*), Chepua (*Cabdio morar*), Bachwa (*Eutropiichthys vacha*) and Tengara (*Mystus teng*ara). Some fish like Rohu (*Labeo rohita*) and Catla (*Labeo catla*) were caught more during the monsoon season from Ganga river while they were obtained from nearby waterbodies during rest of the year. **The fisherfolk also reiterated that Hilsa fish, which was once available in the Ganga river stretch of Vaishali Distt. was no longer seen since the last few decades.** Various important factors such as overexploitation of fisheries, water pollution, variations in river flow and changes in climatic conditions such as uncertain monsoons, higher temperatures in summer. were believed to be the main reason for drastic reduction in fish catch and yield from the study region.

12.4 The details of riverine fish recorded during the survey is provided in Table 6 and some notable species are depicted in Images 38-41. The demand for these fish was observed to be very high among local residents as almost 80-90% of the fish stock was sold in just 2-3 hours from the opening of fish market every day. Common fish such as *bachwa* and *buari* were sold at Rs. 350 per kg while rohu was sold at Rs. 300 per kg and *Ghaichi* was sold at Rs. 500 per kg in Jadhua Macchli Bazar. However, during monsoons when Ganga river swells up, the fish catch and yield is very high due to which the locals claimed to have brought these common fish at Rs. 20-50 per kg.

Table 6 : Riverine Fish Recorded In The Study Region

Sr. No.	Scientific Name	Common Name
1.	*Eutropiichthys vacha*	Bachwa
2.	*Wallago attu*	Buari
3.	*Cabdio morar*	Chepua
4.	*Labeo catla*	Catla
5.	*Labeo rohita*	Rohu
6.	*Channa punctata*	Garai
7.	*Mystus teng*ara	Tengara
8.	*Puntius* sp.	Sidhari
9.	*Cirrhinus mrigala*	Naini
10.	*Mastacembelus armatus*	Gaichi

Image 38 : Bachwa Fish

Image 39 : Buari Fish

Image 40 : Rohu Fish

Image 41 : Sidhari Fish

13.0 Groundwater In Vaishali Distt.

13.1 Ground water characteristics of a particular area are subject to several natural factors like precipitation, drainage, topography, lithology and hydrogeological conditions of the region. Geomorphologically, Vaishali Distt. comprises of extensive plain formed by the alluvium brought by the Ganga, Gandak and distributaries of Gandak. The morphology of this region has been shaped by mainly Gandak river and it can be divided broadly into three different categories – Hazipur surface, Vaishali surface and Diara surface. The quarternary alluvial deposit consisting of alternate layers of sand, silt, clay and gravel forms prolific unconfined and confined aquifer system in the district. The aquifer in the Distt. is highly potential with a yield of 50-100 m^3/hr which can be obtained from a well by tapping 40 m thick aquifer for nominal draw. The movement of groundwater in the Distt. is in south-east direction towards river Ganga (CGWB, 2013).

13.2 During the survey in this Distt., ground water levels of different villages were recorded based on the interactions with local residents. The details of these villages and the ground water availability is provided in Table 7. Image 42 depicts an old well in the Distt. used for drawing ground water. The groundwater availability was found to be highest in Bidupur village with 35 feet [below ground level] while it was lowest in Chechar with 180 feet [below ground level]. Most of the villages surveyed made use of dug wells for drawing the groundwater while only few employed handpumps.

13.3 A study conducted by Jangle et al. (2016) highlighted that the groundwater samples collected from different blocks of the Distt. were exposed to arsenic concentrations exceeding 0.05 mg/L (the permissible limit of arsenic in drinking water set by the Govt. of India; the limit for acceptable safe drinking water is 0.01 mg/L). Arsenic concentrations of 0.07 mg/L and higher were observed in sample sites located in low lying floodplain areas of Ganga and Gandak rivers. The study also predicted higher arsenic concentrations in aquifers located in the vicinity of the rivers in the entire Distt.

Sr. No.	Place	Coordinates		Ground Water Table in Feet
		Lat.	Long.	
1.	Bidupur	25°38'42.66"N	85°20'0.96"E	35 ft.
2.	Madhurapur	25°44'8.74"N	85°12'15.47"E	40 ft.
3.	Kathaulia	25°36'46.40"N	85°24'2.11"E	60 ft.
4.	Mahnar	25°36'35.93"N	85°29'39.14"E	50 ft.
5.	Naya Tola	25°36'57.59"N	85° 9'54.55"E	20 ft.
6.	Raghopur Diara	25°31'48.13"N	85°23'18.32"E	50 ft
7.	Chechar	85°23'18.32"E	85°23'18.32"E	180 ft.
8.	Konhara Ghat	25°40'41.93"N	85°11'46.65"E	50 ft.

Table 7 : Groundwater Levels Of Different Villages In Vaishali Distt.

Image 42 : An Old Well Used For Drawing Groundwater In Kabir Muth, Bidupur

14.0 Ganga River Bank Erosion In Vaishali Distt.

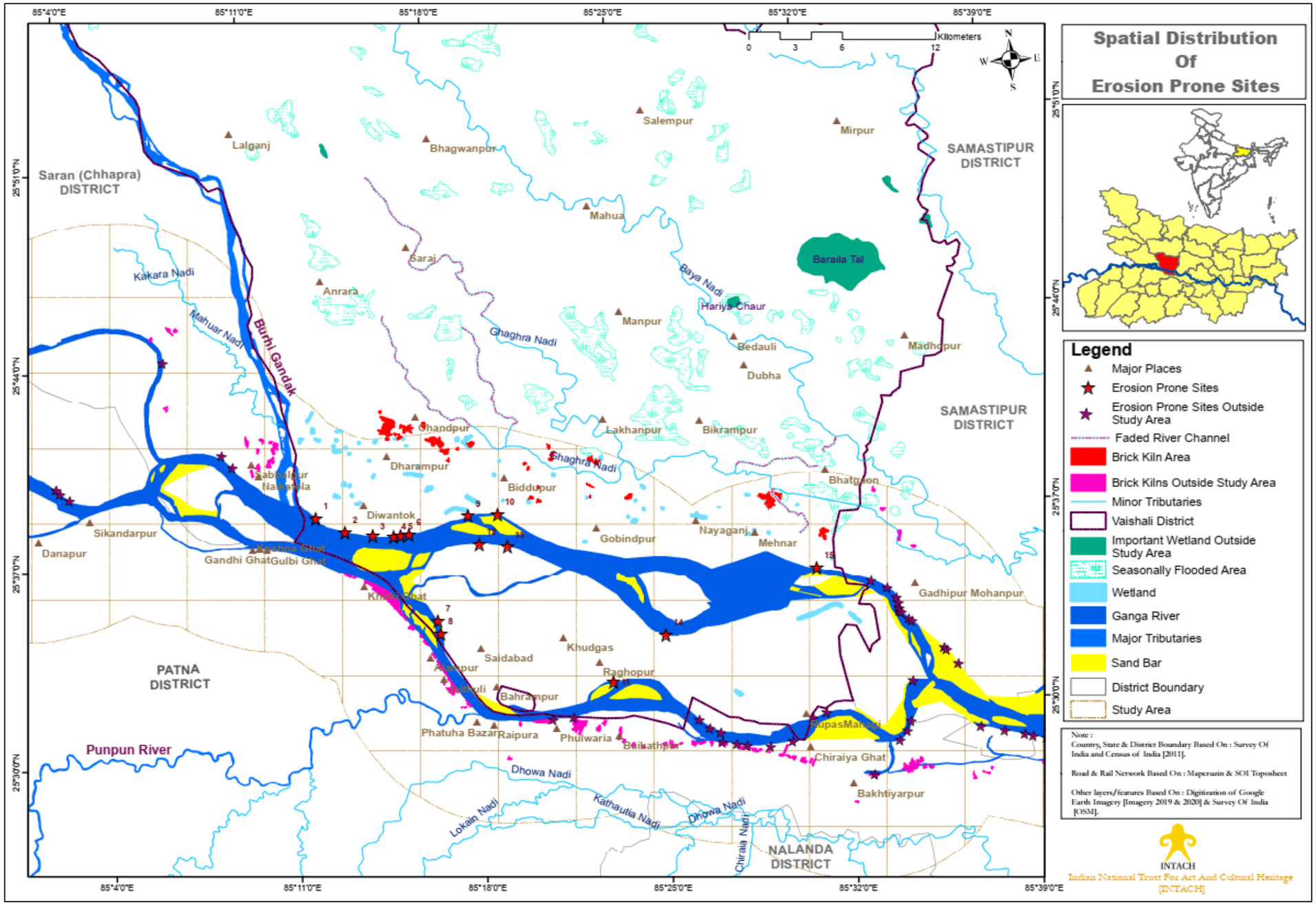
14.1 Weathering of soils by natural forces is both constructive and destructive. Erosion is the chief agent responsible for the natural topographic cycles as it wears down higher elevations, banks (lateral erosion) and deposits sediments in the plains. However, erosion gets aggravated due to human interventions through change in land use, excessive grazing, extensive farming, cultivation without taking proper conservation measures, destruction of forest and riparian vegetation. It is well known that exposed soil may erode rapidly (Singh et al., 2004).

14.2 During this survey, high erosion prone sites were observed in areas such as Bidupur, Maniarpur, Hajipur, Chechar, Hasanpur and Raghopur diara. Map 07 depicts the erosion prone sites recorded along Ganga river in Vaishali Distt. In some sites, the intense rainfall accompanied by torrential flow of water in Ganga river resulted in lateral bank erosion [Images 43-44]. Upon interacting with local residents, they reiterated that many villages at the above-mentioned sites had been destroyed due to bank erosions forcing them to move away to more interior parts. They also claimed that no kind of help or assistance was available from the government in this matter and hence, the erosion of houses in these villages resulted in huge personal losses for them. Various factors such as unchecked sand mining along Ganga river, decrease in riparian vegetation and land use changes are believed to be the major factors in contribution to this severe erosion in the study region.

14.3 A study conducted by Bhunia et al. (2016) highlighted that frequent channel shifting of Ganga river was also a major reason for severe bank erosion in Vaishali Distt. and Raghopur diara. They also emphasized on the interrelationship of river morphology and adjoining land use/land cover characteristics which is often impacted by increased human interferences. They also recommended taking up of suitable plantations along Ganga river bank in this region to reduce the erosion impacts.

Image 43 : Lateral Bank Erosion Observed Near Maniarpur In Vaishali Distt.

Image 44 : Lateral Erosion On A Diara Near Sultanpur In Vaishali Distt.



Map 7: Erosion Prone Sites And Brick Kilns In The Study Area

15.0 Mining And Brick Kilns In Vaishali Distt.

15.1 **Sand mining :** Sand is a major mineral resource [although classified as a minor mineral] available in plenty throughout Ganga river stretch in Vaishali Distt. The demand for sand has grown multifold in the last couple of years with rapid expansion of settlements in this Distt. Hence, sand mining was found to be an important activity almost all along the Ganga river course in this survey. Sand collection was observed at sites such as Hajipur, Bidupur, Nawanagar, Hasanpur and Raghopur diara some of which are depicted in Images 45-46. At most of these sites, sand mining permissions were acquired by major miners from concerned authorities but according to some local residents, other people were also involved in sand collection illegally. Such unchecked and reckless sand mining operations are often considered to be detrimental to the river ecosystem and hence, the **'Enforcement and Monitoring Guidelines for Sand Mining 2020'** need to be implemented seriously in the study region.

Image 45 : Sand Resources Collected From Ganga River Near Nawanagar Ghat

Image 46 : Sand Collection From Ganga River Bed Near Raghopur Diara

15.2 **Brick Kilns :** An important economic activity in the Distt. is production of bricks in the brick kilns. With rapid urbanization, bricks have become an important building material for construction activities. Brick kilns in the study area provide livelihood opportunity to the local community. However, this industry has posed current and potential future threats to the soil, air, biota and water system of the region. Except select few, most of the brick kilns observed in this survey were situated at a distance from Ganga river but mostly in the floodplain region. The spatial distribution of brick kilns in the study region is depicted in Map 07 and a brick kiln is depicted in Image 47.

Image 47 : A Brick Kiln Observed Near Hajipur In Vaishali Distt.

16.0 Boatmaking In Vaishali Distt.

16.1 Most of the boats used by local fisherfolk in Vaishali Distt. were made by carpenters (locally known as '*Mistry*') from Sonepur region in Saran Distt. In most cases, the fishermen got these boats made in Sonepur and brought it to this region for fishing. While in some cases, a *mistry* was called from Sonepur into the respective villages where he constructed the boat using local resources. One such situation was observed on Kaunhara Ghat where a *mistry* was constructing a fishing boat (Image 48) using Shisham (*Dalbergia sisoo*) wood. In case of Shisham wood not being available, the wood of Jamun (*Syzygium cumini*) tree was also used for boatmaking in the region.

Image 48 : A *Mistry* from Sonepur Involved in Boatmaking at Kaunhara Ghat

17.0 Sacred Sites In Vaishali Distt.

17.1 **Ancient Shiva temple at Kathariya Ghat :** An ancient temple dedicated to Lord Shiva was found to be present at Kathariya Ghat close to Bidupur town in Vaishali Distt. [25°38'26.87"N, 85°18'40.03"E]. Upon interaction with the caretaker of this temple and other villagers, it was recorded that this temple is believed to be more than 200 years old and is popular among the local residents who frequently visit here with offerings in order to get their wishes fulfilled. The main attraction of this temple is the Shivalinga present in the sanctum sanctorum which is believed to have two eyes carved in it naturally [Image 49]. The respondents also believed that this Shivalinga came floating in the Ganga river and was found by a sage who established it at this site. Despite the rich history and spiritual significance of this site, it is left comparatively neglected with no attention/assistance provided by the concerned authorities. An old and sacred peepal tree (*Ficus religiosa*) also found to be attached with another part of this temple dedicated to Goddess Kali [Image 50].

Image 49 : The Shivalinga At Kathariya Ghat Shiva Temple

Image 50 : An Old And Sacred Tree Associated With Kali Temple At Kathariya Ghat

17.2 **Ancient Temple at Madhurapur Bhinda :** Alkapuri Dham (also locally known as Ram-Janki Mandir) is a famous site located on a small hilltop in Madhurapur village of Vaishali Distt. [25°37'45.24"N, 85°20'12.54"E]. The residents of this village reiterated that this temple is more than 300-400 years old and is a very important site in this region with many politicians also visiting this place thereby leading to its development in the last couple of years. The temple complex comprises of three different temples – one dedicated to Lord Ram and Goddess Sita, one dedicated to Lord Shiva, one dedicated to Lord Ganapati and a small one dedicated to Lord Hanuman with a sacred peepal tree (*Ficus religiosa*) in the backdrop [Images 51-52]. The hill is surrounded by wild vegetation comprising mostly of teak (*Tectona grandis*), Neem (*Azadirachta indica*), Yellow flame (*Peltophorum pterocarpum*) and Khajuri (*Phoenix* sp.) trees along with *Lantana* & *Zizyphus* sps. Every year a mela is organized at this site after Karthik Month which goes upto Diwali and is thronged by visitors from near and far. One of the respondents during our interaction revealed that below this hill lies the hidden settlement of a local ruler about 400 years ago who had buried his wealth in order to safeguard it. Apart from this, he also emphasized the importance of

this site from Buddhist mythology point of view owing to which many foreigners such as Japanese, Chinese and even Russian researchers often throng this site in search of some evidence. Despite such rich mythological and spiritual value, this site lacks proper documentation and attention from concerned stakeholders in India.

Image 51 : Part Of Alkapuri Dham With Shiva Temple And Ram-Janki Temple

Image 52 : Part Of Alkapuri Dham With Ganesha Temple And Wild Vegetation In Backdrop

17.3 **Buddha Temple at Chechar:** A temple dedicated to Lord Buddha was found to be present on the bank of Ganga river in Chechar [25°36'35.70"N, 85°21'42.20"E]. This village in Vaishali Distt. is an important Neolithic site where numerous excavations have taken place by Archaeological Survey of India which have resulted in statues and other materials being found dating back to the Mauryan dynasty. Some of the excavated Buddha statues from this village have been established in this temple [Image 53] and is visited by numerous people across the country. At a little distance from this temple also lies the excavation site from where these statues were found. But that site has been filled over the period of time by the local residents and is now used for cultivation of bananas. Adjacent to this temple lies another small temple containing a Shivalinga which the locals believe to be slowly growing in size by itself. Along with these temples, there is an old and sacred tree of *Ficus benghalensis* (Banyan) which is worshipped especially by female residents of this region [Image 54].

Image 53 : Buddha Temple In Chechar

Image 54 : An Old And Sacred Banyan Tree Associated With Buddha Temple Complex In Chechar

17.4 **Bhuiya Baba Sthan:** According to a popular belief among the local residents of Bidupur and nearby areas in Vaishali Distt., Bhuiya baba was a cattle farmer who lived hundreds of years ago and revolted against the then ruler of this land for the safety and well being of fellow villagers. Thereafter, people started respecting him which over a period of time converted into spiritual belief and thus, Bhuiya baba became a local deity figure in this region. Since the last 100-200 years as the popularity and belief grew stronger, the Bhuiya baba Sthan was developed where worshippers come from far and wide to pray and offer milk [Image 55]. It is widely believed by the cattlemen in this region that by praying and offering milk to Bhuiya baba, the cattle remain blessed, free from all diseases and yields good quality milk. Every week on Monday, Thursday and Friday people come in huge numbers to offer milk in Bhuiya Baba Sthan. On special occasions such as Vasant Panchmi, the temple remains packed with devotees and thousands of liters of milk is offered here which in turn is collected by temple authorities and sold back as 'Prasad' with nominal charges of 10-15 Rs./Kg.

Image 55 : Bhuiya Baba Sthan In Bidupur

17.5 **Baba Ganninath Palwaiya Dham:** The temple of a folk deity – Baba Ganninath who is popularly worshipped by people of Vaishali and other nearby districts was found to be present on Ganga river bank in Hasanpur panchayat near Mahnar town [25°35'1.21"N, 85°31'46.57"E]. This site comprised of an old temple of Baba Ganninath which was believed to be centuries old but was destroyed during recurring floods in this region. Thereafter, many people including local politicians chipped in to build a grand new temple at this site [Image 56] wherein the statues of Baba Ganninath, Mata Khema Sati and Govindji were established along with fourteen

Diwan pinds. Devotees who visit this temple from far and wide offer flowers and pray to Baba Ganninath for their wishes to get fulfilled.

Image 56 : Baba Ganninath Palwaiya Dham

17.6 **Sacred Trees associated with Jogi Baba :** Another popular folk figure in Bidupur and surrounding areas of Vaishali Distt. is Jogi Baba who is worshipped by numerous residents specially to get their wishes fulfilled. According to the local practices, people pray to Jogi Baba for seeking blessings to get their desires or wishes fulfilled, and once they achieve this, they offer a horse with or without a man-like figure riding on it. This sculpture is made in different sizes and of different materials such as stone or metal depending upon the financial situation and belief of the worshipper. These sculptures are kept below a sacred peepal tree [Image 57] after a puja is performed

with friends and relatives. Though, there is a particular temple near Bidupur town where most of these sculptures dedicated to Jogi Baba are offered, there are few sacred trees in other villages too where people offer these sculptures in case, they are not able to reach this particular site due to some reason.

Image 57 : Sacred Peepal Tree Associated With Jogi Baba Near Bidupur Town

18.0 Inland Navigation In Vaishali Distt.

18.1 The Ganga river stretch having Patna Distt. on its right bank and Vaishali Distt. on the left bank was an important source of trading various materials and ferrying people through boats since early 18th century (Buchanan, 1936). However, these records also mention that the presence of Raghopur *diara* and other sand bars divided the river stretch into two parts with the part touching Vaishali Distt. (then part of Tirahut Division) often drying up during lean season. Due to this, the navigation through big boats was only possible in this river stretch during monsoon season, while during rest of the year the boats plied in the river stretch adjoining Patna Distt. which became the major trade center in this region. The interactions with riparian village communities throughout the Distt. also highlighted that till few decades ago, big-sized boats were employed in ferrying people from this region up to Kolkata. These boats were also navigated upto the Gandak river stretch adjoining Kaunhara Ghat where numerous pilgrims and visitors came by this way. However, currently no such long-distance boats operate in this region. Only some medium and small-sized boats are employed in this region for reaching Raghopur and other *diaras* from various riparian villages in Vaishali Distt. [Image 58].

Image 58 : Boats Used For Ferrying People From Riparian Villages In Vaishali Distt. To Raghopur *Diara*

19.0 Key Observations And Recommendations

19.1 One important Hindu ritual associated with Ganga river throughout India is cremation of dead bodies as it is widely believed that by immersing your burnt remains in the holy Ganga water, the person will attain 'Moksha'. This activity was found to be prevalent throughout the Ganga river bank in Vaishali Distt. as most people wanted to burn and subsequently immerse the remains of their loved ones in this river. As there is no designated site for cremation, the cremation activities were observed at many different bank sites in different villages with often items related to last rites being dumped here [Images 59-60]. Some respondents also revealed that often half burnt dead bodies or incomplete cremated remains are directly dumped into the river thereby impacting the riparian and instream biodiversity. Hence, it is strongly recommended in this report to urgently take this matter into consideration and develop appropriate cremation facilities for the local residents little away from Ganga river in order to prevent further pollution and ecosystem damage.

Image 59 : Cremation Of Dead Bodies On Ganga River Bank At Chechar

Image 60 : Remains From Cremations Dumped On Ganga Bank At Nawanagar Ghat

19.2 The riparian ecosystems are of high conservation priority owing to the rich biodiversity they support and the large-scale ecosystem services they provide. However, the cultivation of crops such as mustard up to the current flow of Ganga river [Image 61] in many parts of this Distt. has already impacted the riparian vegetation communities which is evident from the sparse growth and low species diversity of riparian plants recorded during this survey. This in turn impacts the associated faunal diversity as well as bank stability often leading to severe erosion during flood situation. Hence, it is recommended through this study to take up measures for checking the limit of agriculture in riparian areas of Ganga River in order to allow the natural biota to flourish.

Image 61 : Cultivation Of Mustard Up To The Current Flow Of Ganga River

19.3 One important concern often raised during the survey was crop destruction caused by nilgai and wild boar especially in the floodplain agricultural fields. Though the farmers never retaliated violently towards the nilgai, they did admit to kill wild boar as it is equally dangerous to local residents in this region. Nonetheless, both these animals are known to cause huge losses to the farmers who claimed to receive no compensation or help of any kind from the authorities. Hence, this important issue in the study region needs to be mitigated by creating awareness among the local people, ensuring sufficient compensation for their losses and incorporating non-violent techniques to keep these animals away from the fields.

19.4 Another very important observation in the study region is severe bank erosion caused by the floods which lead to destruction of riparian settlements and even cause shifts in the villages from one side to the other. This issue has already impacted thousands of local residents who had to leave their settlements and move to some place far away from the river without any help or support from concerned authorities. Hence, it is

recommended to carry out detailed studies in the Distt. to identify erosion prone and impacted sites along with developing suitable remedies for its control such as extensive plantation of trees, shrubs and grasses having strong root system to bind the soil.

19.5 Most of the wetlands recorded in this study are leased out to local residents for fish rearing. Apart from that, no attention is being paid to them leading to issues like garbage dumping and encroachments thereby impacting its ecosystem. These wetlands if conserved properly have the potential to not only provide good fish resources, but also harbor other flora and fauna diversity, provide aesthetic benefits and clean water for various uses. Hence, it is recommended to take up initiatives for maintaining such water bodies in conjunction with various local stakeholders.

19.6 The fisherfolk dependent mainly on fish resources from Ganga river had raised their concerns about the sharp decline in fish catch and yield owing to various reasons such as changes in river flows, climatic alterations, unsustainable fishing activities by some local dictatorial residents and increasing water pollution. Hence, it is imperative to carry out awareness cum training programs with these communities regarding fish availability, its importance and sustainable fishing along with keeping a check on those disturbing the ecosystem. Along with that alternate livelihoods need to be developed for fishermen communities such as promoting them for building different boats and involving in eco-tourism activities.

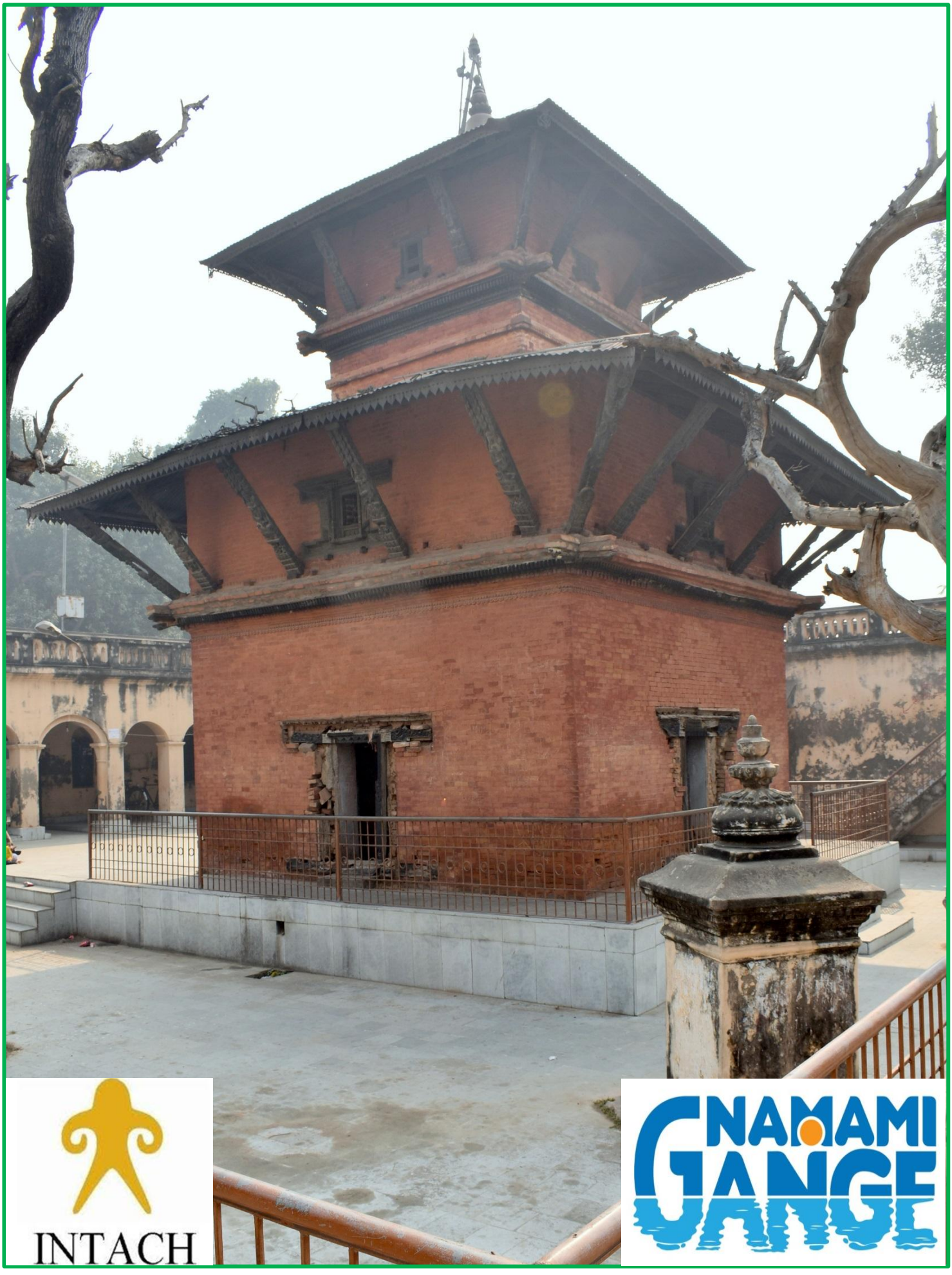
19.7 The Ganga river stretch of Vaishali Distt. is also an important habitat for IUCN Red Listed and Schedule-I (Wildlife Protection Act, 1972) species – Gangetic dolphin and Gharial. The sightings of both these species has decreased in the last few decades which highlights an urgent need for carrying out more surveys to identify their tentative population and presence status in this region. The local Forest department should also carry out awareness activities for sensitizing people directly associated with Ganga River.

19.8 The presence of many ancient and culturally important heritage sites such as Baba Ganninath temple, Alkapuri Dham, Bhuiya Baba Sthan and Buddha temple of Chechar emphasize the rich history along Ganga river in Vaishali Distt. However, despite a huge popularity among local residents, these sites are otherwise unknown and paid less attention to from the point of safeguarding our heritage. Hence, it is recommended to develop tourism potential in these areas for developing local livelihoods and ensuring better conservation of these heritage sites.

20.0 References:

1. Bhattacharyya, U.C. and Goel, A.K. (1982). *Studies on the vegetation of Tehri dam and some rare plants in Garhwal Himalayas*. B.S.I., Howrah. pp. 1-38.
2. Bhunia G.S., Shit P.K. and Pal D.K. (2016), Channel dynamics associated with land use/land cover change in Ganga river, India, 1989-2010. *Spatial Information Research*, DOI 10.1007/s41324-016-0045-7.
3. Buchanan F. (1936), An account of the districts of Bihar and Patna in 1811-1812. Originally published by The Bihar and Orissa Research Society, Reprinted in 2013 by Directorate of Museums, Govt. of Bihar.
4. Castelle, A.J., Johnson A.W. and Conolly, C. (1994). Wetland and stream buffer size requirements: A review. *Journal of Environmental Quality,* 23:878-882.
5. CGWB (2013), Groundwater Information Booklet Vaishali Distt. Bihar state. Report published for Ministry of Water Resources (Govt. of India), Mid-Eastern region, Patna.
6. Das B.K. (2019), Assessment of fish and fisheries of the Ganga river system for developing suitable conservation and restoration plan. Mid-term report submitted to National Mission for Clean Ganga.
7. Gangwar, R.S. and Gangwar, K.K. (2011). Taxonomic and economic classification of riparian floral diversity along river Ganga in Garhwal Himalayan region of India. *Researcher*, 3(4):5-14.
8. Gangwar, R.S. and Joshi, B.D. (2006). Some Medicinal flora in the riparian zone of river Ganga at Saptrishi, Haridwar, Uttaranchal. *Himalayan Journal of Environment and Zoology*, 20(2):237-241.
9. Grimmett R., Inskipp C. and Inskipp T. (2016), Birds of the Indian Sub-continent: India, Pakistan, Sri Lanka, Nepal, Bhutan, Bangladesh and the Maldives. Bloomsburry Publishing, India.
10. Groffman, P.M., Gold, A.J., Husband, T.P., Simmons R.C. and Eddleman W.R. (1990). *An investigation into multiple uses of vegetated buffer strips*. RI: University of Rhode Island, Kingston.
11. Islam Md.S., Rahman M.M., Halder C.G. & Tanaka M. (2006), Fish assemblage of a traditional fishery and seasonal variation in diet of its most abundant species *Wallago attu* (Siluriformes: Siluridae) from a tropical floodplain. *Aquatic Ecology*, 40: 263-272.
12. Jangle N., Sharma V. and Dror D.M. (2016), Statistical geospatial modelling of arsenic concentration in Vaishali district of Bihar, India. *Sustainable Water Resource Management*, DOI 10.1007/s40899-016-0049-4.
13. Kumar, S. (2001). Plant diversity along river Ganga, BSI, Sai Publisher Dehradun.
14. Kumar A. (2018), The existence of 'Khajuraho' of Bihar is in danger !! Will Nepali temple become history? Online news article. https://www.india.com/hindi-news/others/nepali-temple-of-hajipur-under-bihar-ruining-day-by-day-due-to-lack-of-tourists-3402942/

15. MSME (2016), Brief industrial profile of Vaishali district. Report prepared for Ministry of Micro, Small & Medium Enterprises, Govt. of India.
16. Prasad R., Pruthi V. and Saini R.K. (2012), Riparian floral diversity of Ganga river. Report prepared by Indian Institutes of Technology.
17. Ranjan P. (2019), First aquatic census finds 1150 dolphins in Bihar. Online News Article. https://www.hindustantimes.com/cities/first-aquatic-census-finds-1-150-dolphins-in-bihar/story-HjBFKjKC1kTLvjixTujHBL.html
18. Saikia P.K. (2012), Indian Gharial (*Gavialis gangeticus*): Status, Ecology and Conservation. *Rare Animals of India*, 42-58.
19. Shyam R. (2008), Thesis a study on riparian floral biodiversity of river Ganga between Haridwar and Gangotri, submitted to Gurukul Kangri Unversity, Haridwar, India.
20. Singh S.S. (2019), Dolphin numbers drop in Gandak. Online News article. https://www.thehindu.com/sci-tech/energy-and-environment/dolphin-numbers-drop-in-gandak/article26537009.ece
21. Sinha S.K. and Behera S.K. et al., (2018), Reinforcement of gharial in the Gandak river, India for population restoration. In: Soorae P. (Eds.), Global Reintroduction Perspectives: 2018. Published by IUCN/SSC Reintroduction Specialist Group & Environment Agency-Abu Dhabi.
22. Sinha M. & Khan M.A. (2001) Impact of environmental aberrations on fisheries of the Ganga (Ganga) River. *Aquatic Ecosystem Health and Management Society*, 4: 493-504.
23. Tare et al. (2012), Wetland Report for Ganga River Basin Environment Management Plan. Report published by Indian Institutes of Technology.
24. Tripathi S., Gopesh A. and Swivedi A.C. (2017), Fish and fisheries in the Ganga river: Current assessment of the fish community, threats and restoration. *Journal of Experimental Zoology India*, 20(2): 907-912.
25. Vasudeva Rao V., Naresh B., Ravinder Reddy V., Sudhakar C., Venkateshwarlu P. and Rama Rao D. (2015), Traditional management methods used to minimize wild boar (*Sus scrofa*) damage in different agricultural crops at Telangana state, India. International Journal of Multidisciplinary Research and Development, 2(2): 32-36.
26. Verma S.K. (2017), Harappa signs in bricks of Raghopur. https://www.telegraphindia.com/bihar/harappa-signs-in-bricks-of-raghopur/cid/1375856
27. Wildlife Institute of India (WII) (2017), Turtles of Ganga river. Leaflet published for National Mission for Clean Ganga.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