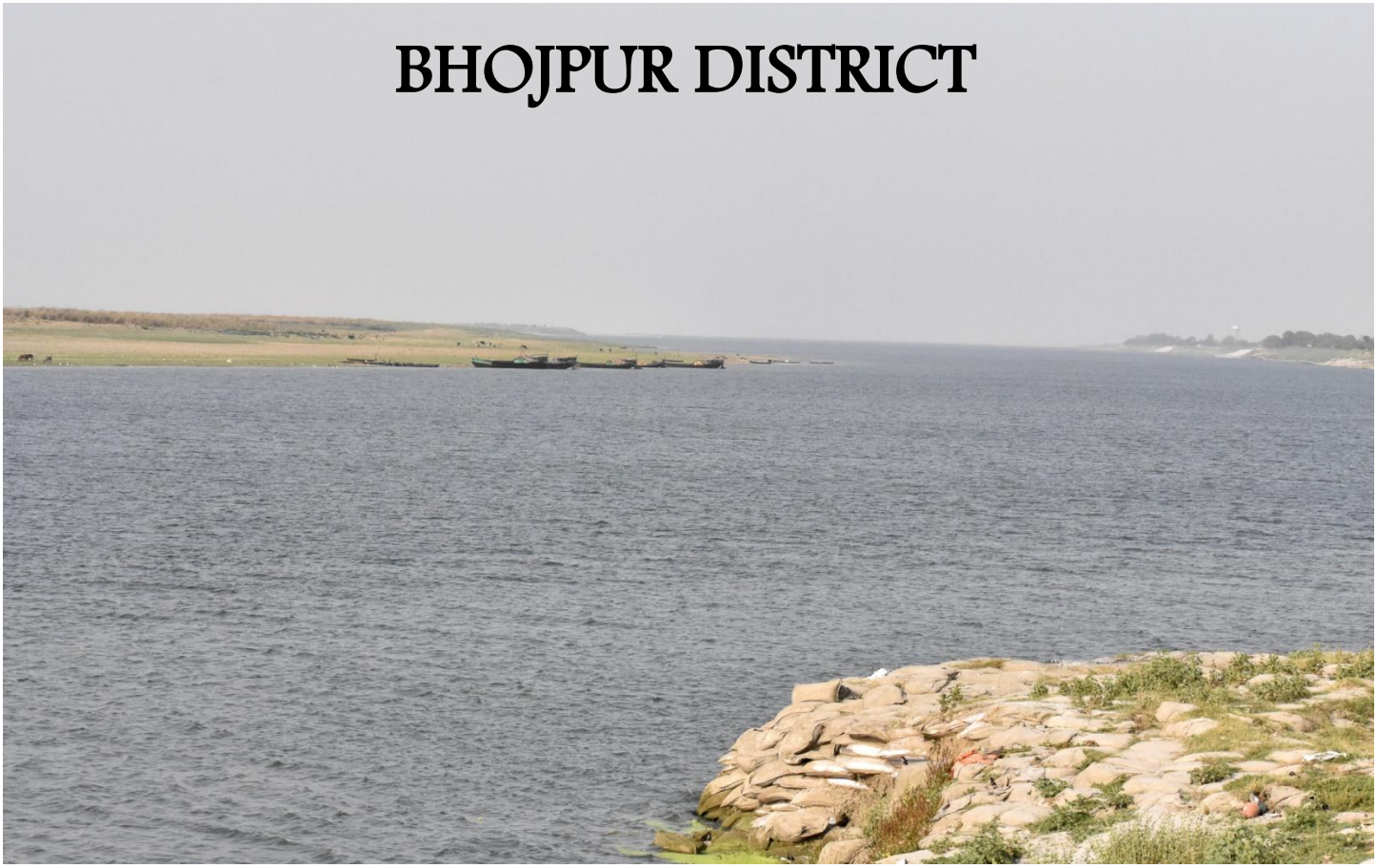
Ganga Cultural Documentation
2021

BHOJPUR DISTRICT



NAMAMI GANGE

National Mission for Clean Ganga

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Front Cover : Ganga river as seen near Piparpanti village

Background : Nathmalpur Jheel

Back cover : A Peepal tree seen near Bhagar Oxbow lake in Suhiya village

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GANGA CULTURAL DOCUMENTATION

BHOJPUR DISTRICT

APRIL, 2021

Sponsored by :

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1.0 Introduction

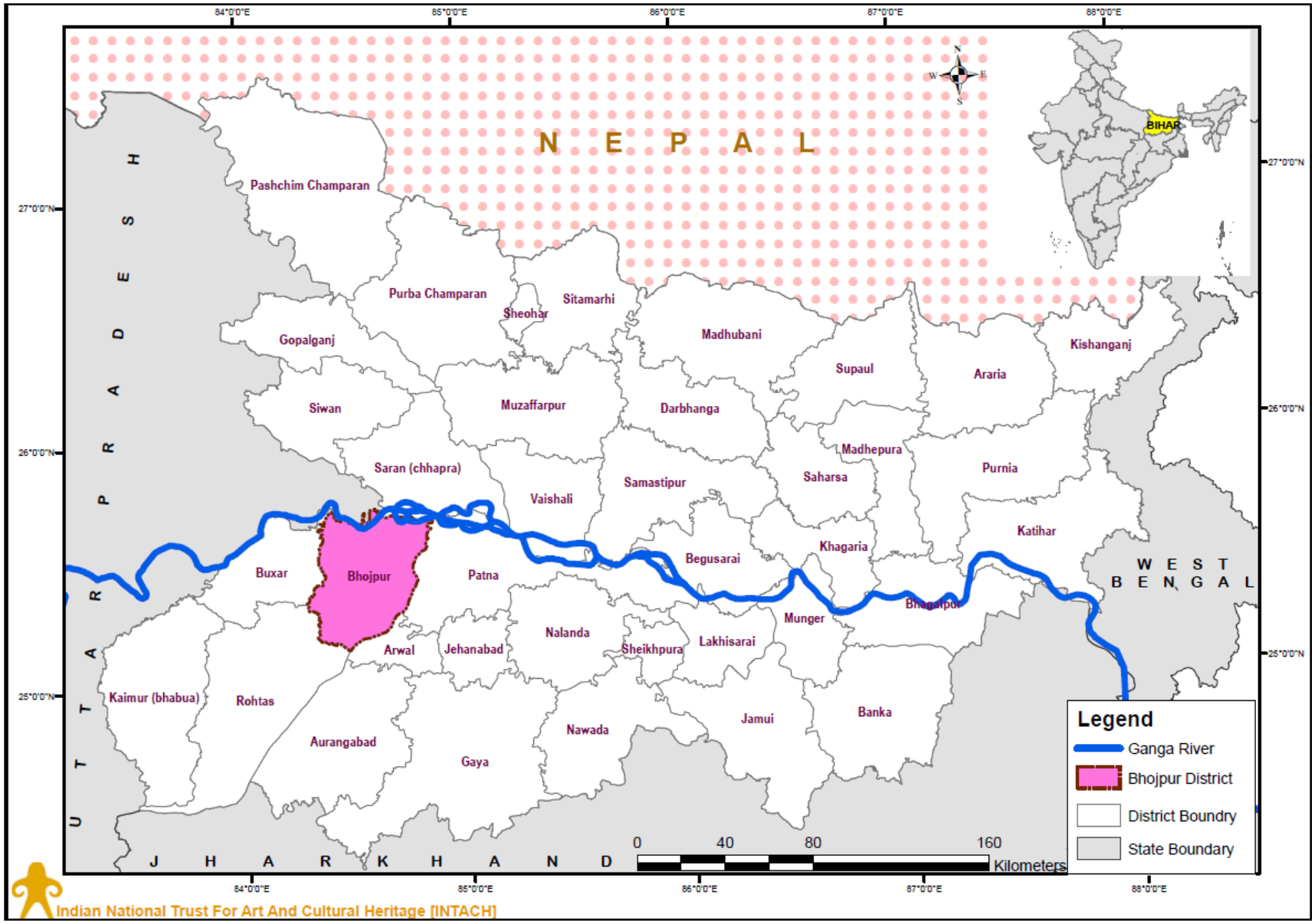
1.1 Bhojpur Distt. is one of the 38 Distt.s of Bihar state situated in its western part with the Distt. headquarters being at Ara town. This Distt. formed part of the erstwhile Shahabad Distt. which was bifurcated into Bhojpur and Rohtas Distt.s during 1972. In 1991, Bhojpur Distt. was further bifurcated into Bhojpur and Buxar Distt.s. The present Distt. of Bhojpur comprises of three sub-divisions namely Ara Sadar, Jagdishpur and Piro comprising of 14 developmental blocks spreading over an area of 2,37,5 Sq. Km. (https://bhojpur.nic.in/geographical-structure/). The Distt. is bounded on the north by the Distt. of Saran and the UP State, on the south by the Rohtas Distt., on the west by Buxar Distt. and on the east by the districts of Patna and Arwal [Refer Map 1].

1.2 Bhojpur Distt. had close linkages with its parent Distt. of Shahabad with old and interesting history. It is believed that the headquarters of this Distt. – Ara derived its name from the Sanskrit word 'Aranya' meaning forest. The name indicates that this area was heavily forested during old days and according to mythological belief, Sage Vishwamitra (Guru of Lord Rama) resided in his Ashram in this region. According to the District Census report of 1961, in old days Shahabad formed part of the ancient Kingdom of Magadh which also comprised of present day portions of Patna and Gaya. Though included in the kingdom of Emperor Ashoka. The general absence of Buddhist' monuments from a greater part of the district suggests that it remained almost immune from the Buddhist influence of time. The famous Chinese pilgrim – Hieun-Tsang also crossed this area near Ara town during 7th century A.D. but found that the inhabitants here were all Brahmins and did not respect the Law of Buddha.

1.3 The Distt. is located in the central part of Ganga basin with the Ganga river forming its northern boundary [Ref. Map 1]. Sone is the other major river flowing along the eastern boundary of this Distt. A newly built 1.5 km long Koilwar bridge over this river which stands parallel to the 138 year old bridge is an important connecting link between Ara and Patna [Image 1]. The overall climate of this Distt. is warm and humid with May being the hottest month and January being the coldest. Monsoon here ranges from the months of June to September with the average annual rainfall varying from 650-1300 mm. According to CGWB (2013), this Distt. is mainly covered with alluvium while hard rocks of Vindhyan Supergroup are situated at the southwestern side beyond the district boundary. The north and northeast parts of the district are covered with Newer Alluvium and younger flood plains (*diara* formations) while the central and southern parts are covered with Older Alluvium and older flood plains. The entire area of the district has a general slope towards the north and northeast. The general

elevation with respect to mean sea level is 50-90 m. The area adjoining the rivers Ganga, Sone, Dharmavati, and Gangi consists of sandy loam, loamy sand and sand, whereas, the area away from the river channels consist of silty sand to sandy silt.

Image 1 : Newly Built Koilwar Bridge Over Sone River As Seen During Field Survey In Bhojpur Distt. On 14th April, 2021

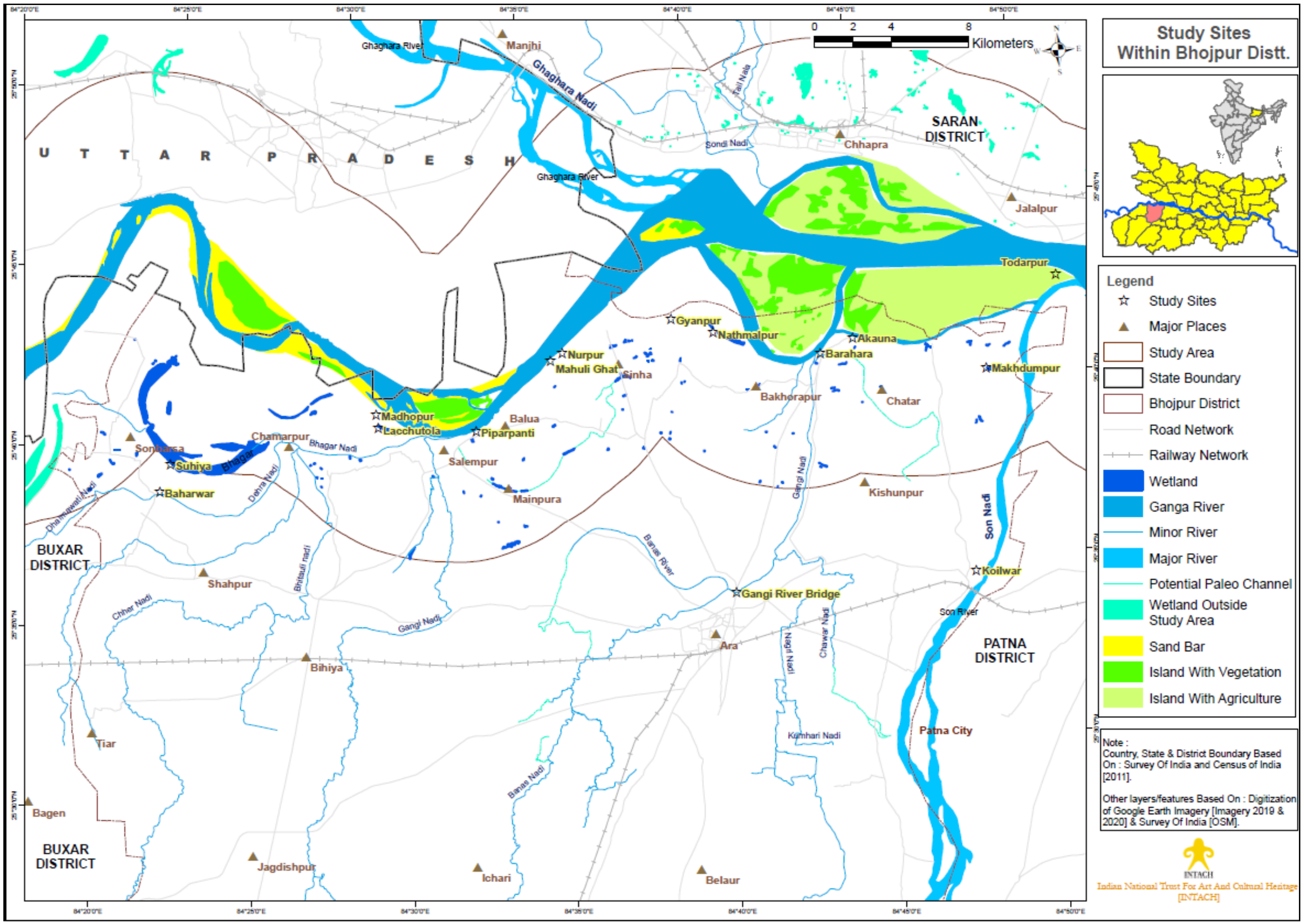


Map 1 : Location Of Bhojpur Distt.

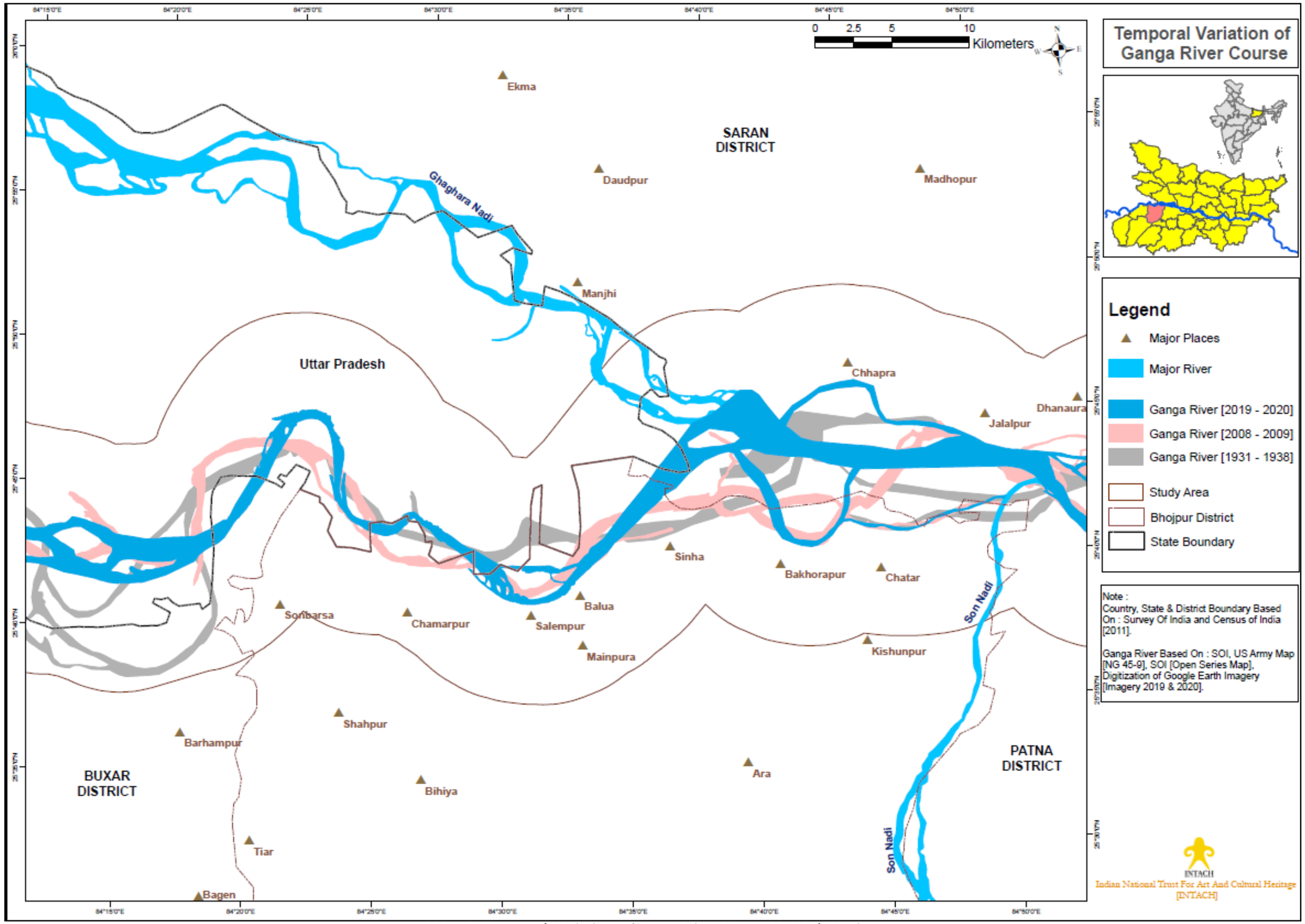
2.0 Ganga River In Bhojpur Distt.

2.1 Ganga River enters Bhojpur Distt. near Nauranga shortly after Nainijor where it exits Buxar. Shortly after it turns south-east for a small distance before making a curve north-eastwards. It confluences with the mighty Ghaghra River which flows in from northern direction near Sitab diara. Thereafter, it flows eastwards and meets another important tributary, Sone river, which confluences with it from southern direction near Todarpur. This confluence of Sone-Ganga also forms the point where Ganga River exits Bhojpur and enters Patna Distt. Between these two confluences, the river channel is braided into different channels due to presence of irregularly shaped diaras. The total length of Ganga River in this Distt. is about 34.2 kms. Map 1A shows the various place locations along the river in Bhojpur Distt, Image 2 depicts the Ganga River as seen during field survey while Map 2 depicts the spatio-temporal changes of Ganga River course in the study region.

Image 2 : Ganga River As Seen Near Madhopur In Bhojpur Distt. On 14th April, 2021



Map 1A: Various Study Locations Along Ganga River In Bhojpur Distt.

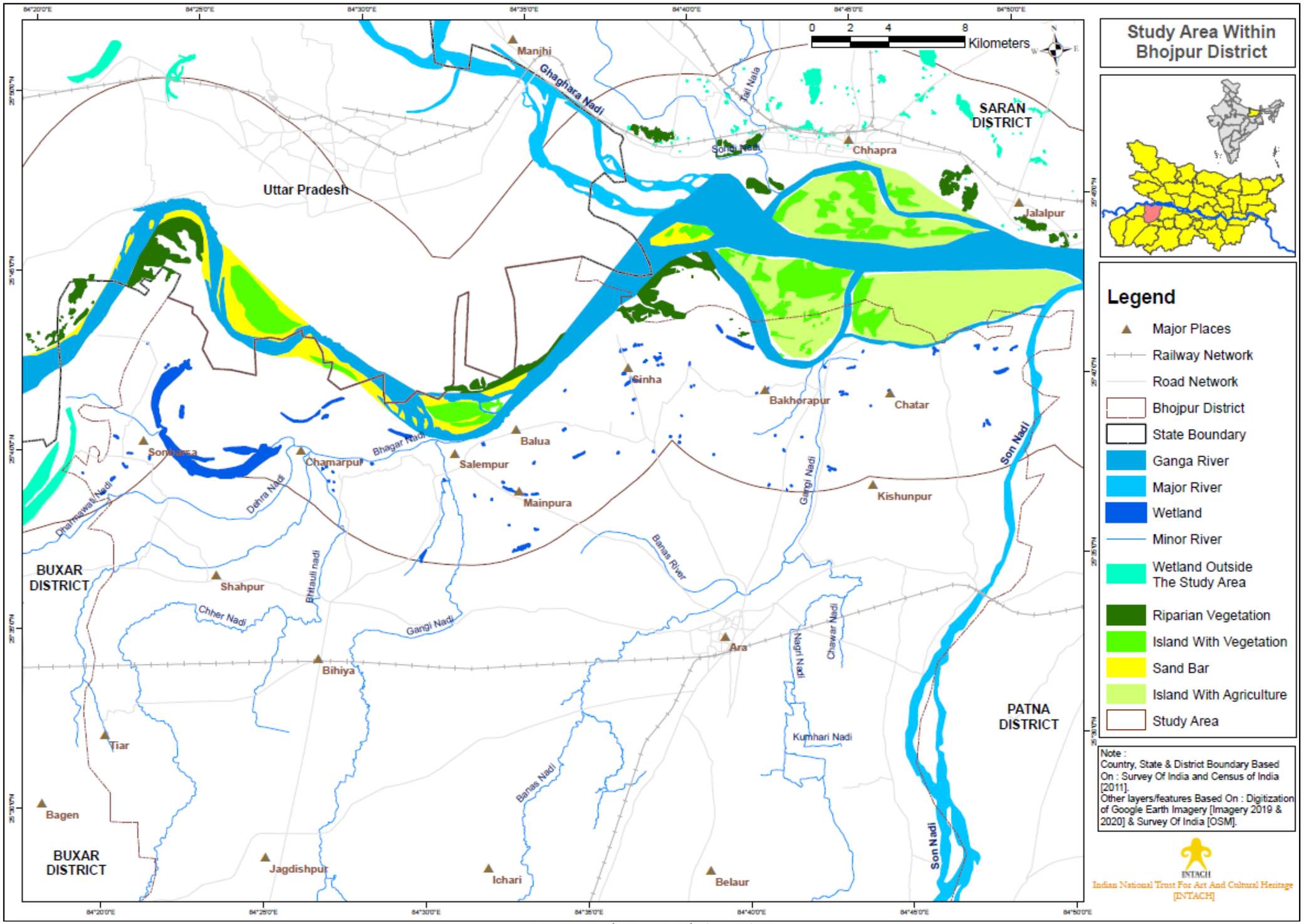


Map 2 : Temporal Variation Of Ganga River Course In Study Region

3.0 Methodology

3.1 Ganga River flows in Bhojpur Distt. for approximately 34.2 kms adjoining it mainly on the right bank. Hence for carrying out the ground survey, a 7 km of buffer zone was selected on the right bank of Ganga River in the Distt. [Refer Map 3]. Based on the secondary information analyzed and the features noted from Google Earth satellite 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 and *Diara* communities in the Distt. for carrying out relevant interactions.

3.2 The field survey in Bhojpur Distt. was carried out from 14th to 16th April, 2021. The documentation and necessary permissions for the survey were taken from DM Office in Ara town. During the survey, various sites such as Suhiya, Lachhutola, Piparpanti, Nurpur, Nathmalpur and Ara town were visited in the study region wherein high quality pictures related tothe study were recorded using Nikon D3400 DSLR camera. The GPS locations were also recorded using Garmin hand-held GPS and videography at the study sites was carried out 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 agriculturists and dairy farmers, temple priests, village heads, fishermen, boatmen and general public.



Map 3 : Study Area In Bhojpur Distt.

4.0 Tributaries Of Ganga River

4.1 **Sone River:** Sone is a perennial river originating near Amarkantak hills in Madhya Pradesh. It is one of the largest rivers in India and second largest among right bank tributaries of Ganga River after Yamuna. After its origin, it flows north-northwest through Madhya Pradesh state before turning sharply eastward where it encounters the southwest-northeast-Kaimur Range. The Sone's course parallels Kaimur hills, flowing east-northeast through Uttar Pradesh, Jharkhand and Bihar states to confluence with Ganga River near Patna where it forms the boundary separating Patna and Bhojpur distt.s [Refer Map 4].The total length of the river is 784 km, out of which about 500 km lies in MP, 82 km in Uttar Pradesh and the remaining 202 km in Bihar. The important tributaries of River Sone are Rihand, Kanhar, Ghaghar and Koel. The total catchment area of the river is spread over 71,259 sq. km. The river has a steep gradient with quick run-off and ephemeral regimes, becoming a roaring river with the rainwater in the catchment area, but turning quickly into a formidable stream (Joshi *et al.*, 2014).

4.2 The river stretch in study region swells up with torrential water flow during monsoons. However, the channel here is unable to carry the heavy flood discharge, thereby leading to water inundations in low-lying areas around it. During summers, the water reduces significantly leading to drying up of river and exposing the river bed at various sites [Image 3]. According to the local interlocutors, the river once had a good flow but is now starving for water which was mainly attributed to the construction of Bansagar Dam in Madhya Pradesh and Indrapuri Barrage in Rohtas Distt. of Bihar. These exposed riverbed sites have become a hotspot for illegal mining in the study region. The active flood plain area of the river provides alluvial and fertile soil for growing crops especially the 'Zaid crops'. Upon further interactions, the Mallah community of nearby villages claimed that owing the decrease in water flow they are hardly able to get adequate fish catch from the river and the river is also not navigable for the major part of the year. According to the Shahabad District Gazetteer (Roy Chaudhury, 1966), navigation used to be intermittent in the Sone river stretch of study region. However, currently no commercial navigation was observed here and the boats that ply currently are mainly for sand collection [Image 4] and fisheries related.

Image 3 : Stretch Of Sone River With Dried Up River Bed And Floodplain Areas As Seen Near Makhdumpur On 15th April, 2021

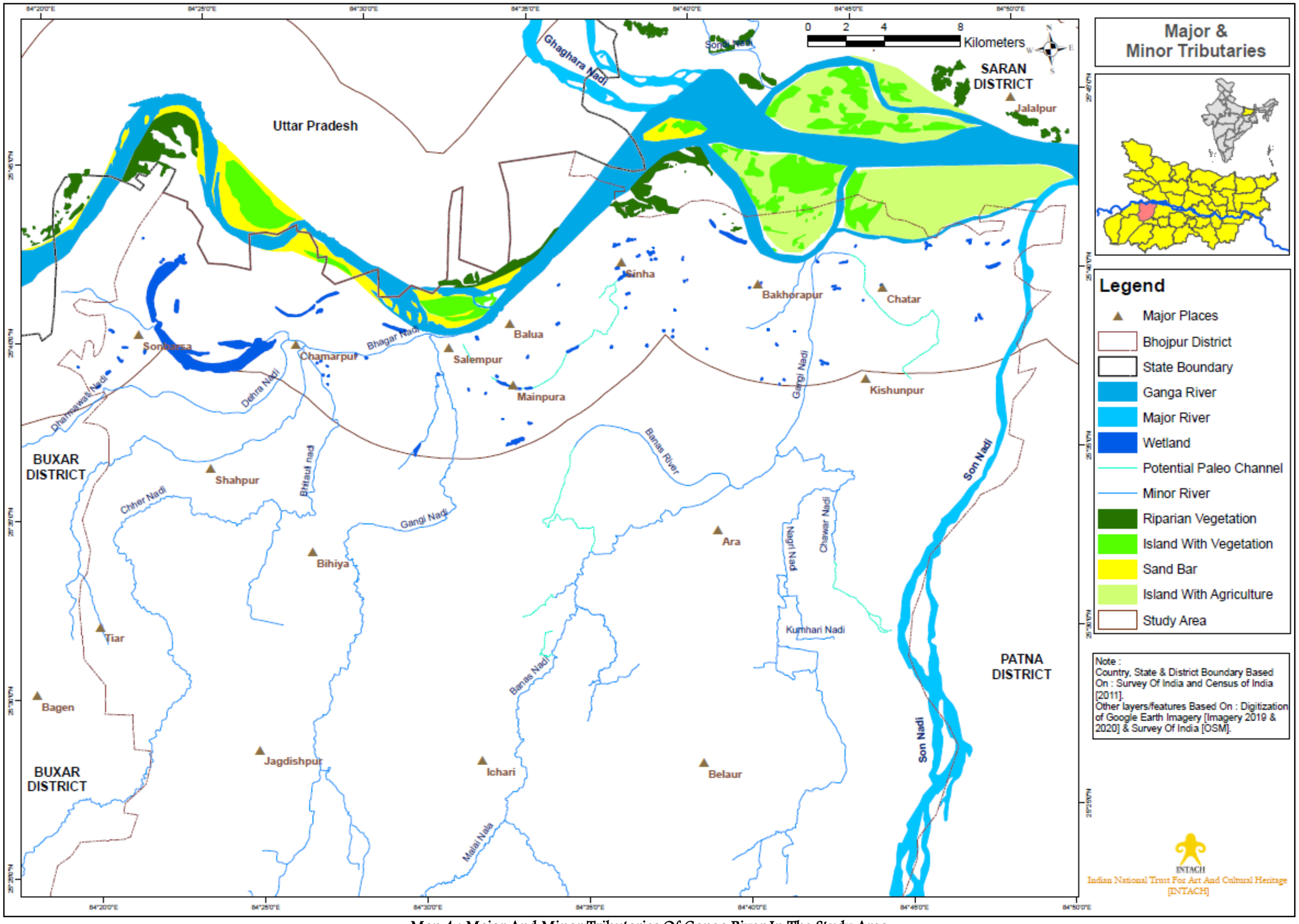
Image 4 : Boats Used For Sand mining As Seen Near Koilwar On 16th April, 2021

4.3 **Dharmavati river:** Dharmavati river (also known as 'Bhagar Nadi/Dehra Nadi' by some residents in this region) is another important tributary of Ganga which originates in Kaimur plateau and passes through the districts of Sasaram, Buxar and Bhojpur before confluencing with Ganga [Refer Map 4]. This river was observed during the survey from a small bridge near Baharwar village [Image 6]. The discharge of water had reduced significantly resulting in extensive growth of water hyacinth (*Eicchornia crassipes*). Upon interacting with local residents it was informed that this river was once very wide and served as an important source of irrigation, fisheries and other purposes for surrounding villages. However, with the passing of time this river has now narrowed to only a few meters width with little or negligible water during post monsoon and summers. Most of the sewage generated from surrounding villages is drained into this river leading to its anemic state at many sites. Fishing activity in this river was found to be almost negligible in this area.

Image 5 : Dharmavati River As Observed Near Baharwar Village On 15th April 2021

4.4 **Gangi River:** It is a perennial river originating from Ganga River near Barahara in Bhojpur Distt. about 15 kms from Ara town [Refer Map 4]. It traverses through Bhojpur Distt. crossing Ara town and then entering Buxar distt. (Imam & Singh, 2010). During the survey, Gangi River was observed from Gangi Bridge near Ara town [Image 8]. According to the local interlocutors, as this river carried water from Ganga, it was considered equally sacred and hence, the residents of Ara town and nearby areas came to bathe here especially during Chhath Puja and other auspicious occasions. A 'Ghat' was also found to be constructed here for this purpose. The river usually expanded during monsoon with the ingress of flood waters from Ganga and remained with reduced water during rest of the year. Fishing from this river was done sporadically by local residents chiefly for their own consumption.

Image 6 : Gangi River As Seen From Gangi Bridge On 14thApril 2021



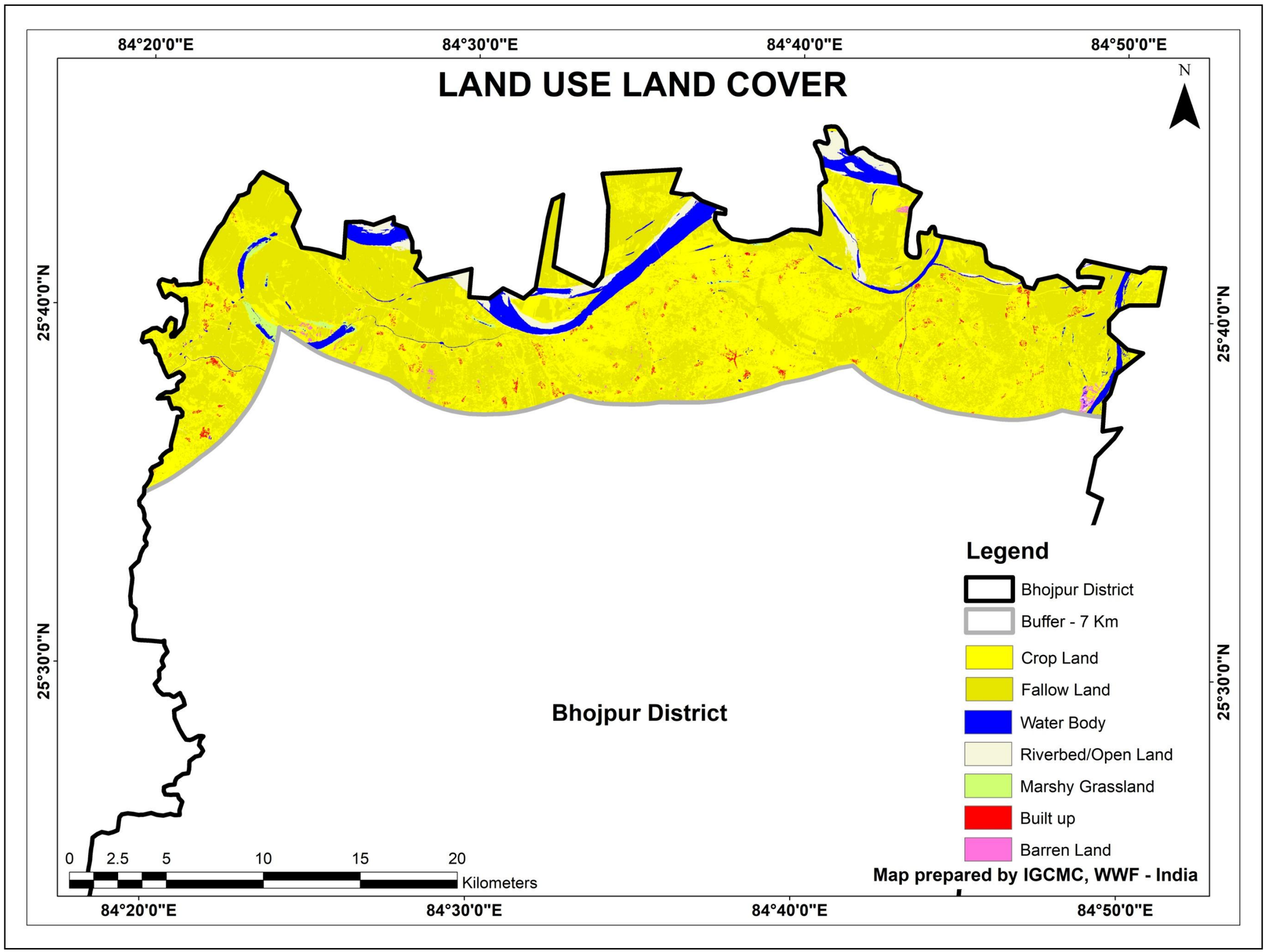
Map 4 : Major And Minor Tributaries Of Ganga River In The Study Area

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,7 different classes were generated –crop land, fallow land, water body, riverbed, marshy grassland, built up and barren land. Agriculture being the principal source of income for local residents, crop land and fallow land dominated the land use with total of 37878.83 hectares (together occupying 89.39% of the total study region).This was followed by water body and riverbed areas (together occupying about 8.45% of total study region) incorporating mainly parts of Ganga, Sone, Dharmavati and Gangi rivers along with Bhagar oxbow lake. The built-up area in study region was low (about 0.88% of total area) which included villages interspersed throughout. The details of these classes in terms of area spread are presented in Table 1 and the land use of the Distt. is depicted in Map 5.

Table 1 : Land Use And Land Cover Details Of Study Region

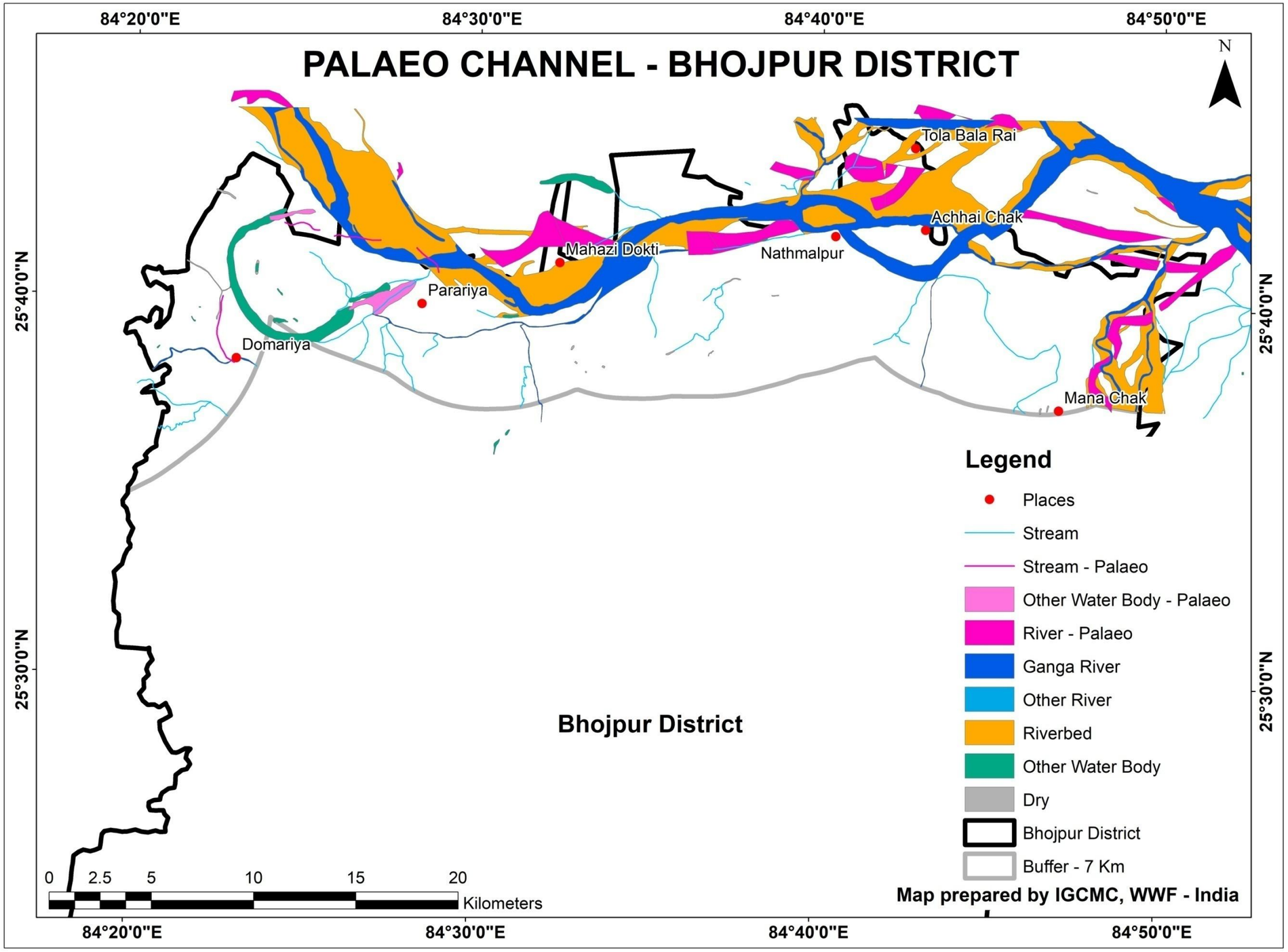
BHOJPUR		
Class Name	**Area (Ha)**	**Area (%)**
Crop land	16221.23	38.28
Fallow land	21657.60	51.11
Water body	2325.52	5.49
Riverbed/Open land	1254.65	2.96
Marshy Grassland	326.26	0.77
Built up	373.59	0.88
Barren Land	218.36	0.52
Total	**42377.21**	**100**



Map 5 : Land Use/Land Cover Map Of Bhojpur Distt.

6.0 PalaeochannelsOfGanga River

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 6 was prepared which depicts the various paleochannels in the study region of Bhojpur Distt.



Map 6 : Paleochannels In Bhojpur Distt.

7.0 Floodplain Of River Ganga In Bhojpur

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 Bhojpur Distt. falls in the South Bihar Alluvial Plain Zone with the major soils being sandy soil, coarse sandy loam soil, fine sandy loam soil, clayey soil and calcareous soil (NICRA-ICAR, 2013). Agriculture is the dominant source of livelihood for residents of this Distt. as it has got almost plain area, fertile soils and river waters for irrigation. During the survey, vast areas of Ganga river floodplain were found to be under wheat cultivation [Images 7 & 8] which was being harvested during the period of field survey [April/2021].Other major crops grown in the floodplain region include Rice, Maize, Mustard, Chana, Bajra and Arhar. Along with these vegetables such as Onion, Tomato, Potato, Brinjal, Chillies, Cauliflower and Lauki are also grown here. This region is also an important hub for Parwal cultivation which is one of the most popular vegetable throughout the state. The details of floodplain villages surveyed along with the crops grown are presented in Table 2.

Image 7 : Vast Floodplain Agriculture Area As Observed Near Salempur In Bhojpur

Image 8 : Wheat Fields In Ganga Floodplain Region Near Suhiya Village In Bhojpur

Table 2 : Some Floodplain Villages And Their Agricultural Produce In Bhojpur Distt.

Sr. No.	Village Name	Agriculture Produce
1.	Suhiya	Wheat, Corn, Parwal, Lauki, Parwal
2.	Lachhutola	Wheat, Chana, Masoor, Lauki, Karela
3.	Nathmalpur	Wheat, Corn, Chana, Karela, Parwal
4.	Mahua	Wheat, Chana, Arhar, Onion, Tomato
5.	Piparpanti	Wheat, Chana, Lauki, Karela, Parwal

7.3 **Floodplain grasses:** The two main floodplain grasses in the study region are – *Saccharum munja* Roxb. (commonly known as *Munj* grass) and *Cynodon dactylon* (L.) Pers. (commonly known as *Doob* or *Durva* grass). Among these, Munj grass is most dominant and luxuriant along the Ganga river banks and on the *diaras*. This species is a perennial wild grass growing upto 2m height and found luxuriantly along river banks in India. It forms extensive root network that binds the soil/pebbles and forms tall thick clumps with high biomass tufts. During the survey, this grass was found growing interspersed with herbaceous riparian vegetation along Ganga river banks in areas such as Akauna, Nathmapur, Nurpur, Gyanpur and Piparpanti [Images 9 & 10]. Upon interaction, it was recorded that this grass is used throughout the Distt. for roof thatching in villages. Along with this some local residents also use this grass in construction of temporary huts to monitor their agricultural fields. Apart from this some villagers also made use of this grass in dried form for making ropes, brooms and mats. The abundance of this grass and availability throughout the year makes it an excellent resource for the residents in this region.

Image 9 : Riparian Vegetation Interspersed With Growth Of *Saccharum* Grass Near Akauna Village In Bhojpur

Image 10 : Riparian Vegetation Interspersed With Growth Of *Saccharum* Grass Near Piparpanti in Bhojpur

8.0 Wetlands In Bhojpur 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. During the current study about 104 different wetlands have been recorded from the study region covering a total area of 667.87 Ha. The details of these wetlands are provided in Table 3. Map 7 depicts the spatial distribution of these water bodies in the study region of Bhojpur Distt. Some of the major wetlands observed during field survey are discussed in this section.

Table 3 : List Of Wetlands In The Study Region

Sr. No.	Wetland	Latitude	Longitude	Area (Ha)
1.	01	25°38'38.34"N	84°20'56.78"E	0.88
2.	02	25°38'59.18"N	84°21'15.15"E	2.10
3.	03	25°39'13.00"N	84°20'22.01"E	0.22
4.	04	25°40'8.74"N	84°21'30.77"E	1.31
5.	05	25°39'41.04"N	84°21'51.66"E	0.70
6.	06	25°39'19.31"N	84°21'40.55"E	1.58
7.	07	25°39'31.39"N	84°22'27.42"E	1.10
8.	08	25°42'42.59"N	84°22'39.58"E	0.22
9.	09	25°42'4.31"N	84°23'14.33"E	0.42
10.	10	25°41'59.61"N	84°23'9.63"E	0.42
11.	11	25°40'44.17"N	25°40'44.17"N	9.19
12.	12	25°40'13.50"N	84°27'7.91"E	10.0
13.	13	25°40'42.22"N	84°28'12.30"E	8.32
14.	14	25°40'18.63"N	84°27'58.34"E	3.10
15.	15	25°38'30.37"N	84°27'55.25"E	0.38
16.	16	25°38'27.93"N	84°28'4.79"E	0.17
17.	17	25°38'54.10"N	84°27'52.74"E	0.37
18.	18	25°38'45.27"N	84°28'4.25"E	0.20
19.	19	25°38'14.35"N	84°28'2.25"E	0.26
20.	20	25°38'59.67"N	84°28'58.56"E	0.77

21.	21	25°38'53.76"N	84°29'17.63"E	0.66
22.	22	25°38'51.68"N	84°27'45.37"E	0.20
23.	23	25°39'38.67"N	84°30'17.06"E	10.30
24.	24	25°38'18.45"N	84°31'29.24"E	0.51
25.	25	25°36'12.92"N	84°30'37.43"E	4.99
26.	26	25°37'48.29"N	84°32'23.00"E	0.34
27.	27	25°38'6.36"N	84°33'18.52"E	0.12
28.	28	25°38'7.56"N	84°33'16.64"E	0.36
29.	29	25°39'14.50"N	84°32'45.06"E	1.26
30.	30	25°37'40.09"N	84°32'53.92"E	0.30
31.	31	25°36'12.67"N	84°33'29.12"E	1.00
32.	32	25°36'15.35"N	84°33'43.53"E	7.99
33.	33	25°36'54.83"N	84°33'22.44"E	0.20
34.	34	25°37'50.13"N	84°33'48.65"E	0.10
35.	Palaeo Channel remains	25°37'59.02"N	84°33'18.29"E	0.19
36.		25°37'56.67"N	84°33'21.38"E	0.16
37.		25°37'54.02"N	84°33'26.49"E	1.19
38.		25°37'54.10"N	84°33'31.25"E	0.36
39.		25°37'50.77"N	84°33'34.29"E	0.99
40.		25°37'44.03"N	84°33'52.09"E	1.36
41.		25°37'43.31"N	84°34'14.77"E	1.41
42.	42	25°38'35.63"N	84°34'16.69"E	0.57
43.	43	25°36'44.76"N	84°34'12.33"E	0.83
44.	44	25°38'43.28"N	84°35'40.98"E	3.37
45.	45	25°39'28.26"N	84°35'18.66"E	0.85
46.	46	25°40'32.70"N	84°35'23.13"E	0.29
47.	47	25°38'42.86"N	84°36'53.52"E	0.61
48.	48	25°41'33.18"N	84°37'13.98"E	2.31
49.	49	25°40'54.14"N	84°37'14.97"E	1.17
50.	50	25°40'41.35"N	84°37'28.86"E	4.94
51.	51	25°39'46.79"N	84°37'25.37"E	0.18
52.	52	25°41'40.27"N	84°37'39.45"E	1.18

53.	53	25°41'40.02"N	84°37'45.83"E	0.42
54.	54	25°41'40.43"N	84°37'51.89"E	0.10
55.	55	25°41'11.54"N	84°37'55.28"E	0.26
56.	56	25°41'13.10"N	84°37'57.26"E	0.12
57.	57	25°40'9.46"N	84°37'29.16"E	0.30
58.	58	25°38'40.86"N	84°37'59.19"E	0.63
59.	59	25°41'4.38"N	84°38'18.73"E	0.29
60.	60	25°41'4.75"N	84°38'26.94"E	0.57
61.	61	25°41'12.00"N	84°38'17.29"E	0.12
62.	62	25°41'17.13"N	84°38'14.20"E	0.38
63.	63	25°41'15.43"N	84°38'17.25"E	0.28
64.	64	25°41'16.30"N	84°38'23.23"E	0.92
65.	65	25°41'24.07"N	84°38'25.29"E	0.1
66.	66	25°38'52.34"N	84°38'47.91"E	0.61
67.	67	25°39'1.66"N	84°38'49.34"E	0.23
68.	68	25°39'2.79"N	84°38'32.32"E	0.51
69.	69	25°41'2.51"N	84°39'17.49"E	0.45
70.	70	25°40'24.04"N	84°39'16.98"E	0.20
71.	71	25°40'25.45"N	84°39'22.46"E	0.13
72.	72	25°39'36.83"N	84°38'55.68"E	0.22
73.	73	25°38'27.96"N	84°39'49.79"E	0.31
74.	74	25°41'57.10"N	84°40'17.41"E	3.41
75.	75	25°41'27.60"N	84°40'56.15"E	17.6
76.	76	25°37'30.43"N	84°41'27.60"E	0.46
77.	77	25°38'52.15"N	84°41'45.77"E	0.33
78.	78	25°40'5.08"N	84°41'17.37"E	0.25
79.	79	25°40'9.22"N	84°41'37.62"E	0.56
80.	80	25°37'19.91"N	84°41'59.50"E	0.11
81.	81	25°37'25.79"N	84°42'8.72"E	0.37
82.	82	25°38'25.22"N	84°42'1.18"E	0.21
83.	83	25°38'27.02"N	84°41'59.00"E	0.16
84.	84	25°38'46.33"N	84°42'34.62"E	0.25

85.	85	25°37'49.05"N	84°43'26.99"E	1.48
86.	86	25°37'47.06"N	84°43'21.37"E	0.22
87.	87	25°40'40.58"N	84°43'26.76"E	0.47
88.	88	25°40'35.90"N	84°44'15.26"E	1.13
89.	89	25°39'56.82"N	84°43'54.06"E	0.61
90.	90	25°39'52.56"N	84°43'58.45"E	1.25
91.	91	25°41'1.48"N	84°44'39.24"E	0.20
92.	92	25°39'29.87"N	84°44'46.13"E	0.24
93.	93	25°39'53.35"N	84°45'21.68"E	0.61
94.	94	25°40'51.12"N	84°46'50.68"E	0.65
95.	95	25°40'54.08"N	84°46'54.57"E	0.55
96.	96	25°40'58.46"N	84°46'50.04"E	0.52
97.	97	25°40'48.34"N	84°48'43.86"E	0.80
98.	98	25°38'47.93"N	84°48'19.95"E	0.71
99.	99	25°40'11.17"N	84°48'53.09"E	6.79
100.	100	25°40'46.14"N	84°49'13.79"E	0.22
101.	101	25°40'50.18"N	84°49'21.92"E	0.88
102.	102	25°38'44.03"N	84°48'12.61"E	0.44
103.	103	25°40'54.05"N	84°48'11.41"E	0.24
104.	Bhagar	84°24'42.31"E	25°38'54.66"N	527.0
Total				**667.87 Ha**

8.2 **Bhagar Oxbow Lake:** Close to the Bhagar Oxbow Lake in Buxar Distt., there lies another oxbow lake which is also known locally as 'Bhagar'. It is approximately 10 km long and about 0.3-0.5 km wide [Image 11]. This is the largest water body of Bhojpur with an area of about 527 Ha. The major villages along this lake include – Isharpura, Sonvarsha, Suhiya and Dhamawal. The lake is fed by monsoon run off and ingress of flood waters from Dharmawati River. According to local residents, this was part of the Ganga river main channel until few decades ago but due to the shift in its course, the

oxbow lake came into existence. During field survey, this lake was observed near Suhiya village [Image 12] where interactions with the villagers were also undertaken to get information about it.

8.3 The water from this lake serves as an important source of irrigation for surrounding agricultural fields where the chief crops grown as wheat, corn and mustard along with some seasonal vegetables. Fishing is an important activity in this lake and the major fish caught here are *Rohu*, *Garai*, *Buari* and *Tilapia*. According to the interlocutors, these fish resources enter the lake during monsoon through flood waters of Ganga and Dharmawati rivers. They serve as an important food resource for local residents during major part of the year. Apart from this, the villagers bathe in this lake especially during festivities along with using the water for bathing their animals, washing clothes and other household purposes. This lake is also an important habitat for different bird species which can be found more in numbers during winter season. Some parts of this lake are also covered with water hyacinth and other aquatic vegetation.

Image 11 : Location Of Oxbow Lake In Bhojpur

Image 12 : Part of Oxbow Lake As Seen Near Suhiya Village On 14th April, 2021

8.4 **Unnamed wetland near Lachhutola (Barsingha):** A wetland covering an area of about 10.3 Ha was observed near Lachhutola (Barsingha) village in Bhojpur Distt. [Image 13]. It was mostly in dried up condition with extensive cover of water hyacinth, grasses and other vegetation [Image 14]. According to local respondents, this wetland is only filled with water during monsoon while slowly dries up during remaining part of the year. The residents mainly use the water for irrigation which was evident from substantial agricultural fields surrounding this wetland.

Image 13 : Location Of Unnamed Wetland Near Lachhutola In Bhojpur

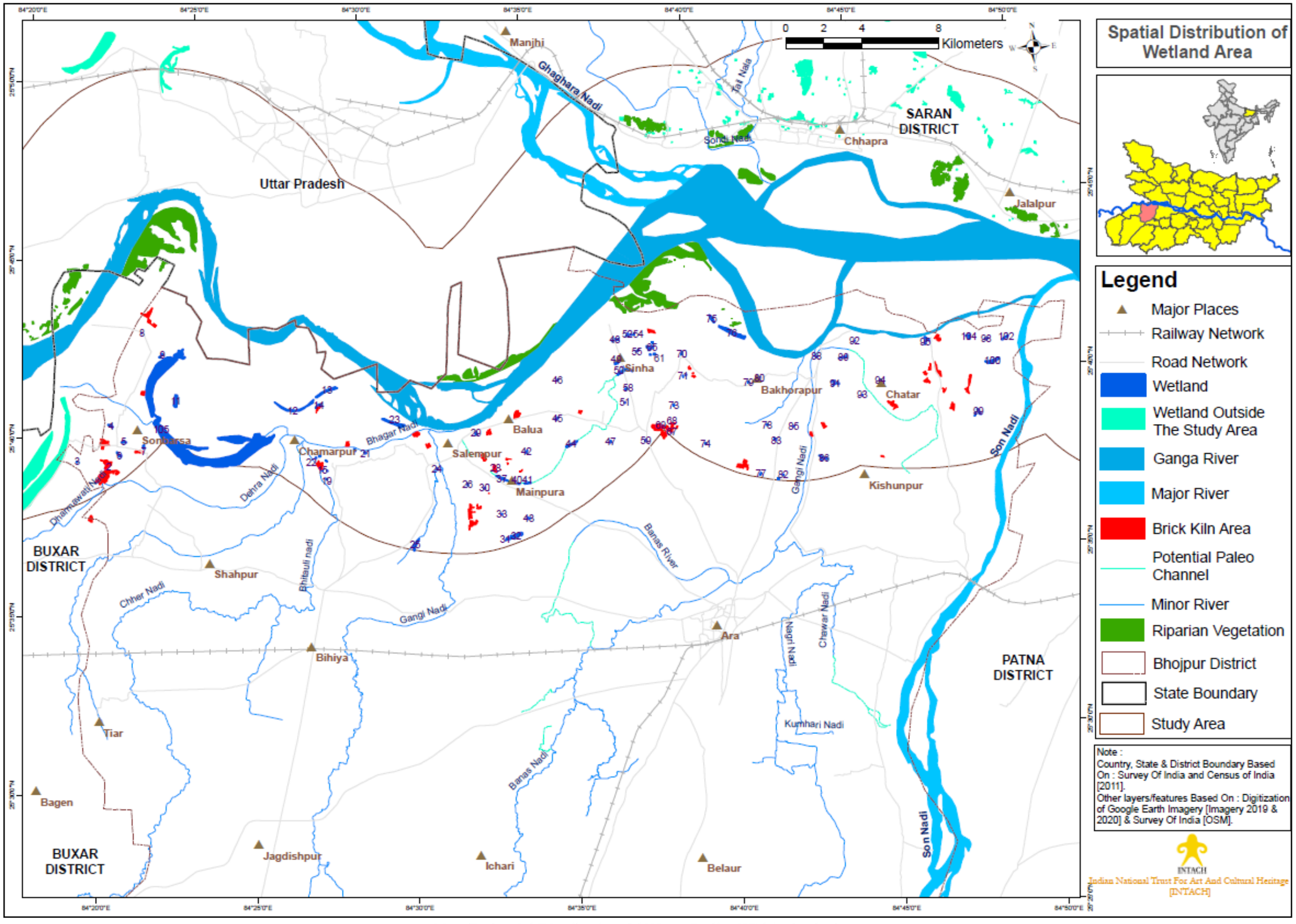
Image 14 : Dried Up Wetland Near Lachhutola In Bhojpur

8.5 **Nathmalpur Jheel:** Two differently sized lens-shaped wetlands were observed near Nathmalpur village in Bhojpur Distt. These wetlands are located close to Ganga River with which they are connected by a small channel [Image 15]. They are together locally referred to as Nathmalpur Jheel. They receive water from river through that channel as well as the flood waters during monsoon season. As the river recedes after that, the water remains in these wetlands for remaining part of the year. This water serves different purposes for the residents of Nathmalpur village. Apart from household activities, the water of this wetland is also used for bathing reared cattle and for performing rituals during festivities. Agriculture fields adjoin the wetland on most sides which depend on water from here and the river for irrigation [Images 16-17]. According to local interlocutors, this wetland also serves as an important habitat for birds especially during winter season.

Image 15 : Location Of Nathmalpur Jheel

Image 16 : The Smaller Part Of Nathmlpur Jheel

Image 17 : The Larger Part Of Nathmalpur Jheel



Map 7 : Spatial Distribution Of Water Bodies Within Study Area

9.0 Riparian Flora Along Ganga River In Bhojpur Distt.

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. Earlier workers have reported from Buxar to Barh, the presence of 7 shrubs, 41 herbs, 6 grasses and 2 sedges, besides these a number of tree species along the banks of river during 1987-88 (Kumar, 2001).

9.3 During the field survey the riparian vegetation was found to comprise more of shrubs and herbs while trees were sparse [Image 18]. The rapid expansion of villages and associated agricultural activities in the floodplain regions is one of the important reasons for the disappearance of natural vegetation. A total of 28 different species were recorded of which 9 are tree species, 7 are shrub species and remaining 12 are herbs and grass species. The common tree species in the region included – Mango, Peepal, Banyan, Neem and Semal among which Peepal and Banyan were also found associated with various religious sites. The commonly found shrubs and herbs in the study region included – *Argemone Mexicana, Lippia alba, Croton bonplandianus* and *Solanum xanthocarpum*. The floodplain grass – *Saccharum munja* was also a major component of riparian vegetation throughout with its luxuriance dominating the other flora at some sites. The list of riparian plant species recorded during the survey is presented in Table 4 and some notable species are depicted in Images 19-21.

Image 18 : Riparian Vegetation As Observed Near Piparpanti

Table 4 : Riparian Plant Species Recorded In The Study Area

Sr. No.	Botanical Name	Family	Habit	Common Name
1.	*Acacia nilotic*a (L.) Delile	Fabaceae	Tree	Babool
2.	*Azadirachta indica* A.Juss.	Meliaceae	Tree	Neem
3.	*Bombax ceiba* L.	Bombacaceae	Tree	Semal
4.	*Dalbergia sissoo* DC.	Fabaceae	Tree	Shisham
5.	*Ficus benghalensis* L.	Moraceae	Tree	Banyan
6.	*Ficus religiosa* L.	Moraceae	Tree	Peepal
7.	*Mangifera indica* L.	Anacardiaceae	Tree	Mango
8.	*Phoenix dactylifera* L.	Arecaceae	Tree	
9.	*Borassus flabellifer* L.	Arecaceae	Tree	Taad
10.	*Argemone mexicana* L.	Papaveraceae	Shrub	Mexican poppy
11.	*Calotropis gigantea* (L.) Dryand.	Apocynaceae	Shrub	Safed Aak
12.	*Calotropis procera* (Aiton) Dryand.	Apocynaceae	Shrub	Aak
13.	*Lippia alba* (Mill.) N.E.Br. ex Britton & P.Wilson	Verbenaceae	Shrub	

14.	*Polygonum glabrum* Willd.	Polygonaceae	Shrub	Common marsh buckwheat
15.	*Justicia adhatoda* L.	Acanthaceae	Shrub	Arus/Arusa
16.	*Ricinus communis* L.	Euphorbiaceae	Shrub	Wild Castor
17.	*Achyranthes aspera* L.	Amaranthaceae	Herb	Chirchira
18.	*Amaranthus spinosus* L.	Amaranthaceae	Herb	Prickly Amaranth
19.	*Blumea lacera* (Burm.f.) DC.	Asteraceae	Herb	Kakronda
20.	*Croton bonplandianus* Baill.	Euphorbiaceae	Herb	Ban Tulsi
21.	*Rumex dentatus* L.	Polygonaceae	Herb	
22.	*Parthenium hysterophorus* L.	Asteraceae	Herb	Congress Grass
23.	*Phyla nodiflora* (L.) Greene	Verbenaceae	Herb	
24.	*Solanum xanthocarpum* Schrad. & H. Wendl.	Solanaceae	Herb	Kateli
25.	*Xanthium strumarium* L.	Asteraceae	Herb	Chhotadhatura
26.	*Saccharum munja* Roxb.	Poaceae	Grass	Munj
27.	*Cyperus* sp.	Cyperaceae	Grass	
28.	*Cynodon dactylon* (L.) Pers.	Poaceae	Grass	Doob/Durva

Image 19 : *Blumea lacera*

Image 20 : *Phyla nodiflora*

Image 21 : *Rumex dentatus*

10.0 Faunal Diversity In Bhojpur Distt.

10.1 **Gangetic Dolphins:** 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 Ganges–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 during 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). During field survey in Bhojpur, no direct sightings of Gangetic dolphins could be made. However, their presence in the study region was reiterated by the interlocutors who claimed that the dolphin population had diminished over last few decades. They also informed that maximum dolphin sightings here could be made only during monsoon while there were few sightings during remaining part of the year. This could be attributed to factors such as decrease in water flow and depth, unavailability of suitable habitats and disturbance caused by extensive sand mining in the region.

10.3 **Blackbucks:** The blackbuck (*Antilope cervicapra*) is a medium-sized antelope species generally found in semi-arid plains and open forests throughout India (Mahato et al., 2010). They are considered to be the most beautiful of all antelopes because of the male's striking black and white pelage and his long spiral horns (Schaller, 1967). Blackbuck is included in the Schedule-I of Wildlife (Protection) Act, 1972 and is currently classified as 'Least Concern' by IUCN Red List. While no direct sightings of blackbucks could be made during field survey, their presence was confirmed by the interlocutors. Upon further interactions, many local residents claimed to have recorded their presence since their childhood. One chief reason for this can be that during earlier time this region had abundant riparian vegetation and grasslands which served as an important abode for this species. However, as population grew and villages expanded, these areas were largely cleared for agriculture due to which these antelopes have learnt to acclimatize with human habitations. Their principal source of food includes some remnant floodplain grasses, herbs and agricultural crops grown here. Despite this, the respondents seemed to be aware of their protection status and refrained from killing them, though they tried fencing the agricultural fields to keep them away from the crops.

10.5 **Turtles:** Turtles form an important component of Ganga riverine biodiversity and play a critical ecological role by controlling aquatic vegetation, serve as scavengers and help maintain rivers (WII-GACMC, 2017). **During the field survey, interactions with local fishermen revealed a significant decrease (almost 80-90%) in the turtle population during last couple of decades.** According to them, turtles would be seen earlier on the sandy river banks and exposed *diaras*. However, especially since last two decades there have been negligible sightings of turtles in the study region.

10.6 **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 field survey, nilgai was found to be present abundantly throughout Bhojpur Distt. especially in and around agricultural fields including Ganga river floodplain areas [Image 22]. 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 prevent intrusion of nilgai and used to drive them away with the help of sticks and stones.

Image 22 : Nilgai Observed Fields Between Nurpur And Piparpanti On 15thApril, 2021

10.7 **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 farmers in villages such as Mahua, Suhiya, Nurpur and Barahara complained about the menace caused by wild boars especially to crops such as potato and onion. **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.

10.8 **Avifaunal Diversity:** Bhojpur 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 55 different species of birds were sighted during the field visit in study region. The list of birds recorded is provided in Table 5 while some of the notable birds in study region are depicted in Images 23-24.

Table 5 : List Of Birds Recorded In Study Region Of Bhojpur Distt.

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	*Egrettagarzetta*	Least Concern
4	Glossy Ibis	*Plegadis falcinellus*	Least Concern
5	Indian Pond Heron	*Ardeola grayii*	Least Concern
6	Common Sandpiper	*Actitis hypoleucos*	Least Concern
7	Asian Openbill	*Anastomus oscitans*	Least Concern
8	Little Cormorant	*Microcarbo niger*	Least Concern
9	Indian Cormorant	*Phalacrocorax fuscicollis*	Least Concern
10	Common Moorhen	*Gallinula chloropus*	Least Concern
11	Eurasian Coot	*Fulica atra*	Least Concern
12	Bronze-winged Jacana	*Metopidius indicus*	Least Concern
13	**River Tern**	***Sterna aurantia***	**Vulnerable**
14	Red-wattled Lapwing	*Vanellus indicus*	Least Concern
15	Black Drongo	*Dicrurus macrocercus*	Least Concern
16	Common Myna	*Acrido therestristis*	Least Concern

17	Bank Myna	*Acridotheres ginginianus*	Least Concern
18	Green Bee-eater	*Merops orientalis*	Least Concern
19	Jungle Babbler	*Turdoides striata*	Least Concern
20	Indian Bushlark	*Mirafra erythroptera*	Least Concern
21	Chestnut-headed Bee-eater	*Meropsles chenaulti*	Least Concern
22	Common Babbler	*Argya caudata*	Least Concern
23	White-browed Wagtail	*Motacilla maderaspatensis*	Least Concern
24	Grey Wagtail	*Motacilla cinerea*	Least Concern
25	Indian Silverbill	*Euodice malabarica*	Least Concern
26	Asian Plain Martin	*Riparia chinensis*	Least Concern
27	Common Tailorbird	*Orthotomus sutorius*	Least Concern
28	Crested Lark	*Galerida cristata*	Least Consern
29	Rose-ringed Parakeet	*Psittaculakrameri*	Least Concern
30	Chestnut-bellied Sandgrouse	*Pterocles exustus*	Least Concern
31	House Sparrow	*Passer domesticus*	Least Concern
32	Indian JungleCrow	*Corvus culminatus*	Least Concern
33	House Crow	*Corvus splendens*	Least Concern
34	Oriental Magpie Robin	*Copsychuss aularis*	Least Concern
35	Common Pigeon	*Columba livia*	Least Concern
36	Barn Swallow	*Hirundo rustica*	Least Concern
37	Brown-headed Barbet	*Psilopogon zeylanicus*	Least Concern
38	Coppersmith Barbet	*Psilopogon haemacephalus*	Least Concern
39	Ashy Prina	*Prinia socialis*	Least Concern
40	Plain Prinia	*Prinia inornata*	Least Concern
41	Asian Koel	*Eudynamys scolopaceus*	Least Concern
42	Greater Coucal	*Centropus sinensis*	Least Concern
43	Red-whiskered Bulbul	*Pycnonotus jocosus*	Least Concern
44	Red-vented Bulul	*Pycnonotus cafer*	Least Concern
45	Shikra	*Accipiter badius*	Least Concern
46	Common Kaestral	*Falco tinnunculus*	Least Concern
47	Black-winged kite	*Elanus caeruleus*	Least Concern
48	Scaly-breasted Munia	*Lonchura punctulata*	Least Concern
49	Golden Oriole	*Oriolus kundoo*	Least Concern
50	Spotted Dove	*Spilopelia chinesis*	Least Concern
51	Eurasian Collared Dove	*Streptopelia decaocto*	Least Concern
52	Laughing Dove	*Spilopelia senegalensis*	Least concern

53	Black-hooded Oriole	*Oriolus xanthornus*	Least Concern
54	Red-naped Ibis	*Pseudibis papillosa*	Least Concern

Image 23 : Bank Myna

Image 24 : Red-Naped Ibis

11.0 Ganga Riverine Islands/Diaras In Bhojpur 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.

11.2 Soon after the confluence of Ganga-Ghaghra on the opposite side of Bhojpur Distt., a group of *diaras* come into existence which braid the Ganga River main channel into different branches. One such small branch that flows adjoining Bhojpur in this region encompasses a roughly U-shaped *diara* [Refer Map 4] which is referred by some local residents as '*Sheo diara'*. This *diara* was observed during the field survey near Barahara village [Image 25]. Upon interaction, the interlocutors reiterated that most of this *diara* land is used for agricultural purposes with the main crops grown there being Parwal and watermelon. During winter season, mustard is also planted on this *diara* along with some seasonal vegetables. Some parts of this *diara* are also covered with natural vegetation mainly dominated by *Saccharum munja* (*Munj* grass). The local residents of nearby villages collected this grass in dried form and used it for construction of temporary huts on the *diara* for watching over their fields. According to the interlocutors, this part of Ganga River had reduced water during summer season which enabled the cattle to cross over for food. The people however made use of small boats for crossing over to the *diara* and sometimes constructed temporary settlements during the cultivation season to stay there [Image 26].

Image 25 : Sheo Diara As Seen Near Barahara Village In Bhojpur

Image 26 : Villagers Using Small Boats To Cross Over At Sheo Diara Near Barahara Village

11.3 Another small lens shaped *diara* is present in the Ganga river stretch near Piparpanti village falling under Bhojpur Distt. limits [Refer Map 4]. This island is primarily covered with dense growth of *Saccharum* grasses [Image 27] which are collected by residents of nearby villages mainly for roof thatching. Agriculture is interspersed in few parts of the *diara* where parwal is grown as the chief crop. Cattle reared in nearby villages crossed the river onto *diara* mainly during summers in search of fodder. In some fringe parts of the diara, sand collection was also observed which was done by the use of big-sized boats [Image 28].

Image 27 : A small *diara* as observed near Piparpanti village in Bhojpur

Image 28 : Sand Extraction From The Diara Near Piparpanti Village In Bhojpur

12.0 Fishing In Bhojpur 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 & 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 Fishing from Ganga River and its tributaries (mainly Sone, Dharmavati and Gangi) was found to be an important source of livelihood and food in the study region of Bhojpur Distt. Several local residents were involved in fishing using small boats throughout the region. 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. Along with this, some local residents also use fishing traps and hook & line technique for catching fish mainly in the tributaries. The fishing traps are also made locally by the residents and can be of different shapes and sizes according to their requirements. While the raw materials for drag nets are obtained from market and woven by the fishermen as per their requirements, the fine mesh plastic nets are available in the markets for about Rs. 600/- per Kg.

12.4 The boats used for fishing are small sized and hand-rowed [Image 39] made usually from 'Sekua' wood (*Shorea robusta*) and sometimes from 'Jamun' wood (*Syzygium cumini*) as well. These boats were earlier mainly constructed using the raw materials available in the villages by local Mallah community members. However, currently only some natives construct these boats by themselves while majority are dependent upon 'Mistry' (carpenters) from other villages for this. The cost of constructing these boats can range from Rs. 50,000 to Rs. 1 lakh depending upon size and specifications.

Image 29 : Small Hand-Rowed Boat Used For Fishing By Local residents In Bhojpur Distt.

12.4 Upon interactions, fishermen in the study region highlighted that the commonly caught fish in this stretch included - Rohu (*Labeo rohita*), Catla (*Labeo catla*), Tengara (M*ystus tengara*), Buari/Barari (*Wallago attu*) and Sidhari (*Puntius* sp.). These fish, especially Rohu and Catla, are found in plenty during monsoons while Tengara is found more during the summer months. Some of the important fish species caught from the region are represented in Table 6. The fish caught are generally sold in Ara town or local markets of nearby villages. While Rohu and Catla are sold anywhere between Rs. 300-500 per kg in the market, Sidhari is least priced fish which is sold for Rs. 60-80 per kg. They also reiterated the increase of exotic fish – common carp/Chinese carp (*Cyprinus carpio*) in the region which is found in more quantity especially during pre-monsoon season. The fishermen also highlighted that more fish were caught from sites which are near river banks which was an important reason of many nets being placed in such areas throughout rather than in the centre of river. They also said that repeated changing of sites helped them in identifying the most ideal areas for fishing in the region.

12.5 The fishermen in this region unanimously raised their concerns over decreasing fish catch and yield (almost 70-80% decrease) during the last few decades. Various important factors such as overexploitation of fisheries, water pollution, and variations in river flow and depth along with changes in climatic conditions such as uncertain monsoons and higher temperatures during summers were believed to be chief reasons for this decrease. Besides this, the increase in population of exotic carps also proved to be a tough competition for survival of Indian major carps in Ganga River. This had

significantly impacted the livelihoods of fishermen in the region who are forced to look for alternate modes of earning income for family. **The respondents also reiterated that Hilsa fish, which was once available in the Ganga river stretch of Bhojpur Distt. was no longer seen since the last few decades.** Despite these difficulties, no aid or help of any kind was provided to these people from the authorities as claimed by them.

Table 6 : Major Fish Caught From Rivers In The Study Region

Sr. No.	Scientific Name	Common Name
1.	*Labeo rohita*	Rohu
2.	*Labeo catla*	Catla/Bhakur
3.	*Wallago attu*	Buari/Barari
4.	*Mystust engara*	Tengara
5.	*Puntius sp.*	Sidhari/Kothia
6.	*Cyprinus carpio*	Common/Chinese carp
7.	*Channa punctata*	Garai
8.	*Oreochromis niloticus*	Tilapia
9.	*Cirrhinus mrigala*	Mrigal carp

13.0 Groundwater In Bhojpur 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, Bhojpur Distt. is mainly covered with alluvium and hard rocks of Vindhyan Supergroup which are situated at the southwestern side beyond the district boundary. The north and northeast parts of the district are covered with Newer Alluvium and younger flood plains (*diara* formations) while the central and southern parts are covered with Older Alluvium and older flood plains. The entire area of the district has a general slope towards the north and northeast (CGWB, 2013).

13.2 According to the Central Ground Water Board (CGWB, 2013), this Distt. is occupied by Quaternary Alluvium which makes the potential aquifers. Beyond the major clay zone (within 100 – 130 m bgl) up to 250 – 300 m bgl, a total of 100 – 120 m thick aquifer with fining upward character from very coarse sand to fine to medium sand is found along the northern part of the district. Above the major clay zone (100 – 130 m bgl) are found medium to coarse sand zones up to an average depth of 30 m bgl. From 0 to 30 m bgl are found clay, silty clay, sandy clay zones with occasional fine sand layers, which sustain the dug wells in the area. During the field survey ground water levels in different villages was recorded based on interaction with local residents which is presented in Table 7.

13.3 The groundwater availability was found to be shallowest in Madhopur village with depth at 50ft. bgl while it was deepest in Balua with depth at 180 ft. bgl. The interlocutors in this region reiterated the use of dug wells for drawing ground water which has now given way to bore pumps in many places. An example of this was observed in Suhiya village where an old well which used to be the chief source of groundwater in the early years was left abandoned since last few decades and was in dilapidated condition [Image 30]. The groundwater in major parts of this Distt. is suitable for drinking and irrigation purposes. However, there are some areas such as Shahpur, Behea, Koilwar and Ara mainly adjoining Ganga river course where the groundwater is contaminated with unusual concentration of Arsenic.

Table 7 : Ground Water Level Of Different Sites In Study Region

Place	Coordinates		Ground Water Table (Ft.)
	Lat.	Long.	
Sundarpur Bajra	25.650251° N	84.513038° E	60
Salempur	25.651621° N	84.532076°E	90
Damodarpur	25.701787° N	84.435726° E	140
Madhopur	25.667159°N	84.497406°E	50
Balua	25.653808°N	84.566781°E	180
Brahmpur	25.602473°N	84.299616°E	80

Image 30 : An Old Dug Well Abandoned In Suhiya Village

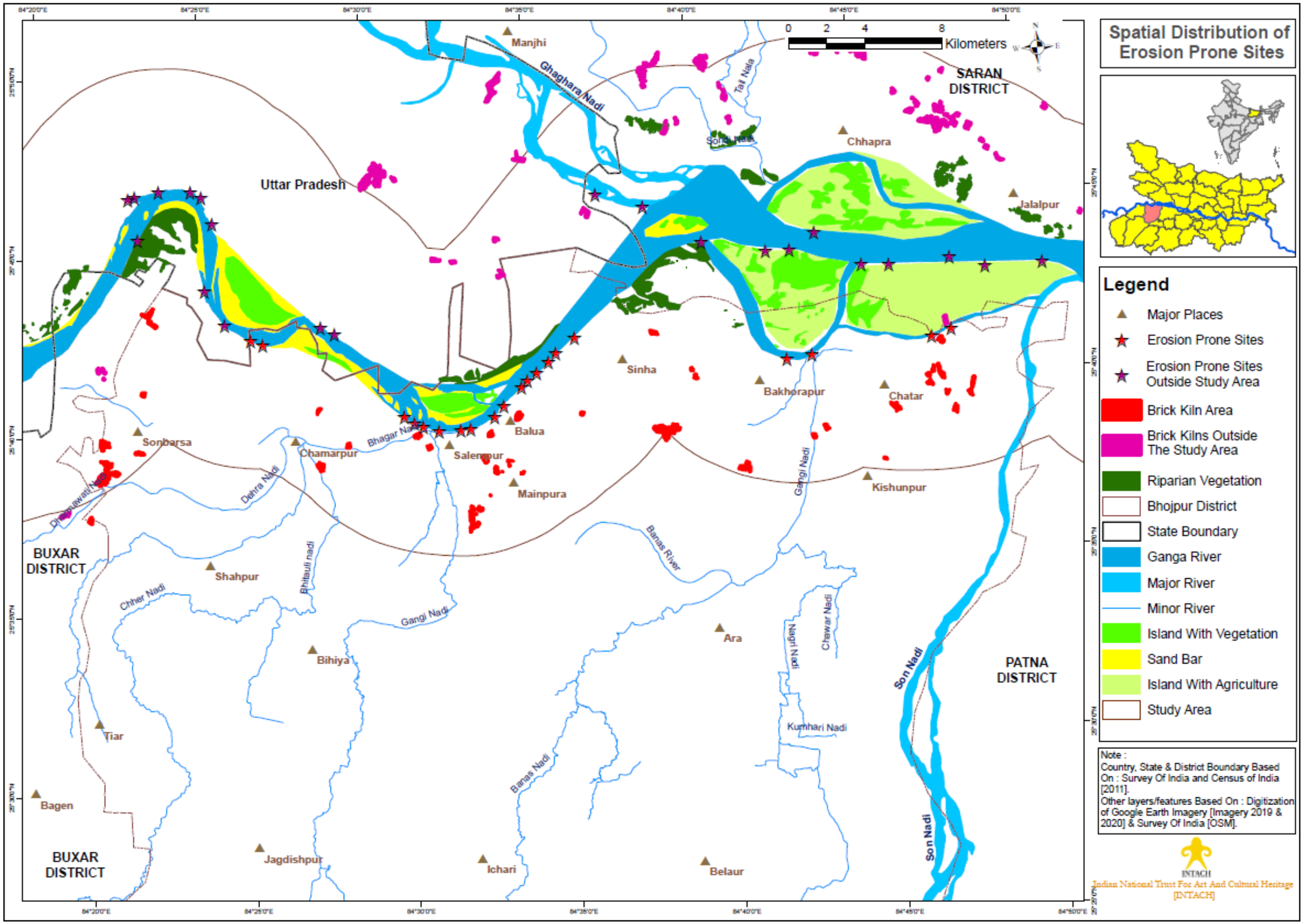
14.0 Ganga River Bank Erosion In Bhojpur Distt.

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.

14.2 During the field survey, majority of the Ganga river bank in study region was found prone to severe erosion especially in sites such as Piparpanti, Mahuli Ghat (Nurpur) and Akauna. Some such sites are represented in Images 31-32 while all the erosion prone sites in the study region are marked on Map 8. The intense rainfall accompanied by torrential flow of water in Ganga River resulted in lateral bank erosion. Various other factors such as decrease in riparian vegetation and large scale land-use changes have also contributed to this severe erosion. The interlocutors reiterated about huge losses caused by floods and associated erosion to their villages and floodplain agriculture fields. They also claimed to have no kind of aid or assistance in this matter from anyone including authorities thereby bearing the brunt of these losses all by themselves. However, in some of these sites, sand bags were employed for protection of river bank along with plantation of some trees and shrubsto reduce the impacts of erosion.

Image 31 : Use Of Sandbags For River Bank Protection Near Mahuli Ghat In Bhojpur

Image 32 : Bank Erosion As Observed Near Akauna In Bhojpur



Map 8 : Spatial Distribution Of Erosion Prone Sites In Bhojpur Distt.

15.0 Mining And Brick Kilns In Bhojpur

15.1 Sand is major mineral of Bhojpur district of Bihar. Yellow sand in Sone river and Ganga River are major source of revenue collection in district as well as soil/clay is actively mined for bricks and pottery industry (MSME-DI, 2020). While sand is vastly collected with the help of big-sized sand boats in the Ganga river stretch of study region, Sone River is also exploited unsustainably for sand mining. During the field survey, rampant illegal mining using trucks and tractors was observed from Sone River in the stretch between Makhdumpur and Koilwar [Image 33]. The local residents reiterated that due to the shift in course of Ganga and Sone Rivers, vast floodplain areas were exposed which has become a paradise for illegal miners especially during last decade. Hundreds of heavy vehicles visit these sites throughout the day and sometime during night as well to collect sand for selling in nearby districts of Bihar and Uttar Pradesh.

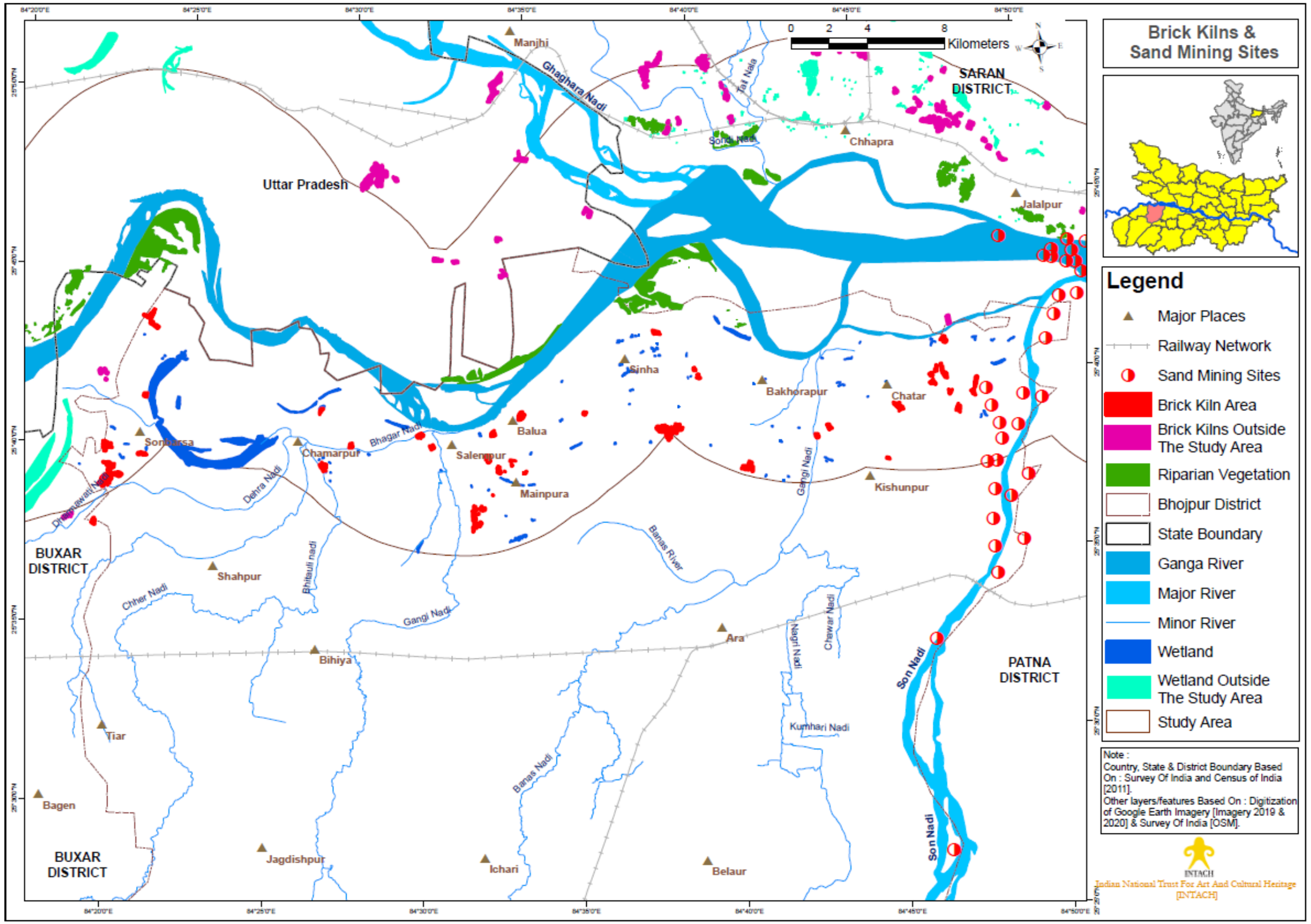
15.2 Apart from this, big-sized sand collection boats plying in the Ganga River approach Sone from their confluence and travel throughout the year for sand collection [Image 34]. These activities not only significantly harm the hydrology and biota of these rivers but also pose serious threat to the life of anyone who tries to object or stop these miners. Various reports and news articles have been published highlighting this issue in the region. However, according to interlocutors no significant actions have taken place so far and rampant mining is undergoing even today. Map 9 presented in this section also highlights the high mining prone areas in and around Sone and Ganga river stretch of study region. Such unchecked and reckless sand mining operations should be immediately attended to and the **'Enforcement and Monitoring Guidelines for Sand Mining 2020'** needs to be implemented seriously in the study region.

Image 33 : Rampant Illegal Sand Mining From Sone River Near Makhdumpur Village In Bhojpur

Image 34 : Sand Mining From Sone River Using Big-Sized Boats As Observed Near Koilwar

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. Several brick kilns are distributed in the study region with some of them situated close to Ganga River and its floodplain. The spatial distribution of brick kilns in the study region is depicted in Map 9 and a brick kiln is depicted in Image 35.

Image 35 : A Brick Kiln Observed Near Balua Village In Bhojpur



Map 9 : Spatial Distribution Of Stone Quarry And Brick Kilns In The Study Region

16.0 Sacred And Old Trees In Bhojpur Distt.

16.1 Various sacred trees were observed during the field survey in study region. Peepal (*Ficus religiosa*) is the major tree species often found associated with temples and other religious sites throughout. The worship of this tree is usually done by the female residents in that region by tying threads around it and offering water along with sindoor, coconuts or incense sticks. Another tree species that is also found commonly associated with sacred sites is *Ficus benghalensis* (Banyan tree). Owing to their protection these sacred trees often develop trunks with huge girths and a luxuriant canopy. Other common sacred trees observed in the study region include – Neem (*Azadirachta indica*) and Semal (*Bombax ceiba*). Some such examples of sacred trees as observed during field survey are depicted in Images 36-39.

Image 36 : An Old And Sacred Peepal Tree Near Akauna Village In Bhojpur

Image 37 : An Old And Sacred Peepal Tree Near Nathmalpur Village In Bhojpur

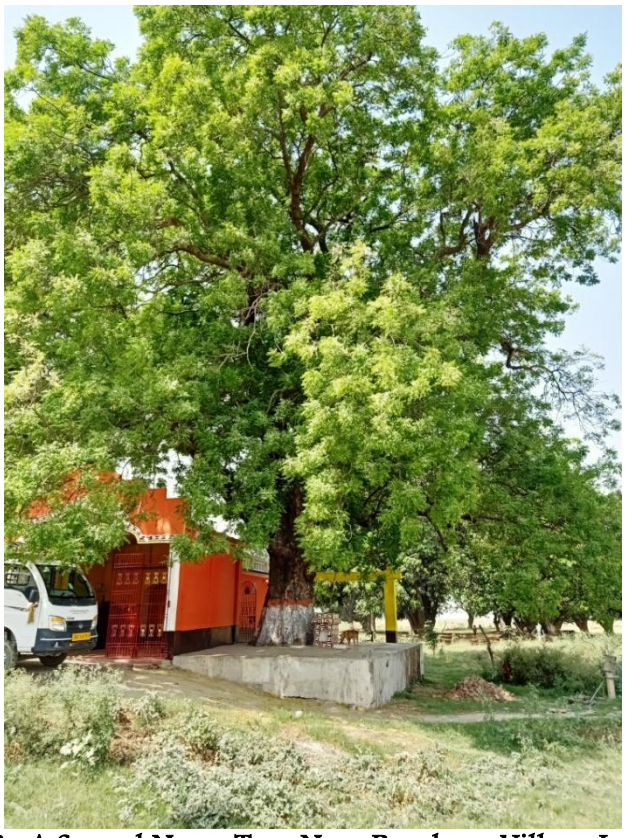


Image 38 : A Sacred Neem Tree Near Barahara Village In Bhojpur

Image39 : An Old And Sacred Peepal Tree In Mahua Village Of Bhojpur

17.0 Key Observations And Recommendations

17.1 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'. Evidences of this activity were seen at some sites along Ganga river in the study region [Image 40]. It can be noted that all the remains of these rites along with other substances such as pots, flowers, clothes, threads and so on are dumped directly into the river thereby impacting the riparian and instream biodiversity. Hence, it is recommended to designate another site for cremation little away from Ganga River and develop appropriate facilities in order to prevent further pollution and ecosystem damage.

Image 40 : Evidences Of Last Rites As Observed Along Ganga River Bank In Bhojpur

17.2 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 killing wild boars as they are 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.

17.3 Another important observation during field survey was the presence of a significant population of blackbucks. There has been a drastic decrease in the original habitat for these antelopes which have now come to acclimatize with agricultural landscapes and scrub like habitats along with human presence. However, their natural food scarcity has led them to invade the crops being cultivated in the region. Despite this, the locals never react violently to these animals owing to the awareness regarding its Schedule I protection under Wildlife Protection Act. However, there is a need to carry out detailed studies on the presence, distribution and ecological linkages of blackbucks in the study region in order to develop suitable habitats for them and also to develop tourism potential in the distt.

17.4 Evidences of severe bank erosion were observed throughout the study region which results in losses of human settlements and agricultural fields. 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.

17.5 Reckless and unchecked sand mining in the study region poses imminent danger to the ecosystem of Sone and Ganga Rivers. Along with this, it also results in numerous criminal activities by hooligans involved in this activity. It is recommended very strongly in this report for the authorities to take decisive actions against this in order to safeguard the natural resources and human lives.

17.6 The wetlands observed in the study serve as crucial resources for livelihoods and day to day needs of local residents associated with them. However, no effort has been made to ensure conservation and maintenance of these resources which has resulted in issues like sewage influx and dominance of invasive species. 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 strongly recommended to pay immediate attention for maintenance of these water bodies especially in conjunction with local stakeholders.

17.7 The fishermen in study region strongly reiterated their concerns regarding sharp decline in the fish availability, catch and yield which could be attributed to reasons such as changes in river flow and depth, climatic alterations and dominance of invasive exotic species such as Chinese/Common carps. Along with this the influx of pollution

in Ganga River from various sources was also to blame for the changes in fisheries. Hence, it is imperative to carry out awareness cum survey programs involving fishermen in the region to understand these changes and address the necessary issues. Along with that alternate livelihoods could to be developed for fishermen communities such as promoting them for building different boats and involving in eco-tourism activities.

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