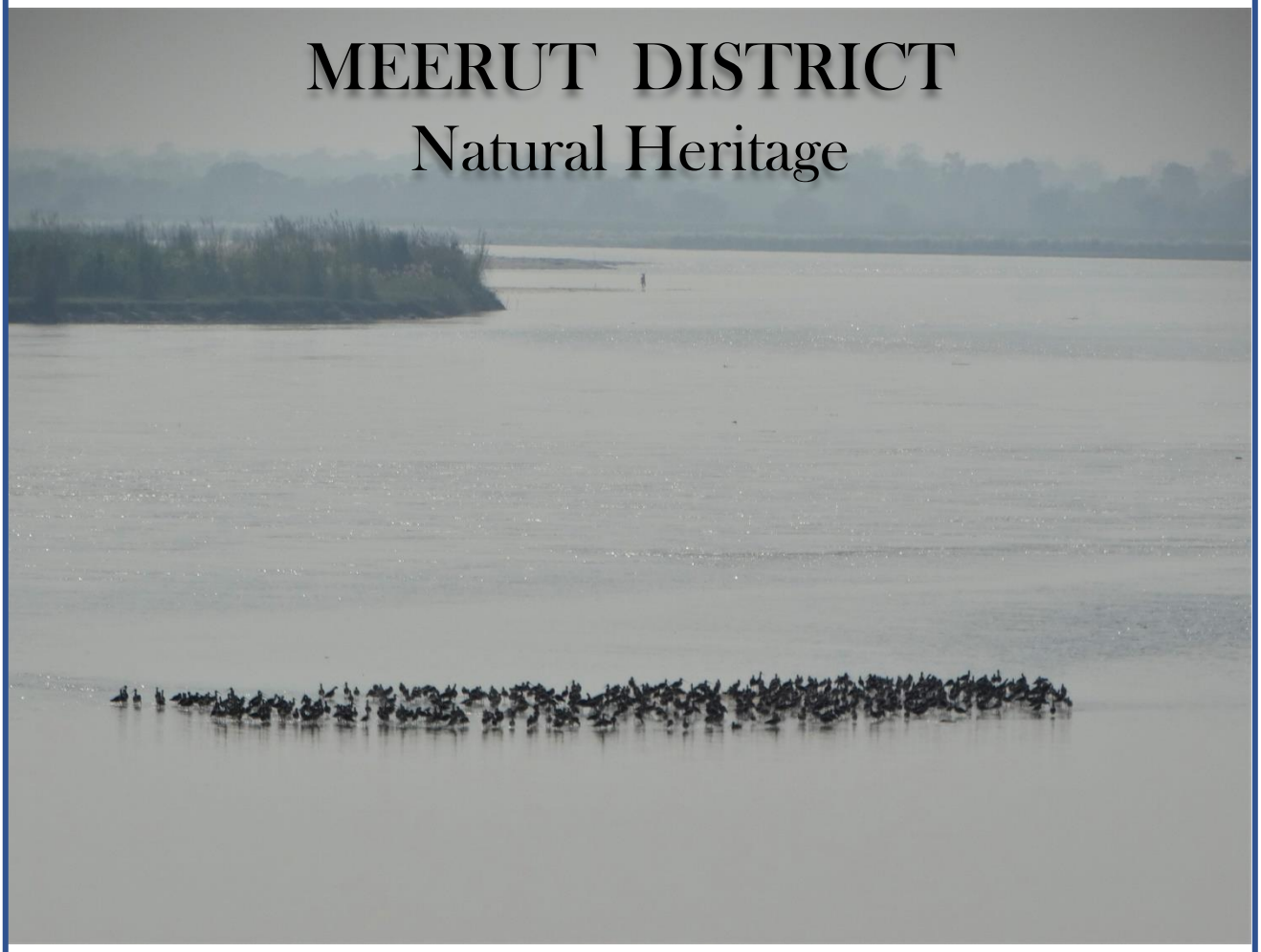
Ganga Cultural Documentation
2022



MEERUT DISTRICT
Natural Heritage

National Mission for Clean Ganga

INTACH

Indian National Trust for Art and Cultural Heritage

71, Lodhi Estate, New Delhi – 110003

Website: www.intach.org

Email: intach@intach.org

Surveyed & Authored by: Mohd. Sajid Idrisi

Team Headed By: Manu Bhatnagar [Principal Director, NHD]

Dr. Ritu Singh [Director, NHD]

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Front Cover: Ganga River At Nandnaur-Hastinapur Bridge, Distt. Meerut

Background: Exposed River Islands In Ganga River, Distt. Meerut

Back cover: Inundated Road to Ganga River at Makhdumpur, Distt. Meerut

Formatting and Design by: Mohd. Sajid Idrisi

GANGA CULTURAL DOCUMENTATION

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Sponsored by :

National Mission for Clean Ganga

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1.0 Introduction

1.1 Distt. Meerut, situated on the right bank of Ganga River [approx. 35 km reach in the Distt.], is one of the 18 divisions [Mandal] of Uttar Pradesh covering districts of Meerut, Hapur, Ghaziabad, Gautam Budhha Nagar, and Bulandshahr. The District lies around 70 km northeast to the NCT Delhi and is connected via NH-34 and Delhi-Meerut Expressway. It apparently derives its name from the word "Maya Rashtra", meaning the country of Maya, who was the architect of the *'Asuras'* (the demons) as per Hindu mythology[1]. The popular 'Hastinapur' mentioned in epic Mahabharata is also situated in the District. Meerut is an important trade hub with its connectivity to the national capital and other districts of Uttar Pradesh and Uttarakhand.

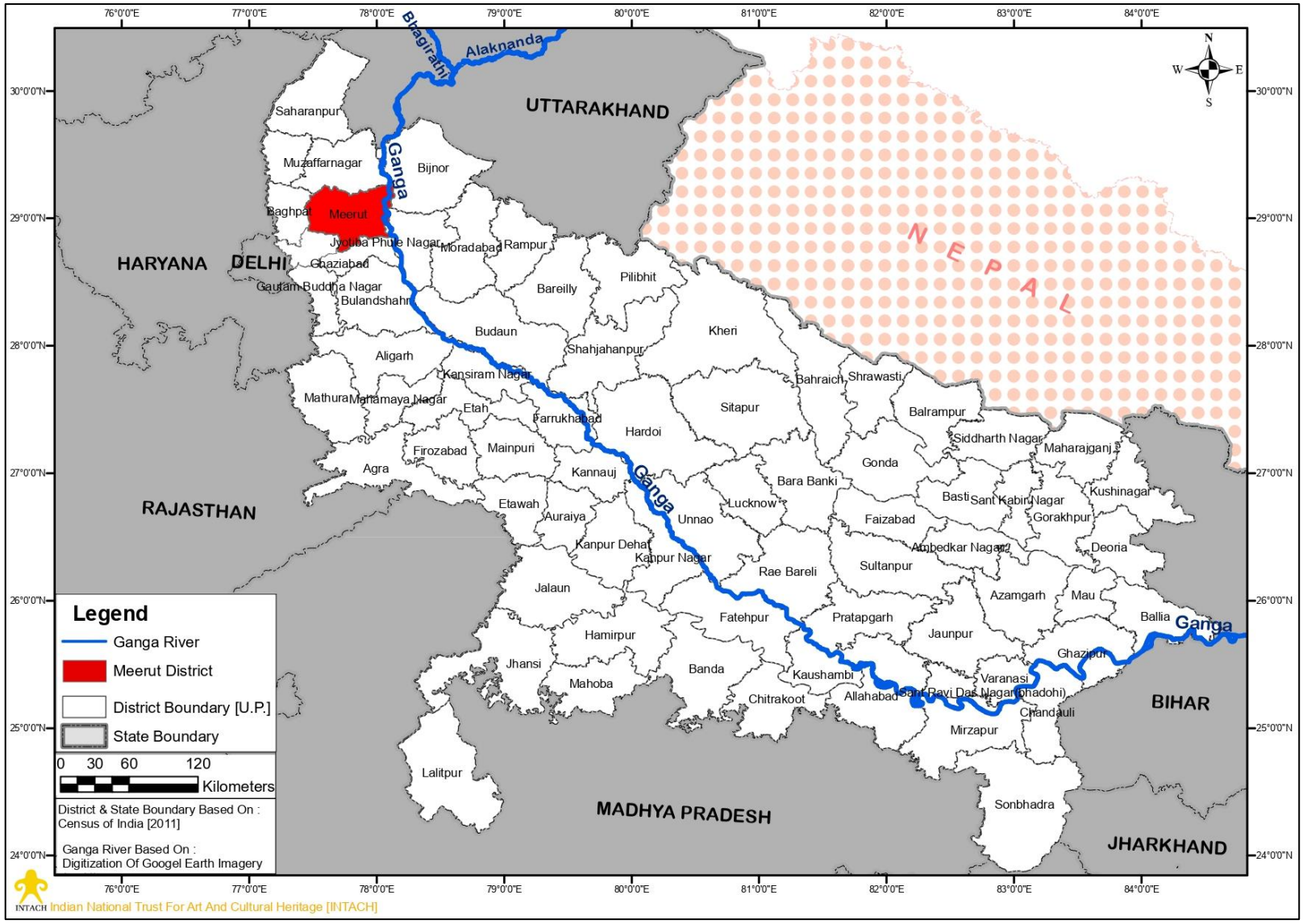
1.2 The geographical area of the Distt. is 2,590 Sq. km which is about 1.0 percent of the total Uttar Pradesh State area. It shares boundaries with Distt.s. Muzaffarnagar in north, District Bijnor and Amroha in east, Distt.s. Hapur and Ghaziabad in south and District Baghpat in west. The Distt. is divided into 16 urban bodies [Nagar Nigams, Nagar Palikas, and Nagar Panchayats] and has around 662 villages under its administration.

1.3 Meerut Distt. is a part of Yamuna-Ganga Doab sloping gently from north to south and west to east. The District is a well cultivated plain except ravines and upland tracts near Ganga River. Geomorphologically, the District can be grouped into four micro regions viz. Hindon Plain, Meerut Plain, Mawana Bhur Tract, and Ganga Khadar[2].

1.4 Distt. Meerut is popularly known as "Sports City of India" due to thriving sports good industry. Other traditional industries include handloom works and scissors manufacturing. Due to easy availability of raw material and its strategic location, Meerut houses many micro, small and medium level enterprises dealing in tyre, textiles, distillery, chemical, engineering, paper and agro based products. Agriculture remains the major employer with wheat, rice and sugarcane as major crops. Other agrarian products include oil seeds, pearl millet, maize, groundnut, pulses, various vegetables and fruits.

[1] http://meerut.nic.in/history

[2] District Census Handbook [Meerut], Village and Town Directory, Directorate of Census Operations, Uttar Pradesh



Map 1 : Location Of Meerut Distt. On Right Bank of Ganga River

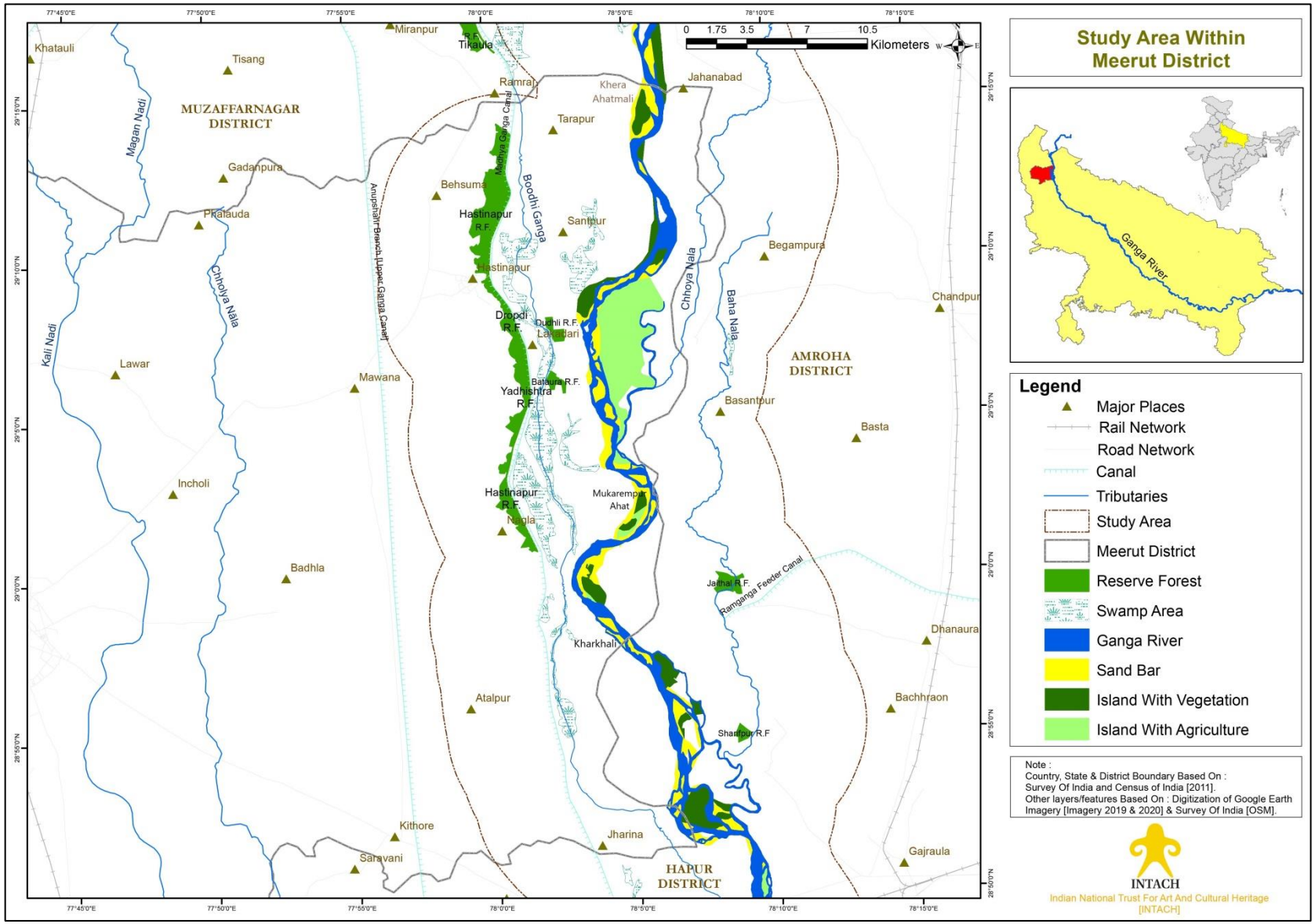
2.0 Ganga River in Meerut Distt.

2.1 Ganga River enters Meerut Distt. near villages – Khera Ahatmali and Bela, after flowing through Bijnor District [See Map No.2]. The river channel is around 0.5 km to 1.5 km in width here. The length of Ganga River in Meerut Distt. is around 35 km, coursing along the District boundary on its right bank. Most of the Distt. boundary area along Ganga River consists of flat floodplain areas which are under cultivation, scrublands at some places, depressions and paleochannels. Major floodplain features are Khola [upland alluvial tracts], Khadar [low lying sandy bed area] and a tributary of Ganga known as Boodhi Ganga with belts of swamps of marshes between Khola and Khadar, which are fed by River Ganga. The Ganga River flows in southwest direction along the District with few meanders. The Madhya Ganga Canal runs parallel towards its east at a distance of 2 km to 8 km approximately. It takes a concave turn towards left bank at Mukarempur Ahat area and then flows southwest leaving the District at Kharkhali area.

2.2 The Meerut Gazetteer of 1965[3] describes Ganga River in the District as:

"This river first touches the district in the northeast, near the village of Bela in tahsil Mawana. Its general direction is from north to south and throughout on the eastern flank it separates this district from those of Bijnor and Moradabad. In the district, it has only two tributaries – the Burhganga and the Soti, both insignificant streams. The former flows in an old bed of the Ganga and the latter joins river at the village of Jalalpur in Tahsil Mawana. The bed of the river is sandy and there is an underlying stratum of nodular limestone here and there. The river's volume and velocity vary at different periods of the year and are greatest during July and August. In summer it is hardly a furlong wide but during the rainy season its span exceeds a mile. It is fordable only at particular places during the cold weather. Its banks generally suffer from slow erosion and the soils of the khadar villages which lie adjacent to it suffer from increasing infertility, due to the sand that it deposits when in flood which is usually in the monsoon month."

[3] Uttar Pradesh District Gazetteers [Meerut], Published by Govt. of Uttar Pradesh, Dept. of Distt. Gazetteers [1965]



Map 2 : Study Area In Meerut Distt

3.0 Methodology

3.1 For carrying out surveys, a 7 km buffer zone of Ganga River in the Distt. was considered. Before carrying out surveys, various access points and routes to the river were located with the help of Google Earth. Special emphasis was given to the sites and features of interest such as river channel, biodiversity, floodplain conditions, farming and fishing activities, sites of natural heritage interest. Some known local residents living in villages near Ganga were contacted for field assistance.

3.2 The survey was undertaken during October, 2021 with the help of taxi, boat, bike and on foot. Sites were visited from downstream floodplain areas in Distt. to upstream areas. Sony Digital Camera Cyber-shot DSC-HX300 with 50X optical zoom and OnePlus 9 Pro mobile phone were used for photography. Garmin handheld GPS eTrex30 was used for marking locations and understanding elevation difference. Pre-marked Google Earth's Kml files and Google Maps were used for navigation. Field guides were used for flora and fauna identification. Information was obtained through informal interviews and discussion with farmers, fishermen, boatmen and local people.

4.0 Tributaries of Ganga River

4.1 There are no major tributaries of Ganga River in Meerut district except Burhganga or Boodhi Ganga which joins Ganga near Garhmukteshwar in Hapur district. Other tributary that passes through district is Kali River [East]. The details are given below:

a) **Burhganga or Boodhi Ganga :** Once an old channel of Ganga River, this smaller stream flows along the right bank of Ganga River and hence the name '*Burhganga*' or '*Boodhi Ganga*' meaning Old Ganga . It is an irregular channel with intermittent swampy areas present on the right floodplain of the river. It has rarely been documented or properly mapped with only brief account mentioned in Meerut Gazetteer of 1965[4] which is as follows:

"*This is a small tributary of the Ganga and is a fluctuating stream entering the district from Muzaffarnagar at the village of Firozpur Saifpur. Its name (meaning 'Old Ganga') indicates that it flows in a bed in which the Ganga once flowed. According to a statement in Timur's memoirs, he camped on the Ganga at Firozpur. If this place is identical with Firozpur Saifpur mentioned above, then either the memoirs mistook the Burhganga for the Ganga or The Ganga till then flowed in the course now occupied by Burhganga (the implication being that the latter came into existence only after 1398-99). After entering the district, the Burhganga flows southwards into pargana Garhmukteshwar where it joins the Ganga. At many places it resembles a chain of swamps, its distance from the high bank (which separates the khadar from the uplands) being a furlong on an average. In the hot weather it is dry in places and though its depth varies considerably, some of the larger swamps always hold water and rushes, used for making matting and reeds for making wicker work chairs are found in them in abundance. It is a sluggish and irregular stream and is not of much importance as a whole.*"

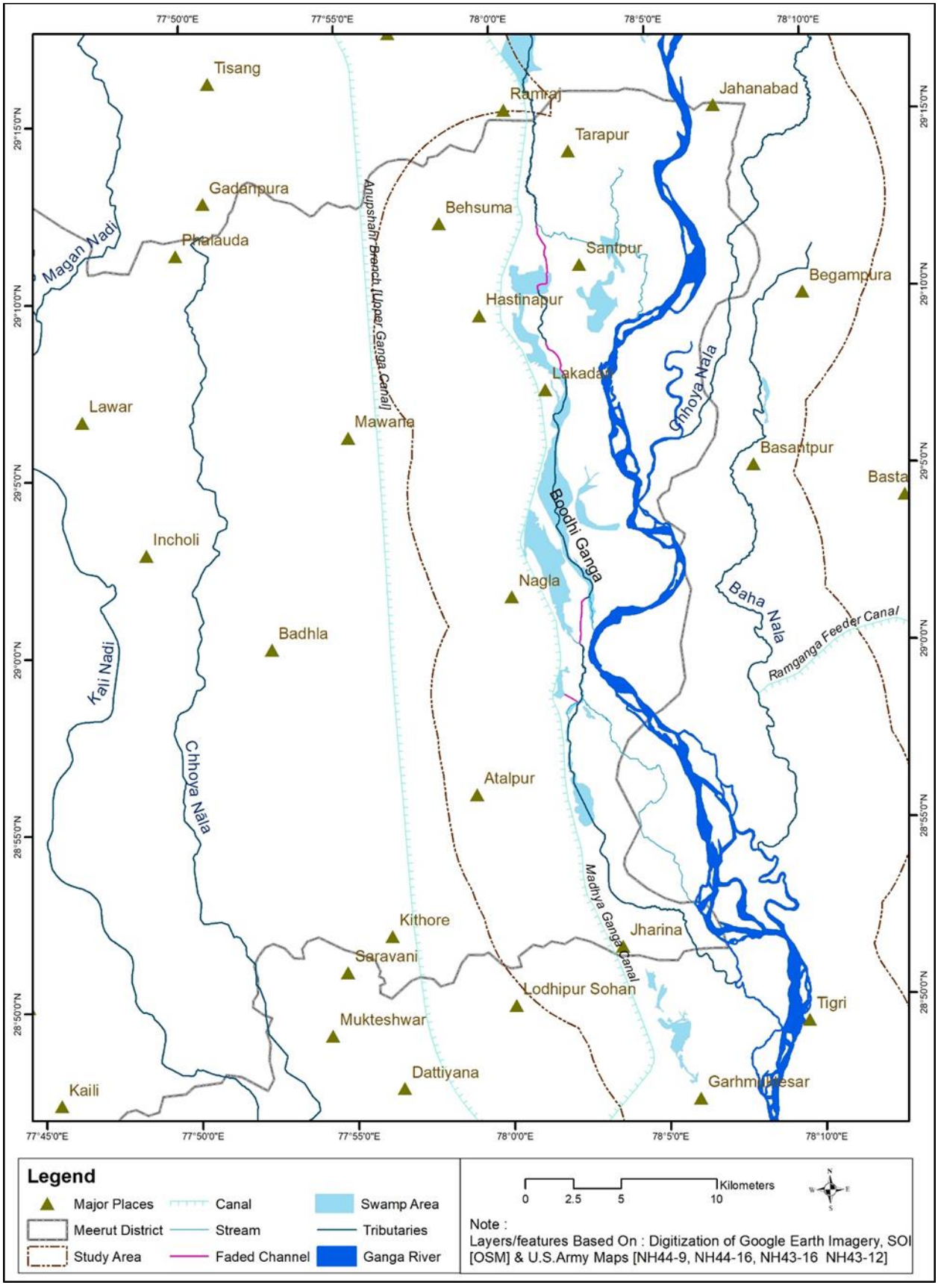
b) **Kali River [East]:** It is generally known as Kali River [East] to distinguish it from Kali River [West] – a tributary of Hindon River. Kali River [East] rises in Distt. Muzaffarnagar and flows southwards into Bulandshahr finally joining River Ganga in District Fatehpur. The Meerut Gazetteer of 1965[5] describes Kali River [East] briefly as :

[4] Uttar Pradesh District Gazetteer : Meerut, Published by Govt. of Uttar Pradesh, 1965
[5] Uttar Pradesh District Gazetteer : Meerut, Published by Govt. of Uttar Pradesh, 1965

"*This river is also known as the Nagin (probably on account of its serpentine windings) and also as the Kali Nadi (East) to distinguish it from the Kali Nadi (West), a tributary of the Hindan. Generally, it traverses undulating sandy slopes which are rarely cut up into ravines. The river has no important towns on its banks and carries very little water except during the rains when it is about fifty yards wide, the breadth increasing to about a furlong in exceptionally wet years. It is joined in its course by three smaller streams, two of which are known by generic name of Chhoiya".*

Image 1 : Burhganga Channel At Hastinapur-Chandpur Road

Image 2 : Dry Kali River Channel Near Dev Priya Papers Pvt Ltd. [NH-34]



Map 3 : Major and Minor Tributaries In Study Area [Distt. Meerut]

5.0 Land Use Land Cover [LULC]

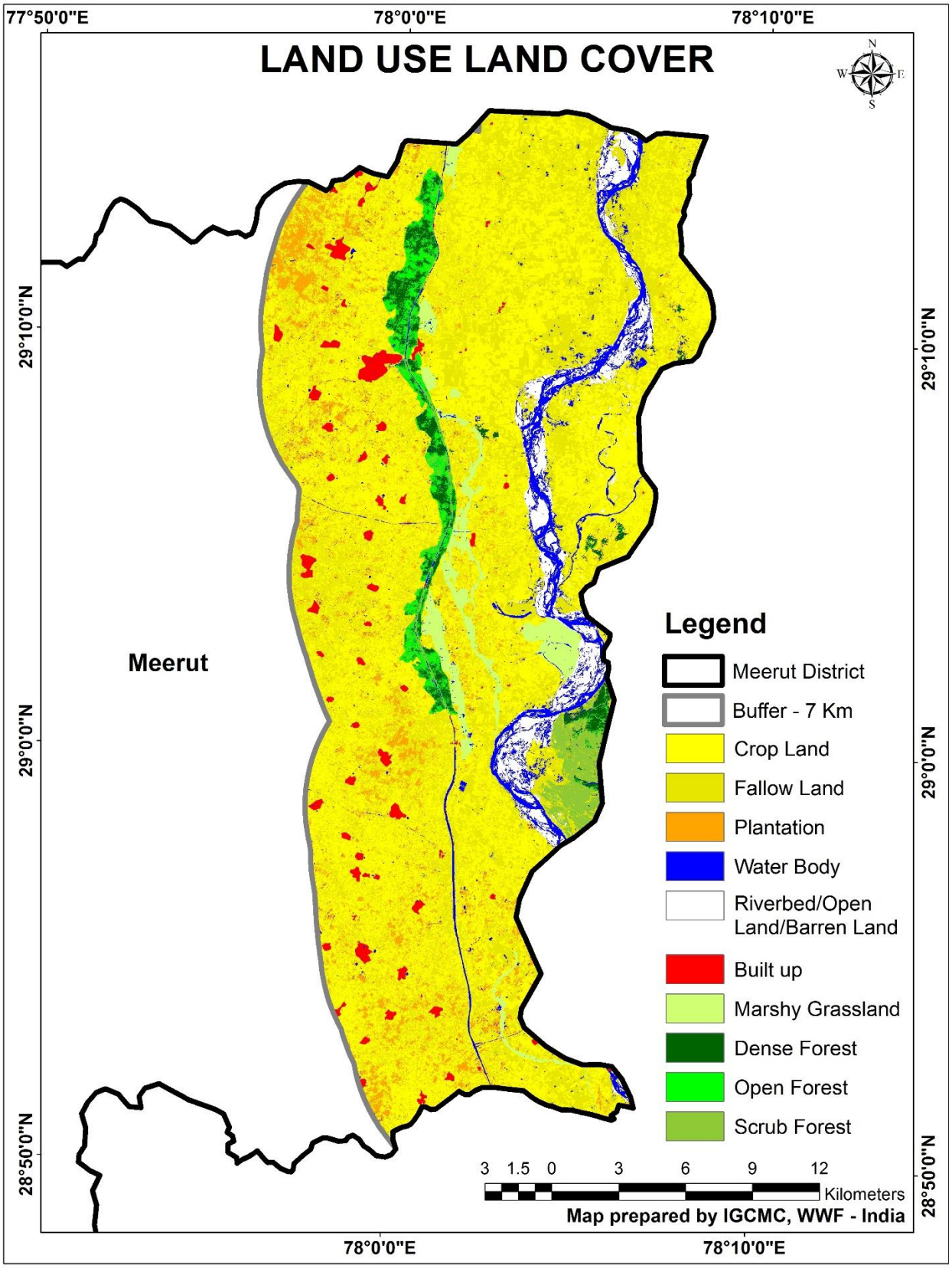
5.1 Land Use Land Cover [LULC] map of the study area has been prepared from Landsat imagery for the year 2020. [Table No.1] Using supervised classification system, 10 different classes were generated – crop land, fallow land, plantation, dense forest, open forest, scrub forest, waterbody, swampy grassland, riverbed/open land/barren land, built-up area [Map 4]. Since agriculture is the primary occupation in the Distt., cropland and fallow land area dominate other classes.

5.2 Major insights are the following :

i. Crop land is the dominant land use with 45.01% area [275.29 Sq.Km]
ii. Fallow land comes second with 30.52 % area under cultivation [186.72 Sq.Km]
iii. Together, the total area under agriculture is around 75.53% [462.01 Sq.km]
iv. Plantation accounted for 6.86% [40.84 Sq.km] which mostly includes mango orchards, poplar and eucalyptus plantation.
v. Dense forest cover is only 1.86% [11.38 Sq.km] while Open and Scrub Forest cover 11.50 Sq.km and 10.93 Sq.km of area respectively.
vi. Waterbody which also includes river area is around 4.17 % [i.e., 25.49 Sq.km]
vii. Built-up area accounts for 1.61% [9.86 Sq.km] only.
viii. Riverbed/Open land/Barren land is only 3.80 % [23.21 Sq.km] while Swampy grassland land is around 2.67% [16.31 Sq.km]

Table 1 : Land Use Land Cover [LULC] of Study Area In Meerut Distt. [2020]

S.No.	Classes	Area (Ha)	Area (Sq.Km)	Area (%)
1.	Crop Land	27529.80	275.29	45.01
2.	Fallow Land	18672.70	186.72	30.53
3.	Plantation	4084.86	40.84	6.86
4.	Dense Forest	1138.31	11.38	1.86
5.	Open Forest	1150.13	11.50	1.88
6.	Scrub Forest	1093.07	10.93	1.79
7.	Water Body	2549.68	25.49	4.17
8.	Swampy Grassland	1631.71	16.31	2.67
9.	Riverbed/Open Land/Barren Land	2321.16	23.21	3.80
10.	Built up	986.05	9.86	1.61
	Total	**61157.47**	**611.57**	**100%**

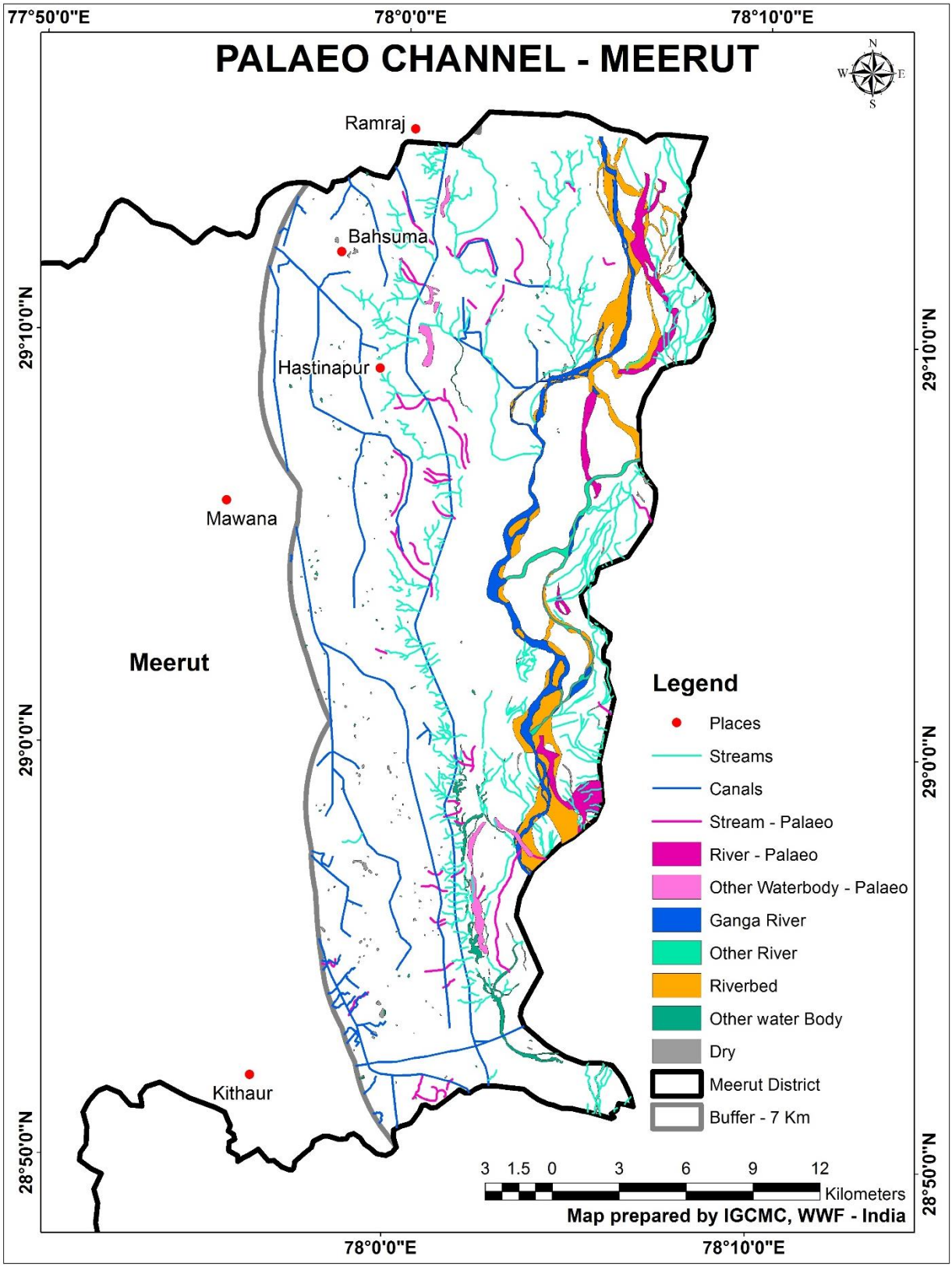


Map 4 : Landuse Landcover Map of Study Area [Distt. Meerut]

6.0 Palaeochannels Of Ganga River In Meerut Distt.

6.1 Palaeochannels are the remnants or old channels of once active rivers or streams, some of which are lie buried under the cover of younger sediments. They are formed when the rivers or streams migrate their courses and form new ones. Paleochannels are important to understand area geology, old river routes, sediment deposition and are considered suitable areas for ground water recharge. Factors such as change in land use pattern, sand mining, agricultural practices, and industrial activities lead to disappearance of such channels along rivers. Generally, such old channels do not carry water during most of the year but may flow during flood events. Such abandoned and silted palaeo-channels can be mapped using old maps and remote sensing techniques. Based on the available satellite data and remote sensing technique, Map No.5 was prepared, which depicts the various palaeo-channels in the study area of Meerut Distt.

Image 3 : Palaeochannel Near Bastora Norang, District Meerut



Map 5 : Palaeochannels in Study Area [Distt. Meerut]

7.0 Floodplain Of Ganga River In Meerut 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 Ganga River floodplains in Meerut Distt. generally comprise of elevated alluvial deposition parallel to the right river bank [locally known as Khola], Khadar area [low lying sandy bed of the ever shifting Ganga River] and Boodhi Ganga [belts of swamps and marshes between Khola and Khadar which are fed by River Ganga], various paleochannels and agriculture fields. The entire floodplain area in Distt. Meerut comes under Hastinapur Wildlife Sanctuary. There are large patches riparian grasses such *Saccharum spontaneum, Phragmites Karka* and *Typha spp.* intermittent with agriculture fields. Other flat floodplain areas are cultivated for major crops such as wheat, rice, maize, sugarcane and seasonal vegetables. Many agriculture fields could be observed extended up to the edge of the active channel of the river and between the paleochannels similar to pattern observed in adjacent districts. Agriculture is one of the major sources of income in the Distt. and farmers of floodplain areas are benefitted by the fertile alluvium brought in by the river. Sugarcane remains the dominant crop. Cucurbit and vegetable cultivation is mostly done in dry river bed areas and on river islands. Water melons, musk melons, cucumbers, ground-nut, tomatoes, oil seeds, potatoes, onions, garlic and ginger are mainly grown crops. According to riparian communities, the river reclaims its original channel every monsoon season, washing away these agriculture fields and changing their structure as it meanders downstream. Many such agriculture fields were observed to be washed away by meandering Ganga River at Makhdumpur

village Closer vicinity to Ganga River and older channels ensures water availability and thus irrigation of crops is easier in floodplain agriculture fields.

Image 4 : Riparian Grasses at Ganga Floodplains, Distt. Meerut

Image 5 : *Saccharum spontaneum* Grass (Kaans), On Ganga River Bank, Distt. Meerut

Image 6 : Agriculture Land Erosion Due To Meandering Ganga River At Makhdumpur

Image 7 : Sugarcane Cultivation On Ganga River Bank At Makhdumpur Village

8.0 Wetlands In Meerut Distt.

8.1 Wetlands are highly productive ecosystems and help in maintaining ecological balance by providing food and habitat to large number of living organisms. They also help in controlling floods, recharging groundwater, nutrient recycling, climate stabilization and carbon sequestration. A report 'Wetland Report for Ganga River Basin Management Plan' published in 2012 by consortium of IITs mentions that 57% of the wetlands in Uttar Pradesh are related to river/streams with 181935 ha area while the National Wetland Atlas [Uttar Pradesh] published by SAC, ISRO in 2010 as a part of project 'National Wetland Inventory and Assessment' of MoEF, estimates it to be 48.88%. It clearly indicates the majority of riverine wetlands and floodplain lakes in the state.

8.2 In the current exercise, a total of 51 wetlands have been mapped in the study area with the help of Google Earth satellite imagery and available maps. The list of mapped wetlands is given in Table No. 2 and their spatial distribution is shown in Map No. 7.

Table 2 : List Of Wetlands In The Study Area

Sr. No.	Wetland	Coordinates		Area [Hectares]
		Latitude	Longitude	
01	01	28°51'45.48"N	78° 2'51.43"E	0.29
02	02	28°52'6.47"N	78° 1'40.42"E	0.71
03	03	28°52'2.32"N	77°59'17.79"E	2.67
04	04	28°52'22.35"N	78° 2'30.20"E	0.47
05	05	28°52'59.63"N	77°59'37.50"E	1.00
06	06	28°53'35.29"N	77°59'55.21"E	5.46
07	07	28°53'41.61"N	78° 0'11.89"E	2.10
08	08	28°53'47.61"N	78° 1'15.55"E	0.46
09	09	28°54'35.58"N	78° 0'33.95"E	1.37
10	10	28°54'35.91"N	78° 0'18.24"E	0.97
11	11	28°55'7.90"N	77°59'39.34"E	1.50
12	12	28°55'13.60"N	77°59'21.31"E	0.72
13	13	28°55'17.75"N	77°59'10.10"E	0.76
14	14	28°54'48.04"N	77°59'9.68"E	1.60
15	15	28°55'31.14"N	78° 1'43.20"E	0.66
16	16	28°56'22.33"N	78° 0'48.09"E	0.95
17	17	28°56'14.59"N	78° 2'5.41"E	2.83
18	18	28°56'20.54"N	78° 3'14.94"E	2.07

19	19	28°56'6.83"N	78° 4'16.05"E	0.70
20	20	28°56'57.21"N	77°59'32.83"E	0.76
21	21	28°57'13.26"N	77°59'9.76"E	1.36
22	22	28°57'42.58"N	77°58'17.71"E	1.27
23	23	28°58'35.39"N	77°57'52.15"E	0.96
24	24	28°58'28.45"N	77°57'59.49"E	1.52
25	25	28°58'21.62"N	78° 0'28.95"E	0.82
26	26	28°59'30.78"N	77°59'49.93"E	2.69
27	27	28°59'9.46"N	77°59'1.43"E	1.06
28	28	28°59'24.25"N	77°58'57.01"E	1.40
29	29	28°59'33.49"N	77°59'6.00"E	0.78
30	30	28°59'59.23"N	77°59'47.23"E	2.60
31	31	29° 2'7.80"N	77°58'56.63"E	0.35
32	32	29° 1'29.17"N	78° 0'29.92"E	1.57
33	33	29° 2'54.81"N	77°59'34.10"E	0.97
34	34	29° 3'22.33"N	77°57'50.63"E	0.20
35	35	29° 4'30.63"N	77°57'44.18"E	0.84
36	36	29° 6'32.49"N	77°58'17.07"E	0.95
37	37	29° 6'26.31"N	77°58'59.13"E	0.54
38	38	29° 6'7.12"N	77°59'34.39"E	2.45
39	39	29° 5'46.01"N	77°59'41.70"E	0.97
40	40	29° 6'54.46"N	77°59'32.26"E	1.49
41	41	29° 7'4.47"N	77°59'42.20"E	0.67
42	42	29° 7'6.04"N	77°58'55.14"E	0.37
43	43	29° 8'43.39"N	77°56'51.93"E	1.69
44	44	29° 8'24.09"N	77°57'45.09"E	1.81
45	45	29° 8'38.90"N	77°57'28.92"E	1.51
46	46	29° 7'42.84"N	77°58'13.14"E	1.18
47	47	29° 7'54.03"N	77°58'3.97"E	0.89
48	48	29° 7'40.85"N	77°59'22.17"E	1.13
49	49	29°12'1.01"N	77°58'31.83"E	4.71
50	50	29°13'9.65"N	77°58'50.18"E	1.19
51	51	29°13'38.46"N	77°59'0.47"E	0.75
Total Area [Hectares]				73.39

8.3 Few waterbodies visited during field survey have been described below:

8.4 **Behsuma Talab :** The talab lies on the easternmost edge of Behsuma town [Wetland No. 49 with Area 4.71 Ha]. It is located on the main road [Mahmudpur Sikhera Road] connected with Meerut-Pauri National Highway [0.5 km]. The waterbody is primarily used for fish breeding and has been leased out to a local fish contractor. It is covered with Water Hyacinth [*Eichhornia crassipes*] on its edges. It receives sewage runoff from the village and also threatened by solid waste thrown on its edges. However continuous watch by villagers have brought a significant change in the practice of solid waste dumping. There are two other smaller waterbodies located on its south [1.16 Ha] and southwest [3.36 Ha]. They must have been a part of this main talab but it could not be confirmed via available historical satellite imageries. Few trees and wasteland species were observed near the waterbody. Major tree species noted were Pipal [*Ficus religiosa*], and Jamun [*Syzygium cumini*], Sheesam [*Dalbergia sissoo*], Mango [*Mangifera indica*] and Banana trees. During interaction with the villagers, it was known that waterbody was in bad condition earlier, it has been cleaned and desilted by the contractor in order to do fish breeding for some years. Earlier [around a decade ago] it was used for bathing, fishing and chest nut cultivation and was comparatively cleaner.

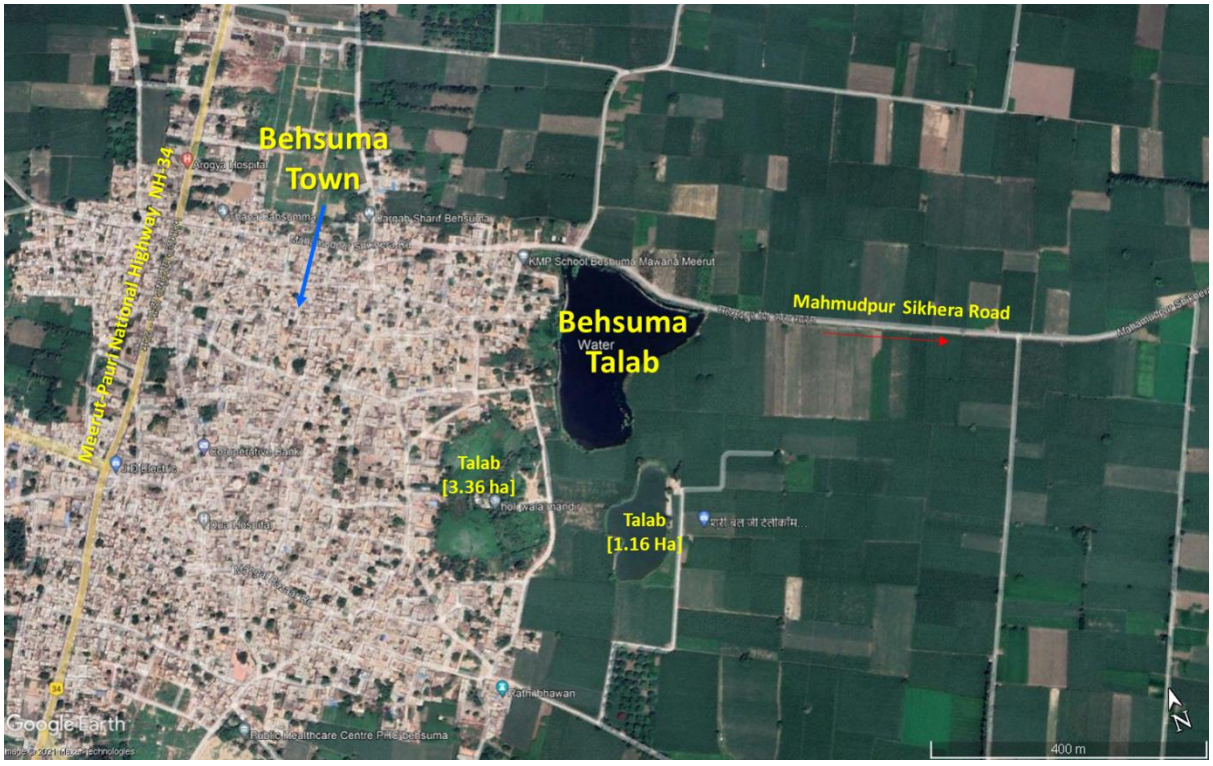


Image 8 : Location of Behsuma Talab [29°12'1.01"N 77°58'31.83"E]

Image 9 : Behsuma Talab [Looking Southeast]

8.5 **Ganeshpur Talab :** This pond is located on the western edge of Ganeshpur village and 100 metres west of Behsuma-Mawana Road [Wetland No. 45]. During field visit, the water body was observed completely infested with Water Hyacinth [*Eichhornia crassipes*] and other aquatic vegetation. It receives sewage runoff from the village and also threatened by solid waste thrown on its edges. It is also facing encroachment pressure from the village side [eastern edge]. As per information obtained from local community members, the waterbody has been in the same condition for many years now. It was used for fishing, bathing, and chestnut cultivation earlier and was comparatively cleaner. The running sewage ensures water availability in the Talab round the year. Now it is lying unused facing apathy of the residents and local administration. The edges of the pond were observed devoid of significant littoral vegetation except some trees of Date [*Phoenix dactylifera*], Seemal [*Bombax ceiba*], Subabool [*Leucaena leucocephala*], Pipal [*Ficus religiosa*], and Neem [*Azadirachta indica*]

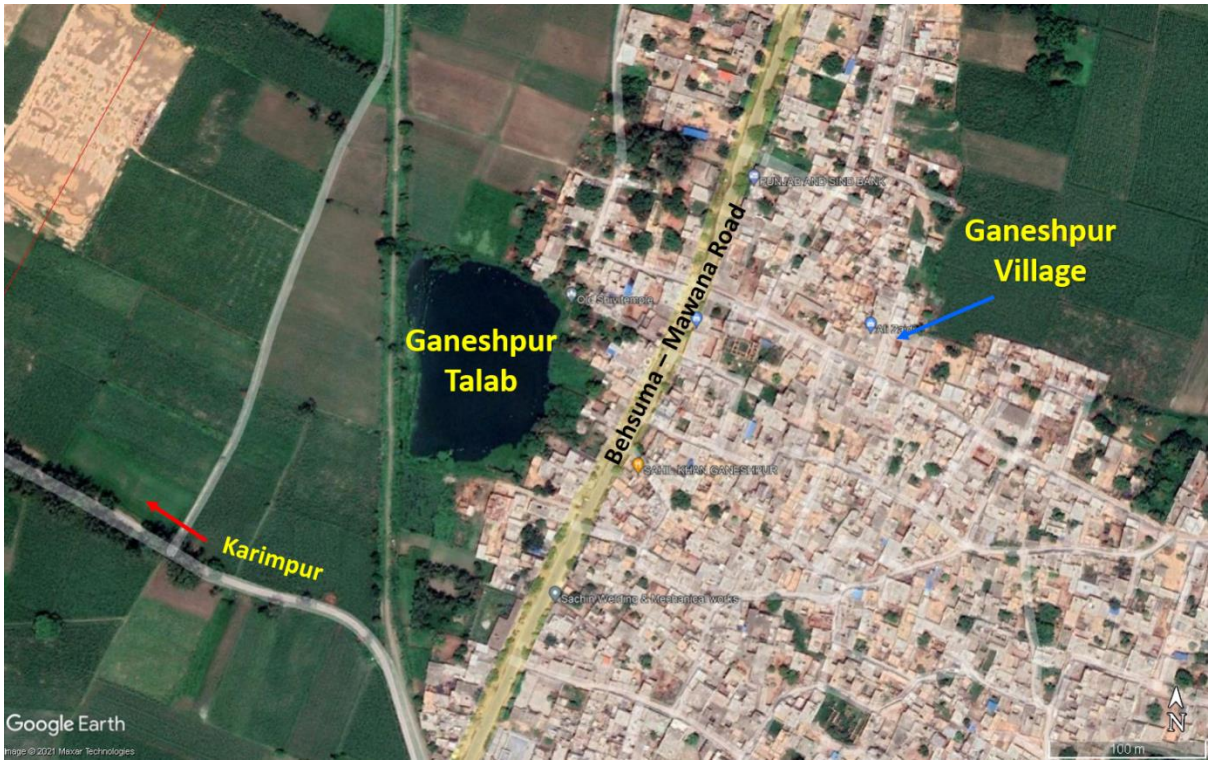
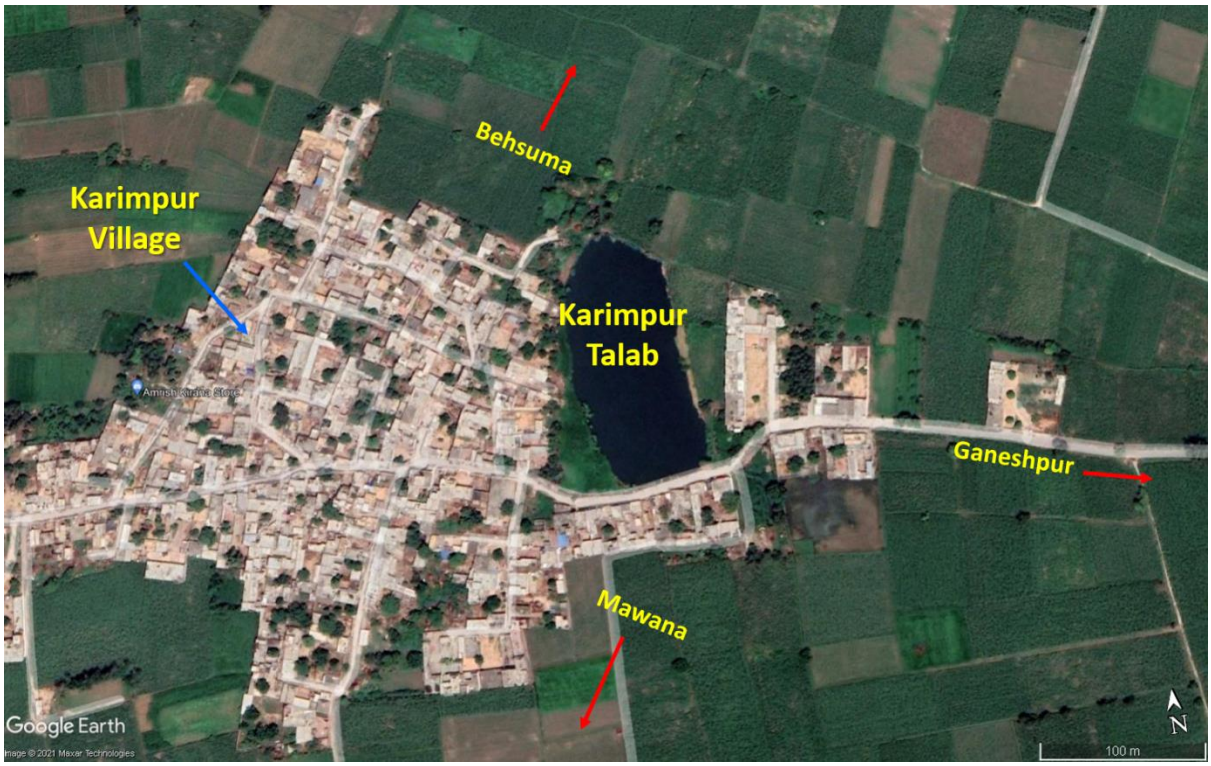


Image 10 : Location of Ganeshpur Talab [29° 8'38.90"N 77°57'28.92"E]

Image 11 : Ganeshpur Talab Completely Covered With Water Hyacinth

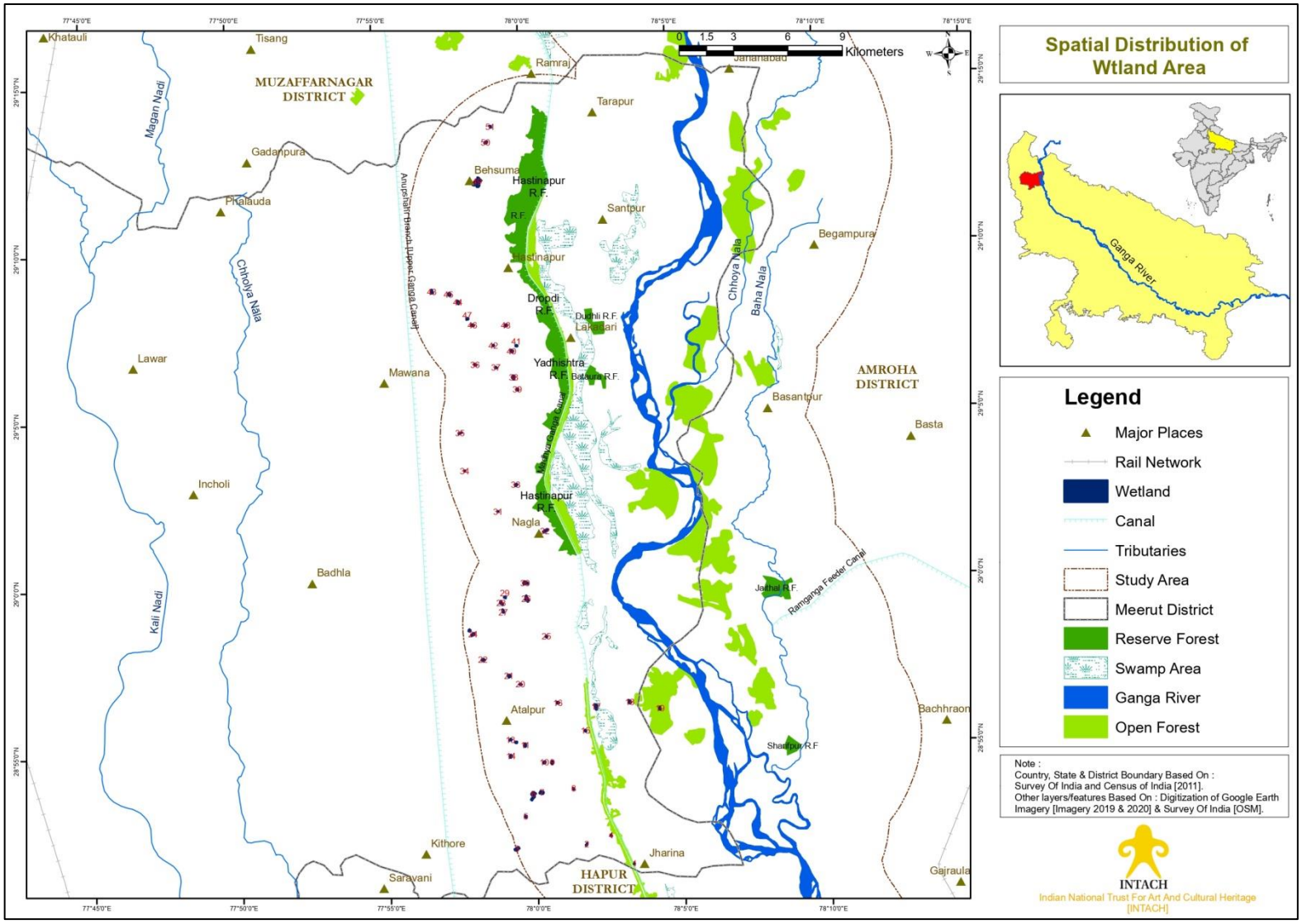
8.6 **Karimpur Talab :** This pond is located around 1 km west of Ganeshpur Talab on the eastern periphery of Karimpur village. A village road running through it southern edge connects with Behsuma Mawana road in the east and the Ganeshpur village. It is the only waterbody in the village and was observed completely infested with Water Hyacinth [*Eichhornia crassipes*]. It receives sewage runoff from the village. Its western edge [village side] is also under encroachment pressure. Few trees of Eucalyptus spp., Subabool [*Leucaena leucocephala*], Neem [*Azadirachta indica*], Mango [*Mangifera Indica*] were observed along its edges.



Map 6 : Location Of Karimpur Talab [29° 8'43.39"N 77°56'51.93"E]

Image 12 : Karimpur Talab Infested With Water Hyacinth [Looking North]

Image 13 : Southern Boundary Of Karimpur Talab [Looking West]



Map 7 : Spatial Distribution Of Wetlands In The Study Area [Distt. Meerut]

9.0 Riparian Flora Along Ganga River In Meerut 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 harbour 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, harbouring faunal diversity and providing livelihood resources [Groffmanet al., 1990; Castelle al., 1994].

9.2 Till recently, no 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], Groffmanet al. [1990], Krishanmurti [1991], Castelle 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.

9.3 The pattern of riparian flora in Meerut district is very similar to those adjacent Ganga districts of Muzaffarnagar, Bijnor and Hapur. Although most of the floodplain area/island area is under agriculture, there are considerable patches of floodplain vegetation along the upland tracts and reserve forests [towards right and across Madhya Ganga canal], aquatic vegetation in various swamps and marshes of Boodhi Ganga. At places, swamps can be spotted intermittently with agriculture fields making distinction difficult. Patches of Kaans [*Saccharum spontaneum*], Common Cattail [*Typha latifolia*], Narkul [*Phragmites Karka*], Doob [*Cynodon dactylon*], Giant cane or Elephant Grass [*Arundo donax*] were observed thriving along the river. The upland tracts and reserve forests have mix cover of various shrub and tree species especially along the Madhya Ganga Canal. Main tree species are Sheesham [*Dalbergia sisso*], Banyan [*Ficus benghalensis*], Peepal [*Ficus religiosa*], Babool [*Acacia nilotica*], Neem [*Azadirachta indica*], Leucaena [*Leucaena leucocephala*], Seemal [*Bombax ceiba*], Jamun [*Syzygium cumini*], Siris [*Albizia lebbeck*], Mango [*Mangifera indica*], Bamboo [*Bambusa vulgaris*], Ber [*Ziziphus mauritiana*], and Eucalyptus spp.

9.4 Some herb/shrub species observed are Congress Grass [*Parthenium hysterophorus*], Goat Weed [*Ageratum conyzoides*], Jhau [*Tamarix spp.*], India Mallow [*Abutilon indicum*], Country Mallow [*Sida cordifolia*], Devil's Thorn [*Tribulus terrestris*], Coffee Senna [*Cassia occidentalis*], Tephrosia [*Tephrosia purpurea*] , Prickly Malvastrum [*Malvastrum coromandelianum*], Creeping Woodsorrel [*Oxalis corniculata*], Setaria [*Setaria viridis*], Khus [*Vetveria zizanoides*], Calotropis [*Calotropis procera*], Lantana [*Lantana camara*] along with riparian grasses.

9.5 Some riparian grasses are economically valuable in the district. Kaans [*Saccharum spontaneum*], Narkul [*Phragmites Karka*] and Patera [*Typha elephantina*] are harvested from Ganga Khadar by local people. The Meerut and Hapur district belt is popular for wicker work – especially furniture and household items made of these grasses. They are also used for making hedges and thatch roof.

9.6 Major tree species found in the study are mentioned in table below:

Table 3 : Main Tree Species Recorded In The Study Area

S. No.	Botanical Name	Common Name	Family
1.	*Ficus religiosa* L.	Peepal	Moraceae
2.	*Ficus benghalensis* L.	Banyan	Moraceae
3.	*Ficus virens*	Pilkhan	Moraceae
4.	*Phoenix dactylifera L.*	Khajur	Arecaceae
5.	*Mangifera indica*	Aam	Anacardiaceae
6.	*Populus spp.*	Poplar	Salicaceae
7.	*Eucalyptus spp.*	Liptis	Myrtaceae
8.	*Ziziphus mauritiana*	Indian Jujube	Rhamnaceae
9.	*Aegle marmelos*	Bel	Rutaceae
10.	*Syzygium cumini*	Jamun	Myrtaceae
11.	*Terminalia arjuna*	Arjun	Combretaceae
12.	*Albizia lebbeck*	Black Siris	Fabaceae
13.	*Albizia procera*	White Siris	Fabaceae
14.	*Leucaena leucocephala*	Subabool	Fabaceae
15.	*Melia azedarach*	Bakain	Meliaceae
16.	*Acacia nilotica* L.	Babool/Kikar	Fabaceae
17.	*Albizia lebbeck*	Siris	Fabaceae
18.	*Morus alba*	Shahtoot	Moraceae
19.	*Butea monosperma*	Dhak	Fabaceae
20.	*Bambusa vulgaris*	Bamboo	Poaceae

21.	*Bombax ceiba*	Seemal	Malvaceae
22.	*Dalbergia sisso*	Sheesham	Fabaceae
23.	*Putranjiva roxburghii*	Putranjiva	Putranjivaceae
24.	*Azadirachta indica*	Neem	Meliaceae
25.	*Senna siamea*	Kassod Tree	Fabaceae
26.	*Tectona grandis*	Saagwan/Teak	Lamiaceae
27.	*Terminalia bellerica*	Baheda	Combretaceae
28.	*Madhuca indica*	Mahua	Sapotaceae
29.	*Saraca ashoka*	Ashok	Fabaceae
30.	*Cassia fistula*	Amaltas	Fabaceae
31.	*Ailenthus excelsa*	Mahaneem	Simaroubaceae

Image 14 : Riparian Vegetation Along Madhya Ganga Canal, Meerut

Image 15 : Trees and Plantation in Dudhli Reserve Forest, Distt. Meerut

Image 16 : Narkul Grass [*Phragmites Karka*] At Ganga River Floodplains, Bhagupur

Image 17 : Swamps And Agriculture Fields – Characteristic Floodplain Area in Meerut

10.0 Faunal Diversity Along Ganga River In Meerut Distt.

10.1 In district Meerut, entire Ganga River floodplain area [with swamps and Reserve Forests] fall under Hastinapur Wildlife Sanctuary. The sanctuary is located in five districts viz. Muzaffarnagar, Meerut, Hapur, Bijnor, and Amroha of Uttar Pradesh. It spreads in an area of 2073 Sq. km while the area of proposed eco-sensitive zone is 293.41 Sq. km[6]. The sanctuary hold good diversity of wildlife fauna which includes 41 species of mammals, 373 species of birds, 36 species of reptiles, 10 species of amphibians and 79 species of fish. Major mammals which share habitat with the Meerut district area are Smooth-coated Otter (*Lutrogale perspicillata*), Dolphin (*Platanista gangetica*), Swamp Deer (*Rucervus duvaucelii*), Leopard (*Panthera pardus*), Blackbuck (*Antilope cervicapra*), Indian Jackal [*Canis aureus indicus*], Indian Fox [*Vulpes bengalensis*], Monkey [*Rhesus macaque*] and Indian Hare [*Lepus nigricollis*]. Nilgai [*Boselaphus tragocamelus*] and Wild Boar [*Sus scrofa*] are also found in variable numbers across the district and known to destroy crops. Meerut Gazetteer of 1965 mentions about huge and dense forest north of Hastinapur which were abound with wild Elephants which were to be found till about middle of nineteenth century. Other

[6] Notification dated 19 September, 2018 by MoEFCC, Published in The Gazette of India. No. 3723

mammals found in the districts were Tiger, Leopard, Wolf, Hyena, Fox And Pigs. Nilgai and Indian Blackbuck were commonly found in most parts of the district. Insects and Arthropods are poorly recorded groups, especially along rivers. During field visit many insects were sighted in riparian vegetation along Ganga River, near palaeochannels, near waterbodies. Most common were Dragonflies and Damselflies (Order: Odonata), Grasshoppers and Crickets (Order: Orthoptera), Stick insects and Leaf insects (Order: Phasmatodea), Butterflies and Moths (Order: Lepidoptera). Among Butterflies, Plain Tiger [*Danaus chrysippus*], Common Grass Yellow [*Eurema hecabe*], and Peacock pansy Butterfly [*Junionia almana*] were sighted. Among Dragonflies and Damselflies, Ruddy Marsh Skimmer [*Crocothemis servilla*], Blue Marsh Hawk [*Orthetrum glaucum*], Coromandel Marsh Dart [*Ceriagrion coromandelianum*] were sighted.

10.2 Some major aquatic fauna found in this stretch of Ganga River stretch have been described briefly below:

10.3 **Gangetic Dolphin** : The Gangetic River Dolphin (*Platanista gangetica gangetica*) is exclusively aquatic and piscivorous, 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 joint census[7] carried out in October, 2019 by Uttar Pradesh Forest Department's divisions of 5 Distt.s namely Bijnor, Meerut, Hapur, Amroha and Bulandshahr and WWF-India recorded 36 dolphins which also included 3 calves. Most of them (31) were recorded in Hastinapur Wildlife Sanctuary which stretches from Bijnor Ganga Barrage to Garhmukteshwar. Starting from this year (Dec5, 2021), '*Annual Gangetic Dolphin Census'* has been initiated by Uttar Pradesh Forest Department [from 5 districts namely Bijnor, Meerut, Hapur, Amroha and Bulandshahr] and WWF-India within Hastinapur Wildlife Sanctuary and till Narora Ramsar Site[8]. Around 15 dolphins were sighted on the first day. In order to boost Dolphin based tourism, the forest department is also planning to declare the Ganga River stretch as Dolphin Conservation Reserve in Meerut on the lines of Vikramshila Gangetic Dolphin Sanctuary near Bhagalpur, Bihar[9]. Based on the interactions with local people, it was known that dolphins are sighted very often in the

[7] With three calves, Ganges dolphin population up to 36 in UP, Times of India, Oct.16, 2019
[8] https://timesofindia.indiatimes.com/city/meerut/gangetic-dolphin-census-begins-15-sighted-on-1st-day/articleshow/88096549.cms
[9] https://timesofindia.indiatimes.com/city/meerut/now-dolphin-conservation-reserve-to-come-up-with-aim-to-increase-population-base-and-boost-tourism/articleshow/85635806.cms

Ganga River stretch of the district especially during monsoon season when the water level is high.

10.4 **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 neighbouring 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).

10.5 Gharials are occasionally sighted by fishermen especially during summer season when the sandbars and island are exposed. In 2015, a batch of 678 Gharials was released in 2015 near Makhdumpur village, Distt. Meerut in Hastinapur Wildlife Sanctuary – out of which only 16 Gharials survived[10]. During field visit, no gharial or crocodile was sighted, however their occasional sightings on sandbars has been confirmed through island farmers.

10.6 **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). Variety of habitats such as muddy and sand banks, islands, varying depth of water in Ganga, and floodplain lakes supports chelonian diversity but major threats such as floodplain agriculture, increasing pollution, irregular flow of water and sand mining activities are altering their habitats and thus their population is continuing to decline.

10.7 A report published by WWF-India[11] in 2011 mentioned the presence of 12 species of turtles between Bijnor and Kanpur stretch of Ganga River [Table-5]. Based on collections of shell and live specimens, eight species belonging to four genera and one family of hard-shell turtles, and four species belonging to three genera and one family of soft-shell turtles were identified by them. During the current field visit, around 30 Brown-roofed turtles were sighted on exposed sandbars in Ganga River from Hastinapur-Nandnaur Bridge [Image-21].

[10] WWF rescues Gharial trapped in Ganga canal after gates shut post-monsoon. Oct.28, 2017

[11] Behera, S., G. Areendran, P. Gautam and V. Sagar (2011), For A Living Ganga–Working with People and Aquatic Species, New Delhi: WWF-India, 84 pp.

Table 4 : Freshwater Turtles In Ganga River Between Bijnor and Kanpur

S.No.	Family	Genus	Species	Common Name
1.	Emydidae	*Hardella*	*thurjii*	Crown River Turtle
2.		*Geoclemys*	*hamiltonii*	Spotted Pond Turtle
3.		*Melanochelys*	*trijuga*	Indian Black Turtle
4.		*Batagur*	*kachuga*	Red-crowned Turtle
5.		*Pangshura*	*smithii*	Brown-roofed Turtle
6.		*Pangshura*	*tecta*	Indian-roofed Turtle
7.		*Pangshura*	*tentoria*	Indian Tent Turtle
8.		*Batagur*	*dhongoka*	Striped Roof Turtle
9.	Trionychidae	*Lissemys*	*punctata*	Indian Flapshell Turtle
10.		*Chitra*	*indica*	Narrow-headed soft-shell Turtle
11.		*Nilssonia*	*gangeticus*	Indian soft-shell Turtle
12.		*Nilssonia*	*hurum*	Indian Peacock Soft-shelled Turtle

Source: WWF-India, 2011

10.8 **Avian Diversity :** During field survey, the diversity of avian species was recorded using binoculars and identified using field guides (Grimmett et al., 2016 and others). The Hastinapur Wildlife Sanctuary (spanning across 5 districts) mentions about the presence of 373 species of birds. Noted bird species are Sarus Crane (*Grus Antigone*), River Tern (*Sterna aurantia*), Egyptian Vulture (*Neophron percnopterus*), Darter (*Anhinga melanogaster*), Black-headed Ibis (*Threskiornis melanoc*ephalus), Painted Stork (*Mycteria leucocephala*), Indian Skimmer (*Rynchops albicollis*), Black-bellied Tern (*Sterna acuticauda*), Shikra (*Accipiter badius*). During the field visit, a total of 48 bird species were sighted. Out of which 21 are aquatic species and remaining 27 are terrestrial birds [Table-5].

10.9 Important observations are:

- Bird population seems to be sizeable due to diversity of habitats – rivers, swamps, depressions, lakes, riparian buffer of channels, open lands, and agriculture fields.
- Aquatic vegetation and riparian grasses of palaeo-channels, waterbodies and depressions are serving as important habitats for birds in the river basin.
- Common birds sighted more often in and around the river are River Tern, River Lapwing, Yellow-wattled Lapwing, White-throated Kingfisher, Asian Openbill, Indian Pond Heron, Little Egret, Great Egret, Cattle Egret, and Cormorants.

- Birds sighted more frequently in and around waterbodies, swamps and palaeochannels are Purple Swamphen, Common Coot, Common Moorhen, Indian Pond Heron, Egrets, White-throated Kingfisher, and White Breasted Waterhen.
- Black-headed Ibis, Eurasian Curlew, River Lapwing comes under 'Near Threatened' and River Tern fall under 'Vulnerable Category'.

Table 5 : List Of Birds Sighted During Field Visit

S. No.	Common Name	Scientific Name	Conservation Status
1.	Little Cormorant	*Microcarbo niger*	Least Concern
2.	Great Cormorant	*Phalacrocorax carbo*	Least Concern
3.	Asian Openbill	*Anastomus oscitans*	Least Concern
4.	Oriental Darter	*Anhinga melanogaster*	Least Concern
5.	**Black-headed Ibis**	***Threskiornis melanocephalus***	**Near Threatened**
6.	**Eurasian Curlew**	***Numenius arquata***	**Near Threatened**
7.	White-breasted Waterhen	*Amaurornis phoenicurus*	Least Concern
8.	Black-winged Stilt	*Himantopus himantopus*	Least Concern
9.	Indian Pond Heron	*Ardeola grayii*	Least Concern
10.	Great Egret	*Ardea alba*	Least Concern
11.	Cattle Egret	*Bubulcus ibis*	Least Concern
12.	Little Egret	*Egretta garzetta*	Least Concern
13.	White-throated Kingfisher	*Halcyon smyrnensis*	Least Concern
14.	**River Tern**	***Sterna acuticauda***	**Vulnerable**
15.	**River Lapwing**	***Vanellus duvaucelii***	**Near Threatened**
16.	Yellow-wattled Lapwing	*Vanellus malabaricus*	Least Concern
17.	Purple Swamphen	*Porphyrio porphyrio*	Least Concern
18.	Grey Heron	*Ardea cinerea*	Least Concern
19.	Common Moorehen	*Gallinula chloropus*	Least Concern
20.	Common Coot	*Fulica atra*	Least Concern
21.	Bronze-winged Jacana	*Metopidius indicus*	Least Concern
22.	Red-vented Bulbul	*Pycnonotus cafer*	Least Concern
23.	Red-whiskered Bulbul	*Pycnonotus jocosus*	Least Concern
24.	Black Drongo	*Dicrurus macrocercus*	Least Concern
25.	Bank Myna	*Acridotheres ginginianus*	Least Concern
26.	Common Myna	*Acridotheres tristis*	Least Concern
27.	Laughing Dove	*Spilopelia senegalensis*	Least Concern
28.	Black-winged Kite	*Elanus caeruleus*	Least Concern

29.	Asian Koel	*Eudynamys scolopaceus*	Least Concern
30.	Greater Coucal	*Centropus sinensis*	Least Concern
31.	Indian Robin	*Saxicoloides fulicatus*	Least Concern
32.	Indian Silver Bill	*Euodice malabarica*	Least Concern
33.	Common Pigeon	*Columba livia*	Least Concern
34.	Common Koel	*Eudynamys scolopaceus*	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.	Common Tailorbird	*Orthotomus sutorius*	Least Concern
39.	Indian Silverbill	*Euodice malabarica*	Least Concern
40.	Yellow Wagtail	*Motacilla flava*	Least Concern
41.	Jungle Babbler	*Turdoides striata*	Least Concern
42.	Black Drongo	*Dicrurus macrocercus*	Least Concern
43.	Green bee-eater	*Merops-orientalis*	Least Concern
44.	Baya Weaver	*Ploceus philippinus*	Least Concern
45.	Ashy Prinia	*Prinia socialis*	Least Concern
46.	Rufous Treepie	*Dendrocitta vagabunda*	Least Concern
47.	Common Tailorbird	*Orthotomus sutorius*	Least Concern
48.	Rose-ringed Parakeet	*Psittacula krameri*	Least Concern

Image 18 : Aquatic Birds Sighted On River Island From Hastinapur-Nandnaur Bridge

Image 19 : Asian Open Bill and Black-headed Ibis In Inundated Agriculture Field

Image 20 : Common Indian Frog [*Rana Tigrina*] Sighted in Ganga River

Image 21 : Brown-roofed Turtles Basking On An Exposed River Island

11.0 Ganga Riverine Islands In Meerut 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]. Islands are generally formed by sand or sediments mass by currents during higher level of river flow and are exposed during dry season. River islands provide habitat to a large variety of living organisms such as birds, butterflies, insects and smaller mammals.

11.2 During the field visit it was observed that in Meerut stretch of Ganga River, there are many exposed and partially exposed river islands of varying shape and size – very similar to those in upstream districts. Almost, the entire channel of Ganga River in the district has such islands and sandbars. As per the fluvial island classification proposed by Wyrick & Klingeman (2011), the islands here would be fall under 'Braided' category – which means many channels divided by islands and bars, which may be washed out in high flows. These islands and sandbars get immersed with the increased water flow in river – especially during monsoon season along with the river channels in between them. Such sand bars make it difficult for motor boats to navigate through as their outboard motor with propellor fan gets stuck in the sand. Local boatmen and fishermen identify these channels with the help of long bamboo or wooden poles which they use to propel their boats.

11.3 These river islands are used for agriculture by local farmers except smaller or less stable ones. Cucurbits such as cucumber, melons, bitter and bottle gourds, tomatoes, pumpkins are grown and known as '*Palez*'. Smaller wooden boats are used for to and fro movement from the main land. During non-monsoon period most of the river islands remain under cultivation. Only smaller islands and exposed sand beds act as remaining habitat to aquatic biodiversity especially migratory birds, turtles, gharials and crocodiles. During current study, brown-roofed turtles were sighted basking on exposed islands and sandbars. The width of the islands varies between 0.25 km – 1 km and length 1 km to 2 km as observed via Google Earth's satellite imagery [Image-22 and 23]

11.4 Post monsoon [September] these islands either get submerged under water or get covered with luxuriant growth of riparian grasses and aquatic vegetation. Plants such

as Kaans [*Saccharum spontaneum*], Water Hyacinth [*Eicchornia crassipes*], Alligator weed [*Alternanthera philoxeroides*], Bush Morning Glory [*Ipomoea carnea*], were sighted on some exposed islands.

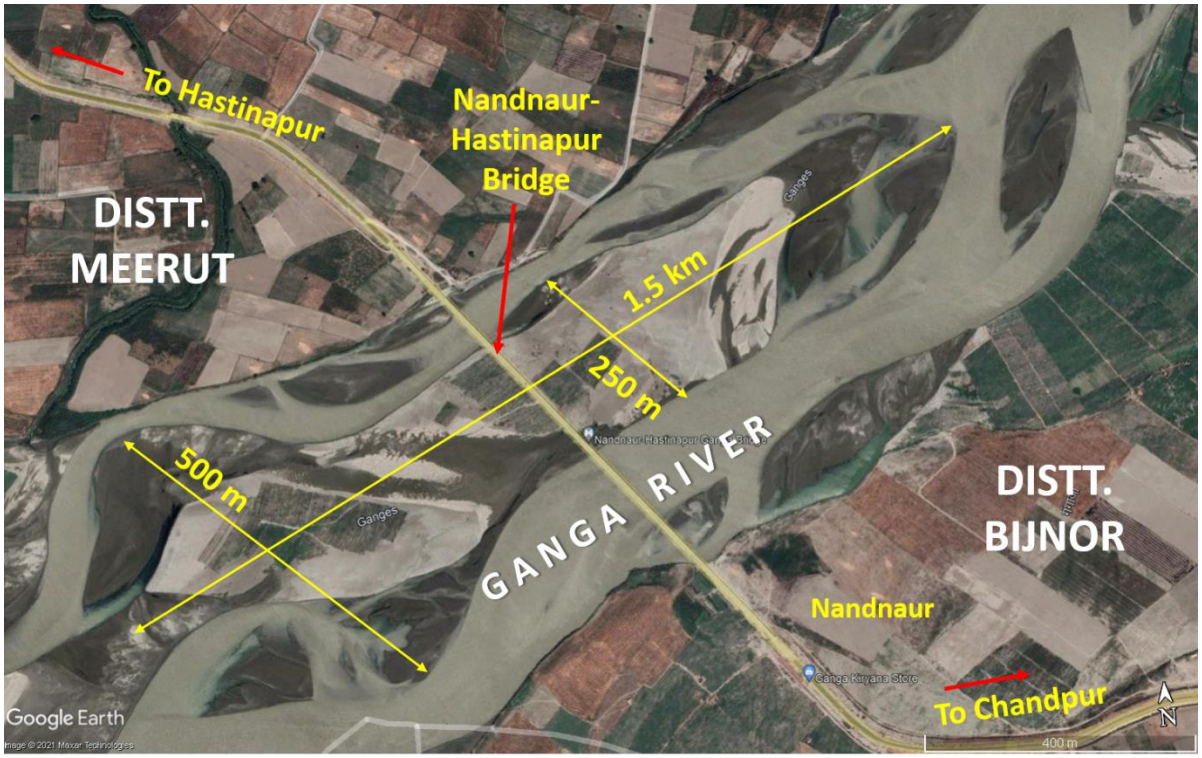


Image 22 : River Island Under Nandnaur-Hastinapur Ganga River Bridge

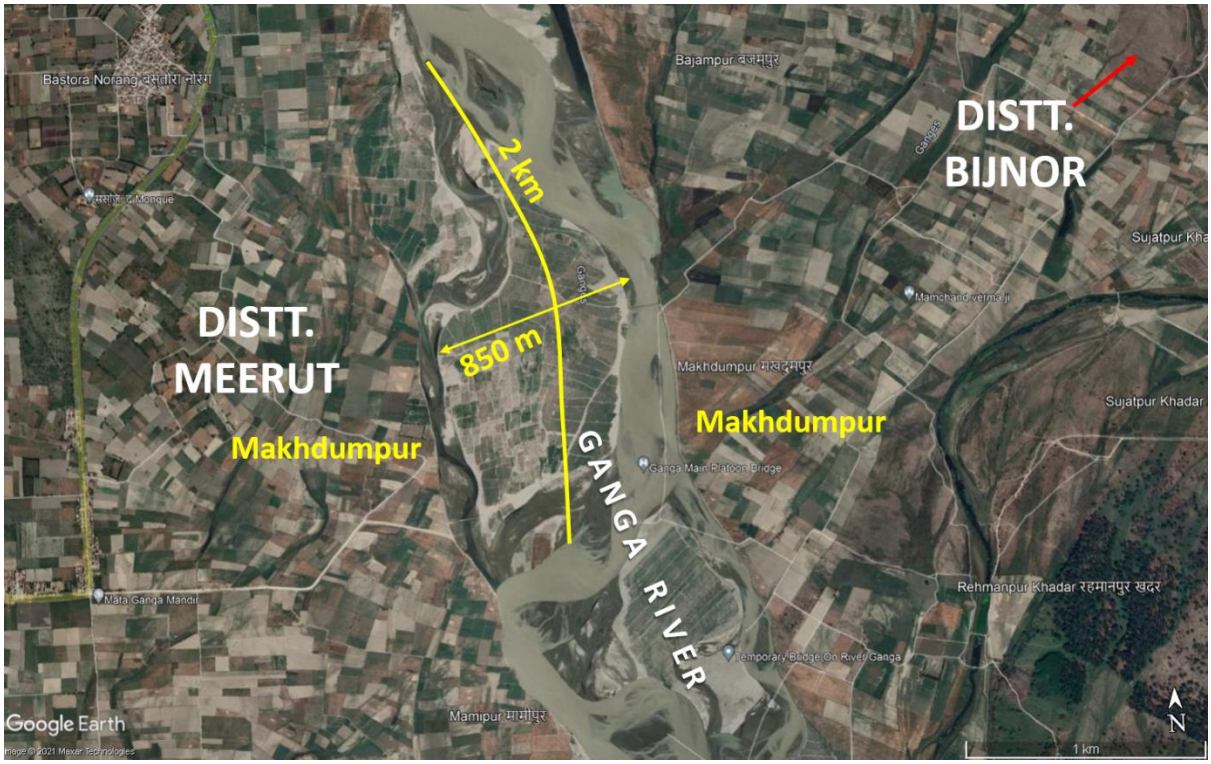


Image 23 : River Islands At Makhdumpur

Image 24 : Exposed River Island Visible From Hastinapur-Nandnaur Ganga Bridge

12.0 Fishing In Meerut 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 Meerut Gazetteer of 1965[12] mentions about the significance of Kali Nadi, Hindan and Yamuna for providing fisheries to the district. However, there is no specific mention of Ganga River and its role in fisheries. It states that : "*The Kali Nadi [East], which is only five miles from Meerut city, was rich both in quantity and in variety of fish till about a*

[12] Uttar Pradesh District Gazetteer : Meerut, Published by Govt. of Uttar Pradesh, 1965.

decade ago when, owing to the continual flow into its waters of molasses from sugar factories and the refuse from the central distillery in Meerut cantonment, the fish began to die at an early stage of development. Before this pollution of the water, the daily catch from the river was about ten maunds which was sufficient for local consumption but now it is practically nil. The fish market of Meerut city now depends on the catch from the Hindan and the Yamuna. About sixty fish are found in the district. Of these the Singhara *(Mystus seenghala).* Silund *(Silundia silundia),* Gonch (*Bagarius bagarius*), Rita (*Rita rita*), Katla (*Catla catla*), Mrigal (*Cirrhina reba*), and Rohu (*Labeo calbasu*) have a good market. *The cheap species include* Singhai (*Heteroneustes fossilis*), Moli (*Wallagu attu*), Vacha (*Eutropilchthys vashas*), Tengra (*Mystus tengara*), Bam (*Mastacembelus armatus*) and Eal (*Amohiphous cuchin*). *The price of fish varies from a rupee to ten rupees per seer".*

12.3 Fishing is an important source of income for fishermen and daily wagers in villages located on the river. Fishing is carried out by various means – nylon & rope nets, rods and nylon fishing lines (threads). Fishing is a favourite hobby of the local community especially for those living near to the Ganga River. Fish captured by fishermen are sold in the local markets and occasionally out of the district.

12.4 Upon interaction with local fishermen, it was found that most of the common fish species are found in this stretch of Ganga River. The fish species diversity increases during monsoon season and decreases as water level goes down post monsoon every year. There are no specific techniques to identify the spots for fishing in river. It entirely depends on accessibility and area divided between fishermen. For rod fishing, stable embankments and levees are preferred.

12.5 The most common fish species are Rohu [*Labeo rohita*], Catla [*Labeo catla*], Singhara [*S. seenghala*], Carp [*Cyprinus carpio*], Singhi [*Heteroneustes fossilis*], Gonch [*Bagarius bagarius*], Sauli or Sawli [*Channa striatus*] and [*Channa punctata*], *Naini* (*Cirrhinus mrigala*) and Barwari [*Wallagu attu*]. All the fish species noted during field survey are mentioned in Table No.6 below:

Table 6 : Riverine Fish Found in Meerut Distt.

S. No.	Common Name	Scientific Name
1.	Rohu	*Labeo rohita*
2.	Common Carp	*Cyprinus carpio*
3.	Grass Carp	*Ctenopharyngodon idella*
4.	Singhi	*Heteroneustes fossilis*
5.	Singhara	*Sperata seenghala*

6.	Sauli or Sawli	*Channa punctata*
7.	Sauli or Sawli	*Channa striatus*
8.	Silund	*Silundia silundia*
9.	Raiya	*Cirrhina reba*
10.	Tenghra/Teenghra	*Mystus tengara*
11.	Karaunch	*Labeo calbasu*
12.	Nain/Naraini	*Cirrhinus mrigala*
13.	Gonch	*Bagarius bagarius*
14.	Manghur	*Clarias gariepinus*
15.	Chilwa	*Oxygaster bacaila*
16.	Chaal	*Chela bacaila*
17.	Puthi	*Puntius sarana (Ham.)*
18.	Bata	*Labeo bata*
19.	Laanchi/Parhan	*Wallagu attu*
20.	Pabda	*Callichorous bimaculatus*
21.	Chiriya	*Engraulis spp.*
22.	Rohu	*Labeo rohita*
23.	Bhakur/Catla	*Labeo catla*
24.	Kawai	*Anabas testudineus*

13.0 Groundwater Condition In Meerut Distt.

13.1 As per Aquifer Mapping and Groundwater Management Plan [Parts of NCR] Report[13] of the CGWB, the NCR area [including Meerut] is a monotonous plain with sporadic occurrences of sand dunes, and sandy ridges, ravine tracts and depressions close to River Ganga. Minor sandy mounds can be seen near minor rivers. In some parts, close to the river system badland topography has developed due to the differential erosion. In such areas, exposed kankar-lenses and beds form mounds. The general slope of the area is northwest to southeast. Geologically, the area is underlain by alluvial deposits of Quarternary age, deposited over Precambrian basement. Thickness of alluvium increases from west to east i.e. From Yamuna River side towards Ganga River.

13.2 In NCR, 3-tier aquifer system exists with presence of Aquifer-IV at some places. The granular zones in Aquifer Group–I are generally thick-bedded, very extensive and are consisting of comparatively coarser material than the deeper Aquifer Group – II, and III

[13] Report on Aquifer Mapping and Groundwater Management Plan, Parts of NCR, Uttar Pradesh by CGWB [2013]

where these are thinly bedded sometimes lensoid in nature consisting of finer sediments with the domination of silty and clayey material. As deciphered from the maps given in Aquifer Mapping and Groundwater Management Plan [Parts of NCR] Report, depth to water levels [pre-monsoon-2013] along Ganga River range from 10 mbgl to 20 mbgl and 5 mbgl to 10 mbgl in post monsoon season [2013].

13.3 As per the 'National Compilation of Dynamic Groundwater Resource Assessment' of India (2020), the 'Total Annual Groundwater Recharge' of Meerut district is 85085.96 Ham [Hectare metre] against 'Annual Extractable Ground Water Resources' of 79096.00 Ham. The 'Stage of Groundwater Development' is 77.69% which indicates 'Safe' and 'Semi Critical' status [i.e. between >70% and <=90% as per CGWB Assessment[14]]

13.4 Major sources of irrigation are Madhya Ganga Canal, Ganga River and its tributaries, govt. and private tube wells, permanent wells and ponds. Out of 8 assessment units, 4 units viz. Hastinapur, Mawana Kalan, Meerut, Parikshitgarh were noted as 'Semi-Critical', 3 units viz. Kharkhoda, Machhra and Rajpura as 'Critical' and 1 unit i.e, Meerut City is 'Over-Exploited' [Year 2020] by 'National Compilation of Dynamic Groundwater Resource Assessment' of India [2020] Report.

13.5 Groundwater levels noted in few villages during the survey are given below:

Table 7 : Groundwater Levels Of Some Villages Along Ganga In Meerut Distt.

S. No.	Village	Coordinates		Depth to Water Table in Feet
		Lat.	Long.	
1.	Behsuma	29°12'2.44"N	77°58'15.85"E	100-150
2.	Hastinapur	29° 9'24.70"N	77°59'29.36"E	80-120
3.	Ganeshpur	29° 8'32.16"N	77°57'39.21"E	80-150
4.	Karimpur	29° 8'42.38"N	77°56'50.81"E	80-150
5.	Makhdumpur	29° 5'21.78"N	78° 3'26.37"E	30-50
6.	Sadullapur	28°55'31.28"N	78° 3'19.24"E	10-50
7.	Nagli Khader	29°11'58.11"N	78° 1'38.38"E	30-50
8.	Dabkheri	29°12'37.50"N	78° 4'34.98"E	10-30

[14] http://cgwb.gov.in/faq.html

14.0 Ganga Bank Erosion In Meerut 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 land use change, excessive grazing and farming, deforestation and removal of riparian vegetation along river banks. It is well known that exposed soil may erode rapidly (Singh et al., 2004).

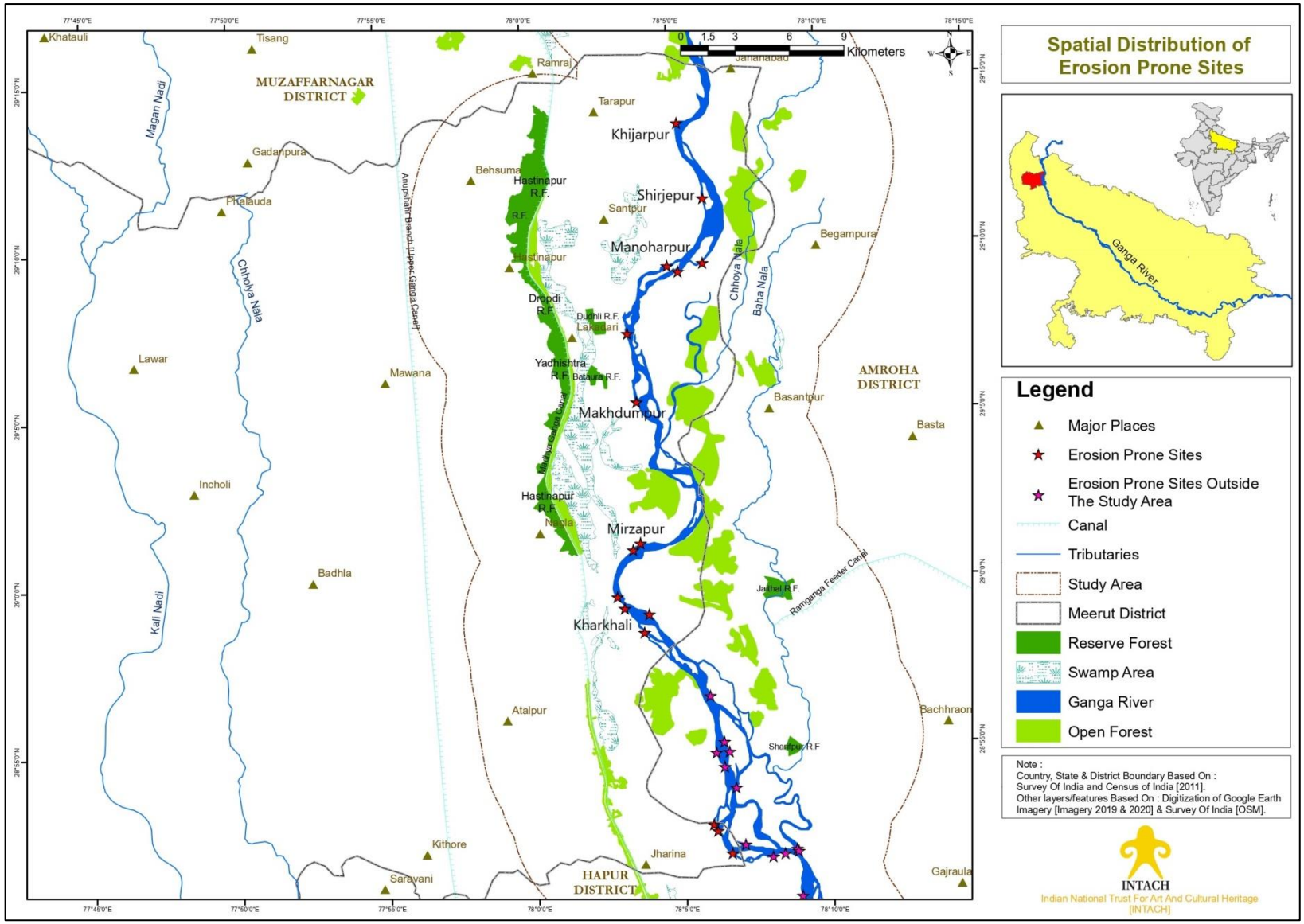
14.2 In a recent attempt to make river banks greener, the Uttar Pradesh State govt. claims to have planted more than 2.2 Crore trees along river banks as a part of annual plantation drive. The Ganga River has got the maximum – around 67 lakh trees and the plantation has been done in all the 27 Distt.s along Ganga in the State as noted by Times of India [August 20, 2020][15]. ***However, this exercise cannot prevent bank erosion which is preventable only through the binding of an extensive root system as available in native riparian grasses.***

14.3 As assessed from the Google Earth imagery [2020], there are few major erosion prone sites on Ganga River in Meerut Distt.. The river bank areas which are more prone to erosion are at Manoharpur, Makhdumpur, Mirzapur and Kharkhali. River Ganga at Nandnaur-Hastinapur Bridge takes a right turn making the area of Manoharpur prone to erosion. It further flows downstream eroding banks at Makhdumpur. Further downstream, it forms a concave turn towards left bank and then again towards right bank eroding banks at Mirzapur and Kharkhali before leaving the district boundary. During field visit, few bank erosion sites were observed at the above areas. [See Image-27 and 28]

[15] River banks made greener in Uttar Pradesh. Aug.20, 2020. Times of India

Image 25 : River Bank Erosion At Makhdumpur, Distt. Meerut

Image 26 : River Bank Erosion Site At Manoharpur, Distt. Meerut



Map 8 : Spatial Distribution Of Erosion Prone Sites In The Study Area [Distt. Meerut]

15.0 Mining And Brick Kilns In Meerut Distt.

15.1 **Sand Mining** : Sand is one of the major minerals resource extracted from the Ganga River, especially in its mid and lower stretch. The demand is ever increasing due to rapid expansion of settlements and their upgradation across the country. Often carried out illegally and excessively to earn large profits, sand mining is altering rivers' overall health. Excessive sand mining results in the destruction of aquatic and riparian habitats and also poses threat to bridges, river banks and nearby structures[16].

15.2 In Meerut Distt., *Sand, Bajri, Murrum* And *Gitti* are the major minerals mined from Ganga River in the district. Areas for sand mining are leased out to private parties by mining division of the district administration. Although the district administration keeps regular check, there have been many incidences of illegal sand mining in the district. As per information obtained from news – and during field surveys, sand mining is carried out at Ganga River and the Madhya Ganga Canal [At Ramraj] running through the district. Major mining hotspots are areas falling under Mawana, Hastinapur and Behsuma police station jurisdiction. In a recent attempt to curb illegal sand mining, district administration of Meerut has made it mandatory to put mine tags on vehicles registered for transportation of minerals[17]. Local community members from villages situated along the Ganga River also carry out sand mining regularly and transport it with the help of their bullock carts. The sand is sold locally for construction purposes. It becomes difficult during monsoon season when sand bars and accessible routes to the river bed are submerged under water.

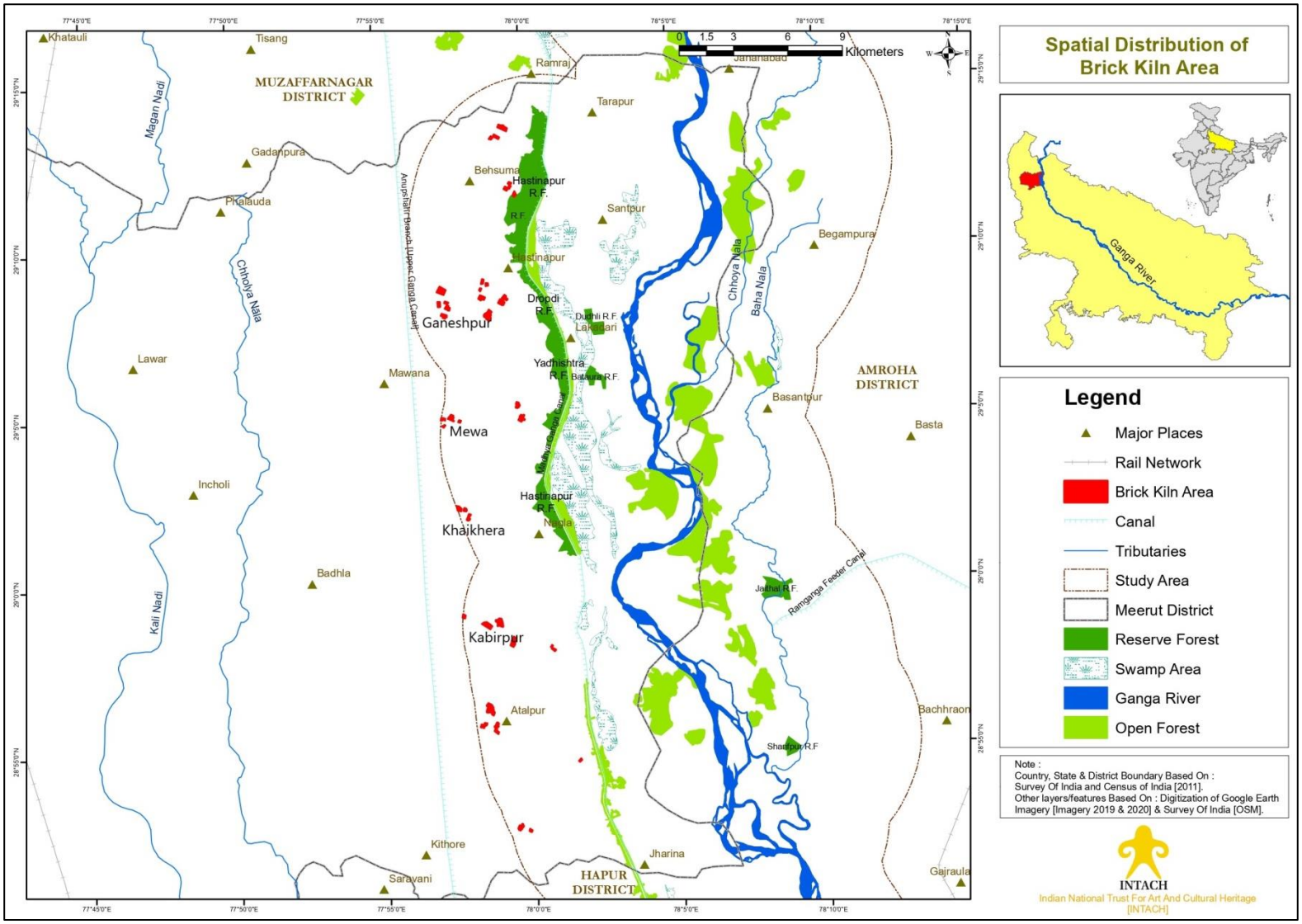
15.3 **Brick Kilns:** Brick making is one of the major economic activities in the Distt., providing employment to many daily wage workers. With rapid urbanisation, bricks have become important building material with ever increasing demand. However, the industry has current and future implications for the soil, agriculture land and air quality of the region. In Meerut district, there are many brick kilns that fall within study area [west of Madhya Ganga Canal] – mainly scattered at Hastinapur, Ganeshpur, Mewa, Khaikhera, Kabirpur and Atalpur [Map-9]. Expansion of various towns and villages has increased the demand for bricks and other construction materials. In the study area, the brick kilns and soil mining/brick making sites are mostly located between 5 km to 10 km away from the main Ganga River in a cluster of 4-5 units. There are distance obligations for establishment of brick kilns from roads, railways, villages, mango

[16] Impacts of Sand Mining. ENVIS Centre on Environmental Problems of Mining, IIT Dhanbad, Jharkhand
[17] Mine tags made mandatory for vehicles in UP's Meerut to curb illegal mining, ANI, Oct.22, 2020

orchards etc. set in 'The Uttar Pradesh Brick Kilns (Siting Criteria from Establishment) Rules 2011' but there is no mention of distance from river, floodplains or a waterbody in these rules.

Image 27 : Fresh Sand Deposit In Ganga River At Kharkhali

Image 28 : Brick-Kiln Near Behsuma, Distt. Meerut



Map 9 : Brick Kilns In The Study Area [Distt. Meerut]

16.0 Boatmaking In Meerut Distt.

16.1 Boatmaking is not a popular profession or income source in the Distt. Several fishermen or farmers whose livelihoods depend on the fishing or floodplain farming keep the smaller wooden boats. In district Meerut, boats are either sourced from Meerut city or other popular towns situated near Ganga River. These are also made by local carpenters and blacksmiths from villages situated along the Ganga River.

16.2 As per information obtained from boatmen, farmers and fishermen, boats are made by carpenter/blacksmiths in different parts of Meerut district – in Meerut city, Mawana, Hastinapur, Parishitgarh and Ramraj areas. A simple small wooden boat making cost ranges between Rs.10,000 to Rs.20,000 while an iron boat without motor costs somewhere between Rs. 50,000 to Rs. 60,000. Iron boat with country made motor costs with an additional cost of Rs. 25,000 to Rs. 50,000 i.e. at a cost between Rs. 75,000 to Rs. 1,00,000 or even more depending on quality of material and the motor brand. Now days, wooden boats are being replaced by boats made up of iron because of their longevity and fewer leakage issues. Tourist boats made of iron [Thick Gauge GI Sheet] are mostly used during religious festival and ceremonies. However, there are many smaller boats found parked along the Ganga River, which are used by island farmers and fisherman for their daily commute and transportation.

Image 29 : Farmer Carrying Fuelwood On Small Wooden Boat, Distt. Meerut
[Made Of Wood and Thick Gauge GI Sheet]

17.0 Inland Navigation In Meerut Distt.

17.1 The Ganga River at Meerut Distt. has poor navigability due to presence of various sandbars and islands, which get exposed due to lower flow – leaving few running channels of water. Such channels are used by farmers and fisherman for their daily livelihood activities. They use small wooden boats to move around the river landscape.

17.2 As per the information obtained during field surveys, the Ganga River offers poor navigability throughout its channel in the district due to presence of large number of islands and sandbars. However, during monsoon months, high level of water offers smooth navigation to fishermen and farmers. River route is generally not used to travel downstream rather to cross the river by island farmers. Fishermen or farmers rarely move beyond 2 km to 5 km upstream or downstream from their main base.

Image 30 : Exposed River Island As Seen From Nandnaur-Hastinapur Bridge

18.0 Key Observations and Recommendations

18.1 **Flattening of Upland Tracts/Levees:** Naturally formed levees and upland tracts support growth of riparian vegetation and keep riverbanks stable – making them resilient to erosion. They also act as vantage points to enjoy the river scenery. As observed during field visit, they are being flattened by farmers to extend their agriculture lands or take soil for household/construction purposes. In absence of any legislation to protect river floodplains, such natural upland areas are under serious threat. Authorities must take note of this ongoing practice and take appropriate measures to halt it.

Image 31 : Flattened Ganga River Banks For Agriculture [Distt. Meerut]

18.2 **Palaeochannels and Floodplain Lakes :** The Distt. authorities as well as farmers must acknowledge the role of palaeochannels, floodplain lakes and depressions along the Ganga River in the Distt. From acting as groundwater recharge zones to maintaining river biota especially aquatic plant species and fish diversity, their role along rivers have been undervalued. Their edges provide space for riparian grasses and trees and thus help in maintaining food chains by providing habitat to various birds, reptiles and insects. They provide invaluable service to farmers as water retention ponds for irrigation. They also add visual appeal to large and monotonous agricultural landscapes – especially in a state like Uttar Pradesh.

18.3 **Waterbodies Encroachment :** Waterbodies in the Distt. are highly threatened by encroachment, pollution and increasing eutrophication. During the field visit, it was observed that not even a single waterbody has been spared from solid waste dumping and illegal encroachment. There are settlements coming on their edges and thus decreasing their area and water spread. Healthy water bodies in villages and towns of the Distt. would ensure income generation options for the local people through fisheries and water chest nut production. They would also help in groundwater recharge as the current rate of withdrawal is high across villages due to installation of private submersible pumps.

18.4 **Riparian Flora :** The river banks along forest uplands are comparatively rich in riparian vegetation partly due to presence of swampy areas and palaeochannels. In addition to providing habitat to many aquatic and terrestrial species, riparian vegetation provides bank stability. Such areas may be marked and considered as 'Riparian and Aquatic Vegetation Bank' for Ganga River River ecological studies.

18.5 **Aquatic Fauna:** The stretch of Ganga is an important habitat of major aquatic fauna such as Gangetic Dolphin, Gharial, Crocodile and at least 12 species of turtles – many of which are threatened by multiple factors. And there are many other associated species such as frogs, toads, butterflies, insects, aquatic invertebrates that are poorly documented but form important part of the food web. Forest dept. should carry out annual faunal surveys in collaboration with expert institutions besides bird census. Such annual exercise would supplement the existing data on Ganga River biodiversity.

18.6 **Protection for River Islands :** River islands support better bird diversity in rivers and act as safe habitats for turtles, gharials, and crocodiles. Such islands and exposed sand-beds should be seen as refuges for biodiversity. River islands must be protected. Agriculture practices on such islands and sand-beds should be curbed and a central 'River Island Policy' must be drafted. Any conservation planning or initiative for rivers in the state should consider protection of islands an important priority.

18.7 **Sand and River Bed Mining** should be checked and curbed completely. Excessive mining alters the natural river bed forcing the river to change course and thus promotes banks erosion. It has also been noted that deep excavations due to mining transforms into deeper pools after the high flow in the river and thus endanger lives of people who come for bathing during religious ceremonies. To keep a regular track, distt. authorities may utilise Google Earth and drones to keep themselves updated. Excessive sand mined

areas could be easily spotted from the Google Earth or other high resolution satellite imageries.

18.8 **Cremation :** Cremation of dead bodies and immersion of their remains is quite common along the Ganga River and its tributaries. The ongoing practice of cremation by local communities at their nearest river banks instead of designated crematorium sites pollutes the river. This, on a daily basis is contributing to the pollution levels in the river. Distt. authorities should encourage them to cremate at the designated crematorium facilities.

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INTACH

NAMAMI GANGE