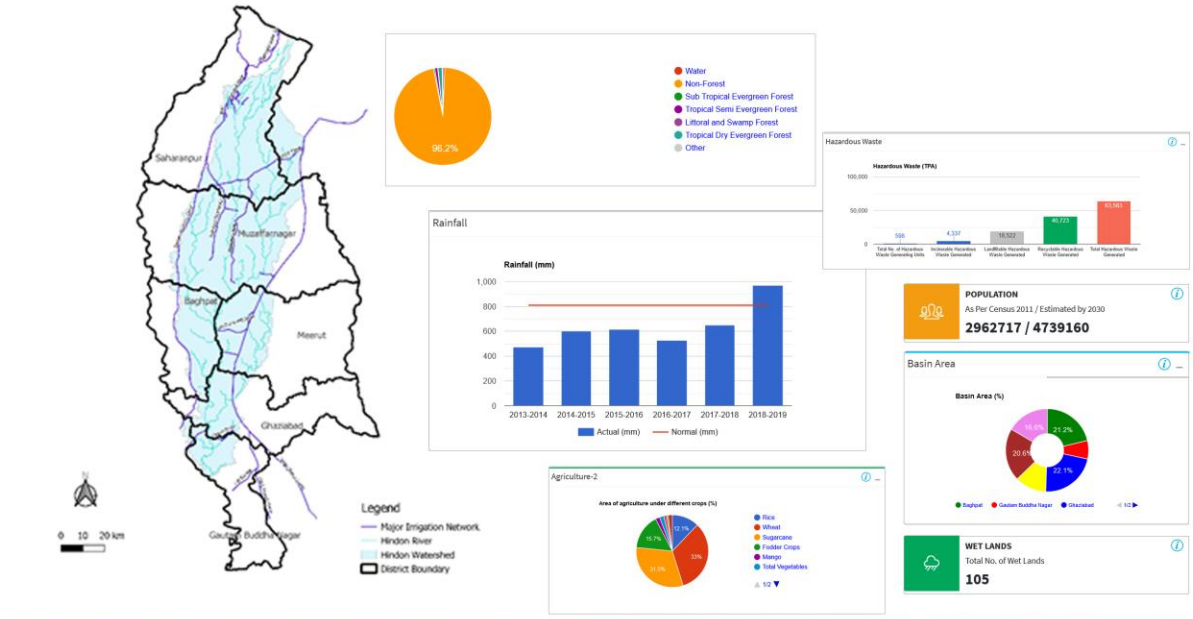
REPORT

Continuing Support to MSP by Developing Decision Support System



Report submitted by:
Tree Craze Foundation
December, 2021

Global Water Partnership South Asia
India Water Partnership

REPORT

on

Continuing Support to MSP by Developing Decision Support System (Operational Dashboard) for Hindon River

Porject Duration	
Overall Duration (months)	10
Start Date	25.02.2021
End Date	31.12.2021

Submitted to:

India Water Partnership (IWP)

By:

Tree Craze Foundation (also referred as TCF)

Acknowledgement

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Brief Summary of the Project

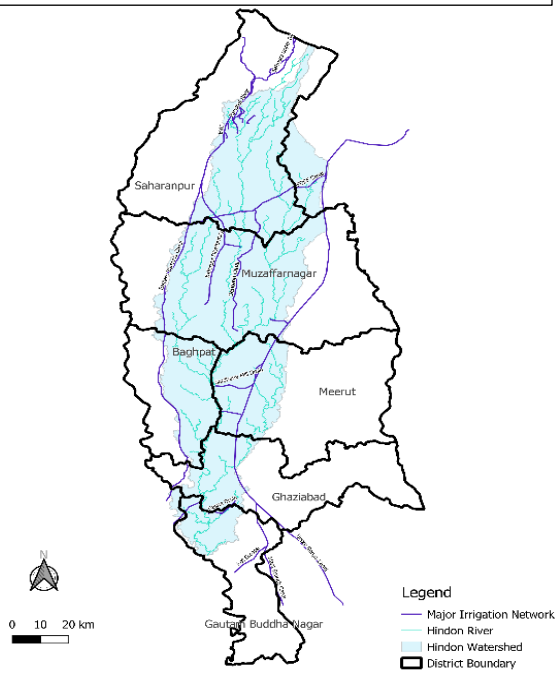
The first phase of the project involved in creation of the various spatial and non-spatial datasets and creation of an openly accessible platform to access these datasets among the various stakeholders involved in the rejuvenation and management of the Hindon River. In the second phase of the project, about which this report is based on, it was decided that the real success of a community project is determined by the difference it brings in the ground, its acceptance by the end users depending on how it would assist them in their day-to-day working.

Keeping this in mind, the second phase of the project was defined as "**Continuing Support to MSP by Developing Decision Support System (Operational Dashboard) for Hindon River**". The project primarily intends to assess the end user requirements, identification of data gaps by the end users, enhancement of the data/portal as per their needs, some ground level indicator interventions such as plantation and wetland restoration etc., value addition in the story maps developed in Phase-I and story map sensitization sessions for the Namami Gange volunteers, officials of National Mission for Clean Ganga (NMCG), SPMG (State Project Management Group) officers, Nehru Yuva Kendra (NYKS) volunteers, NGOs and civil society volunteers, Ganga Doots and Ganga Praharis and Researchers and Academicians, etc.

Executive Summary

Hindon River basin was proposed as the study area for the project. Hindon River, which is primarily a rain fed river is approx. 300 km long. It originates from lower Shivaliks in Saharanpur district and merges with Yamuna in Gautam Budh Nagar (district of western Uttar Pradesh), downstream of Delhi. The catchment area of the river lies between latitude 28° 30' 27" to 30°15' 22" N and longitude 77°20'18" to 77° 50' 16"E.Hindon River Basin area covers seven districts of Uttar Pradesh viz. Saharanpur, Shamli, Muzaffarnagar, Meerut, Baghpat, Ghaziabad, Gautam Budh Nagar; and one district of Uttarakhand viz. Haridwar.

Major Irrigation Network along Hindon River



Key achievements of the project are enlisted below:

- In continuation to the works completed in Phase-I (2020), some new datasets were added to the database in Phase-II (2021) namely: the delineation of the drains falling into the Hindon River basin, their starting points and the end points, all the major irrigation canals and important Ghats (Bathing Places) present along the basin, important cultural and historical sites were added as new datasets in the database.
- An attempt was also made to improve the visual appearance and various functionalities of the Hindon River Dashboard. In this regard, a sample dashboard was also created with some changes in the visuals. Various suggestions and new ideas have been discussed with the developer for incorporation in the Dashboard.
- A detailed Users' Manual for the dashboard has been developed with details such as creating an account, logging-in, downloading a consolidated report and using other functionalities of the dashboard.
- Voiceover has been given to the two-story maps created during the first phase of the project.

Introduction

Hindon River, a tributary of Yamuna River, originates in Saharanpur District, from Upper Shiwaliks Hills and flows through Saharanpur, Shamli, Muzaffarnagar, Meerut, Baghpat, Ghaziabad and Gautam Buddha Nagar districts of Western Uttar Pradesh and Haridwar District of Uttarakhand. The Hindon River and its tributaries are now at the verge of dying due to substantial water abstraction and severe pollution loads. Consistent efforts from the government, non-governmental bodies and the conservationist have not yielded desirable impact, thus, a holistic basin level approach is needed to rejuvenate the river and its tributaries. Government of Uttar Pradesh and various stakeholders are working for rejuvenation of HindonRiver and its tributaries. India Water Partnership (IWP) in partnership with 2030 Water Resources Group also joined hands with them in this initiative since 2015.

To support the inventiveness, this Dashboard developed by Tree Craze Foundation and IWP in 2020 has been operationalized in 2021 under the IWP supported project "Continuing Support to Multi-Stakeholder Partnership (MSP) by developing a Decision Support System (Operational Dashboard) for Hindon River Rejuvenation". This Dashboard has incorporated all the information of various elements of the Hindon river basin so that, different elements could overlay and interact with each other to reach a common conclusion and define the Hindon River Basin Development Plan accordingly. This would not only reduce the redundant efforts by different stakeholders considerably, but also help them to arrive at a more scientific and logical development plan incorporating versatile perspectives together.

The Dashboard is intended to present as one stop solution for a variety of users interested to gain information on Hindon River Basin which include decision makers from the government, non-government organizations working for the betterment of environment/society, research organizations/independent researchers interested in the area.

Objectives

The main objectives of the project were to bring together various stakeholders and the community, identify their requirements and address the gaps and issues they face in their day-to-day jobs with respect to the spatial data availability and address their basic spatial queries by enhancing the work done under Phase I of the project so as to make it more useful for them. As the rivers had been very neat and clean in olden days not heavily/partly polluted like in present due to industrialization and urbanizations and other human interventions, the project intends to make best use of latest available technologies by empowering community workers with the know-how to utilize such technologies so that they can sensitize the community to own up their rivers by relating them to back history of rivers, making them a party in various environment rejuvenation activities and imparting them knowledge about the natural and anthropogenic attributes of the rivers so as to develop their emotional connect with the rivers.

1.1. Approach and Methodology

1.1.1. User Need Assessment (UNA)

The dashboard developed in Phase-I was presented to the various Government and Non-government stakeholders. Interactive workshops for government departmentswere conducted in collaboration with National Mission for Clean Ganga (NMCG), an authority responsible for implementing Namami Gange program (Hindon River being part of Ganga Basin is directly under their aegis). The UNAs conducted across various months starting from June till November 2021 (prior to that due to the country wide pandemic Covid-19, it was not possible to conduct these sessions). These sessions were held with the SPMG (State Project Management Group) officers, Nehru Yuva Kendra (NYKS) volunteers, NGO and civil society volunteers, Ganga Doots and Ganga Praharis and Researchers and Academicians. Date-wise and month-wise details of various UNA conducted are given below:

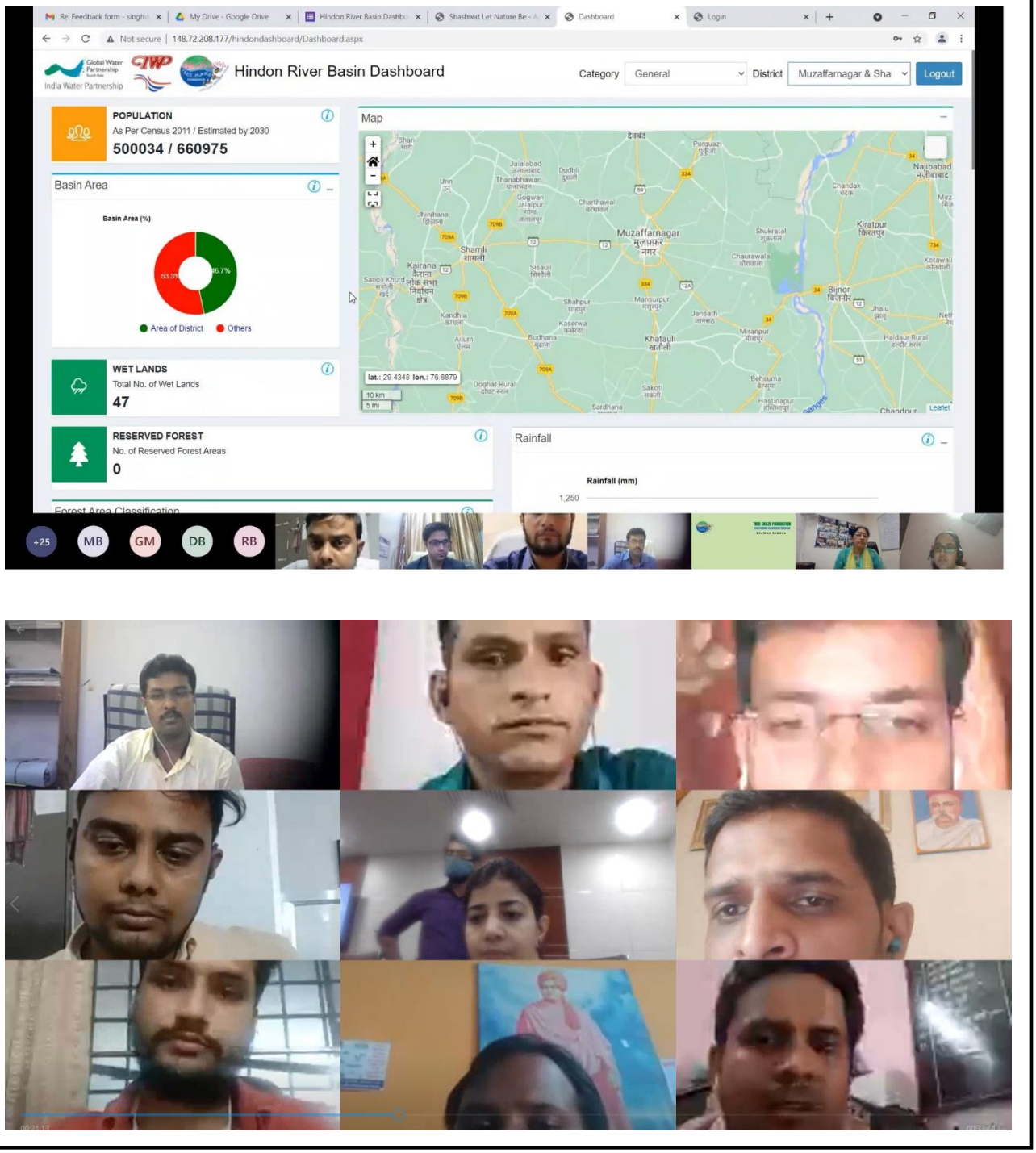


Figure i: User Need Assessment with different stakeholders

Table 1: Details of Users' Need Assessment Workshop

Workshop No. or Type	Date Organized	No. of Participants & Type	Particpants' Response
UNA-1	13th July, 2021	29 District Project Officers & 5 Project Assistants Nehru Yuva Kendra Sangathan	• Data source and year to be clearly given in the dashboard. • Location of ghats and its type (kachcha, pakka) to be provided. • Location of community Toilets and crematoria.
UNA-1	11th August, 2021	82 District Project Officers of Nehru Yuva Kendra Sangathan, and Ganga Doots of Nehru Yuva Kendra Sangathan	• All the participants found the dashboard useful in their area of work. • They considered it to be an authentic data source for their river basin and some were even unaware of the fact that such a data even exists. • More than 71% of the users found it easy to use whereas rest were not sure of its user friendliness.
UNA-2	12th August, 2021	34 Ganga Mitras associated with Mahamana Malviya Research Centre for Ganga, River Development & Water Resource Management, Banaras Hindu University, Varanasi andGanga Praharis, associated with Wildlife Institute of India	• Approx. 50% of the participants considered the data in the dashboard was sufficient to their requirements. • It was also suggested that the dashboard should not be freezed for atleast a period of 2 years so that it may evolve in terms of the requirements.
Meeting with various officials regarding afforestation activity in the sites identified along Hindon basin	August - September	Some 13 officials of Noida authority were approached	The officers were willing to permit the plantation activity only if a responsibility of two years of maintenance was defined.

Workshop No. or Type	Date Organized	No. of Participants & Type	Particpants' Response
Meeting with Dr.Manu Bhatnagar	27th October, 2021	Dr.Manu Bhatnagar, Principal Investigator, Natural Heritage Division, INTACH	Various inputs regarding the additional datasets that could be included in the dashboard were discussed in this meeting.
UNA – 3	25th November, 2021	12 Researchers/ Academicians (List of invited researchers is given in Annexure I)	• All the participants found it useful if such a dashboard is openly accessible by the community. Also, all the participants found the dashboard to be user-friendly. • Within their domain they felt it to be a useful source for secondary datasets and also suggested that it could be used as a reference data source to determine the remedial action required in the basin area. • 67% of the users said that the available datasets were sufficient to address the commonly encountered challenges in their area of work.
UNA-4	21st December, 2021	Some representatives from Shamli, Aligarh, Deoband	No major outcomes of the workshop.
Capacity Building workshop for creation of story maps	28th of January 2022[1]	48 DPOs of Nehru Yuva Kendra (NYKS) attended the workshop	The main agenda of the work shop was demonstrating how to create a story map. It was explained by Ms. Pallavi Singhvi. Different aspect of the platform such as the creation of user account, new story title/ subtitle/background image edit, addition of slides with content and pin pointing location on the map platform, adding a video file etc. all these functions were explained in detail and feedback was received for the same.

[1] Due to non-availablity owing to pre-occupation of NYKS, DPOs prior to January, 2022, this workshop was conducted on 28th January, 2022.

Table 2: Details of feedback received and implemented after conducting various workshops

Workshop No. or Type	Feedbacks received	Feedbacks implemented
UNA –1 and UNA-2	A total of 13 responses were received as feedback for the dashboard which have been briefed as under: • It was suggested that a detailed manual of the dashboard data should be prepared in the local languages for the villagers to be able to use it. • Even a local version of the dashboard was suggested by some of the participants to make it more useful from the locals' perspective.	A detailed Users' Manual for the dashboard has been created. But currently it is in English. May be in the future, user manual in local languages can be created
UNA-3	• It was suggested that data on the dashboard should be authenticated with the field level workers. • Participants also suggested that such a dashboard should be made available for other river basins of the country as well.	A mobile app was suggested to be also developed that can be used by the field level workers to authenticate the data incorporated in the dashboard
Meeting with Dr.Manu Bhatnagar	It was suggested that the following datasets may be included in the dashboard: • Ground Water Data needs to be taken for block level. • Ground Water Levels may also be taken from Tube Well Drillers as the data may be more reliable. • Temperature data may also be incorporated • Dams and canal systems data must also be included.	Among the suggestions, the following were implemented: • Ground water data at the district level has been included in the database. Data with respect to the blocks level and also getting them verified from the tube well drillers may be taken up in the next phase of the project. • Dams and canal GIS datasets were created and have been be included in the report as well as the dashboard.

Workshop No. or Type	Feedbacks received	Feedbacks implemented
UNA-4	-	• Additional water quality parameters have been included in the report. In the same way, extreme event data related to rainfall has been included. • Admin and super admin users will be able to download a consolidated report from the dashboard portal. The instructions to the same are mentioned in the Dashboard Users' Manual. • Various workshops were conducted among types of the stakeholders for awareness generation.
Capacity Building workshop for creation of story map	• It was suggested to involve district administrators in the workshop. A collaboration involving both the Ministry of Youth Affairs and the Ministry of Jal Shakti was also suggested. • A story map creating competition was also planned for the future.	-

1.1.2. Updating Datasets

In continuation to the works completed in Phase-I (2020), some new datasets were added to the database in Phase-II (2021) namely: the delineation of the drains falling into the Hindon River, their starting points and the end points, all the major irrigation canals and important Ghats present along the basin, important cultural and historical sites were added as new datasets in the database.

Table 3: New GIS datasets created in Phase II of the project

S.No	GIS Layers	Source
1.	Irrigation Canals	Reviving Hindon River – A Basin Approach, 2017. By: Natural Heritage Division, Indian National Trust for Art and Cultural Heritage (INTACH), New Delhi.
2.	All drains falling into Hindon along with the starting and end points.	UPPCB Action Plan for Hindon, 2018
3.	Historical Sites along Hindon River	Reviving Hindon River – A Basin Approach, 2017. By: Natural Heritage Division, Indian National Trust for Art and Cultural Heritage (INTACH), New Delhi.
4.	Ghats along Hindon River	Various newspaper articles and Wikipedia
5.	Dams & Barrages along the basin	Wikipedia
6.	Soil Layers – Texture, Depth, Slope, Productivity, Erosion	Soil Data – India WRIS

Table 4: New Datasets created/updated in Phase II of the project (Details given in the annexure II)

S.No	Datasets	Status	Source
1.	Groundwater level data	updated	India WRIS – CGWB data
2.	Extreme events data	New dataset	India WRIS – Extreme event data
3.	Seasonal Groundwater data	New dataset	India WRIS – ground water data
4.	WRIS – Soil Data	New dataset	India WRIS – Soil data
5.	Area classification	updated	Source: aps.dac.gov.in/ (2018-19)
6.	Agriculture - 1	updated	Source: aps.dac.gov.in/ (2018-19)
7.	Agriculture – 2	updated	Source: aps.dac.gov.in/ (2018-19)
8.	Source Irrigated Area	updated	Source: aps.dac.gov.in/ (2018-19)
9.	Rainfall	updated	India WRIS – IMD
10.	Forest cover	updated	India State of Forest Report - 2021
11.	Surface water quality	updated	India WRIS

1.1.3. Dashboard Modification

In order to improve the usability of the dashboard in terms of both visual and functionality, a new sample dashboard was created and inputs were taken on it. The suggested modifications have been listed and a Terms of Reference (TOR) along with an estimate has also submitted by the dashboard developer to Tree Craze Foundation, which was discussed with India Water Partnership.

Table 5: Modifications suggested in the Dashboard

S.No	Modifications suggested	Datasets
1.	Updating various datasets	• Forest cover • Rainfall • Source Irrigated Area • Agriculture – 1 • Agriculture – 2 • Area classification • Groundwater level data • Surface water quality
2.	Addition of new datasets	• Seasonal Groundwater data • Extreme events data • WRIS – Soil Data
3.	Visual changes	• New GIS layers to be included in the dashboard map section. • Some new chart types with enhanced visual appearance to be used. Example: Bubble chart, Funnel chart etc. • A theme based color scheme.
4.	Functional changes	• All categories of surface water quality to be made visible in the dropdown. • The chart heading area to be highlighted and aligned to the center. • Number of visitors and number of reports downloaded statistics to be made available on the dashboard screen. • Legend section in the map section to be improved.

1.1.4. Story Map Voice over

The script to the story map was modified in a series of meeting conducted with IWP. The script was later finalized and the voiceover was given to the two-story maps namely 'The Journey of a River-Case Study: Hindon' and 'Human Interventions and their Impact on River Physiology'that were created in the first phase of the project.

The link to these story maps and its recording is given below.

The Journey of a River: Case Study Hindon https://arcg.is/1jvz

Human Interventions and their Impact on River Physiology https://arcg.is/1f1TS80
Recording of story map narration is given here:
https://drive.google.com/file/d/1jLJ13qb7EITpVVPrS4Lf0D56ial_E3xG/view?usp=sharing

1.1.5. Story Map Creation Session for NYKS DPOs (District Project Officers)

A story map creation session was conducted on 28th January, 2022 (with the special permission of IWP and NMCG) for the NYKS DPOs with a main agenda of creating a story map. Different aspects of the platform such as the creation of user account, new story title/subtitle/background image edit, addition of slides with content and pin pointing location on the map platform, adding a video file etc. all these functions were explained.

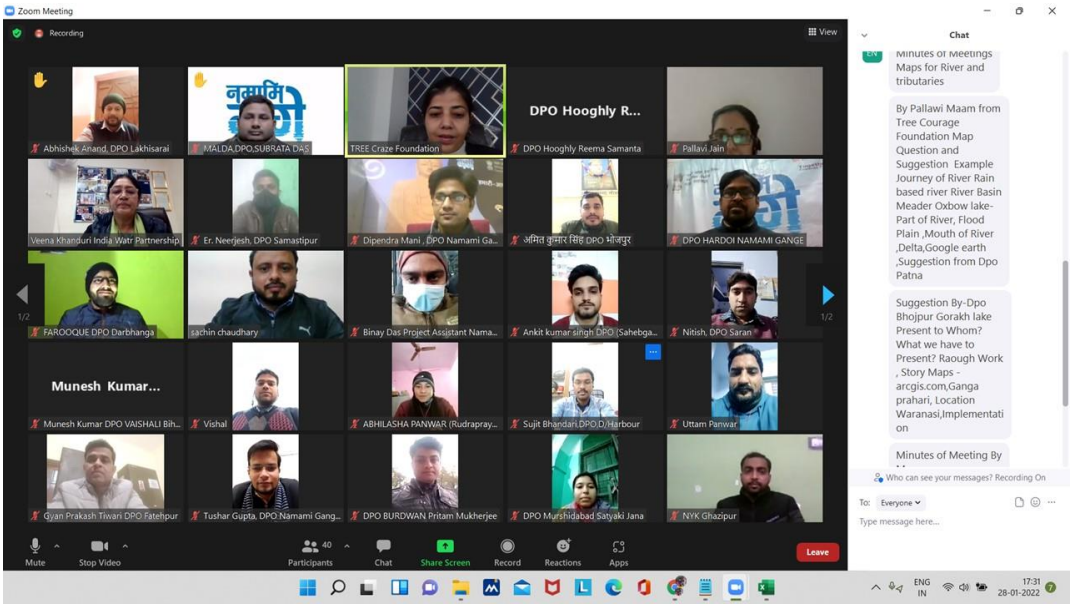


Figure ii: Story Map Creation Session for NYKS

1.1.6. Identifying area for afforestation and pilot ground activity based on GIS data identification, verified through field visit

Starting from the month of June 2021, an attempt was made to identify suitable sites for plantation/afforestation activities using the datasets available in dashboard created during the first phase of the project. A GIS based overlay analysis was conducted to identify the areas suitable for afforestation in Hindon River Basin. The parameters considered for the study included the slope of the area (less than 10 degrees), the availability of land (open lands as per land cover classification) and their vicinity from the riparian zone (500 m from drainage line).

The open areas from the land cover data were extracted and vectorised to calculate the area of the polygons. Polygons with area of more than 500 sqkm were considered for the study. This polygon file was then overlaid over the Hindon basin area excluding the riparian zone which was considered to be 500 meters from the drainage line.

Some of the maps generated showing the sites identified which are suitable for afforestation is shown below.

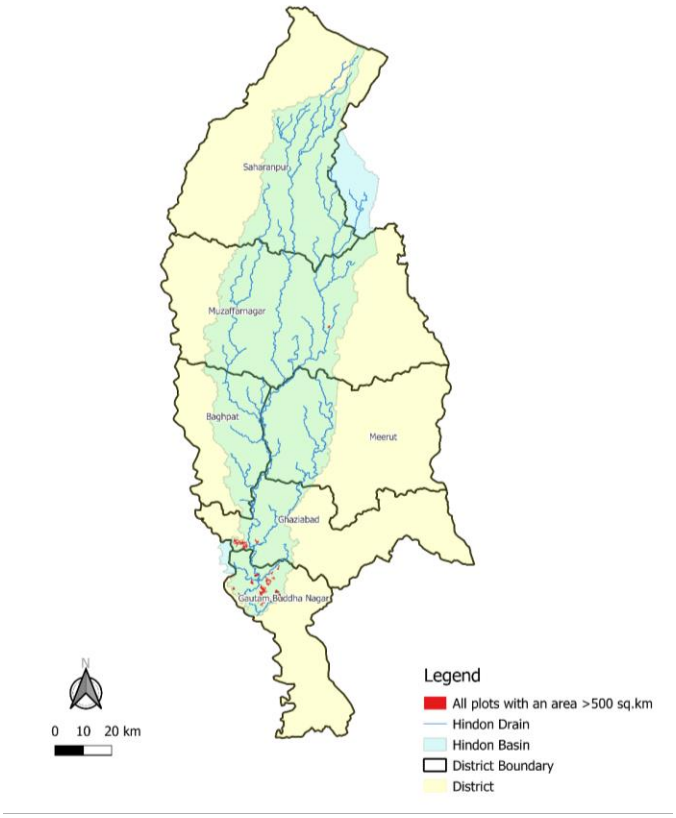


Figure i: Map showing all the sites located for afforestation along the Hindon River

Figure ii: Map showing a 500m buffer along the Hindon drain

The resultant polygon file with polygons>500 sqkm and more than 500 meters away from the drainage line were then overlaid on the slope file and polygons falling in areas with slope < 40 degrees were further taken into consideration.

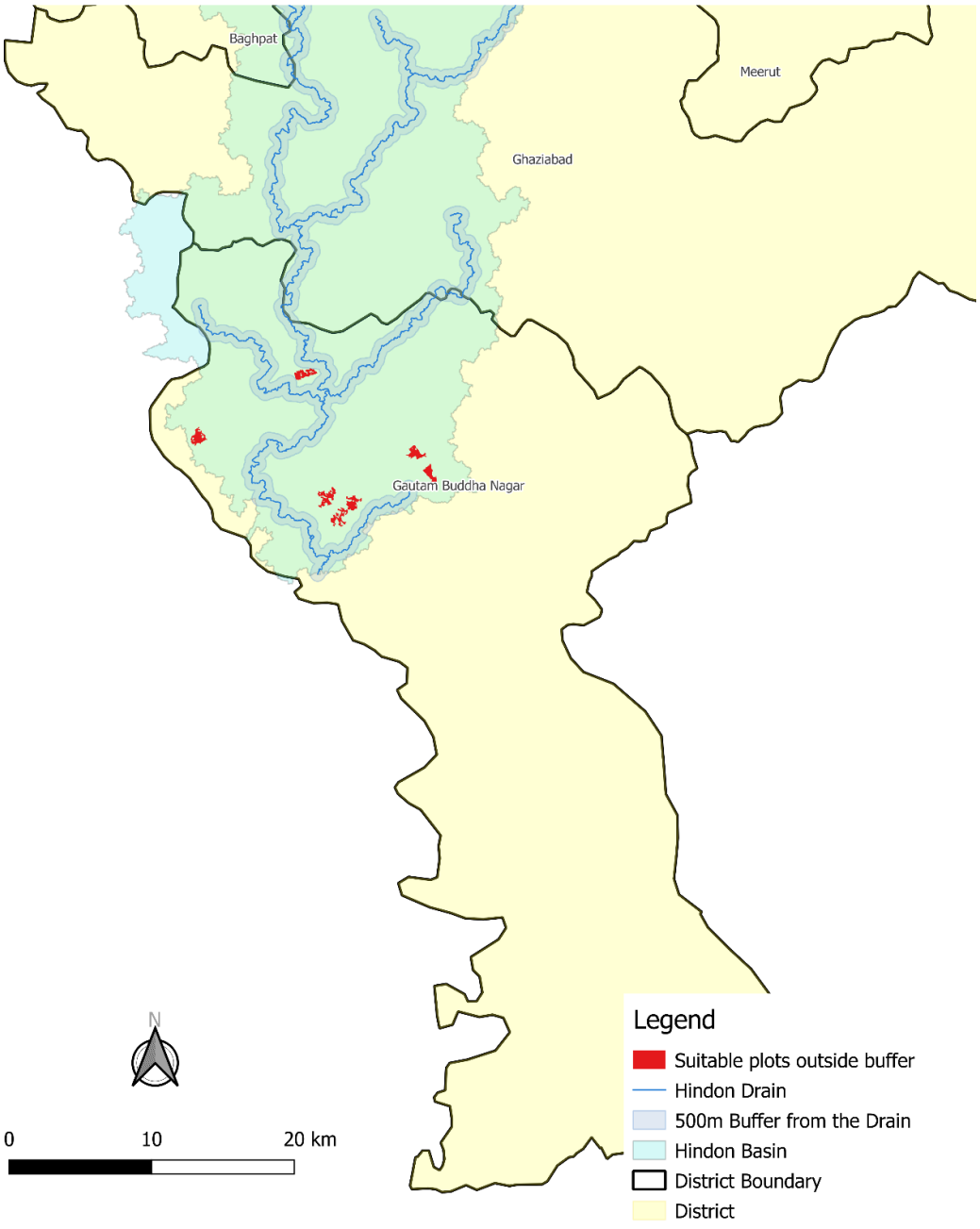


Figure iii: Map showing suitable afforestation sites outside the buffer area

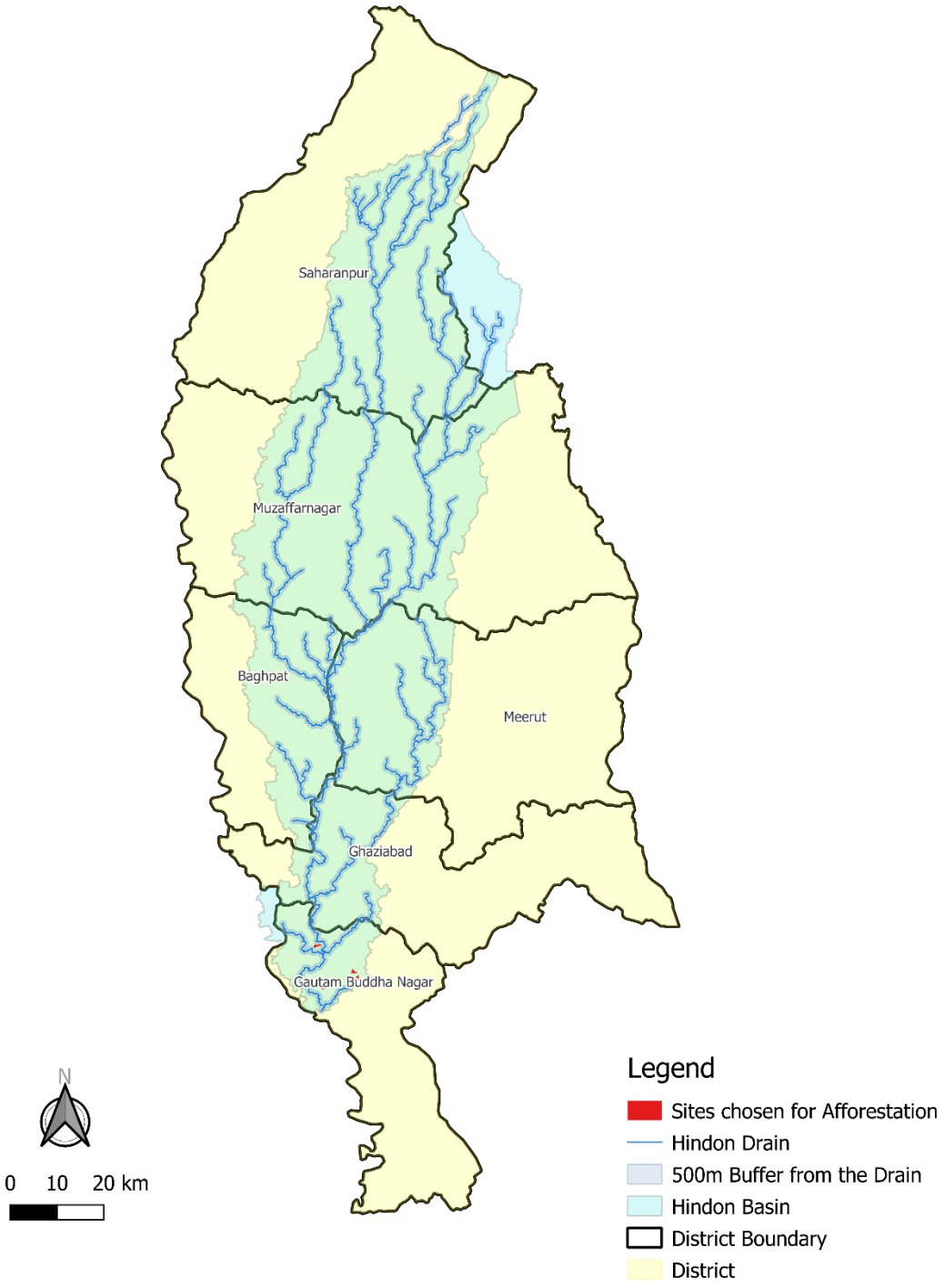


Figure iv: Map showing final sites chosen for afforestation

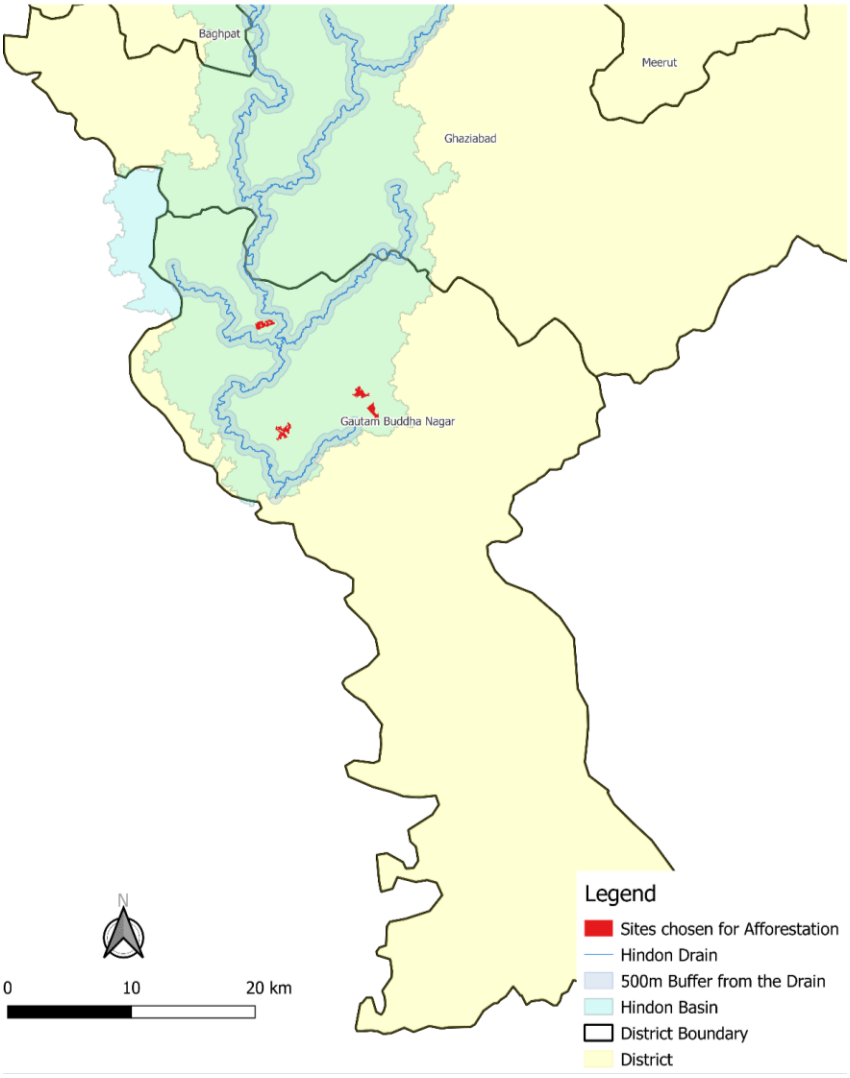


Figure v: Zoomed in map showing final sites chosen for afforestation

As a result, 18 polygons were found suitable for the plantation as per the current analysis. Most of these (15) polygons were in Gautam Budh Nagar, (2) in Ghaziabad and (1) in Muzaffarnagar. Out of these, only 4 polygons in Gautam Budh Nagar after initial verification through Google Earth were identified for plantation. A field verification was also conducted to verify the plots. The details of these polygons are given in the ***Annexure III***.

A few meetings were conducted with the NOIDA Administrative Authority officials, Horticulture Department etc. for getting the ownership details and viability of the sites under consideration for plantation purposes.

The details of officials contacted are listed below in the table:

Table 6: List of officials contacted for site approval

Name	Designation	Telephone	E – mail
Shri Sanjiv Mittal	Chairman	2422160,2422239(O)	chairman@noidaauthorityonline.com
Smt. Ritu Maheshwari	CEO	2422704(O)	ceo@noidaauthorityonline.com
Ms Neha Sharma	ACEO	2422387	aceon@noidaauthorityonline.com
Mr. Praveen Mishra	ACEO	2422348	aceop@noidaauthorityonline.com
Mr. Sudhir Singh	FC	2424248	Office.fcnoida@gmail.com
Mr. Nijilingappa	CFAO	2422444(O)	cfao@noidaauthorityonline.com
Mr. Indu Prakash Singh	OSD(I)	2422349	osdinoida@noidaauthorityonline.com
Ms. Jyotsna Yadav	OSD(J)	2422950	osdj@noidaauthorityonline.com
Dr. Avinash Tripathi	OSD(T)	2422209	industry@noidaauthorityonline.com
Mr. Kumar Sanjay	OSD(S)	2422213	kumar.sanjay@noidaauthorityonline.com
Mr. Avinash Tripathi	OSD(A)	2422309	osda@noidaauthorityonline.com
Mr. Rajeev Tyagi	Chief General Manager	2422428	cgm@noidaauthorityonline.com
Mr. Ishtiyak Ahmed	GM (Planning)	2425087	cap@noidaauthorityonline.com

The officers were willing to permit the plantation activity only if a responsibility of two years of maintenance is defined. Hence, the project of afforestation is currently on hold, owing to the lack of resources in order to commit for maintenance of a two-years period.

1.1.7. Capacity Building Workshop for the identified owners of the dashboard

A capacity building workshop with the administrators was planned after dashboard is modified with suggestions that came up in the user need assessments. However, with modification still pending as India Water Partnership needs to approve the budget estimated by the developer.

1.1.8. Development of Users' Manual of Dashboard

A detailed users' manual explaining all the functionalities of the dashboard was developed under the project. The manual gives information on the creation of user accounts, logging in, downloading reports etc. the User Manual dashboard is shared separately.

Final outputs

- New datasets were created. Both GIS layers and other dashboard related datasets like seasonal ground water, extreme events etc. were added.
- Modifications related to improving visual and functional aspects of the dashboard have been initiated.
- A series of user need assessments were conducted and some of the feedbacks received from the stakeholders have been implemented. The information regarding the same is mentioned in the feedback section of the report which is present immediately after the monthly report compilation.
- A detailed dashboard user – manual has been prepared. It involves all the steps ranging from registering of a new user to the using of all the functionalities of the dashboard.

Conclusions

The dashboard for Hindon River developed under this project was found to be useful by the stakeholders specifically ground based volunteers, researchers and academicians. It was communicated that they need additional data such as ghats, historical sites, all point source pollution datasets. Hence, GIS Layers have been created for ghats, historical sites, and all drains that fall into the Hindon river apart from datasets for canals, soil related datasets, and others. They need to be incorporated in the dashboard. It was suggested in the user need assessment that a detailed manual of the dashboard data should be prepared in the local languages for the villagers to be able to use it. Currently a detailed manual is prepared in English which may be translated into local language for local use. A need to develop a similar dashboard for other river basins of the country as well was also expressed by the stakeholders along with a mobile app that can be used by the field level workers to authenticate the data incorporated in the dashboard. One User Need Assessment workshop (as proposed) with administrators could not be done first due to Covid-19 pandemic and also due to election in States. A torch bearer or the guardian of the dashboard could not be identified and needs to be further assessed. We may also make it a paid portal in order to sustain the maintenance cost of the dashboard. However, several features in the portal are recommended (given in ***Annexure-IV***) in order to make the dashboard more useful for the stakeholders.

The story map was widely appreciated by the stakeholders and our efforts to train the ground based volunteers to create story maps in order to communicate to senior officers was also appreciated. We may further develop a program to educate the young change makers about the power of technology through communicating challenges and solutions in form of a story map.

The field level intervention in form of afforestation could not be completed because Horticulture Department of NOIDA Authority Administration wanted us to take up maintenance for 2 years which was not budgeted in the project.

Recommendations

It may a continued program for Hindon River basin in order to take up following activities:

1. Modification of the dashboard as per recommendations given in ***Annexure-IV***.

2. Further mobilize youth and build their capacity to develop a shared vision for the river Hindon and to strengthen the governance of river Hindon by making the decision makers hear the youth voices.

3. Take up user need assessment for administrators, the main stakeholders and to assess whether similar dashboard are available with them.

4. Make a sustainability plan for the dashboard by either making it a paid portal or handing it over to administrators to be able to maintain the dashboard.

Annexure I: List of Researchers invited for User Needs Assessment Sessions

S. No.	Name	Research Paper Name	College	Email & Contact No.
1	Divya Ghidyal	Statistical Analysis of Coliforms and Bod Levels in Hindon River at Meerut: A Pilot Study.	JSS Academy of Technical Institution, NOIDA, U.P.	divyaghildyal@jssaten.ac.in 9810320303
2	Deepak Kumar	Study on water quality of hindon river (Tributary of Yamuna river).	Amity Institute of biotechnology, Gurugram, India	Deepak.biotech@hotmail.com
3	Mayuri Chabukdhara	Assessment of heavy metal contamination in Hindon River sediments: A chemometric and geochemical approach	Department of Environmental Biology and Wildlife Sciences, Cotton University	mayuri.chabukdhara@gmail.com
4	Arvind Kumar Nema	Assessment of heavy metal contamination in Hindon River sediments: A chemometric and geochemical approach	Department of Civil Engineering, Indian Institute of Technology, Hauz Khas, New Delhi-110 016	aknema@civil.IItd.ac.in
5	Surindra Suthar	Assessment of metals in water and sediments of Hindon River, India: Impact of industrial and urban discharges	Doon University, School of Environment & Natural Resource	sutharIItd@gmail.com 9410707882
6	Sanjay Kumar Gupta	Assessment of metals in water and sediments of Hindon River, India: Impact of industrial and urban discharges	Department ofCivil Engineering, Indian Institute ofTechnology, Hauz Khas, New Delhi-110 016	a26685@civil.IItd.ac.in
7	Prabha krshukla	Study of water quality in Hindon River using pollution index and environ metrics, India	Research Scholar in Department of Civil Engineering, Motilal Nehru National Institute of Technology [MNNIT] Allahabad	7379400080, yaahoo.india@gmail.com
8	Saurabh Mishra	Study of water quality in Hindon River using pollution index and environmetrics, India	Alternate Hydro Energy Centre, Indian Institute of Technology Roorkee, Uttarakhand-247667 I	Tel. +91 7417575326 (not valid); email: saurabhmishra20057@gmail.com
9	Amit Kumar	Study of water quality in Hindon River using pollution index and environmetrics, India	Alternate Hydro Energy Centre, Indian Institute of Technology Roorkee, Uttarakhand- 247667	Tel. +91 9045939559; email: amit.agl09@gmail.com

S. No.	Name	Research Paper Name	College	Email & Contact No.
10	Dr. Rakesh Bhutiani	Limnological characterisation of Hindon River at NCR (Uttar Pradesh), India (2017)	Department of Zoology & Environmental Sciences, Gurukula Kangri Vishwavidyalaya, Haridwar - 249404, Uttarakhand, India	Mobile: +91-9412072917 Email: rbhutani@gkv.ac.in rbhutiani@gmail.com
11	Mukesh Ruhela	Limnological characterisation of Hindon River at NCR (Uttar Pradesh), India (2017)	Associate professor& Head in Swami VevekanandSubharti University, Meerut, UP.	Phone-09457671171, 7906063506 Email: mruhela@gmail.com, mukesh_ruhela@rediffmail.com
12	Siraj Ahmed	Hydrogeochemical assessment of groundwater quality in parts of the Hindon River basin, Ghaziabad, India: implications for domestic and irrigation purposes (2019)	Department of Geology, Aligarh Muslim University, Aligarh -202002, U.P.	sirajalig05@gmail.com
13	Dr.Prafull Singh	Drainage Morphometric Analysis and Water Resource Management of Hindon River Basin, using Earth Observation Data Sets. (2017)	Asst. Professor, Amity Institute of Geo-informatics and Remote Sensing, Amity University, NOIDA, U.P	Contact: Office: 0120-4392370 Mobile: 9958196406
14	Lubna Najam	Levels and Distribution of OCPs, (specially HCH, Aldrin, Dieldrin, DDT, Endosulfan) in Karhera Drain and Surface Water of Hindon River and their Adverse Effects. (2015)	Department of Chemistry, D.A.V (P.G) College, Muzaffarnagar	E-mail: najam.lubna@gmail.com
15	Deepak Kumar	Study on Water Quality of Hindon Rriver (tributary of Ymuna River) (2018)	Amity Institute of Biotechnology, Amity University, 122143, Gurgaon Haryana, India	deepak.biotech@hotmail.com
16	Shilpi Sharma	Pollution Shapes the Bacterial Community of a River: a Case Study (2019)	Department of Biochemical Engineering and Biotechnology, Indian Institute of Technology Delhi, Hauz Khas, New Delhi	shilpi@dbeb.IItd.ac.in
17	Aditya Sarkar	Factors controlling groundwater quality of yamuna river flood plain in noida-faridabad region (2016)	Department of Geology, University of Delhi, Delhi-110007	adi_sarkar.com@rediffmail.com

S. No.	Name	Research Paper Name	College	Email & Contact No.
18	Ajay Kumar	Impact of seasonal variation on water quality of Hindon River: physicochemical and biological analysis (2021)	Assistant Professor, Department of Biotechnology Mewar Institute of Management, Sec-4C, Vasundhara Ghaziabad, U.P. 201012, INDIA	ajaykmr1986@gmail.com
19	Dr Sudhir Kumar	-	Scientist G & Head, Hydrological Investigations Division, National Institute of Hydrology	-
20	Dr Anupma Sharma	-	Scientist F, Groundwater Hydrology Division, National Institute of Hydrology	-
21	Dr Jyoti Patil	-	Scientist D, Research Management & Outreach Division, National Institute of Hydrology	-
22	Dr Nitesh Patidar	-	Scientist B , Groundwater Hydrology Division, National Institute of Hydrology	-
23	Prof. V.C. Goyal	-	Director, National Institute of Hydrology, Roorkee, Uttrakhand	vcg.nihr@gov.in, vcgoyal@yahoo.com
24	Nida Rizvi	Assessment of Water Quality of Hindon River in Ghaziabad and NOIDA, U.P. by using multivariate statistical methods	University School of Environment Management, GGSIP University	-
25	Abhishek Verma	-	Nagar Nigam, Aligarh	abhishekcms08@gmail.com
26	Dr Sitaram Taigor	-	Environment Specialist – Ganga, SMCG	srtganga@gmail.com
27	Dr Mohammad Faisal	-	Scientist, Yamuna Biodiversity Park,	m9faisal@gmail.com

S. No.	Name	Research Paper Name	College	Email & Contact No.
28	Abdullah Ansari	-	Research Scholar, IIT Roorkee	ansari.abdullah@gmail.com
29	Sonu Kumar	-	Nagar Nigam, Ghaziabad	sksonukatariya@gmail.com
30	Mr. Sajid Idrisi	-	Consultant, National Heritage Division, Indian National Trust for Art & Cultural Heritage (INTACH),	idrisisajid@yahoo.com
31	Mr Ajay Kumar	-	Assistant Professor, Department of Biotechnology, Mewar Institute of Management,	ajaykmr1986@gmail.com
32	Dr. Surendra Singh Suthar	-	Associate Professor, School of Environment and Natural Resources, Doon University,	sutharIItd@gmail.com
33	Prof. Nadeem Khalil	-	Professor, Environmental Engineering Section, Department of Civil Engineering, Aligarh Muslim University	krnadeemkhalil@gmail.com

Annexure II: Updated Datasets for Dashboard

Rainfall (mm)

District	Normal	2014	2015	2016	2017	2018	2019	2020	2021
Baghpat	649	417.92	615.07	499.52	522.06	771.3	547.23	444.76	848.08
GB Nagar	-	246.08	359.08	435.63	502.95	431.54	381.96	191.73	514.15
Ghaziabad	750.3	379.79	628.56	538.66	657.4	621.96	513.38	356.39	731.39
Meerut	904.7	572.16	750.63	710.73	779.71	927.83	725.5	608.78	883.7
Muzaffarnagar	833.7	628.73	833.7	719.3	772.34	1038.41	767.53	831.97	858.92
Saharanpur	912.2	848.83	940.21	894.46	1052.16	1197.72	864.06	976.14	1025.28
Consolidated Rainfall Data	**674.98**	**515.59**	**687.88**	**633.05**	**714.44**	**831.46**	**633.28**	**568.30**	**810.25**

***Source**: IMD Data - India WRIS portal, 2021*

Vegetated Area Classification

District	Total Area (Hectares)	Forest (%)	Area Under Non Agricultural Uses (%)	Barren and Uncultura ble Land (%)	Permanent Pasture and Other Grazing Land (%)	Land Under Misc. Tree Crops and Groves not Included in Net Area Sown (%)	Culturable Waste Land (%)	Fallow Lands Other Than Current Fallows (%)	Current Fallow (%)	Net Area Sown (%)
Baghpat	134983	1.21	14.19	1.37	0.07	0.09	1.85	0.59	1.15	79.50
GB Nagar	125422	1.49	37.11	1.51	0.34	0.27	1.38	7.36	8.37	42.17
Ghaziabad	92658	1.97	32.05	1.32	0.01	0.15	2.34	2.87	4.31	54.98
Meerut	273005	7.81	16.30	1.21	0.11	0.03	0.59	0.89	1.14	71.94
Muzaffar-nagar & Shamli	421498	12.33	26.17	0.80	0.27	0.87	0.52	0.89	1.72	156.41
Saharanpur	363791	9.14	14.34	0.08	0.05	0.75	0.12	0.58	1.09	73.86

***Source**: aps.dac.gov.in/(2018-19)*

Graph showing Area sown more than once

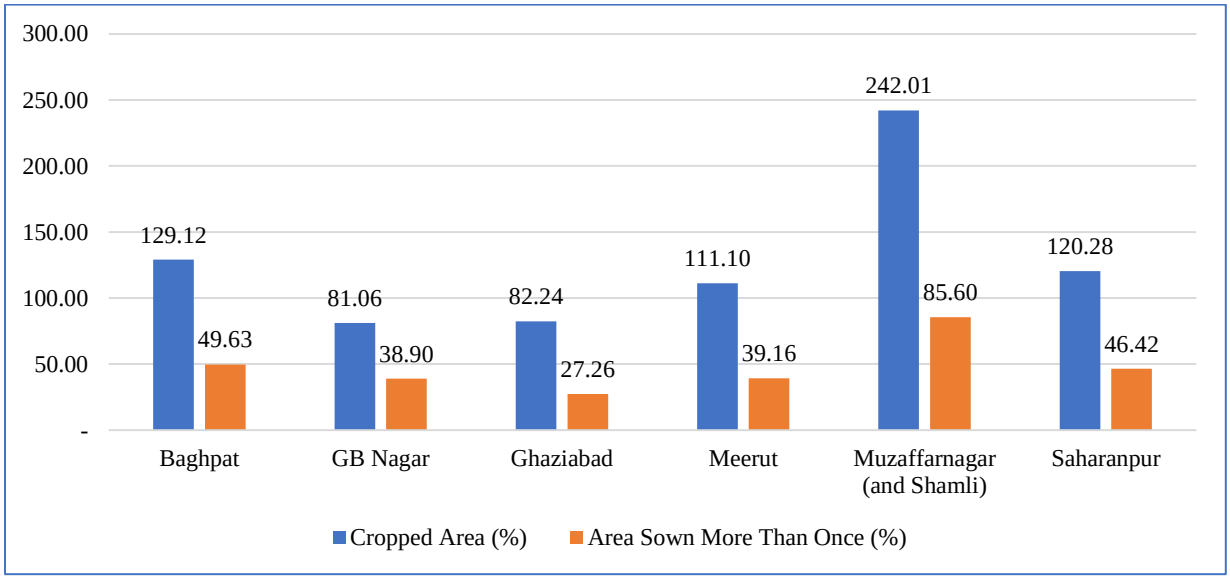


Table 7: Area sown more than once

District	Cropped Area (%)	Area Sown more than once (%)
Baghpat	129.12	49.63
GB Nagar	81.06	38.90
Ghaziabad	82.24	27.26
Meerut	111.10	39.16
Muzaffarnagar & Shamli	242.01	85.60
Saharanpur	120.28	46.42

***Source**: aps.dac.gov.in/(2018-19)*

District-wise Source of irrigation

District	Net Total Canal (Govt & Pvt)	Net Total Tube well and Well	*Net Irrigated Area Total	Gross Total Canal (Govt & Pvt)	Gross Total Tube well and Well	**Gross Irrigated Area Total
Baghpat	1732	105526	107258	2646	171599	174245
GB Nagar	8814	44052	52866	23815	77836	101651
Ghaziabad	5409	45517	50926	6080	70107	76187
Meerut	29266	167125	196391	40856	262444	303300
Muzaffarnagar & Shamli	61553	259979	321533	78440	411638	490097
Saharanpur	31018	228296	259314	49909	367684	417593

***Source**: aps.dac.gov.in/(2018-19)*

***Unit**: Hectares*

Net Irrigated Area: It is the area irrigated through any source once in a year.*

***Total/Gross Irrigated Area**: It is the total area under crops, irrigated once and/or more than once in a year.*

District-wise Major Crops grown

(Crop Area in %age)

District	Rice	Wheat	Sugarcane	Fodder Crop	Mango	Total Vegetables	Oilseeds	Total Pulses	Others
Baghpat	3.92	31.46	43.69	15.79	0.56	2.02	1.39	0.40	0.77
GB Nagar	30.24	45.90	0.83	15.82	0.00	0.30	0.36	0.62	5.92
Ghaziabad	12.12	35.22	29.30	18.39	0.43	2.20	1.54	0.46	0.34
Meerut	6.48	25.72	41.85	15.36	2.55	4.39	2.06	0.94	0.65
Muzaffarnagar & Shamli	20.47	57.52	86.39	25.04	3.49	2.31	2.38	1.11	1.30
Saharanpur	18.64	32.40	24.89	12.33	6.34	1.34	1.17	0.63	2.25

***Source**: aps.dac.gov.in/ (2018-19)*

District-wise Ground Water Level

DISTRICT	2013 (m)	2014 (m)	2015 (m)	2016 (m)	2017 (m)	2018 (m)	2019 (m)	2020 (m)
BAGHPAT	16.16	14.87	16.06	13.11	15.94	13.83	17.70	19.97
GB NAGAR	9.51	9.13	10.09	10.85	10.65	8.74	7.68	8.10
GHAZIABAD	11.43	12.89	13.85	14.77	14.36	13.45	10.91	12.06
MEERUT	10.20	11.27	11.36	12.67	13.41	11.07	11.34	12.80
MUZAFFARNAGAR	12.75	13.54	14.95	12.78	15.52	16.19	16.64	10.56
SAHARANPUR	10.08	11.57	12.97	11.80	14.74	14.34	14.32	14.57

***Source**: CGWB Data - India WRIS Portal (2013-2020)*

Surface Water Quality in selected districts

DISTRICT	STATION	BOD									
		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Meerut	Galeta	39.05	-	41.54	85.43	38.81	53.76	57.02	51.86	42.27	50.76
Saharanpur	Kalanaur	14.54	-	0.75	0.85	5.64	5.74	8.78	3.03	1.88	1.58
Muzaffarnagar	Mawi	3.68	-	2.83	5.49	7.55	7.23	5.52	4.90	2.64	2.92
Ghaziabad	Mohna	3.75	-	18.79	30.96	22.52	16.51	18.73	23.48	19.20	26.35

District	Station	Faecal Coliform (MPN)									
		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Meerut	Galeta	111.66	966.66	1337.5	-	2560	212457.1	238236.4	280000	1486667	802222.2
Saharanpur	Kalanaur	16.16	5.66	3.083	-	12.33	800	5295	62840	10800	39750
Muzaffarnagar	Mawi	39	29	15.5	-	103	15730	8530.09	67111.11	33422.22	41344.44
Ghaziabad	Mohna	102.5	766.66	1075	-	2410	8654.545	22600	309000	257777.8	521777.8

District	Station	COD									
		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Meerut	Galeta	97.75	110.00	77.25	99.25	142.17	99.23	125.50	122.27	100.64	129.67
Saharanpur	Kalanaur	18.83	17.67	5.25	12.17	44.33	27.50	23.25	20.40	5.80	12.00
Muzaffarnagar	Mawi	16.20	24.92	9.50	18.73	38.75	24.67	23.09	35.56	14.67	11.22
Ghaziabad	Mohna	42.92	46.75	31.75	51.00	63.42	49.22	45.86	63.70	45.70	79.67

District	Station	pH									
		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Meerut	Galeta	7.70	7.74	7.95	7.74	7.80	7.81	7.76	7.44	7.45	0.00
Saharanpur	Kalanaur	8.10	7.77	7.99	7.65	7.41	8.02	8.18	7.65	7.84	0.00
Muzaffarnagar	Mawi	7.72	7.92	7.84	7.65	7.47	7.70	8.15	7.60	7.45	0.00
Ghaziabad	Mohna	7.69	7.75	8.02	7.43	7.73	7.81	7.40	7.57	7.55	0.00

District	Station	Total Hardness									
		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Meerut	Galeta	142.16	181.83	207.65	335.17	293.88	385.78	396.46	296.65	301.89	380.00
Saharanpur	Kalanaur	145.27	165.70	154.09	140.97	152.19	133.78	208.03	210.43	152.36	174.82
Muzaffarnagar	Mawi	152.98	141.90	137.47	169.05	128.19	156.03	194.85	174.50	134.75	165.41
Ghaziabad	Mohna	207.17	237.22	278.90	281.05	246.79	323.37	293.23	313.34	273.00	307.03

District	Station	NH3									
		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Meerut	Galeta	0.98	3.28	3.38	8.95	10.06	17.10	13.50	8.66	6.94	17.40
Saharanpur	Kalanaur	0.13	0.04	0.15	0.18	0.10	0.14	1.50	0.13	2.09	0.05
Muzaffarnagar	Mawi	0.31	0.17	0.21	0.48	0.25	0.74	0.37	1.15	0.35	0.58
Ghaziabad	Mohna	3.80	8.57	14.04	4.04	8.67	16.48	11.40	26.01	10.23	13.63

District	Station	Total Alkality									
		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Meerut	Galeta	153.58	211.98	160.34	341.81	345.69	351.96	407.39	252.15	270.37	366.42
Saharanpur	Kalanaur	117.50	124.88	119.51	128.46	119.28	82.33	163.80	129.85	91.73	104.40
Muzaffarnagar	Mawi	125.85	115.85	106.94	141.44	100.83	101.79	114.94	117.85	91.15	95.82
Ghaziabad	Mohna	214.17	282.80	242.92	261.04	277.74	271.21	250.27	278.42	226.08	261.22

District	Station	Total Dissolved Solids									
		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Meerut	Galeta	`	-	-	693.33	653.33	836.00	839.17	555.92	602.30	765.44
Saharanpur	Kalanaur	-	-	-	174.67	207.00	177.17	199.25	240.80	160.80	187.75
Muzaffarnagar	Mawi	-	-	-	236.64	199.67	213.23	238.91	266.67	164.22	185.89
Ghaziabad	Mohna	-	-	-	662.08	799.17	776.25	752.59	967.20	733.20	956.56

District	Station	Dissolved Oxygen (DO)									
		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Meerut	Galeta	-	-	2.16	0.95	9.00	0.00	0.02	-	-	-
Saharanpur	Kalanaur	5.62	-	5.45	7.36	7.79	-	5.10	-	-	-
Muzaffarnagar	Mawi	5.14	-	5.09	6.64	6.73	-	2.81	-	-	-
Ghaziabad	Mohna	2.90	-	-	3.48	4.19	-	0.80	-	-	-

***Source**: India WRIS Portal (2010-19)*

Canals

Major Irrigation Network along Hindon River Basin

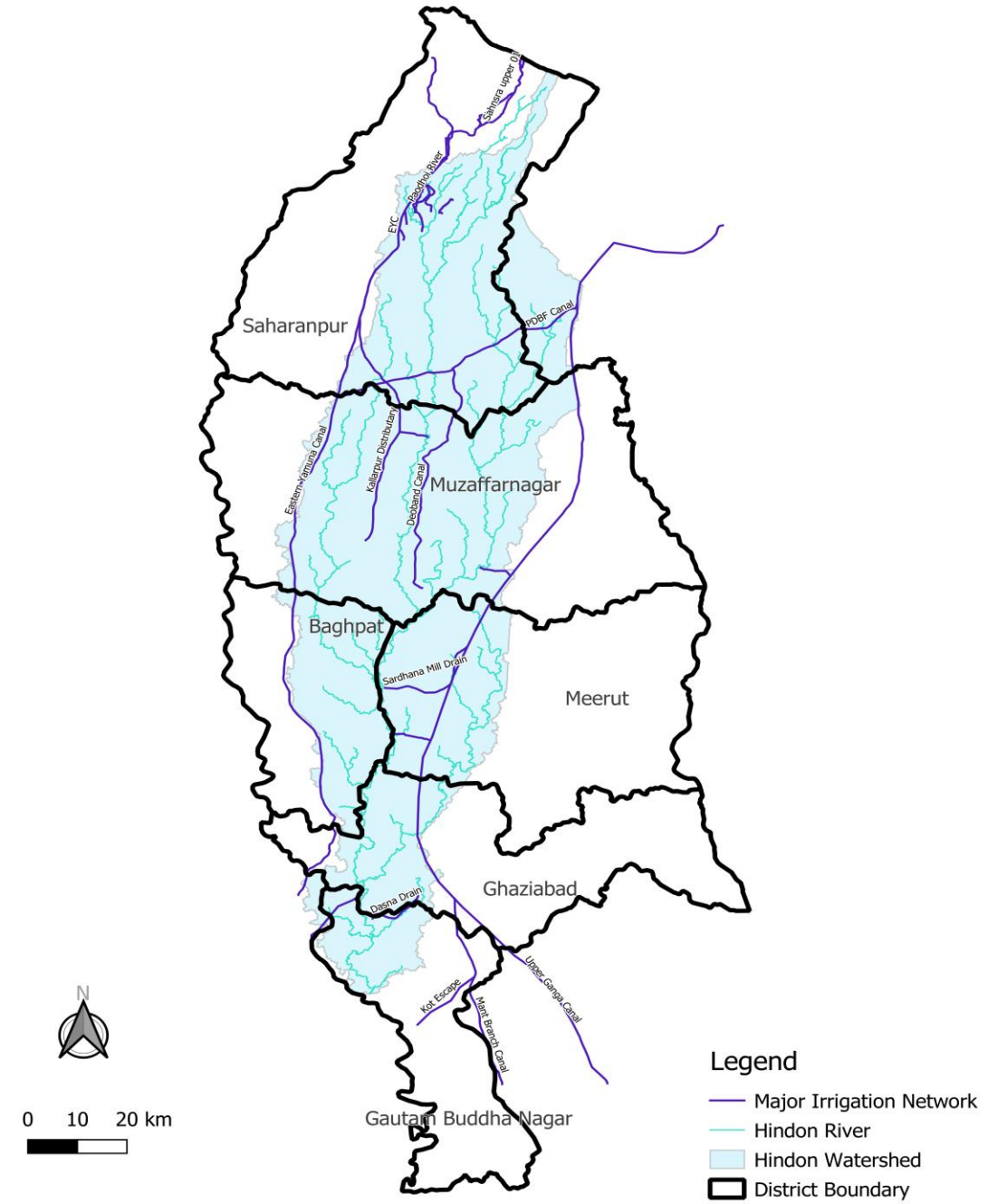


Table 8: Major Irrigation Network along Hindon River Basin

S. No.	Name
1	PDBF Canal
2	Deoband Canal
3	Dasna Drain
4	Upper Ganga Canal
5	Sardhana Mill Drain
6	Jani Escape
7	Khatauli Escape
8	Hindon Cut Canal
9	Kot Escape
10	Mant Branch Canal
11	Kallarpur Cut
12	Biralsi
13	Eastern Yamuna Canal

***Source**: 'Reviving Hindon River – A Basin Approach.' Natural Heritage Division, Indian National Trust for Art and Cultural Heritage (INTACH), New Delhi, 2017*

Drains

Drains falling into the Hindon River along with origin and end points

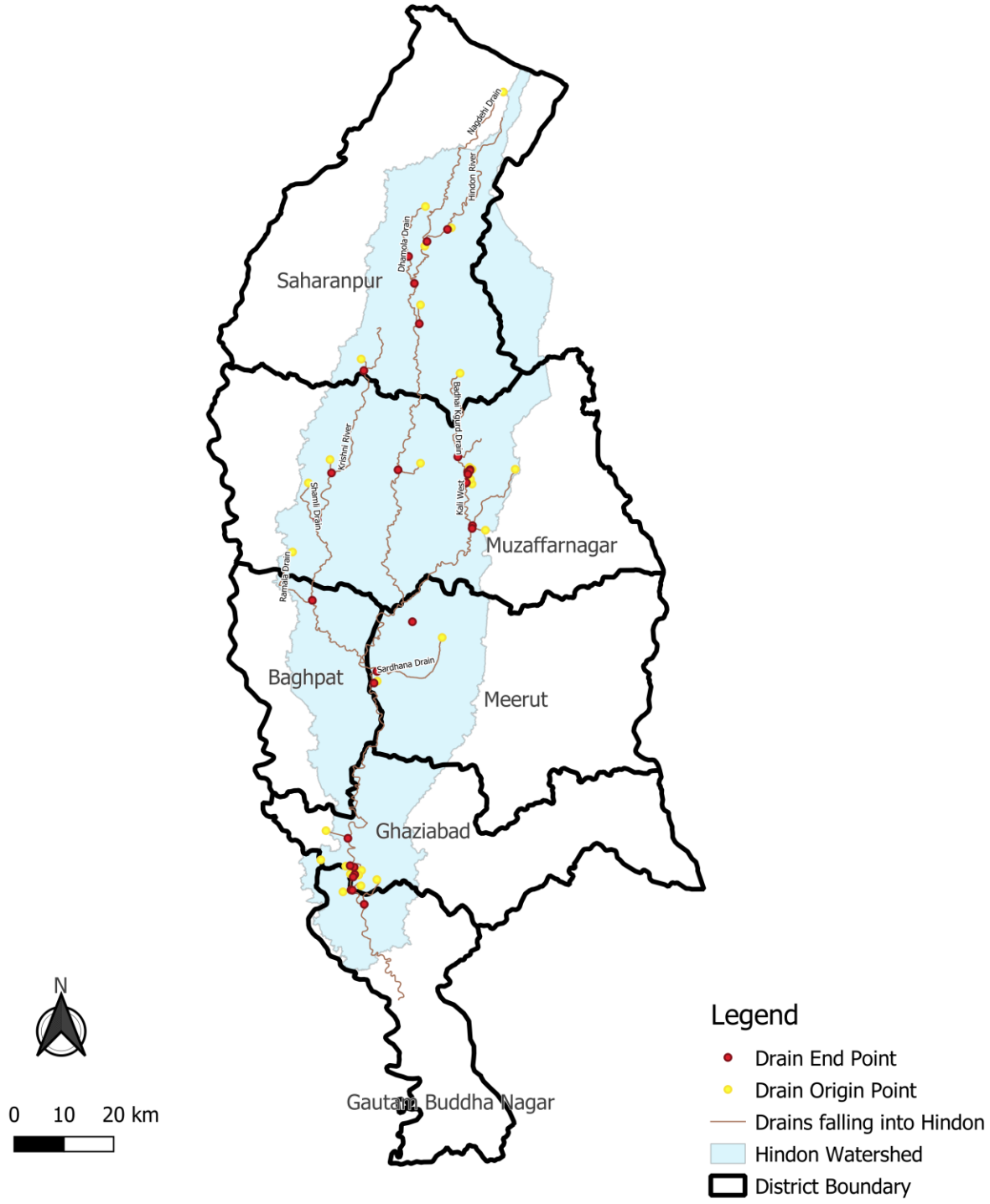


Table 9: Status of Water Discharaged by the Industries in the Project Area

S. No.	Name	Discharge	Length	Nature	pH	BOD (mg/l)	COD (mg/l)	TSS (mg/l)	T coli
1	Nagdehi Drain	0.27 MLD	59.50 km	NA	NA	NA	NA	NA	NA
2	Star Paper Mill Drain	12.0 MLD	15.0 km	Industrial	6.7	45.0	192.0	116.0	2800
3	Bajaj Sugar Drain	1.0 MLD	5.75 km	Mixed	6.9	52.0	240.0	614	31000
4	Thaska Drain	1.90 MLD	3.83 km	Industrial	8.5	50.0	232.0	412.0	38000
5	BadhaiKgurd Drain	1.368 MLD	30.0 km	Mixed	8.2	80.0	320.0	482.0	38000
6	Dhamola Drain	0.561 MLD	17.1 km	Mixed	6.9	48.0	232	520	23000
7	Daya Sugar Drain	0.50 MLD	0.29 km	Industrial	NA	NA	NA	NA	NA
8	Titawi Drain	1.1 MLD	3.5 km	Mixed	7.1	147	1160	1320	120000
9	Shamli Drain	13.35 MLD	12 km	Mixed	7.4	198	960	837	450000
10	Ramala Drain	0.50 MLD	17.10 km	Industrial	7.3	38	280		84000
11	Kinauni Drain	1.2 MLD	1.0 km	Industrial	7.3	38	280	690	84000
12	Sardhana Drain	10 MLD	22.5 km	Mixed	7.8	86	372		210000
13	Sikka Drain	0.5 MLD	5.5 km	Mixed	7.1	202	1040	492	300000
14	Nyajupura Road Drain	3.16 MLD	2.0 km	Domestic	7.1	251.0	816	252	920000
15	Shamli Road Drain	1.47 MLD	2.35 km	Domestic	7.2	222.0	656.0	220.0	1600000
16	Laddawala Drain	20.43 MLD	1.5 km	Domestic	7.1	218	624	210	540000
17	Khadarwala Drain	5.41 MLD	0.5 km	Domestic	6.9	232	798	218	1900000
18	Krishnapuri Drain	16.83 MLD	1.3 km	Domestic	7.1	261	664	212	2800000
19	Suzru Village Drain	2.08 MLD	1.1 km	Domestic	7.2	200	688	215	2600000
20	Nai Basti – Khalapar Drain	1.71 MLD	1.9 km	Domestic	7.3	216	672	242	22000000
21	Mansurpur Drain	0.9 MLD	10 km	Mixed	7.0	330	1387	840	100000
22	Begrajpur/Dhandhera Drain	56.7 MLD	22 km	Mixed	6.9	561	2486	415	110000
23	Jawali Drain	2.422 MLD	5.37 km	Industrial	7.9	50.0	113	160	1600000
24	Karkheda Drain	3.657 MLD	0.85 km	Mixed	7.3	225	464	160	NA
25	HindonVihar Drain	7.0 MLD	2.73 km	Domestic	7.8	120	384	343	210000
26	Dasna Drain	50.69 MLD	8.83 km	Mixed	7.6	299	152	210	9200000
27	Arthala Drain	0.263 MLD	1.12 km	Industrial	7.2	162	223	170	43000000
28	Meerut Road Kaila Bhatta Road Drain	17.93 MLD	1 km	Mixed	6.1	142	287	280	2200000
29	Pratap Vihar Drain	40.0 MLD	2.9 km	Domestic	7.9	100	165	300	3500000
30	Indirapuram Drain	112 MLD	1.89 km	Mixed	7.2	70	150	250	16000000

***Source**: UPPCB Action Plan for Hindon, 2018; **NA** – Data not available*

Ghats (Bathing Places) along Hindon River

Ghats present along Hindon Basin

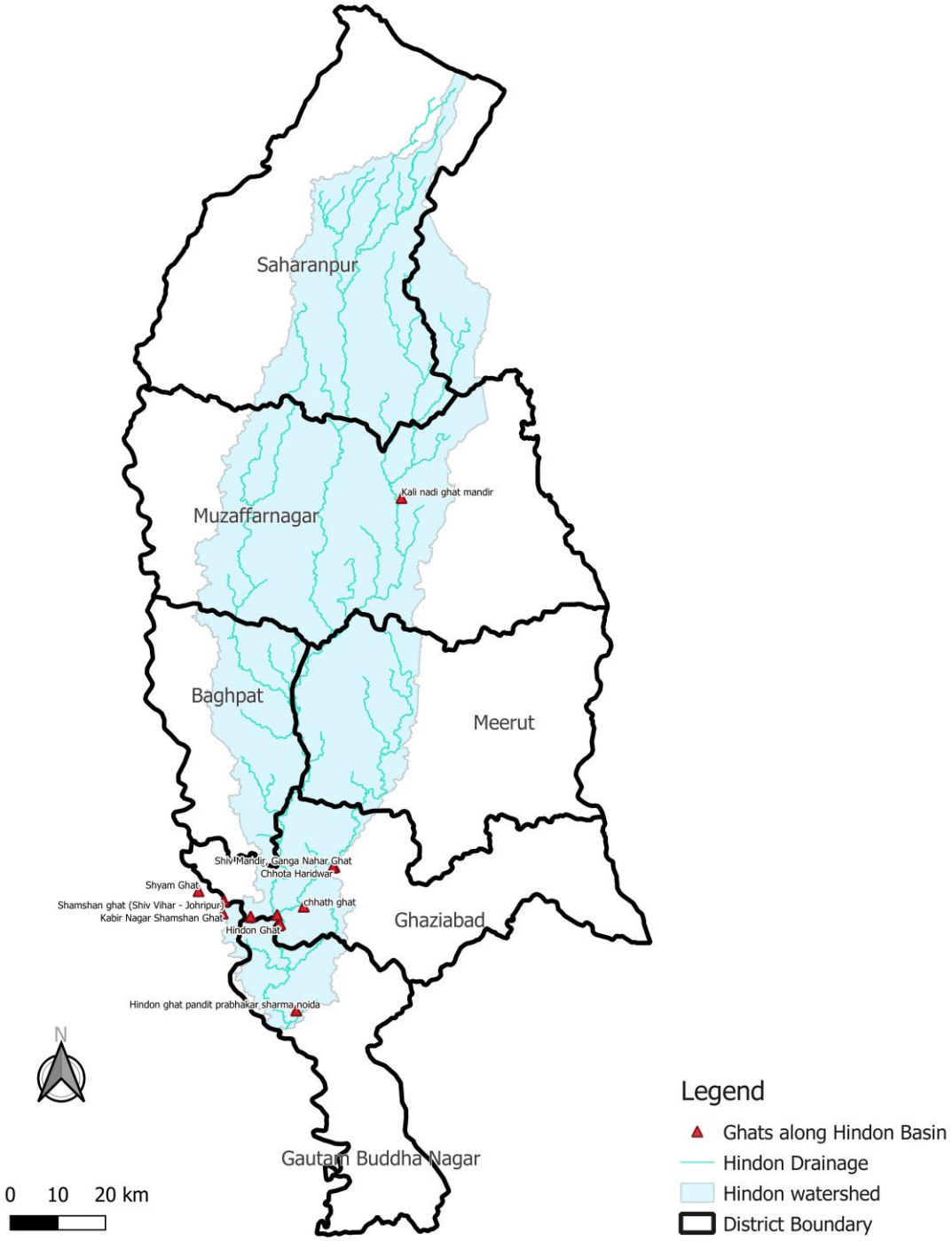


Table 10: Ghats present along Hindon Basin

Name	Lat	Long	District
Hindon River Ghat	28.6731	77.40339	Ghaziabad
Surya Mandir Chhath Ghat Shalimar Garden	28.68822	77.34042	Ghaziabad
ChhathGhaatDeenDayalpuri	28.69096	77.39726	Ghaziabad
Shiv Mandir, Ganga Nahar Ghat	28.78014	77.52314	Ghaziabad
Chhota Haridwar	28.77857	77.51929	Ghaziabad
Shalimar Garden (Surya Mandir Chhath Ghat Shalimar Garden)	28.68869	77.34043	Ghaziabad
Hindon Ghat Pandit Prabhakar Sharma Noida	28.50882	77.43441	GB Nagar
Shamshan Ghat (Shiv Vihar - Johripur)	28.71988	77.28346	NCR
Shyam Ghat	28.73905	77.22934	NCR
Kabir Nagar Shamshan Ghat	28.69585	77.28051	NCR
HindonChaath Ghat	28.67089	77.39972	Ghaziabad
Hindon Ghat	28.67324	77.40343	Ghaziabad
Chhath Ghat	28.70571	77.45517	Ghaziabad
Kali Nadi Ghat Mandir	29.47724	77.68542	Muzaffarnagar

Dams

Dams and Reservoirs along Hindon River

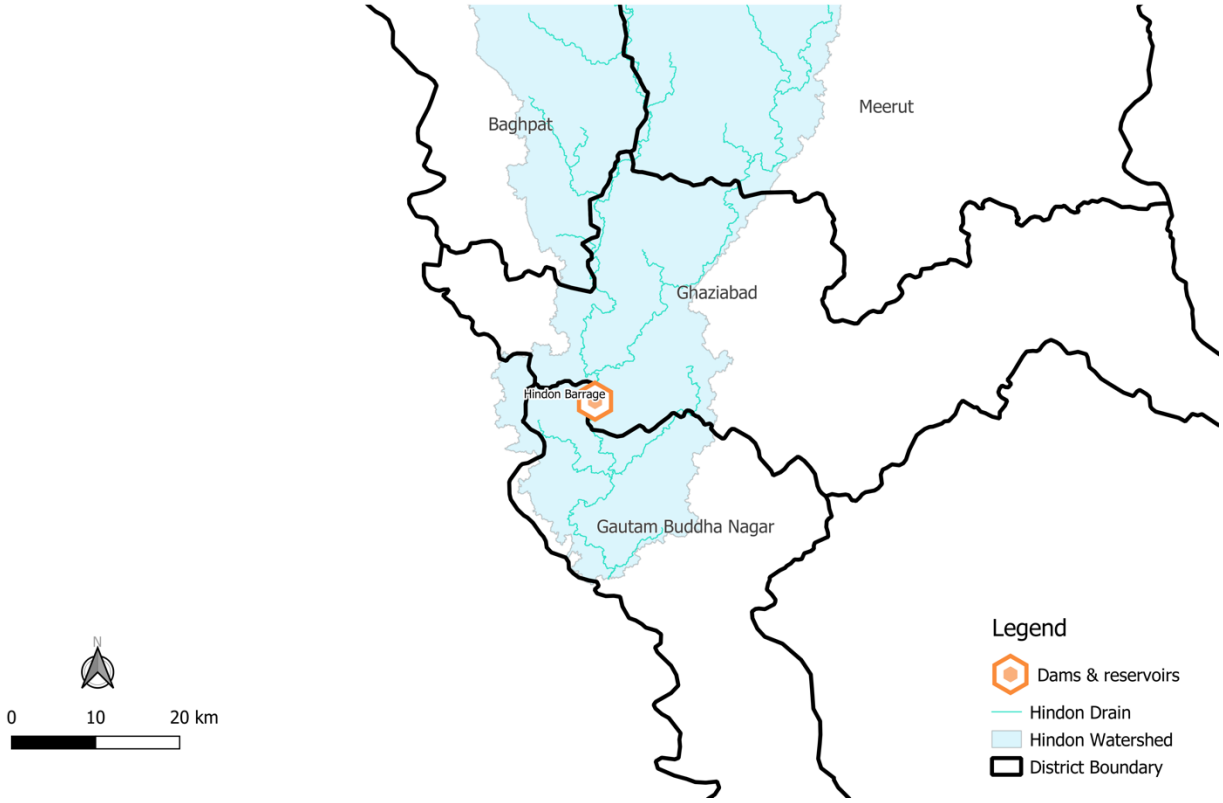


Table 11: Dams and Reservoirs along Hindon River

Name	District
Hindon Barrage	Ghaziabad

Historical and Cultural Sites

Historical and cultural sites along Hindon Basin

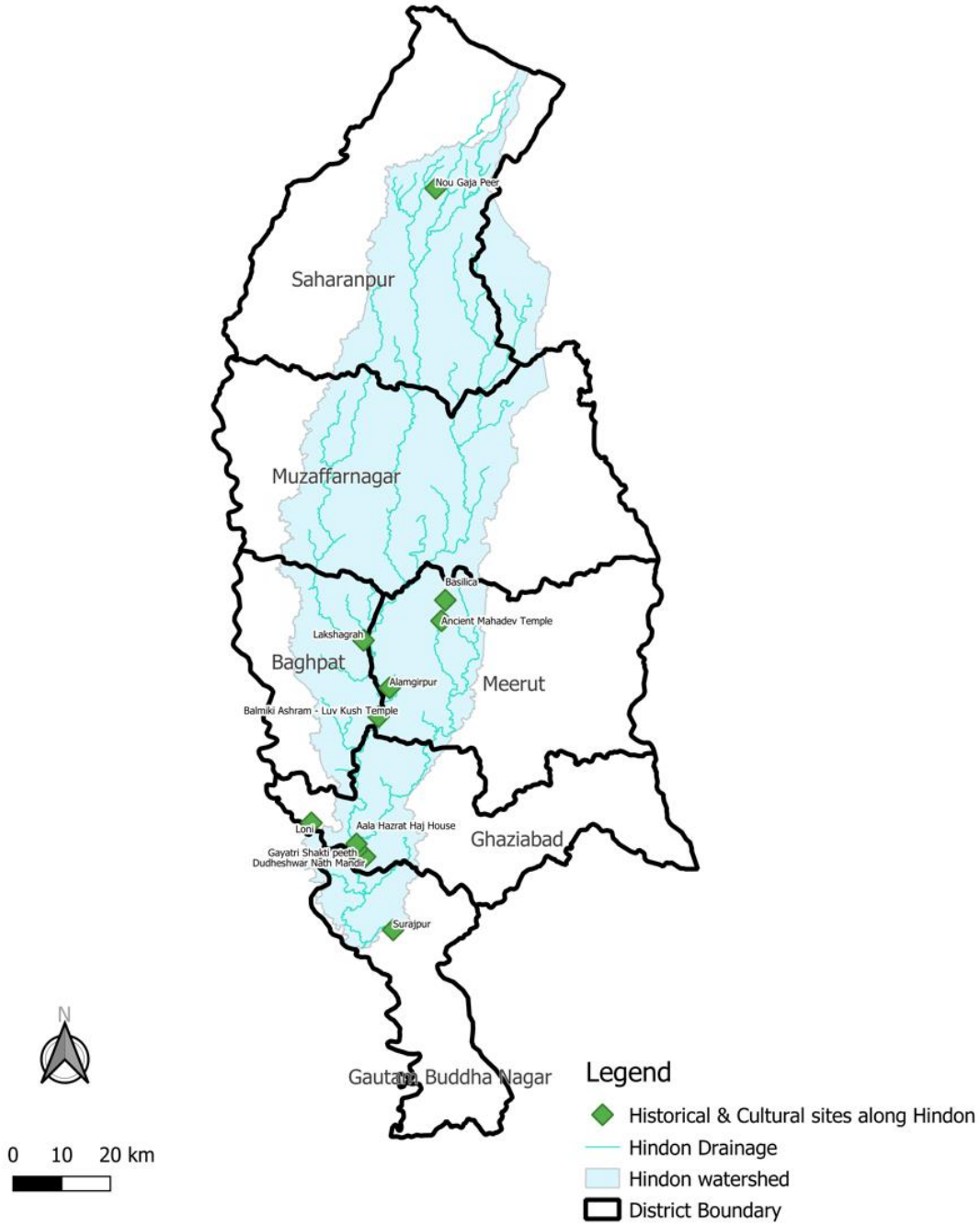


Table 9: Historical and Cultural Sites along Hindon Basin

Name	District	Category of sites
Alamgirpur	Meerut	Indus Valley Site
Lakshagrah	Baghpat	Indus civilization site
Balmiki Ashram - Luv Kush Temple	Baghpat	Ancient religious site
Dudheshwar Nath Mandir	Ghaziabad	Ancient religious site
Loni	Ghaziabad	War site
Ancient Mahadev Temple	Meerut	Ancient religious site
Gayatri Shakti Peeth	Ghaziabad	Religious Site
AalaHazrat Haj House	Ghaziabad	Religious site
Basilica	Meerut	Religious site
NouGaja Peer	Saharanpur	Religious site
Surajpur	GB Nagar	War site

***Source**: 'Reviving Hindon River – A Basin Approach.' Natural Heritage Division, Indian National Trust for Art and Cultural Heritage (INTACH), New Delhi, 2017*

Soil Depth

Soil Depth Map of Hindon River Basin Districts

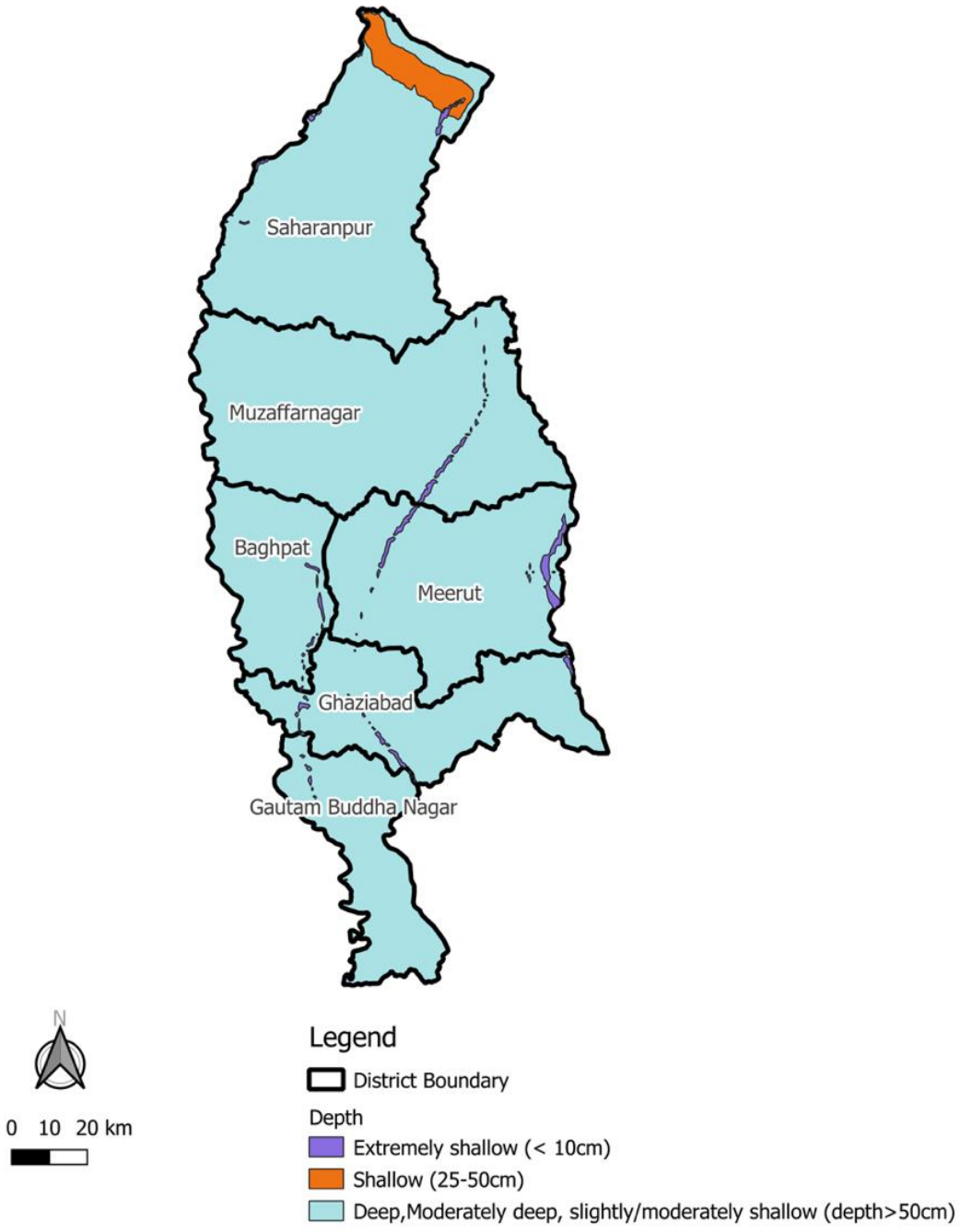


Table 10: Soil Depth

District (% Area)	Deep,Moderately deep, slightly/moderately shallow (depth>50cm)	Extremely shallow (< 10cm)	Shallow (25-50cm)
Baghpat	96.73	3.27	0.00
GB Nagar	96.61	3.39	0.00
Ghaziabad	97.22	2.78	0.00
Meerut	96.61	3.39	0.00
Muzaffarnagar	98.77	1.23	0.00
Saharanpur	89.85	1.81	8.33

***Source**: Soil Data – India WRIS*

Soil Erosion

Soil Erosion Map of Hindon River Basin Districts

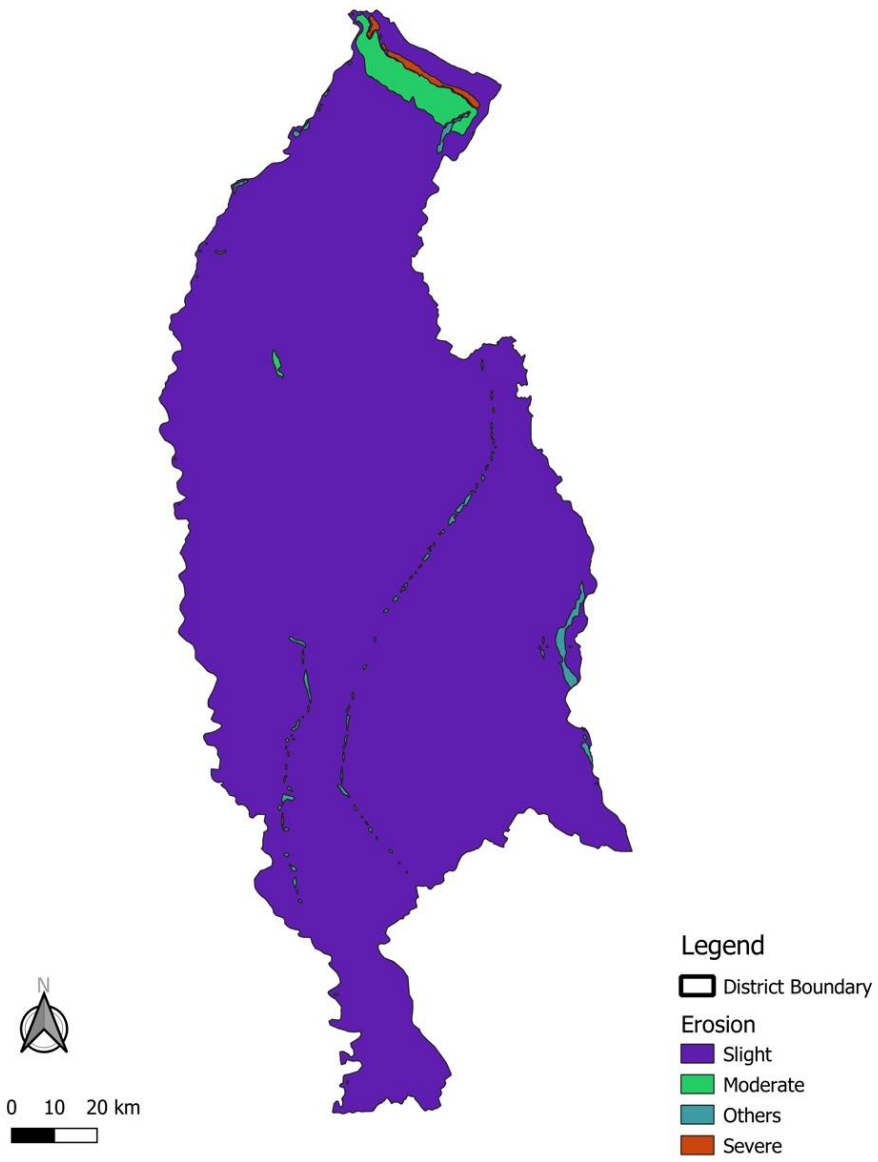

N
0 10 20 km
Legend
District Boundary
Erosion
Slight
Moderate
Others
Severe

Table 11: Soil Erosion

District (% Area)	Moderate	None to slight, slight	Severe	Very severe, gullied
Baghpat	0.18	96.54	0.00	3.27
GB Nagar	0.00	96.61	0.00	3.39
Ghaziabad	0.00	97.22	0.00	2.78
Meerut	0.00	96.61	0.00	3.39
Muzaffarnagar	0.18	98.59	0.00	1.23
Saharanpur	7.19	89.50	1.49	1.81

***Source**: Soil Data – India WRIS*

Soil Productivity

Soil Productivity Map of Hindon River Basin Districts

Table 12: Soil Productivity

District (% Area)	Highly Productive	Low Productive	Moderately Low Productive	Moderately Productive	Non Productive
Baghpat	96.56	0.17	0.00	0	3.27
GB Nagar	96.61	0.00	0.00	0	3.39
Ghaziabad	97.14	0.08	0.00	0	2.78
Meerut	96.61	0.00	0.00	0	3.39
Muzaffarnagar	98.61	0.16	0.00	0	1.23
Saharanpur	86.51	1.88	6.84	2.96	1.82

***Source**: Soil Data – India WRIS*

Soil Slope

Soil Slope Map of Hindon River Basin Districts

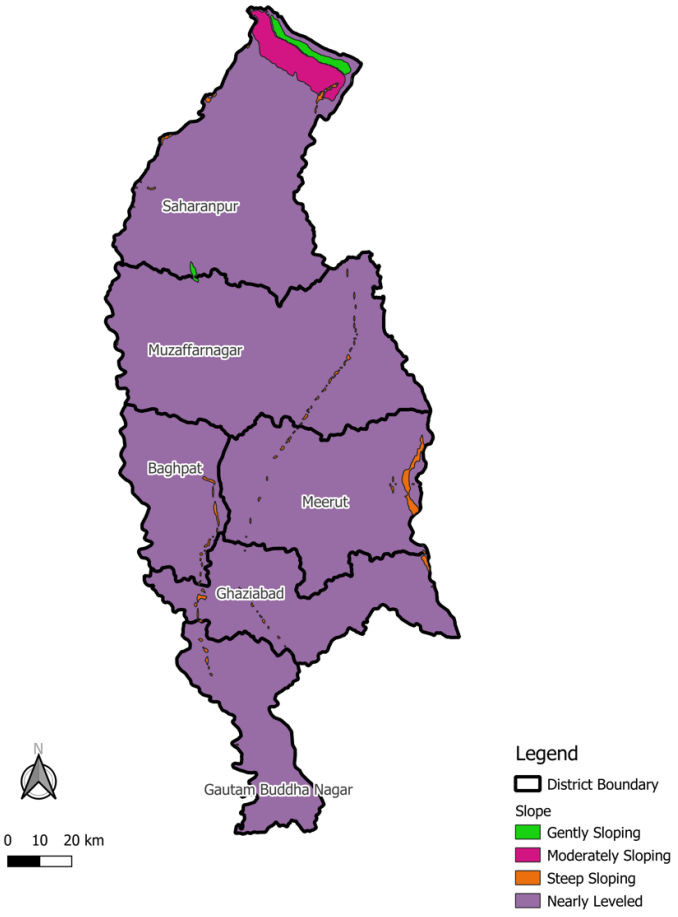


Table 13: Soil Slope

District (% Area)	Gently Sloping (3-8%)	Moderately Sloping (8-15%)	Moderately Steep Sloping (15-30%), Steeply Sloping (3-15%)	Nearly Leveled (0-1%), Very Gently Sloping (1-3%)
Baghpat	0.00	0.00	3.27	96.73
GB Nagar	0.00	3.39	0.00	96.61
Ghaziabad	0.00	0.00	2.78	97.22
Meerut	-	-	3.39	96.61
Muzaffarnagar	0.09	0.00	1.23	98.68
Saharanpur	3.17	8.33	1.82	86.68

***Source**: Soil Data – India WRIS*

Soil Texture

Soil Texture Map of Hindon River Basin Districts

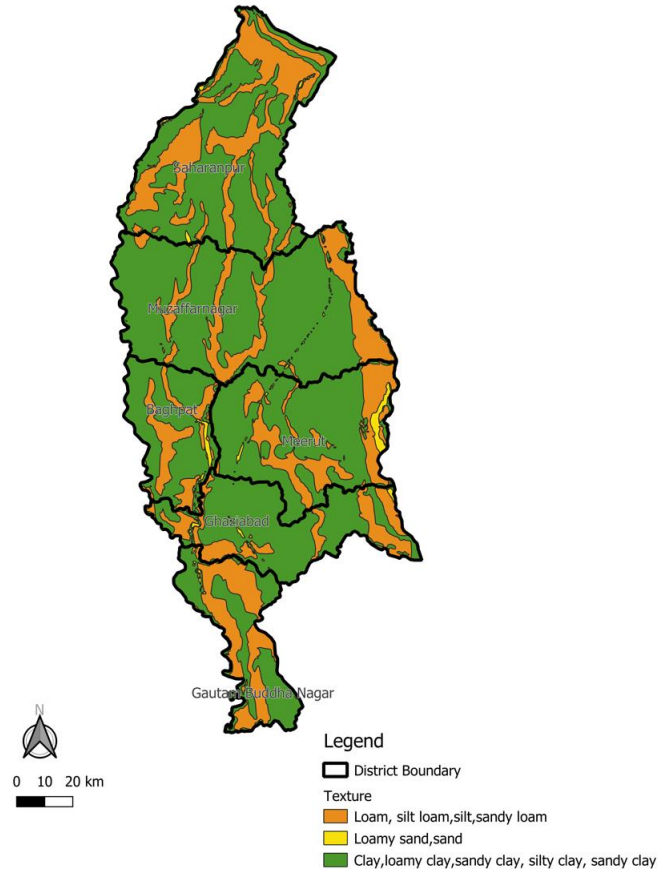


Table 14: Soil Texture (% Area)

District	Clay, Loamy Clay, Sandy Clay, Silty Clay, Sandy Clay	Loam, Silt Loam, Silt, Sandy Loam	Loamy Sand, Sand	Rocky, Other Non-Soil Categories (Built-up, Water Bodies)
Baghpat	62.25	34.30	3.44	0
GB Nagar	61.38	35.23	3.39	0
Ghaziabad	65.33	31.81	2.86	0
Meerut	61.38	35.23	3.39	0
Muzaffarnagar	73.94	24.66	1.40	0
Saharanpur	55.90	41.89	2.20	0

***Source**: Soil Data – India WRIS*

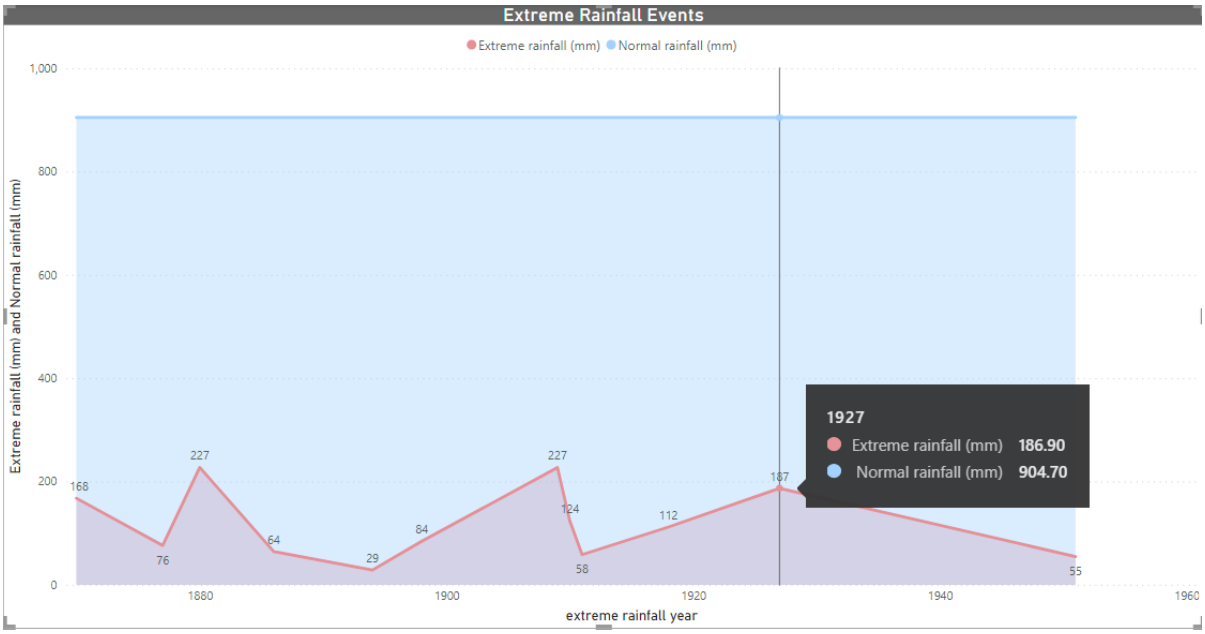
Seasonal Ground water level data from 2013 to 2021

Year	Season	Bagpat	GB Nagar	Ghaziabad	Meerut	Muzaffar Nagar	Saharanpur
		Ground Water level (m)	Ground Water level (m)	Ground Water level (m)	Ground Water level (m)	Ground Water level (m)	Ground Water level (m)
2013	Jan-Mar	17.55	12.94	10.06	10.33	11.12	7.57
	Apr-Jun	16.65	12.70	10.32	10.21	11.78	8.63
	Jul-Sep	19.81	12.41	10.88	10.84	10.26	6.28
	Oct-Dec	15.54	11.67	10.40	9.65	9.82	7.46
2014	Jan-Mar	16.27	12.54	9.89	9.45	10.23	7.53
	Apr-Jun	16.16	12.75	10.08	10.20	11.43	9.51
	Jul-Sep	16.95	13.98	12.91	11.12	13.99	11.14
	Oct-Dec	9.46	9.88	8.76	9.26	9.47	8.89
2015	Jan-Mar	18.58	15.51	14.97	12.98	13.19	10.74
	Apr-Jun	14.87	13.54	11.57	11.27	12.89	9.13
	Jul-Sep	13.85	13.20	11.25	10.95	10.90	8.00
	Oct-Dec	14.50	15.20	11.99	11.19	11.52	7.97
2016	Jan-Mar	13.39	9.71	10.96	9.52	11.35	9.36
	Apr-Jun	16.06	14.95	12.97	11.36	13.85	10.09
	Jul-Sep	19.17	15.23	14.69	12.85	13.84	11.84
	Oct-Dec	13.11	13.82	12.31	11.74	13.01	9.31

Seasonal Ground water level data from 2013 to 2021 (Contd…)

Year	Season	Bagpat	GB Nagar	Ghaziabad	Meerut	Muzaffar Nagar	Saharanpur
		Ground Water level (m)	Ground Water level (m)	Ground Water level (m)	Ground Water level (m)	Ground Water level (m)	Ground Water level (m)
2017	Jan-Mar	12.41	13.86	11.55	11.67	12.89	9.74
	Apr-Jun	13.11	12.78	11.80	12.67	14.77	10.85
	Jul-Se	11.49	10.32	10.89	11.08	11.43	8.87
	Oct-Dec	13.42	15.22	12.79	11.49	12.21	9.44
2018	Jan-Mar	13.10	15.08	12.91	11.60	12.42	9.34
	Apr-Jun	15.94	15.54	14.70	13.41	14.36	10.65
	Jul-Sep	11.78	8.83	11.47	11.82	12.61	8.42
	Oct-Dec	10.42	16.54	13.41	11.79	11.00	7.25
2019	Jan-Mar	19.71	19.96	19.41	19.14	19.26	19.44
	Apr-Jun	15.37	15.52	16.29	16.53	16.20	15.89
	Jul-Sep	15.93	16.65	15.34	15.39	15.13	15.29
	Oct-Dec	22.14	22.24	20.83	19.88	20.39	20.05
2020	Jan-Mar	16.85	17.13	16.29	16.03	16.19	15.78
	Apr-Jun	22.41	23.70	21.52	20.81	20.99	20.68
	Jul-Sep	16.82	17.40	18.67	19.68	18.49	18.42
	Oct-Dec	13.53	14.46	14.96	15.48	15.08	15.03
2021	Jan-Mar	12.78	12.53	15.00	15.97	15.51	16.12
	Apr-Jun	4.11	4.11	4.11	4.11	4.11	4.11
	Jul-Sep	14.51	15.10	15.70	16.02	15.67	16.10
	Oct-Dec	14.31	14.73	16.51	17.77	17.42	17.90

***Source**: Seasonal Ground Water Data (All agencies) - India WRIS Portal, 2021*



Extreme events data (Meerut Station) – Rainfall events

Rainfall (mm) Data of Meerut		
Rainfall	**Extreme Rainfall year**	**Normal Rainfall**
167.6	1870	904.7
76.2	1877	904.7
227.3	1880	904.7
64.3	1886	904.7
28.5	1894	904.7
84.3	1898	904.7
227.1	1909	904.7
123.9	1910	904.7
58.4	1911	904.7
111.8	1918	904.7
186.9	1927	904.7
54.6	1951	904.7

***Source**: Extreme events data - India WRIS Portal*

Forest Cover Data

S.No	District	Open Forest	Moderately Dense Forest	Very Dense Forest	Scrub	Non Forest
1	Baghpat	0.912	0.378	0	0	98.71
2	Gautam Buddha Nagar	1.17	0.39	0	0	98.44
3	Ghaziabad	1.4	0.735	0	0	97.86
4	Meerut	1.34	1.32	0	0	97.33
5	Muzaffarnagar	1.29	0.34	0	0	98.35
6	Saharanpur	8.65	4.71	0	0.01	86.62

***Unit**: Percentage of total geographical area*

***Source**: India State of Forest Report, Forest Survey of India, 2021*

Annexure III: Details of sites for afforestation

Site 1 : Location: Near Tussiyana Village, behind Knowledge Park 5, Greater Noida. (Surveyed in July, 2021)

Lattitude: 28°32'55.50"N Longitude: 77°28'49.58"E

Picture 1 Site 1 Satellite Image: Behind Knowledge Park 3, Greater Noida

Picture 1 Site 1 Field Pictures

Site 2: Location: Near Surajpur Wetand, Greater Noida. (Surveyed in July, 2021)

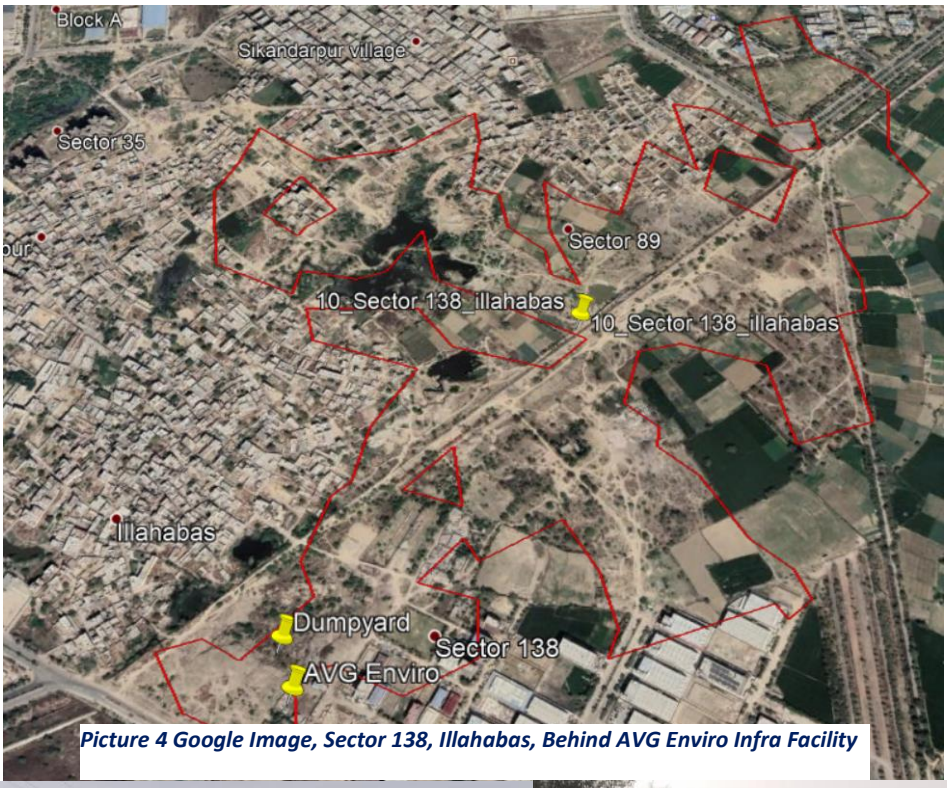
Lattitude: 28°31'51.17"N Longitude: 77°29'48.00"E

Picture 2 Site 2 Satellite Image: Near Surajpur Wetland, Greater Noida

Picture 3 Site 2 Field Pictures

Site 3: Location: Sector 138, Illahabas. (Surveyed in August, 2021)

Lattitude: 28°31'23.99"N Longitude: 77°25'12.65"E



Picture 4 Google Image, Sector 138, Illahabas, Behind AVG Enviro Infra Facility

Picture 6 Site 3 Image Fareed Road (behind dump site)

Picture 5 Site 3 Image Main Road

Site 4: Location: On Vikas Marg opposite Pisecia Power 400 KV GIS Substation, HCX4+7GP, Sector 123, Noida, with a concrete boundary wall (Surveyed in August)

Lattitude: 28°36'2.58"N Longitude: 77°24'24.57"E

Picture 7 Google Image

Picture 9 Site picture

Picture 8 Site Picture 2

Annexure- IV: Recommended Modifications for Dashboard

Tasks	Sub Task
Server Migration	Handholding to procure the server and transfer the hosting of dashboard on IWP server
Dashboard	Change in the visual representation of graph and chart in the dashboard (example will be shared)
Data Modification	Rainfall - IMD
	Groundwater – CGWB
	Surface water quality - Pollution dashboard
	Seasonal groundwater data
	Extreme events - rainfall
	Irrigated area
	Area under different crops
	Total cropped & area sown more than once
	Area classification
CMS	Ability for administrator to modify the attribute data from backend
WebGIS	Adding following new vector map to WebGIS
	Historical sites & Cultural sites
	Hindon Drain + upper rivulets
	Drains + Drain origin points + Drain end point
	All Canals
	Ghats along Hindon
	Transparency of various layers on the portal should be controllable by the user.
	Dams & Reservoirs
	Soil Datasets
	Transparency of various layers on the portal should be controllable by the user.
Spatial Analysis through QGIS	Buffer generation and overlay of the same
	No. of features in a polygon layer
	Clip based on the polygon layer etc.
	Adding of a temporary layer (point/line/polygon)
	Area/distance calculation of temporary layer features
Mobile App	A mobile application can be developed where the data on the portal can be used as a base and verified on field.
	Following functionalities may be required:
	Base map may use GPS in real time for locating users in the field
	The user should be able to tag various entities of the datasets and comment on it.
	Adding a temporary point, line or polygon with some attributes should be a possibility
	The data captured on field can be imported on the portal.
Dynamic Graph	Add additional columns to the dataset that should reflect on the front-end graph
	The report can be dynamically generated and downloaded from the portal.

India Water Partnership (IWP) and Tree Craze Foundation (TCF)

India Water Partnership (IWP) is a non-profit organization, accredited with the Global Water Partnership (GWP), Stockholm, Sweden. IWP is a Country Water Partnership of GWP. IWP works towards water security in India by following the concept of Integrated Water Resources Management (IWRM). It engages in a dispassionate analysis of various water related issues and steers the policy discourse on social, economic, and ecological issues on a scientific basis.

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F: (+91-124) 239 7392
E-mail: iwpneer@gmail.com; veena@cwp-india.org; https://www.cwp-india.org

Tree Craze Foundation (TCF) is a not for profit (section -8) company committed to the cause of Trees, Rivers, Ecosystems & Environment. It acknowledges the power of communities and is striving to charge up the communities to own up their rivers and act for them leveraging international best practices. TCF is revolutionizing the environment education space by innovating the pedagogy and involving committed work force to inculcate attitude building in place of mere awareness creation.

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