TE-27/3/2021-GIS NMCG

PROJECT REPORT

FLUVIAL GEOMORPHOLOGY MAPPING OF HINDON RIVER BASIN

Submitted by

NEW ENVIRONMENT AND ENERGY RESEARCH

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Introduction

The Hindon River is a significant river in North India, flowing through the states of Uttar Pradesh and Uttarakhand. It is a tributary of the Yamuna River and plays a crucial role in the region's ecology and economy. The area is located in between Yamuna and Hindon river, which are highly polluted rivers of western Uttar Pradesh, is polluted by municipal, industrial and agricultural effluents, and flows through the city of Saharanpur, Muzaffar Nagar and Ghaziabad districts (Lewis, 2007).

As surface water resources are inadequate to fulfill the water demand. Productivity through groundwater is quite high as compared to surface water, but groundwater resources have not yet been properly developed through exploration. Groundwater interacts with the surface layer in three ways, first by getting recharged during the rainy season, secondly provides moisture to the surface layer in the dry season, and third way by interacting dynamically in both space and time. The dynamics of groundwater further depends on hydraulic conditions, local geology, and the climate of the region (Amanambu et al., 2020; Cuthbertet al., 2019; Kløve et al., 2011).

Although groundwater occurs beneath essentially every spot on the Earth, finding usable supplies can be a challenge. Groundwater commonly occurs within earth materials through which water moves very poorly, and thus its extraction may be impossible. Groundwater also may occur very deep in the Earth, making extraction impractical, even if its quality were acceptable for everyday use. Also, groundwater may contain excessive amounts of salts or minerals, or it may be contaminated. Satellite remote sensing provides shallow-earth information about plants, geologic materials, and structure. These techniques are particularly good in areas where water flow may be concentrated in fractures or other geologic structures that have surface expression, but are not readily discerned by walking over them (Perrin et al., 2011; Montginoul et al., 2016; Pophare et al., 2014; Goyal et al., 2013; Sakthivadivel, 2007).

Detailed hydrogeomorphological mapping survey can give a clear picture of the groundwater resources and the associated problems. The visual interpretation and Digital Image Processing of CARTOSAT/LANDSAT and ASTER satellite data may provide information pertaining to hydro-geomorphic features to understand the nature and water potentiality of different landforms. The integration of geological and lineament information is important in preparing hydrogeomorphic potential map. Interrelationship of hydro geomorphic units and other topographical features and their importance shall be very helpful in delineating the groundwater potential zones, specifically in the hilly terrain (Poole, 2010; Gurnell et al., 2016; Thorp et al., 2010)

In drier climates, plants often align along water-bearing fractures and appear readily in aerial photographs. Conversely, in wetter climates, the types of plants may differ over water-bearing zones and thus show up distinctly in spectral sensing. Buried or hidden River-channel sediments can become obvious using ground-penetrating radar. Fractures and faults are particularly easy to spot using side-scan radar. Drilling is then directed into the fractures, ancient River channels, fault zones, or layers where water is either known or suspected to be moving (Sethupathi et al., 2012; Nag and Ghosh, 2013).

Reliable information on land and water resources and its proper management are the most important components for planning area specific development activities. For scientific management of natural resources, it is essential to integrate the data on various land and water resources together with the data on socio-economic conditions for optimal utilization of these natural resources.

A lot of study has been done on the parametric characteristics of Hindon river through conventional and neural network modules. There is no or very little literature available for this basin relating to ground water modelling and its inter-connection with other parameters i.e., soil, geomorphology, seismology and surface water data etc.

Here's a brief introduction to the Hindon River:

Importance:

Water Source: The river serves as a major source of water for agricultural, industrial, and domestic purposes in the region. Many towns and cities along its course depend on the Hindon for their water supply needs.

Agriculture: The water from the Hindon River is extensively used for irrigation, supporting agriculture in the surrounding areas. Farmers rely on this water source for cultivating crops.

Biodiversity: The Hindon River and its floodplains are home to various flora and fauna. The river sustains a diverse ecosystem, including numerous bird species, fish, and other aquatic life.

Historical Significance: The region around the Hindon River has historical and cultural significance. Several ancient and medieval sites are located along its banks, reflecting the rich heritage of the area.

Challenges:

Despite its importance, the Hindon River faces several challenges, including pollution from industrial effluents, sewage discharge, and agricultural runoff. These issues have led to water quality degradation and adversely affected the river's ecosystem and the communities dependent on it (Mishra et al., 2016; Sharma et al., 2021).

Efforts are being made by the government and various organizations to address these challenges, including initiatives to clean the river, regulate industrial discharges, and promote sustainable agricultural practices to ensure the Hindon River's long-term health and usability.

The provided table appears to show the total effluent discharge 78.39 MLD (in Million Liters per Day, MLD) from various types of industries and drains in different districts.

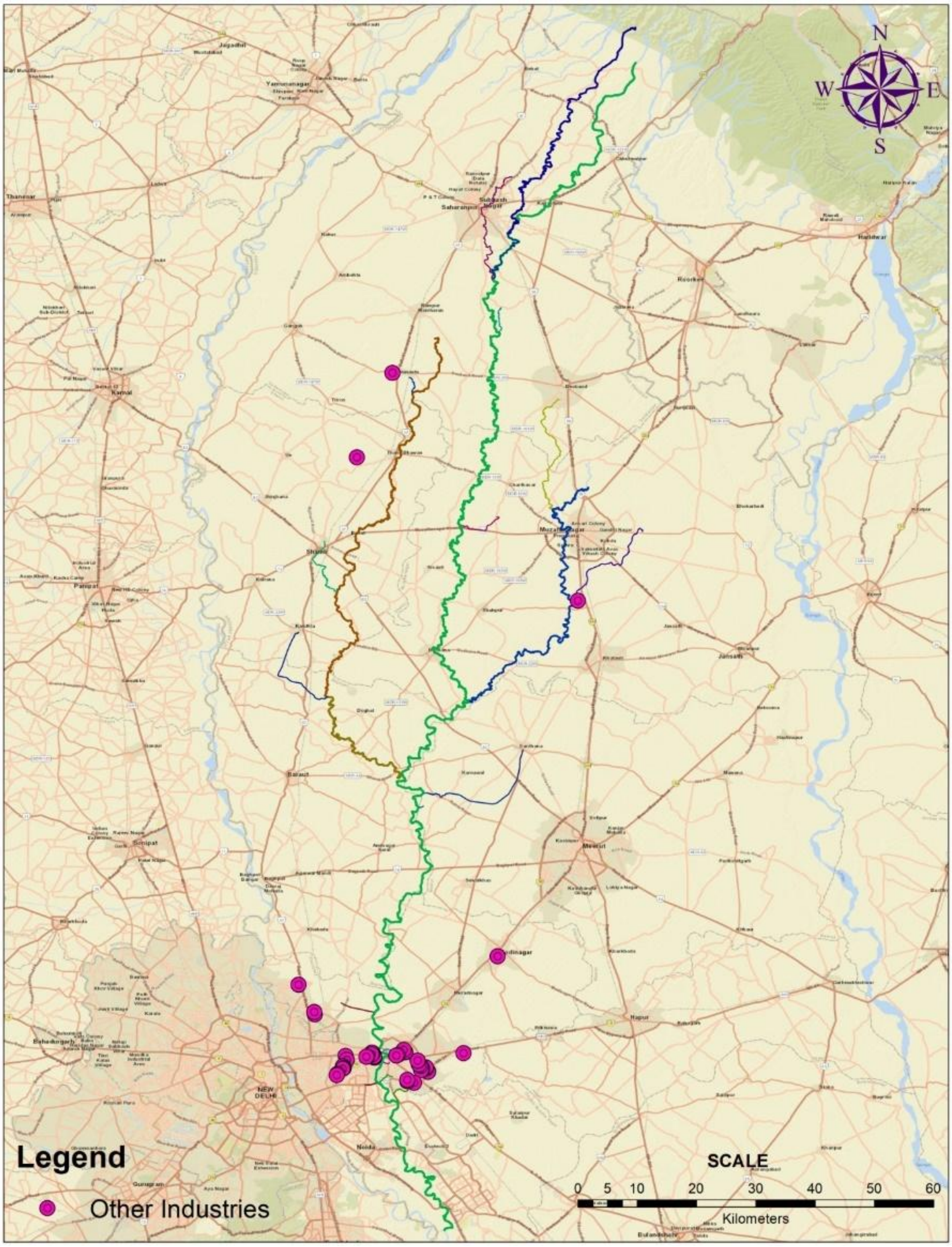


Fig. 1. Image showing industrial units discharging effluent into Hindon river

S. No.	District	Drain	Type of Industry (may be changed as per local conditions)								Total Effluent Discharge (MLD)
			Sugar	Pulp & Paper	Distillery	Textile	Slaughter House	Tannery	Others	Total	
1	Sahranpur (Self Closed-5, Onland -6, ZLD-1)	Dhamola	0	15	0	16	1	0	0	32	0.561
		Star Paper Mill Drain	0	1	0	0	0	0	0	1	12
		Bajaj Sugar Drain	1	0	1	0	0	0	0	2	1
		Daya Sugar Drain	1	0	0	0	0	0	0	1	0.5
		Naagdehi Drain	0	1	0	0	0	0	1	2	0.27
		Thaska Drain	1	0	1	0	0	0	1	3	1.9
		Badhai Khurd	1	0	0	0	0	0	0	1	1.368
2	Muzaffar nagar	Dhandhera Drain	0	36	1	0	1	2	1	41	34.45
		Mansurpur Drain	1	0	1	0	0	0	0	2	0.7
		Titawi Drain	1	0	0	0	0	0	0	1	0.8
3	Shamli	Sikka Drain	0	1	0	0	0	0	0	1	0
		Shamli Drain	1	1	1	0	0	0	0	3	2.35
4	Meerut	Sardhana Drain	0	1	0	0	0	0	1	2	1.26
		Kinauni	1	0	0	0	0	0	1	2	1.2
5	Baghpat	Ramala Drain	1	0	0	0	0	0	0	1	0.5
6	Ghaziabad	Arthla Drain	0	0	0	0	0	0	2	2	0.263
		Karedha Drain	0	0	0	15	0	0	4	19	1.657
		Dasna Drain	0	1	0	6	6	2	30	45	3.697
		Meerut Road Kaila Bhatta Drain	0	1	0	2	3	1	14	21	1.933
		Sahibabad Drain	0	1	0	74	0	0	39	114	8.79
		Jawli Drain	0	0	0	141	1	0	10	152	2.4
	Total		**9***	**59**	**6**	**254**	**12****	**5**	**104**	**448**	**78.39**

Table 1. Statistics of industrial units discharging effluent into Hindon river

Sewage pollution discharge in Hindon river

S. No.	District	Name of Drain	Meeting Point of Drain		Domestic/ Industrial/ Mixed	Tapped/ Untapped / Partially Tapped	Industries		Sewage Discharge (MLD)			Status of Bar- mesh
			Latitude	Longitude			Number	Treated Effluent (MLD)	Treated	Untreated	Total	
1	Sahranpur	Dhamola Drain	29°54'35.07"N	77°33'19.50"E	Mixed	Untapped	32	0.561	38	81	119	No
2		Star Paper Mill Drain	29°51'18.65"N	77°34'3.07"E	Industrial	Untapped	1	12	0	0	0	No
3		Bajaj Sugar Drain	29°46'25.24"N	77°34'36.37"E	Industrial	Untapped	2	1	0	0	0	No
4		Daya Sugar Drain	29°57'58.38"N	77°39'12.47"E	Industrial	Untapped	1	0.5	0	0	0	Yes
5		Thaska Drain	29°40'54.48"N	77°26'46.82"E	Mixed	Untapped	3	1.9	0	0.5	0.5	No
6		Nagdehi Drain	29°56'34.3"N	77°36'17.3"E	Industrial	Untapped	2	0.27	0	0	0	No
7		Badhai Khurd Drain	29°30'14.6"N	77°39'31.6"E	Mixed	Untapped	1	1.368	0	0.5	0.5	No
		Total					**42**	**17.599***	**38**	**82**	**120**	
8	Muzaffarnagar	Titawi Drain	29°28'49.3"N	77°31'13.3"E.	Mixed	Untapped	1	0.8	0	0.3	0.3	No
9		Dhandhera Drain	29°21'53.4"N	77°41'20.0"E.	Mixed	Untapped	41	34.45	0	22.25	22.25	No
10		Mansurpur Drain	29°21'32.7"N	77°41'16.8"E.	Mixed	Untapped	2	0.7	0	0.2	0.2	No
11		Nyajipur Drain	29°28'38.9"N	77°41'10.8"E.	Domestic	Untapped	0	0	0	3.16	3.16	No
12		Laddawala Drain	29°28'33.1"N	77°41'09.5"E.	Domestic	Partially Tapped	0	0	0	20.43	20.43	No
13		Shamli Road Drain	29°28'21.4"N	77°40'50.3"E.	Domestic	Untapped	0	0	0	1.47	1.47	No
14		Khadarwala Drain	29°28'06.8"N	77°40'51.7"E.	Domestic	Untapped	0	0	0	5.41	5.41	No
15		Krishnapuri Drain	29°28'06.5"N	77°40'51.6"E.	Domestic	Untapped	0	0	0	16.83	16.83	No
16		Suzru Village Drain	29°27'03.2"N	77°40'36.1"E	Domestic	Untapped	0	0	0	2.08	2.08	No
17		Nai Basti Khalapar Drain	29°27'06.1"N	77°40'37.0"E.	Domestic	Untapped	0	0	0	1.71	1.71	No
		Total					**44**	**35.95****	**0**	**73.84**	**73.84**	
18	Shamli	Shamli Drain	29°22'59.06"N	77°19'53.70"E	Mixed	Untapped	3	2.35	0	10	10	No
19		Sikka Drain	29°28'36.85"N	77°22'0.92"E	Mixed	Untapped	1	0	0	0.5	0.5	No
		Total					**4**	**2.35*****	**0**	**10.5**	**10.5**	
20	Ghaziabad	Jawali Drain	28°44'25.43"N	77°23'15.33"E	Industrial	Untapped	152	2.422	0	0	0	NO
21		Hindonvihar Drain	28°40'55.37"N	77°24'1.74"E	Domestic	Untapped	0	0	0	7	7	NO
22		kailabhatta road drain	28°40'1.27"N	77°24'5.77"E	Mixed	Untapped	21	1.933	0	16	16	NO
23		Arthala Drain	28°39'44.18"N	77°23'52.35"E	Industrial	Untapped	2	0.263	0	0	0	NO
24		Indirapuram Drain	28°38'10.50"N	77°23'32.85"E	Mixed	Untapped	0	0	112	0	112	NO
25		PratapVihar Drain	28°38'8.29"N	77°23'43.39"E	Domestic	Untapped	0	0	0	40	40	NO
26		Dasna Drain	28°36'24.34"N	77°25'18.74"E	Mixed	Untapped	45	3.697	0	47	47	NO
27		Karedha Drain	28°41'6.72"N	77°23'29.46"E	Mixed	Untapped	19	1.657	0	2	2	NO
28		Sahibabad Drain	28°66'2.87"N	77°34'3.40"E	Mixed	Partially Tapped	114	8.797	74	83.203	157.203	No
		Total					**353**	**18.769**	**186**	**195.203**	**381.203**	
29	Meerut	Sardhana Drain	29° 4'28.32"N	77°27'44.22"E	Mixed	Untapped	2	1.26	0	10	10	NO
30		Kinauni Drain	29° 3'7.44"N	77°27'17.09"E	Industrial	Untapped	2	1.2	0	0	0	NO
		Total					**4**	**2.46**	**0**	**10**	**10**	
31	Baghpat	Ramala Drain	29°13'16.36"N	77°19'0.56"E	Industrial	Untapped	1	0.5	0	0.1	0.1	No
		Total					**1**	**0.5**	**0**	**0.1**	**0.1**	

Table 2. Statistics of sewage units discharging effluent into Hindon river

Study area

The Hindon River originates in the Saharanpur District of Uttarakhand and flows through the districts of Muzaffarnagar, Meerut, Baghpat, Ghaziabad, Noida, Greater Noida, and Bulandshahr in the state of Uttar Pradesh (Fig. 1).

The study area for the proposed work consists of an approximately 100 km linear stretch of the Hindon river segment starting from Baparasi Village near the Meerut Karnal highway 82 falling at 29°11’7.76” N, 77°29’37.13” E till the river joins Yamuna River in Gautambuddh Nagar at 28°24’42.77” N, 77°29’39.18” E. The fluvial geomorphic features have been mapped along this stretch along the flood plains falling 10 km on either side. The geomorphic features mapped consists of various agradational and degradational landforms such as paleochannels/abandoned channels, river flood plain (younger alluvial plain, older alluvial plain and active flood plain), point bars, channel bars, braided bars, scroll bar, ox bow lakes, meander scar etc. Further the region close to the river’s confluence with Yamuna River within Gautam buddh nagar has been sampled for surface and groundwater from specific locations to understand the contamination levels within this stretch.

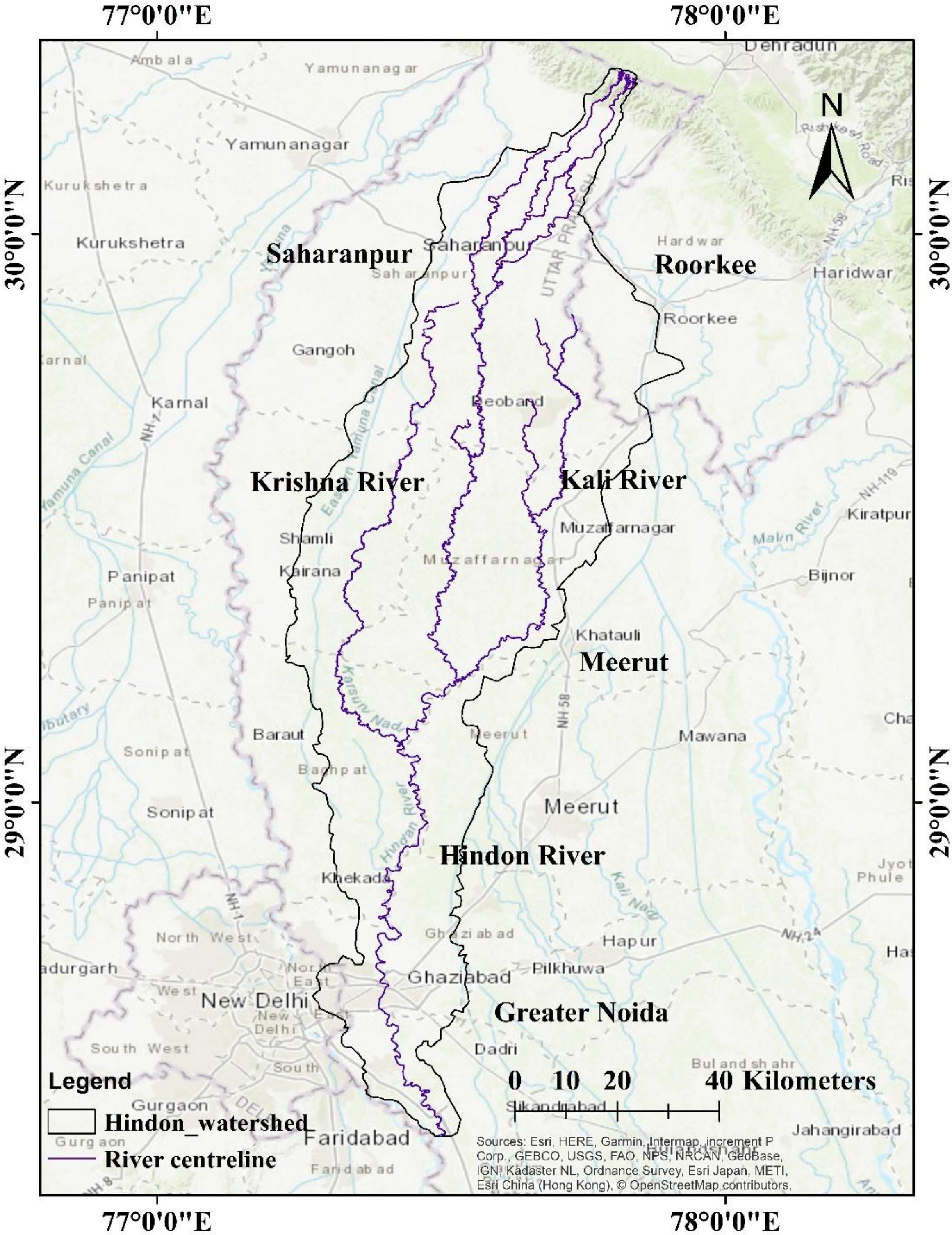
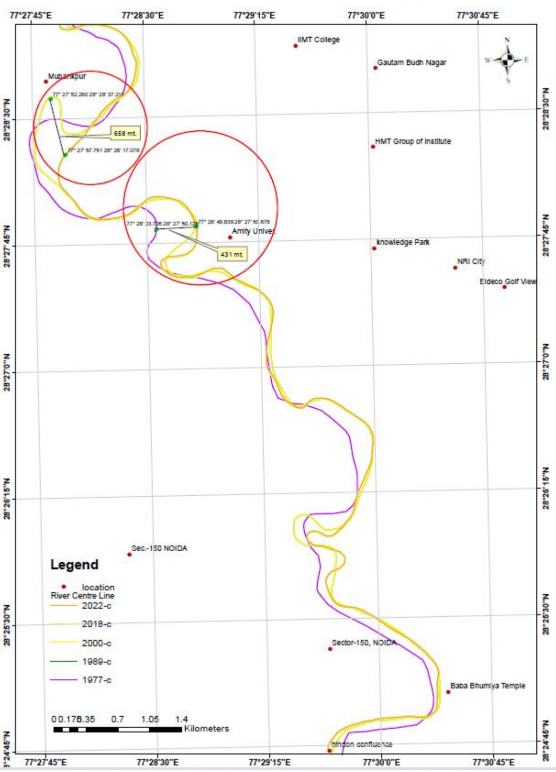


Fig. 2. Hindon river map showing river flow channel

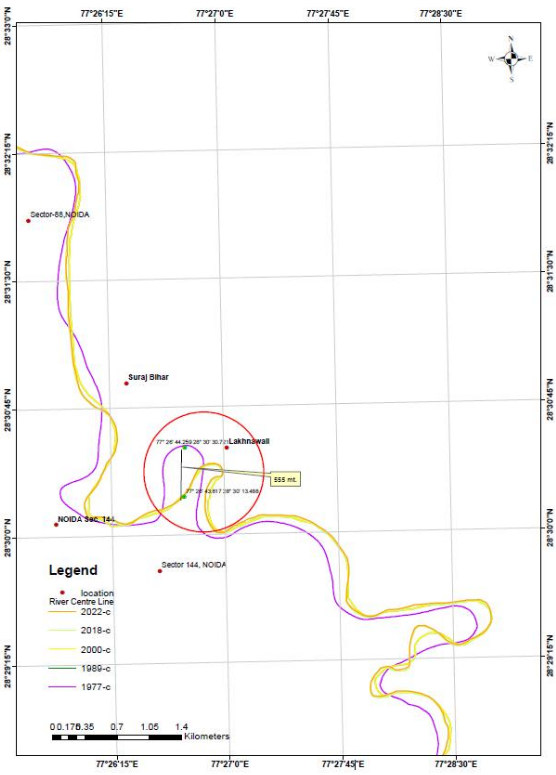
Migration of Hindon river

Alterations in river channel morphology, such as meandering patterns or channelization, can affect the groundwater regime. Changes in riverbed elevation and flow dynamics influence groundwater levels in adjacent areas. Natural changes in river channels, such as erosion, sedimentation, and meandering, can lead to the migration of a river over time. As the river migrates, it may interact with different geological formations, contributing to the recharge of groundwater aquifers. Altered river courses may influence the flow paths of groundwater. Groundwater that would have discharged into the river may now follow different routes, affecting discharge patterns. Permeable geological formations and well-connected aquifers enhance the exchange of water between rivers and groundwater. Human activities, such as channelization, dam construction, and urbanization, can significantly impact river migration. Altered river courses due to human interventions can affect both groundwater recharge and discharge.

Migration of Hindon River (Location Specific) Part-1



Migration of Hindon River (Location Specific) Part-2



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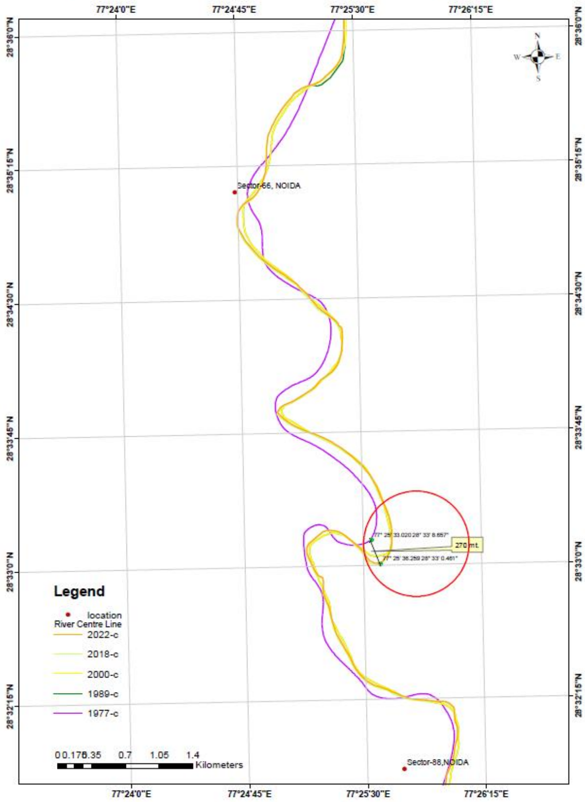
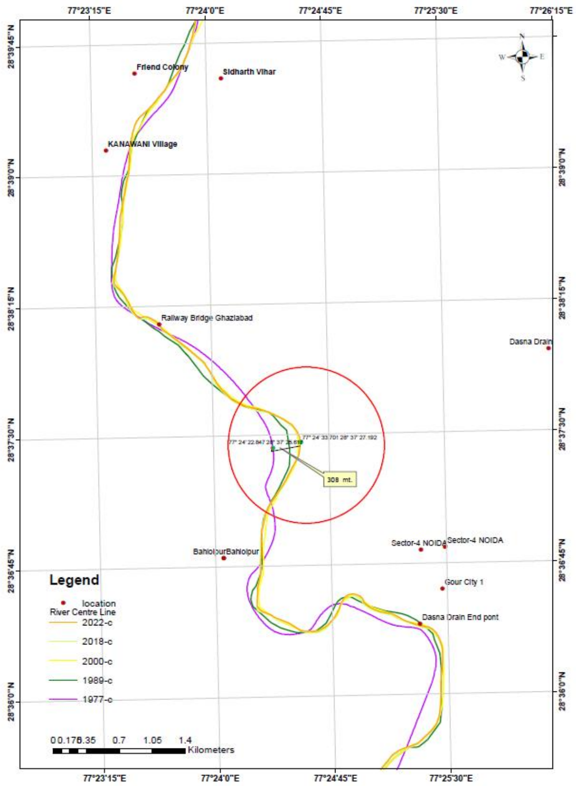
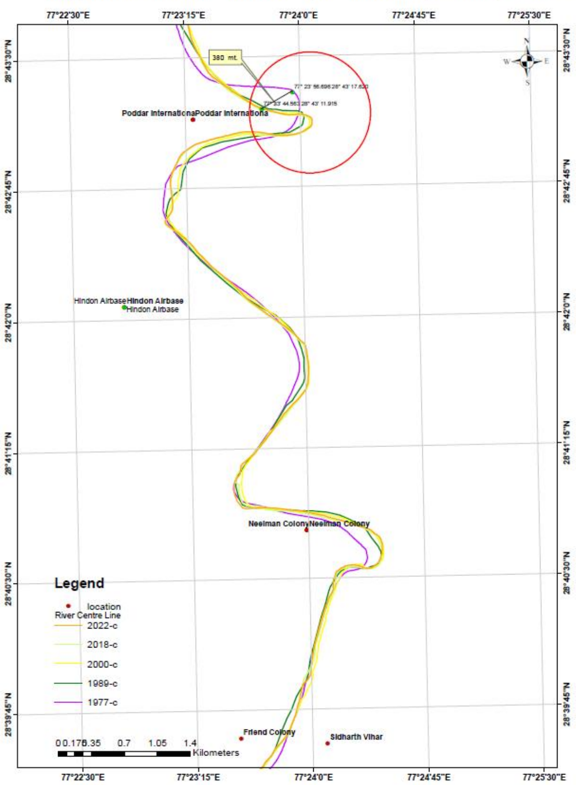


Migration of Hindon River (Location Specific) Part-4



Migration of Hindon River (Location Specific) Part-5



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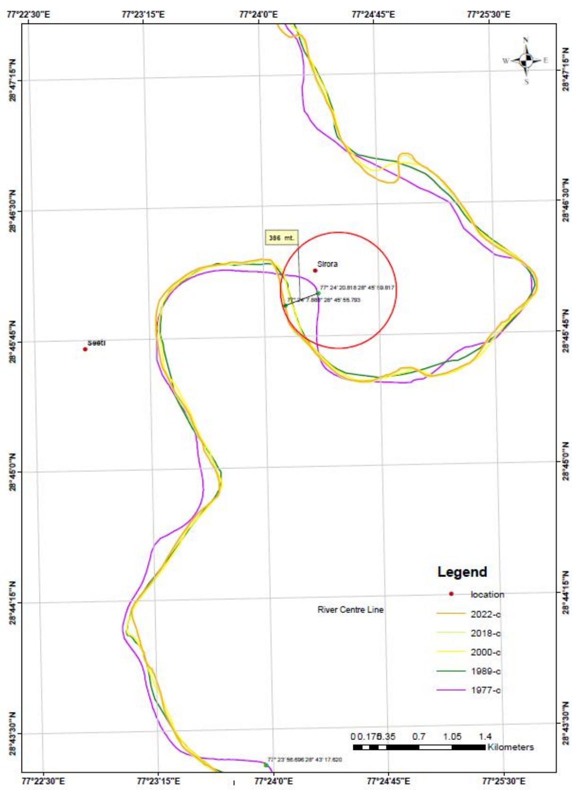

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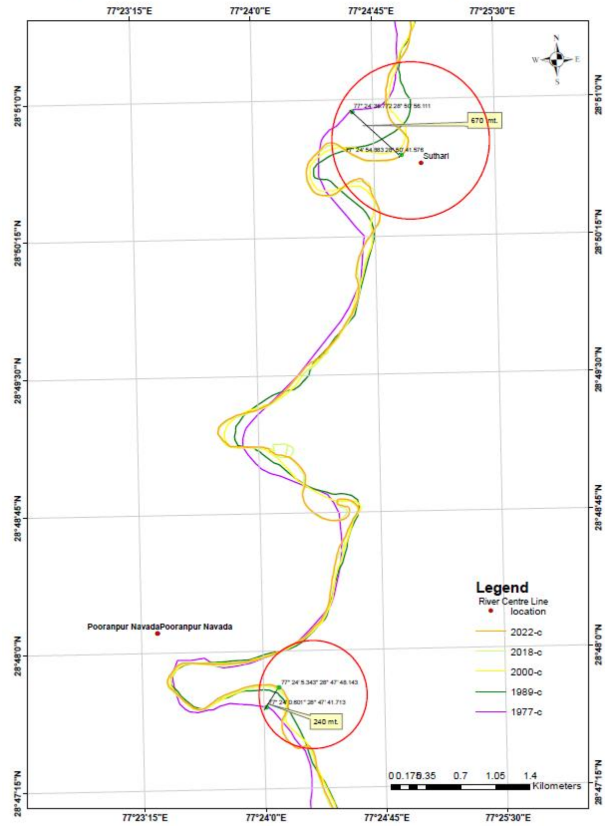

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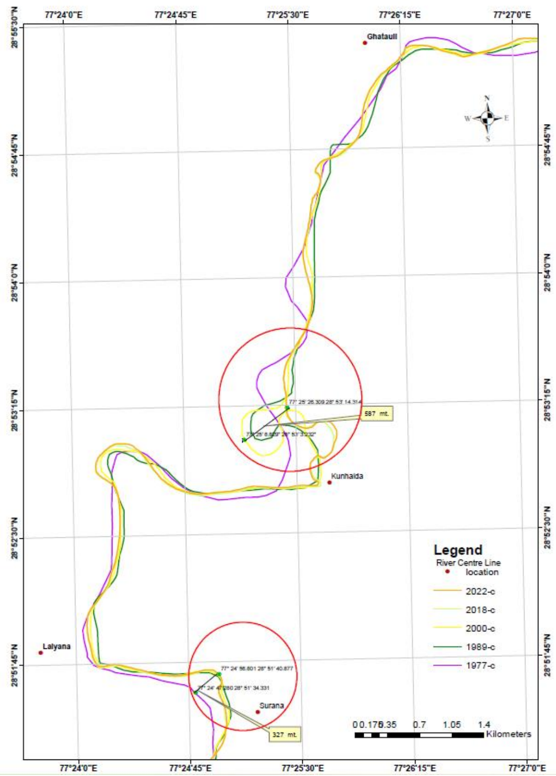

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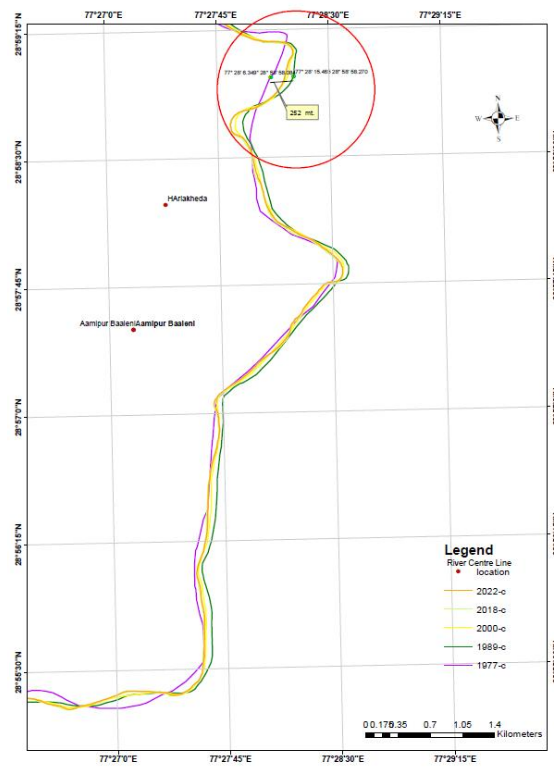

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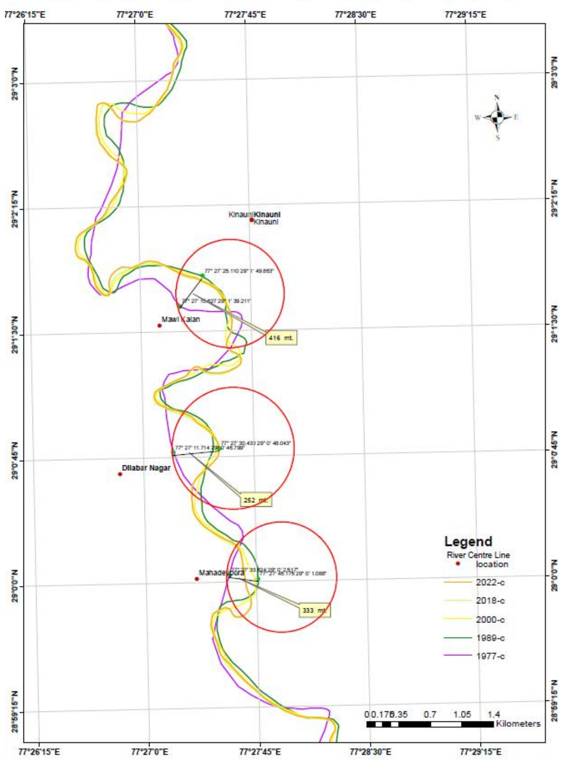
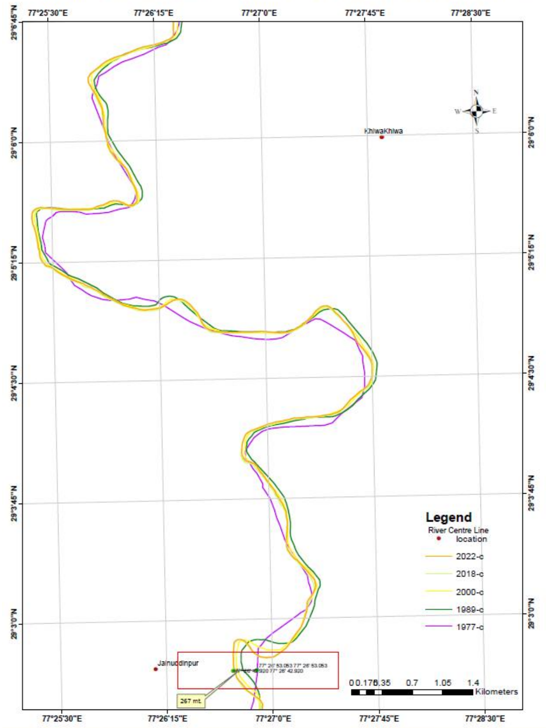
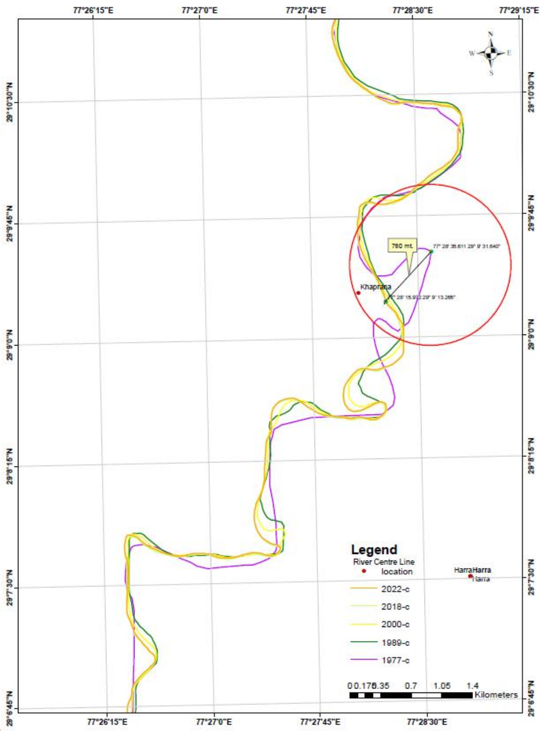


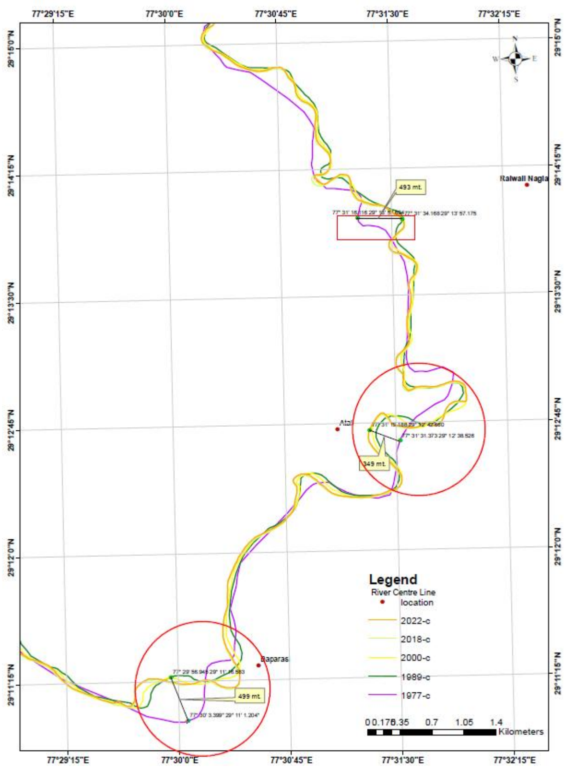
Migration of Hindon River (Location Specific) Part-11



Migration of Hindon River (Location Specific) Part-12



Migration of Hindon River (Location Specific) Part-13



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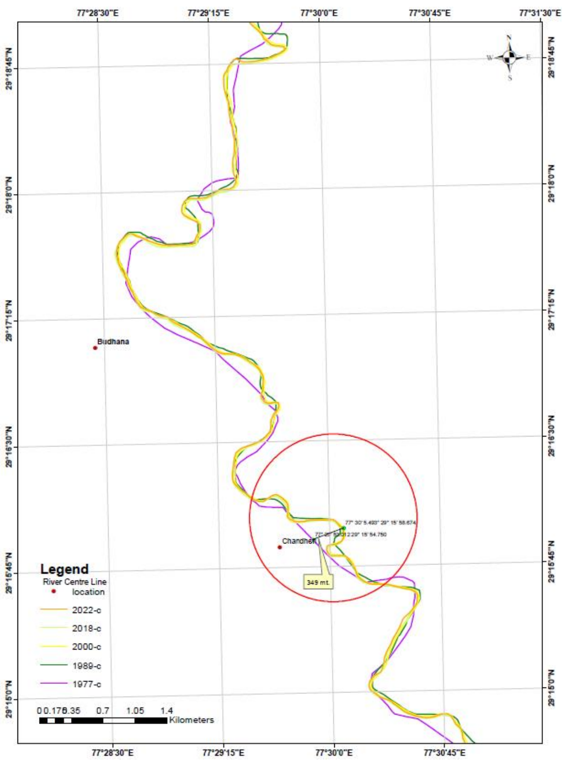


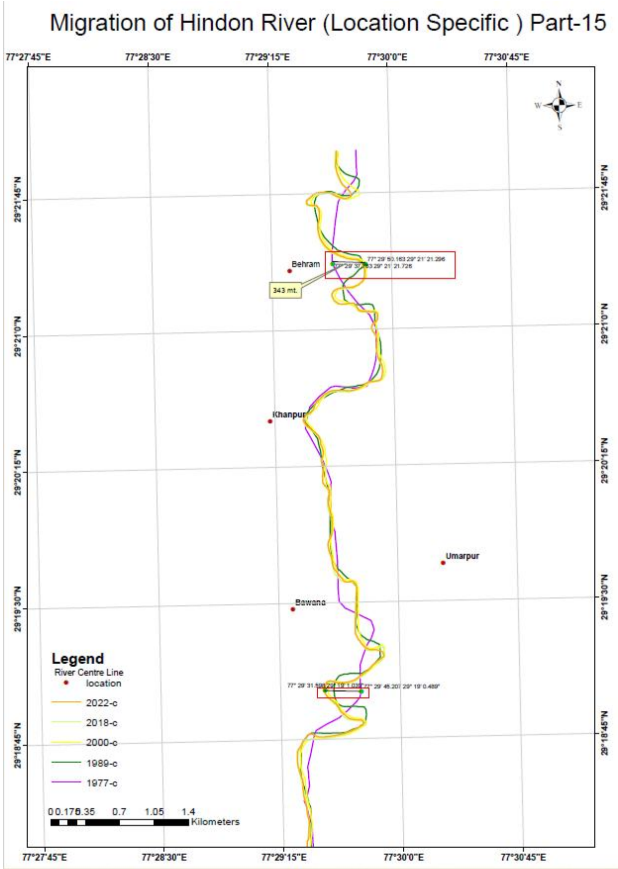


Fig. 3. Hindon river migration shown in part 1 to part 15

Hindon Migration region			
Sr No	Location	Lattitude	Longitude
1	Mubarakpur and Amity University	28°28'30"	77°27'52"
2	Laknawall	28°30'30"	77°26'44"
3	Sabbir Masjid	28°33'08"	77°25'33"
4	Behlolpur	28°37'25"	77°24'22"
5	Poddar international	28°43'11"	77°23'44"
6	Sirora	28°45'50"	77°24'20"
7	Suthari	28°50'56"	77°24'36"
8	Kunhalda	28°53'03"	77°25'08"
9	Harikhera	28°58'58"	77°26'05"
10	Mawl Kalan	29°01'30"	77°27'15"
11	Jauddinpur	28°53'06"	77°26'42"
12	Khaprana	29°09'31"	77°28'35"
13	Baparas	29°11'16"	77°29'56"
14	Chanderi	29°15'56"	77°30'05"
15	Bawana	29°19'01"	77°29'31"

Methodology

Various sets of remote sensing data are geometrically corrected with the help of survey of India topographical maps. All these images have been co-registered with each other. Base map is created with the help of topographic maps and PAN data. Infra-structure layer map is prepared first. LANDSAT data is classified into actual land categories. Through image processing algorithms, various thematic layers i.e., land use/ land cover, crop land, fallow land, wasteland, geology and geomorphology etc. are prepared. Vegetation anomaly studies are also done through LANDSAT data.

Ground water and soil samples obtained in the field are tested in the lab for DETAILED TEXTURE analysis and water quality parameters were also included in the study to understand the specific requirement of the land and soil ingredients respectively. The image data and tested field data along with the texture of soil analysis data were incorporated to infer suitability of the areas for rainwater harvesting.

Water and Soil sampling analysis

Water sample were collected started from its origin to end into Yamuna River. A total of 10 samples were collected and analyzed in laboratory using Titrimetric and UV-Vis spectrophotometer for anions and, Flame photometer and ICP-OES for major cations and heavy metals. Soil samples obtained from Hindon river were passed through sieve to get insight about grain size.

Satellite image preprocessing

Sentinel 2 data was atmospheric corrected using Flash tool of ENVI, and further converted into reflected band for calculating NDWI of the region.

Preliminary Results

Digital Elevation Model

10 m DEM was extracted using Sentinel 1 image and contour were form in the interval of 10m all over the region. DEM helps identify watershed boundaries by delineating the topographic divide, separating areas where water drains into different river systems. Understanding watershed boundaries is essential for estimating the extent of the area contributing to river water recharge. DEM assists in analyzing river channel morphology, identifying features such as meanders, pools, and riffles. These features influence the

interaction between river water and groundwater, impacting recharge dynamics. DEM provides elevation data, helping to estimate subsurface storage capacity. Low-lying areas, depressions, or areas with specific geological characteristics may serve as potential storage reservoirs for infiltrating water. DEM data is often used in hydrological models to simulate water movement through the landscape. These models incorporate elevation information to assess how water infiltrates, flows, and recharges groundwater within the watershed.

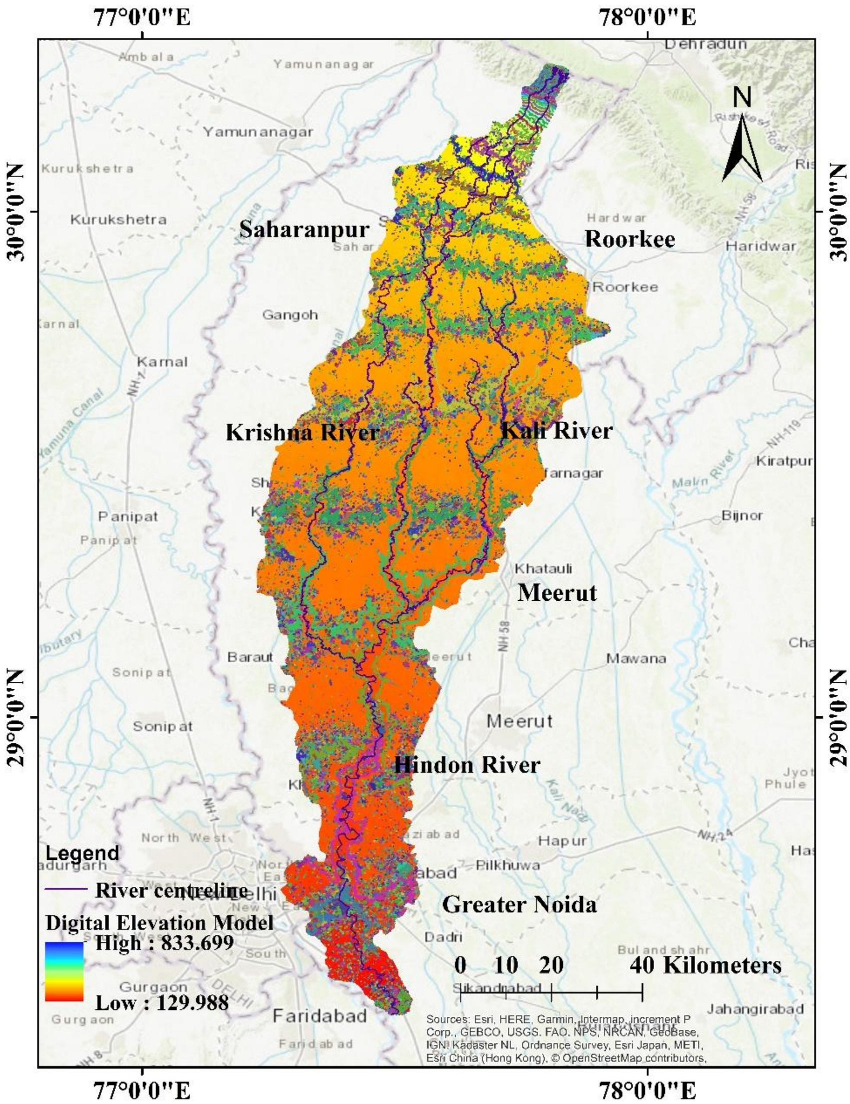


Fig. 4. Hindon river digital elevation model with contour of 10m

Lineaments

Lineaments, which are linear features on the Earth's surface, can play a significant role in influencing water recharging capacity in river beds. Areas along lineaments where fractures enhance storage capacity may experience more localized recharge, contributing to the sustainability of river flow during dry periods. Fractured zones within lineaments can provide preferential pathways for rainwater or surface water to infiltrate into the groundwater aquifers beneath river beds. Lineaments may influence the transport and deposition of sediments in river beds. The presence of fractures can affect sediment permeability, influencing how water interacts with the riverbed. Lineaments may include faults, fractures, and other structural features that can affect the movement and storage of water. Lineaments can act as pathways for the movement of water. In river beds, fractures may enhance the permeability of the subsurface, allowing water to infiltrate more effectively. When rivers intersect fault lines, these features can influence the movement of water both horizontally and vertically. Faults may connect different aquifers, allowing water from the river to recharge deeper groundwater reservoirs. This connectivity enhances the overall recharging capacity of the aquifer system. Incorporate lineament mapping into hydrogeological modelling to identify areas where fractures and faults intersect with river beds. This mapping can help assess potential pathways for water movement and recharging. Utilize groundwater modeling techniques to simulate the interaction between lineaments and river beds. This can provide insights into the spatial distribution of recharging capacity and the dynamics of groundwater flow.

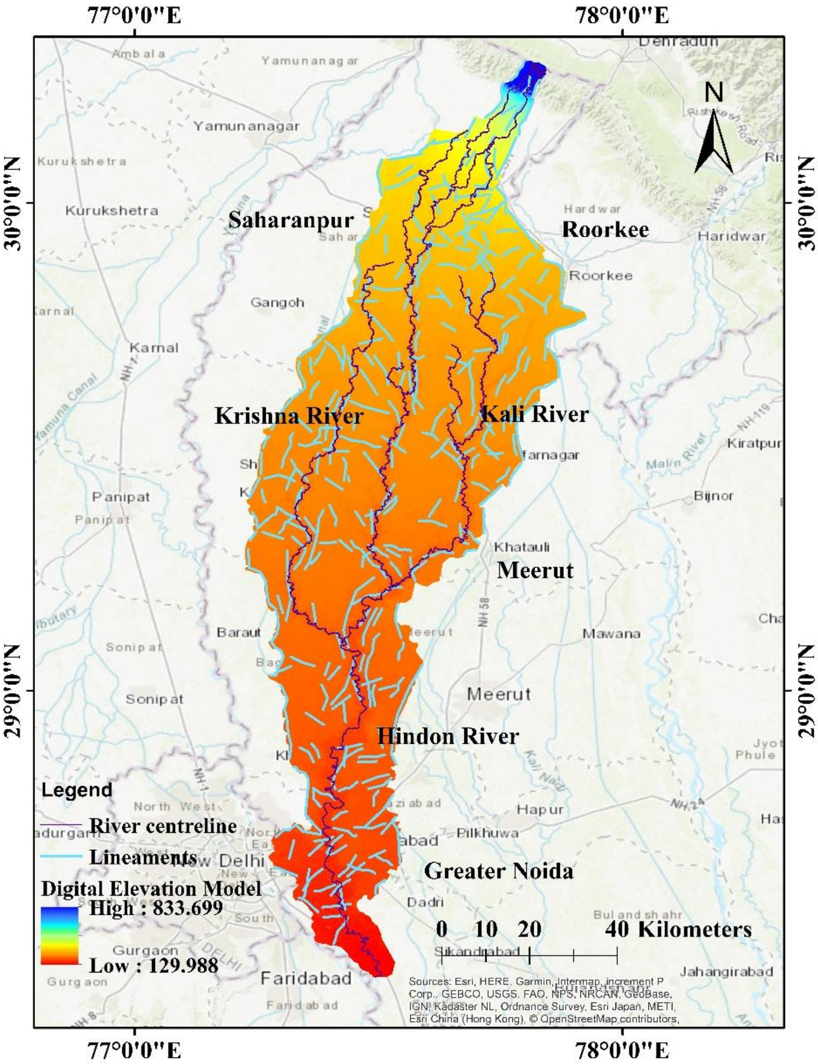


Fig. 5. Hindon river lineament with digital elevation model

Thermal data analysis

LST derived from Landsat 9 data for the river basin or watershed of interest be used for water quality estimation. It requires collection of water quality data from field measurements or monitoring stations along the river and parameters of interest may include temperature, dissolved oxygen, turbidity, nutrient levels, and pollutants. To find the correlation certain statistical methods such as regression be used to analyze the correlation between LST and various water quality parameters. Similarly, temporal trends in water quality parameters at seasonal variations and specific events (e.g., heavy rainfall, drought) using LST.

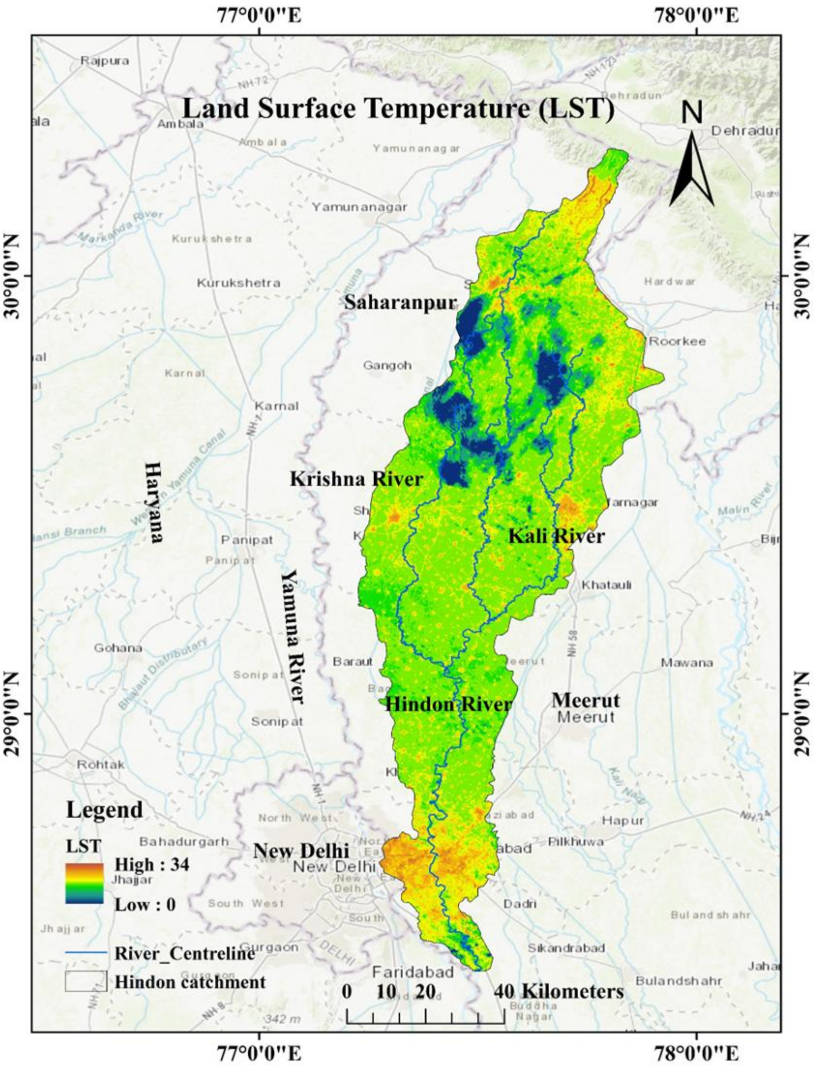


Fig. 6. Hindon river map with Land surface temperature

Water quality

The pH values range from 3.9 to 8, indicating a slightly acidic to alkaline nature of the water samples. Sample 4 has a notably lower pH (3.9), suggesting acidic conditions. Sample 7 has the highest EC and TDS values, indicating higher salinity and dissolved solids. The high EC and TDS in Sample 7 suggest potential salinity issues. Samples 4 and 10 exhibit higher concentrations of various constituents, indicating potential pollution or natural geochemical variations. Sample 10 has a significantly high phosphate concentration. Sample 4 has notable concentrations of sulphate, nitrate, and chloride. Fluoride concentrations are relatively consistent, with the highest in Sample 2. Bicarbonate concentrations vary, with Sample 6 having the highest value. Sample 7 shows elevated concentrations of several trace elements, including Fe, Mn, Ni, and Pb.

Sample no	pH	EC (µS/cm)	TDS (ppm)	Phosphate(mg/l)	Sulphate (mg/l)	Nitrate (mg/l)	Fluoride (mg/l)	Bicarbonate (mg/l)	Chloride (mg/l)	Cd (ppm)	Co (ppm)	Cr (ppm)	Fe (ppm)	Mn (ppm)	Ni (ppm)	Pb (ppm)	Mg (ppm)	Ca (ppm)	Na (ppm)	K (ppm)
1	6.99	784	572	3.329	0.344	0.844	1.460	195.200	56.720	BDL	BDL	BDL	0.06	0.01	0.02	BDL	9.23	4.1	47.4	10.1
2	6.54	1397	1030	BDL	0.638	0.931	1.679	341.600	85.080	BDL	BDL	BDL	0.04	BDL	BDL	BDL	24.46	32.7	62.5	33.5
4	3.9	2950	2150	BDL	0.405	0.451	1.493	48.800	411.220	0.01	0.01	0.09	56.94	0.76	0.05	0.04	23.12	32.2	115.6	19.2
5	6.83	460	336	BDL	0.138	0.116	1.548	219.600	28.360	BDL	BDL	BDL	0.27	0	BDL	BDL	6.49	25.1	13.5	8.8
6	6.62	2270	1650	3.022	0.460	0.240	1.113	878.400	113.440	BDL	BDL	BDL	0.22	0.15	0.01	0.01	20.69	33.7	141.7	23.2
7	6.59	3980	2880	BDL	0.890	0.239	1.304	610.000	411.220	BDL	BDL	BDL	0.19	0.12	0.01	0.01	20.24	114.6	191.9	20.4
8	8	184	135	BDL	0.071	0.141	1.298	122.000	28.360	BDL	BDL	BDL	0.15	0.18	0.01	0.01	17.18	8.8	2.1	3.2
9	7.5	567	415	BDL	0.028	0.164	1.685	292.800	28.360	BDL	BDL	BDL	0.07	0.27	0.01	BDL	7.51	18.4	4.7	2.1
10	7.34	220	163	8.714	0.081	0.226	1.573	292.800	42.540	BDL	BDL	BDL	0.02	0.13	BDL	BDL	6.01	76.2	33.4	30.1
11	7.4	246	180	BDL	0.137	0.169	1.567	122.000	28.360	BDL	BDL	BDL	BDL	0.01	BDL	BDL	3.18	9.5	5.4	14.6

Table 3. Physiochemical parameters of Hindon river water

Soil texture analysis

Soil obtained near to Hindon river were found Gravelly sand, slightly gravelly sand and slightly gravelly muddy sand.

Gravelly sand typically has high permeability and infiltration capacity due to the presence of coarse particles. This allows water to move through the sediment more easily, facilitating groundwater recharge. While gravelly sand promotes rapid infiltration, it may have a lower storage capacity compared to finer sediments.

Slightly Gravelly Sand:

The permeability of slightly gravelly sand is influenced by the proportion of gravel and sand. Higher gravel content generally leads to increased permeability, supporting efficient groundwater recharge. The presence of fine particles can influence water retention to some extent. Slightly gravelly sand with good connectivity can enhance groundwater recharge.

Slightly Gravelly Muddy Sand:

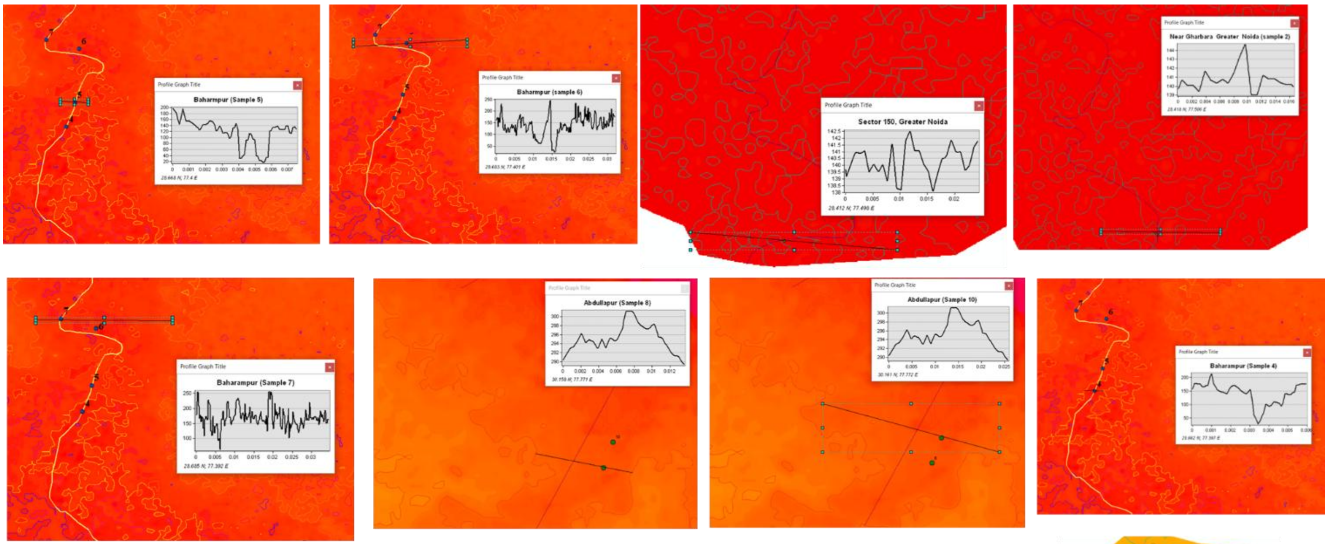
The presence of mud or silt in slightly gravelly muddy sand can reduce overall permeability compared to cleaner sands. Infiltration in slightly gravelly muddy sand may be slower compared to coarser sediments, but the mud content can contribute to prolonged recharge by retaining water. However, the mud content may enhance water retention. Contaminants may be filtered or attenuated as water moves through the sediment.

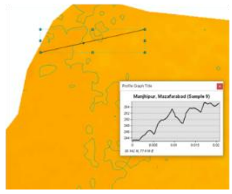
Location name	Lattitude	Longitude	Elevation (m)	>=2.36mm	>=1.18mm	>=600 μm	300 μm	150 μm	63 μm	45 μm	<45 μm	Total weight (From 100g	Texture data
Jhatta	28.4697667	77.4435667	193	9.94	18.53	7.39	15.29	21.47	23.68	2.29	0.84	99.43	Gravelly Sand
Deri Kambakshpur	28.4512	77.46225	197	4.98	17.98	9.36	20.75	20.37	22.34	2.41	1.28	99.47	Gravelly Sand
Sec-150	28.4310833	77.4802167	180	0.09	3.69	8.25	30.03	26.32	28.66	1.95	0.42	99.41	Slightly Gravelly Sand
Suthiyana	28.5259833	77.4609333	198	2.56	14.32	8.65	20.09	10.58	35.68	5.85	1.55	99.28	Slightly Gravelly Sand
Brick Kiln	28.5739667	77.4534833	202	3.12	17.78	9.8	20.25	11.95	32.24	3.66	0.67	99.47	Slightly Gravelly Sand
Bisrakh	28.57475	77.4308333	209	1.66	8.71	5.04	10.92	7.22	56.79	6.03	3.18	99.55	Slightly Gravelly Sand
Patwari	28.5836333	77.4406167	195	0.43	8.72	9.66	34.77	33.55	12.01	0.32	0.14	99.6	Slightly Gravelly Sand
Brick Kiln (Roza Yakub	28.6130833	77.4695667	198	3.93	7.68	5.59	15.03	22.73	39.96	3.45	1.09	99.46	Slightly Gravelly Sand
Brick Kiln (Roza Yakub	28.6133333	77.4694167	199	1.27	11.09	7.92	14.79	14.16	43.49	5.05	1.54	99.31	Slightly Gravelly Sand
Milk Lachi	28.5926667	77.4642833	202	1.85	2.81	3.68	9.18	8.77	67.68	3.96	1.11	99.04	Slightly Gravelly Sand
Mamura	28.5902333	77.37635	198	1.45	6.97	5.39	13.07	8.82	51.32	10.2	2.15	99.36	Slightly Gravelly Sand
Basi	28.5936	77.38685	203	0.35	0.94	1.91	8.01	22.14	57.97	6.16	1.82	99.3	Slightly Gravelly Sand
Sarfabad	28.5916833	77.3844333	195	17.74	16.01	7.28	18.39	9.85	24.73	4.13	1.39	99.52	Gravelly Sand
Garhi Chaukhandi	28.5966	77.3951	196	1.83	15.02	10.39	19.18	20.62	28.87	2.75	0.61	99.27	Slightly Gravelly Sand
Hindon floodplain	28.6011333	77.4106833	190	0.2	2.3	3.96	11.5	9.86	60.78	8.09	2.26	98.95	Slightly Gravelly Muddy Sand
Partala	28.6027667	77.4111167	201	6.07	10.5	4.63	9.15	33.32	30.73	3.63	1.27	99.3	Gravelly Sand
Aminabad	28.5586	77.4583333	204	1.82	6.03	3.43	6.93	2.75	62.52	13.4	2.24	99.14	Slightly Gravelly Muddy Sand
Kheda Chauganpur	28.5573167	77.4637	198	1.43	15.84	12.71	23.37	10.65	28.98	4.91	1.49	99.38	Slightly Gravelly Sand
Surajpur	28.5507667	77.4979833	190	1.9	7.48	7.45	18.06	20.91	37.91	4.73	1.1	99.54	Slightly Gravelly Sand
Panchvihar	28.5174333	77.4939833	189	0.36	1.65	1.74	5.77	33.04	47.86	6.95	2.24	99.61	Gravelly Sand
Jalpura	28.55235	77.4342167	196	7.25	18.24	7.2	13.27	8.45	41.29	3.41	0.38	99.49	Gravelly Sand

Table 4. Grain size analysis of Hindon river floodplain

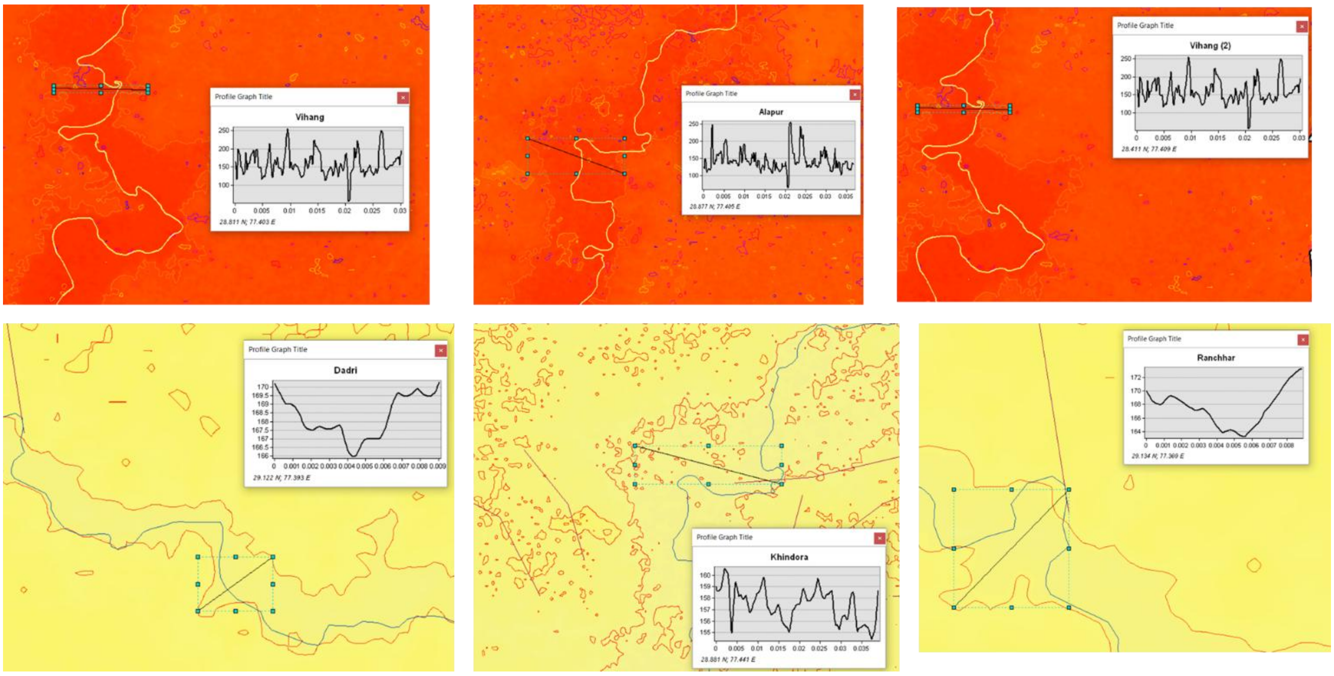
Cross section profile analysis

Understanding the dynamic relationship between the cross-sectional profile of a river and groundwater is crucial for effective water resources management and sustainable development. Hydrogeological investigations, river morphological studies, and continuous monitoring of groundwater levels contribute to a comprehensive understanding of these interactions. The river and the aquifer are physically connected, allowing for the exchange of water between the two systems. Rivers can serve as a source of recharge for groundwater. When a river flows over permeable materials, water from the river can infiltrate into the subsurface, contributing to groundwater recharge. During high flow periods, river water may enter the riverbanks and contribute to bank storage, influencing groundwater levels in the adjacent aquifer. River incision and the formation of terraces can create interactions between the river and underlying aquifers. The presence of terrace deposits may influence groundwater movement and storage. Groundwater discharges into rivers, contributing to baseflow. This is particularly significant during dry periods when river flow is sustained by groundwater discharge. This natural filtration process effect water quality and can be an pollutant in groundwater source of drinking water. Excessive groundwater pumping near a river may lead to the depletion of river water, impacting both surface water and groundwater availability.





Cross-Sectional profile of river near water sample collection



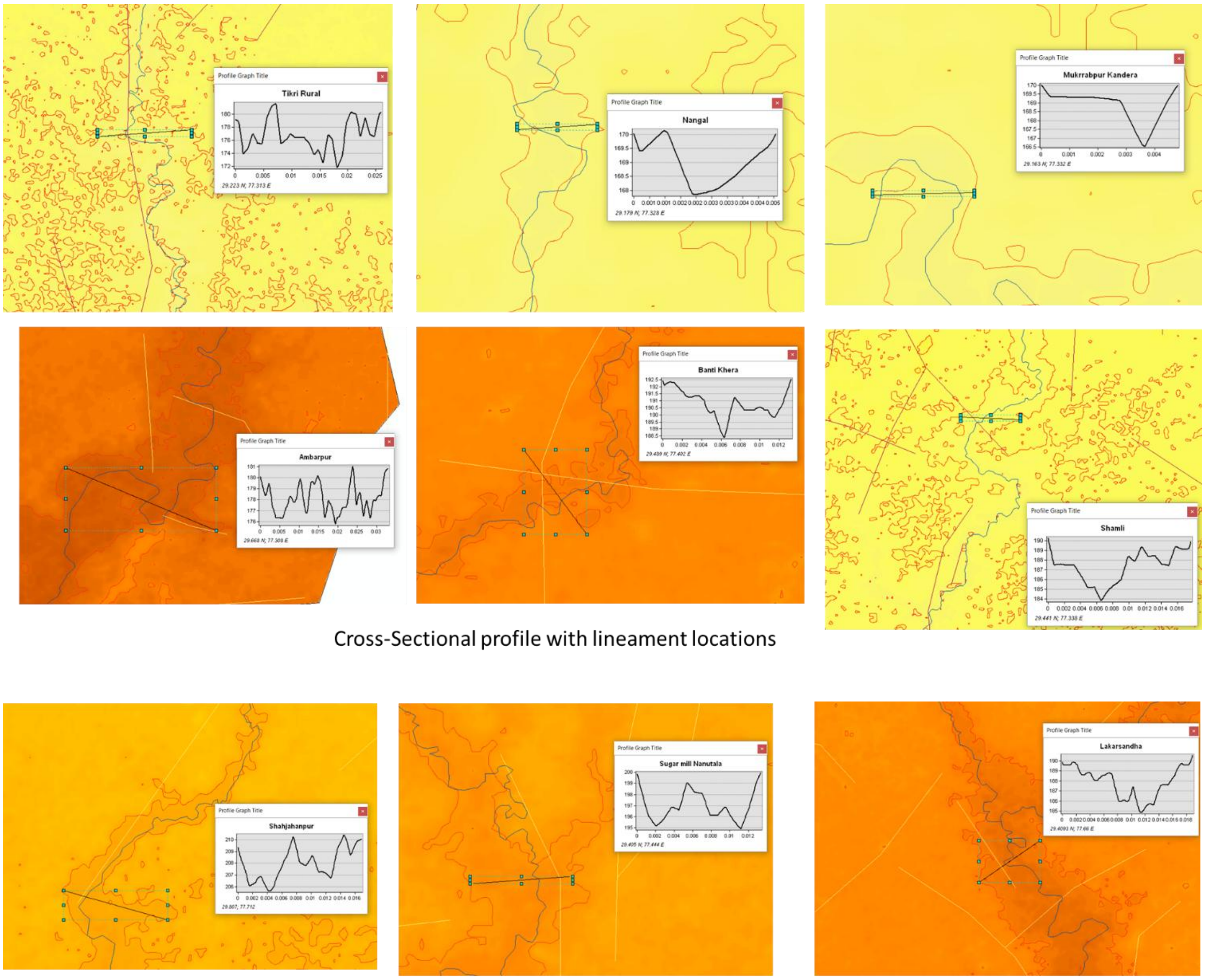


Fig. 7. Cross-section profile of Hindon river channel using contour at 10m intervals

Groundwater Recharge zones

Meander Patterns Analysis: Satellite imagery, GIS data, and topographic maps were utilized to analyze the meander patterns of the Hindon River. Meanders represent dynamic zones where the river interacts significantly with its surroundings, influencing the potential for groundwater recharge. Points with pronounced meanders were prioritized for further assessment.

Soil Texture Classification: To assess the hydrogeological suitability for recharge, detailed soil texture analysis was conducted. Data from soil surveys, remote sensing, and ground sampling were integrated to classify the soil into categories such as gravelly sand, slightly gravelly muddy sand, and slightly gravelly sand. These soil types are known for their high infiltration capacities, essential for effective groundwater recharge.

Integration of Meander Patterns and Soil Texture: The overlay of meander patterns and identified soil textures revealed specific zones along the riverbanks with high potential for groundwater recharge. Areas exhibiting gravelly sand, slightly gravelly muddy sand, and slightly gravelly sand within the meander belts were earmarked as priority recharge points.

Vegetation and Land Use Considerations: In addition to meander patterns and soil texture, the study considered the existing vegetation cover and land use in the identified zones. Natural vegetation can enhance recharge processes by reducing surface runoff and promoting infiltration. Areas with minimal urbanization and impermeable surfaces were prioritized to maximize recharge potential.

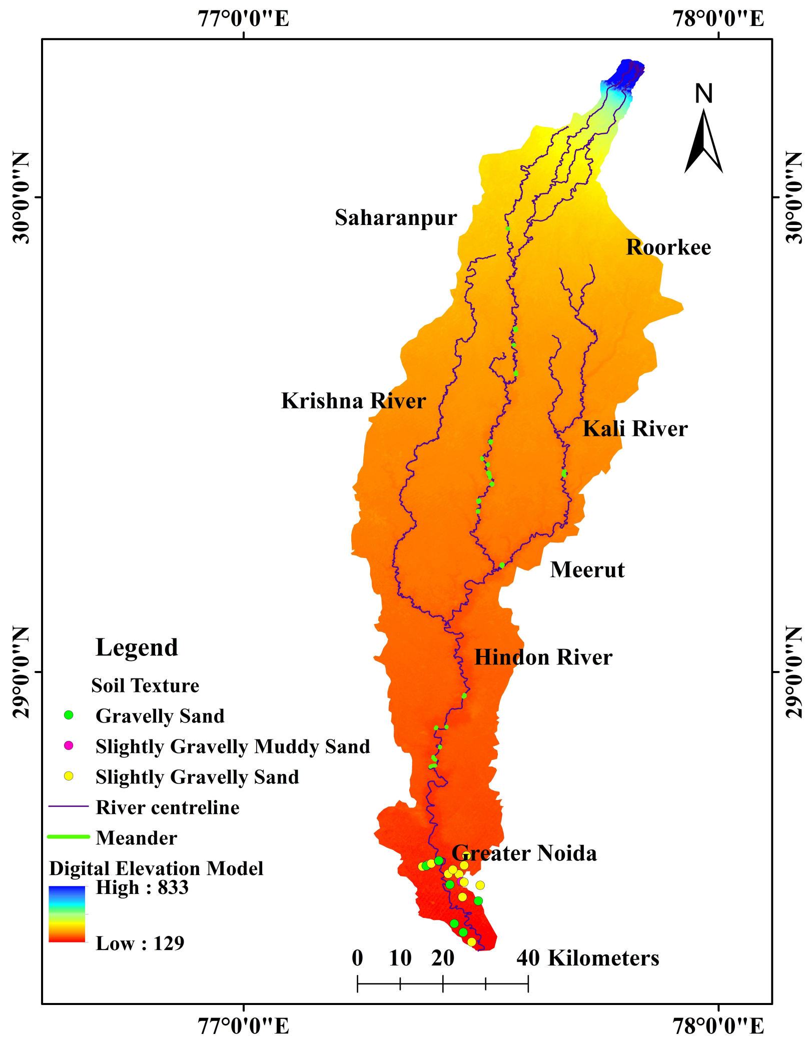


Fig.8. Hindon river map with meandering and soil texture

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TE-27/3/2021-GIS NMCG

ANNEXURE-I

HINDON RIVER REJUVENATION FOR SUSTAINABLE WATER MANAGEMENT

Submitted by

NEW ENVIRONMENT AND ENERGY RESEARCH

(NEER)

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Detailed Project Report (DPR) for River Rejuvenation: Hindon River, Uttar Pradesh, India

1. Executive Summary

Project Title: Hindon River Rejuvenation for Sustainable Water Management

2. Introduction

The Hindon River, a vital water source for Uttar Pradesh, faces challenges such as pollution, sedimentation, and bank erosion. This project aims to implement river rejuvenation approaches to enhance water quality, mitigate erosion, and promote sustainable management.

Mitigating natural river incision and maintaining a predetermined path for a river involves a combination of engineering, ecological, and sustainable management approaches. It's important to note that while human interventions can influence rivers, there are environmental and regulatory considerations that must be taken into account.

Meander Patterns Analysis: Satellite imagery, GIS data, and topographic maps were utilized to analyze the meander patterns of the Hindon River. Meanders represent dynamic zones where the river interacts significantly with its surroundings, influencing the potential for groundwater recharge. Points with pronounced meanders were prioritized for further assessment.

Soil Texture Classification: To assess the hydrogeological suitability for recharge, detailed soil texture analysis was conducted. Data from soil surveys, remote sensing, and ground sampling were integrated to classify the soil into categories such as gravelly sand, slightly gravelly muddy sand, and slightly gravelly sand. These soil types are known for their high infiltration capacities, essential for effective groundwater recharge.

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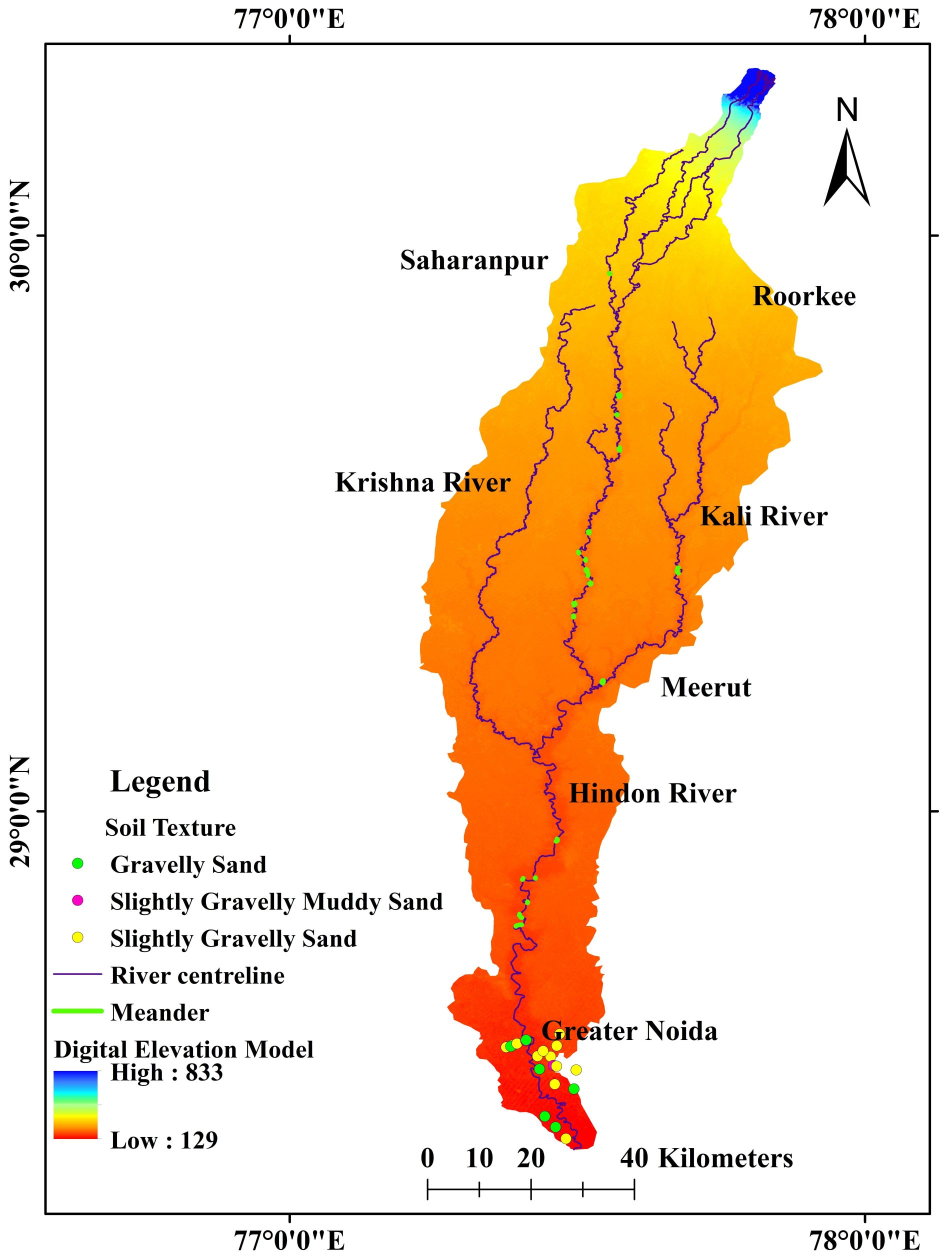

Fig1. Hindon river map with meandering and soil texture

3.Soil texture analysis

Soil obtained near to Hindon river were found Gravelly sand, slightly gravelly sand and slightly gravelly muddy sand.

Gravelly sand typically has high permeability and infiltration capacity due to the presence of coarse particles. This allows water to move through the sediment more easily, facilitating groundwater recharge. While gravelly sand promotes rapid infiltration, it may have a lower storage capacity compared to finer sediments.

Slightly Gravelly Sand:

The permeability of slightly gravelly sand is influenced by the proportion of gravel and sand. Higher gravel content generally leads to increased permeability, supporting efficient groundwater recharge. The presence of fine particles can influence water retention to some extent. Slightly gravelly sand with good connectivity can enhance groundwater recharge.

Slightly Gravelly Muddy Sand:

The presence of mud or silt in slightly gravelly muddy sand can reduce overall permeability compared to cleaner sands. Infiltration in slightly gravelly muddy sand may be slower compared to coarser sediments, but the mud content can contribute to prolonged recharge by retaining water. However, the mud content may enhance water retention. Contaminants may be filtered or attenuated as water moves through the sediment.

Location name	Lattitude	Longitude	Elevation (m)	>=2.36mm	>=1.18mm	>=600 µm	300 µm	150 µm	63 µm	45 µm	<45 µm	Total weight (From 100g	Texture data
Jhatta	28.4697667	77.4435667	193	9.94	18.53	7.39	15.29	21.47	23.68	2.29	0.84	99.43	Gravelly Sand
Deri Kambakshpur	28.4512	77.46225	197	4.98	17.98	9.36	20.75	20.37	22.34	2.41	1.28	99.47	Gravelly Sand
Sec-150	28.4310833	77.4802167	180	0.09	3.69	8.25	30.03	26.32	28.66	1.95	0.42	99.41	Slightly Gravelly Sand
Suthiyana	28.5259833	77.4609333	198	2.56	14.32	8.65	20.09	10.58	35.68	5.85	1.55	99.28	Slightly Gravelly Sand
Brick Kiln	28.5739667	77.4534833	202	3.12	17.78	9.8	20.25	11.95	32.24	3.66	0.67	99.47	Slightly Gravelly Sand
Bisrakh	28.57475	77.4308333	209	1.66	8.71	5.04	10.92	7.22	56.79	6.03	3.18	99.55	Slightly Gravelly Sand
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Brick Kiln (Roza Yakub	28.6130833	77.4695667	198	3.93	7.68	5.59	15.03	22.73	39.96	3.45	1.09	99.46	Slightly Gravelly Sand
Brick Kiln (Roza Yakub	28.6133333	77.4694167	199	1.27	11.09	7.92	14.79	14.16	43.49	5.05	1.54	99.31	Slightly Gravelly Sand
Milk Lachi	28.5926667	77.4642833	202	1.85	2.81	3.68	9.18	8.77	67.68	3.96	1.11	99.04	Slightly Gravelly Sand
Mamura	28.5902333	77.37635	198	1.45	6.97	5.39	13.07	8.82	51.32	10.2	2.15	99.36	Slightly Gravelly Sand
Basi	28.5936	77.38685	203	0.35	0.94	1.91	8.01	22.14	57.97	6.16	1.82	99.3	Slightly Gravelly Sand
Sarfabad	28.5916833	77.3844333	195	17.74	16.01	7.28	18.39	9.85	24.73	4.13	1.39	99.52	Gravelly Sand
Garhi Chaukhandi	28.5966	77.3951	196	1.83	15.02	10.39	19.18	20.62	28.87	2.75	0.61	99.27	Slightly Gravelly Sand
Hindon floodplain	28.6011333	77.4106833	190	0.2	2.3	3.96	11.5	9.86	60.78	8.09	2.26	98.95	Slightly Gravelly Muddy Sand
Partala	28.6027667	77.4111167	201	6.07	10.5	4.63	9.15	33.32	30.73	3.63	1.27	99.3	Gravelly Sand
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Kheda Chauganpur	28.5573167	77.4637	198	1.43	15.84	12.71	23.37	10.65	28.98	4.91	1.49	99.38	Slightly Gravelly Sand
Surajpur	28.5507667	77.4979833	190	1.9	7.48	7.45	18.06	20.91	37.91	4.73	1.1	99.54	Slightly Gravelly Sand
Panchvihar	28.5174333	77.4939833	189	0.36	1.65	1.74	5.77	33.04	47.86	6.95	2.24	99.61	Gravelly Sand
Jalpura	28.55235	77.4342167	196	7.25	18.24	7.2	13.27	8.45	41.29	3.41	0.38	99.49	Gravelly Sand

Table1. Grain size analysis of Hindon river floodplain

4.Strategies:

Bank Stabilization

Use erosion control measures such as riprap, gabions, and revetments along the riverbanks to stabilize them and reduce the likelihood of erosion.

Vegetative Cover

Promote the growth of native vegetation along the riverbanks. The roots of plants help bind the soil, reducing erosion and providing natural stabilization.

Terracing

Construct terraces or step-like structures along the riverbanks to slow down water flow, reducing erosive force and promoting sediment deposition.

Check Dams

Install check dams or weirs strategically to control the flow of water and reduce its erosive power. These structures can also help trap sediment.

River Channelization

Design and implement controlled channelization to guide the river along a predetermined path. This involves modifying the course of the river to reduce erosion and stabilize the banks.

Erosion-Resistant Materials

Use erosion-resistant materials for construction in and around the river, such as concrete or reinforced structures, to minimize the impact of erosive forces.

Sediment Management

Implement sediment management practices to control the transport of sediments. This can involve dredging or sediment retention structures to maintain a stable riverbed.

Hydrological Management

Implement water flow management strategies to control the discharge and flow patterns of the river. This may involve regulating dam releases or controlling upstream development to minimize erosion.

Community Engagement

Involve local communities in the decision-making process to ensure that interventions align with their needs and the sustainable use of natural resources.

Adaptive Management

Implement adaptive management practices that allow for adjustments based on monitoring and assessment of the river's behavior and the effectiveness of interventions.

5. Objectives

- Mitigate river incision and stabilize riverbanks.
- Improve water quality and reduce pollution.
- Implement sustainable practices for long-term river health.
- Enhance ecosystem resilience and biodiversity.

6. Proposed Project Components

6.1 Bank Stabilization:

Location: Along the stretch at 15 points (refer to Table1 Hindon Migration Region)

Approach: Use riprap, gabions, and revetments to stabilize riverbanks and prevent erosion.

Image 1 Riprap

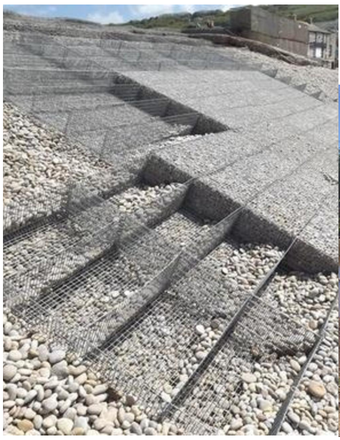


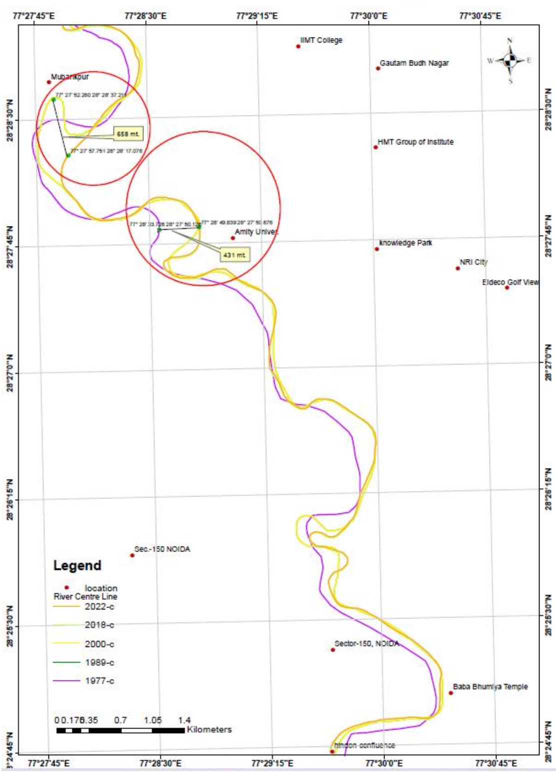
Image 2 Gabions

Image 3 Revetments

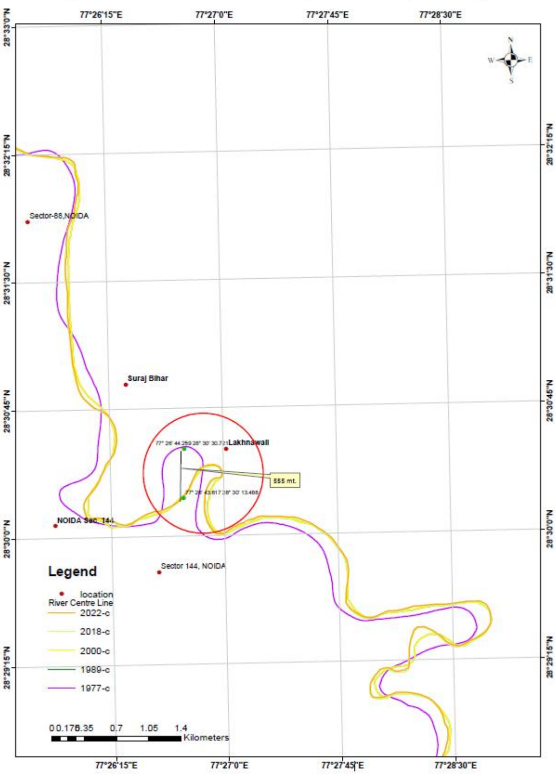
Hindon Migration region			
Sr No	Location	Lattitude	Longitude
1	Mubarakpur and Amity University	28°28'30"	77°27'52"
2	Laknawall	28°30'30"	77°26'44"
3	Sabbir Masjid	28°33'08"	77°25'33"
4	Behlolpur	28°37'25"	77°24'22"
5	Poddar international	28°43'11"	77°23'44"
6	Sirora	28°45'50"	77°24'20"
7	Suthari	28°50'56"	77°24'36"
8	Kunhalda	28°53'03"	77°25'08"
9	Harikhera	28°58'58"	77°26'05"
10	Mawl Kalan	29°01'30"	77°27'15"
11	Jauddinpur	28°53'06"	77°26'42"
12	Khaprana	29°09'31"	77°28'35"
13	Baparas	29°11'16"	77°29'56"
14	Chanderi	29°15'56"	77°30'05"
15	Bawana	29°19'01"	77°29'31"

Table2. Hindon river migration Region

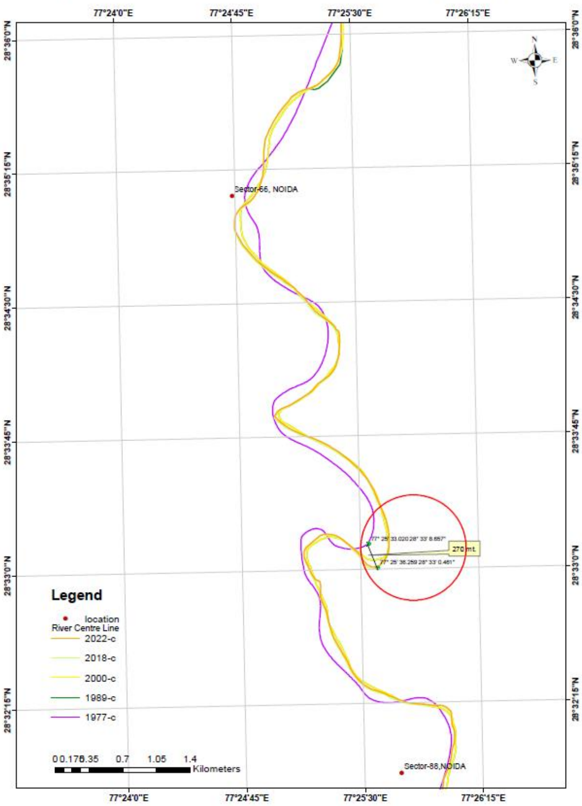
Migration of Hindon River (Location Specific) Part-1



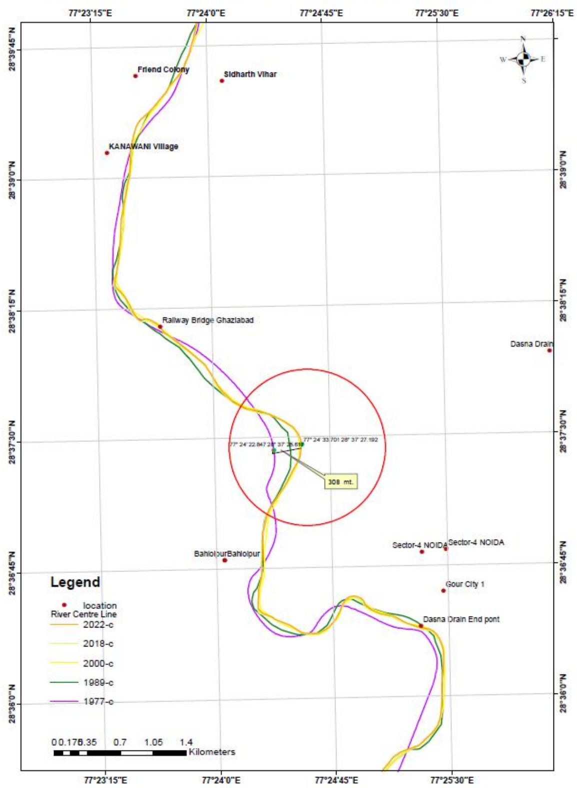
Migration of Hindon River (Location Specific) Part-2



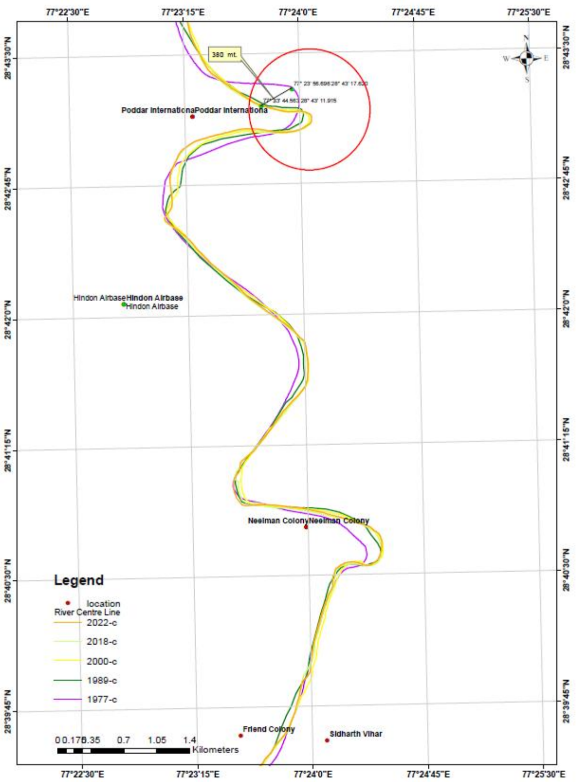
Migration of Hindon River (Location Specific) Part-3



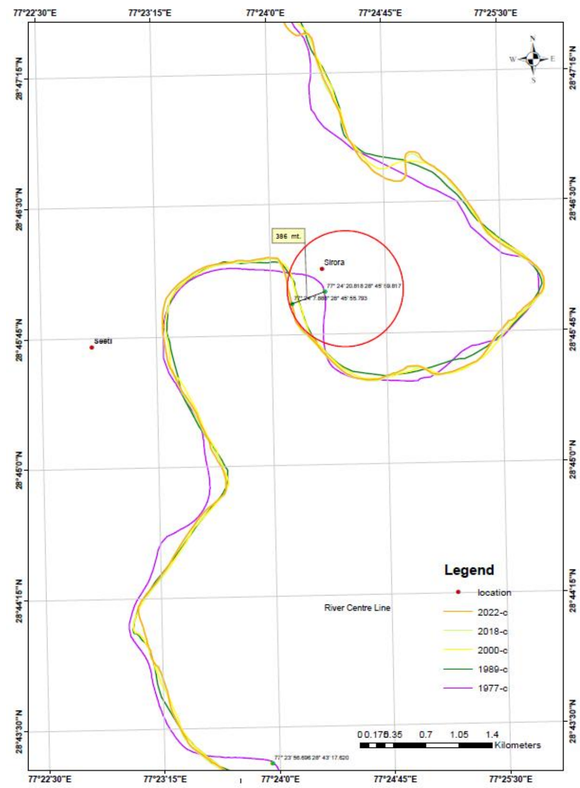
Migration of Hindon River (Location Specific) Part-4



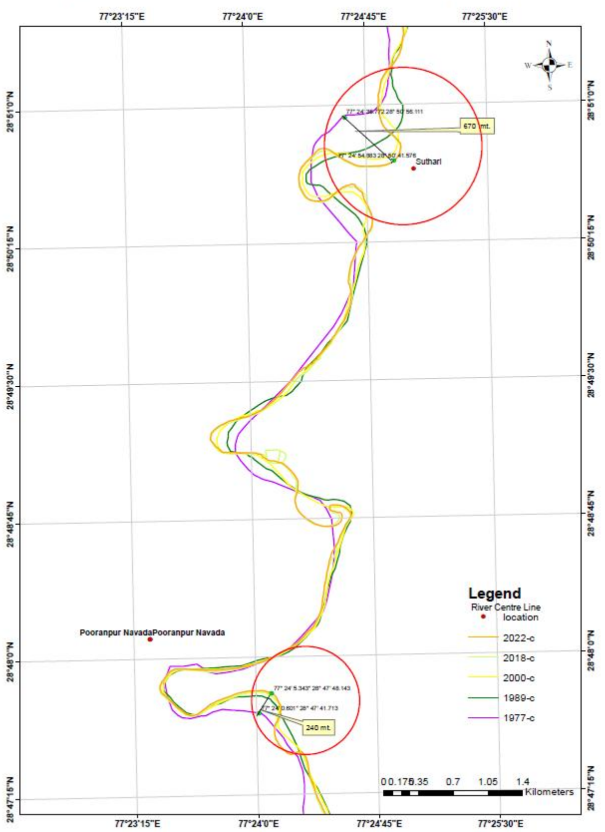
Migration of Hindon River (Location Specific) Part-5



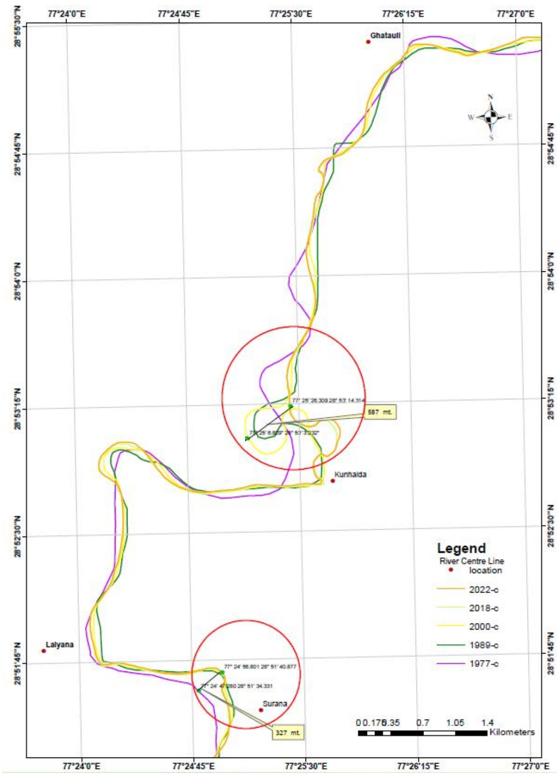
Migration of Hindon River (Location Specific) Part-6



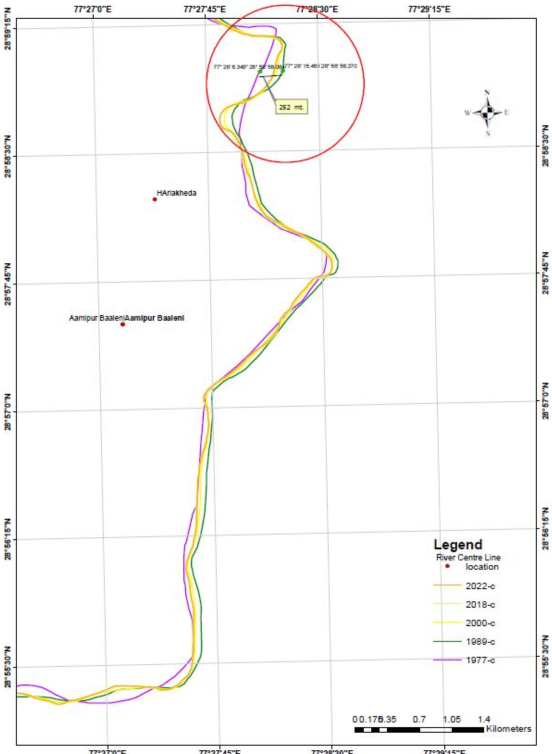
Migration of Hindon River (Location Specific) Part-7



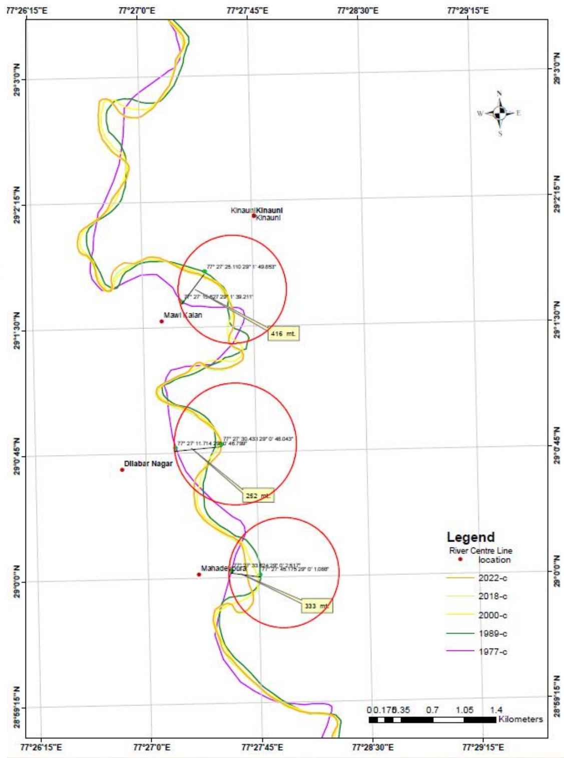
Migration of Hindon River (Location Specific) Part-8



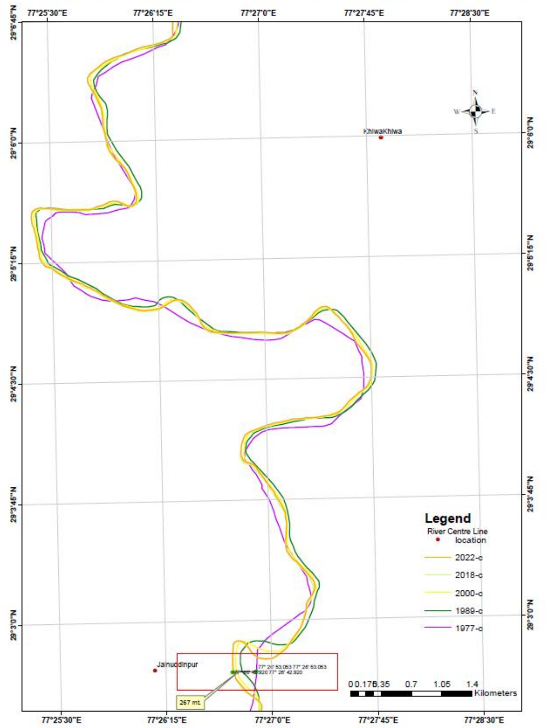
Migration of Hindon River (Location Specific) Part-9



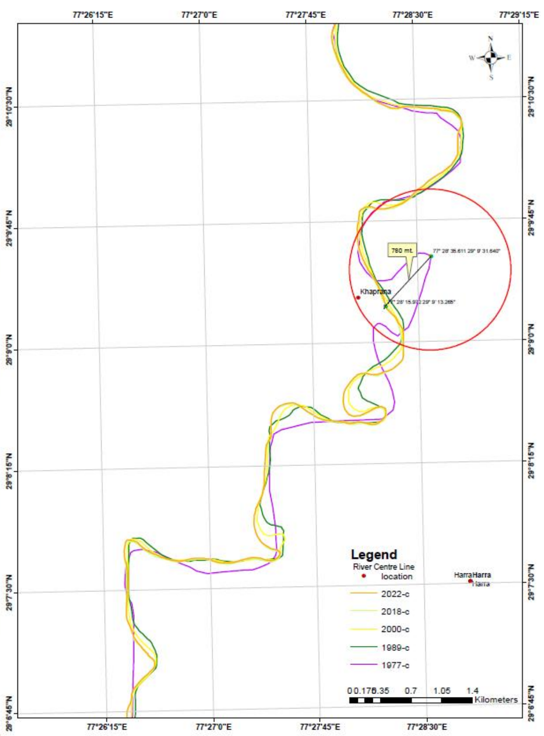
Migration of Hindon River (Location Specific) Part-10

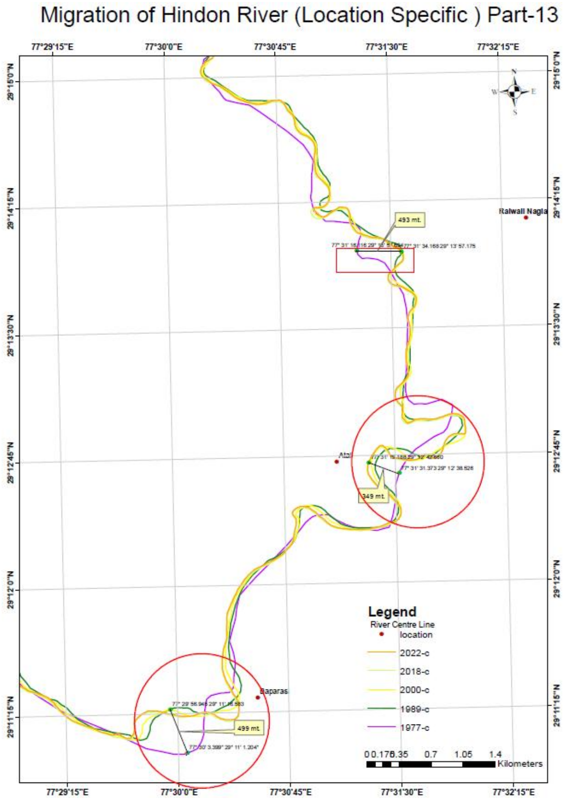


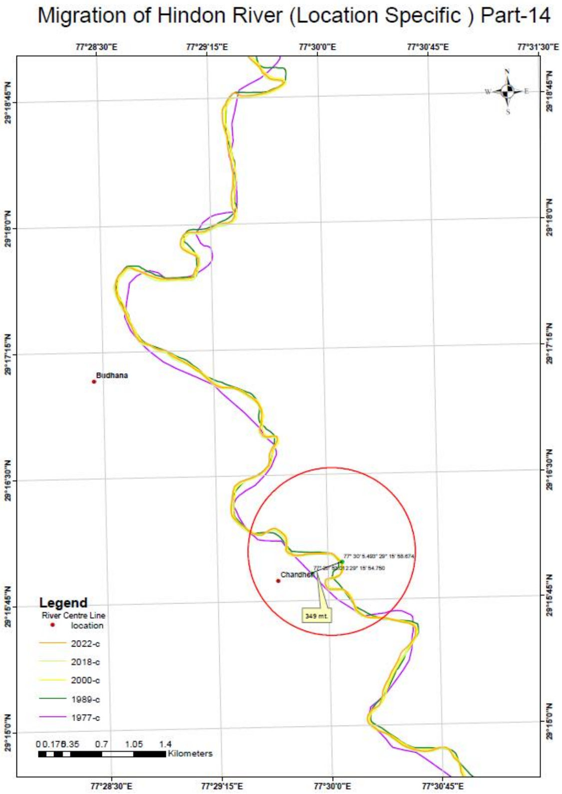
Migration of Hindon River (Location Specific) Part-11



Migration of Hindon River (Location Specific) Part-12







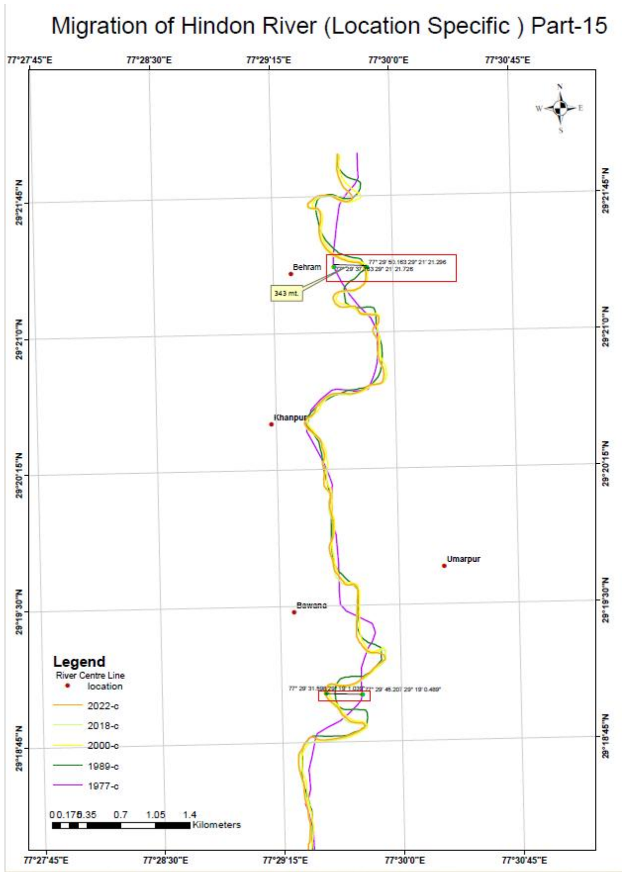


Fig. 3. Hindon river migration shown in part 1 to part 15

7. Technical Specifications

- Use erosion-resistant materials such as Riprap stones and concrete for bank stabilization.

Constructed against a bank/escarpment to protect it from erosion while absorbing wave and flow energy. Permanent ground cover structure made up of large loose angular stones.

7.1 Shear-stress method

• Shear-stress method

Effective rock size required for riverbank stabilization under applied shear stress is

estimated from Lanes relationship:

$$d_m = \frac{\tau_0}{\tau_{*c}\gamma(G-1)\left[\sqrt{1-\frac{\sin^2\phi_1}{\sin^2\phi}}\right]}$$

dm = effective rock size
$\tau 0$= applied shear stress
$\tau * c$ = critical Shield parameter
Ø1 = side slope of bank
Ø = angle of repose of riprap rock
γ = unit weight of water
G= Specific weight of rock

7.2 Velocity method

Effective rock size required for riverbank stabilization under applied critical shear

Velocity

$$V_c = K_c\sqrt{2(G-1)gd_s}$$

$$K_c = \log\left(\frac{4h}{d_s}\right)\sqrt{\tan\phi}$$

Vc = critical mean flow velocity
ds = stone diameter
Ø = angle of repose of riprap rock
h= flow depth
h/ ds=relative submergence

7.3 RipRap Gradation

Size of representative of stability of riprap is determined by the larger size of rock as these are not transported under given flow condition. Riprap with angular stone is more stable. For poor gradation of riprap a filter is placed between riprap and bank material

Table 8.2. *Suggested riprap size gradation*

Percent finer by weight	Sieve diameter ($\times d_{50}$)	Stone diameter ($\times d_{50}$)
0	0.25	—
10	0.35	0.28
20	0.50	0.43
30	0.65	0.57
40	0.80	0.72
50	1.00	0.90
60	1.20	1.10
70	1.60	1.50
90	1.80	1.70
100	2.00	1.90

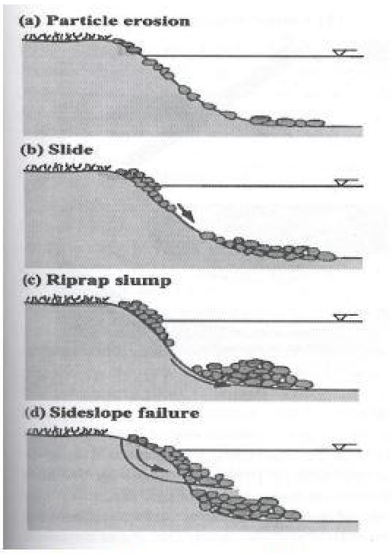
From: Julien, 2002

Riprap can fail due to particle erosion, translational slides, slumps and side slope failure

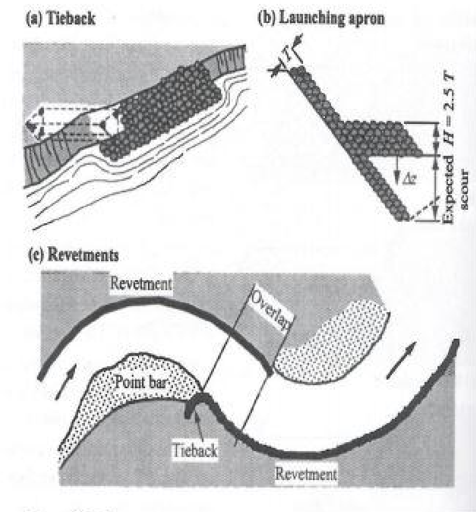
Riprap should not be used on slopes steeper than 1V:1.5H

Upstream and downstream ends of structure should be tied into stream banks

A launching apron is an effective revetment for riprap protection



Types of Riparian failure



Types of Riparian protection

Diagrams From: Julien, 2002

- Used under riprap revetment to allow water to drain easily from bank without carrying out soil particles
- Filter thickness should not be less than 6-9 in
- Opening of 25% to 30% is desirable to minimize clogging and reduce head loss
- Two types: Gravel filter and synthetic fabric filters

Suggested specification for gradation of filter material size
Julien, 2002

$$\frac{d_{50}(filter)}{d_{50}(base)} < 40$$

$$5 < \frac{d_{15}(filter)}{d_{15}(base)} < 40$$

$$\frac{d_{15}(filter)}{d_{85}(base)} < 5$$

- Select native plant species with strong root systems for vegetative cover.
- Construct check dams with appropriate height and spacing for effective water flow regulation.

7.4 Approaches for river bank stabilization

Strengthening the bank

– Hard Approaches : Riverbank Riprap & retaining walls

– Softer Approaches: Bioengineering and vegetation

Reducing Hydrodynamic force

– Flow control structures

7.4.1 Hard Approaches

- Riprap

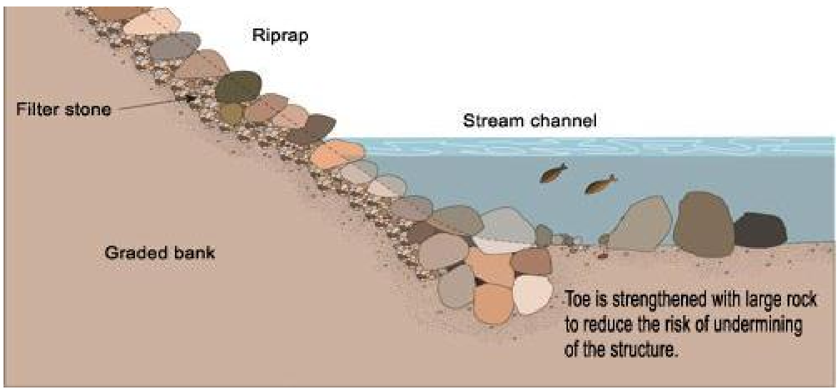


Image 1 Cross section of Riprap stream bank

Engineered Revetments

- Gabions and mattresses
- Sacks and blocks
- Concrete mattresses
- Soil cement

Retaining Walls

- Gravity walls
- Cantilever walls
- Sheet pilling

Flow Control Structures

- Reduce hydrodynamic forces against stream banks
- Control the direction, velocity, or depth of flowing water
- Reduce the possibility of bank degradation by diverting the flow
- These structures generally have certain degree of permeability

7.4.2 Soft Approaches (Bioengineering)

- Pole Plantings
- Coir Rolls
- Tree and Bush Revetment
- Brushwood bundles
- Woven stems
- Biodegradable geotextiles
- Brushwood layering
- Brushwood mattresses
- Green Toe protection
- Re-profiling
- Root wads

Comparing Hard And Soft Approaches

`	Hard, Engineering Approaches	Soft, Bioengineering Approaches
Advantages:	Durable, highly stable, can give rise to vegetation Local damages can be repaired easily	Long-term, re-generating protection Often less costly Potential for better environmental outcomes
Disadvantages:	Need construction practice and restricted to some design parameter Need manpower, materials, equipment Comparatively costly	May require time to establish Not always practical (requires, soil, water and mild slopes) Can cause damage later on via wind-throw of mature vegetation

6. Environmental Impact Assessment (EIA)

Conduct a comprehensive EIA to assess potential ecological impacts. Conduct thorough environmental impact assessments before implementing any intervention. This helps in understanding potential ecological consequences and guides decision-making.

Evaluate the proposed interventions' effects on biodiversity, aquatic life, and local ecosystems.

Implement mitigation measures identified in the EIA.

7. Project Timeline

Phase 1: Site assessment and Budget allocation

Phase 2: Site preparation along the bank (as per Table2. Hindon river migration Region)

Phase 3: Riprap, gabions and revetment construction

Phase 4: Monitoring and adaptive management

8. Monitoring and Evaluation

- Establish monitoring points at key locations.
- Regularly assess water quality, riverbank stability, and vegetation growth.
- Modify the project plan based on continuous monitoring and feedback.

9. Stakeholder Engagement

- Collaborate with local communities, environmental organizations, and government agencies.
- Conduct awareness programs to involve the community in the project.
- Seek approvals and support from relevant authorities.

10. Conclusion

The Hindon River Rejuvenation Project aims to address environmental challenges, enhance water quality, and contribute to sustainable water management. The comprehensive approach outlined in this DPR emphasizes the importance of balancing ecological conservation with the needs of local communities.

NEER

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To
The Director General (NMCG)
Department of Water Resources RD &amp: GR
Ministry of Jal Shakti, Government of India
National Mission for Clean Ganga
Major Dhyanchand National Stadium
Near India, New Delhi-110002

Subject: Release of Final Installment of 20% sanctioned amount for execution of the Project "Fluvial Geomorphology Mapping of Hindon River Basin" under Namami Gange Program.

Ref: **TE-27/3/2021-GIS-NMCG** Dated : 11th December 2023

Sir

I request you to release the final installment of 20% santioned amount (Rs.15,40,000.00), upon consumption of 2nd tranche, for the project "**Fluvial Geomorphology Mapping of Hindon River Basin**" under Namami Gange Program. Kindly find attached **Utilization Certificate (UC)** in the prescribed format **(Form GFR 12-A)**. Details of the bank account of New Environment and Energy Research (NEER) has been given along with this.

Thanking you

Sincerely

Abhijit Mukherjee
NEER
New Environment and Energy Research

Abhijit Mukherjee
P.I. ("Fluvial Geomorphology Mapping of Hindon River Basin")
C.E.O., New Environment and Energy Research (NEER)

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Bank details of New Environment and Energy Research (NEER) are as follows:

Name	NEW ENVIRONMENT AND ENERGY RESEARCH
Account no.	40765602214
IFS Code	SBIN0010441
Bank Branch	(10441) - JNU, NEW CAMPUS, NEAR GODAWARI HOSTEL
Address	NEW DELHI, NCT OF DELHI 110067
PAN	GEPPM5959K
AADHAAR	453082374927

Abhijit Mukherjee
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GFR 12-A
[{See Rule 238 }]

UTILIZATION CERTIFICATE

FOR FINANCIAL YEAR 2023-24 in respect of

NON RECURRING
GRANTS-IN-AID-GENERAL (REVENUE)

1. Name of the Scheme : NATIONAL MISSION FOR CLEAN GANGA (NMCG)

2. Whether Recurring or Non-Recurring grants : **Non Recurring**

3. Grants position of the beginning of the Financial year
   i) Cash in Hand/Bank : Rs. 40 % Received Rs .616000/-
   ii) Unadjusted advances : Rs. -194/-
   iii) Total : Rs. 615806

4. Details of grants received, expenditure incurred and closing balances: (Actuals)

Unspent Balances of Grants received years {figure as at Sl. No. 3 (iii)	Interest Earned thereon	Interest deposited back to the Government	Grant received during the year			Total available funds (1+2-3+4)	Expenditure incurred	Closing Balance (5 - 6)
1	2	3	4			5	6	7
			Sanction number (i)	Date (ii)	Amount (iii)			
			TE-27/3/2021-GIS NMCG	30/11/2022	Rs 6,16,000/-	Rs.6,15,806/-	Rs. 7,14,035/-	Rs. 98,035/-

Abhijit Mukherjee
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New Environment and Energy Research

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Component wise utilization of grants:

Grants-in-aid-General	Tota l
Salary	Rs. 514900/- out of which Rs. 105000/- due
Travel/Field Work	Rs. 134182/-
Office Equipment, Furniture and Consumables	Rs. 13605/-
Miscellaneous	Rs. 24348/-

Details of grants position at the end of the year

(i) Cash in Hand/Bank : Rs.
(ii) Unadjusted Advances : Rs. -98035/-
(iii) Total : Rs.

Certified that I have satisfied myself that the conditions on which grants were sanctioned have been duly fulfilled/are being fulfilled and that I have exercised following checks to see that the money has been actually utilized for the purpose which it was sanctioned:

(i) The main accounts and other subsidiary accounts and registers (including assets registers) are maintained as prescribed in the relevant Act/Rules/Standing instructions (mention the act/Rules) and have been duly audited by designated auditors. The figures depicted above tally with the audited figures mentioned in financial statements/accounts.
(ii) There exist internal controls for safeguarding public funds/assets, watching outcomes and achievements of physical targets against the financial inputs, ensuring quality in asset creation etc. & the periodic evaluation of internal controls is exercised to ensure their effectiveness.
(iii) To the best of our knowledge and belief, no transactions have been entered that are in violation of relevant Act/Rules/standing instructions and scheme guidelines.
(iv) The responsibilities among the key functionaries for execution of the scheme have been assigned in clear terms and are not general in nature.
(v) The benefits were extended to the intended beneficiaries and only such areas/districts were covered where the scheme was intended to operate.
(vi) The expenditure on various components of the scheme was in the proportions authorized as per the scheme guidelines and terms and conditions of the grants-in-aid.

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(vii) It has been ensured that the physical and financial performance under... (name of the scheme) has been according to the requirements, as prescribed in the guidelines issued by Govt. of India and the performance/targets achieved statement for the year to which the utilization of the fund resulted in outcomes given at Annexure-I duly enclosed.

(viii) The utilization of the fund resulted in outcomes given at Annexure-II duly enclosed (to be formulated by the Ministry/Department concerned as per their requirements/specifications)

(ix) Details of various schemes executed by the agency through grants-in-aid received from the same Ministry or from other Ministries is enclosed at Annexure-II (to be formulated by the Ministry/Department concerned as per their requirements/specifications)

Date: 06/12/2023

Place: Greater Noida, Uttar Pradesh

POOJA KAPOOR & CO. CHARTERED ACCOUNTANTS NEW DELHI

Signature: Pooja kapoor

Name: CA POOJA KAPOOR
Chief Finance Officer
(Head of Finance)

UDIN: 23097825BGSVGQ3919

Signature:

Name: ABHIJIT MUKHERJEE
Head of organization

Abhijit Mukherjee
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New Environment and Energy Research