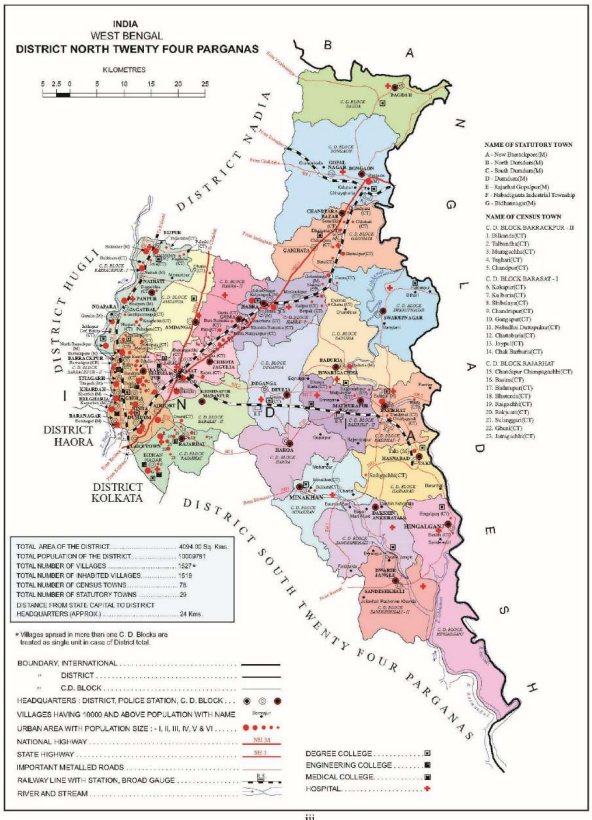
DISTRICT SURVEY REPORT

North 24-Parganas District

Prepared As Per Ministry of Environment, Forest And Climate Change Notification S. O. 3611 (E), Dated 25th July 2018



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UNDER THE GUIDANCE OF:

West Bengal Mineral Development And Trading Corporation Limited
A Govt. of West Bengal Undertaking
Regd. Office: 13, Nellie Sengupta Sarani (Lindsay Street), 2nd Floor
Kolkata – 700 087, West Bengal

Content

PREAMBLE

Keeping in view of experience gained in period of one decade, the MOEF&CC came out with Environmental Impact Assessment Notification S.O.-1533(E) dated 14th Sept.2006. It has been made mandatory to obtain environmental clearance for different kinds of development projects as listed in Scheduled -1 of notification.

Further, pursuance of the order of Hon'ble Supreme Court Petition (C) No. 19628-19629 of 2009, dated 27th Feb.2012 In the matter of Deepak Kumar etc., Vs State of Haryana and others etc., prior environmental clearance has now become mandatory for Mining of Minor Minerals irrespective of the area of Mining Lease.

And also in view of the Hon'ble National Green Tribunal, order dated the 13th Jan.2015 the matter regarding Sand, Brick earth, & borrowed earth cutting for Road Construction has to take prior E.C. For Mining Lease irrespective of the fact that whether the area involved is more or less than 5 hectares. They also suggested to make a policy on E.C. for sand including other minor minerals mining lease in cluster.

MOEF & CC notification S.O.- 141 (E) dated 15th January 2016, Under 7(iii)(a) it was also suggested to prepare the District survey report for sand mining or river bed mining and mining of other mineral as prescribed in appendix X. This has been modified vide S.O. No.- 3611(E) dated 25th July 2018.

MOEF&CC in consultation with State Government has prepared Guidelines on Sustainable Sand & other Minor minerals mining detailing the provisions on Environmental Clearance for cluster. To ease out E.C. activities MOEF & CC has taken initiative vide S.O.- 190(E) dated 20th January 2016 to create District Environmental Impact Assessment Authority (DEIAA) & DEAC under the chairman ship of respective district commissioner for proper monitoring of Minor Minerals (0-5 Ha.) Mining using Information Technology to track the mineral out material from source to destination.

Appraisal Committee will scrutinize and recommend the prior environmental clearance of Mining of Minor Mineral on the basis of District Survey report. This will model and guiding document which is a compendium of available mineral resources, geographical setup, environmental and ecological set up of the district and replenishment of minerals and is based on data of various departments, published reports, Journal and websites. The District Survey report will form the basis for application for environmental clearance, preparation of reports and appraisal of projects. District Survey Reports are to be reviewed once in every five years as per statue, however the data bank of DSR can be updated, if required. This order took effect from 01-12-2017

The Main objective of the preparation of District Survey Report is to ensure the following:-

1. Identification of River Bed Sand with geo references.

2. Identification of deposition of silt with geo reference, which is being used for filling purposes and brick manufacturing.

3. Identification of other mineral resources if available.

Chapter - 1 Introduction

❖ *North 24 Parganas At A Glance:-*

Location and Geographical Area: North 24 Parganas or sometimes North Twenty Four Parganas is a district in southern West Bengal, of eastern India. North 24 Parganas extends in the tropical zone from latitude 22° 11′ 6″ north to 23° 15′ 2″ north and from longitude 88°20' east to 89°5' east. It is bordered to Nadia by north, to Bangladesh (Khulna Division) by north and east, to South 24 Parganas and Kolkata by south and to Kolkata, Howrah and Hoogly by west. Barasat is the district headquarters of North 24 Parganas. North 24 Parganas is West Bengal's most populous district and also the second most populated district in the whole of India. It is the tenth-largest district in the State by area

The district lies within the Ganges-Brahmaputra delta. The river Ganges flows along the western border of the district. There are many other rivers, which include the Ichhamati, Jamuna, and Bidyadhari.

It falls in parts of the Survey of India Toposheet Nos. 79A/16, 79B/5, 79B/6, 79B/9, 79B/10, 79B/11, 79B/12, 79B/13, 79B/14, 79B/15, 79B/16, 79C/9, 79C/10, 79C/13, 79C/14, 79F/3, 79F/4, 79G/1, 79G/2.

Table 1.1 : Salient Features of the district

Sl. No.	Items	Statistics
	Geography	
1.	Area	**4094 Sq. Km.**
2.	Coverage (Latitude and Longitude)	23°15′2″ N to 22°11′6″ N 98°5′ E to 88°20′ E
3.	Average Elevation	-------
4.	Major Rivers	Chhamati, Kalindi, Raimangal, Dansa, Borokalagachi, Benti, Haribhanga, Gaourchrar, Bidyadhari, Hooghly, etc.
5.	Soil Type	Alluvial to Clay Loam
	Demography as per Census 2011	
6.	Population	**10,009,781**
7.	Male Population	5,119,389
8.	Female Population	4,890,392
9.	Sex Ratio	972/1000
10.	Population Density	2445 per sq.km
11.	Literacy	84 %

12.	No. of Villages	1571
	Agriculture	
13.	Total Area	223017 Hectare
14.	Major Product	Tea, Timber
15.	Non Agriculture Land	124782 Hectare
	Administrative Structure	
16.	No. of Block	22
17.	No. of Sub Divisions	5
18.	No. of Municipality	27
19.	Panchayat Smiti	22
20.	Gram Panchayats	214
	Climatology	
22.	Rainfall	1750 mm
23.	Temperature	9 to 40 0 C
24.	Annual Humidity	50 %
	Socio-Economic	
25.	Language	Official- Bengali, English Regional- Hindi, Nepali, Bodo
26.	Tribe	Boro, Mech, Toto, Santhal.
27.	Livelihood	Collecting Tea leaf and forest product, wood industry, Agriculture.
28.	Important Establishment	[1]. Padmaja Naidu Himalayan Zoological Park [2]. Happy Valley Tea Garden [3]. Observatory Hill & Mahakal Temple
	Public Health	
29.	Primary Health Centers	48
30.	Private Hospitals	98

Source: *District Census Report, North 24 Pargnas*

Administrative Units:

The district with an area of 4094 sq. kms has 5 Sub-divisions, 22 Blocks, 33 Police Stations, 22 Panchayat Samities, 214 Gram Panchayats, 27 Municipalities and 1 Notified Area. The district headquarters is at Barasat.

Table 1.2 : Number of Administrative Units in the district of North 24-Parganas

Sub-Divisions	Blocks	No. of Samities	No. of Gram Panchayats	Municipalities
Barasat	Barasat-I Barasat-II Harbra-I Habra-II Amdanga Rajarhat Deganga	7	13 7 7 8 8 6 13	6
Barrackpore	Barrackpore-I Barrackpore-II	2	24	16
Bidhannagar	Bidhannagar (M)	-	-	1
Bashirhat	Bashirhat-I Bashirhat-II Baduria Haroa Hasnabad Swarupnagar Minakhan Hingalgunj Sandeshkhali-I Sandeshkhali-II	10	90	3
Bangaon	Bangaon Gaighata Bagdah	3	38	1
	Total	22	214	27

Source: Brief Industrial Profile of North 24 -Parganas District West Bengal

❖ *Connectivity facilities in North 24-Parganas District:-*

Railway:

The electrified suburban rail network of the ER is extensive and penetrates far and deep into the neighbouring districts of Kolkata, South 24 Parganas, Nadia, Howrah, Hooghly etc.

The Circular Rail encircles the entire city of Kolkata, and also used to provide an offshoot to connect the Dum Dum Airport, but now it is limited up to Dum Dum Cantonment. Jessore Road and Biman Bandar railway stations are closed for the construction work of Noapara–Dum Dum Airport–Barasat Metro rail (Kolkata Metro Line 4)

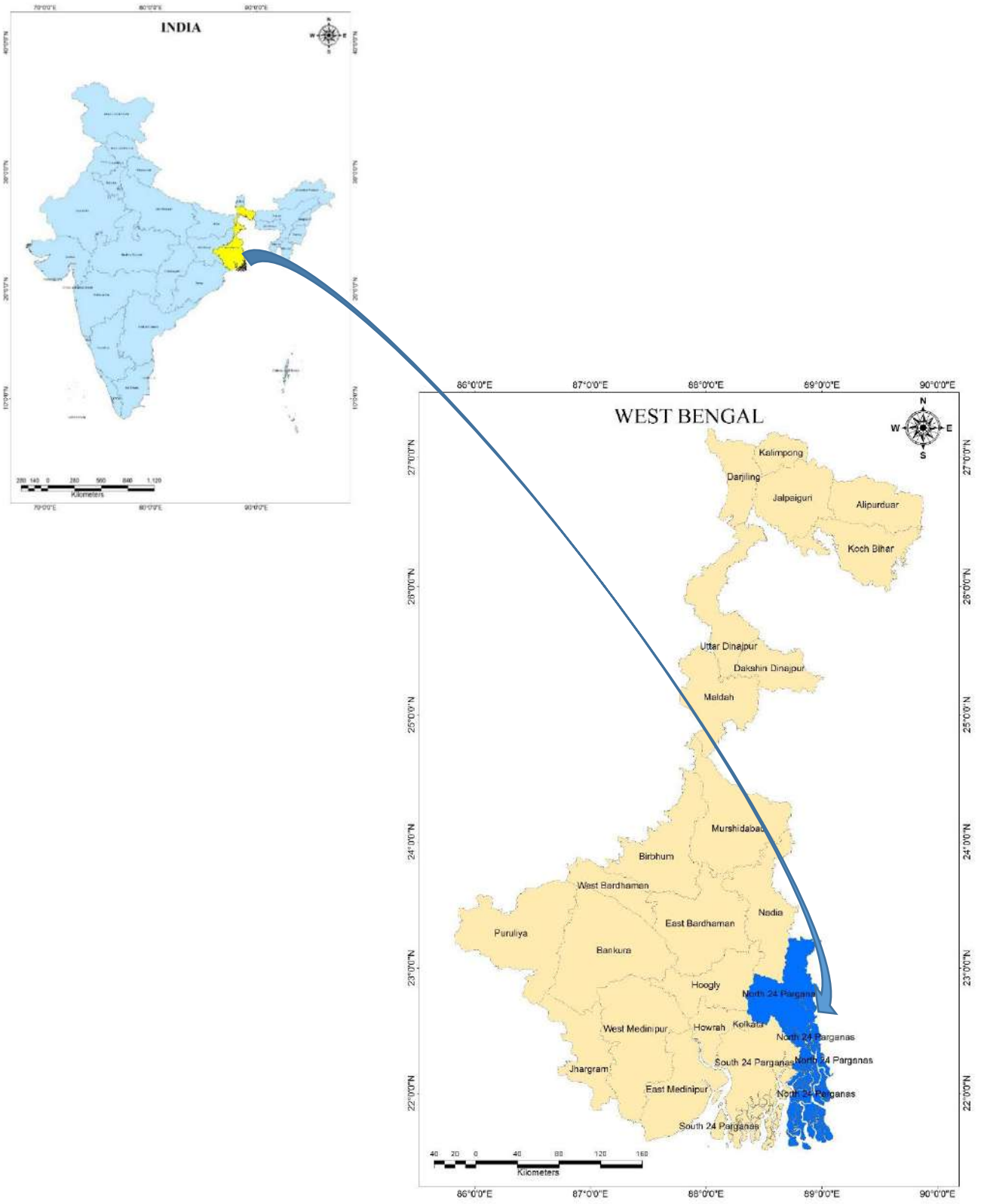
Metro rail is also a transport medium of this district's people. Two stations of Kolkata Metro Line 1 are located here, Dum Dum metro station at Dum Dum and Noapara metro station at Noapara

Road

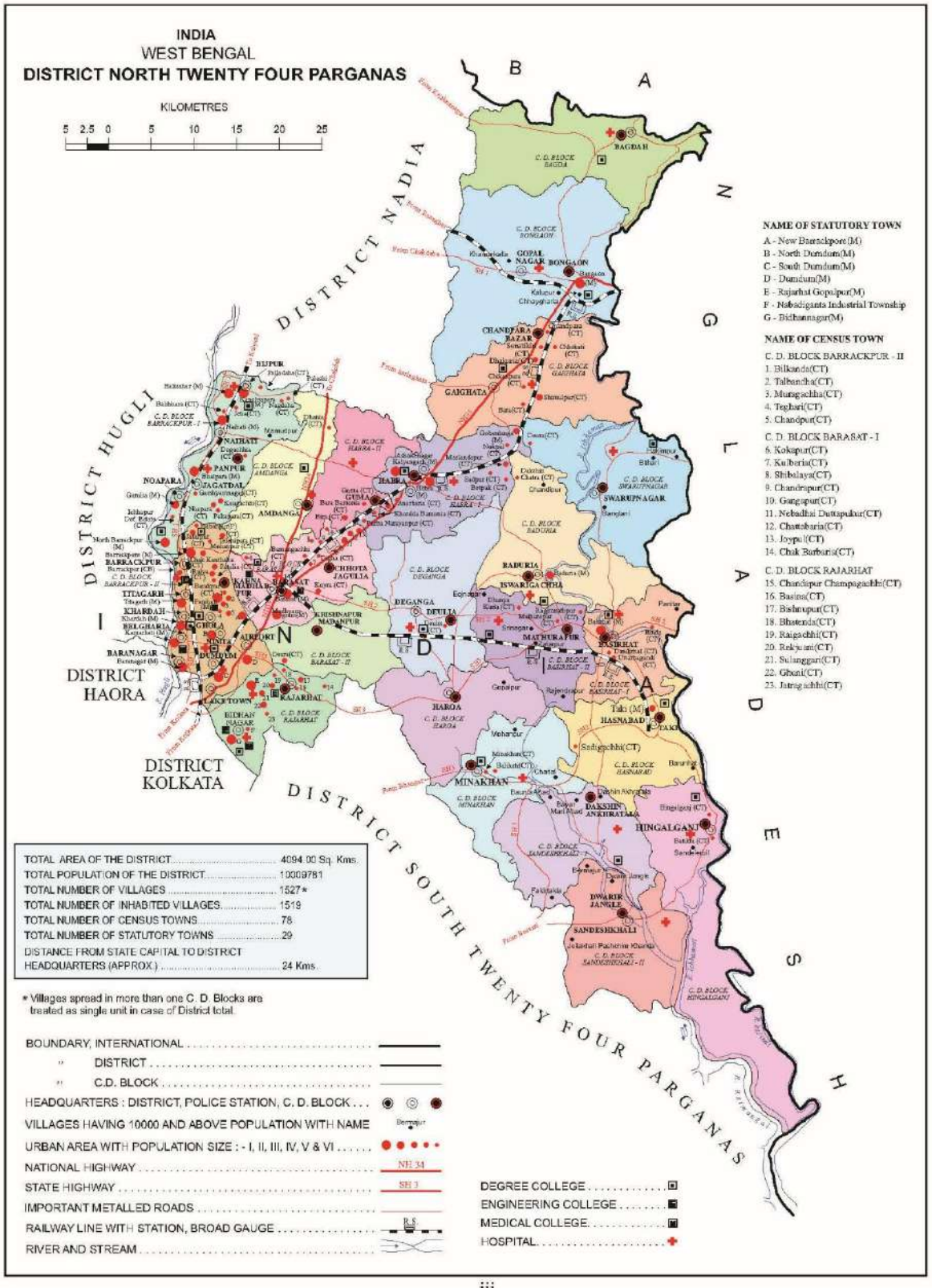
The road network is fairly well developed. Sparsed across by state-highways, it provides a convenient means of transport. NH 12 connects the district with northern and southern region of the state and its sub road NH 112 connect the district headquarter Barasat with the border town Bangaon and Petrapole, the largest land port of India.

Airways

The Netaji Subhash Chandra Bose International Airport which is at Dum Dum (previously known as Dum Dum Airport) in North 24 Parganas, is the only airport serving the city Kolkata. It operates both domestic and international flights. It is a gateway to North-East India, Bangkok, and Bangladesh. The number of people using the airport has consistently increased over the last few years.



Location Map of North 24 Parganas District In West Bengal


INDIA
WEST BENGAL
DISTRICT NORTH TWENTY FOUR PARGANAS
KILOMETRES
5 2.5 0 5 10 15 20 25
DISTRICT NADIA
DISTRICT HUGLI
DISTRICT HAORA
DISTRICT KOLKATA
DISTRICT SOUTH TWENTY FOUR PARGANAS
BAGDAH
BONGAON
GAIGHATA
CHANDPARA BAZAR
BARRACKPUR
NAIHATI
PANPUR
JAGATDAL
NOAPARA
BARANAGAR
DUMDUM
AIRPORT
BIDHAN NAGAR
RAJARHAT
HABRA
SWARUPNAGAR
BADURIA
ISWARIGACHHA
DEGANGA
HAROA
MINAKHAN
HASNABAD
BASIRHAT
DAKSHIN ANKHRATALA
HINGALGANJ
DWARIK JANGLE
SANDESHKHALI
NAME OF STATUTORY TOWN
A - New Barrackpore(M)
B - North Dumdum(M)
C - South Dumdum(M)
D - Dumdum(M)
E - Rajarhat Gopalpur(M)
F - Nabadiganta Industrial Township
G - Bidhannagar(M)
NAME OF CENSUS TOWN
C. D. BLOCK BARRACKPUR - II
1. Bilkanda(CT)
2. Talbandha(CT)
3. Muragachha(CT)
4. Teghari(CT)
5. Chandpur(CT)
C. D. BLOCK BARASAT - I
6. Kokapur(CT)
7. Kulberia(CT)
8. Shibalaya(CT)
9. Chandrapur(CT)
10. Gangapur(CT)
11. Nebadhai Duttapukur(CT)
12. Chansbaria(CT)
13. Joypul(CT)
14. Chak Barburia(CT)
C. D. BLOCK RAJARHAT
15. Chandpur Champagachhi(CT)
16. Basina(CT)
17. Bishnupur(CT)
18. Bhatenda(CT)
19. Rajagachhi(CT)
20. Rekjuani(CT)
21. Sulanggari(CT)
22. Ghuni(CT)
23. Jatragachhi(CT)
TOTAL AREA OF THE DISTRICT ..... 4094.00 Sq. Kms.
TOTAL POPULATION OF THE DISTRICT 10009781
TOTAL NUMBER OF VILLAGES 1527*
TOTAL NUMBER OF INHABITED VILLAGES 1519
TOTAL NUMBER OF CENSUS TOWNS 78
TOTAL NUMBER OF STATUTORY TOWNS 29
DISTANCE FROM STATE CAPITAL TO DISTRICT HEADQUARTERS (APPROX.) ..... 24 Kms.
* Villages spread in more than one C. D. Blocks are treated as single unit in case of District total.
BOUNDARY, INTERNATIONAL
" DISTRICT
" C.D. BLOCK
HEADQUARTERS : DISTRICT, POLICE STATION, C. D. BLOCK
VILLAGES HAVING 10000 AND ABOVE POPULATION WITH NAME
URBAN AREA WITH POPULATION SIZE : - I, II, III, IV, V & VI
NATIONAL HIGHWAY
STATE HIGHWAY
IMPORTANT METALLED ROADS
RAILWAY LINE WITH STATION, BROAD GAUGE
RIVER AND STREAM
DEGREE COLLEGE
ENGINEERING COLLEGE
MEDICAL COLLEGE
HOSPITAL

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Chapter - 2 Overview of Mining Activity in the District

❖ *Availability of Minerals:-*

Due to its varied geological structure, West Bengal is endowed with a wide variety of mineral resources. West Bengal falls into the North-Eastern Plateau region along with Jharkhand, Odisha and Chattisgarh. This district doesn't contain any prominent mineral reserve, however, ordinary earth cutting is a running practice for preparation of bricks. This district is rich in brick manufacturing industry. Apart from this, some smaller chunks of filler earth deposit has been identified, but due to it's area being very small and depth is too low, economic viability of these areas are not suitable for mineral concession.

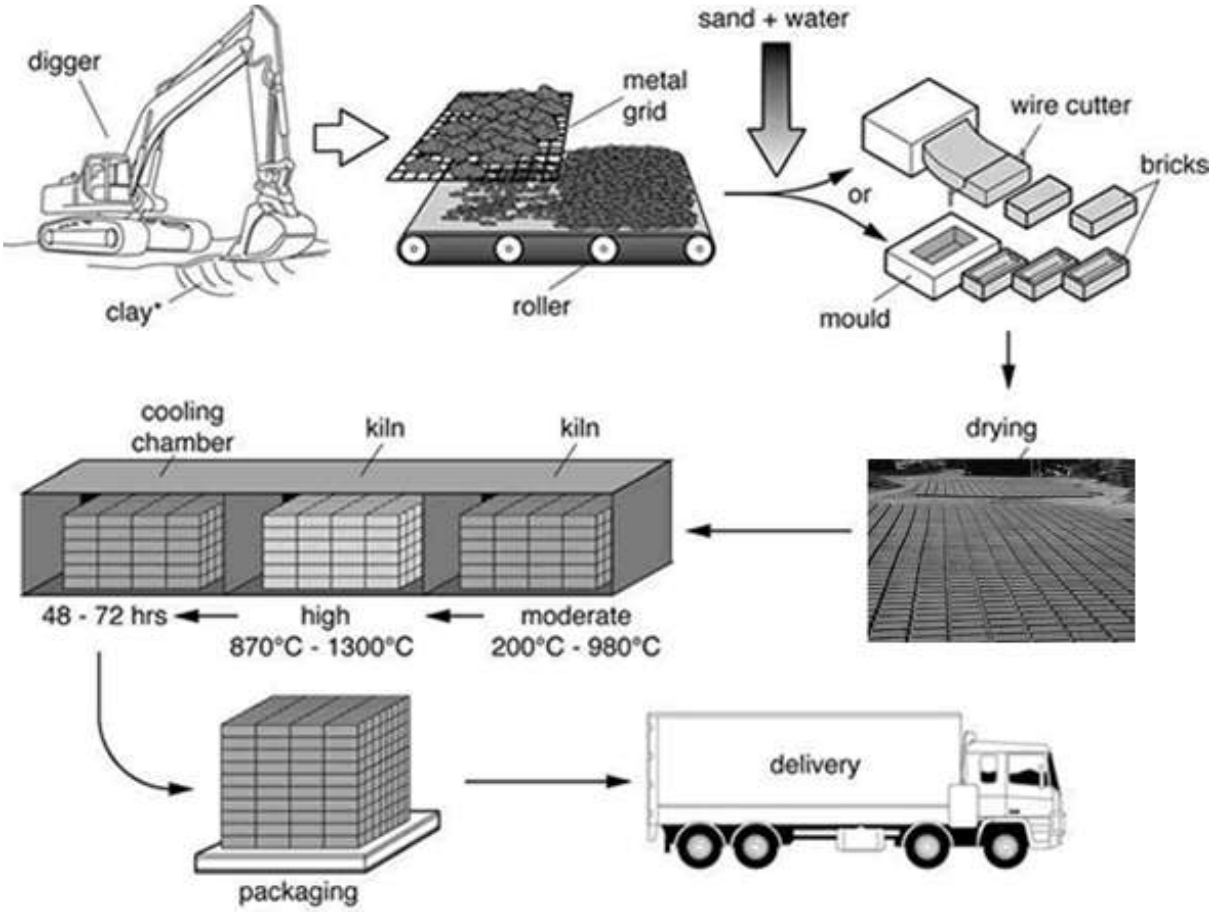
Silt Earth Brick:-

Silt Earth Brick manufacturing process in West Bengal was started in way back 200 years ago during English regime. Presently more than 15000 such Brick Manufacturing units are operating in W.B. These units are producing approximately 1200 million Bricks per year which is 70% of the total requirement. Way back since 1936, mostly Silt collection ponds are recorded as 'IT-KHOLA" on ROR (Right of Record) i.e in revenue record of W.B Govt. till date.

STEPS INVOLVED IN BRICK MANUFACTURING

Manufacturing of bricks consists of the following 4 operations or steps.

1. Preparation of brick clay or brick earth
2. Moulding of bricks
3. Air drying of bricks
4. Burning of bricks



❖ Silt Collection:-

West Bengal have long coastal line from Orissa to Bangladesh, where large number of small & big rivers ends in Bay of Bengal. Apart from about 50 to 60 small rivers from Bhutan enters in West Bengal and goes to Bangladesh. All such rivers also collect Silts while passing from West Bengal. During high tide, the height varies from 1.5 to 3 m (especially during PURNIMA & AAMAWASHYA) in sea (Bay of Bengal) twice in 24 hours the natural flow of river water get reverted back towards up stream side of the river due to high tide. During this period the river water height go up to 1.5 m to 3m from the normal water level of river having no turbulence. The muddy water of river enters in to the series of Silting ponds connecting each other which is at lower level of normal water level of the river through a water canal opening connecting the river & remain stagnant for 2 to 21/2hours, due to nil turbulence which allows the silt ('POLI MITTI"-Local term) to deposit in the silting ponds. During low tide period the water from the silting pond goes back to river natural flow. The complete one cycle takes 12 hrs & the same is repeated in remaining 12hrs of a day. The connecting river canal mouth closing operation starts in the ASTHAMI OR NOVMI TITHI of October every year because of low tide period & full closing completed by AMAWASHYA/PURANIMA, i.e. No Moon or Full Moon of same month to avoid entering of water during high tide period. In the same way the canal mouth is opened in the end of May every year in the similar dates (TITHI) because of start of monsoon season to get higher concentrate of silt from back flow of river.

Silt Rich Water Entering Silt-Tanks

Closing of Canal Mouth

Chapter - 3

List of Mining Lease in the District with location, area and period of validity

3.1 List of Brick Kiln/Bhatta in the district:-

Sr. No.	Name of brick Field	Name of Applicant	LOCATION DETAILS OF BRICK FIELD	MOUZA	Environment Clearance Obtained
1	RUBA BRICK FIELD	KUDDUS MIDDER & OTHRERS		CHIMTA	No
2	MAHAPRABHU BRICK FIELD	SUDESH HALDER		PUNRA	
3	KOHINOOR BRICK FIELD	ROBIUL ISLAM MOULLA		MEDIA	
4	ASHA BRICK FIELD	BISWA NATH ROY		PUNRA	YES
5	SAKTI BRICK PRODUCT	ASIT BARAN MANDAL	BADURIA	FATELLAPUR	NO
6	MAMONI BRICK SUPPLY	ASIT BARAN MANDAL	BADURIA	MEDIA	No
7	BENGAL BRICK SUPPLY	CHANCHAL GHOSH	BADURIA	PUNRA	
8	LION-I BRICK FIELD	SATYAJIT SARKAR	BADURIA	TARAGUNIA	
9	KING BRICK FIELD	BASANT DAS		MEDIA	YES
10	DARPAN BRICK FIELD	SUKUMAR BAIDYA	BADURIA	MEDIA	YES
11	ATM BRICK FIELD	RABIUL ISLAM		MEDIA	
12	SHYAMA BRICK FIELD	HARIDAS MANDAL	UTTAR MEDIA,BADURIA	PUNRA	
13	RAJA BRICK FIELD	MOSTAQ AHMED		NERULABAD	YES
14	AASHTHA BRICK FIELD	MANTU GHOSH		BANKRA	
15	U B M BRICK FIELD	ASHIM DAS		BANKRA	
16	RONY-I BRICK FIELD	ASHOKE GHOSH		HINGALGANJ	
17	SONIC BRICK CONSTRUCTION	MASUM BILLAH SAHAJI		CHIMTA	
18	SONA BRICK FIELD	ALLAUDDIN MISTRI		CHIMTA	
19	DURGA BRICK FIELD	GOSTA BIHARI GHOSH		CHIMTA	
20	SIBA BRICK FIELD	SUBAL MISTRI		CHIMTA	
21	A T M BRICK FIELD	AKHER ALI MANDAL		CHIMTA	
22	JOY GOPAL BRICK FIELD	SAYARAP MANDAL		TAKI	NO

23	DURGA -I BRICK FIELD	BISWAJIT GHOSH	BAYMARI ABAD	BAYMARI ABAD	
24	SIBA BRICK FIELD	TAPAN KUMAR MISTRI		CHIMTA	
25	KOHINOOR BRICK FIELD		BADURIA	MEDIA	
26	POWER BRICK FIELD		BADURIA	PUNRA	
27	POWER BRICK MINNING PROJECT	SAMIRUL ISLAM		MEDIA	
28	HEERA BRICK FIELD	ASHOK SARKAR		HASNABAD	YES
29	RANI-I BRICK FIELD	AYUB ALI MOULLA	CHAMPALI ABAD	CHAMPALI ABAD	YES
30	RAKHI BRICK FIELD	NUR ISLAM MANDAL		RAJENDRAPUR	YES
31	POWER BRICK FIELD	SAMIRUL ISLAM		MEDIA	
32	DHOPABERIA BRICK MANUFACTURE	ANOWAR ALI MANDAL		DHOPABERIA	YES
33	RAJA BRICK FIELD	ABDUL HOSSAIN MOULLA		HOSAINPUR	.
34	SEKO BRICK FIELD	MASTAIN GAZI	BAILANI,BISHPUR	DURGAPUR	
35	NOKIA BRICK MANUFACTURE	GOLAM MUSTAFA GAZI	MAGURUTI,TARAGUNIA	TARAGUNIA	
36	EDEN BRICK FIELD	SAHANUE MANDAL	KETARCHAK,KOTHABARI	KETARCHAK	
37	NICE BRICK FIELD	MASTAIN GAZI	DAKSHIN BEGUNDI	PURBA MADHAYAMPUR	
38	SONA-2 BRICK FIELD	SAHANUR MONDAL		ABADKULIA DANGA	
39	SONA-1 BRICK FIELD	SAHARAP MANDAL		ABADKULIA DANGA	
40	SAYAN BRICK FIELD	SELIM MOULLA		SOUTH AKHRATOLA	
41	BADAL BRICK FIELD	SELIM MOULLA		ABADKHARAMPUR	
42	RUPOSI BRICK FIELD	BARIK BISWAS		MEDIA	
43	RUPA BRICK FIELD	SANTANU MANDAL	BASIRHAT	GHONA	
44	ROXY-2 BRICK FIELD	KUDDUS MIDDER		BHAWANIPUR	
45	TOP TEN BRICK FIELD	ABU TAHER NAIYA		MATHER DIGHI	
46	BASANA BRICK MANUFACTURE	ALOK KUMAR NAG	CHOWRA SANGRAMPURE		
47	BRIGHT BRICK INDUSTRY	SUNITI MANDAL	CHOWRA SANGRAMPURE		
48	AMAR BRICK FIELD	RAFAUL SARDAR	PANIHATI SANGRAMPUR		
49	FRIENDS BRICK FIELD	SEKH SIRAJUL KARIM	PANIHATI SANGRAMPUR		

50	FRIENDS BRICK FIELD	SEKH SIRAJUL KARIM	PANIHATI SANGRAMPUR		
51	SHIBSHA BRICK MANUFACTURE	SAHIDUL ISLAM	SANGRAMPUR		
52	SHIBSHA BRICK FIELD	DEBDAS MODAK	SANGRAMPUR		
53	SUDHA BRICK FIELD	SUBHAS CH SARDAR	SANGRAMPUR		
54	RUPSHA BRICK FIELD	SUBHAS CH SARDAR	SANGRAMPUR		
55	EDEN BRICK FIELD	AMIN MANDAL	SANGRAMPUR		
56	JAMUNA BRICK FIELD	ABDUL HAKIM MONDAL	SANGRAMPUR		
57	UTTARA BRICK FIELD	AMIJADALI DHALI	SANGRAMPUR		
58	INDRANI BRICK FIELD	AMIJADALI DHALI	SANGRAMPUR		
59	PUBALI BRICK FIELD	KASED ALI DHALI	SANGRAMPUR		
60	PURBANI BRICK FIELD	ABDUL HAKIR MONDAL	SANGRAMPUR		
61	PURBASHA BRICK FIELD	ROUSAN ALI DHALI	SANGRAMPUR		
62	PURABI BRICK FIELD	SUJIT GHOSH	SANGRAMPUR		
63	RUPASI BRICK FIELD	GOUTAM HALDER	SANGRAMPUR		
64	NETAJI BRICK MANUFACTURE	SK SIRAJUL KARIM	KHORGACHI		
65	MODEL BRICK FIELD	AMAL MANDAL	KHORGACHI, PIN-743427		
66	SRI GOPAL BRICK FIELD	SHYAMAL MANDAL	KHORGACHI		
67	N D B BRICK FIELD	SUBRATA ROY	BHOGPARA		
68	DISHA BRICK FIELD	SOUREN DEY	BHOGPARA,		
69	SRI KRISHNA BRICK FIELD	LALTU PAL	BHOGPARA,		
70	RUNA BRICK FIELD	LALTU PAL	DAKHANMADIA, BHOGPARA		
71	ROSE BRICK FIELD	ABDUL KHALEK	BHOGPARA, PIN-743427		
72	PRINCE BRICK FIELD	ANARUL FAKIR	FATULLAPUR, PUNRA		
73	EAATA BRICK FIELD	KARTIK BISWAS	SANGRAMPUR		
74	HARD BRICK FIELD	NILRATAN DAS	SANGRAMPUR		
75	PROVAT-1 BRICK FIELD	SANJAY MANDAL	SANGRAMPUR		

76	PROVAT BRICK FIELD	MUJIB RAHAMAN KARIKAR	SANGRAMPUR		
77	TELCO BRICK FIELD	SK YOUSUF ALI	SANGRAMPUR		
78	BABA BRICK WORKS	NILIMA SANA	MERUDENDI, SANGRAMPURE		
79	AZAD BRICK FIELD	GOLAM RAHAMAN GAZI	AKHARPUR		
80	RUPO BRICK FIELD	PRASANTA GHOSH	PANITOR, P.O=HENDA		
81	DONA BRICK FIELD	SHANKA MANDAL	FARIDKATI, P.O-PUNRA		
82	RADHA KRISHNA BRICK FIELD	PARTHA GHOSH	FARIDKATI, P.O-PUNRA		

SR NO	NAME & ADDRESS OF BRICK FIELD	PARTNER NAME	Environmental Clearance	Environmental Clearance
1	M/S Suny Brick Field , Vill – Nolkora, PO – Karnalkora, PS-Basirhat,North 24 Parganas.	Minarul Islam	Yes	
2	M/S Sathi Brick Field, Vill – Bansjhari PO – Soladana, PS-Basirhat,North 24 Parganas.	Abul Mridha	Yes	
3	M/S Rana Brick Field -1, Vill – Bansjhari PO – Soladana, PS-Basirhat,North 24 Parganas.	Musa Karim Midder	Yes	
4	M/S Mukti Brick Construction 2, Vill + PO – Nalkora,PS-Basirhat,North 24 Parganas.	Arun Ghosh		No
5	M/S Mukti Brick Construction, Vill + PO – Nalkora,PS-Basirhat,North 24 Parganas.	Khadem Gazi		No
6	M/S National Brick Field, Vill + PO – Nalkora,PS-Basirhat,North 24 Parganas.	Ashabul Islam		No
7	M/S Mother Brick Field, Vill + PO – Nalkora,PS-Basirhat,North 24 Parganas.	Serajul Islam		No
8	M/S Rana Brick Field (Soha), Vill + PO – Nalkora,PS-Basirhat,North 24 Parganas.	Hannan Midder		No

9	M/S Roket Brick Field, Vill + PO – Nalkora,PS-Basirhat,North 24 Parganas.	Abdul Kalam	Yes	
10	M/S Crown Brick Field, Vill + PO – Nalkora,PS-Basirhat,North 24 Parganas.	Abdul Odud	Yes	
11	M/S United Brick Works, Vill + PO – Nalkora,PS-Basirhat,North 24 Parganas.	Sanjoy Sarkar		No
12	M/S United Brick Works -1, Vill + PO – Nalkora,PS-Basirhat,North 24 Parganas.	Imran Islam		No
13	M/S Swadhin Brick Construction-1, Vill + PO – Soladana, PS-Basirhat,North 24 Parganas.	Imran Islam	Yes	
14	M/S Swadhin Brick Construction, Vill + PO – Soladana,PS-Basirhat,North 24 Parganas.	Hasanurjaman		No
15	M/S Bright Brick Construction ,Vill – Bansjhari, PO – Soladana,PS-Basirhat,North 24 Parganas.	Abdul Hamid	Yes	
16	M/S Modern Brick Field, Vill – Bansjhari, PO – Soladana, PS-Basirhat,North 24 Parganas.	Hayat Ali Gazi	Yes	
17	M/S Shila Brick Field, Vill-Bansjhar, PO – Soladana,PS-Basirhat, North 24 Parganas.	Ziad Ali Molla	Yes	
18	M/S Bright Brick Construction-2, Vill-Bansjhari PO – Soladana,PS-Basirhat,North 24 Parganas.	Abdul Hamid	Yes	
19	M/S Indian Brick Field (Sova), Vill – Bansjhari PO – Soladana,PS-Basirhat,North 24 Parganas.	Maruf Billa (Proprietor)	Yes	

20	M/S Prodip Brick Field, Vill - Bansjhari, PO – Soladana, PS-Basirhat,North 24 Parganas.	Jahangir Mondal		No
21	M/S Moon Brick Field, Vill - Bansjhari, PO – Soladana, PS-Basirhat,North 24 Parganas	Ichaque Ali	Yes	
22	M/S Netaji Brick field, Vill - Bansjhari, PO – Soladana, PS-Basirhat,North 24 Parganas	Ashit Das	Yes	
23	M/S Sonali Brick Works – II, Vill + PO – Soladana,PS-Basirhat,North 24 Parganas.	Ruhul Amin		No
24	M/S Sonali Brick Works, Vill + PO – Soladana,PS-Basirhat,North 24 Parganas.	Sarifuddin Mondal	Yes	
25	M/S Rupali Brick Mfg., Vill + PO – Soladana, PS-Basirhat,North 24 Parganas.	Abdul Odud	Yes	
26	M/S Star Brick Field, Vill + PO – Soladana,PS-Basirhat,North 24 Parganas.	Nasiruddin	Yes	
27	M/S Friend Brick Field, Vill + PO – Soladana, PS-Basirhat,North 24 Parganas.	Abdul Majed	Yes	
28	M/S Lion Brick Field, Vill + PO – Soladana, PS-Basirhat,North 24 Parganas.	Asraf Mondal		No
29	M/S Adarsha Brick Field, Vill + PO – Soladana, PS-Basirhat,North 24 Parganas.	Jainal Abedin		No
30	M/S Titan Brick Mfg., Vill + PO – Soladana, PS-Basirhat,North 24 Parganas.	Gour Ch. Ghosh	Yes	

31	M/S Sagar Brick field, Vill + PO – Soladana, PS-Basirhat,North 24 Parganas.	Arun Ghash	Yes	
32	M/S Rupasree Rick Mfg., Vill + PO – Soladana, PS-Basirhat,North 24 Parganas.	Prasanta Ghosh	Yes	
33	M/S Uttam Brick Mfg., Vill + PO – Soladana, PS-Basirhat,North 24 Parganas.	Basudev Biswas	Yes	
34	M/S Provati Brick Mfg, Vill + PO – Soladana, PS-Basirhat,North 24 Parganas.	Hasanur Gazi	Yes	
35	M/S Asli Brick Mfg, Vill + PO – Soladana, PS-Basirhat,North 24 Parganas.	Bapi		No
36	M/S Sony Brick Field, Vill + PO – Soladana, PS-Basirhat,North 24 Parganas.	Amjed hosen Gazi	Yes	
37	M/S Bharat Brick Field, Vill + PO – Soladana, PS-Basirhat,North 24 Parganas.	Madhab Ch Biswas	Yes	
38	M/S Sun brick Field, Vill + PO – Soladana, PS-Basirhat,North 24 Parganas.	Jiyarul Gazi	Yes	
39	M/S Janak Brick Field Vill – Hariharpur PO – Soladana, PS-Basirhat,North 24 Parganas.	Harapada Mondal		No
40	M/S Moni Brick Field Vill – Hariharpur PO – Soladana, PS-Basirhat,North 24 Parganas.	Hazi Abdus Sattar Molla	Yes	
41	M/S B.Das & Co, Vill – Hariharpur PO – Soladana, PS-Basirhat,North 24 Parganas.	Bhola Nandi	Yes	

42	M/S Kaberi Brick Field, Vill – Hariharpur PO – Soladana, PS-Basirhat,North 24 Parganas.	Harapada Mondal		No
43	M/S Kakuli Brick Mfg, Vill – Hariharpur PO – Soladana, PS-Basirhat,North 24 Parganas.	Tapan Mondal (Proprietor)		No
44	M/S Tufan Brick co, Vill – Hariharpur PO – Soladana, PS-Basirhat,North 24 Parganas.	Krishna Ghosh		No
45	M/S Rana I Brick Field, D Bagundi , Basirhat North 24 parganas	Rabiul Gazi	Yes	
46	M/S Akash Brick Field, D Bagundi , Basirhat North 24 parganas	Nazrul Islam		No
47	M/S Batas Brick Field, D Bagundi , Basirhat North 24 parganas	Arsad Mollick	Yes	
48	M/S Suvam Brick Field, D Bagundi , Basirhat North 24 parganas	Aparna Ghosh (Proprietor)	Yes	
49	M/S Nice Brick Field, D Bagundi , Basirhat North 24 parganas	Mostain Gazi	Yes	
50	M/S Akash Brick Field – 1,D Bagundi , Basirhat North 24 parganas	Sirajul Islam	Yes	
51	M/S Shine Brick Field . Vill – Nolkora, PO – Karnalkora, PS-Basirhat,North 24 Parganas.	Rony Gazi		No

Chapter - 4

Detail of Royalty or Revenue Received in last three years

Sl. No	Year	Royalty (Amount in Lakhs)
1		
2		
3		

Chapter - 5

Details of Production of Sand Or Bajri or Minor Mineral In Last Three Years

Sl. No.	Year	Production (in Million Tonne)
1		
2		
3		

Chapter - 6

Process of Deposition of Sediments In The Rivers of The District

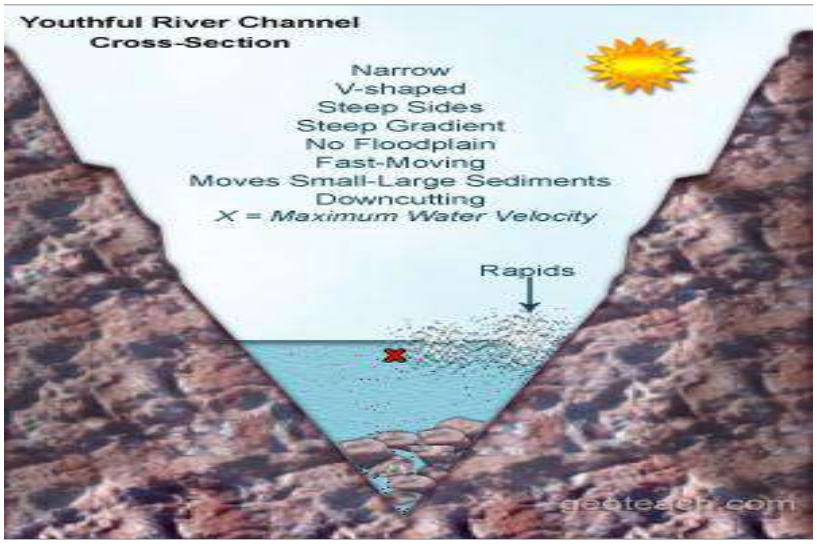
❖ *Classifying Rivers - Three Stages of River Development*

These categories are: Youthful, Mature and Old age. A Rejuvenated River, one with a gradient that is raised by the earth's movement, can be an old age river that returns to a Youthful State, and which repeats the cycle of stages once again.

Characteristics found in the 3 Stages of River Development:

YOUTHFUL RIVER-

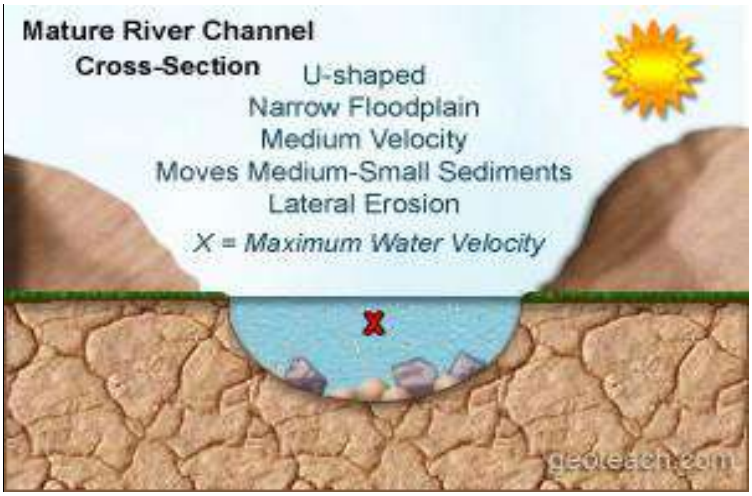
Perhaps the most dynamic of all rivers is a *Youthful River*. Characteristically youthful rivers are found at higher elevations, in mountainous areas, where the slope of the land is steeper. Water that flows over such a landscape will flow very fast. Youthful rivers can be a tributary of a larger and older river, hundreds of miles away and, in fact, they may be close to the headwaters (the beginning) of that larger river.



MATURE RIVER:-

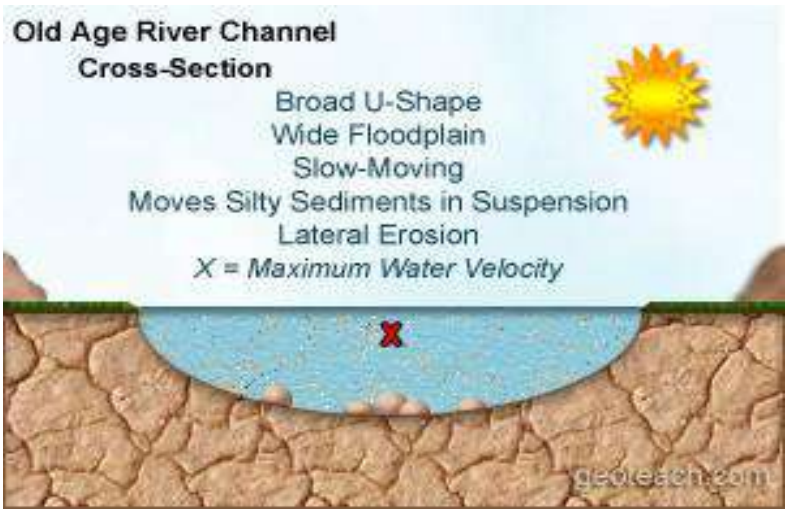
The Mature River is an in-between stage. The river still down cuts though to a much lesser degree than the Youthful River does but it also erodes laterally, though not as extensively, when compared to the Old Age River. The landscape over which it passes is steep enough that the river's slope enables a velocity capable of moving not only the finer sediments, but also the larger pebbles and cobbles by way of rolling, bouncing and saltation along the river bed. The area through which the river flows may be mountainous but they will not be as high as the Young River's locale. A "hilly" landscape would be a better description for the

surrounding area. Rapids are absent and so is the V-shaped channel. The channel of a Mature River is U-shaped but deeper than and not as wide as the Old Age river's channel.



OLD AGE RIVER:-

Old rivers flow slowest and their rate of erosion is encounter acted by the degree of sediment they deposit. Their course is no longer straight and widened floodplains are a common characteristic. An old river rests in an almost flat valley as a result of the many years of erosion that have taken place.



❖ *STREAM EROSION AND DEPOSITION:-*

Flowing water is a very important mechanism for both erosion and deposition. Water flow in a stream is primarily related to the stream's gradient, but it is also controlled by the geometry of the stream channel. As shown in Figure 2, water flow velocity is decreased by friction along the stream bed, so it is slowest at the bottom and edges and fastest near the surface and in the middle. In fact, the velocity just below the surface is typically a little higher than right at the surface because of friction between the water and the air. On a curved section of a stream, flow is fastest on the outside and slowest on the inside.

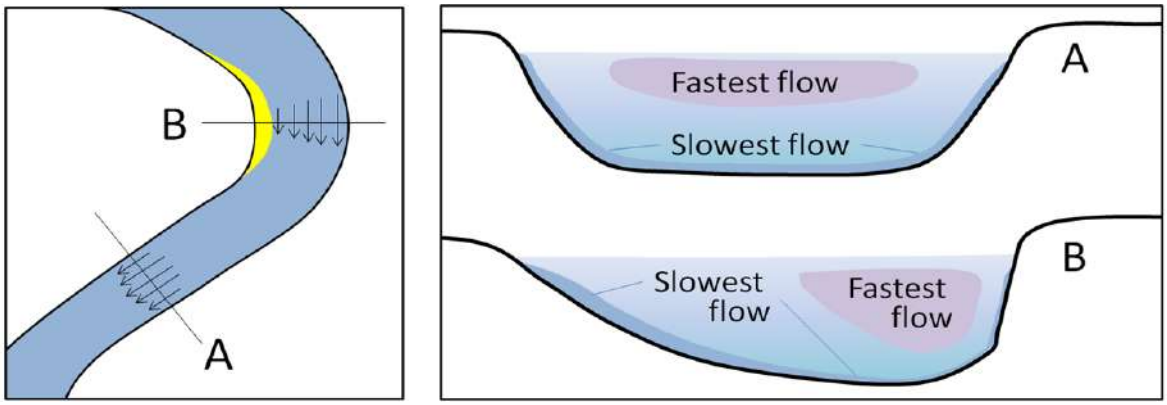


Figure 2: *The relative velocity of stream flow depending on whether the stream channel is straight or curved (left), and with respect to the water depth (right).*

Other factors that affect stream-water velocity are the size of sediments on the stream bed — because large particles tend to slow the flow more than small ones — and the discharge or volume of water passing a point in a unit of time (e.g., m^3/second). During a flood, the water level always rises, so there is more cross-sectional area for the water to flow in; however, as long as a river remains confined to its channel, the velocity of the water flow also increases.

Figure 3 shows the nature of sediment transportation in a stream. Large particles rest on the bottom — bedload — and may only be moved during rapid flows under flood conditions. They can be moved by saltation (bouncing) and by traction (being pushed along by the force of the flow).

Smaller particles may rest on the bottom some of the time, where they can be moved by saltation and traction, but they can also be held in suspension in the flowing water, especially at higher velocities. As you know from intuition and from experience, streams that flow fast tend to be turbulent (flow paths are chaotic and the water surface appears rough) and the water may be muddy, while those that flow more slowly tend to have laminar flow (straight-line flow and a smooth water surface) and clear water. Turbulent flow is more effective than laminar flow at keeping sediments in suspension.

Stream water also has a dissolved load, which represents (on average) about 15% of the mass of material transported, and includes ions such as calcium (Ca+2) and chloride (Cl-) in solution. The solubility of these ions is not affected by flow velocity.

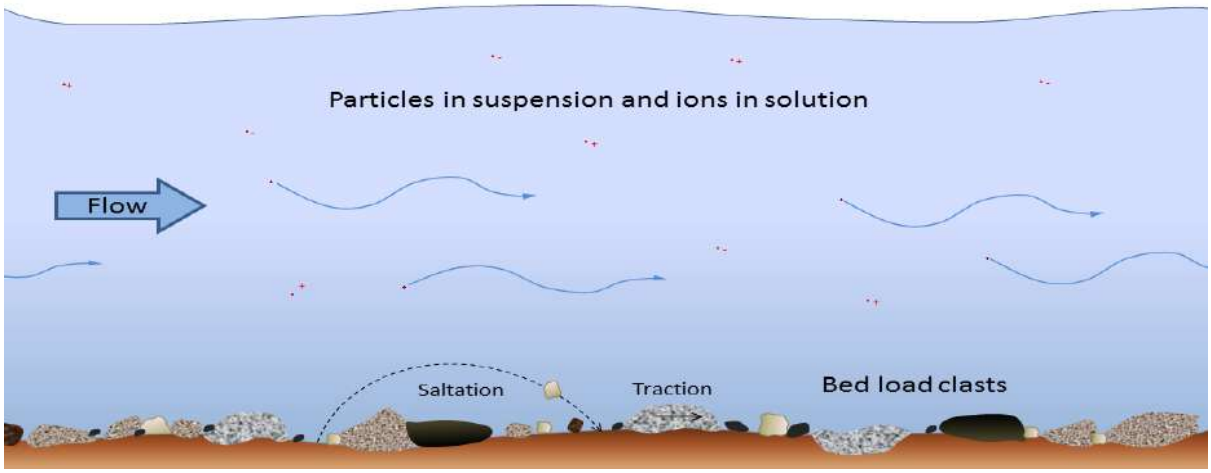


Figure 3: *Modes of transportation of sediments and dissolved ions (represented by red dots with + and – signs) in a stream. [SE]*

The faster the water is flowing, the larger the particles that can be kept in suspension and transported within the flowing water. However, as Swedish geographer Filip Hjulström discovered in the 1940s, the relationship between grain size and the likelihood of a grain being eroded, transported, or deposited is not as simple as one might imagine. Consider, for example, a 1 mm grain of sand. If it is resting on the bottom, it will remain there until the velocity is high enough to erode it, around 20 cm/s. But once it is in suspension, that same 1 mm particle will remain in suspension as long as the velocity doesn't drop below 10 cm/s. For a 10 mm gravel grain, the velocity is 105 cm/s to be eroded from the bed but only 80 cm/s to remain in suspension.

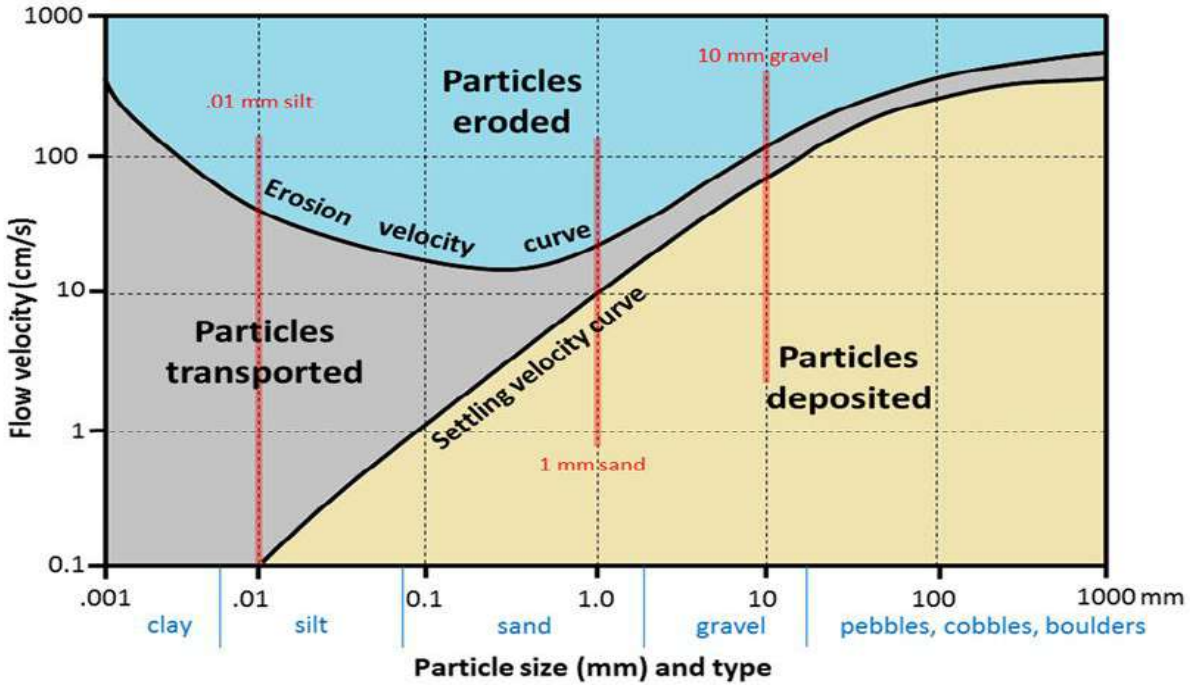


Figure 4: *The Hjulström-Sundborg diagram showing the relationships between particle size and the tendency to be eroded, transported, or deposited at different current velocities*

On the other hand, a 0.01 mm silt particle only needs a velocity of 0.1 cm/s to remain in suspension, but requires 60 cm/s to be eroded. In other words, a tiny silt grain requires a

greater velocity to be eroded than a grain of sand that is 100 times larger! For clay-sized particles, the discrepancy is even greater. In a stream, the most easily eroded particles are small sand grains between 0.2 mm. and 0.5 mm. Anything smaller or larger requires a higher water velocity to be eroded and entrained in the flow. The main reason for this is that small particles, and especially the tiny grains of clay, have a strong tendency to stick together, and so are difficult to erode from the stream bed.

It is important to be aware that a stream can both erode and deposit sediments at the same time. At 100 cm/s, for example, silt, sand, and medium gravel will be eroded from the stream bed and transported in suspension, coarse gravel will be held in suspension, pebbles will be both transported and deposited, and cobbles and boulders will remain stationary on the stream bed.

A stream typically reaches its greatest velocity when it is close to flooding over its banks. This is known as the bank-full stage, as shown in Figure 5. As soon as the flooding stream overtops its banks and occupies the wide area of its flood plain, the water has a much larger area to flow through and the velocity drops significantly. At this point, sediment that was being carried by the high-velocity water is deposited near the edge of the channel, forming a natural bank or **levée.**

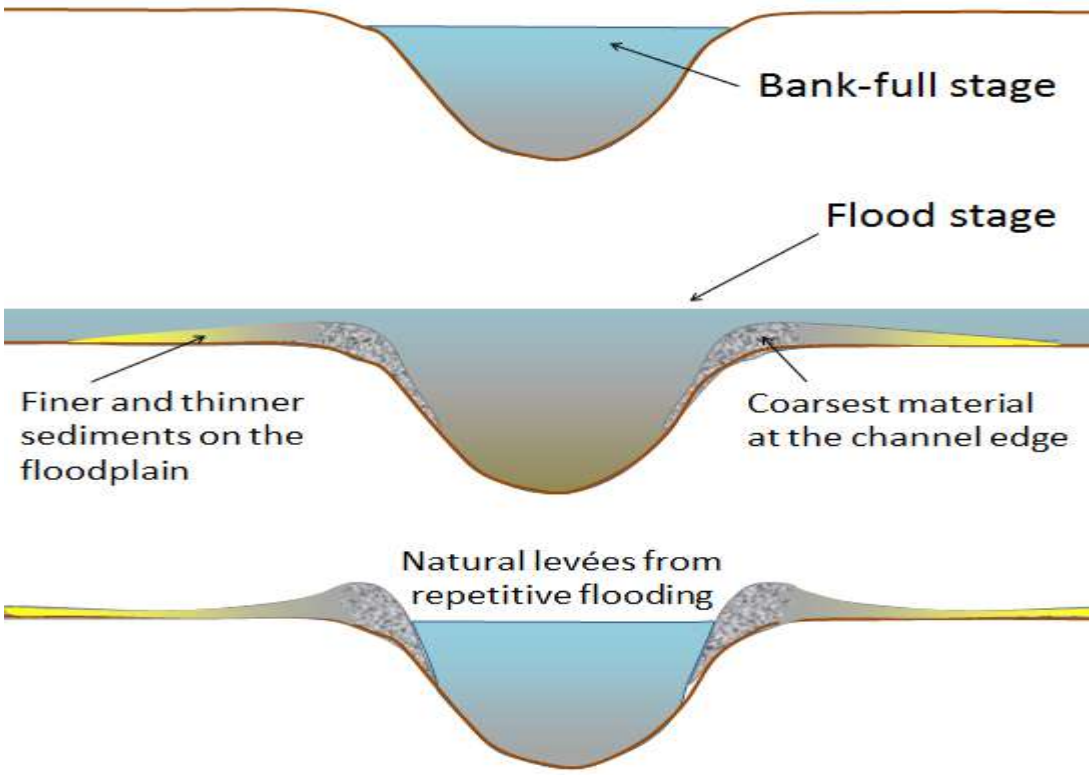
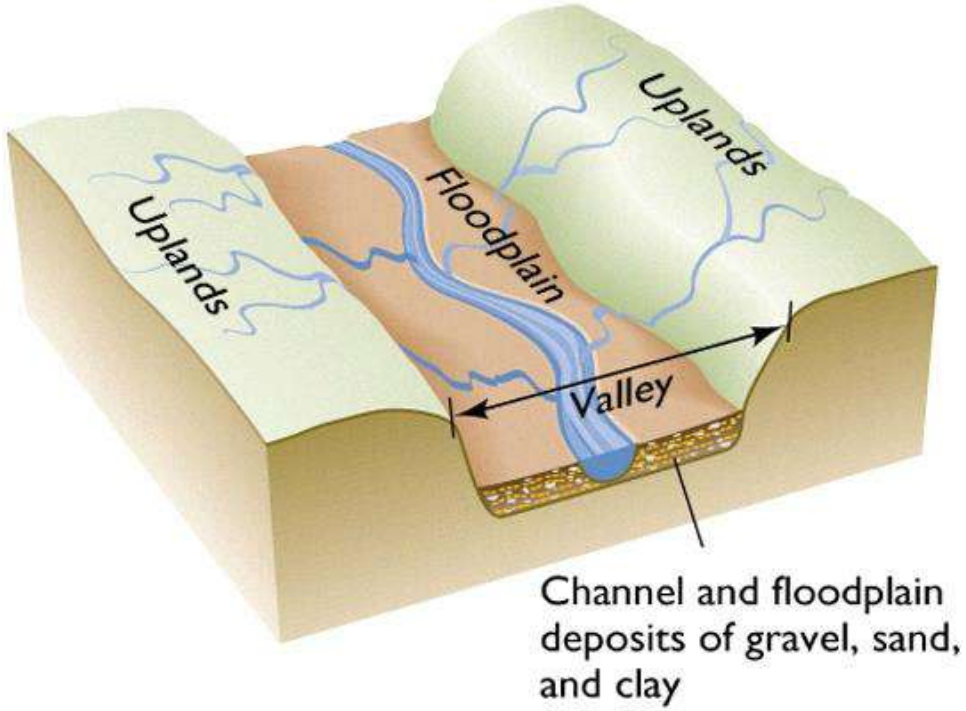


Figure 5: *The development of natural levées during flooding of a stream. The sediments of the levée become increasingly fine away from the stream channel, and even finer sediments — clay, silt, and fine sand — are deposited across most of the flood plain. [SE]*

❖ *Flood Plain:-*

Flood-plain is an area of land adjacent to a stream or river which stretches from the banks of its channel to the base of the enclosing valley walls, and which experiences flooding during periods of high discharge. The soils usually consist of clays, silts, and sands deposited during floods.

Floodplains are formed when a meander erodes sideways as it travels downstream. When a river breaks its banks, it leaves behind layers of alluvium (silt). These gradually build up to create the floor of the plain. Floodplains generally contain unconsolidated sediments, often extending below the bed of the stream. These are accumulations of sand, gravel, loam, silt, and/or clay, and are often important aquifers, the water drawn from them being pre-filtered compared to the water in the river.



❖ Replenishment of Sand :-

The deposition in a river bed is more pronounced during rainy season although the quantum of deposition varies from stream to stream depending upon numbers of factors such as catchment, lithology, discharge, river profile and geomorphology of the river course where annual deposition is one meters, but it is noticed that during flood season whole of the pit so excavated is completely filled up and as such the excavated area is replenished with new harvest of minerals.

In order to calculate the mineral deposits in the stream beds, the mineral constituents have been categorized as clay, silt, sand, bajri and boulder. However during present calculation, the waste material i.e. silt which vary from 10 to 20% in different streams has also been included in the total production. Further the Survey of India Topo-Sheets are used as base map to know the extent of river course. The mineral reserves have been calculated only upto 1.00 meter depth although there are some portions in the river beds such as channel bars, point bars and central islands where the annual deposition is raising the level of river bed

thus causing shifting of the rivers towards banks resulting in to cutting of banks and at such locations, removal of this material upto the bed level is essential to control the river flow in its central part to check the bank cutting. While calculating the mineral potentials, the mineral deposits lying in the sub- tributaries of that particular stream/river has not been taken into consideration. Since these mineral deposits are adding annually.

❖ *Surface Runoff*

Also known as overland flow is the flow that occurs when excess storm water, melt water, or other sources flows over the Earth's surface. This might occur because soil is saturated to full capacity, because rain arrives more quickly than soil can absorb it, or because impervious areas (roofs and pavement) send their runoff to surrounding soil that cannot absorb all of it. Surface runoff is a major component of the water cycle. It is the primary agent in soil erosion by water.

Runoff that occurs on the ground surface before reaching a channel is also called a nonpoint source. If a nonpoint source contains man-made contaminants, or natural forms of pollution (such as rotting leaves) the runoff is called nonpoint source pollution. A land area which produces runoff that drains to a common point is called a drainage basin. When runoff flows along the ground, it can pick up soil contaminants including petroleum, pesticides, or fertilizers that become discharge or nonpoint source pollution.

In addition to causing water erosion and pollution, surface runoff in urban areas is a primary cause of urban flooding which can result in property damage, damp and mold in basements, and street flooding.

❖ *Effects of Surface Runoff:-*

Erosion and deposition

Surface runoff can cause erosion of the Earth's surface; eroded material may be deposited a considerable distance away.

There are four main types of soil erosion by water:

- Splash Erosion,
- Sheet Erosion,
- Rill Erosion,
- Gully Erosion.

Splash erosion is the result of mechanical collision of raindrops with the soil surface: soil particles which are dislodged by the impact then move with the surface runoff.

Sheet erosion is the overland transport of sediment by runoff without a well-defined channel.

Soil surface roughness causes may cause runoff to become concentrated into narrower flow paths: as these incise, the small but well-defined channels which are formed are known as **rills.** These channels can be as small as one centimeter wide or as large as several meters.

If runoff continue to incise and enlarge rills, they may eventually grow to become **gullies.**

Figure 6: Soil erosion by water on intensively-tilled farmland.

Gully erosion can transport large amounts of eroded material in a small time period.

Reduced crop productivity usually results from erosion, and these effects are studied in the field of soil conservation. The soil particles carried in runoff vary in size from about .001 millimeter to 1.0 millimeter in diameter. Larger particles settle over short transport distances, whereas small particles can be carried over long distances suspended in the water column.

There are many sediment transport equations which are suitable for use in the prediction of the replenishment rate of rivers/ watershed. Some of the Famous sediment transport equations are: -

1. **Dandy – Bolton Equation**
2. Yang Equations
3. Engelund-Hansen Equation
4. Modified Universal Soil Loss Equation (MUSLE)

❖ *DANDY - BOLTON EQUATION*

Dandy Bolton formula is often used to calculate the sedimentation yield. But use of these equations to predict sediment yield for a specific location would be unwise because of the wide variability caused by local factors not considered in the equations development. However, they may provide a quick, rough approximation of mean sediment yields on a regional basis for preliminary watershed planning. Computed sediment yields normally would be low for highly erosive areas and high for well stabilized drainage basins with high plant density because the equations are derived from average values. The equations express the general relationships between sediment yield, runoff, and drainage area. Many variables influence sediment yield from a drainage basin. They include climate, drainage area, soils, geology, topography, vegetation and land use. The effect of any of these variables may vary greatly from one geographic location to another, and the relative importance of controlling factors often varies within a given land resource area. Studies revealed that sediment yield per unit area generally decreases as drainage area increases. As drainage area increases, average land slopes usually decrease; and

there is less probability of an intense rainstorm over the entire basin. Both phenomena tend to decrease sediment yield per unit area. In arid regions, sparse precipitation and low run-off are the limiting factors. As_precipitation increases, density of vegetation also increases, resulting in less erosion. In areas with adequate and evenly distributed precipitation, vegetation thus becomes the limiting factor. The accuracy of the sedimentation surveys varied, ranging from reconnaissance type measurements of sediment deposits to detailed surveys consisting of closely spaced cross-sections or contours. Runoff data are translated to inches per year per unit area and sediment deposition data to tons per year per square mile of net drainage area. Net drainage area is defined as the sediment-contributing area and normally excluded areas above upstream reservoirs or other structures that were effective sediment traps. Actual sediment yields undoubtedly were slightly higher because most reservoirs do not trap inflowing sediment. Sediment Yield vs. Drainage Area: - On the average, sediment yield is inversely proportional to the 0.16 power of drainage area between 1 and 30,000 square miles. Sediment Yield vs. Runoff: - Sediment yield increased sharply to about 1,860 tons per square mile per year as run-off increased from 0 to about 2 inches. As runoff increased from 2 to about 50 inches, sediment yield decreased exponentially. Because sediment yield must approach zero as runoff approaches zero, a curve through the plotted points must begin at the origin. The abrupt change in slope of a curve through the data points at Q equals 2 inches

Precluded the development of a continuous function that would adequately define this relationship. Thus, there are two equations derived for when Q was less than 2 inches and when Q was greater than 2 inches.

❖ *Combined Effect of Drainage area and Surface Run off on Sediment Yield*

Dandy- Bolton determined the combined influence of runoff and drainage area on sediment yield to compute the sediment yield. They developed two equations i.e. for run off less than 2 inch and for run off more than 2 inch, which are given below:-
Where: S = Sediment yield (tons/sq miles/yr)
Q = Mean Annual runoff (inch)
A = Net drainage are in sq mile

For run off less than 2 inch.

(Q<2in) S=1289*(Q) 0.46*[1.43-0.26 Log (A)] F

For run off more than 2 inches.

(Q > 2 in): S= 1958*(e -0.055*Q)*[1.43-0.26 Log (A)]

❖ *UNIVERSAL SOIL LOSS EQUATION*

Sediment loss from water erosion

Modeling sediment loss

MUSLE is a modification of the Universal Soil Loss Equation (USLE). USLE is an estimate of sheet and rill soil movement down a uniform slope using rain- fall energy as the erosive force acting on the soil
(Wischmeier and Smith 1978). Depending on soil characteristics (texture, structure, organic matter, and permeability), some soils erode easily while others are inherently more resistant to the erosive action of rain- fall.
MUSLE is similar to USLE except for the energy component. USLE depends strictly upon

rainfall as the source of erosive energy. MUSLE uses storm-based runoff volumes and runoff peak flows to simulate erosion and sediment yield (Williams 1995). The use of runoff variables rather than rainfall erosivity as the driving force enables MUSLE to estimate sediment yields for individual storm events. The water erosion model uses an equation of the form:

$$Y = X \times EK \times CVF \times PE \times SL \times ROKF$$

where:

Y = sediment yield in tons per hectare
EK = soil erodibility factor
CVF = crop management factor that captures the relative effectiveness of soil and crop management systems in preventing soil loss
PE = erosion control practice factor (including management practices such as terraces, contour farming, and strip cropping)
SL = slope length and steepness factor
ROKF = coarse fragment factor

For estimating MUSLE, the energy factor, X, is represented by

$$X = 1.586 \times (Q \times q)^{0.56} \times WSA^{0.12}$$

where:

Q = runoff volume in millimeters
qp = peak runoff rate in millimeters per hour WSA = watershed area in hectares

Runoff volume is estimated using the SCS curve number method. Peak flow was estimated using a modification of the rational method which relates rainfall to peak flow on a proportional basis. The rational equation is:

$$q = C \times i \times A$$

where:

q = peak flow rate
C = runoff coefficient representing watershed characteristics
i = rainfall intensity for the watershed's time of concentration
A = watershed area

Chapter - 7 GENERAL PROFILE OF THE DISTRICT

❖ *River System*

The main rivers of the district of North 24 Parganas are Ichhamati, Kalindi, Raimangal, Dansa, Borokalagachi, Benti, Haribhanga, Gaourchrar, Bidyadhari, Hooghly, etc. Ichhamati is the longest among these rivers. It enters the district through Bagdah block in the north of the district from Nadia and flows south through Bangaon, Swarupnagar, Baduria, Bashirhat-I, Hasnabad and Hingalganj. This river flows into river Kalindi and Kalindi in turn flows into Raimangal. It indicates the borderline between India and Bangladesh during its course of flow from Bashirhat to Hingalganj. River Hooghly lies between Hooghly and North 24 Parganas district

Hooghly River :

River Hooghly or Bhagirathi is the main river of the district. It has form the western boundary of the district along with Haora and Hugli districts. Important urban centers of North Twenty Four Parganas district viz. Halisahar, Naihati, Bhatpara, Barrackpore, Titagarh, Khardah, Kamarhati, Baranagar etc. is situated along its 35 km. run inside the district.

Ichhamati River:

Ichhamati River is a trans-boundary river which flows through India and Bangladesh and also forms the boundary between the two countries. The river is facing the problem of siltation leading to thin flow of water in the dry season and floods in the rainy season., It enters the district through Bagdah block in the north of the district from Nadia and flows south through Bangaon, Swarupnagar, Baduria, Bashirhat-I, Hasnabad and Hingalganj. This river flows into river Kalindi and Kalindi in turn flows into Raimangal. It indicates the borderline between India and Bangladesh during its course of flow from Bashirhat to Hingalganj

Kalindi River:

Kalindi River is a tidal estuarine river in and around the Sundarbans in North 24 Parganas district in the Indian state of West Bengal, bordering on Satkhira District of Bangladesh. The Ichamati breaks up into several distributaries below Hingalganj the chief of which are the Raimangal, Bidya, Jhilla, Kalindi and Jamuna. These fan out into wide estuaries in the Sundarbans. The river Kalindi branches off from the Jamuna at Basantpur, and flows south to enter Sunderban and finally discharges its water into the Raimongal.

Raimangal River:

Raimangal River is a tidal estuarine river in and around the Sundarbans in the Indian state of West Bengal and Satkhira District in Bangladesh. The Ichamati breaks up

into several distributaries below Hingalganj the chief of which are the Raimangal, Bidya, Jhilla, Kalindi and Jamuna. These fan out into wide estuaries in the Sundarbans. It forms the international boundary between India and Bangladesh for some distance

Bidyadhhari River

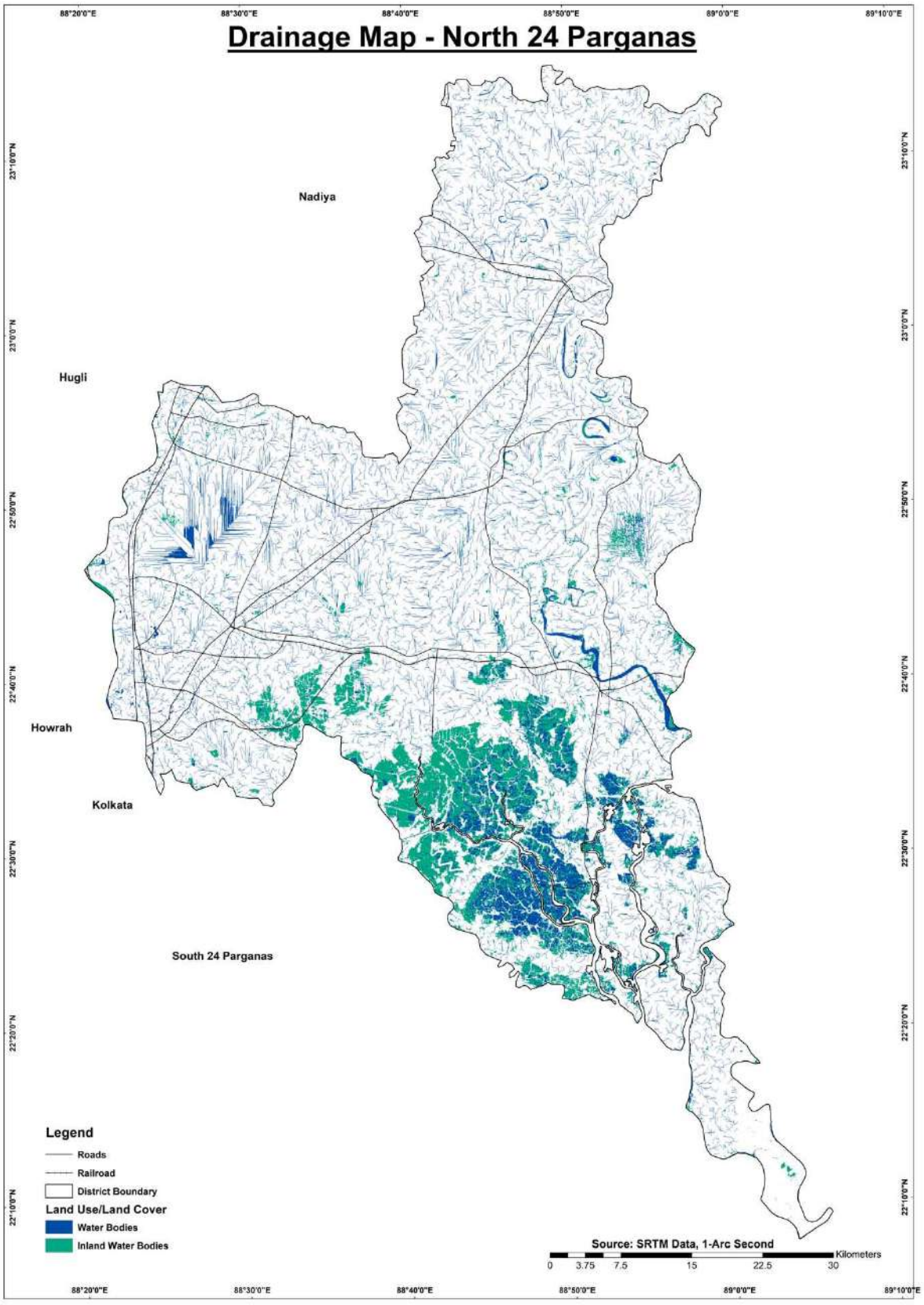
Bidyadhari River is a river in the Indian state of West Bengal. It originates near Haringhata in Nadia district and then flows through Deganga, Habra and Barasat areas of North 24 Parganas before joining the Raimangal River in the Sundarbans. The river has formed a major navigation route for earlier civilisations. The river port of Chandraketugarh in the third century BC was on the banks of this river. This river has been the major drainage system of North 24 Parganas and Kolkata. The Sundarbans area has a network of interconnecting waterways. The larger channels are often a mile wide running in a north-south direction. The Bidyadhari and other such channels now carry little freshwater as they are mostly cut off from the Ganges, the main source of fresh water. As a result of the subsidence of the Bengal Basin and a gradual eastward tilting of the overlying crust the Hooghly-Bhagirathi channels have progressively shifted eastwards since the seventeenth century.

Sunti River

Sunti Nadi, an important distributary of Jamuna river in the northern part of the district flows across the area from north to south and then to the east to be renamed as Harua Ganga and ultimately merges with Bidyadhari river in the southeast which goes across the Sunderban. Here the offtakes of all these rivers have been silted up so that the rivers have lost their heads. In their lower portions they serve as drainage channels.

Jamuna River

Jamuna River is a tributary of the Ichamati River. It flows through the Indian state of West Bengal and is one of the major rivers of the North 24 Parganas district. Till the 17th century, the Jamuna originated as a distributary of the Hooghly River separating from it near Tribeni, along with the Saraswati River , hence giving the town its name. Unlike the Saraswati that flowed southwest from Tribeni, the Jamuna used to flow eastwards, along the northern borders of the present day town of Kalyani and the region around the Indian Institute of Science Education and Research, Kolkata, Nagarukhra in the Nadia district, then enter the North 24 Parganas district and finally merge with the Ichamati River. From the 18th century onwards, the Padma river emerged as the main distributary of the Ganga. Reduction of the waters in the Hooghly and silting up of the upper reaches of the Jamuna, resulted in it being totally cut off from the Hooghly river. The Jamuna is now an independent rain fed channel that emerges south-east of the Nadia district and empties itself into the Ichamati river



Drainage Map of the District

❖ Climate

The climate is tropical, like the rest of the Gangetic West Bengal. It is also characterised by the Monsoon, which lasts from early June to mid September. The weather remains dry during the winter (mid November to mid February) and humid during summer.[Temperature ranges from 41 °C in May and 10 °C in January while relative humidity ranges between 50% in March & 90% in July. The average annual rainfall is 1,579mm. Hot humid summer, a characteristic of the tropical climatic region, prevails all over the district. The monsoon mainly occurs during the months of July, August and September. During this period almost two-third of the normal annual rainfall occurs which leads to sultry weather, flood and water logging in low areas.

❖ Geomorphology

The district falls under the lower Gangetic deltaic plain land. There is no hill in the district. Broadly the district may be divided into three geographic units.

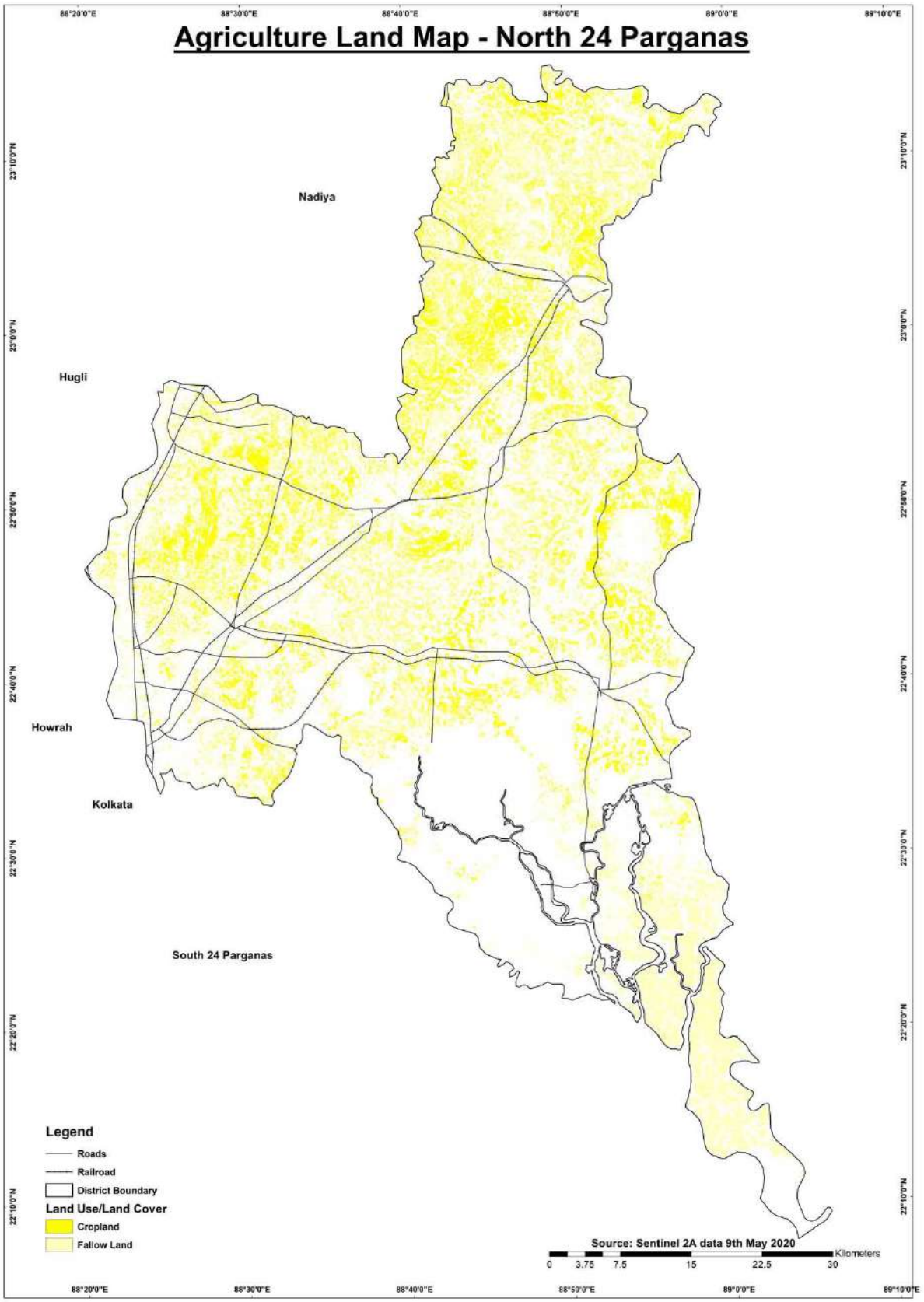
- Natural Leevee Areas
- Swamp Areas
- Older Flood Plain

Physiographic division of the district:-

1. **Ichhamati-Raimangal Plain :** Ichhamati-Raimangal Plain contains soil of mature black or brownish loam to recent alluvium. It occupies the northern and eastern parts having a local slope towards south and drained by these two rivers.

2. **North Bidyadhari Plain :** North Bidyadhari Plain is full of sewerages and marshes with salt water lake region.

3. **North Hugli Flat :** North Hugli Flat is a raised alluvium strip along the Hugli river lying on the Western part of the district. In fact this zone is formed by silts of Hugli river.


Agriculture Land Map - North 24 Parganas
88°20'0"E
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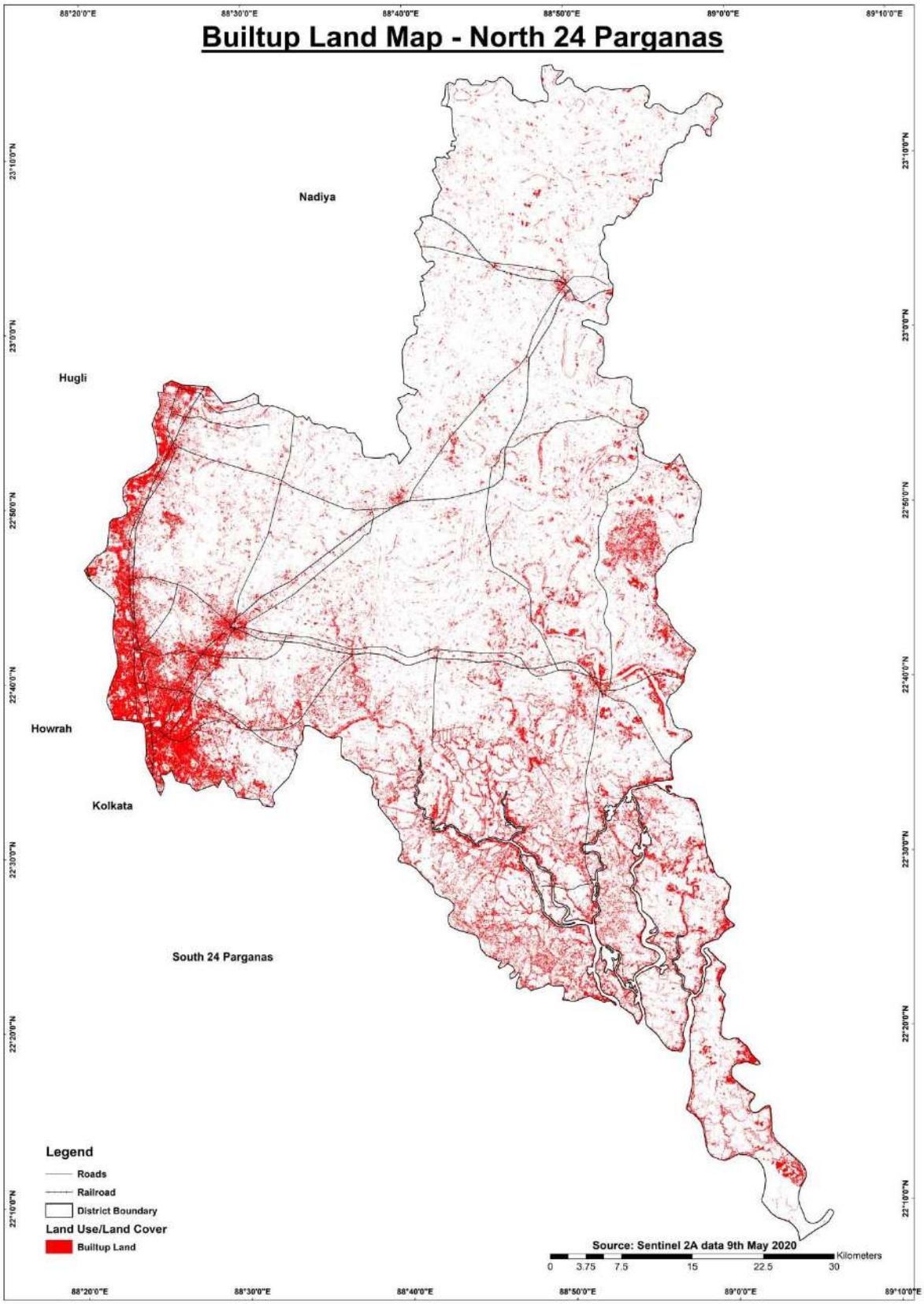
22°30'0"N
22°20'0"N
22°10'0"N
Nadiya
Hugli
Howrah
Kolkata
South 24 Parganas
Legend
Roads
Railroad
District Boundary
Land Use/Land Cover
Cropland
Fallow Land
Source: Sentinel 2A data 9th May 2020
0 3.75 7.5 15 22.5 30
Kilometers


Builtup Land Map - North 24 Parganas
88°20'0"E
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23°10'0"N
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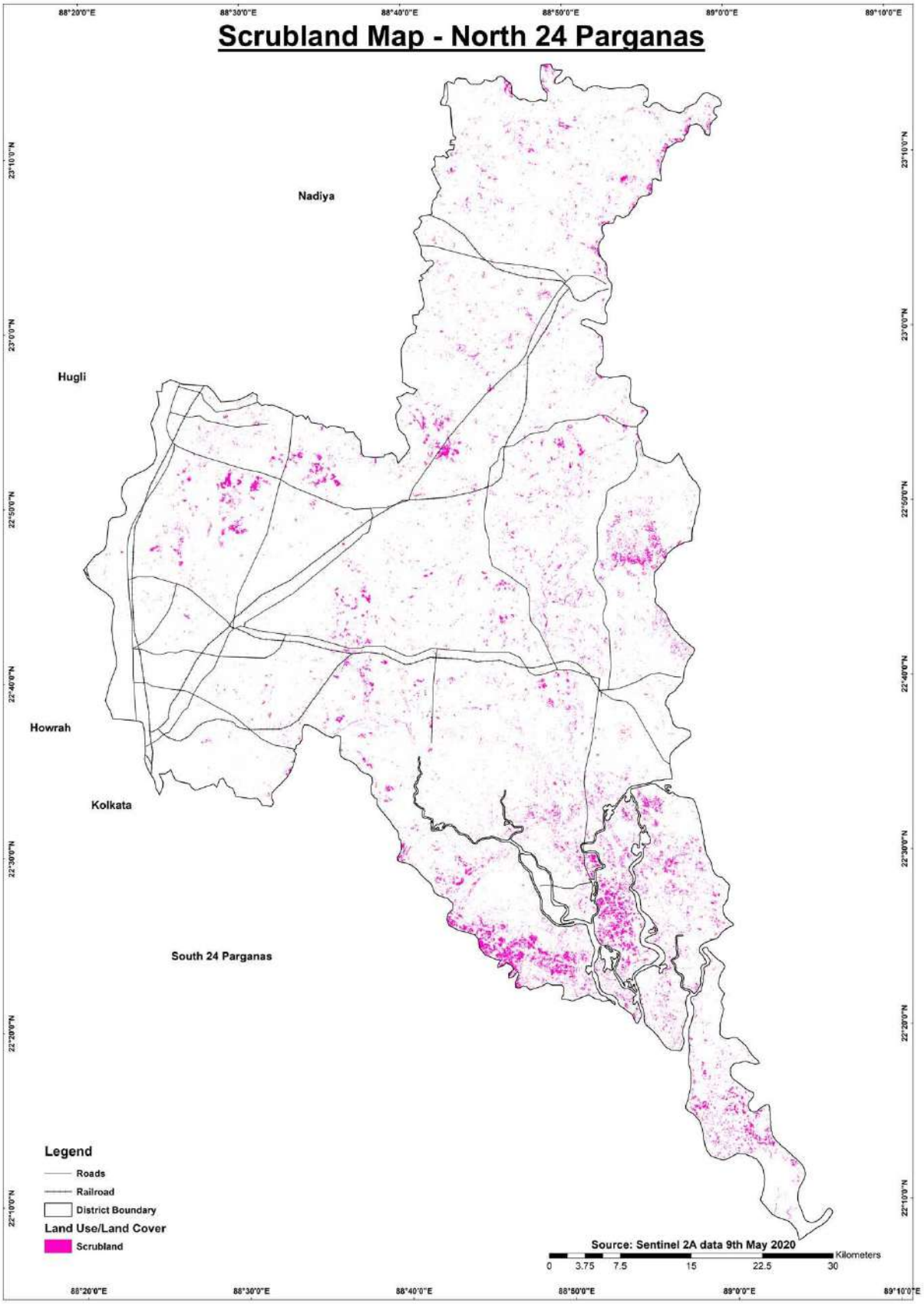
Source: Sentinel 2A data 9th May 2020
0 3.75 7.5 15 22.5 30
Kilometers


Scrubland Map - North 24 Parganas
88°20'0"E
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89°10'0"E
23°10'0"N
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Howrah
Kolkata
South 24 Parganas
Legend
Roads
Railroad
District Boundary
Land Use/Land Cover
Scrubland
Source: Sentinel 2A data 9th May 2020
0 3.75 7.5 15 22.5 30
Kilometers

Sunderbans

The Sundarbans is a mangrove area in the delta formed by the confluence of the Ganges, Brahmaputra and Meghna Rivers in the Bay of Bengal. It spans from the Hooghly River in India's state of West Bengal to the Baleswar River in Bangladesh. It comprises closed and open mangrove forests, agriculturally used land, mudflats and barren land, and is intersected by multiple tidal streams and channels. Four protected areas in the Sundarbans are enlisted as UNESCO World Heritage Sites, viz. Sundarbans National Park, Sundarbans West, Sundarbans South and Sundarbans East Wildlife Sanctuaries. Despite these protections, the Indian Sundarbans was considered endangered in a 2020 assessment under the IUCN red list of ecosystems framework.

The Sundarbans mangrove forest covers an area of about 10,000 km2 (3,900 sq mi), of which forests in Bangladesh's Khulna Division extend over 6,017 km2 (2,323 sq mi) and in West Bengal, they extend over 4,260 km2 (1,640 sq mi) across the South 24 Parganas and **North 24 Parganas districts.** The most abundant tree species are sundri (Heritiera fomes) and gewa (Excoecaria agallocha). The forests provide habitat to 453 faunal wildlife, including 290 bird, 120 fish, 42 mammal, 35 reptile and eight amphibian species.

Ganges Delta

The Ganges delta consists of the whole of Nadia, Kolkata, North 24 Parganas, and South 24 Parganas districts and the Eastern half of Murshidabad district. River Ganges passes through this vast area and divides into three distinct parts – the old delta, the mature delta and the active delta.

The old delta consists of the districts of Murshidabad and Nadia. The formation of delta is complete and the rivers here are heavily silted and many have even dried up in due course of time. Silted rivers, swamps, beels and oxbow lakes forms the area. This area is also known as Bagri region.

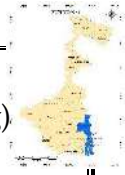
The districts of Kolkata and North 24 Parganas form mature delta region. The rivers are slow and meandering and frequently shift their courses. Swamps, beels and oxbow lakes characterises the scenery.

❖ *Soil*

The district of North 24 Parganas falls within the new alluvium sub-region of the lower Gangetic Plain (Zone-Ill) and considered being most fertile for crop production. The soil type varies from sandy to clay sandy loam being the predominant ratio of high: medium: low land is 17:33:39. The soil of northern part of district is sandy, in the central middle part it is sandy with clay loam and in southern side it is clay loam. The physiographic structure of the district is mostly plain.

As the district falls within the Gangetic delta, the soil of the district is very favourable for cultivation. Shallow black and brown soils are also found.

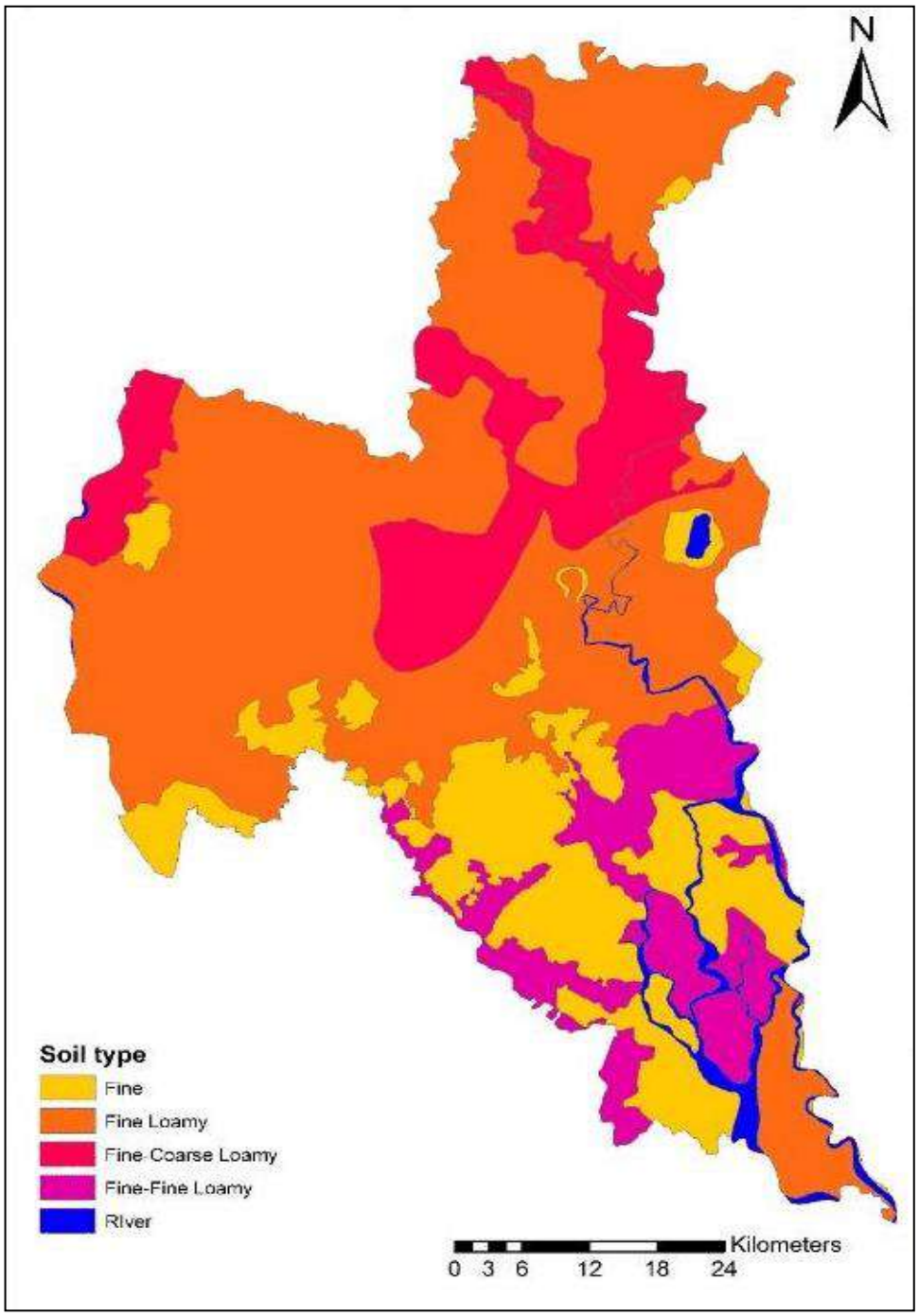
Soil of different wetland areas is usually grey to greyish black in colour, silty clay to silty clay loam in texture having high water retentive capacity. In marshy areas silt and clay predominate over sand. In brackishwater bhelies the pH of the surface soil is almost neutral varying between 6.5 and 7.5, while the subsoil is acidic. In general bheri soils are poor in nitrogen (14.0-17.8 mg N/1OO g) but medium in organic carbon content (0.53-0.69% C) and rich in phosphorus (8.1-12.4



mg P_2O_5/100 g), while both organic carbon (0.89%) and available nitrogen (19.0 mg N/lOO g) were higher in sewage polluted saline bheries because of higher organic loads.

Depending upon the soil types the district is divided in two separated zones:-

a. Entisols comprises Sandy loam which is found in the northern, central and western part of the district.
b. Alfisols comprise loam, silty loam which is found in the southern and south eastern part of the district.



Soil Map of the District

Source: *Wetland Faunal Resources of West Bengal North and South 24-Parganas Districts, Records of the Zoological Survey of India,*

❖ *Irrigation*

Irrigation is done mainly by groundwater through shallow and deep tubewells alongwith surface water from rivers through river lifting and also from canals, ponds etc.

Irrigation by different sources (as on 2004-05) :-

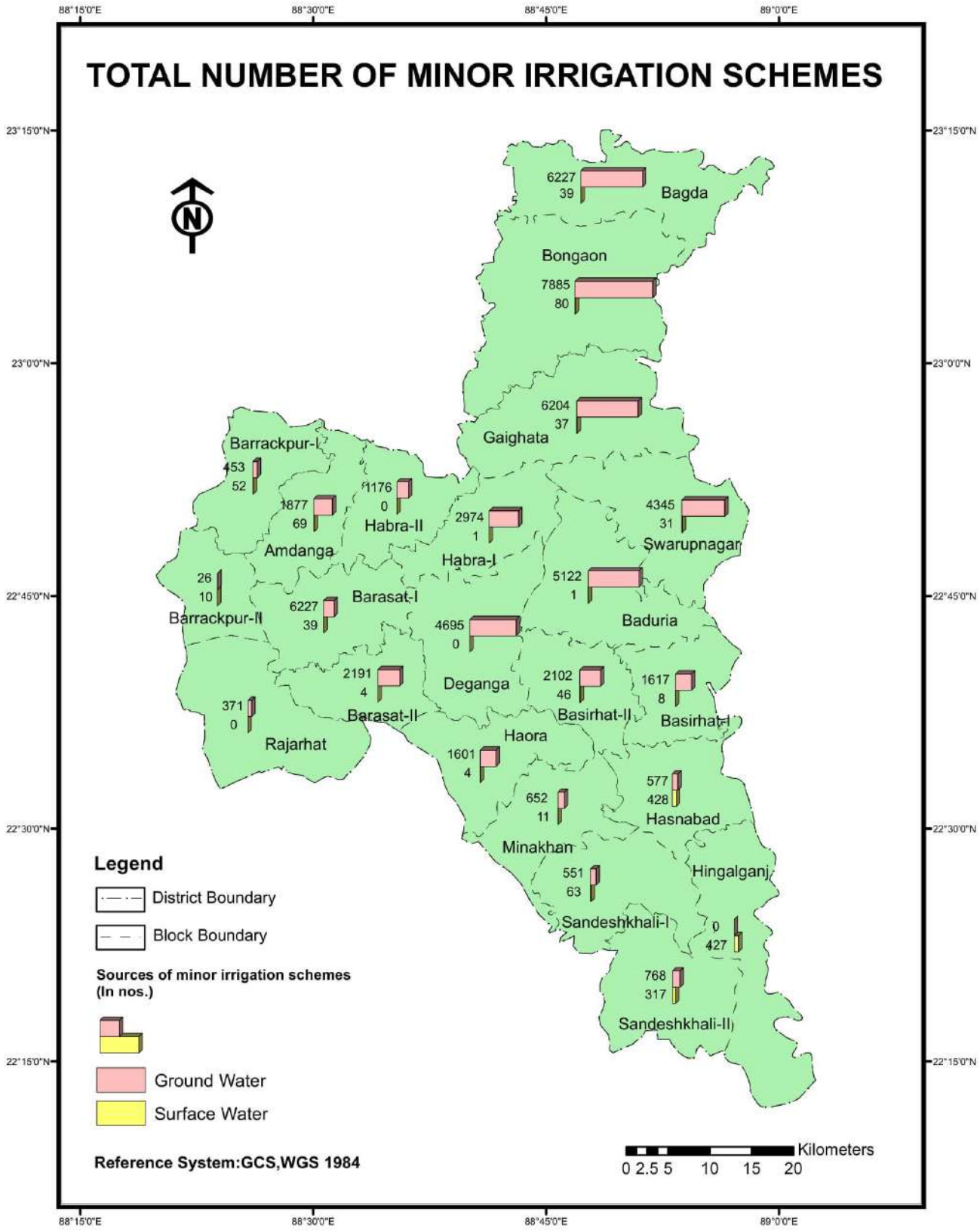
1	Tube wells / Bore wells	1490.26 sq. km. area irrigated through 62142 STW and 146.7 sq. km. area irrigated through 314 DTW.
3	Surface Flow	37.9 sq. km. area irrigated through 44 nos. of RLI.
4	Surface Lift (RLI)	10.7 sq. km. area irrigated through 44 nos. of RLI.
5	Net Irrigated Area	19628.25 sq.km.
6	Gross Irrigated Area	2120.64 sq.km.

Source- CGWB Report of North 24 Parganas

Irrigation Area

Irrigation Area type	Area (Thousand Hectare)
Net Sown area	259.22
Gross Cropped area	520.41
Net Irrigated Area	200.56
Gross Irrigated area	461.63
Rainfed area	58.78
Cropping intensity %	201%

Source:
http://www.crida.in/CP2012/statewiseplans/West%20Bengal%20(Pdf)/BCKVV,%20Kalyani/WestBengal%2013-North%2024%20Parganas-31-12-2011.pdf



Source- http://wbwridd.gov.in/swid/map.html

❖ *Demography*

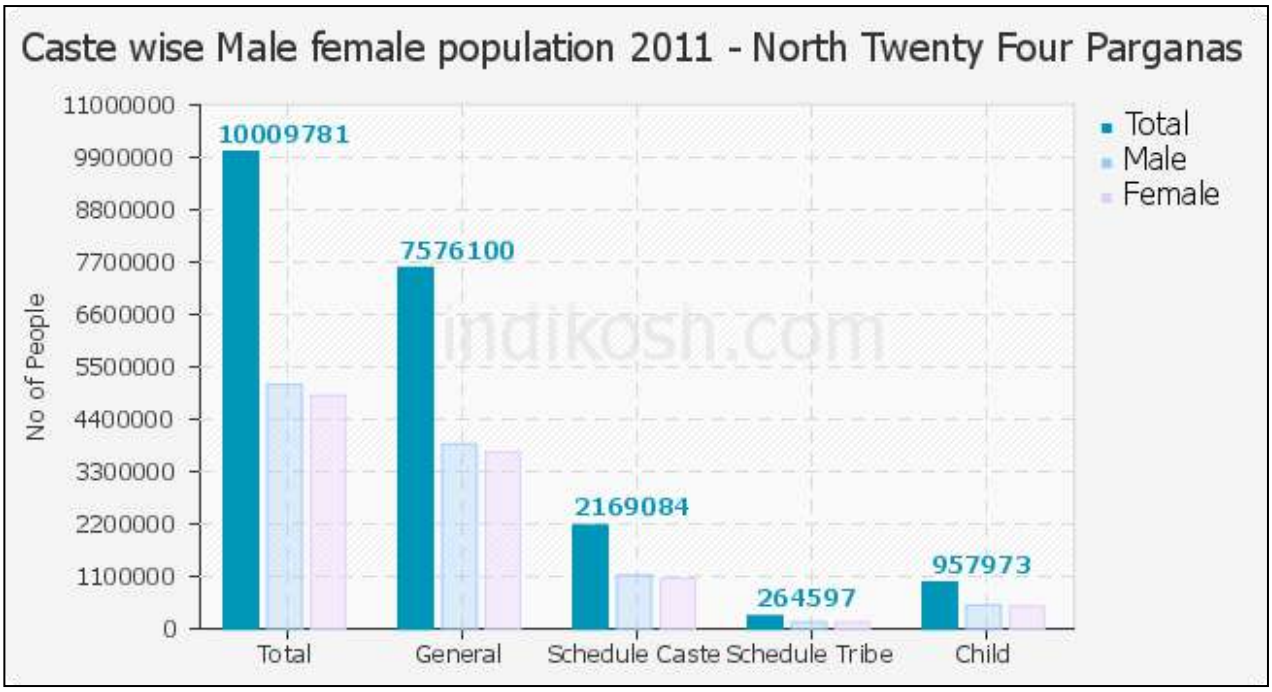
According to the 2011 census North 24 Parganas district has a population of 10,009,781. This gave it a ranking of 2nd in India (out of a total of 640) and 1st in its state. However, in 2014 the Thane district (in Maharashtra), which had been ranked 1st in India in 2011, was divided into two, thus promoting North 24 Parganas District to 1st in India. The district has a population density of 2,463 inhabitants per square kilometre (6,380/sq mi). Its population growth rate over the decade 2001–2011 was 12.86%. North Twenty Four Parganas has a sex ratio of 949 females for every 1000 males, and a literacy rate of 84.95%

The administrative division and population of the district is given below:-

DEMOGRAPHY (Census 2011)	
Total Population	**10,009,781**
Male Population	**5,119,389**
Female Population	**4,890,392**
Population Growth	**12.04 %**
Area Sq. Km.	**4,094**
Density / Km²	**2,445**
Proportion to West Bengal Population	**10.97%**
Sex Ratio (Per 1000)	**955**
Child Sex Ratio (0-6 Age)	**956**
Average Literacy	**84.06**
Male Literacy	**87.61**
Female Literacy	**80.34**
Total Child Population (0-6 Age)	**957,973**
Male Population (0-6 Age)	**489,824**
Female Population (0-6 Age)	**468,149**
Literates	**7,608,693**
Male Literates	**4,056,046**
Female Literates	**3,552,647**
Child Proportion (0-6 Age)	**9.57%**

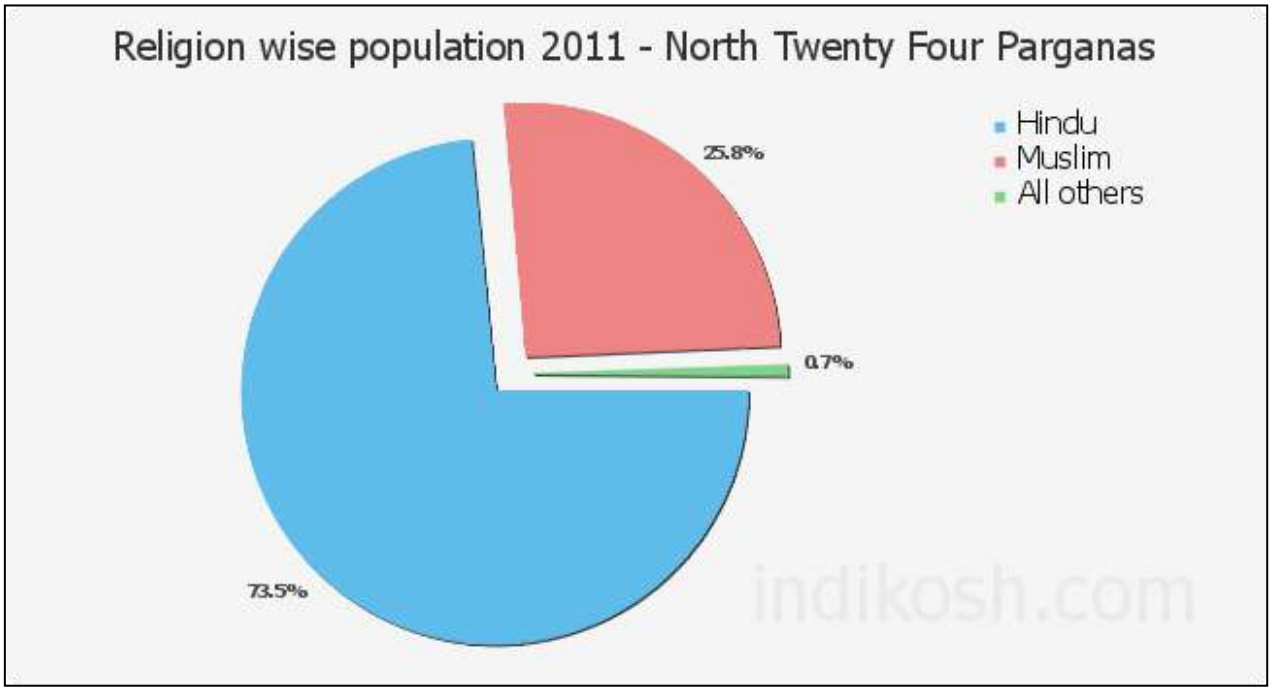
DEMOGRAPHY (Census 2011)	
Boys Proportion (0-6 Age)	**9.57%**
Girls Proportion (0-6 Age)	**9.57%**

Source: Census Data of North 24 Parganas

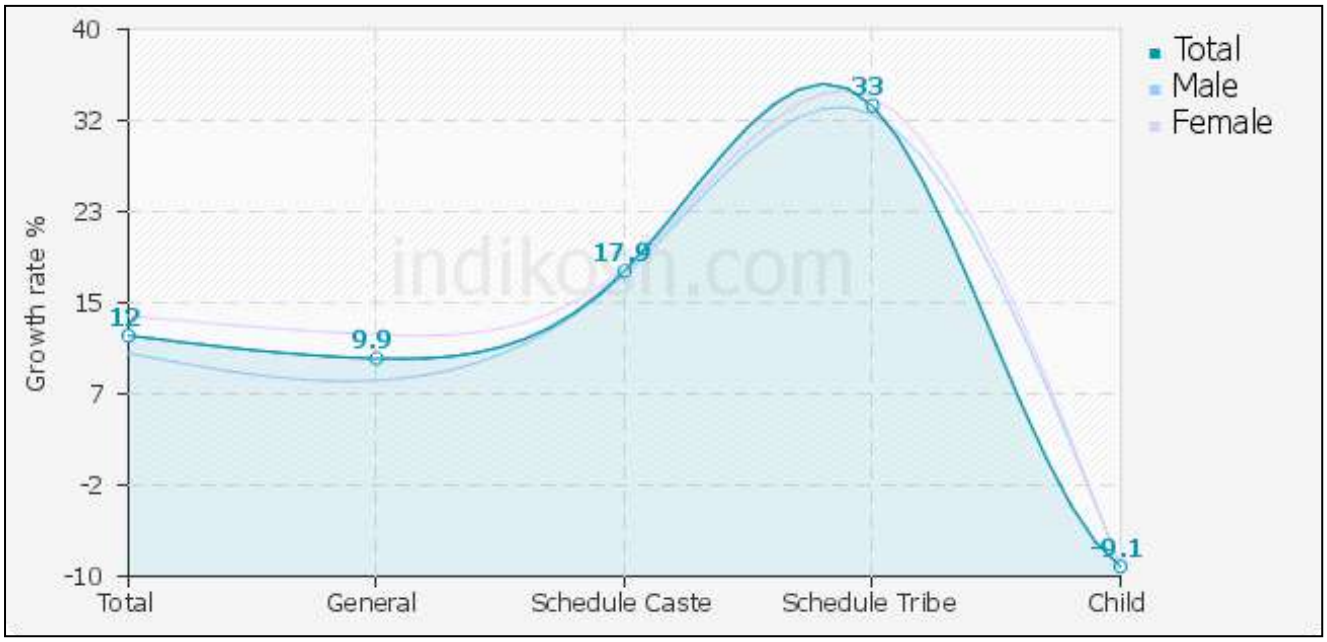


Caste wise Male Female population 2011

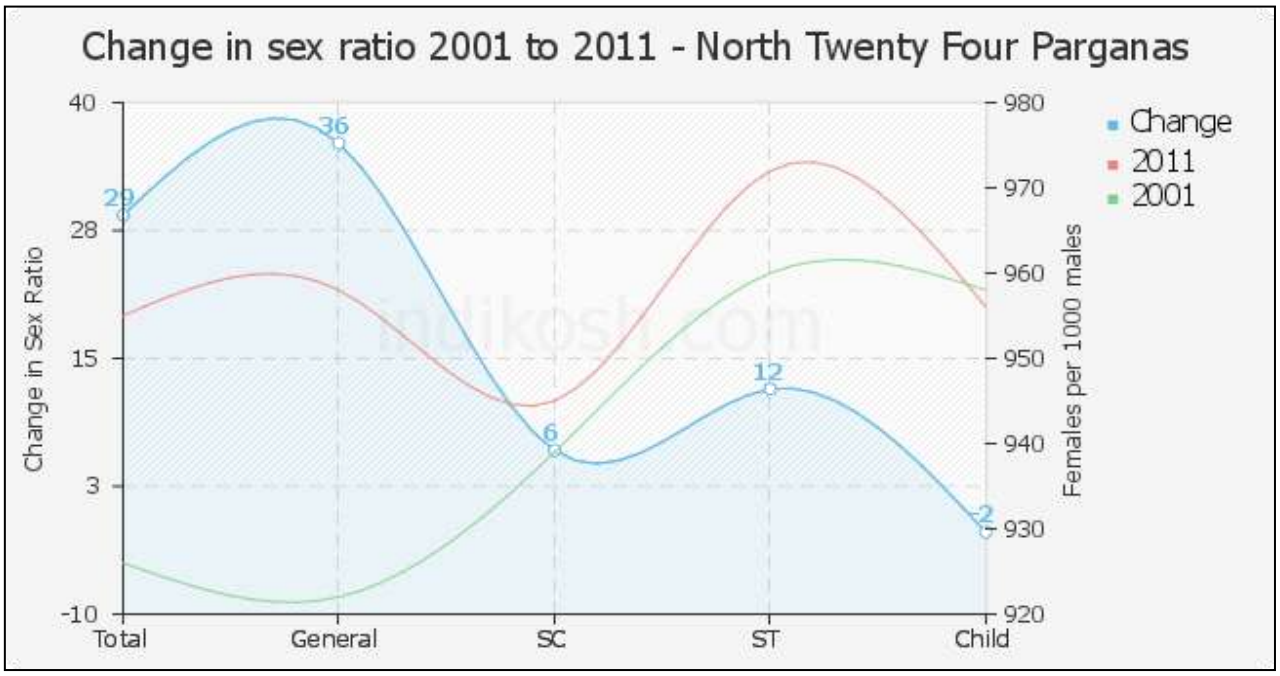
Source: *https://indikosh.com/dist/339383/north-twenty-four-parganas*



Religion wise population District



Growth of Population District



Change in Sex Ratio District

Source: https://indikosh.com/dist/339383/north-twenty-four-parganas

❖ *Forest*

The forests of West Bengal are classified into seven categories viz., Tropical Semi-Evergreen Forest, Tropical Moist Deciduous Forest, Tropical Dry Deciduous Forest, Littoral and Swampy Forest, Sub- Tropical Hill Forest, Eastern Himalayan Wet Temperate Forest and Alpine Forest.

The forests of this state has a rich assemblage of diverse habitats and vegetation designated with the help of eight different forest types. The diverse fauna and flora of West Bengal possess the combined characteristics of the Himalayan, sub-Himalayan and Gangetic plain.

The district has no forest area as such except the Sunderbans Reserve Forests The Sundarbans is a mangrove area in the delta formed by the confluence of the Ganges, Brahmaputra and Meghna Rivers in the Bay of Bengal. It spans from the Hooghly River in India's state of West Bengal to the Baleswar River in Bangladesh. It comprises closed and open mangrove forests, agriculturally used land, mudflats and barren land, and is intersected by multiple tidal streams and channels. Four protected areas in the Sundarbans are enlisted as UNESCO World Heritage Sites, viz. Sundarbans National Park, Sundarbans West, Sundarbans South and Sundarbans East Wildlife Sanctuaries. Despite these protections, the Indian Sundarbans was considered endangered in a 2020 assessment under the IUCN red list of ecosystems framework.

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A network of estuaries, tidal rivers, and creeks intersected by numerous channels, it encloses flat, marshy islands covered with dense forests. The name Sundarbans is perhaps derived from the word meaning "forest of sundari," a reference to the large mangrove tree that provides valuable fuel. Along the coast the forest passes into a mangrove swamp; the southern region, with numerous wild animals and crocodile-infested estuaries, is virtually uninhabited. It is one of the last preserves of the Royal Bengal tiger and the site of a tiger preservation project. The cultivated northern area yields rice, sugarcane, timber, and betel nuts.

The forests of Sundarban can be classified in to following categories:

(i) Mangrove Scrub: The Mangrove Scrub is formed along the edge of tidal water ways and sheltered muddy coast. The forest is usually dense with average height 3- 6 m. The plant species are evergreen type with leathery leaves.

(ii) Mangrove Forest: Mangrove Forest is also evergreen but of moderate height. It is usually found in the Tidal mud flats on the bank of deltaic streams which are permanently wet with salt water and are reached by the tidal forces.

(iii) Salt Water Mixed Forest: This type of forests is spread over the mouths of larger river streams. The Ground is susceptible to the tidal waves but the volume of silt deposition is lesser than that of the fresh water region. The soil is comparatively stiffer with lesser presence of humus. The trees are not very large.

(iv) Brackish Water Mixed Forest : The trees are usually very tall with pneumatophores and rare presence of stilt roots. The soil is usually not very salty, especially during the Monsoons.

(v) Palm Swamp Type Forest: This type of forests usually exists in the dryinner land. Tidal salt water sometimes reaches this part.

Mangrove Forest and Water Mixed Forest of the district

Source: *http://www.north24parganas.gov.in/about_district/geography*

The region is also famous for some commonly domesticated livestock breeds which includes the Garole breed of sheep and China hens or Muscovy ducks, the Garole sheep is considered as the progenitor of the Booroola merino sheep and is noted for its prolific character.

Protected Area (National Park)	Area in Sq. Km.	Flagship Species	District
1. Singalila N.P.	78.60	Red Panda	Darjeeling
2. Neora Valley N.P.	88.00	Red Panda	Darjeeling
3. Buxa N.P.	117.10	Tiger	Alipurduar
4. Gorumara N.P.	79.45	Rhinoceros	Jalpaiguri
5. Sundarban N.P.	1330.10	Tiger	S. 24 Parganas
6. Jaldapara N.P.	216.34	Rhinoceros	Alipurduar
(Wildlife Sanctuary)			
1. Jorepokhri W.L.S.	0.04	Salamander	Darjeeling
2. Senchal W.L.S.	38.88	Himalayan Black Bear	Darjeeling
3. Chapramari W.L.S.	9.60	Gaur	Jalpaiguri
4. Mahananda W.L.S.	158.04	Elephant	Darjeeling
5. Raiganj W.L.S.	1.30	Bird	North Dinajpur
6. Bethuadahari W.L.S.	0.6686	Spotted Deer	Nadia
7. Ballavpur W.L.S.	2.021	Spotted Deer	Birbhum
8. Ramnabagan W.L.S.	0.145	Spotted Deer	Bardhaman
9. Bibhutibhusan W.L.S.	**0.68**	**Spotted Deer**	**North-24 Parganas**
10. Chintamoni Kar Bird	0.07	Bird	S. 24 Parganas
11. Sajnakhali W.L.S.	362.40	Tiger	S. 24 Parganas

12. Halliday Island W.L.S.	5.95	Crocodile	S. 24 Parganas
13. Lothian Island W.L.S.	38.00	Crocodile	S. 24 Parganas
14. Buxa W.L.S.	314.52	Tiger	Jalpaiguri
15. Pakhi Bitan (Bird Sanctuary)	14.09	Bird	Jalpaiguri

✓ Bibhutibhushan Wildlife Sanctuary

Bibhutibhusan Wildlife Sanctuary (formerly Parmadan Forest) is an animal sanctuary in North 24 Parganas district in the Indian state of West Bengal. The forest is located about 100 km from Kolkata and 25 km from Bongaon. Situated on the banks of the Ichamati River covering an area of 0.68 km² it has more than 200 deer, birds, rabbit and many langurs. It also has a children's park, a small zoo and a tourist lodge of the forest department. The sanctuary began in 1964 when 14 chital were released in the forest. In 1980, it was named "Parmadan" when it was declared a wildlife sanctuary. In 1995 it acquired its present name after the famous Bengali author Bibhutibhushan Bandyopadhyay.

Bibhutibhushan Wildlife Sanctuary

In West Bengal emphasis has been given to conservation and management of sustainable resources in order to achieve the goal of long-term biodiversity conservation. The over all strategy involves protection of critical habitats of endangered species. The strategies also focus on improved PA management, development of infrastructure, habitat improvement programme, reduction of man animal conflict, capacity building and involvement of local people in management of PA areas.The Bengal wilderness is also home of an array of highly endangered species like the Asian Elephant , Great one horned Rhino, Serow, Red Panda, Pigmy Hog, Bengal Florican, Black Necked Crane, Great pied Hornbill, Goliath Heron, Estuarine Crocodile, Salvator Lizards, Olive Ridley Marine Turtle, rare Batagur terrapin, let alone being the habitat for most of the cats of India, e.g. Bengal Tiger and Leopard and the Clouded Leopard, Marbled Cat, Leopard Cat, Golden Cat, Jungle Cat and, Fishing Cat representing the lesser cats, etc.

Population status of major wild animal: Elephants in West Bengal

- About 650 wild elephants spread over two distinct regions:
- North Bengal (Jalpaiguri & Darjeeling): around 529

- South Bengal (W. Midnapur, Bankura & Purulia): around 118
- West Bengal also receives seasonal visits from 100-150 elephants from Assam and Jharkhand.
- The elephant habitat in West Bengal extends over 4200 sq km.
- West Bengal has two Elephant Reserves: Eastern Dooars ER and Mayurjharna ER.

Tiger Conservation

Tiger Lands of West Bengal are

1. **Sundarban Tiger Reserve**

   The home of Royal Bengal Tigers. A 'World heritage site'. The world's largest estuarine forest - one of the very few in the world still having its flora and fauna intact, a remarkable feature being the bayonet like roots of mangrove forests sticking out above the water levels.

   64-90 nos. during 2010 (as per report of Wildlife Institute of India, Dehradun's All India Tiger Estimation 2010). A minimum of 81 Tigers during 2012-13 Camera Trap Analysis conducted by WWF & WII.

2. **24 Parganas (South) Division:**

   A minimum of 22 tigers during 2011-12 as per Camera Trap Analysis conducted by WWF.

3. **Buxa Tiger Reserve**

   20 nos. during 2011 (as per Scat analysis through DNA finger-printing technique) by CCMB- Hyderabad, Aranyak, Assam & BTR authority)

Rhino Conservation:

- Population increased from 22 (1986) to 255 (2015)
  - Jaldapara WildlifeSanctuary:204
  - Gorumara National Park & adjoining areas: 51

❖ *Hydrogeology*

Groundwater occurs in a thick zone of saturation in the alluvium deposited by the river system. The sand and gravel horizons of different textures constitute main aquifers.

Groundwater in the northern and central part of the district occur under water table conditions. However, in isolated patches in Barrackpore, Amdanga, Hadra- II and Rajarhat blocks, the top clay and sandy clay locally thick (20- 30 metre) imparting semi-confined nature to the ground water body.

In the southern and south eastern part of the district, comprising Hasanbad, Hindalganj, Sandeshkhali and Minakhan blocks, ground water occurs under confined condition.

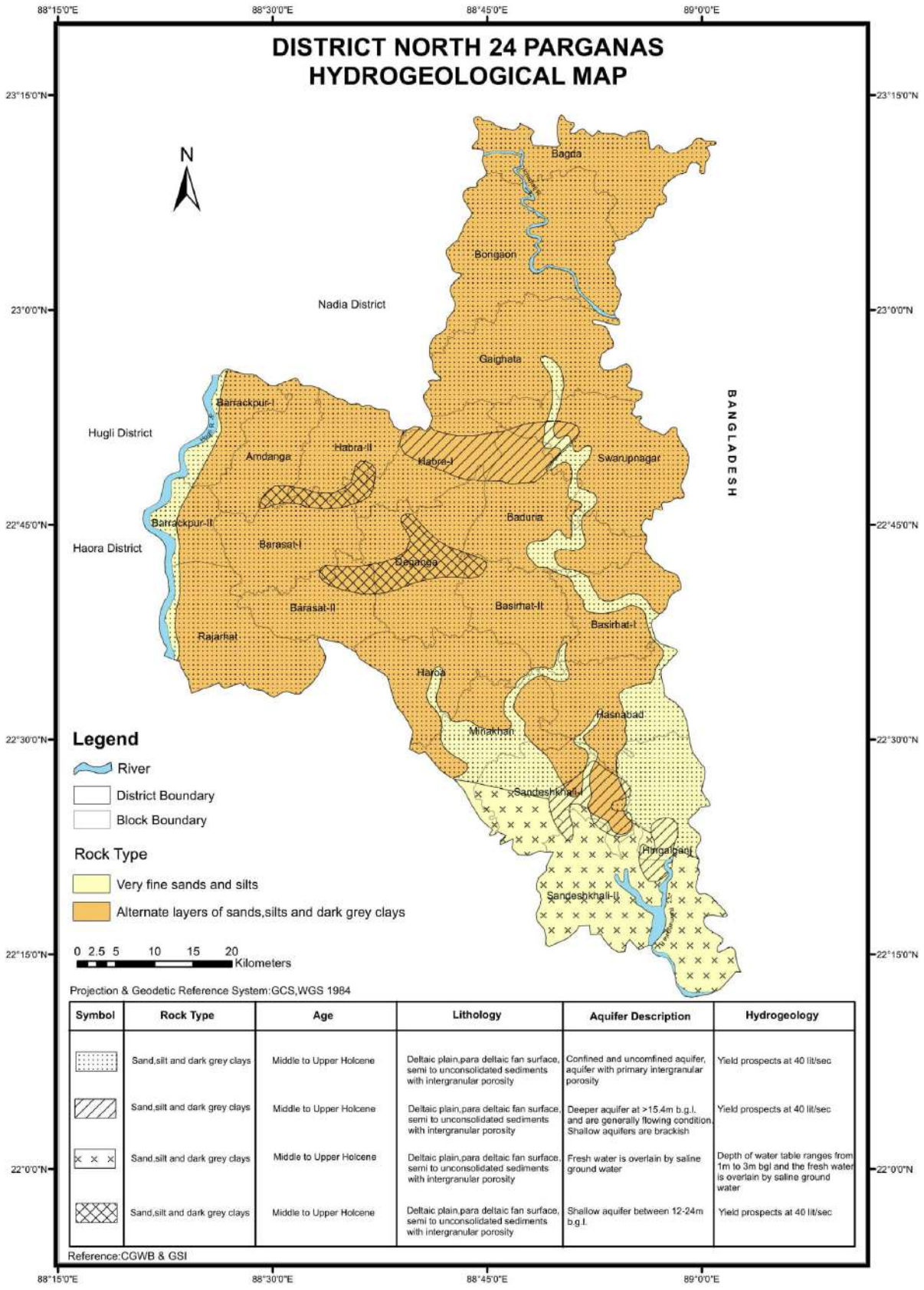
Depth to water level in unconfined aquifer during pre-monsoon period (2006) varies from 2.00 to 13.60 mbgl whereas that to post monsoon it is from 1.64 to 10.66 mbgl. Piezometric head in confined aquifer during pre-monsoon period (2006) varies from 3.47 mbgl to 6.25 mbgl whereas that to post monsoon period (2006) varies from 1.91 mbglto 5.89 mbgl.

Aquifer Characteristics- Tubewells in the district are constructed tapping both unconfined and confined aquifers and are capable to yield 50 to 150 m^3 /hr with nominal drawdown of 4-5 metre. The yield of the shallow tubewells is about 20 to 40 m^3/hr with a drawdown less than 4 metre. Transmissivity values range from 699 to 8127 m^2/day and the Storativity ranges from 699 – 8127 m^2/day and the storativity ranges from 1.05 x 10^{-3} to 1.45 x 10^{-4} . Specific yield ranges from 0.035 to 0.765.

❖ Groundwater Resources:-

The dynamic ground water resources of North 24 Parganas district has been estimated jointly by CGWB and SWID, Govt. of West Bengal, following the norms laid down by GEC 1997 methodology and projected as on 31.03.04.
The reconciled figure are as under:

Total Ground Water Resources	157,640 ham
Net Annual Ground Water Availability	141,876 ham
Existing Ground Water Draft for all uses:	101,005 ham
For Irrigation	94,066 ham
For Domestic & Industrial Water Supply	6,939 ham
Stage of Ground Water Development	71.19 %
Allocation for domestic & industrial water , Supply requirement up to 25 yrs.	10,859 ham
Net Ground Water Availability for future irrigation development	36,951 ham
Categorisation of blocks	All blocks are categorized under 'Safe' category.



Symbol	Rock Type	Age	Lithology	Aquifer Description	Hydrogeology
	Sand,silt and dark grey clays	Middle to Upper Holcene	Deltaic plain,para deltaic fan surface, semi to unconsolidated sediments with intergranular porosity	Confined and uncomfined aquifer, aquifer with primary intergranular porosity	Yield prospects at 40 lit/sec
	Sand,silt and dark grey clays	Middle to Upper Holcene	Deltaic plain,para deltaic fan surface, semi to unconsolidated sediments with intergranular porosity	Deeper aquifer at >15.4m b.g.l. and are generally flowing condition. Shallow aquifers are brackish	Yield prospects at 40 lit/sec
	Sand,silt and dark grey clays	Middle to Upper Holcene	Deltaic plain,para deltaic fan surface, semi to unconsolidated sediments with intergranular porosity	Fresh water is overlain by saline ground water	Depth of water table ranges from 1m to 3m bgl and the fresh water is overlain by saline ground water
	Sand,silt and dark grey clays	Middle to Upper Holcene	Deltaic plain,para deltaic fan surface, semi to unconsolidated sediments with intergranular porosity	Shallow aquifer between 12-24m b.g.l.	Yield prospects at 40 lit/sec

(Source: State Water Investigation Directorate, Govt. of West Bengal)

❖ Groundwater Quality:-

The chemical quality of groundwater in the area in general of bicarbonate type. The Chloride content in groundwater is low (18-234) mg/l in northern and central part of the district. The southern and south-eastern part of the district viz., Basirhat, Harora, Hasnabad, Hingal ganj, Sandeshkhali, Minakhan upper aquifers are brackish to saline nature with chloride value ranges from 300-1241 mg/l.

The water is mainly neutral to mildly alkaline in nature and pH value ranges between 7.5 and 8.2. Total hardness as $CaCO_3$ ranges from 140-670 mg/l . Generally iron content is above permissible limit in all the blocks ranges from 1.23 -18.10 mg/l but in few places it is found even of the order of 0.09-0.56 mg/l. Shallow aquifers within the depth of 100 mbgl shows arsenic concentration > 0.05 mg/l occurring in 253 mouzas in 17 blocks of the district. Deeper aquifers down to the depth of 350 mbgl are arsenic free.

❖ Groundwater Management Strategy:-

Groundwater Development:

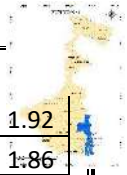
At present groundwater development in this district is mainly controlled by the shallow tubewells alongwith some deep tubewells which are very less in number. As per the Groundwater Estimation Committee, 1997, the total groundwater resources for 17 blocks thus calculated is about 157640 mham . About 101005 mham is being withdrawn from different purposes which is about 71.19%. Thus all the 17 blocks belongs to safe category which means further ground water development feasibility. Other 6 blocks (Hingalganj, Minakhan, Hasnabad, Sandeshkhali I & II and part of Barasat –II block) where ground water occurs in confined condition as well as upper part of the aquifer is brackish to saline, deeper aquifers may be developed by low to medium tube wells (50 to 150 m^3/hr discharge).

Estimation of groundwater has been calculated based on the data of shallow tubewells only. But there are sufficient deep tubewells are existing in the district which are being utilized for piped water supply and irrigation also. Thus development through deep tubewells may be taken up through tubewells applying cement sealing techniques particularly in the arsenic affected blocks in the district.

❖ Depth of Ground Water Level (in MBGL)

Sl. No.	Block	Average Pre Monsoon 2001	Average Post Monsoon 2001	Average Pre Monsoon 2002	Average Post Monsoon 2002	Average Pre Monsoon 2003	Average Post Monsoon 2003	Average Pre Monsoon 2004	Average Post Monsoon 2004
1	Amdanga	8.49	3.49	8.49	3.4	9.21	3.84	8.57	4.07
2	Baduria	4.34	2.69	5.61	2.78	5.73	2.56	5.72	3.2
3	Bagdah	4.02	2.25	4.5	3.03	4.58	2.68	4.40	1.81
4	Barasat-I	6.4	3.09	7.41	3.4	6.84	3.5	7.45	4.16
5	Barasat-II	6.53	3.25	6.6	3.44	6.28	3.52	6.95	4.17
6	Barrackpore-I	10.00	7.45	10.3	8.2	10.4	8.05	10.8	8.8
7	Basirhat-I	4.15	2.02	4.58	1.79	3.6	2.07	4.29	2.44
8	Basirhat-II	4.05	1.94	4.4	2.93	4.83	2.13	4.7	2.71
9	Bongaon	4.79	2.36	4.62	3.21	4.67	2.66	4.98	2.33
10	Deganga	5.04	1.42	5.01	1.99	4.52	1.68	5.08	2.16
11	Gaighata	4.16	1.45	4.7	2.33	4.71	2.13	4.79	1.76
12	Habra-I	5.55	2.39	6.2	3.18	6.41	2.91	7.22	3.55
13	Habra-II	8.45	2.88	7.68	3.44	8.46	3.23	8.43	3.81
14	Haroa	6.18	1.95	3.95	1.89	4.01	1.6	4.14	2.18
15	Hasnabad	2.45	1.74	2.89	1.96	3.10	1.82	3.15	2.89
16	Minakhan	2.00	0.33	1.78	0.28	1.63	0.67	2.63	0.83
17	Rajarhat	4.30	2.1	4.53	1.93	4.33	1.94	4.08	2.16
18	Saneshkhali-I	3.25	1.65	4.07	1.48	3.43	1.38	3.1	1.86
19	Saneshkhali-II	2.78	0.86	3.67	1.23	2.71	1.05	2.85	2.02
20	Swarupnagar	3.67	1.45	3.96	2.50	4.35	1.89	4.79	1.33

Sl. No.	Block	Average Pre Monsoon 2005	Average Post Monsoon 2005	Average Pre Monsoon 2006	Average Post Monsoon 2006	Average Pre Monsoon 2007	Average Post Monsoon 2007	Average Pre Monsoon 2008	Average Post Monsoon 2008
1	Amdanga	7.85	5.09	8.77	5.35	9.40	4.45	8.51	4.49
2	Baduria	5.01	2.98	5.6	3.33	4.22	2.33	4.71	2.24
3	Bagdah	4.13	2.43	4.86	2.66	4.87	1.72	4.19	2.13
4	Barasat-I	7.45	4.30	8.33	4.81	8.09	4.16	7.25	4.24
5	Barasat-II	6.51	4.14	7.23	4.66	7.19	4.22	6.49	4.09
6	Barrackpore-I	11.20	8.5	11.5	9.49	10.05	7.08	9.55	7.65
7	Basirhat-I	3.88	2.14	4.45	2.41	4.70	2.09	4.18	2.16
8	Basirhat-II	4.48	2.38	3.33	2.62	3.83	3.2	3.6	1.99
9	Bongaon	4.70	2.91	5.35	3.36	5.62	1.69	4.54	2.35
10	Deganga	4.37	2.01	5.23	2.50	5.19	1.60	3.99	2.30
11	Gaighata	4.33	2.4	5.23	2.57	4.79	1.47	4.04	1.88
12	Habra-I	5.37	3.27	6.35	3.71	6.29	2.62	6.15	2.82
13	Habra-II	7.00	4.02	9.02	4.62	8.99	3.19	7.2	3.14
14	Haroa	3.79	2.00	5.00	2.26	4.51	2.06	3.55	2.1
15	Hasnabad	4.86	3.29	3.43	2.64	3.22	2.33	2.89	2.45
16	Minakhan	2.15	0.48	2.92	0.86	3.63	0.85	3.58	0.51
17	Rajarhat	4.31	2.28	4.65	2.49	6.77	4.45	6.06	4.1



18	Saneshkhali-I	3.70	1.49	4.57	1.55	4.4	1.79	4.37	1.92
19	Saneshkhali-II	3.88	1.67	4.30	1.55	3.76	1.69	4.04	1.86
20	Swarupnagar	4.16	2.02	4.81	2.07	4.13	1.17	3.96	1.59

Sl. No.	Block	Average Pre Monsoon 2009	Average Post Monsoon 2009	Average Pre Monsoon 2010	Average Post Monsoon 2010	Average Pre Monsoon 2011	Average Post Monsoon 2011	Average Pre Monsoon 2012	Average Post Monsoon 2012
1	Amdanga	10.83	8.47	11.10	8.37	10.36	6.07	9.72	7.44
2	Baduria	5.09	3.22	4.50	N.A	4.98	2.6	4.24	2.84
3	Bagdah	4.75	3.45	4.97	3.37	5.12	3.21	4.71	2.93
4	Barasat-I	7.36	4.63	12.09	10.41	12.10	9.2	11.7	9.82
5	Barasat-II	7.38	9.7	8.87	8.2	8.70	6.4	7.96	7.63
6	Barrackpore-I	11.03	9.42	7.48	11.48	8.43	9.95	7.59	11.98
7	Basirhat-I	4.45	3.2	4.74	3.19	5.50	2.52	4.42	3.23
8	Basirhat-II	3.65	2.43	4.03	3.1	3.35	3.25	3.30	3.1
9	Bongaon	4.89	3.17	4.83	3.63	5.37	3.48	4.86	3.56
10	Deganga	4.32	3.25	5.32	4.92	4.99	3.80	4.70	2.97
11	Gaighata	4.64	3.08	5.30	3.27	5.29	2.09	4.72	2.71
12	Habra-I	4.8	4.74	6.79	5.8	6.84	4.14	7.09	5.7
13	Habra-II	8.34	4.54	8.44	6.86	8.08	4.7	6.67	5.98
14	Haroa	6.2	2.66	5.35	1.85	4.69	1.38	4.2	2.84
15	Hasnabad	N.A	2.58	3.25	2.59	3.53	2.36	2.58	2.56
16	Minakhan	2.86	0.97	3.55	0.96	2.94	0.75	4.91	0.85
17	Rajarhat	6.83	5.31	6.96	N.A	8.32	N.A	7.72	7.94
18	Saneshkhali-I	6.10	2.49	5.64	2.63	7.48	2.62	6.36	2.65
19	Saneshkhali-II	5.68	2.38	5.22	2.30	7.46	2.55	6.18	2.46
20	Swarupnagar	5.13	2.5	5.16	2.85	5.33	1.90	4.38	2.80

Sl. No.	Block	Average Pre Monsoon 2013	Average Post Monsoon 2013
1	Amdanga	11.27	5.93
2	Baduria	5.13	2.08
3	Bagdah	5.03	2.56
4	Barasat-I	12.20	9.17
5	Barasat-II	11.05	7.33
6	Barrackpore-I	6.93	3.54
7	Basirhat-I	5.35	2.05
8	Basirhat-II	3.75	1.6
9	Bongaon	5.74	2.42
10	Deganga	5.32	1.93
11	Gaighata	5.69	1.63
12	Habra-I	7.16	3.02
13	Habra-II	9.08	3.84
14	Haroa	5.49	2.31
15	Hasnabad	3.64	2.24
16	Minakhan	4.43	0.3

17	Rajarhat	9.85	6.61
18	Saneshkhali-I	7.68	2.55
19	Saneshkhali-II	7.66	2.47
20	Swarupnagar	5.07	1.67

(Source: State Water Investigation Directorate, Govt. of West Bengal)

❖ Water Conservation & Artificial Recharge:-

Scheme for Artificial recharge is completed in overdeveloped andarsenic affected area at Khatura Bangar, Swarupnagar and Gaighata Block. Details are given in the following:

Type of structure: Excavation of silt- 69000m^3

Approved Cost- 12.02 lakhs

Implementing agency- SWID, Govt. of West Bengal

Amount utilized- 12.02 lakhs

❖ Ground water related issues and problems:-

1) **Ground water quality problem (Geogenic) :**

a) Arsenic in groundwater in sporadic manner has been identified in 19 blocks in this district. A total population of 1523560 are residing in risk zone. Arsenic concentration in groundwater varies from 0.001-3.37 mg/l.

Groundwater exploration by CGWB reveals that in arsenic affected area, arsenic free deeper aquifers are available which are capable of yielding arsenic-free water. So far CGWB has constructed 39 deep tubewells in 11 blocks which are handed over to state agencies to supply arsenic free drinking water.

Apart from this, the state govt., as well as other organization/agencies have installed arsenic-removal plants and domestic filters which are producing arsenic free water . In some part of the district surface water is being provided by the state government to the arsenic affected people.

However, salinity problems in south eastern part (Barast – II, Hasnabad, Hingalganj, Minakhan, Sandeshkhali I & II) of the district does exist, where fresh water aquifers underlies saline aquifer.

b) Areas having decline in water level: From the long term monitoring of water level, declining trend (38 cm/year pre-monsoon time) has been observed in some parts of district specially in Amdanga block.

❖ *Awareness & Training Activity:-*

MASS AWARENESS PROGRAM (M.A.P.) –

Two mass awareness programme conducted in the district. Details are given below:-

Sl. No.	Place / Block	Participants	Theme
1.	Barasat / Barasat I	175	Arsenic contamination in ground water in West Bengal and its mitigation.
2.	Asoknagar / Habra	180	Ground Water Development & Management in arsenic infested areas with scope for Rain Water Harvesting.

Source: CGWB Report, Ministry of Water Resources

❖ *Water Management Training Programme (WMTP):-*

One Ground Water Management Training Programme was conducted in this district Detail is given below:-

Sl. No.	Place / Block	Participants	Theme
1.	Asoknagar / Habra	14	Ground Water Development & Management in arsenic infested areas with scope for Rain Water Harvesting.

❖ *Exhibition/Mela/Fair etc.-*

CGWB has participated in a Mela-cum-Exhibition in recent years in this district. The details are as follows:

Sl. No.	Place / Block	Organizer	Objectives
1.	Thakurnagar/ Gaighata	Thakurnagar book fair commitee	To aware people regarding the activities of CGWB.
2	Madhyamgram/ Barasat I	Madhyamgram Municipality	To aware people regarding Ground water development and managements in arsenic affected areas in N-24 Parganas.
3	Baguihati/ Rajarhat	Science and cultural organization for youth.	To aware people regarding the activities of CGWB.

Area Notified by CGWB/SGWA:- **Nil**

❖ Conclusions & Recommendations:-

1. At present district has ground water resources of 157640 mham of which gross ground water draft is 101005 mham which itself indicates that present stage of GW development is nearly 71.19%. Therefore it is essential to take cautious approach for further ground water development of the district as a whole.

2. In arsenic infested blocks ground water used for drinking purposes by identifying arsenic free tubewells as well as from arsenic free deeper aquifers and tubewells which should be properly designed by adopting cement sealing techniques. Ground water from contaminated aquifer may be used after properly treated through arsenic removal units and same may be periodically monitored.

3. Rainwater harvesting techniques (construction of recharge shaft with percolation tank) may be adopted for artificial recharge specially in Amdanga block, where water level is declining and other blocks where saline water underlies fresh water. In this regards Roof top rain water harvesting techniques can be followed for water conservation and in places for artificial recharge.

4. Cropping Pattern can be changed and crops with low water requirement (e.g. sun flower cultivation) can be adopted in Amdanga block.

5. Modern irrigation practice, such as, sprinkler and drip irrigation should be adopted to minimize the use of ground water especially in Amdanga block.

6. Change the nature pisciculture from saline water to fresh water, by checking the intrusion of saline / brackish water from rivers especially during high tide period, by introduction of salt tolerant crop may be a good remedial measures in Barasat II where saline water underlies fresh water.

Source- CGWB Report, Ministry of Water Resources (North 24 Parganas District)

Chapter - 8

Land Utilization Pattern In The District

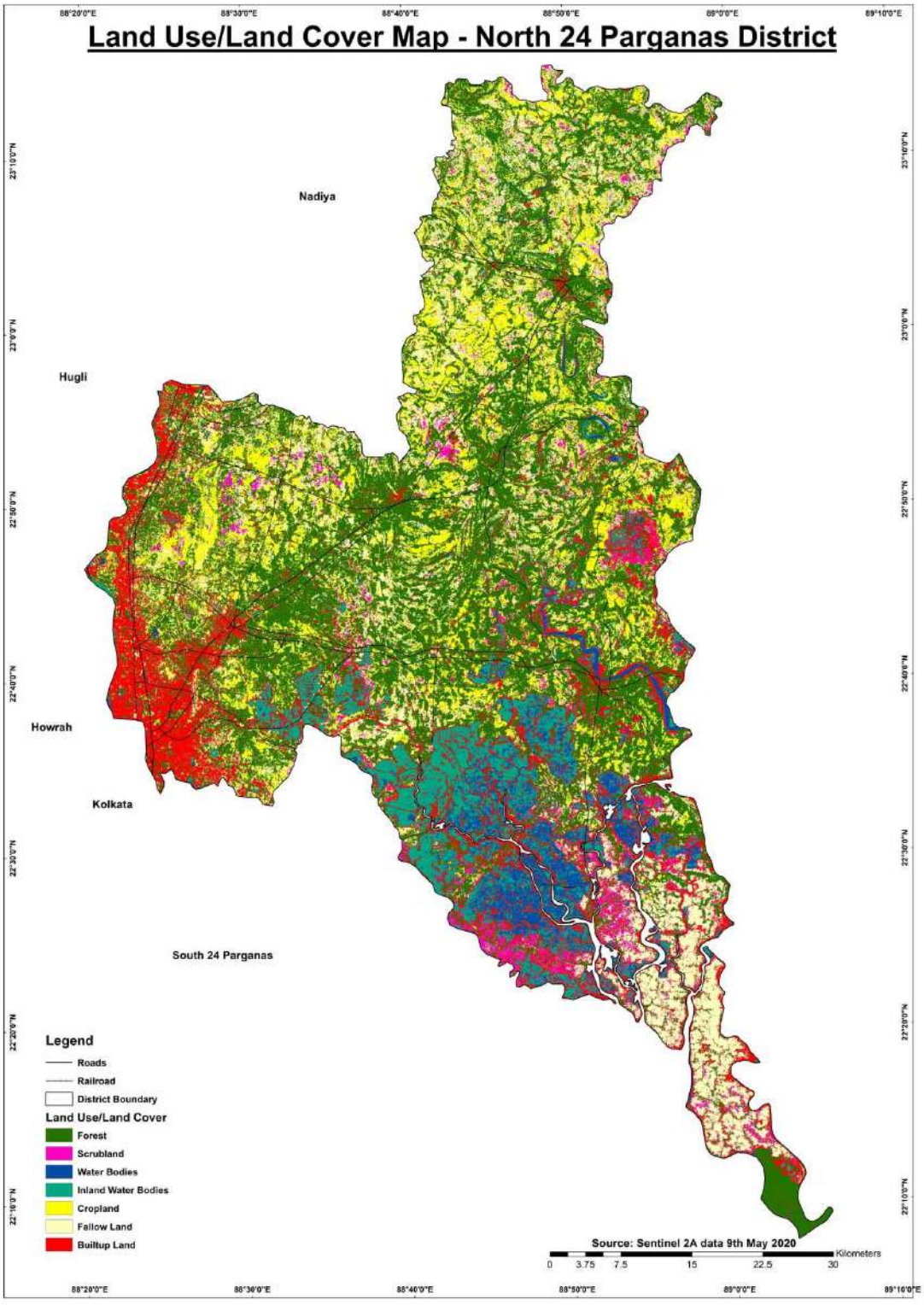
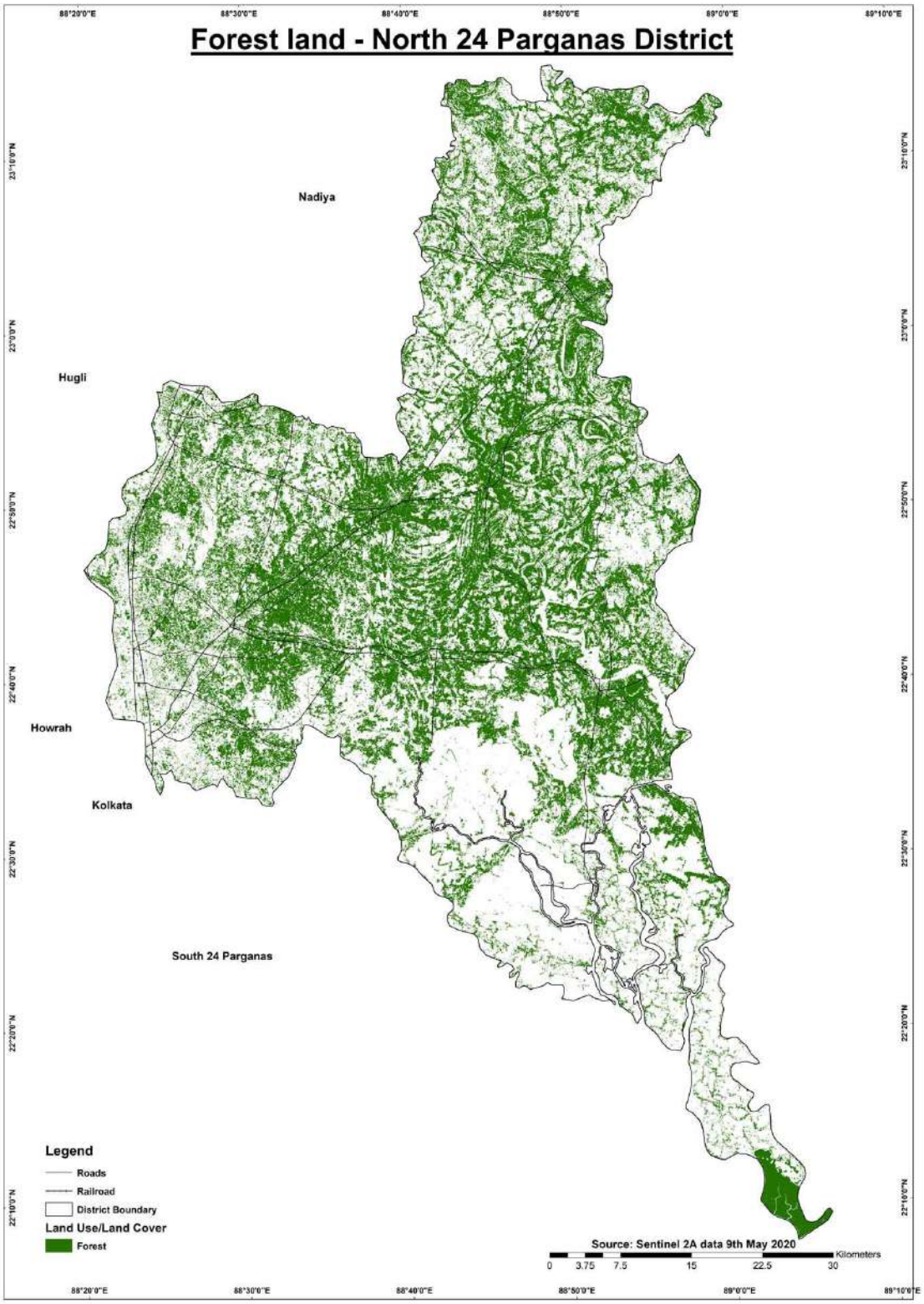


Figure 8.1 : LULC Map of the District

a. Forest:



The district has no forest area as such except the Sunderbans Reserve Forests. The total area under reserve forest is 91.98 hectares covering 1.05% of the total geographical area of the district. Out of these 91.98 hectares, 63.00 hectares have been earmarked as Bhibhuti Bhushan

Wildlife Sanctuary. However, these forests being positioned in the largest delta of the world, has a major role to play in maintaining the ecological balance of southern part of the State.

The forests of Sundarban can be classified in to following categories:

(i) Mangrove Scrub: The Mangrove Scrub is formed along the edge of tidal water ways and sheltered muddy coast. The forest is usually dense with average height 3- 6 m. The plant species are evergreen type with leathery leaves.

(ii) Mangrove Forest: Mangrove Forest is also evergreen but of moderate height. It is usually found in the Tidal mud flats on the bank of deltaic streams which are permanently wet with salt water and are reached by the tidal forces.

(iii) Salt Water Mixed Forest: This type of forests is spread over the mouths of larger river streams. The Ground is susceptible to the tidal waves but the volume of silt deposition is lesser than that of the fresh water region. The soil is comparatively stiffer with lesser presence of humus. The trees are not very large.

(iv) Brackish Water Mixed Forest : The trees are usually very tall with pneumatophores and rare presence of stilt roots. The soil is usually not very salty, especially during the Monsoons.

(v) Palm Swamp Type Forest: This type of forests usually exists in the dryinner land. Tidal salt water sometimes reaches this part.

Figure 2.11: Mangrove Forest and Water Mixed Forest of the district

Source: *http://www.north24parganas.gov.in/about_district/geography*

b) Agriculture & Irrigation:

More than half of the total area of this interfluve falls under agricultural areas and major occupation is agriculture. People are mainly engaged in intensive cultivation of staple crops like- rice in the kharif season and wheat in the Rabi seasons. Aman is the predominant paddy where as Boro occupies the second most choice to the cultivators in this interfluve. Least area is under Aus paddy cultivation. During the dry seasons or Rabi seasons some common vegetables grown in maximum villages' are- Tomato, Chilly, Potato, Brinjal, Pumpkin, Onion, Cabbage, Cauli-flower, and Beetle leaves.

Pulses and cereals like- Musur (Lentils), Khesari, Mustard, Til (Sesame), Tisi (Linseed), Bean, Sunflower etc. are mainly 153 grown here

Table 8.1: Irrigation Area

Irrigation Area type	Area (Thousand Hectare)
Net Sown area	259.22
Gross Cropped area	520.41
Net Irrigated Area	200.56
Gross Irrigated area	461.63
Rainfed area	58.78
Cropping intensity %	201%

Source:http://www.crida.in/CP-2012/statewiseplans/West%20Bengal%20(Pdf)/BCKVV,%20Kalyani/WestBengal%2013-North%2024%20Parganas-31-12-2011.pdf

Chapter - 9 Physiography of The District

North 24 Parganas is a deltaic district of West Bengal. It embraces the moribund delta in the north, matured delta in the middle, and active delta in the south and a depressed zone of brackish marshes between the active and the mature delta. Most of the soils derived from alluvial deposits are azonal with little or no profile development. Clay loam is the predominating type. Clays with or without muck soils occur in swamps and alluvial lakes. These soils have been formed from deposits brought by tidal currents. The active delta still growing southwards is a system of innumerable tidal rivers, canals and creeks, saline soils, swamps and marshes. A part of this active delta contains forests. Known as Sunderbans, this part of the active delta region is under reserve forests. Quite a large part of Sunderbans has been brought under cultivation. Even then the area of Sunderbans spread over 24 Parganas (north and south) is .42 million hectares (1629 sq. km.). Sunderbans is a mangrove forest. All the mangroves protect the shore from erosion and aid in accumulation of deposit of peat and mud. Snails, crabs and other marine species usually populate heavily beneath mangroves.

The district falls under the lower Gangetic deltaic plain land. There is no hill in the district. Broadly the district may be divided into three physiographic zones.

1. Ichhamati-Raimangal Plain : Ichhamati-Raimangal Plain contains soil of mature black or brownish loam to recent alluvium. It occupies the northern and eastern parts having a local slope towards south and drained by these two rivers.

2. North Bidyadhari Plain : North Bidyadhari Plain is full of sewerages and marshes with salt water lake region.

3. North Hugli Flat : North Hugli Flat is a raised alluvium strip along the Hugli river lying on the Western part of the district. In fact this zone is formed by silts of Hugli river.

- ## Sunderbans

The Sundarbans delta is the largest mangrove forest in the world situated in the North 24 Parganas & South 24 Parganas district. It lies at the mouth of the Ganges and is spread across areas of Bangladesh and West Bengal, India. The Bangladeshi and Indian portions of the jungle are listed in the UNESCO world heritage list separately as the Sundarbans and Sundarbans National Park respectively, though they are parts of the same forest. The Sundarbans are intersected by a complex network of tidal waterways, mudflats and small islands of salt-tolerant mangrove forests, and presents an excellent example of ongoing ecological processes. The formation of the delta is an ongoing process and new bars and islands are being created along the rivers and at the river mouth. A large section of the area remains under water during incoming times.

The area is known for its wide range of fauna. The most famous among these is the royal Bengal tiger, but numerous species of birds, spotted deer, crocodiles and snakes also inhabit

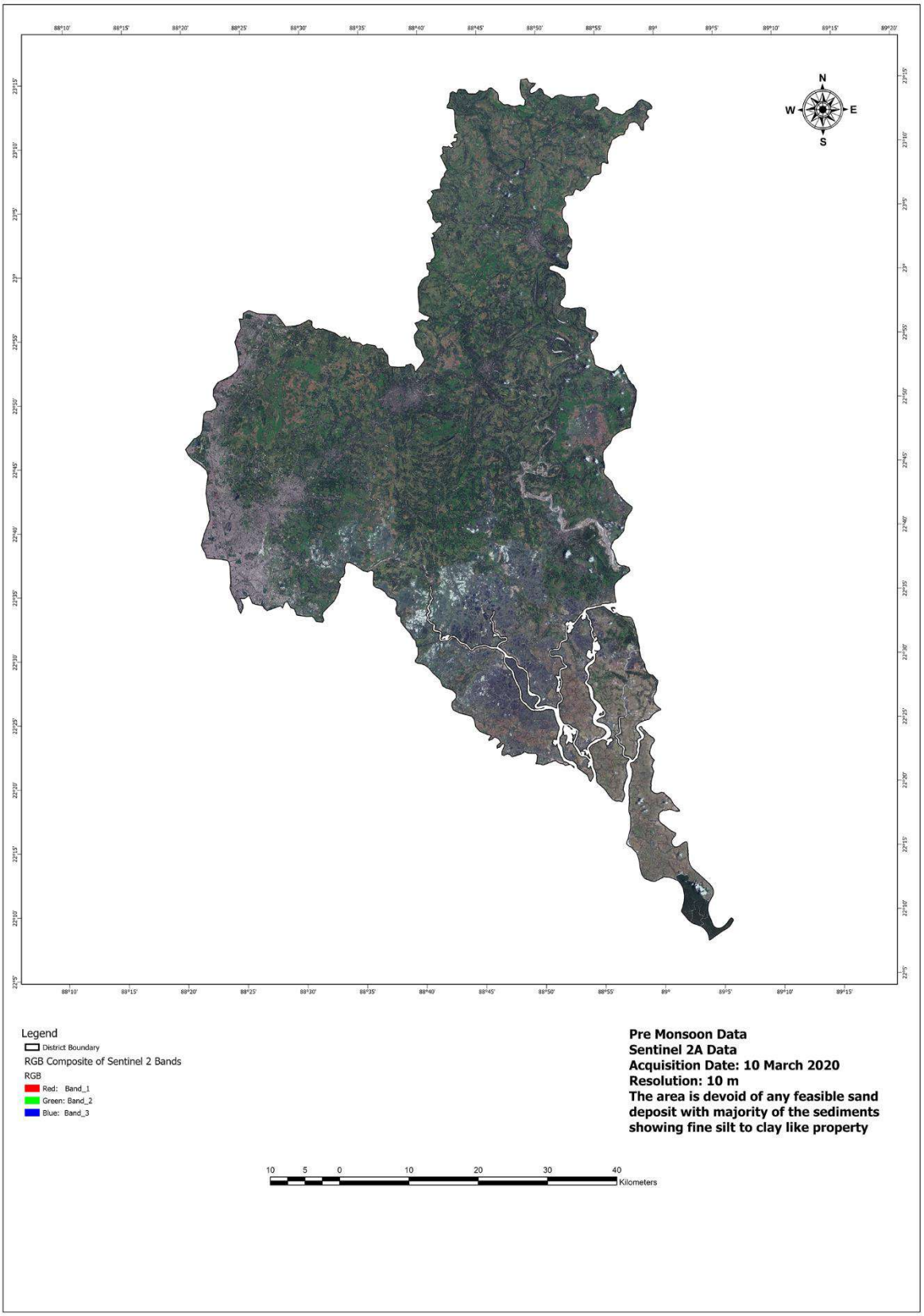
it. It is estimated that there are now 400 Bengal tigers and about 30,000 spotted deer in the area

- **Ganges delta**

The Ganges delta consists of the whole of Nadia, Kolkata, North 24 Parganas, and South 24 Parganas districts and the Eastern half of Murshidabad district. River Ganges passes through this vast area and divides into three distinct parts – the old delta, the mature delta and the active delta.

The old delta consists of the districts of Murshidabad and Nadia. The formation of delta is complete and the rivers here are heavily silted and many have even dried up in due course of time. Silted rivers, swamps, beels and oxbow lakes forms the area. This area is also known as Bagri region.

The districts of Kolkata and North 24 Parganas form mature delta region. The rivers are slow and meandering and frequently shift their courses. Swamps, beels and oxbow lakes characterises the scenery. The district of South 24 Parganas is known to be the active delta of the Ganges, where the formation of delta is still an ongoing process.


N
W
E
S
Legend
District Boundary
RGB Composite of Sentinel 2 Bands
RGB
Red: Band_1
Green: Band_2
Blue: Band_3
Pre Monsoon Data
Sentinel 2A Data
Acquisition Date: 10 March 2020
Resolution: 10 m
The area is devoid of any feasible sand deposit with majority of the sediments showing fine silt to clay like property
10 5 0 10 20 30 40
Kilometers

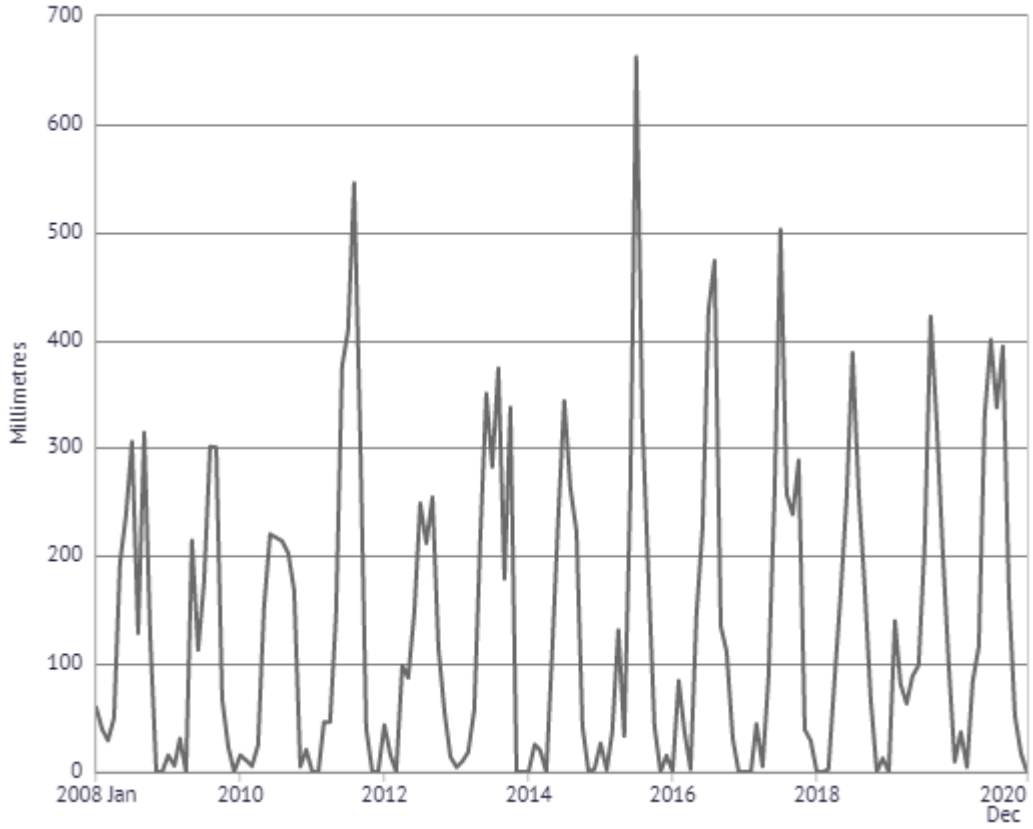
Chapter - 10 Rainfall: Month Wise & Climate Condition

Dist. - North 24 Parganas Rainfall Data (mm.)					
	2020	2019	2018	2017	2016
Jan	36.70	0.00	0.00	0.00	0.70
Feb	4.40	139.70	0.00	0.00	84.40
Mar	83.80	81.60	2.40	44.20	37.80
Apr	115.80	63.20	85.70	5.20	2.50
May	330.50	88.70	162.90	87.60	146
Jun	400.20	98.70	254.00	258.60	225.80
Jul	337.50	208.70	388.10	502.30	427.10
Aug	394	421.60	259.80	257.20	473.40
Sep	162.70	322.70	169.70	238.40	135
Oct	51.90	204.70	67.50	288.50	111.30
Nov	16.80	98.200	0.00	39.00	30.70
Dec	0.00	9.50	12.50	28.80	0.00

Source: Indian Meteorological Department, Nagpur

The Indian Meteorological Department, Nagpur, vide letter No. NAGPUR RMC/CS-312, dated 18th January, 2016 has provided the period of Rainy Season viz. Normal dates of Onset and Withdrawal of South West Monsoon over India as state-wise. The duration for the period is 10th June to 15th October.

The annual precipitation of the district is around 1661.1 mm, while the temperate varies throughout the year is 33.2° C to 19° C with relative annual humidity of 72% to 83%.


700
600
500
400
300
200
100
0
Millimetres
2008 Jan
2010
2012
2014
2016
2018
2020 Dec

Chapter - 11 GEOLOGY AND THE MINERAL WEALTH OF THE AREA

The district of North 24 Parganas of West Bengal occurs in the southern part of the Bengal basin. The basin is actually a peri-cratonic basin and comprises of Ganga-Brahmaputra delta. It had broken from the Gondowanaland along the margin of the Indian plate and then moved towards north in the early Cretaceous (125Myr ago) period.

The collision of the Indian and Euratia plates began in the early Eocene (40-41 Myr ago) period and resulted in the Himalayas and subsequently Himalayan Rivers like Ganga and Brahmaputra. Due to this the two groups of sediments from Ganga and Brahmaputra sediments got subsequently merged. There is a thickening of the Ganga-Brahmaputra delta towards the south. This occurs by the deposition of sediments not only of Ganga but also of the rivers Mayurakhi, Ajoy, Damodar etc. originating from the Chotanagpur uplands lying in the west in a word, geologically it is composed of alluvium of almost identical nature.

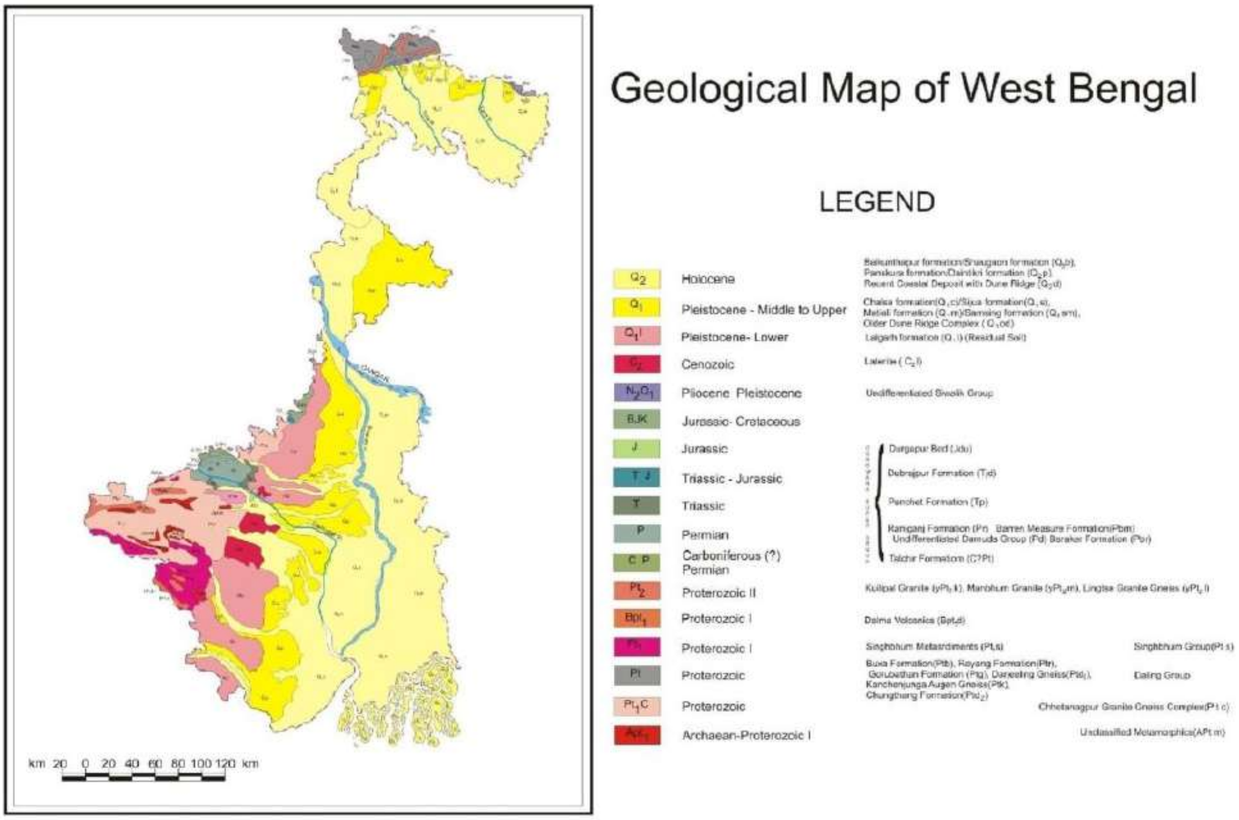
The district falls under the lower Gangetic deltaic plain land. There is no hill in the district. Broadly the district may be divided into three physiographic zones.

1. Ichhamati-Raimangal Plain: Ichhamati-Raimangal Plain contains soil of mature black or brownish loam to recent alluvium. It occupies the northern and eastern parts having a local slope towards south and drained by these two rivers.

2. North Bidyadhari Plain: North Bidyadhari Plain is full of sewerages and marshes with salt water lake region.

3. North Hugli Flat: North Hugli Flat is a raised alluvium strip along the Hugli River lying on the Western part of the district. In fact this zone is formed by silts of Hugli River.

Source: https://shodhganga.inflibnet.ac.in/bitstream/10603/165696/10/10_chapter%203.pdf


Geological Map of West Bengal
LEGEND
Holocene
Pleistocene - Middle to Upper
Pleistocene- Lower
Cenozoic
Pliocene Pleistocene
Jurassic- Cretaceous
Jurassic
Triassic - Jurassic
Triassic
Permian
Carboniferous (?) Permian
Proterozoic II
Proterozoic I
Proterozoic I
Proterozoic
Proterozoic
Archaean-Proterozoic I
Undifferentiated Siwalik Group
Durgapur Bed (Jdu)
Debrajpur Formation (Tjd)
Panchet Formation (Tp)
Talchir Formation (C?Pt)
Dalma Volcanics
Singhbhum Group
Daling Group
Chhotanagpur Granite Gneiss Complex
km 20 0 20 40 60 80 100 120 km

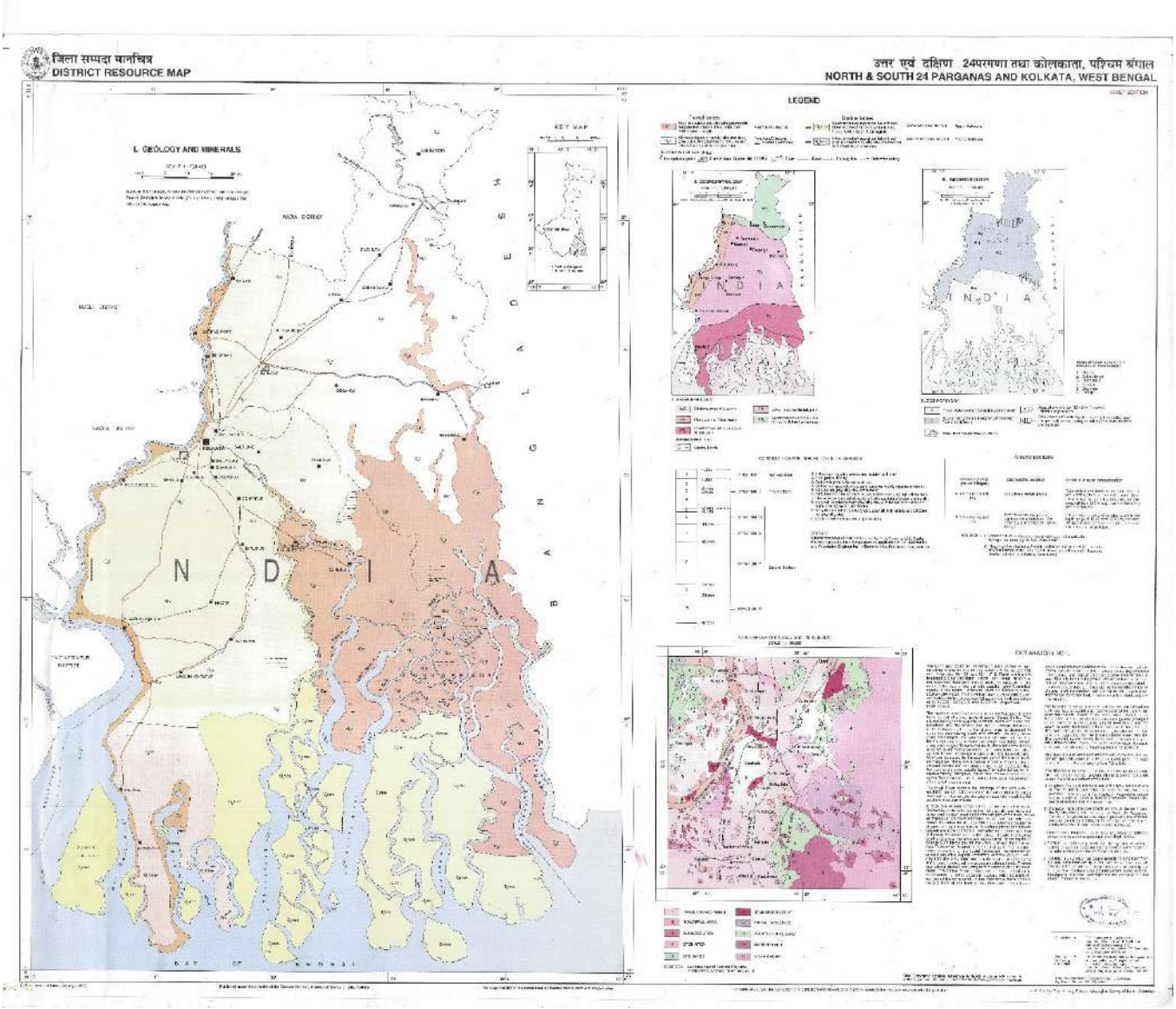
Chapter - 12 ADDITIONAL INFORMATION

❖ *Salient features of Important Rivers and Streams*

Drainage system with description of main river			
Sl.no	**Name of the River**	**District of North 24 Pgns area in (square km)**	**% Area Drained in the District**
1	Ichhamati	303.257	8.06%
2	Bidyadhari	36.348	0.96%
3	Kodala	23.907	0.63%
4	Jamuna	8.384	0.22%

Salient Features of Important River and Streams				
S.no	**Name of the River Stream**	**Total Length in the District (in km)**	**Place of Origin**	**Altitude at Origin**
1	Ichhamati	78.018	Nalabara, West Bengal	5 m
2	Bidyadhari	60.58	Bamunbaria, West Bengal	8 m
3	Kodala	29.884	Haringhata, West Bengal	10 m
4	Jamuna	41.923	Tribeni, West Bengal	3 m

Chapter - 13 MINERAL MAP OF THE DISTRICT



Chapter - 14

DETAILS OF ECO- SENSITIVE AREA IN THE DISTRICT

Part of the Sundarban Reserve Forest falls in this district, other than that no such Eco-Sensitive area has been identified in this district.

Chapter - 15 IMPACT ON THE ENVIRONMENT DUE TO MINING

❖ *For Sand Mining:-*

The environmental components that are likely to be influenced or modified by the continuation of mining activities are: Air, Water, Noise, Soil, Hydrology, Ecology & Bio-diversity, Socio-economic status etc.

Major activities involve in the operation phase are -

- Excavation,
- Loading of material on truck by excavator
- Movement of vehicle on 'kaccha' road of villages

✓ Air Pollution

In this mining project the only source of air pollution is excavation, transportation, loading and handling of minerals etc. The proposed mining operations are not anticipated to raise the concentration of pollutants beyond prescribed limits. However, the measures are suggested to mitigate the negative impact of the proposed mining activity to control the pollutants by plantation of trees along haul roads, specially near settlements, to help to reduce the impact of dust on the nearby villages; planning transportation routes of mined material so as to reach the nearest paved roads by shortest route (minimize transportation over unpaved road); regular water sprinkling on unpaved roads to avoid dust generation during transportation etc.

Emission of PM_{10}

The major sources of PM10 emission in case of sand mining project are the loading activity at mine site (loading of material over trucks / trucks by excavators) and the movement of vehicles on unpaved haul roads.

Loading of Material

The excavated materials will be loaded on dumpers using excavators.

Emission of PM10 due to Transportation

The hauling of minerals from the mine lease area to the end users via haul road (unpaved road) will cause emission of particulate matters. This emission will be limited to the extent of unpaved haul road starting from mining pit to nearest paved road connectivity.

Emission of CO from Vehicles

The excavated minerals will be transported outside the mining area for end use. The ARAI emission factors for CO emitting from heavy vehicles (diesel) is 3.92 gm/km or 6.32 g/mile.

Air Emissions

- Dust and air emission particularly due to the excavation, construction and movement of vehicles resulting in air pollution.

- No. of PCU/Hr will increase due to mining in existing traffic scenario lead to air pollution which can cause adverse effect on human health of neighbouring villagers like effect on breathing and respiratory system, damage to lung tissue, cancer and premature death, influenza or asthma.

✓ Noise Pollution

- Noise Impact due to mining activities.
- Human Noise from the machinery can cause hypertension, high stress level, hearing loss, sleep disturbance etc. due to prolonged exposure.
- Increase in the existing traffic due to this mining activity may occur unwanted sound and can also cause impact on human health of neighbouring villagers like effect on breathing and respiratory system, damage to lung tissue, cancer and premature death, influenza or asthma.

✓ Water Pollution

- Flow pattern might be changed due to river bed mining.
- Mining activities depth will be increased, which may result in increase of flow velocity.
- Change in surface water quality and ground water quality.
- Impact on ground water recharge potential as the thickness of the natural filter materials (sediments) is reduce causing less infiltration.
- Waste water discharge.

✓ Soil Environment

- Mining activity may increase the soil erosion and soil degradation which have adverse impact on soil fertility.
- Top soil extraction from outside riverbed may also affect the soil fertility and productivity.
- During the flood, the soil erosion may occur.

✓ Solid Waste Generation / Management

- Flow pattern might be changed due to river bed mining.
- Mining activities depth will be increased, which may result in increase of flow velocity.
- Waste water discharge.

✓ Land Use

- The mining activity in the outside riverbed will be converted into the pit. which may cause soil erosion, soil degradation etc.
- Mining in the riverbed may change complete land use pattern including channel geometry, bed elevation, sediment transportation capacity which can reduce flow of the river and downstream erosion.

✓ Hydrology

- The mining in the riverbed area may cause the ground water contamination due to intersection of the water table.
- Change the topography will divert the river flow.
- Change in topography can change the river flow and flood may occur.
- Slope of mining area will change which can create soil erosion and divert rain water runoff channel.

✓ Topography, Drainage and Ground water Contamination

- Spillage of oil from construction / transportation vehicles and equipment.

✓ Biological Environment

- Transportation of sand in the trucks/dumper will disturb the movement of wild animals like jungle cat, jackal, and other reptiles. Fugitive emission from vehicle movement will form a layer in leaves thus reducing the gaseous exchange process. This ultimately affects the growth of plants. Chances of vehicle collisions with wildlife attempting to cross roads are possible.
- Any human settlement in the mining area will disturb the vegetation cover and reptiles
- Indiscriminate mining from active channels of rivers causes many adverse effects on the benthic fauna, which inhabits the bottom sandy substratum. Excessive sand extraction from rivers affects the eco-biology of many terrestrial insects whose initial life history begins in aquatic environments
- Stomatal index may be minimized due to dust deposit on leaf.

✓ Socio-economic

- Such shops along the roads will generate solid waste and waste water which will have adverse impact on human health.
- Further, the deep pits created in the channel also can contribute to an increase in accidents in the working environment.

❖ *For Mines Other Than Sand Mining:-*

Mining is the extraction of minerals and other geological materials of economic value from deposits on the Earth. Mining adversely affects the environment by inducing loss of biodiversity, soil erosion, and contamination of surface water, groundwater, and soil. Mining can also trigger the formation of sinkholes. The leakage of chemicals from mining sites can also have detrimental effects on the health of the population living at or around the mining site.

✓ AIR POLLUTION

Air quality is adversely affected by mining operations. Unrefined materials are released when mineral deposits are exposed on the surface through mining. Wind erosion and nearby vehicular traffic cause such materials to become airborne. Lead, arsenic, cadmium, and other toxic elements are often present in such particles. The air borne particulate matter generated by mining of mineral (drilling & blasting), handling of minerals and transportation. The emissions of Sulphur dioxide (SO2), Oxides of Nitrogen (NOx) are from diesel operated excavation/loading equipment, Compressor, DG set and vehicles plying on haul roads. These pollutants can damage the health of people living near the mining site. Diseases of the respiratory system and allergies can be triggered by the inhalation of such airborne particles.

Sources of air pollution are as follows:

- Dust and gaseous emissions due to Drilling & Blasting, stockpiling, extraction and loading of stone by various mining activities.
- Dust and gaseous emissions due to movement of transport vehicles
- Gaseous emissions due to operation of Compressor, DG Set.

WATER POLLUTION

Mining also causes water pollution which includes metal contamination, increased sediment levels in streams, and acid mine drainage. Pollutants released from processing plants, tailing ponds, underground mines, waste-disposal areas, active or abandoned surface or haulage roads, etc., act as the top sources of water pollution. Sediments released through soil erosion cause siltation or the smothering of stream beds. It adversely impacts irrigation, swimming, fishing, domestic water supply, and other activities dependent on such water bodies. High concentrations of toxic chemicals in water bodies pose a survival threat to aquatic flora and fauna and terrestrial species dependent on them for food. The acidic water released from metal mines or coal mines also drains into surface water or seeps below ground to acidify groundwater. The loss of normal pH of water can have disastrous effects on life sustained by such water.

Sources of water pollution from the Mine shall be as follows:

- Domestic waste water from Office & Rest Room
- Run-off from waste dump in rainy season

Adequate control measures will be adopted to check not only the wash-off from soil erosion but also uncontrolled flow of mine water.

NOISE POLLUTION

Mining operations involve deployment of mining machineries, drilling, blasting, excavation and transportation of stone. Noise may be generated by the impact from drill bits and mechanical vibration from drill casings, as well as impulse noise from exhaust and ancillary equipment such as fans and blowers for mine ventilation.

LAND ENVIRONMENT

The creation of landscape blots like open pits and piles of waste rocks due to mining operations can lead to the physical destruction of the land at the mining site. Such disruptions can contribute to the deterioration of the area's flora and fauna. There is also a huge possibility that many of the surface features that were present before mining activities cannot be replaced after the process has ended. The removal of soil layers and deep underground digging can destabilize the ground which threatens the future of roads and buildings in the area.

Chapter - 16

REMEDIAL MEASURES TO MITIGATE THE IMPACT OF MINING ON THE ENVIRONMENT

❖ *REMEDIAL MEASURES FOR SAND MINING :-*

✓ Air Environment

In this mining project the only source of air pollution is excavation, transportation, loading and handling of minerals etc. However, the measures are suggested to mitigate the negative impact of the proposed mining activity to control the pollutants by plantation of trees along haul roads, specially near settlements, to help to reduce the impact of dust on the nearby villages; planning transportation routes of mined material so as to reach the nearest paved roads by shortest route (minimize transportation over unpaved road); regular water sprinkling on unpaved roads to avoid dust generation during transportation etc.

Impact	Mitigation Measures
Air Emissions • Dust and air emission particularly due to the excavation, construction and movement of vehicles resulting in air pollution.	• Provision of spraying water to reduce dust emission on roads and particularly near existing settlements. • Excavated topsoil to be preserved and reused for landscaping. • The amount of exposed ground and stockpiles will be minimized so that re-suspension due to wind and subsequent dust fall is prevented. Heights of stock piles should control dust fall in nearby areas. • Arrangement of the soil will be such that existing drainage pattern, though altered, will still ensure that runoff does not carry away topsoil but reaches the water bodies with which it is linked. Ensuring all vehicles, generators and compressors are well maintained and regularly serviced.

The following measures are suggested to mitigate any negative impacts of mining:

- Planned multiple transportation routes in different direction to minimize the dust generation.
- Planned paved roads outside mine lease area to minimize the dust generation. Alternatively, planning transportation routes so as to reach the nearest paved roads by shortest route. (Minimize transportation over unpaved road).
- Frequent water sprinkling on unpaved roads (>2L/m2).
- Plantation of trees along haul roads, especially near settlements, to reduce the impact of dust on the nearby villages.

- Dust mask shall be provided to the workers engaged at dust ge1neration points like excavations and loading points.
- Transportation of material shall be carried out during day time only.
- The speed of trucks plying on the haul road should limited to 20 km/hour to avoid generation of dust.
- Covering of material by tarpaulin during transportation on trucks to prevent spillage of materials from the trucks.
- Overloading shall be avoided.

Movement of Traffic-

Impact	Mitigation Measures
• No. of PCU/Hr will increase due to mining in existing traffic scenario lead to air pollution which can cause adverse effect on human health of neighbouring villagers like effect on breathing and respiratory system, damage to lung tissue, cancer and premature death, influenza or asthma.	• Vehicles with PUC Certificate will be hired. Regular maintenance of vehicles will be done to ensure smooth running of vehicle. It is proposed to plant local species trees per year with consultation of Forest department with some fruit bearing and medicinal trees, along the haul roads, outer periphery within the lease area to prevent the impact of dust in the nearby village. Regular Health checkup camps will be organized.
• No. of PCU /Hr will increase in the existing traffic due to this mining activity hence vehicle collation may occur unwanted sound and can also cause impact on human health.	• In addition, truck drivers will be instructed to make minimum use of horns in the village area and sensitive zones. It is proposed to plant local species trees per year with consultation of Forest department with some fruit bearing and medicinal trees, along the haul roads, outer periphery within the lease area to reduce the impact of noise in the study area. Regular Health checkup camps will be organized.
• Accidents may be occurring due to fast movement of vehicles.	• To avoid accidents the speed of vehicles will be low near habitation areas.

✓ **Noise Pollution**

It can be stated that the impact on the present noise levels due to mining operations will be minimal and shall be restricted to transportation route only. There is no drilling and blasting envisaged in the sand mining so there is no impact of vibration.

Impact	Mitigation Measures
• Noise Impact due to mining activities. • Human Noise from the machinery can cause hypertension, high stress level, hearing loss, sleep	• Noise generated be this equipment will be intermittent and does not cause much adverse impact. • The noise measurement data indicated that present noise levels in the study area is within the permissible limits of National Ambient Noise Quality Standards.

Impact	Mitigation Measures
disturbance etc. due to prolonged exposure. • Increase in the existing traffic due to the mining activity may occur unwanted sound and can also cause impact on human health of neighboring villagers like effect on breathing and respiratory system, damage to lung tissue, cancer and premature death, influenza or asthma.	• Periodical monitoring of noise will be done. • No other equipment except the transportation vehicles and excavator for loading will be allowed. • Proper maintenance of all equipment / machines will be carried out which help in reducing noise during operations. • In addition, truck drivers will be instructed to make minimum use of horns in the village area and sensitive zones. • Plantation will be taken up along the approach roads and vicinity of river bank. The plantation minimizes propagation of noise and also arrests dust. • Ear muffs will be provided while working on mining equipment. • Regular health check-ups will be conducted for any such health implications

✓ **Water Environment**

Impact	Mitigation Measures
• Flow pattern might be changed due to river bed mining. • Mining activities depth will be increased, which may result in increase of flow velocity.	• No diversion is proposed. There will not be any adverse impact on flow pattern, surface hydrology and ground water regime. • Mining activities will be restricted to 1.5 m depth, which will not cause much change in flow pattern of the river.
• Change in surface water quality and ground water quality. • Impact on ground water recharge potential as the thickness of the natural filter materials (sediments) is reduce causing less infiltration. • Waste water discharge.	• The mining will not be allowed below the water table. • Regular monitoring of water samples will be done as precautionary measures. • Mining will be done as per approved Mine Plan and applicable Rules & Regulation, so that there is no damage on ground water recharge potential due to sand mining. • Portable Bio-toilets will be used; hence no sewage / liquid effluent will be generated and contamination is also not expected due to percolation.

✓ **Soil Environment**

Impact	Mitigation Measures
• Mining activity may increase the soil erosion and soil	• It is already proposed to plant local species trees per year with consultation of Forest department with some fruit bearing and medicinal trees, along the haul

Impact	Mitigation Measures
degradation which have adverse impact on soil fertility.	roads, outer periphery within the mining area which enhances the binding property of the soil to check the erosion. • Water will be sprinkled on unpaved roads to avoid dust generation and soil erosion.
• Top soil extraction from outside riverbed may also affect the soil fertility and productivity.	• In case of riverbed, no top soil will be generated during the mining activity.
• During the flood, the soil erosion may occur.	• Mine lease area has been proposed leaving a safety distance from the bank inwards which will protect the banks. Check dams have been constructed at various places for protection of banks against direct attack of the rivers and avoid bank cutting.

✓ **Solid Waste Generation / Management**

Impact	Mitigation Measures
• Flow pattern might be changed due to river bed mining. • Mining activities depth will be increased, which may result in increase of flow velocity.	• No diversion is proposed. There will not be any adverse impact on flow pattern, surface hydrology and ground water regime. • Mining activities will be restricted to 1.5 m depth, which will not cause much change in flow pattern of the river.
• Waste water discharge.	• Portable Bio-toilets will be used; hence no sewage / liquid effluent will be generated and contamination is also not expected due to percolation.

✓ **Land Use**

Impact	Mitigation Measures
• The mining activity in the outside riverbed will be converted into the pit. Which may cause soil erosion, soil degradation etc.	• It is proposed to plant of local species trees per year with consultation of Forest department with some fruit bearing and medicinal trees, along the haul roads, outer periphery within the mining area which enhances the binding property of the soil.
• Mining in the riverbed may change complete land use pattern including channel geometry, bed elevation, sediment transportation capacity which can reduce flow	• The mining is planned in non-monsoon seasons only so that the excavated area will be replenished naturally during the subsequent rainy season for the river bed mining block. • Mine lease area has been proposed leaving a safety distance from the bank inwards which will protect the

of the river and downstream erosion.	banks so channel geometry will not be disturbed. Check dams have been constructed at various places for protection of banks against direct attack of the rivers and avoid bank cutting. • Pre and post monsoon survey for sedimentation in the riverbed will be done regularly

Remedial Measures for Air Pollution

- All machineries and transport vehicles will be properly maintained and pollution check will be done once in a year to keep the emissions from machineries and vehicle under control.
- Water sprinkling will be done on haul road to control emission of dust while transporting minerals and waste. Provision for water spray by tankers on 'kaccha' road shall be done.
- Water sprinkling at loading area.
- Tree plantation along the haul roads & approach road will be done. Plantation along the mine boundary shall be done with tree density of 2000 trees per Hectare as per the norms of MoEF&CC, to control dust & noise.
- Use of personal protective equipment like dust mask.
- Ambient air pollution monitoring will be carried out

Remedial Measures for Water Pollution

- Mining is proposed to plan above the ground water table. Therefore, pumping of ground water from mine pit does not arise in this mine. The rain water during rainy season is proposed to settle in a pit and shall be use for dust suppression and plantation. Excess water, if any shall be discharged in natural stream after settling of suspended particles in the pit. Pump having required capacity will be installed to lift accumulated rain water from working pit and pumped to the settling tank.
- Garland drain shall be made around the Waste dump and the rain water shall be collected in garland drain and allowed to settle in a small pit for settling suspended particles before allowing discharge to natural drainage system.
- For domestic waste water Septic Tank with Soak Pit shall be provided, discharge from Soak Pit, if any shall be used for plantation

Remedial Measures for Noise Pollution

- Diesel powered machineries, which is major source of noise in open cast mining shall be properly maintained. Attention shall be paid towards rigorous maintenance of the silencer of the diesel engines.
- Protective devices shall be provided for use of persons employed in the vicinity of high noise areas.
- Plantation around the lease boundary will cut the noise levels.

Remedial Measures for Land Environment

Some of the measures followed to minimize the impacts are as follows:

- The mining activities will be restricted within the lease area only.
- The waste material will be utilized for the construction of road and also will be used by the local people for construction work.
- The surface run off from the lease area will be retain within the lease and used for plantation, dust suppression and block cutting. So, there will be no soil erosion from the lease area and its surrounding due to mining activity.
- The dump will have inward slope with catch drains at inward side of the terrace and the catch drain of the individual terrace will be connected to the garland drain outside the periphery of the dump. Retaining wall and garland drain will be constructed around the dumps and the surface runoff water pass through the garland drain and finally settled in a settling pit before released outside.
- Retaining wall and garland drains for the proposed waste dump will be constructed to arrest wash offs from the dump.
- Maintenance/ repair of vehicles and machineries will not be inside the mining area. However, steel trays will be used for any emergency repair and sudden leakage of oil.

Remedial Measures for Waste Management

The solid waste shall be dumped systematically with proper repose angle and stabilization as follows:

- Gradation of dump shall be done automatically as coarser materials go to the bottom and finer at the top and therefore drain of rain water flow freely to the bottom without endangering the stability of dump.
- Stabilization of dump with top soil and tree plantation shall make the dump more stable on long. Dump should be terraced for every 5 m height and stabilized
- 1m height parapet shall be constructed for dumps more than 6m height along the toe to prevent and control wash out from dumps entering into natural system through rain water
- Garland drainage around dump shall prevent under wash of dump by hydrostatic pressure to be developed by surface water and control wash outs and collapse.

Remedial Measures for Flora and Fauna

Extensive plantation comprising of pollutant resistant trees will be undertaken, which will serve not only as pollution sink but also as a noise barrier. It is proposed to include Azadirachta indica, and Ficus religiosa in the plantation program as they serve as sinks for gaseous emissions.

The impact on the fauna of the buffer zone due to the mining activity will be insignificant. The proposed progressive plantation over a period of time will reduce the impact, if any, on the fauna.

Chapter - 17

RISK ASSESSMENT & DISASTER MANAGEMENT PLAN

❖ *RISK ASSESSMENT FOR SAND MINING*

Since the Sand Mining Operation does not attract Mine Act 1952, it does not require any statutory personals, however the entire operation must be under the supervision of experience qualified person who can handle the labour employment effectively. The person must have knowledge of transportation activities with traffic rule & safety. It is always advisable to appoint such person who can understand the language of Mine plan & implement the same.

1. As such in case of sand mining activities does not have any short of risk in operational activity except prior to start the monsoon period all the manpower & equipment's to be withdrawn to safe location.
2. In case of temporary discontinuation of operation due to natural calamity or labour strike & Risk management plan to be developed based in the local condition.

ACCIDENTS DUE TO TRANSPORTATION AND MOVEMENT OF MINING MACHINERIES

Risk

Most of the accidents occur during transportation by tippers/ trucks and movement of Mining machineries.

Mitigation Measures

- This can be prevented by regular training of all vehicle/machinery drivers/operators, regular maintenance of equipment and ensuring safe operations.
- All safety precautions and provision of MMR 1961 shall be strictly followed during all mining operations.
- Regular maintenance and testing of all mining equipment as per manufacturer's guidelines.
- All transportation within the main working area should be carried out under the direct supervision and control of the management;
- The vehicles must be maintained in good repairs and checked thoroughly at least once a week by a competent person authorized for this purpose by the management;
- Broad signs should be provided at each and every turning point specially for the guidance of the drivers of vehicles.

- To avoid dangers while reversing the trackless vehicles, especially at the embankment and tripping points, all areas for reversing of lorries should, as far as possible, be made man free, and there should be a light and sound device to indicate reversing of trucks; and
- A statutory provision of the fence, constant education, training etc. will go a long way in reducing the incidence of such accidents.

RISK AND MITIGATION MEASURES

OVER BURDEN

Risk

The overburden dumps may cause landslides. High overburden dumps created at the quarry edge may cause sliding of the overburden dump or may cause failure of the pit slope due to excessive loading, thereby causing loss of life and property. Siltation of surface water may also cause run-off from overburden dumps.

Mitigation Measures

- To prevent the failure of overburden slopes, especially during the rainy season, proper garland drain & bund are constructed around the dump.
- To prevent this, height of overburden dumps will be restricted. Further, no stone or loose rock or loose tree will be allowed to remain within 3 meters of the edge of the quarry. To prevent siltation of surface water, retaining wall will be constructed on the down side of each OB dump.

ACCIDENTS DUE TO TRANSPORTATION AND MOVEMENT OF MINING MACHINERIES

Risk

Most of the accidents occur during transportation by tippers/ trucks and movement of Mining machineries.

- Operations of jackhammers are often attributable to mechanical failures and human errors.

Mitigation Measures

- This can be prevented by regular training of all vehicle/machinery drivers/operators, regular maintenance of equipment and ensuring safe operations.
- All safety precautions and provision of MMR 1961 shall be strictly followed during all mining operations.

- Regular maintenance and testing of all mining equipment as per manufacturer's guidelines.
- All transportation within the main working area should be carried out under the direct supervision and control of the management;
- The vehicles must be maintained in good repairs and checked thoroughly at least once a week by a competent person authorized for this purpose by the management;
- Broad signs should be provided at each and every turning point specially for the guidance of the drivers of vehicles.
- To avoid dangers while reversing the trackless vehicles, especially at the embankment and tripping points, all areas for reversing of lorries should, as far as possible, be made man free, and there should be a light and sound device to indicate reversing of trucks; and
- A statutory provision of the fence, constant education, training etc. will go a long way in reducing the incidence of such accidents.

FUEL STORAGE

- No major storage of fuel envisaged in the mining lease area

WATER LOGGING

Risk

Filling of mine pit with excessive rain

Mitigation Measures

- Provision of adequate capacity pumps for pumping out water from the mining pit with standby arrangements.
- Checking and regular maintenance of garland drainage and earthen bunds to avoid any inflow of surface water into the mine pit.
- Proper drainage will be maintained to eliminate inundation of working pits during rains from run-off water. Suitable garland drain will be provided around pit along with sedimentation pits on each side.
- There is no danger of flood or inundation as the ground level is well below the plateau top, where mining will be carried out.

CARE AND MAINTENANCE DURING TEMPORARY DISCONTINUANCE:

In case of emergency arise as situation of temporary discontinuance due to court order or due to statutory requirements or any other unforeseen circumstances pit will be fenced and locked properly so as no one can enter in pit. All plantation will be protected with all due care for their survival. Maintenance and monitoring of discontinued mining operations i.e. maintenance of haul roads, will be done in view of re-open in near future.

DISASTER MANAGEMENT PLAN

❖ Vulnerability of the State

West Bengal has been no exception as far as sufferings inflicted by natural and man-made hazards are concerned. The state has been frequented by cyclones, floods, droughts, landslides, subsidence and occasional earthquakes. Progressive trends of any region are controlled to a large ex- tent by the requirements of the inhabitants, agriculture, industries, transportation, communication, education and culture, which generally form the vulnerability attributes. Because of the high population density and concentration of industrial and agricultural activities across West Bengal, risk or vulnerability to natural or man-made disasters is particularly high. With increasing developmental activities in high-hazard zones, e.g. the coastal regions, the vulnerability scenario appears to be worsening with time.

❖ The Regional Perspectives

The prevailing hazards are seen interlinked to each other in many cases. Nevertheless, individualistic hazard scenario is reviewed in the regional context to understand the needs and priority distribution.

❖ Floods

Approximately 55.8% of the region is susceptible to floods. Furthermore, complicacy is implicated by the origination of major flood-producing rivers beyond the state jurisdictional limits.

An outline of flood management

A monograph on flood management prepared on the basis of hands-on experience of the State Government officials recommends a standard operating procedure. Three phases of actions are specified: pre-flood, during flood and post-flood. The pre-flood phase activities consist of preparatory measures, which involve vulnerability assessment, personnel and organizational database development, viable emergency action plan such as deployment of early warning system, training of personnel for rescue and evacuation, verification and updating of existing search, rescue and evacuation plans, and inventories of essential commodities and relief materials. A district disaster management committee is expected to be coordinated before the onset of the monsoon season to ensure adequate preparedness. Participation of various government and non-governmental organizations is anticipated in knowledge and expertise sharing. Strategic planning focuses on hazard elements and formulates actions such as construction, restoration or improvement of drainage channels, and removal of human encroachment along the riverbanks. On the very onset of the hazard, the highest priority is on 'search, rescue and evacuation', in addition to 'organization of relief facilities'. Quick and correct dam- age assessment would enable speedy restoration and re-habilitation in terms of physical, economic and social aspects. The disaster related information should be well documented to enable future management plans.

The overall impetus at the national and global level is on preparedness and mitigation 7, 8. Several recent com- missions have been formed at the national level, such as National Water Policy, 1987; National Commission for Integrated Water Resource Development Plan, 1996 and Regional Task Forces, 1996, and the ensuing recommendations adopted. However, effectiveness of recommendations seems to be lacking in several cases. The National

Commission for Integrated Water Resources Development, 1999, recommended management approach rather than control, emphasizing failure to render complete protection. The strategies include flood-plain zoning, flood proofing, forecasting, disaster preparedness, response planning and insurance, etc. In respect of flood-plain zoning, the National Commission on Floods–1980 proposed a legislation to classify flood-prone zones according to occurrence and intensity. However, in West Bengal, the problem is rather vexing due to high population density and large flood-prone areas. While it is imperative to pre- vent encroachment of river beds, it is not feasible to relocate structures and developmental activities from all the hazard-prone areas. In recent times, flood forecasting is advancing with utilization of satellite and remote-sensing techniques. If the approaching flood can be predicted/ observed, evacuation through monitoring and warning is possible.

❖ *Cyclones And Storm Surges*

West Bengal has been one of the most cyclone-affected territories of the country.

Perspectives on cyclone management

The Cyclone Distress Mitigation Committee was launched nationwide during 1969 for the coastal states, with a major objective to formulate a communication system for quick dissemination of meteorological warnings and prevention measures thereof. The World Meteorological Organization established in 1972, introduced a Tropical Cyclone Project to assist member countries in increasing their capabilities to forecast tropical cyclones, and in developing strategies for disaster prevention and preparedness.

At the state level, the Relief Department has developed a disaster-management system, outlining sustainable development with disaster mitigation at state and district levels13. This involved delineation of planning areas for departmental activities, including those at the village level within two frameworks – prevention and crisis management. The approach embodies integrated coastal environmental planning combined with cyclone mitigation strategies to reduce susceptibility. The strategies include development of accurate and prompt cyclone-warning systems, design and construction of robust structures ('cyclone proofing' through incorporation of storage and sleeping areas high-off the ground and use of water-resistant materials), implementation of hazard-reduction methods such as construction and strengthening of sea embankment, drains, shelterbelts, conservation and promotion of natural windbreakers (mangrove), reliable communication system, mass awareness on preparedness and mitigation, and community preparedness at all levels to meet the exigencies. Further, landuse planning is suggested to reduce the risk. Timely relay of information is of utmost importance. In this respect, a cyclone dissemination sys- tem has been set up by India Meteorological Department at Kolkata. Special addresses are given to cyclone fore- cast and warning services, rapid dissemination of warnings to the government agencies, ports, fisheries, shipping, the general public, and organizations to construct cyclone shelters in cyclone-prone areas and ready machinery for evacuation of people, and involvement of the local community.

The Meteorological Department has been equipped with cyclone surveillance radars, and satellite picture-receiving equipment. Further, Indian geo-stationary satellite INSAT- 1B (operative since 1983) has enhanced tracking and fore- casting through continuous monitoring. The operations are carried out through Area Cyclone Warning Centres and Cyclone Warning Centres. The present scientific knowledge and tools enable predictions with an average error of about 200 km for a 24 h forecast.

Formulation of contingency plans must be done at all levels – community, government and civil society. Fore- casting and early warning systems involve coordination by a steering committee for continual appraisal and improvement in the analyses of different forecasting

methods, facilitating resources sharing and collaborations, training of personnel, and capacity enhancement. The working plan for an integrated coastal zone and flood control developed for the state addresses natural windbreak development and preservation, assessment of impacts and risks, com- munity participation, education and awareness, and village-level planning. Technical aspects include a multi- disciplinary approach towards environmental and social concerns, water-flow management, relocation/resettlement if needed, and designing break waves and sea walls. Preparedness implies mitigation and prevention rather than just response. Therefore, the need to link disaster management with development plans.

❖ *Landslides*

The landslide hazard in West Bengal has been observed mostly in the hilly terrains of Darjeeling District. However, incidents of landslide have also been reported to have occurred on the banks of Hooghly River. In 1968, floods in the Darjeeling area destroyed vast areas of West Bengal and neighboring state of Sikkim by unleashing about 20,000 landslides and killing thousands of people16. These landslides occurred over a three-day period, with precipitation ranging from 500 to 1000 mm in an event of a 100-yr return period. The 60 km hilly highway from Siliguri to Darjeeling was cut off at 92 locations by land- slides, resulting in total disruption of the road transporta- tion system.

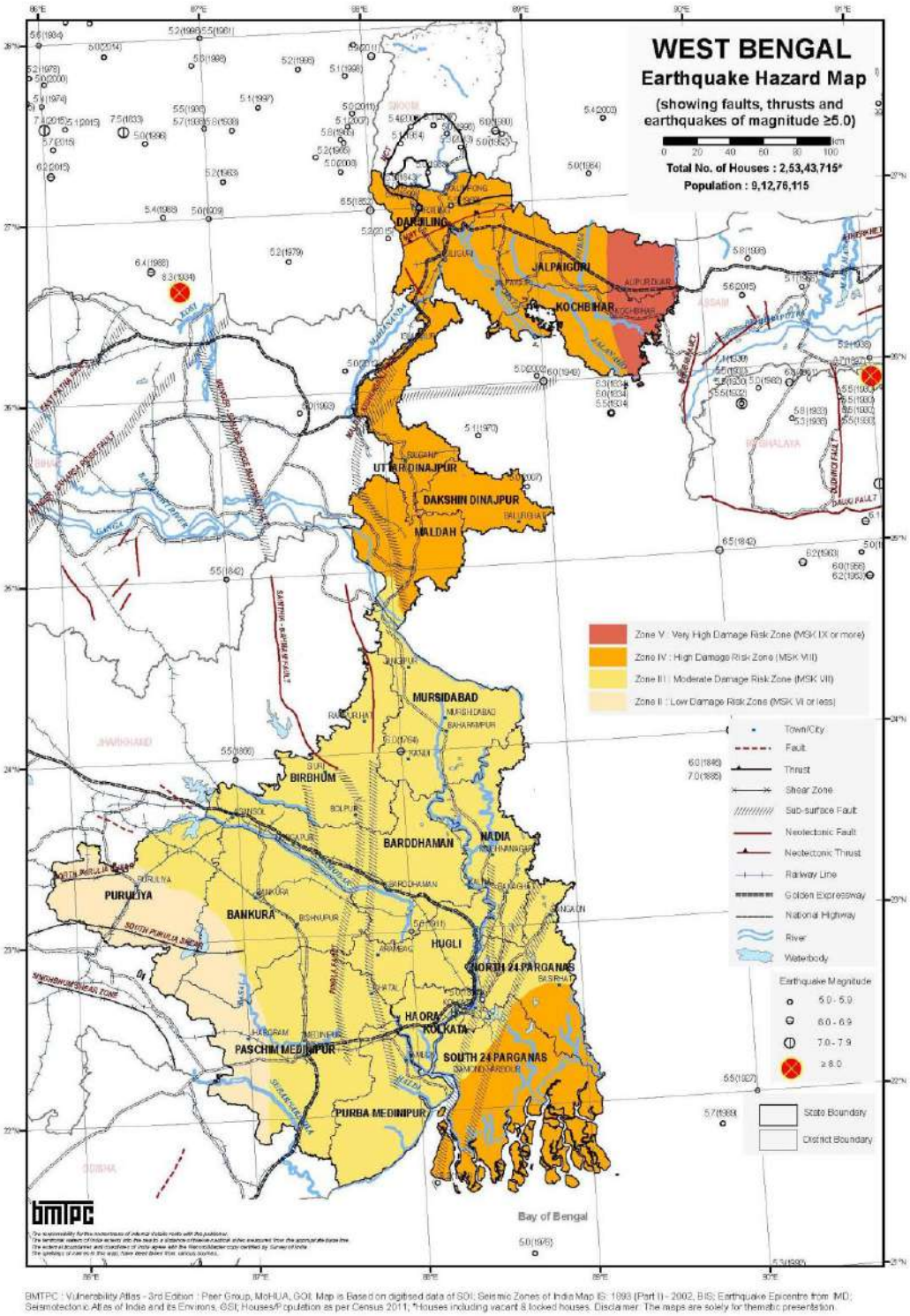
Urbanization, especially in the hilly terrains, involving construction activities often causes perturbations in the hill slopes triggering landslides. Prior identification of the hazard potential is therefore necessary. Major tools em- ployed for hazard delineation include remote sensing and GIS techniques. Various thematic layers describing the geological characteristics, water conditions, material prop- erties, topographical inclinations, seismic activities, pre- diction of soil behaviour under load, etc. are considered for the thematic integration to achieve hazard zonation.

❖ *Earthquakes*

West Bengal experiences earthquakes at a relatively lower frequency of the seismic hazard zonation map. The Bureau of Indian Standards places the region in the seismic zones II–IV, corresponding to peak ground acceleration (PGA) of 0.1, 0.2 and 0.25 (1 g = 980 Gal) respectively 2, 19. The lowest perceived hazard, zone II, is in the southwestern part of West Bengal (Purulia), while zone IV covers the north and southeast of Kolkata. Zone V is delineated on the eastern parts of Jalpaiguri and Coochbehar. The districts of Kolkata, Murshidabad, Birbhum, Bardhaman, Hooghly, Howrah, Nadia, Bankura and East and West Midnapur come under zone III. Darjeeling, North and South Dina- jpur, the remaining parts of Jalpaiguri and Coochbehar, North and South 24-Parganas and Malda fall under zone IV. Similarly, the Global Seismic Hazard Assessment Programme classifies the seismic hazard variation in terms of PGA from low (0.2 m/s2) in the southwest to high (6.0 m/s2 and above) in the north, with 10% probability of non-exceedance in 50 years20. The earthquakes mostly occur either in the Himalayan ranges in the north or in Northeast India, and a few also occur in the Bengal Basin/ Fan areas. The Great Assam earthquake of 1897 is reported to have caused widespread damage in Kolkata. The largest instrument-recorded earthquake occurred on 15 April 1964, West of Sagar Island (mb 5.2), which caused damages in West Bengal and Orissa.

The region has considerable area close to river basins and deltas that are characterized by Holocene alluvium deposits, which are likely to soften and hence are susceptible to liquefaction during an earthquake. Considerable spatial variation is associated with seismic hazards owing to the variation of geological-dependent site response22. This necessitates local specific analysis, especially in urban areas where the implications are far higher. The utility of seismic microzonation is emphasized in such cases. Seismic microzonation combines geological, geotechnical, seismological and earthquake engineering approaches

towards spatial hazard classification. The zonation enables decision-making process towards planning and organization of landuse, response and mitigation. The site-specific design parameters obtained through microzonation would enable cost-effective structural designs.



BMTPC : Vulnerability Atlas - 3rd Edition | Peer Group, MoHUA, GOI. Map is Based on digitised data of SOI; Seismic Zones of India Map IS: 1893 (Part I) - 2002, BIS; Earthquake Epicentre from IMD; Seismotectonic Atlas of India and its Environs, GSI; Houses/Population as per Census 2011; *Houses including vacant & locked houses. Disclaimer: The maps are solely for thematic presentation.

Earthquake Hazard Map of West Bengal

(Source: Ministry of Earth Sciences)

❖ *Tsunamis*

Although hazards due to trans-oceanic tsunamis have not been quantified for the coastal areas of West Bengal, be- cause of the presence of mangroves and shallow continental shelf (unlithified fan deposits at the mouth of the Meghna– Ganges estuary) extending to several hundred kilometres, tsunamis are unlikely to pose a significant hazard. As such, there is no report of damage in the territory due to the catastrophic tsunami earthquake of 26 December 2004. However, any future offshore developments off the coast may be affected by tsunamis

❖ *Subsidence*

Subsidence hazard has been exhibited in underground coal mining areas of the state, such as Raniganj and Asansol. A fundamental preventive approach towards avoidance of adverse impacts of the hazard is reliable prediction23 and the ensuing geotechnical considerations. The techniques involve tomography–sub-surface mapping, subsidence profiles and behaviour model, e.g. viscoelastic model.

❖ *Conclusion*

The predominant natural hazards in the West Bengal territory are investigated through historical accounts and prevailing mitigation aspects. A preliminary integrated perspective on the prevailing hazards has been qualitatively estimated as a first-order composite vulnerability distribution across the state. Consequently, a holistic outlook of disaster management as envisaged is emphasized to incorporate (a) collaborations of different organizations, local participation, (c) inputs from scientific and re- search institutions, (d) awareness and promotion, and (e) delivering appropriate regulations and policies. Addressing multiple hazards, such as usage of multi-hazard maps, synergized methodologies, etc. is recommended to be more pragmatic.

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