केन्द्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण

विभाग, जल शक्ति मंत्रालय

भारत सरकार

Central Ground Water Board

Department of Water Resources, River Development and Ganga Rejuvenation,

Ministry of Jal Shakti

Government of India

AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES

Katihar District
Bihar

मध्य पूर्वी क्षेत्र, पटना

Mid Eastern Region, Patna

भारत सरकार
Government of India
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जलभृत मानचित्रण और भूजल प्रबंधन योजना

कटिहार जिला, बिहार

Aquifer Mapping and Ground Water Management Plan

Katihar District, Bihar

(Falka, Korha, Hasanganj, Kadwa, Balrampur, Barsoi, Azamnagar, Pranpur, Dandkhora and Katihar block)

Cover photographs: 'Dhar' and a dugwell in Katihar districts (Nov.20)

क्षेत्रीय कार्यालय
मध्य-पूर्वी क्षेत्र, पटना

Regional Office
Mid-Eastern Region, Patna

October 2022

Management Plan of Amdabad, Manihari, Kursela, Mansahi, Barari and Samelii blocks are also incorporated.

Report on

जलभृत मानचित्रण और भूजल प्रबंधन योजना
कटिहार जिला, बिहार
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(Falka, Korha, Hasanganj, Kadwa, Balrampur, Barsoi, Azamnagar, Pranpur, Dandkhora and Katihar block)

AAP – 2020-21

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Aquifer Mapping and Management Plan

(2020-21)

Katihar district, Bihar

(Falka, Korha, Hasanganj, Kadwa, Balrampur, Barsoi, Azamnagar, Pranpur, Dandkhora and Katihar block)

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"The Amdabad, Manihari, Kursela, Mansahi, Barari and Sameli blocks of Katihar district has already been covered, under aquifer mapping for being a problematic area (Arsenic contamination) for which report on ***"National Aquifer Mapping in Parts of Bhojpur, Buxar, Patna, Bhagalpur and Patna district"****, published in October 2018. However, these blocks are also incorporated in this report to present the entire Katihar district.*

Since these blocks are not the part of present study, the previous published report may be gone through for more information about Amdabad, Manihari, Kursela, Mansahi, Barari and Sameli blocks."

CHAPTER 1

1. INTRODUCTION

The vagaries of rainfall, inherent heterogeneity, over exploitation of once copious aquifers, lack of regulation mechanism etc. has a detrimental effect on ground water scenario of the Country in last decade or so. Thus, prompting the paradigm shift from **"Traditional Groundwater Development concept**" to **"Modern Groundwater Management concept**". Varied and diverse hydrogeological settings demand precise and comprehensive mapping of aquifers down to the optimum possible depth at appropriate scale to arrive at the robust and implementable ground water management plans. This leads to concept of Aquifer Mapping and Ground Water Management Plan. Aquifer mapping is a process wherein a combination of geologic, geophysical, hydrologic and chemical analyses is applied to characterize the quantity, quality and sustainability of ground water in aquifers. The proposed management plans will provide the "Road Map" for ensuring sustainable management and equitable distribution of ground water resources, thereby primarily improving drinking water security and irrigation coverage. Thus the crux of NAQUIM is not merely mapping, but reaching the goal-that of ground water management through community participation.

During XII five year plan (2012-17) National Aquifer Mapping (NAQUIM) study was initiated by CGWB to carry out detailed hydrogeological investigation. The Aquifer Mapping programme has been continued till 2023 to cover whole country. The present studies of Katihar district, Bihar have been taken up in AAP 2018-19 as a part of NAQUIM Programme. The aquifer maps and management plans will be shared with the administration of Katihar district and other user agencies for its effective implementation.

1.1 Objective and Scope

The major objectives of aquifer mapping are

- Delineation of lateral and vertical disposition of aquifers and their characterization
- Quantification of ground water availability and assessment of its quality to formulate aquifer management plans to facilitate sustainable management of ground water resources at appropriate scales through participatory management approach with active involvement of stakeholders.

The groundwater management plan includes Ground Water recharge, conservation, harvesting, development options and other protocols of managing groundwater. These

protocols will be the real derivatives of the aquifer mapping exercise and will find a place in the output i.e, the aquifer map and management plan.

The main activities under NAQUIM are as follows:

a. Identifying the aquifer geometry

b. Aquifer characteristics and their yield potential

c. Quality of water occurring at various depths

e. Preparation of aquifer maps and

f. Formulate ground water management plan.

The demarcation of aquifers and their potential will help the agencies involved in water supply in ascertaining, how much volume of water is under their control. The robust and implementable ground water management plan will provide a "Road Map" to systematically manage the ground water resources for equitable distribution across the spectrum.

1.2 Approach and Methodology

The on-going activities of NAQUIM include hydrogeological data acquisition supported by geophysical and hydro-chemical investigations supplemented with ground water exploration down to the depths of 80 meters.

Considering the objectives of the NAQUIM, the data on various components was segregated, collected and brought on GIS platform by geo-referencing the available information for its utilization for preparation of various thematic maps. The approach and methodology followed for Aquifer mapping is as given below:

Compilation of existing data (Central & State Govt.)
↓
Generation of different thematic layers
↓
Identification of Primary Aquifer
↓
Identification of data gaps
↓
Data generation (water level, exploration, geophysical, hydrochemical, hydrogeological etc.)
↓
Aquifer Maps with 3D disposition
↓
Preparation of Aquifer Management Plan
↓
Capacity building in all aspects of ground water through IEC Activities

1.3 Area Details and Brief Description

Katihar district has a geographical area of 3057 Sq.Km. and located in the eastern part of Bihar on the northern bank of the Ganga River. It lies between North Latitudes 25° 10' and 25° 55' and East Longitudes 87° 10' and 88° 05' and covers the Survey of India toposheet nos. 72 Of 2,3,5,6,7,9,10,11,13,14,15 & 16 and 78 C/2. The district is bounded on the North by Purnea and part of West Bengal, in South by Bhagalpur and Santhal Pargana districts, on the east by the district of West Dinajpur and on the West again by the district of Purnea.

The district town Katihar is connected by two National highways NH 31 and Nh 131A. NH31 connects Katihar town to Patna the capital of Bihar. NH 131A connects Katihar and Purnea. The district headquarter is connected to the capital, Patna by National Highway No. 31. Block headquarters are connected with district headquarters by all-weather metal road. There are good network of roads connecting various remote localities with block and district headquarters (**Figure-1**)

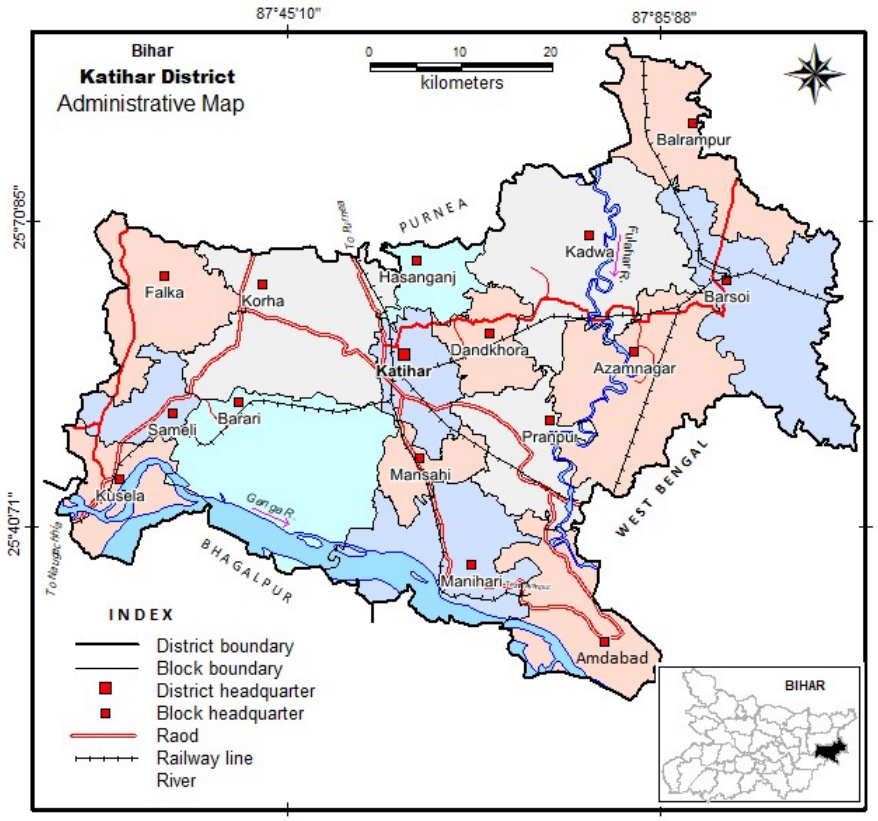


Figure 1: Administrative map

The district has 16 community development blocks under 3 civil sub divisions, covering 1540 revenue villages. These sub divisions are namely Katihar Subdivisions, Barsoi Sub-divisions and Manihari Sub-division **(Table-1).**

Table 1: Administrative Subdivisions and Blocks

SN	Sub-division	Block	ब्लॉक
1	Katihar	Katihar	कटिहार
2		Dandkhora	डंडखोरा
3		Hasanganj	हसनगंज
4		Korha	कोढ़ा
5		Sameli	समेली
6		Falka	फलका
7		Kursela	कुर्सेला
8		Barari	बरारी
9		Mansahi	मनसाही
10		Pranpur	प्राणपुर
11	Barsoi	Barsoi	बारसोई
12		Balrampur	बलरामपुर
13		Ajamnagar	आजमनगर
14		Kadwa	कदवा
15	Manihari	Manihari	मनिहारी
16		Amdabad	अमदाबाद

Katihar.nic.in/subdivision-blocks

A report on "Aquifer Mapping in parts of Bhojpur, Buxar, Patna, Bhagalpur & Katihar Districts, Bihar (NAQUIM Phase - IV & V), year 2016-17 & 2017-18" has already been published which includes Amdabad, Manihari, Kursela, Mansahi, Barari and Sameli block of Katihar district, even then, in this report the entire Katihar district has been covered by taking findings of these block in previous study.

These blocks have been prioritised for aquifer mapping based on the ground water quality issues (arsenic affected area). As per the present ground water scenario, the necessary information of these blocks has been added. The previous report on aquifer mapping covering these blocks may also be referred for detail information.

1.4 Demography

The district has population of 3071029 (2011 census) out of which 91% are rural and 9% urban. About 88% of urban population is concentrated in Katihar only. The district has only 3 (three) urban area viz- Katihar, Manihari and Barsoi. Scheduled caste population is 263100 (9%) and scheduled tribe population is 179971 (6%) **(Table-2).** Population wise districts constitute 9% of the state population. It has a population density of 1005 persons/Km^2 (2011).

In 2011, Katihar had population of 3,071,029 of which male and female were 1,600,430 and 1,470,599 respectively.

Table 2: Demographic Data

SN	Blocks	Area (sq km)	Total	Rural	Urban	SC	ST	Main worker	Marginal worker
1	Amdabad	188.63	167398	167398	0	4882	21087	25600	27400
2	Azamnagar	290.77	315610	315610	0	16513	10664	77570	25652
3	Balrampur	174.28	158976	158976	0	12542	6191	36245	12471
4	Barari	327.8	285381	285381	0	23211	13661	60968	28700
5	Barsoi	279.14	344133	337778	6355	23157	1964	75427	35075
6	Dandkhora	89.21	68055	68055	0	5007	10913	16070	10689
7	Falka	169.48	155663	155663	0	17751	11525	43529	17415
8	Hasanganj	71.11	55906	55906	0	3703	9649	12545	8106
9	Kadwa	339.92	346902	346902	0	29545	7407	76744	37726
10	Katihar	110.05	321817	80979	240838	33918	14380	71088	24519
11	Korha	298.48	282813	282813	0	38826	22963	66812	27794
12	Kursela	61.06	63928	63928	0	5649	398	10643	11177
13	Manihari	250.12	191407	164778	26629	18446	26287	30171	29715
14	Mansahi	78.14	84257	84257	0	9033	10088	14716	13344
15	Pranpur	153.06	144297	144297	0	11809	11217	31121	20015
16	Sameli	128.66	84486	84486	0	9108	1577	18353	16166

1.5 Data Availability

The drilling data (Lithologs) has been taken from total 31 tube wells drilled by the State Govt. and other agency. Total 13 permanent observation well (National hydrograph Network Station) has been taken to represent ground water scenario of the area. These are being monitored by Central Ground Water Board 04 times in a year for ground water regime of phreatic (shallow) aquifer and one time ground water sampling for chemical analysis (Pre-monsoon) to assess its chemical quality. The water samples are taken from total 11 locations which have collected during May 2019. In addition to that 8 samples from ground water collected during Nov. 2020, are also taken to know the chemical quality of ground water.

1.6 Climate and Rainfall

The area experiences sub-tropical climate with three well marked seasons, i.e. winter, summer and monsoon. Winter begins, in November and continues upto February, though March is also somewhat cool. Westerly wind and dust storms begin to blow in the second half of March and temperature rises considerably. May is the hottest month when temperature

goes up to 43° Celsius. Monsoon generally starts in the middle of June. The rains continue till the end of September, or middle of October and with the cession of rains the temperature fall and climate becomes rat her pleasant. The climate of the area, in general, is healthy and bracing. The temperature varies from 25°C to 47°C in summer months and reduces to 4°C to 25°C in winter months.

The rainfall is largely confined to the southwest monsoon. The district receives about 83% of the annual rainfall from southwest monsoon. In general, July is the month with the highest rainfall with the normal value of 358.9 mm. The month wise normal rainfall (1951-2000) is given in **figure 2.** On an average, there are 54 rainy days (i.e. days with rainfall of 2.5 mm or more) in a year in the district.

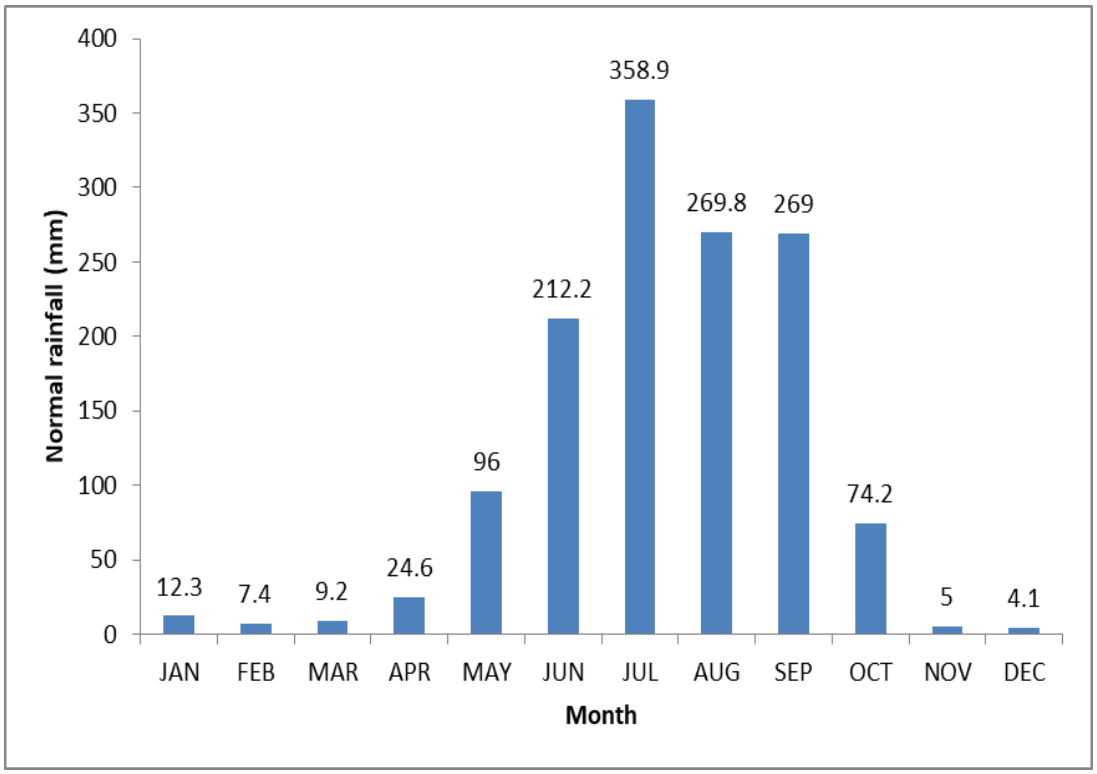


Figure 2: Monthly normal rainfall

In comparison to normal rainfall pattern, it is observed that the rainfall occurring in the districts depicts that there is an absolute departure of rainfall in last five years from normal rainfall. There is a decrease in rainfall in the month of June and July except the year 2020. The rainy season is considerably delayed in the district. Thereby it affects the timely-sowing of Kharif crops. **Table-3** shows that except the year 2021, the rainfall departure in the month of June is upto 47% (2019).

Table 3: Departure monthly average rainfall from normal rainfall in last five years

YEAR	JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEPT		OCT		NOV		DEC	
	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP
2017	0	-100	0	-100	16.5	80	51.5	109	124.3	29	139.5	**-34**	359.4	0	344.6	28	202.9	-25	228.4	208	0	-100	0.7	-84
2018	0	-100	0	-100	9.9	8	0	-100	10.6	-89	185.3	**-13**	185	-48	205.9	-24	77.1	-71	50.2	-32	0	-100	8.9	117
2019	3.3	-61	25.6	224	0	-100	64.6	129	69.8	-34	114.8	**-47**	377.6	6	121.5	-55	401.9	50	38.9	-52	0	-100	7.5	40
2020	2.3	-73	33.7	326	47.7	408	76.6	172	108.9	3	163.4	**-24**	488	37	310.2	15	580.7	117	56.6	-30	0	-100	0	-100
2021	0.2	-98	0.2	-97	0	-100	4.1	-86	400.2	279	327.4	53	238.1	-33	339.6	26	57.3	-79	217.9	168	0	-100	4.1	-24

Customized Rainfall Information System (CRIS) (imd.gov.in)

1.7 Physiographic setup

The area of the district comprises southern part of Kosi mega fan deposits and is a parts of Kosi and Mahananda Sub-Basins of Ganga Basin. It is devoid of any appreciable relief feature and thus forms a monotonous plain. The Kosi Sub-Basin has a gentle slope from north to South along which the river Kosi is flowing. Regionally it depicts a fan shaped alluvial landscape with its apex near the Inda-Nepal border in the north· Part of the broad toe portion (or distal fan) of this huge fan, occurring in the district, gets truncated by the Ganga in the south. The relief of the land forms decreases from north to south with slight tilt from west to east.

1.8 Physiographic DEM

The elevation in the area ranges from 17.9 to 45.2 m above mean sea level (SRTM data with WGS 84 Spheroid). The generated elevation map by SRTM map is given in **fig-3.** It shows that general slop of the area is towards north to south direction.

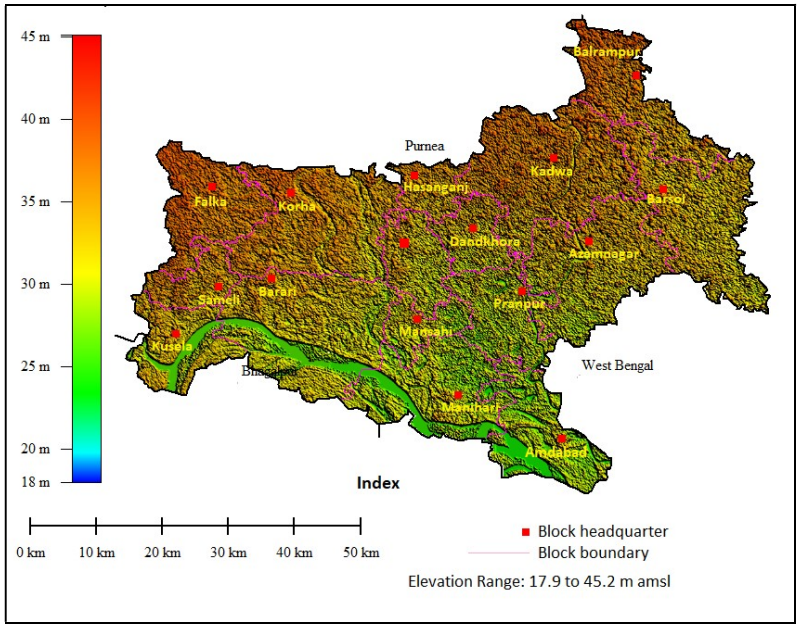


Figure 3: DEM of the area based on SRTM Data

1.9 Geomorphology

The Katihar district occupies the part of Kosi mega fan deposits gently sloped towards south. Numerous active and inactive channels in the area run from north to south locally known as 'dhar'. The map given under **figure 4** has been re-prepared from 'LGEOM'. The map shows that major part of Katihar district can be characterised by the alluvial plain (deep). The adjoining area of rivers, almost flowing towards north, can be characterised as flood plains. There are also some patches of back swamps also in the distict.

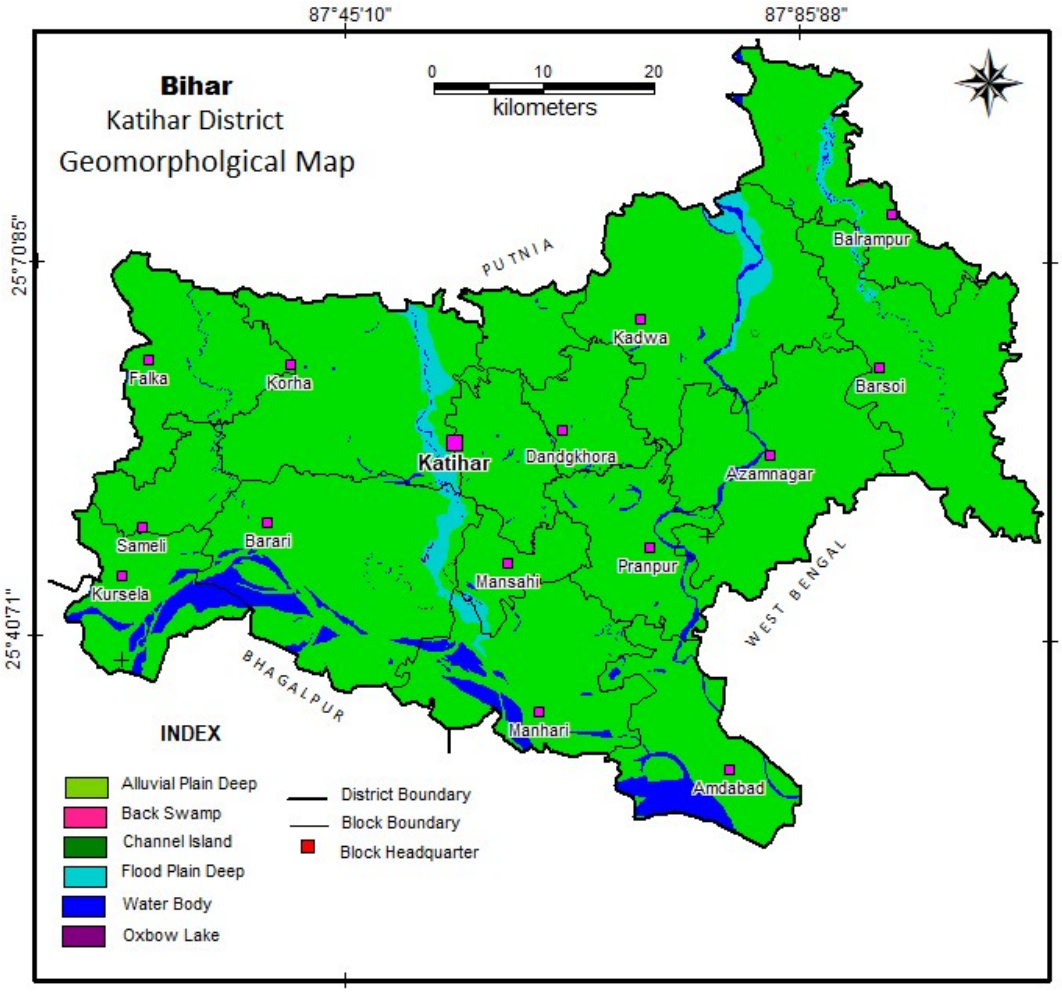
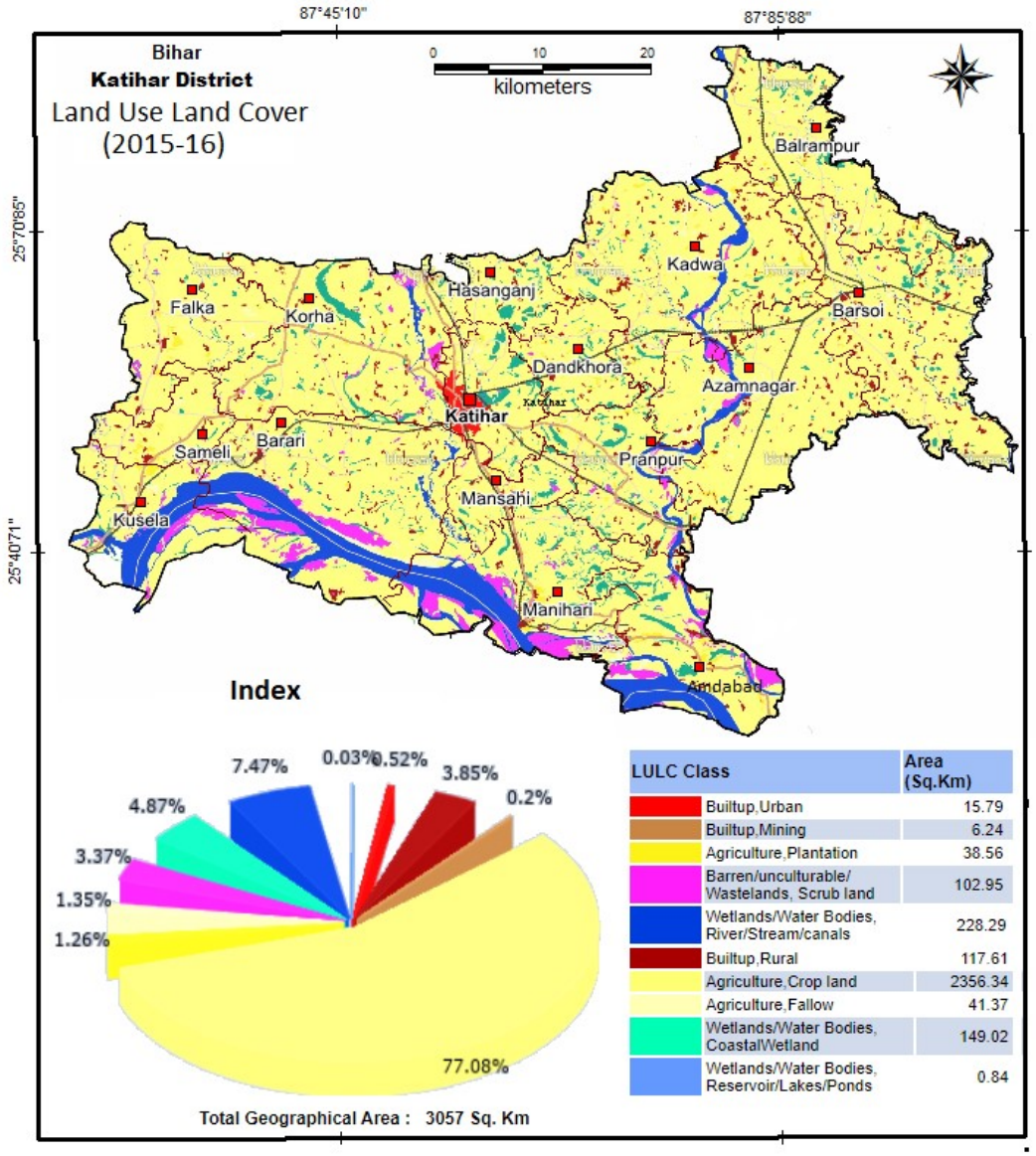


Figure 4: Geomorphological Map

1.10 Land Use

To know the spatial distribution of the '**land use Land Cover (10K): SIS-DP**, a map obtains (on 20 April. 2020) from the website https://bhuvan-app1.nrsc.gov.in/ and given in **Figure 5**. To show the spatial distribution of LULC units. Based on the data presented in table a pie chart (In-sat) has also been prepared The data of land use has also been collected from

the website of 'Web Based Land Use Statistics System' and presented in **table 4.** The table inferred that the principal utilisation of land is under agriculture and almost evenly distributed in the district. It occupies nearly 95% of the area reported for LULC (291349 ha). Area under uncultivable land excluding fallow land includes 3.8% of the area and forest cover only 0.6% of the area reported. Other major land utilisations are the lands put under non-agriculture use.



Source: ***Bhuvan - NRSC***

Figure 5: Land use map

Table 4: Land use pattern (2017-18)

Total Area and Classification of Katihar district for the Year Ending 2019-20 (Hectare)

Reporting Area for LUS (Hactare)			291349
Classification of Reporting Area	Forests		1785
	Not Available for Cultivation	Area Under Non Agricultural Uses	59459
		Barren and Unculturable Land	22109
		Total	81568
	Other Uncultivated Land Excluding Fallow Land	Permanent Pasture and Other Grazing Land	112
		Land Under Misc. Tree Crops and Groves not Included in Net Area Sown	11140
		Culturable Waste Land	622
		Total	11874
	Fallow Land	Fallow Lands Other Than Current Fallows	6675
		Current Fallow	61369
		Total	68044
Net Area Sown			128078
Cropped Area			232177
Area Sown More Than Once			104099

Year- 2019-20, In Hactare
Source: Web Based Land Use Statistics System

1.11 Soil

Soil, the loose surface material, consists of inorganic particles and organic matter, provides water and nutrients to plants. Its texture or the percentage of sand, silt and clay, affects the rate of infiltration. Water moves more quickly through the large pores in sandy soil than it does through the small pores in clayey soil.

The steady state Steady-state infiltration rate (inch/hr) of the soil types is given below (Hillel, 1982):

Sand	> 0.8
Sandy and silty soils	0.4-0.8
Loam	0.2-0.4
Clayey soils	0.04-0.2
Sodic clayey soils	<0.04

The GIS layer of soil has been downloaded from 'GSI' and its 'classes' are grouped based on the soil texture and presented in **figure 6.** The map reveals that major part of the district is covered with the coarse loamy soil and fine loamy soil. The fine soil can be seen only near eastern boundary of the district. No area has been classified as 'clayey'. It indicates that overall, the area may have good infiltration rate.

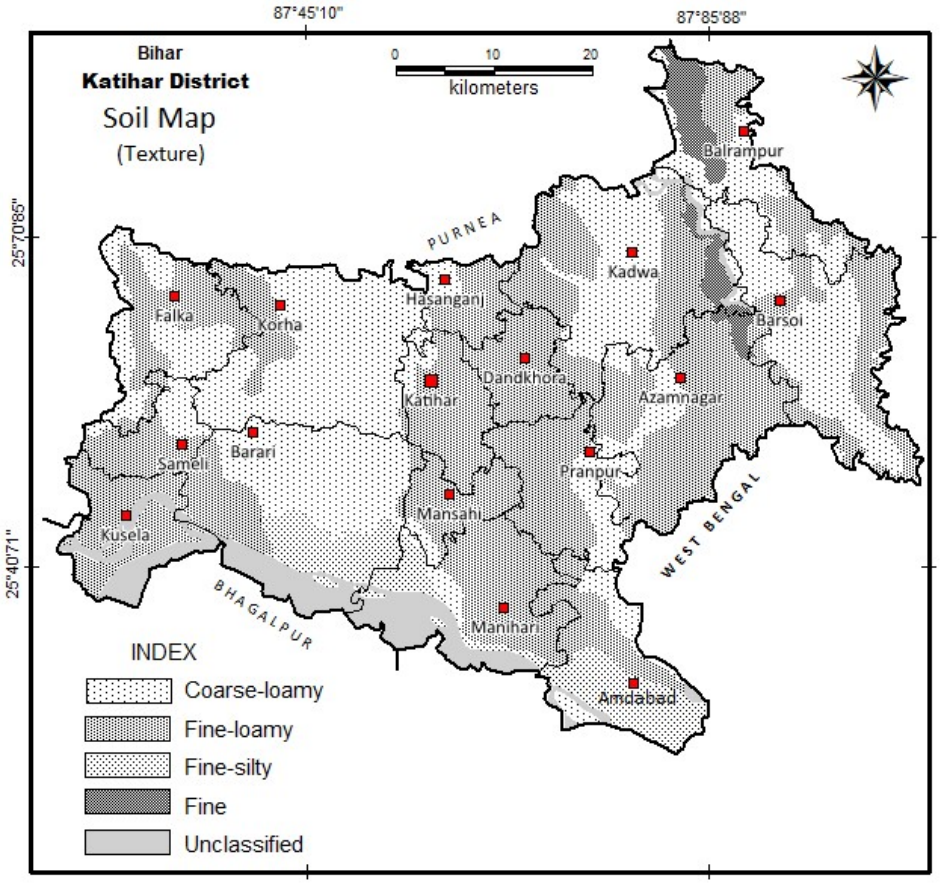


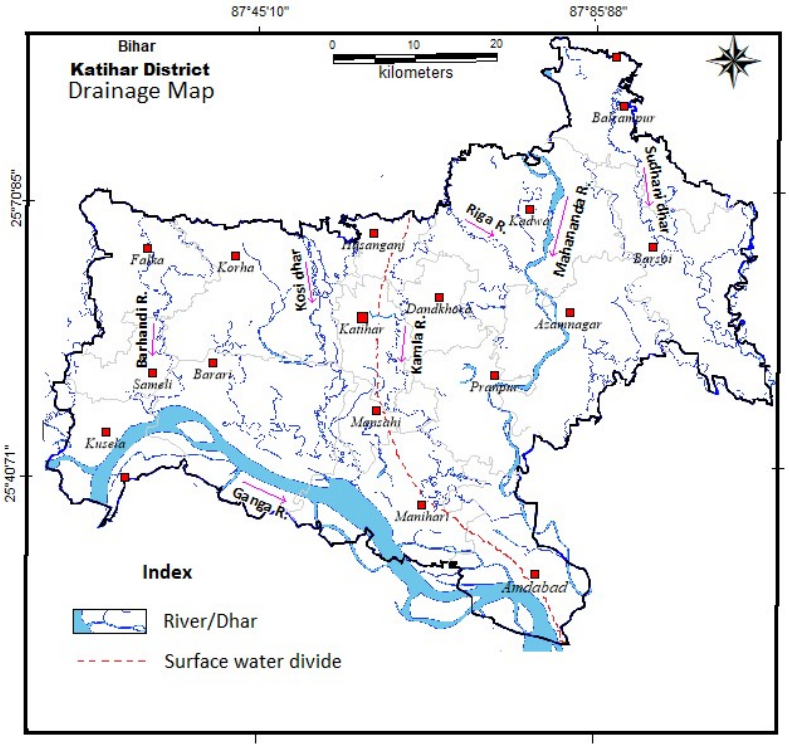
Figure 6 : Soil map

1.12 Hydrology and Drainage

As per the 'Watershed Atlas of India (CGWB)' the district is a part of Lr. Ganga basin. In the district there are two distinct sub-basins which drain the water of the area into river Ganga. These are named as 'Gandak and Others' river sub-basin. Western part of the district is drained by rive Kosi whereas the Eastern part by the river Mahananda.

The drainage map shown in **Figure 7** has been reproduced after downloading from the website of 'Jal Jivan Hariyali'.

The overall drainage pattern prevailing in the Kosi basin is sub parallel. The Kosi (East) Sub-Basin and Kosi - Mahananda interfluve are bordered by present course of the Kosi in the west and the Mahananda river in the East. The Kosi Sub-basin is traversed by a number of partially aggraded, braided and meandering distributaries of the Kosi River called Kosi Dhars (Old bed of Kosi). Some of the Old distributaries are still perennial. The major distributaries of old Kosi in the district are Sursar, Faryani N., and Kamla or Kajra which are called Kosi Dhars.

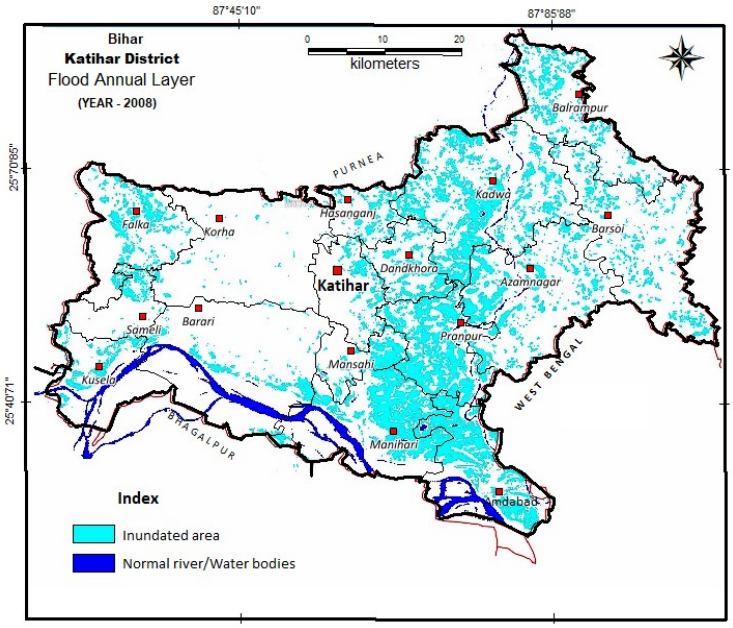


Source: Jal Jivan Hariyali

Figure 7: Drainage Map

The mighty Ganga River occupies the southern part of the district and forms the natural boundary between Katihar and Sahebganj districts. It follows a south-easterly direction and inters into the Bengal.

Almost every year the district experiences season flood. **Figure 8** shows flooded area during the year 2008



Source: ***Bhuvan - NRSC***

Figure 8: Flood Annual Layer - 2008

1.13 Agriculture

The Katihar district has agrarian economy. The district is part of Agro-climatic zone (NARP) of North East Alluvial Plain Zone (BI-2) II. Fertile alluvial plain of the district is coupled with favourable climate boosted agricultural activity. The main crops of the district are Rice, Maize and wheat. The **tables-5** shows the production and productivity of major crops for the year 2019-20.

Table 5: Area under Crops in Katihar District for the Year Ending 2019-20

खाद्य फसल Food Crop	अनाज व बाजरा Cereals and Millets	Rice	Autumn	8796
			Winter	65598
			Summer	21568
			Total	95962
		Maize		65902
		Wheat		23810
		Other Cereals and Millets	Kharif	-
			Rabi	2
			Total	2
		Total Cereals and Millets		185676
	दलहन Pulses	Arhar(Tur)		3
		Other Pulses	Kharif	1616
			Rabi	4826
			Total	6442
		Total Pulses		6445
	मसाले Condiments and Spices	Chillies		751
		Ginger		100
		Turmeric		111
		Garlic		227
		Coriander		2
		Total Condiments and Spices		1191
	फल Fruits	Fresh Fruits	Mango	1089
			Banana	2422
			Other	606
			Total	4117
		Total Fruits		4117
	सब्जियाँ Vegetables	Potato		9057
		Sweet Potato		15
		Onion		450
		Other Vegetables	Kharif	5707
			Rabi	6974
			Total	12681
		Total Vegetables		22203
	Total Fruits and			26320
	Other Food Crops			-
	Total Food Crop			219632
अखाद्य फसल Non Food Crop	तिलहन Oilseeds	Sesamum		108
		Rapeseed and Mustard		1960
		Other Oilseeds		143
		Total Oilseeds		2211
	रेशेवाली फसलें Fibres	Jute		8051
		Mesta		764
		Sanhemp		33
		Total Fibres		8848
	Other Non Food Crops			1486
	Total Non Food Crop			12545
Total Cropped Area				232177
Area Sown More Than Once				104099
Net Area Sown				128078

Year- 2019-20, In Hactare

Source: Web Based Land Use Statistics System

1.14 Cropping Pattern

Rice, Maize, Potato, Wheat etc. are is the main crop of Katihar district. The season wise areas under different crops are given in Table. **(Table 5).** Major area is utilised for rice cultivation. The net sown area during the year is 128078 ha only whereas the Area Sown More Than Once is 401099 ha. The cropping intensity of the district is calculated to be 181.28% (2019-20). About 6.28% area also included for Jute in net sown area. This crop requires about 20 days soaking in water. **Table 6** shows the sowing and harvesting period of major crops of the district.

Table 6 : Sowing and harvesting period of some major crops

Crop	*Season*	*From*	*To*	*Period*
Greengram	Kharif	April (Beg)	July (Beg)	Sowing
Masur/Lentil	Kharif	June (Mid)	July (Beg)	Sowing
	Kharif	November (Beg)	December (End)	Harvesting
Rice/Paddy	Kharif	June (Mid)	July (Beg)	Sowing
	Kharif	January (Mid)	July (Beg)	Sowing
	Kharif	November (End)	December (End)	Harvesting
Pulses	Rabi	January (Beg)	April (Beg)	Sowing
Masur/Lentil	Rabi	October (Mid)	November (Mid)	Sowing
	Rabi	March (Beg)	March (End)	Harvesting
Wheat	Rabi	November (Mid)	December (End)	Sowing
	Rabi	March (Mid)	April (End)	Harvesting

https://nfsm.gov.in/nfmis/rpt/calenderreport

1.15 Irrigation

An analysis of the contribution of major sources for irrigation has been done after downloading the data from 'Web Based Land Use Statistics Information System'. Downloaded data is presented in **Table 7.**

The source wise irrigated area has been taken for the preparation of table 7. It indicates that in comparison to the canal (surface water), tube well (ground water) covers the major part of the area irrigated.

Table 7: Source wise Irrigated Area for the year-2019 (ha)

Net Irrigated Area				Gross Irrigated Area			
Canal	Well	Other Source	**Total**	Canal	Well	Other Source	**Total**
2117	63807	645	**66569**	6074	183178	1757	**191009**

Source: https://aps.dac.gov.in

Hence, the groundwater is the major source of irrigation in the district. As per 5th MI census, total 71 dug wells are being used for Irrigation. The block wise data of tube wells during 5th MI census has been compiled and presented in **table 8 and figure 9.** During 5th MI (2013-14) census the tube wells are categorised on the basis of their depth. The depth of shallow tube wells are considered up to 35 m bgl. A new category of medium tube wells segment has been introduced in 5th MIS census for the depth range of 35 to 40 m bgl. The tube well with the depth more than 70 m bgl are categorised under deep tube wells.

Table 8: No. of Tube Well for Irrigation during 5th MI Census

SN	Block	0 to 20	20- 35	35-40	40-60	60-70	>70	70-90	90-110	110-130	130-150	>150
1	Amdabad	134	885	0	0	0	0	0	0	0	2	29
2	Azamnagar	1775	1474	0	0	0	0	0	0	0	0	0
3	Balrampur	5	196	0	0	0	0	0	0	0	0	0
4	Barari	89	1575	0	0	0	0	0	0	0	0	0
5	Barsoi	111	1610	0	0	0	0	0	2	0	0	0
6	Dandkhora	865	258	0	0	0	0	0	0	1	0	0
7	Falka	244	1003	0	0	0	0	0	0	0	0	1
8	Hasanganj	147	131	0	0	0	0	0	8	0	0	0
9	Kadwa	1358	2524	0	0	0	0	0	0	0	0	0
10	Katihar	35	169	0	0	0	0	0	1	0	2	8
11	Korha	586	1737	0	0	0	0	0	1	0	0	0
12	Kursela	100	69	0	0	0	0	0	**19**	0	0	0
13	Manihari	36	537	0	0	0	0	0	0	0	0	0
14	Mansahi	371	739	0	0	0	0	0	0	0	0	2
15	Pranpur	1215	879	0	0	0	0	0	2	0	0	0
	Total	**7071**	**13786**	**0**	**0**	**0**	**0**	**0**	**33**	**1**	**4**	**40**

The data of 5th MI census reveals that 99% wells has been found to be categorised within the depth range of 35 m bgl. The majority of the wells in district are shallow tube wells only. **Table 8** shows that in shallow tube well segment, total 13786 numbers of wells are within the depth range 20 – 35 m bgl, whereas 7071 number of wells are within depth of 20 m bgl. **Figure 9** shows that except three blocks Azamnagar, Dandkhora, and Pranpur, majority of wells are within depth of 20 to 35 m bgl. Only 0.4% (78) wells are deeper, shown in shaded cell on table 8.

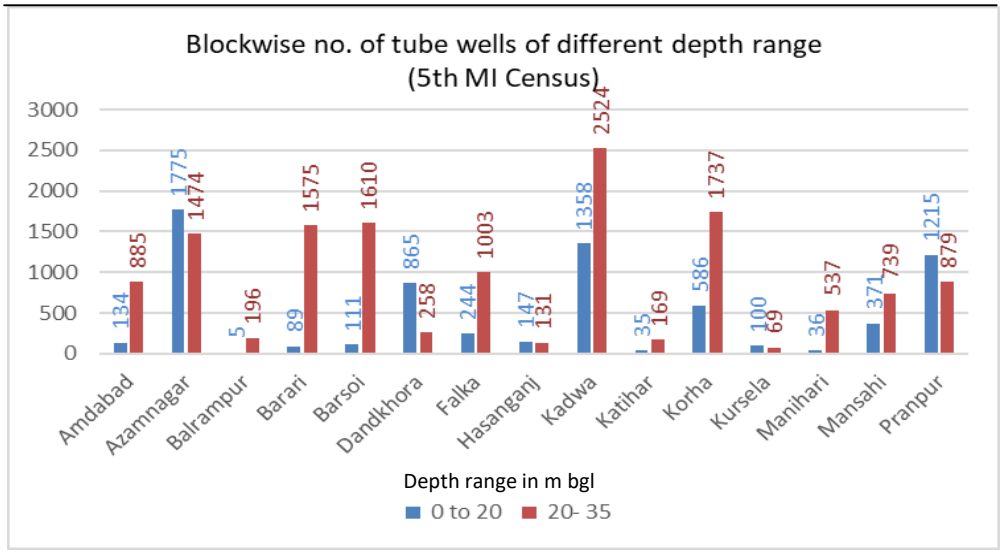


Figure 9: Block wise and depth wise Number of tube wells in 5th Minor Irrigation Census

To understand the growth and distribution of irrigation tube wells over time 4th and 5th MI census data has been collected and analysed.

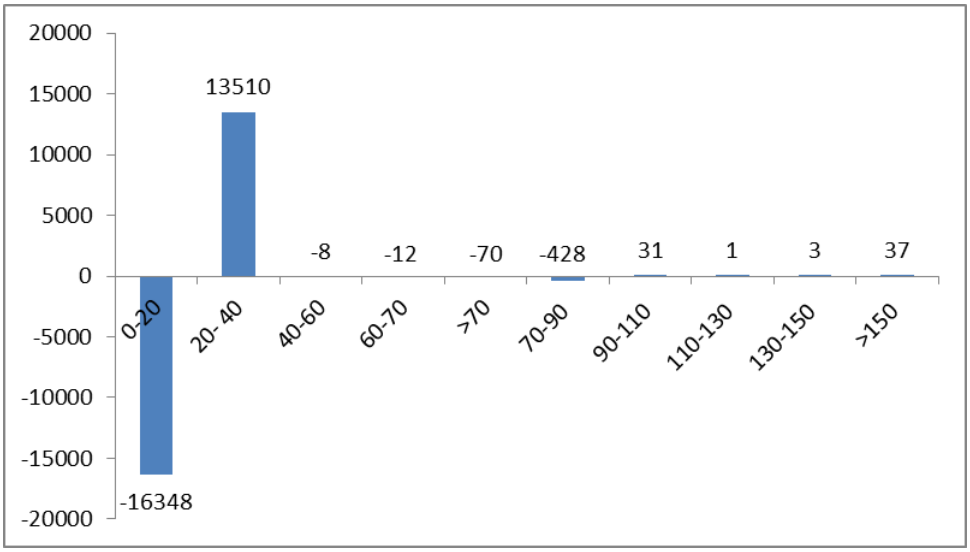


Figure 10: No. of Tube Wells in 5th MI Census w.r.t. 4th MI Census

Number of tube wells categorised under different depth range are remarkably changed in 5th MI census. Total 16348 number of tube well from 4th MI census (2006-07) to 5th MI (2013-14) census has been decreased within the depth of 20 m bgl and whereas 13510 number of tube wells increased in the next depth range of 20 to 40 (35) m bgl. **(Figure -10).** It indicates that there may be the matter of sustainability of shallow aquifer for irrigation purpose, availability of power energy for ground water exploitation from deeper depth and/or a sense of surety of groundwater availability for a long time.

Figure 11 shows that in every block, number of tube well within the depth range of 20 to 40 m bgl is increased. The number of tube well in the range of down to the depth of 20 m bgl is remarkably decreased in all blocks except 'Pranpur' where the number of tube wells increased in shallowest depth segment also.

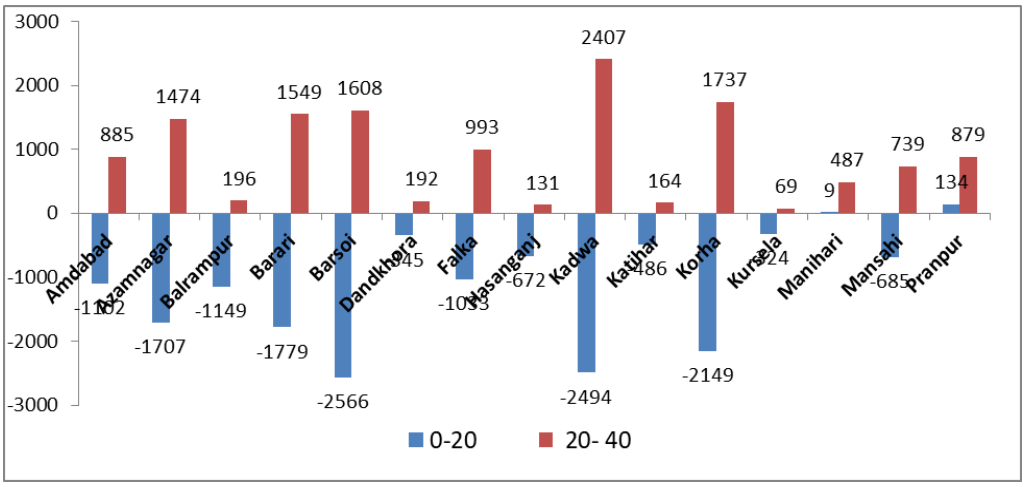
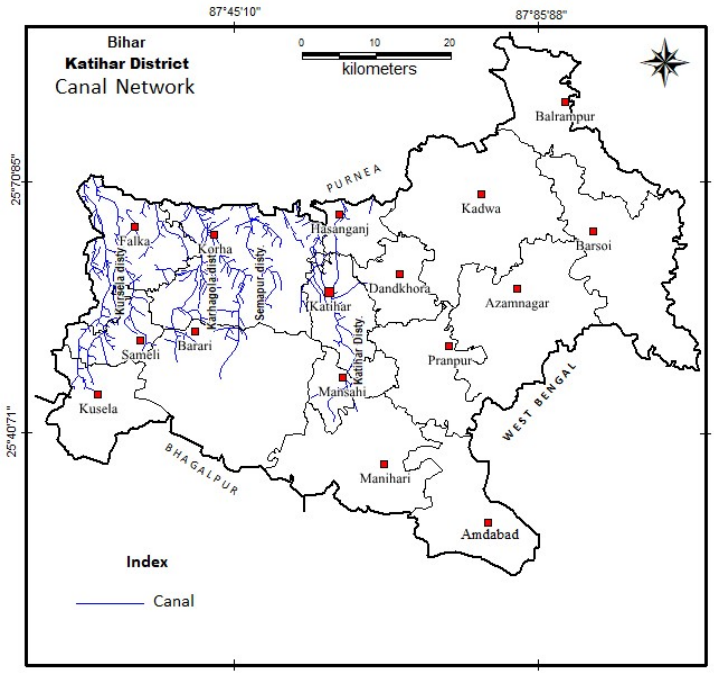


Figure 11: Block wise Number of Tube Well during 5th MI Census w.r.t. 4th MI Census

Canal (Surface water) is the second major source of irrigation after ground water. This canal irrigation system is a part of Kosi Irrigation Project. The canal system developed in north western part of the district. The net and gross irrigated area by canal is 2117 ha and 6074 ha respectively, whereas the irrigated area by tube wells is 63807 ha and 183178 ha respectively. However, the canal network mainly covers only north-western part of the district. **(Figure 13).**



Source: Jal Jian Hariyali

Figure 12: Canal Network

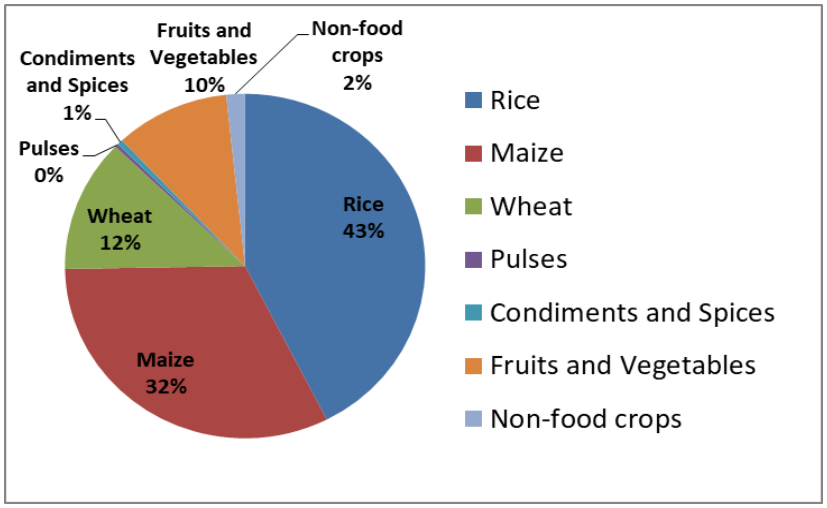


Figure 13: Crop wise irrigated area (%) for the year ending 2019-20

The **figure 13** prepared for the year 2019-20 indicates that Rice, wheat and maize constitutes about 87 % consumption of irrigation water. Rice is being cultivated in autumn, winter and summer season. Change in cropping pattern for the management of ground water in demand side may reduce the ground water exploitation in the district.

CHAPTER 2

2. DATA COLLECTION AND COMPILATION

The primary Data such as water level, quality, geophysical data and exploration details available with CGWB has been collected and utilised as baseline data. The Central Ground Water Board has established a network of observation wells under National Hydrograph Network programme to study the behaviour of ground water level and quality of ground water in the district and is being monitored four times in a year within scheduled time frame. To understand the sub–surface geology, identify the various water bearing horizons including their depth, thickness and compute the hydraulic characteristics such as transmissivity and storativity of the aquifers, exploratory drilling programme was carried out by Central Ground Water Board. For other inputs such as hydrometeorological, Landuse, cropping pattern etc. were collected from concerned State and Central Govt departments and compiled.

2.1 Data collection and Compilation:

The data collection and compilation for various components was carried out as given below

i. Hydrogeological Data: Water level data of 13 key wells and historical water level trend of monitoring wells were collected and compiled representing phreatic aquifer.

ii. Hydrochemical Data: To evaluate the quality of ground water, 20 samples were collected from dug wells as well as surface water body.

iii. Tube Wells data: The data of tube wells from 31 locations of state agencies drilled has been taken.

iv. Hydrometeorological Data: Normal rainfall data for each of the block has been collected from IMD.

v. Land use and cropping pattern data: The data of land use and cropping pattern obtained from the website of 'Bhuvan.nrsa' and District Statistical Office, Katihar

2.2 Data Generation:

After taking into consideration, the data available with CGWB on ground water monitoring wells (GWMW), ground water quality and ground water exploration, the data adequacy was compiled. The requirement, availability and gap of major data inputs i.e., exploratory wells, geophysical data, ground water monitoring wells and ground water quality data.

2.2.1 Ground water Monitoring Wells

Total 13 NHNS monitored to assess the ground water scenario of shallow aquifer (Aquifer-I) of the area. During 2018, the pre monsoon (May) depth to water level in these wells was between 2.3 to 5.78 m bgl. The post monsoon depth to water level (Nov. 2018) in the dug wells ranges from 1.72 to 4.76 mbgl. Average pre-monsoon water level was calculated 3.89 m bgl and in post monsoon 2.73 m bgl respectively. A detail of key wells and water level data is presented in **Annexure – I**

2.2.2 Ground Water Exploration

On perusal of **table- 11**, total 5 exploratory wells drilled in Katihar district have been taken to assess the aquifer characteristics of the area.

2.2.3 Ground Water Quality

To assess the quality of ground water, 11 samples were collected from dug wells representing Aquifer – I in pre-monsoon period and 7 sample in post-monsoon period.

2.2.5 Micro Level Hydrogeological Data Acquisition

The micro level study has been badly affected by the Covid-19 pandemic. However post monsoon survey in limited area has been carried out and 11 ground water samples have been collected.

2.2.6 Thematic Layers

The following thematic layers were also generated which supported the primary database and provided precise information to assess the present ground water scenario and also to propose the future management plan.

1. Drainage
2. Geomorphology
3. Elevation
4. Land use
5. Geology & structure

The thematic layers such as drainage, geomorphology, DEM and land use have been described in Chapter – I.

CHAPTER 3

3. DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING

The data collected and generated on various parameters viz., water levels, water quality, exploration, aquifer parameters, geophysical, hydrology, hydrometeorology, irrigation, thematic layers was interpreted and integrated. Based on this the various aquifer characteristic maps on hydrogeology, aquifer wise water level scenario both current and long term scenarios, aquifer wise ground water quality, sub-surface disposition of aquifers by drawing fence and lithological sections, aquifer wise yield potential, aquifer wise resources, aquifer maps were generated and as discussed in details.

3.1 Geological set up

The district forms a part of vast monotonous alluvial terrain of Kasi-alluvial fan and Kosi-Mahananda interfluve, in Kosi and Mahananda Sub-basins, consisting of a thick pile of unconsolidated Quaternary sediments. These Quaternary sediments consist of a sequence of sand, silt and clay. Proportion of finer elastics sediments progressively increase towards south.

Quaternary alluvial sediments of the area have been classified, primarily on the principles of soil stratigraphy and oxidation characteristics of the cover sediments and lithology, into three geological units (after GSI). These geological units have been assigned informal geological status of format ions and members.

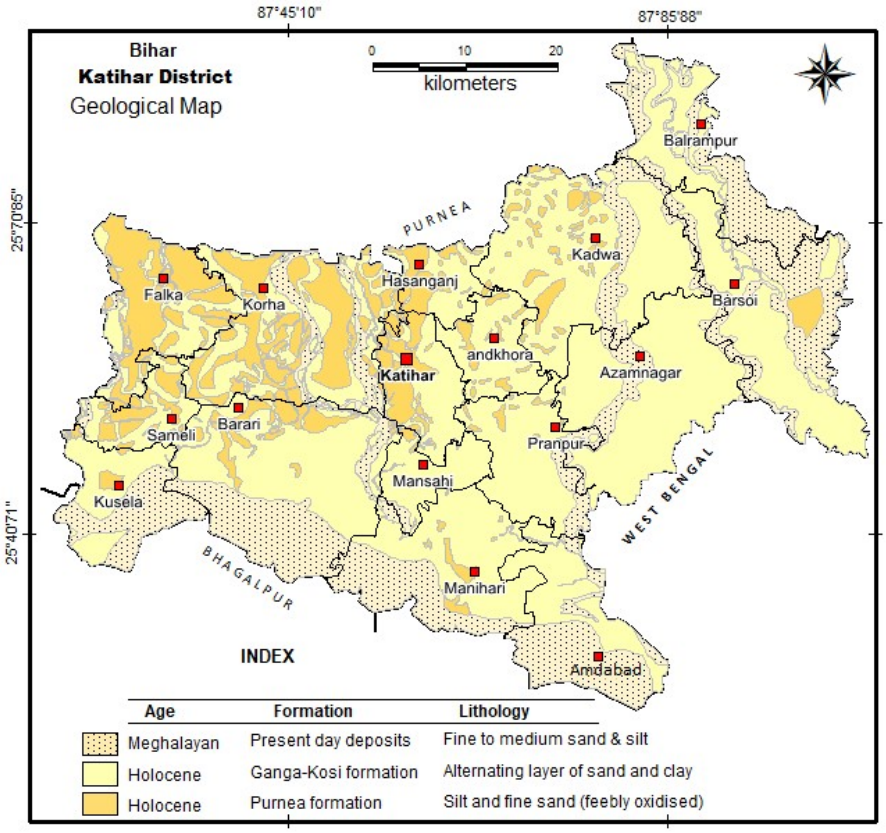
The maximum area of Katihar district is occupied by alluvial sediments of Quaternary age, constituting three morpho-stratigraphic units classified on the basis of relief, state of preservation of landforms, degree of dissection of surface and the degree of oxidation of alluvial fill. **(Figure 14)** These three units, in order of decreasing antiquity, are named as

(1) Katihar formation

(2) Ganga-Kosi formation and

(3) Present day flood plain deposit.

Major area covered by Ganga-Kosi formation of Holocene age which constitutes alternate layer of sand and clay. In the north western part of the district, there is Purnea formation of Holocene age constituting silt sand fine sand. The southern border and north eastern part of the district, which are adjacent to river Ganges contains the recent deposits fine to medium sand and silt.



Source:-Geological Survey of India

Figure 14: Geological map

3.2 Hydrogeology

The occurrence and movement of ground water in the area is variable, which depends on geomorphology, structure, geological setting, hydraulic properties, tectonic setup etc. The Katihar district comprises one of the most prolific aquifer systems in the Gangetic alluvial of North Bihar Plain. The quaternary unconsolidated sediments consisting of sand, grave, pebbles constitute the potential aquifer though facies-change is a common phenomenon in the area, by and large. The aquifer is regionally extensive it is found to occur continuously down to the depth of exploration of ~300 meters, at places capped by thin veneer of clay of 3-6 metres thickness. As observed from the field study and the lithological logs of the exploratory wells, the clay capping is not persistent over the entire area making the aquifer unconfined in nature. The whole area can be considered to be a single aquifer system to the explored depth of ~300 meter.

3.3 Ground Water Dynamics

The present study has been taken under Annual Actin Plan 2020-21. In the Year 2019-

20 and 2020-21 Covid -19 pandemic has affected ground water monitoring therefore pre and post monsoon data for the same year is not available to represent the ground water scenario of the area. Hence, water level data for the year 2019 has been taken. However, the field work has been carried out during the year 2020 in post monsoon and collected the water sample for chemical analysis. The data of total 13 NHS (National Hydrograph Station) wells have been taken for analysis.

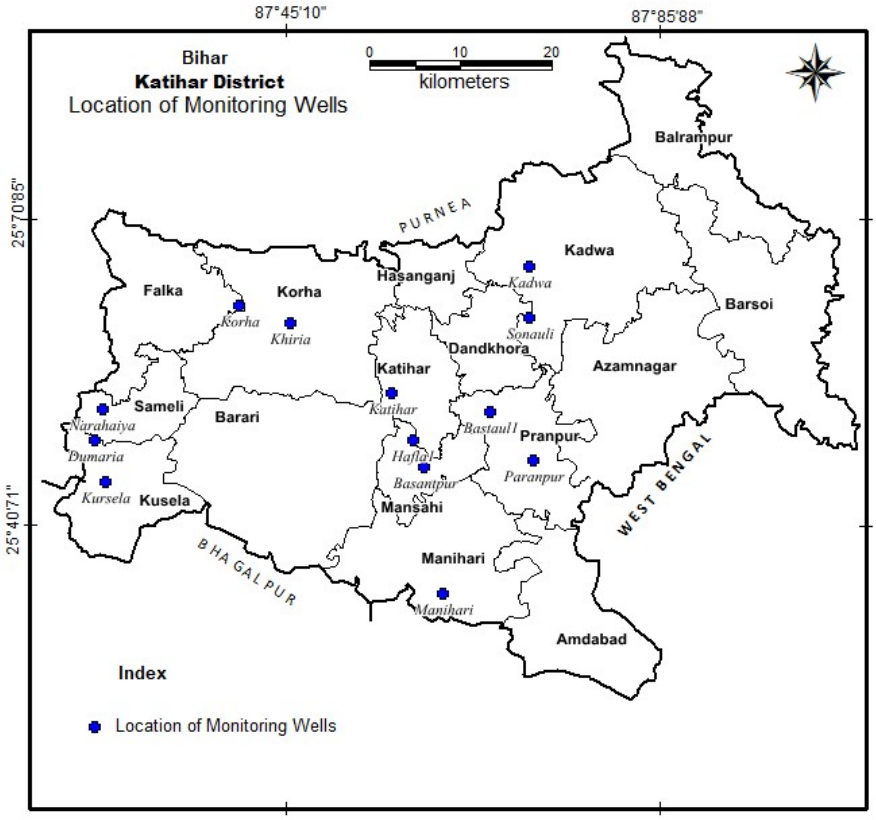


Figure 15: Location of monitoring well

Based on collected data, maps are prepared in GIS environment, using *Mapinfo*™ and *Vertical Mapper*™ softwares. Data interpolation is done through *Natural Neighbor Interpolation method.* The data then converted to delineate area classes of 0-2, 2-5, 5-10 and >10 m bgl water level.

3.3.1 Depth to water level – May 2019

During pre-monsoon period, the water level varied from 2.3 to 5.78 m bgl. Major part of the district is categorized in the depth range of 2-5 m bgl water level. Some small patches in the district comprising parts of Manihari and Amdabad block has shown depth to water level in the range of 5 to 10 m bgl. **(Figure 16)**.

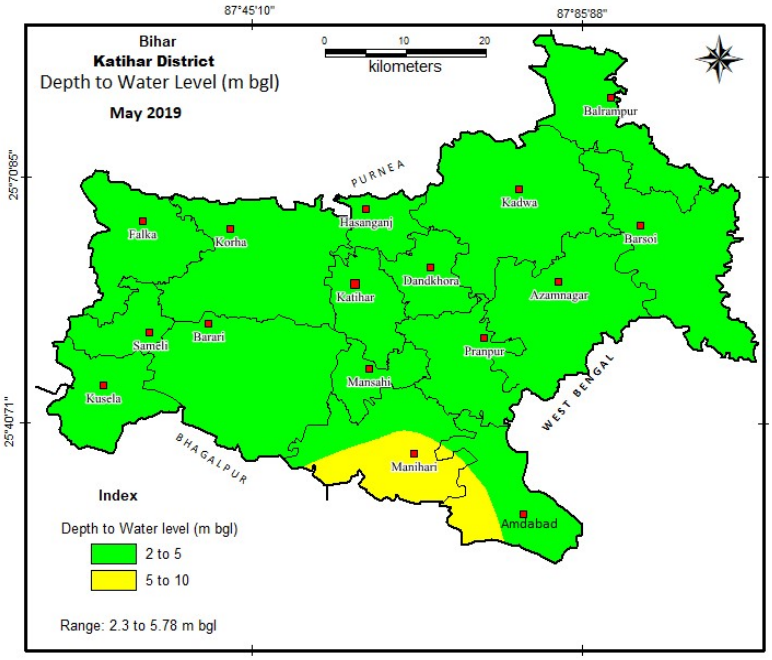


Figure 16: Depth to water level- May 2018

3.3.2 Depth to water level – November 2019

During post-monsoon period, Depth to water level ranged from 1.72 to 4.64 m bgl. Almost entire area has shown water level between 2 and 5 m bgl. Only a small patch covering small patch of Katihar and Mansahi block has shown water level less than 2 m. (**Figure 17)**

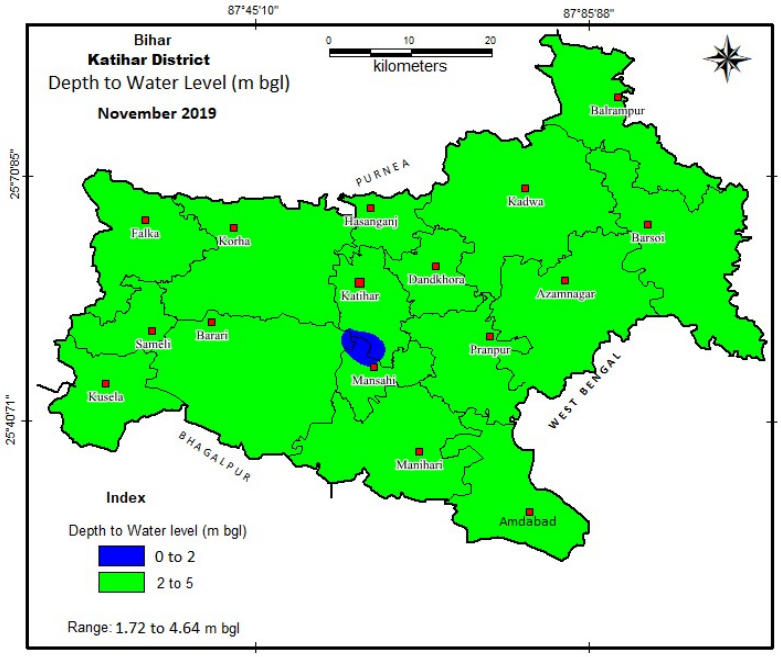


Figure 17: Depth to water level - Nov. 2018

3.3.3 Water level fluctuation during Nov. 2019 w.r.t. May 2019

The water level fluctuation during November w.r.t. May 2019 has been calculated between -0.7 to 3.78 m. Major part of the district water level fluctuation within 2 m to 4m only. A western elongated part shows rise in water level within range > 4 m. Middle part shows rise 0 to 2 m. A very small part shows fall in water level within 2 m due to some localised reason **(figure 18).**

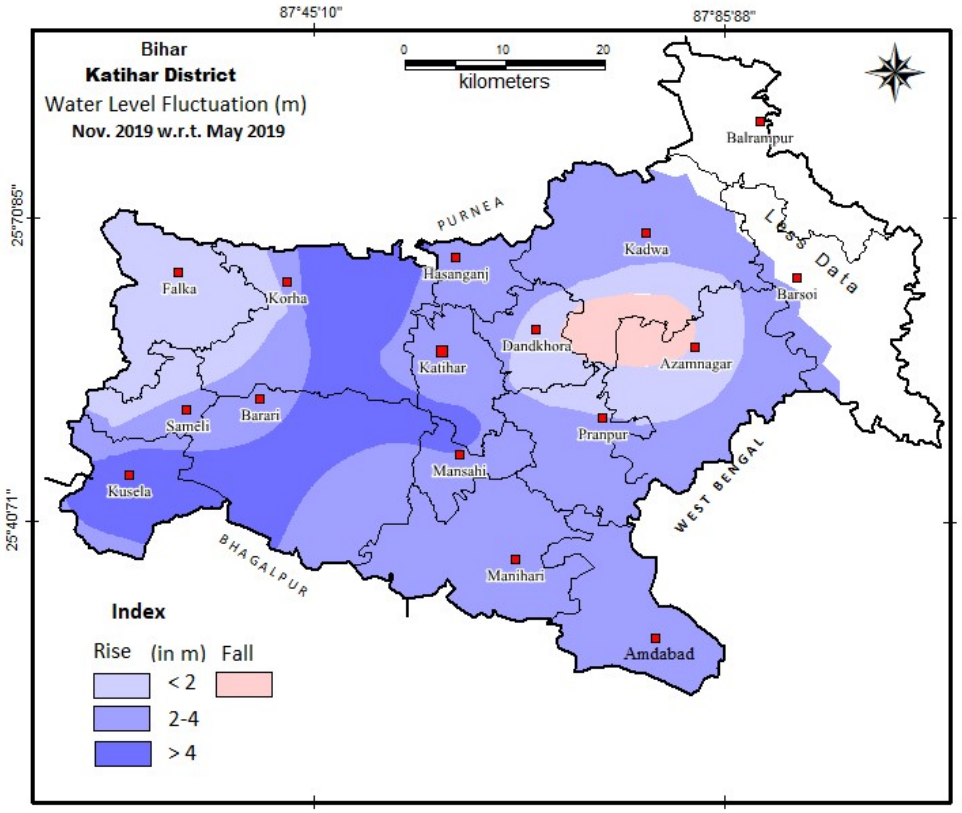


Figure 18: Water level fluctuation map (Nov.2019 w.r.t. May 2019)

3.3.4 Water Table Contour

The water table contour has been shown in **Fig. 19.** Water table contour is more or less following slop of the area. Map reveals that the general flow of groundwater in phreatic aquifer towards southern direction. The ground water flow changes direction towards east-west from almost central part of the district. The influence of river and ground water flow in eastern part of district is difficult to conclude as the data is less.

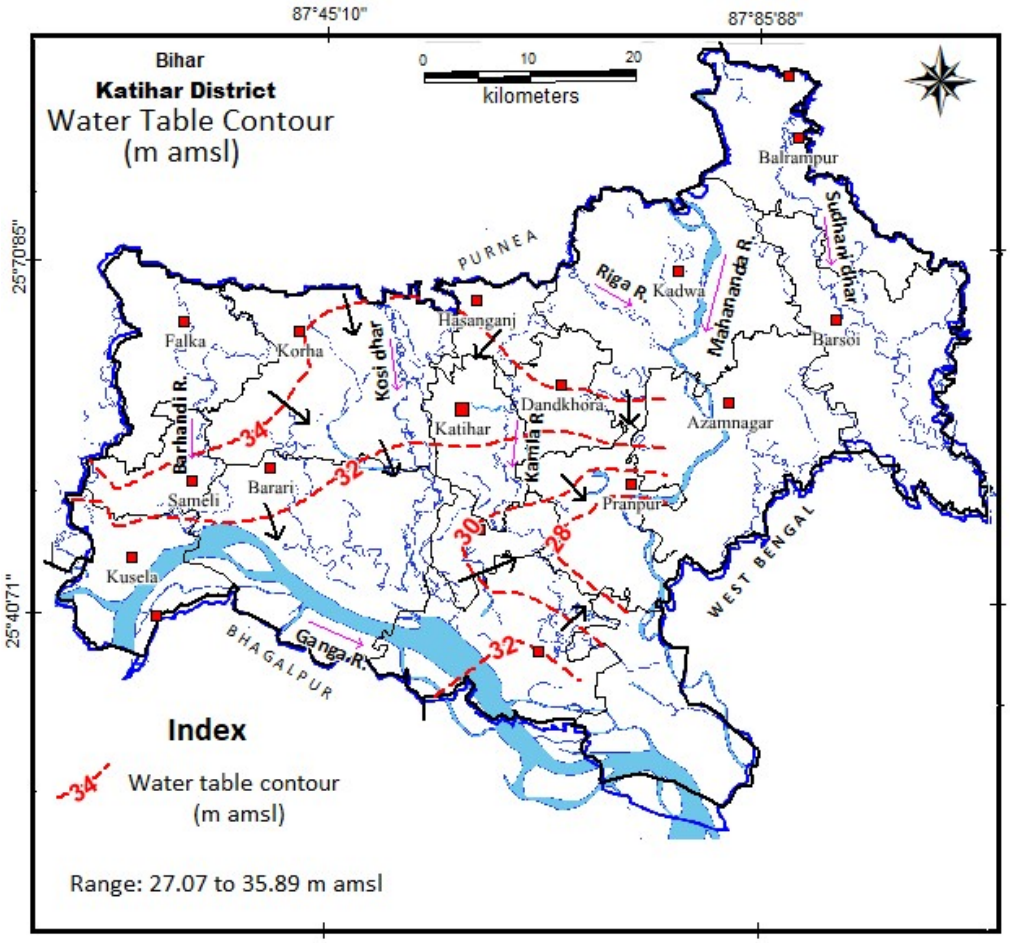


Figure 19: Water Table Contour map

3.3.4 Water Level Trend

Analysis of nine (09) hydrograph network stations located at Katihar and one from Purnea district were carried out using GEMS software **(Figure 20 to 28)** and analysed for the period from 2010-2019. One neighbouring hydrograph has also been taken from Purnea block. It is observed that all 10 hydrograph stations are showing rising trend. Out of four hydrograph analysed for long-term water level trends during pre and post-monsoon seasons, three (03) are not showing any significant trend. The water level trend for pre-monsoon period ranged from 0.3 (Basantpur) to 0.018 (Bastaul) and for post-monsoon period it is between 0.036 to 0.08 m/year. Except 'Narahiya' the water level trends calculated are not significant.

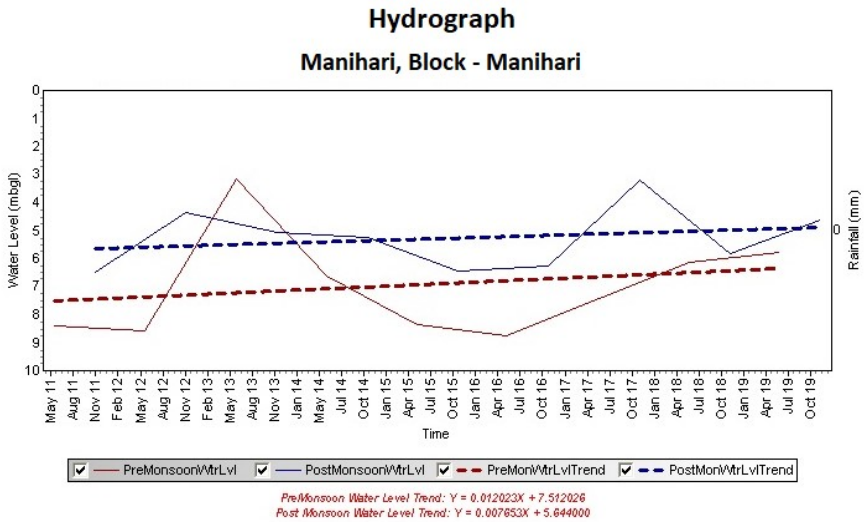


Figure 20: Water Level Trend at Manihari, Block Manihari

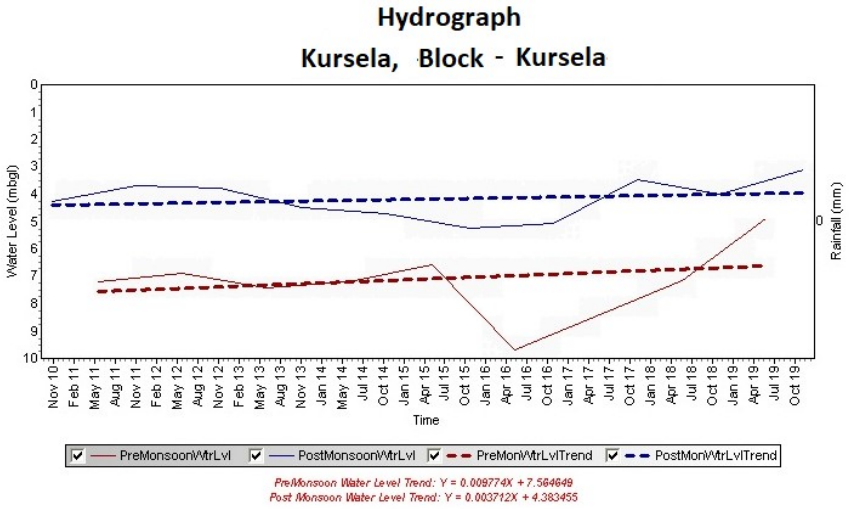


Figure 21: Water Level Trend at Kursela, Block - Kursela

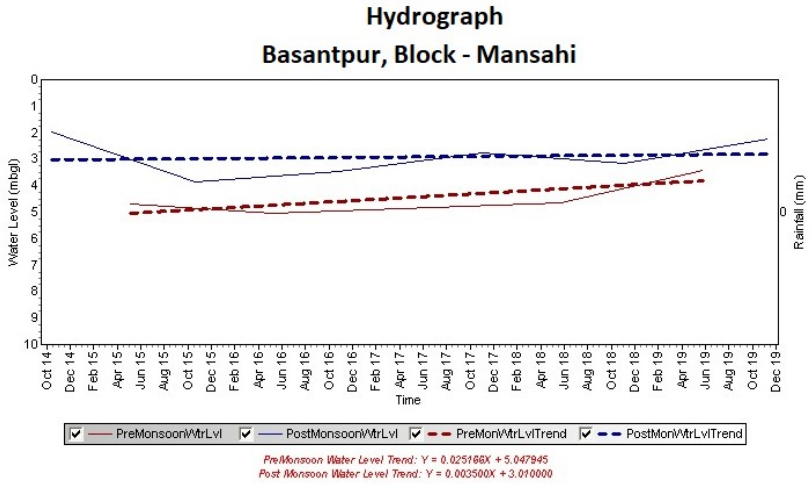


Figure 22: Water Level Trend at Basantpur, Block - Mansahi

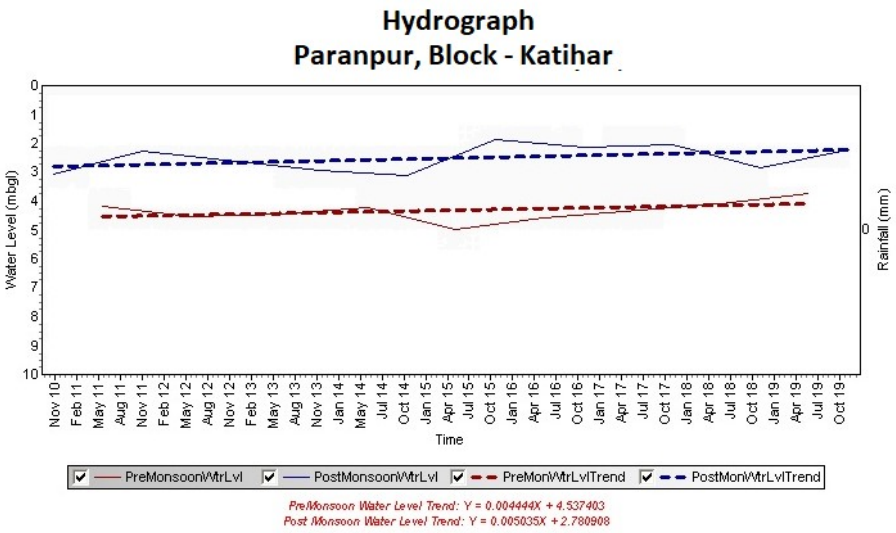


Figure 23: Water Level Trend at Paranpur, Block-Katihar

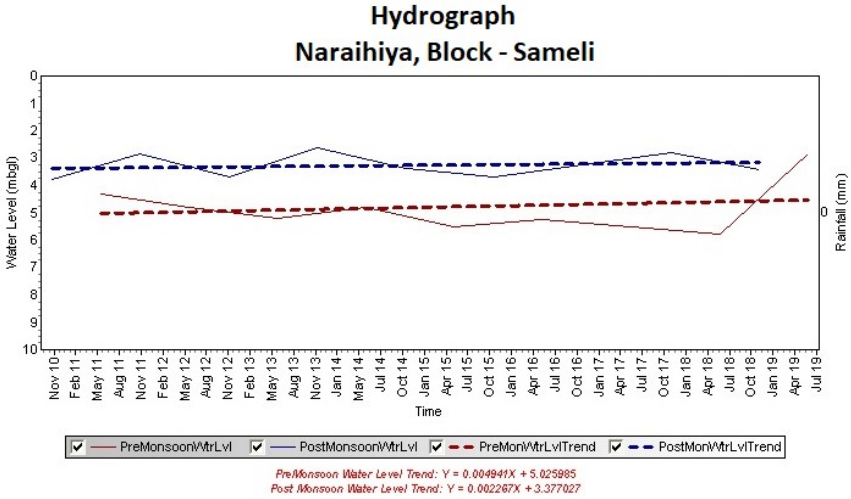


Figure 24: Water Level Trend at Naraihiya, Block - Sameli

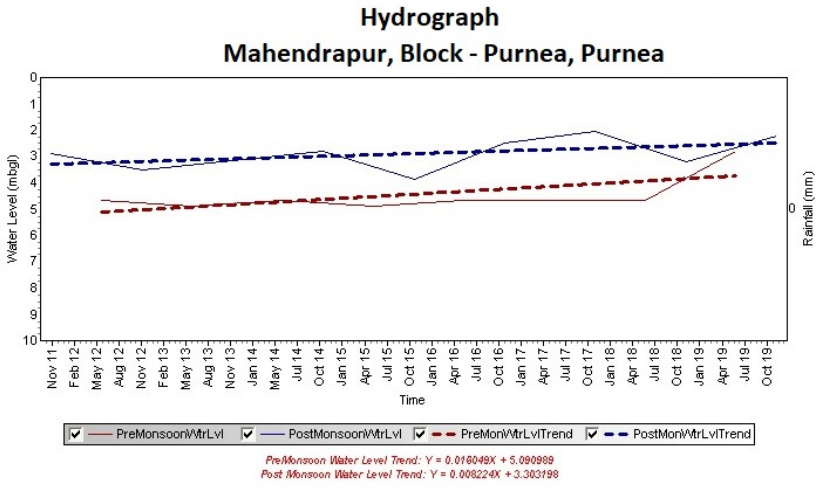


Figure 25: Water Level Trend at Mahendrapur, Block-Purnea (Purnea)

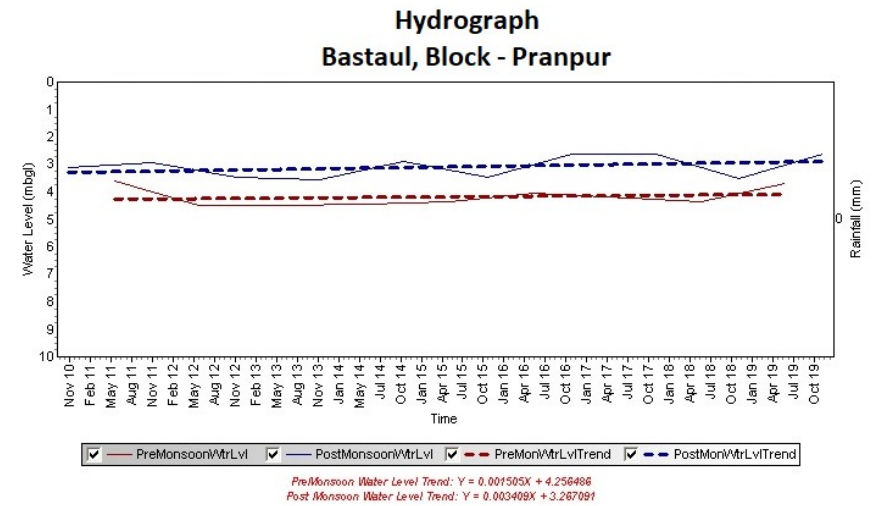


Figure 26: Water Level Trend at Bastaul, Block – Pranpur

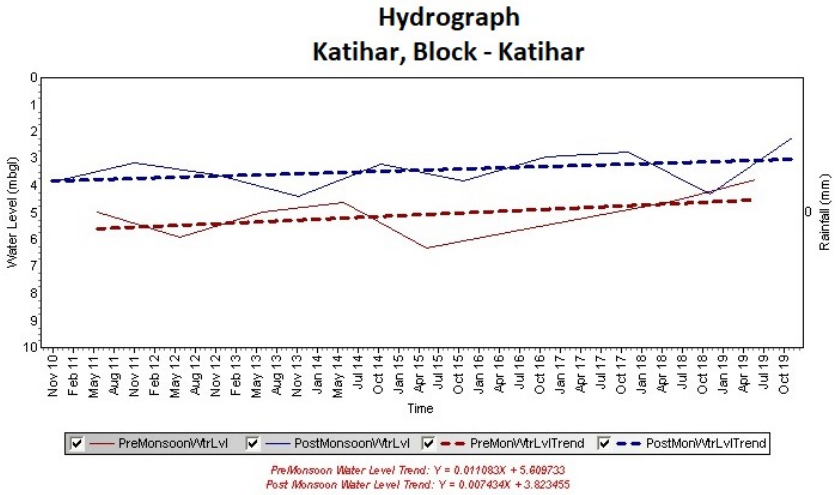


Figure 27: Water Level Trend at Katihar, Block-Katihar

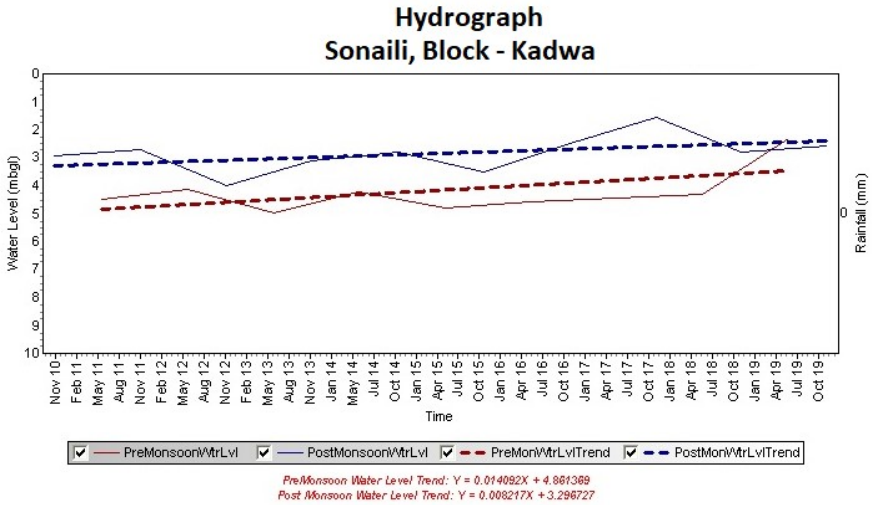


Figure 28: Water Level Trend at Sonaili, Block - Kadwa

3.5 Ground Water Exploration

The exploratory drilling has been carried out in Katihar district. The summarised result of the pumping test is given in **Table 9.** The location of these wells has been given in **figure 29.** Drilling depths of these exploratory wells are between 104 to ~300 m bgl. The zone tapped below the depth from 42 to 208 m bgl. Transmissivity value calculated to be 153 to 5643 m^2/day and storativity value ranged from 1.9×10^{-3} to 6.3×10^{-3}.

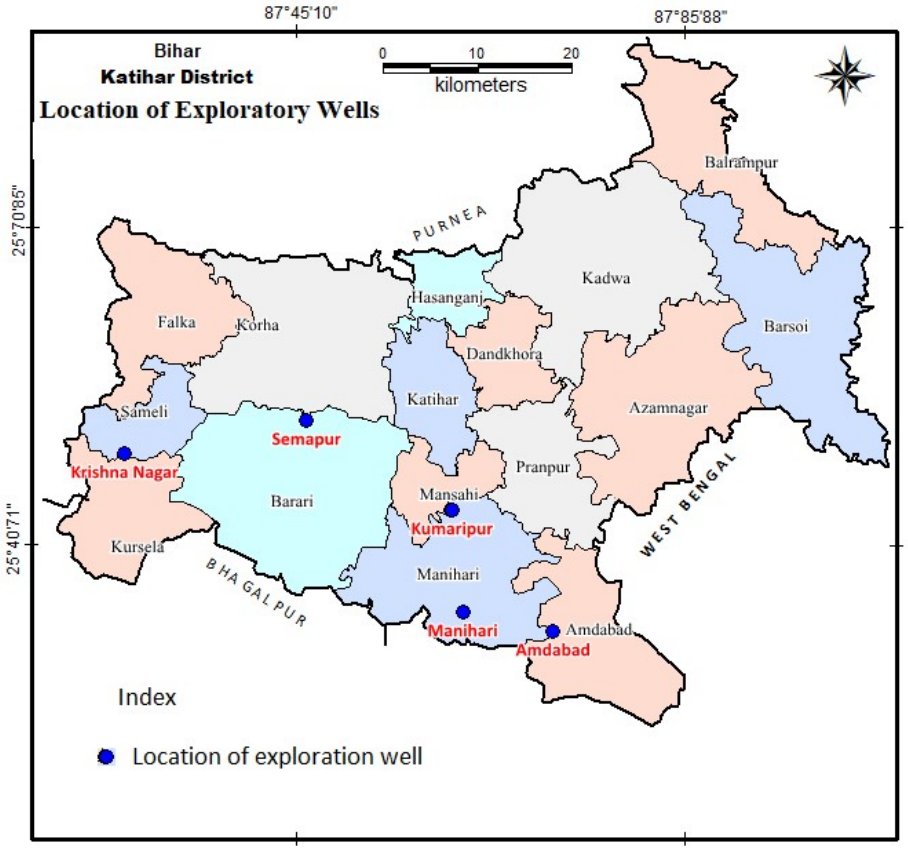


Figure 29: Location of Exploratory Wells

Table 9: Pumping test details

SN	Name	Block	Lat	Long	Depth drilled (m bgl)	Zone tapped from (m bgl)	Clay (Hard or sticky) encountered ?	Discharge m3/day	Discharge (lps)	Tranm Issiviy (m^2/day)	Storat Ivity
1	Amdabad	Amdabad	25.3250	87.71980	304	208	No	1662	19	154	-
2	Krishna Nagar	Sameli	25.4939	87.26880	302	154	No	3380	39	5643	-
3	Kumaripur	Manihari	25.4403	87.61370	257	151	No	3640	42	1190	$6.3x10^{-3}$
4	Manihari	Manihari	25.3445	87.62520	104	42	Yes	1902	22	3481	$1.9x10^{-3}$
5	Semapur	Semapur	25.5254	87.46040	304.2	135	No	3313	38	4331	-

3.4 Ground Water Quality

To study the groundwater chemistry of the area, data of chemical sample collected during pre-monsoon period of May 2019 and November 2020 from National Hydrograph Network Station has been taken. The detailed field work could not be carried out due to Covid-19 pandemic. The samples are collected from ground water and surface water. Analytical results of ground water samples are given in **Annexure II.**

3.4.1 Classification of Ground Water

The determination of groundwater facies helps for its evaluation. It can be done by the plotting of the percentage of selected chemical constituens in Modified Piper diagrame (Chadha et al 1999) which is a simplified version of Piper plot.

The plot prepared by using percentage of major cationns data on X axis and major anoions in Y axis plotted and **figure 30** has been prepared.

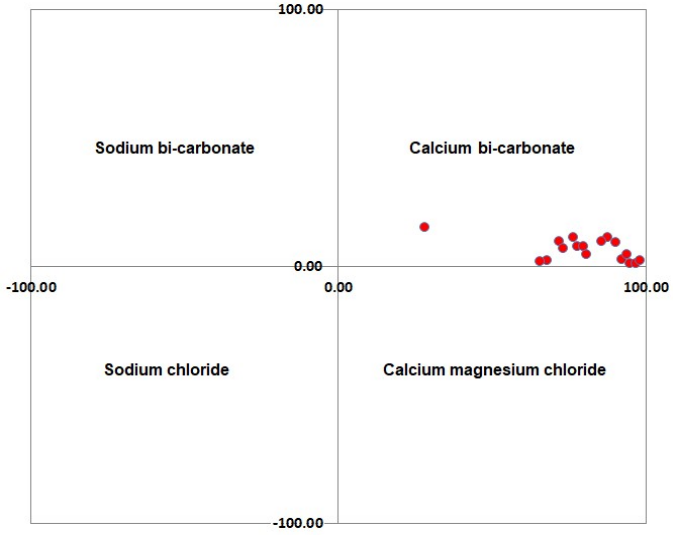


Figure 30: Classification of ground water

The groundwater samples are classified as calcium bicarbonate type water. The Ca -HCO_3 water is primarily a result of dissolution of carbonate minerals, and the origin of water is mainly due to rainfall-derived recharge, over decades to centuries.

3.4.2 Suitability for Drinking Purpose

Since water is a good solvent, it always contains some essential minerals in nature. But excess mineralisation of water is not good for health. Bureau of Indian Standard (BIS) has recommended extent of mineralisation suitable for drinking purpose. The recommendation of

BIS (2012) and concentration of each chemical constituent of the samples collected during May 2019 are presented in **Table 10.**

Table 10: Chemical Quality Data

SN	Block	Location	pH	F^-	Cl-	HCO_3^-	SO_4^{2-}	NO_3^-	TH	Ca_2^+	Mg_2^+
1	Barari	Barari	8.17	0	31.9	190.65	41.06	18.95	180	24	29.16
2	Pranpur	Basantpur	8.26	0.11	61.5	172.2	17.31	19.44	205	62	12.15
3	Pranpur	Bastaul	7.6	0.02	70.92	184.5	38.71	11.78	185	24	30.37
4	Kathihar	Hafla	7.92	0.22	38.99	129.15	45.39	25.32	169	38	18
5	Kathihar	Kathihar	8.14	0.69	95.742	311.1	5.36	29.78	272	28	49.2
6	Korha	Khiria	7.45	0.14	120.53	311.66	14.32	43.84	70	18	6
7	Korha	Korha	7.76	0	88.62	473.55	12.24	15.43	405	64	59.53
8	Falka	Mahendrapur	8.13	0.81	120.53	325.95	16.26	9.32	300	44	46.17
9	Falka	Narhaiya	7.23	0.03	35.45	123	7.95	29.45	90	14	13.36
10	Pranpur	Pranpur	7.66	0	104.55	430.5	10.25	41.94	427	74	58.8
11	Korha	Routara	7.82	0.61	21.27	141.45	23.05	0.07	115	24	13.36
BIS 2012	*Acceptable limit*		***<6.5***	***1***	***250***	***200***	***200***	***NA***	***200***	***75***	***30***
	Permissible limit (in the absence of alternate source)		***>8.5***	***1.5***	***1000***	***600***	***400***	***45***	***600***	***200***	***100***

Value in mg/l

From the above table it can be inferred that in general, water is potable.

3.4.3 Hardness

The term hard and soft as applied to water date from Hippocratus (480-354 BC), the father of medicine, in his treatise on public hygiene. Hardness results from the presence of divalent metallic cation, of which calcium and magnesium are the most abundant in ground water. These ions react with soap, hard waters are unsatisfactory for household cleansing purposes.

The degree of hardness in water is commonly based on the classification given by Sawyer and Mc Carty, 1967 as under:

Hardness (mg/l) as $CaCO_3$	*Water Class*
0-75	Soft
75-150	Moderate
150-300	Hard
300-600	Very hard
>600	Extremely hard

As per the water samples collected from Katihar district (May 2019), hardness ranged from 70 to 427 mg/l (as $CaCO_3$). Majority of the samples (55%) have been categorised as hard out of 11 sample analysed. Only 2 samples are categorised as 'moderate hardness' and 1 sample as 'soft'**.** Rest 2 samples are "very hard" having shown hardness value more than 300 mg/l (as $CaCO_3$).

3.4.4 Suitability for Irrigation

The suitabality of groundwater for irrigation purpose is based on its chemical characterstics which creates soil condition hazardous to crop growth and yield. It depends on the following prevailing criteria:-

1. Salinity :- Total concentration of soluble salt.

   Excess salts in the root zone hinder plant roots from withdrawing water from surrounding soil. Hence, the excess salinity in soil water can decrease plant available water and cause plant stress.

   Ex.: The permeability index (PI) :- It is an indicator to study the suitability water for irrigation purpose. Water movement capability in soil (permeability) is influenced by the long-term use of irrigation water (with a high concentration of salt) as it is affected by Na+, Ca^{2+}, Mg^{2+} and HCO_3^- ions of the soil.

2. Sodicity: Concentration of sodium relative to calcium and magnesium.

   The forces that bind clay particles together are disrupted when excess sodium ions come between them. When this separation occurs, the clay particles expand, causing swelling and soil dispersion. When soil is repeatedly wetted and dried and clay dispersion occurs, it then reforms and solidifies into almost cement-like soil with little or no structure results reduced infiltration, reduced hydraulic conductivity, and surface crusting.

3. Relative proportion of carbonates + bicarbonate to calcium + magnesium.

Based on the above, many method has been suggested by the scientst/chemist to check its suitability. Suggsted method wise suitabality of groundwater (May 2019) for irrigation purpose is given in the table below:-

Table 11: Suitability of ground water for irrigation purpose

SN	Block	location	Sodium Adsorption Ratio	Sodium Soluble Percentage	Kelley's Index	Permeability Index
			Na/sqrt(Ca+Mg/2)	*Na*100/Ca+Mg+Na*	*Na/(Ca+Mg)*	*Na+sqrtHCo3)/(Ca+Mg+Na)*100*
1	Barari	Barari	5.74	40.16	0.67	55.70
2	Pranpur	Basantpur	4.83	34.94	0.54	46.46
3	Pranpur	Bastaul	6.91	44.32	0.80	58.23
4	Kathihar	Hafla	4.57	35.85	0.56	48.87
5	Kathihar	Kathihar	7.85	42.44	0.74	55.59
6	Korha	Khiria	4.23	44.70	0.81	85.38
7	Korha	Korha	6.40	33.41	0.50	45.14
8	Falka	Mahendrapur	8.21	42.72	0.75	54.19
9	Falka	Narhaiya	8.63	58.91	1.43	75.57
10	Pranpur	Pranpur	3.80	22.55	0.29	34.65
11	Korha	Routara	5.43	44.59	0.80	62.23
		Minimum	3.80	22.55	0.29	34.65
		Maximum	8.63	58.91	1.43	85.38
		Average	6.05	40.42	0.72	56.55
		Suitable	<10	<50	<1	25-75
		Marginal	NA	NA	1.2	NA
		Not suitable	>10	>50	>2	>75

Ionic concentrations are calculated in milliequivalents per litre

The **table 11** shows that, the ground water quality of the area is within the range of 'suitable' except few places. Thus, based on the above table it can be inferred that the ground water of the phreatic aquifer is suitable for irrigation purpose.

3.4.5 USSL diagram

The United States Soil Laboratory Staff's (USSLS's) diagram classifies water quality into 16 zones to assess the degree of suitability of water for irrigation **(Figure 31)** in which waters have been divided into C1, C2 C3 and C4 types on the basis of salinity hazard and S1, S2, S3, S4 types on the basis of sodium hazard.

Classification of irrigation waters with respect to SAR is primarily based on the soil. Sodium sensitive plants may, however, suffer injury as a result of sodium accumulation in plant tissue when exchangeable sodium accumulation in the physical condition of the soil. Sodium-sensitive plants may, however, suffer injury as a result of sodium accumulation in the plant tissue when exchangeable sodium values are lower than those effective in causing

deterioration of the physical condition of the soil.

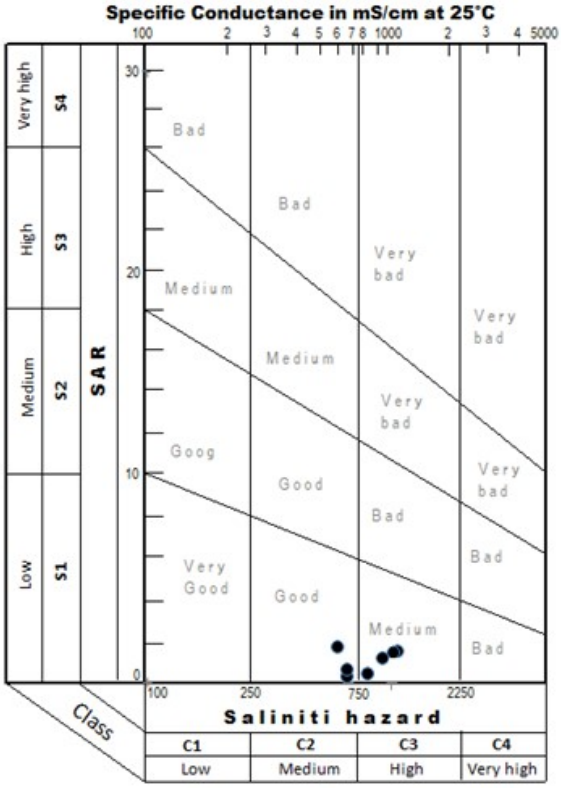


Figure 31: US Salinity Diagram

The salinity hazard classes (After Handa 1969) and the EC value observed has been given below

Classes	*EC (µS/cm)*	*Water salinity*
C_1	0-250	Low (excellent quality)
C_2	250-750	Medium (good quality)
C_3	750-2250	High (permissible quality)
C_4	2250-600	Very high

The **Figure 28** shows that all the samples collected during May 2019 have fall in medium to high sodium hazard class and low salinity class

This empirical attempt for determining salinity hazard is based on SAR only. The other factors like cropping pattern, soil type, rainfall recharge, climate etc. should also be considered.

3.5 Aquifer Disposition

Fence (2-D) diagrams are prepared to identify spatial disposition and vertical extent of Aquifer. The tube wells, drilled by Bihar State Development Authority and other agency have also been taken for the 2-D diagrams. Diagrams are also taken and re-prepared from the

previous reports. Locations of these wells are shown with the diagram concerned.

3.5.1 Aquifer Disposition in the area

The aquifer geometry on regional scale has been attempted for Katihar district based on the available data. Since the no significant clay layer has been observed at regional scale, aquifers are delineated as per the sand size. These cross sections/fence diagrams are given below along with the map to locate on the area concerned**.**

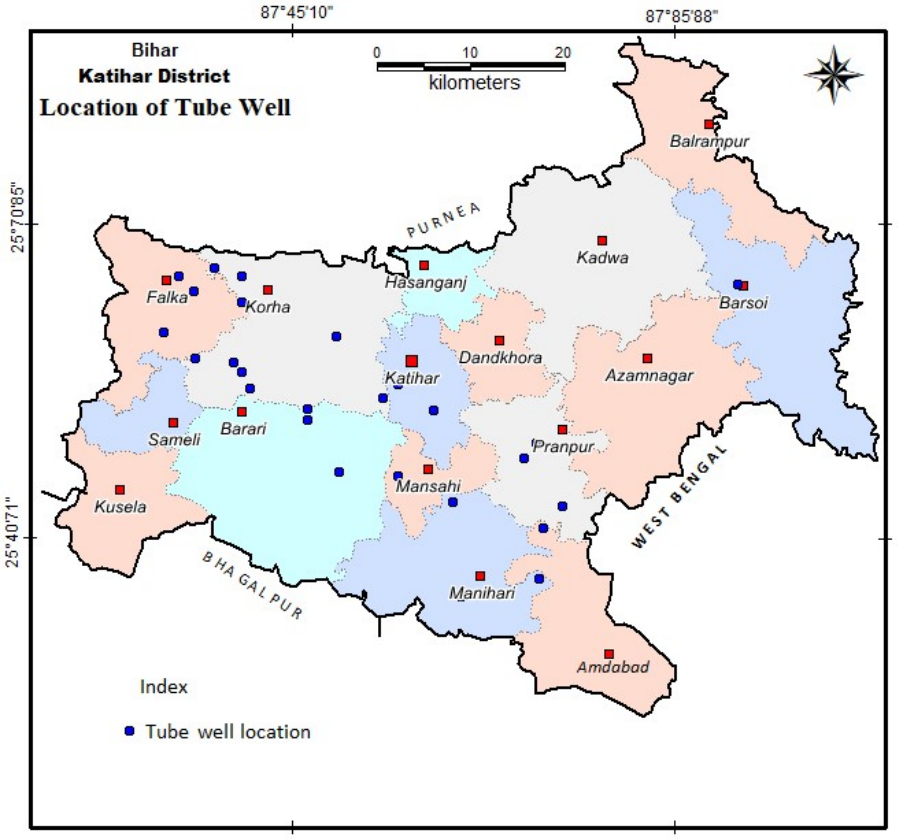


Figure 32: Location of Tube Wells

Locations of the tube well are shown in **figure 32.** Majority of these wells are utilised for the preparation of fence diagram by taking their lithology.

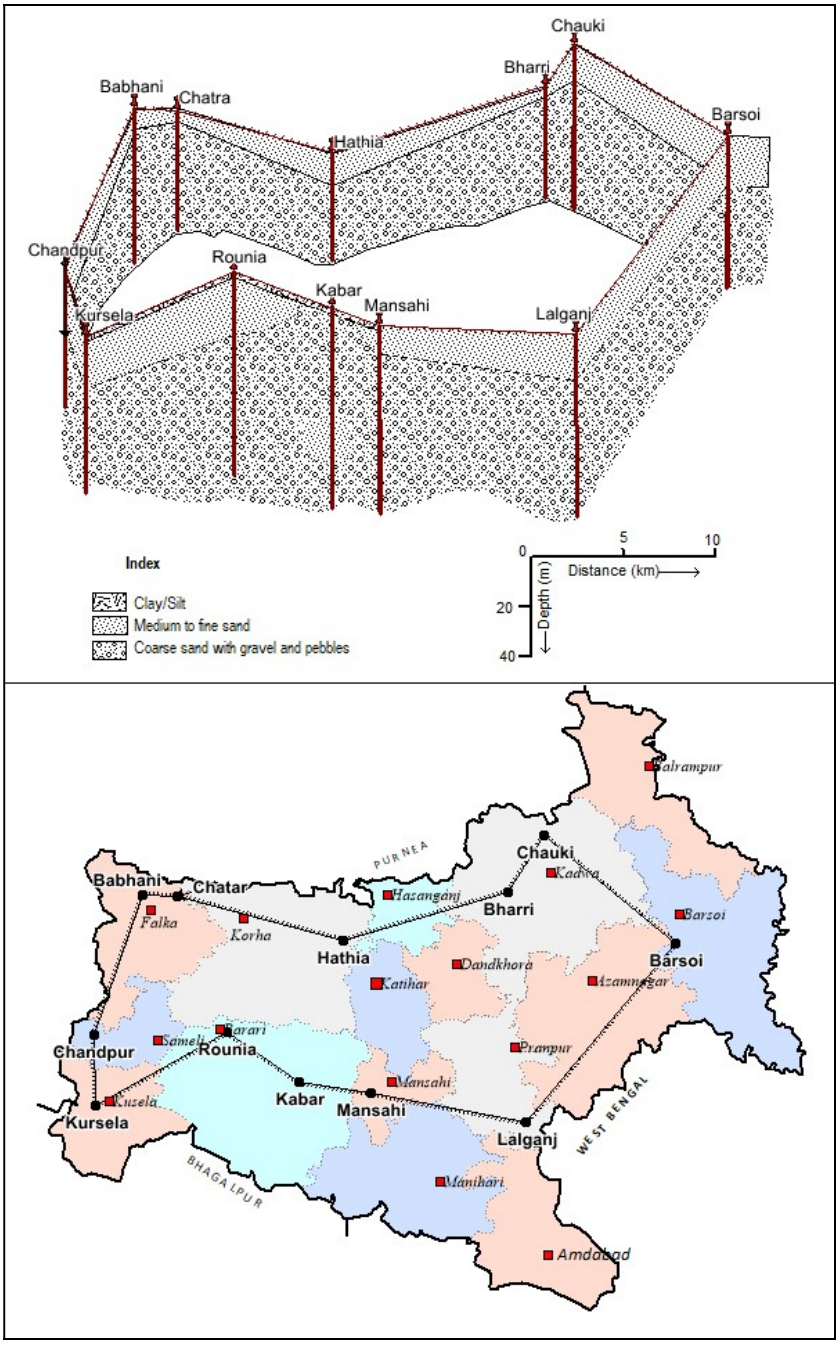


Figure 33: Fence Diagram - 1

The **figure 33** has been reproduced after taking it from a report (Hydrogeology and Ground Water Development Potential of Katihar district, Bihar) published in March 1993. The figure reveals that the area has the general sequence of clay/silt, medium to fine sand and coarse sand with gravel and pebble from top to the drilled depth at regional scale. No significant clay layer has been observed. This figure indicates the presence of a single unconfined aquifer down to the drilled depth.

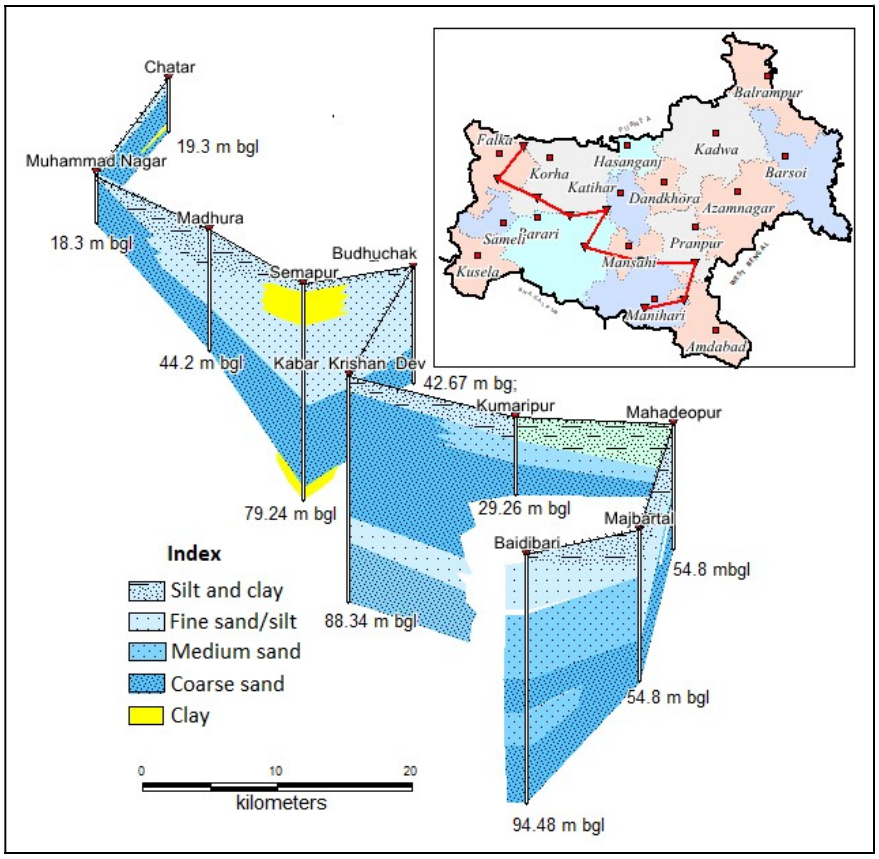


Figure 34: Fence Diagram - 2

Figure 34 has been prepared after taking the lithology data of tube wells located in almost western part (Kosi river) of the district. As compare to fence diagram -1, the fnece diagram - 2 magnifies the lithological information and almost follows the same depositional pattern. The clay layers have been observed locally in Semapur (Barai block) but it is discontinued. This fence diagram also indicates the occurrence of a single unconfined aquifer down to the maximum drilled depth of ~94 m bgl.

This figure also reveals the presence of a coarse sand layer in the area down to the depth of ~40 m bgl. It may be the reason that majority of irrigation tube well in the district are shallow (within this depth range).

3.6 Aquifer Characterisations

Characterization of aquifer upto ~80 m bgl in the study area has been arrived at by convergence of the observations from the study of the different lithological sections, fence diagrams, geo-electrical sections, sections based on lithologs and overall lithological model of the area. All these figures reveal the presence of a thick pile of alluvial sediments. The area is characterized by occurrence of fairly thick sands of various grades forming aquifers.

The perusals of the sections, fence diagram and lithological model indicate that there is an only one principal aquifer system below the top aquitard layer (water table aquifer) down to the explored depth of 80 m bgl. In the central part and western part of the district there is a considerable thickness of but discontinued clay layer below the depth of ~50 m bgl.

As per the available data, collected from the wells drilled between 104 to 311 m depth in district Katihar **Table 9** has been compiled. The yield of these wells is ranged from 19 to 46.5 lps. The transmissivity value calculated to be ~150 to ~5500 m^3/day. The storativity value after tapping the aquifer below ~140 m bgl indicates that aquifer is unconfined in nature.

Based on the above data and the analysis carried out, a hydrogeological map has been prepared. As there is no major change in geology and being a part of the Kosi mega fan deposits the area is a monotonous alluvial terrain the district may be considered as single hydrogeological unit.

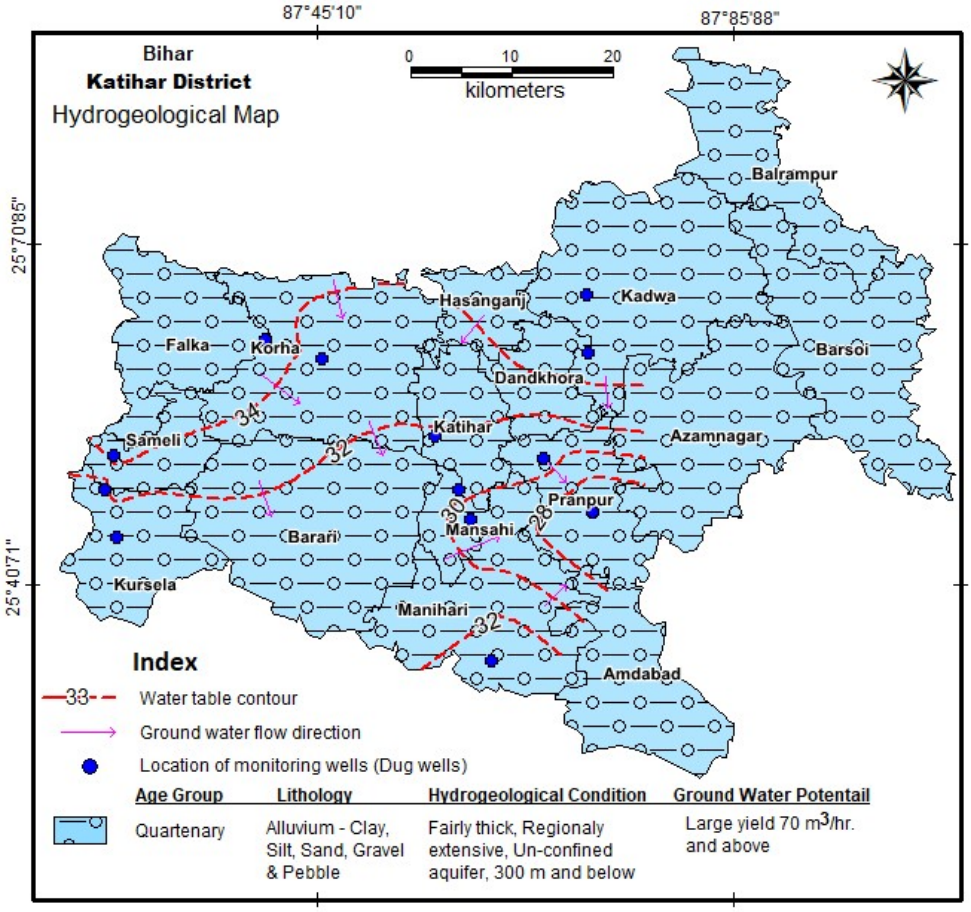


Figure 35: Hydrogeological Map of Katihar District

CHAPTER 4

4. REPLENISHABLE GROUND WATER RESOURCES

Ground Water Resource of the area has been estimated block wise based on for base year as on 2020. In the present report GEC 2015 methodology has been used and based on the assessment has been made using appropriate assumptions. This methodology recommends aquifer wise ground water resource assessment of both the Ground water resources components, i.e., replenishable ground water resources or Dynamic Ground Water Resources and In-storage Resources or Static Resources. Development planning is mainly depending on dynamic resource as it gets replenished every year. Changes in static or in-storage resources reflect impacts of ground water mining. Such resources may not be replenishable annually and may be allowed to be extracted only during exigencies with proper recharge planning in the succeeding excess rainfall years.

4.1 Assessment of Annually Replenishable or Dynamic Ground Water Resources (Unconfined Aquifer i. e Aquifer-I)

The methodology for ground water resources estimation is based on the principle of water balance as given below:

Inflow – Outflow = Change in Storage (of an aquifer)

The equation can be further elaborated as

$$\Delta S = RRF+RSTR+RC+RSWI+RGWI+RTP+RWCS \pm VF \pm LF - GE - T - E - B$$

Where,

ΔS – Change is storage, RRF – Rainfall recharge, RSTR- Recharge from stream channels

RC – Recharge from canals, RSWI – Recharge from surface water irrigation

RGWI- Recharge from ground water irrigation, RTP- Recharge from Tanks & Ponds

RWCS – Recharge from water conservation structures, VF – Vertical flow across the aquifer system, LF- Lateral flow along the aquifer system (through flow), GE- Ground Water Extraction, T- Transpiration, E- Evaporation, B-Base flow

The dynamic Ground Water Resources has been assessed by CGWB, MER, Patna in association with Minor Water Resources Department, Bihar for base year as on 2020 based on GEC, Methodology 2015. The summarized detail of Annually Replenishable or Dynamic Ground Water Resources of Katihar district is given in **Table-12 & 13.**

As per the assessment year 2020, all 16 block are categorised as ‘safe’ except Dandkhora block which is categorised as ‘Semi-critical’. The table indicates that Dandkhora block has highest percentage (76.75%) of ground water extraction for irrigation purpose.

The stage of ground water extraction has been ranged from 28.02% (Manihari) to 76.75% (Dandkhora). It indicates that still there is ample scope for ground water development in the district. The result of the assessment of Dynamic Ground Water Recourses is given in **Table 12 and Table 13.**

Table 12: Net ground water availability (GWRE - 2020)

SN	Assessment Unit Name	Total Area of Assessment Unit (Ha)	Recharge from Rainfall-Monsoon Season	Recharge from Other Sources-Monsoon Season	Recharge from Rainfall-Non Monsoon Season	Recharge from Other Sources-Non Monsoon Season	Total Annual Ground Water (Ham) Recharge	Total Natural Discharges (Ham)	Annual Extractable Ground Water Resource (Ham)
	1	2	3	4	5	6	7	8	9
1	Amdabad	18863	4287.36	599.67	551.4	406.54	5844.97	584.49	5260.48
2	Azamnagar	29077	9913.35	2190.52	849.98	1421.17	14375.02	1437.51	12937.51
3	Balrampur	17428	5941.8	866.03	509.46	588.39	7905.68	790.56	7115.12
4	Barari	32780	11175.83	819.1	958.22	554.29	13507.44	1350.74	12156.7
5	Barsoi	27914	9516.84	1407.18	815.98	960.98	12700.98	1270.1	11430.88
6	Dandkhora	8921	3041.48	656.95	260.78	444.02	4403.23	440.32	3962.91
7	Falka	16948	3852.1	667.72	495.42	454.13	5469.37	546.93	4922.44
8	Hasanganj	7111	1616.26	243.67	207.87	166.54	2234.34	223.43	2010.91
9	Kadwa	33992	11589.04	1878.54	993.65	1268.9	15730.13	1573.02	14157.11
10	Katihar	11005	3751.98	294.06	321.7	200.14	4567.88	456.78	4111.1
11	Korha	29848	10176.21	1612.54	872.52	1089.19	13750.46	1375.05	12375.41
12	Kursela	6106	1387.83	119.94	178.49	81.61	1767.87	176.79	1591.08
13	Manihari	25012	5684.97	296.02	731.15	202.4	6914.54	691.46	6223.08
14	Manshi	7814	2664.06	785.13	228.42	483.48	4161.09	416.11	3744.98
15	Pranpur	15306	5218.34	1308.47	447.42	795.06	7769.29	776.93	6992.36
16	Sameli	12866	2924.31	298.76	376.1	205.58	3804.75	380.48	3424.27
	Total	**300993**	**92741.76**	**14044.3**	**8798.56**	**9322.42**	**124907**	**12490.7**	**112416.3**

Table 13: Stage of ground water development

SN	Assessment Unit Name	Ground Water Extraction				Annual GW Allocation for for Domestic Use as on 2025 (Ham)	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited Critical/ Semicritical/ Safe/Saline)
		for Irrigation Use (Ham)	for Industrial Use (Ham)	for Domestic Use (Ham)	Total (Ham)				
	1	10	11	12	13	14	15	16	17
1	Amdabad	2526.93	135.00	288.39	2950.32	323.95	2274.6	56.08	safe
2	Azamnagar	7987.14	423.00	543.73	8953.87	610.78	3916.59	69.21	safe
3	Balrampur	3638.25	189.00	273.88	4101.13	307.66	2980.21	57.64	safe
4	Barari	3460.59	198.00	491.66	4150.24	552.28	7945.84	34.14	safe
5	Barsoi	5868.45	315.00	614.77	6798.22	690.57	4556.86	59.47	safe
6	Dandkhora	2780.19	144.00	117.25	3041.44	131.7	907.02	76.75	Semi_critical
7	Falka	2800.98	153.00	268.18	3222.16	301.24	1667.22	65.46	safe
8	Hasanganj	1014.93	54.00	96.31	1165.25	108.19	833.78	57.95	safe
9	Kadwa	7956.9	423.00	597.64	8977.55	671.34	5105.86	63.41	safe
10	Katihar	1232.28	117.00	1384.26	2733.54	1554.95	1206.87	66.49	safe
11	Korha	6830.46	360.00	487.23	7677.69	547.31	4637.64	62.04	safe
12	Kursela	502.74	27.00	110.14	639.88	123.72	937.62	40.22	safe
13	Manihari	1232.28	90.00	421.51	1743.79	473.48	4427.32	28.02	safe
14	Manshi	2271.78	117.00	145.16	2533.93	163.06	1193.15	67.66	safe
15	Pranpur	4288.41	225.00	248.59	4762	279.25	2199.7	68.10	safe
16	Sameli	1232.28	72.00	145.55	1449.83	163.5	1956.49	42.34	safe
	Total	**55624.59**	**3042**	**6234.248**	**64900.84**	**7002.98**	**46746.77**	**57.73**	

About 50 % blocks have the stage of ground water development is more than 60% and approaching to the safe limit of 70%. It indicates the dependency on ground water to fulfil the domestic, industrial and irrigation need. Although the scope exists for the further development of ground water but the artificial recharge practices and demand side management of ground water is required.

CHAPTER 5

5. GROUND WATER RELATED ISSUES

5.1 Identification of issues

The district is a part of Kosi mega fan deposits. Lithologs of the tube wells drilled in the area and the pumping tests is done in the district revels that there is thick pile of sediments having no significant clay layers down to the drilled depth of ~80 m bgl. The aquifer is seems to be 'unconfined'.

The Stage of Ground Water Extraction of the assessment unit (administrative blocks) has been calculated between 28.02 to 76.75% (as on March 2020). It shows that in spite of irrigation practice by ground water as a main source, there is still a scope of further ground water exploitation except the Dandkhora block which is categorised as 'semi-critical'.

Out of 16 blocks, the Stage of Ground Water Extraction of 8 blocks is more than 60%. The late monsoon is also affects to the exploitation of ground water. The canal irrigation covers only north-western part of the district, major part of the district is depends on ground water for irrigation purpose.

There is a shifting of the number of tube wells to the deeper zone indicates that demand of ground water may be due to surety from next sustainable zone .

The **Amdabad, Manihari, Kursela, Mansahi, Barari and Sameli block,** however not the part of present study, has been already taken up for study and report has been published owing to problematic area in terms of ground water quality (Arsenic contamination).

5.2 Major Ground Water Issues

1. As per the ground water resources estimation – 2020, block wise estimated Stage of Ground Water Extraction of the district is 57.73 % only. It shows that there is a scope to develop ground water further to fulfil the demand of water.
2. Out of 16 administrative blocks, Stage of Ground Water Extraction of 8 blocks is more than 60%. Hence, although scope exists for ground water development there is a need of Artificial Recharge to ground water in the area.
3. Judicious use of ground water may be encouraged in the area to get the maximum benefits.
4. The **Amdabad, Manihari, Kursela, Mansahi, Barari and Sameli block,*** however not the part of present study, are arsenic affected.

*Report has already been published under National Aquifer Mapping for these blocks. The published report may be referred for information in detail

CHAPTER 6

6. MANAGEMENT STRATEGIES

6.1 Possibility for construction of additional shallow tube wells

On the basis of Ground Water Resource Estimation -2020, additional number shallow tube well for alluvium area for each block has been calculated within the safe limit of the Stage of Development up to 70% by considering unit draft for each tube well 1.89 ha m. As per the calculation, a total of 7438 number of tube wells can be constructed to fulfil the future demand of ground water. The block wise additional number of tube well is given in table.

Table 14: Additional Nos. of STW feasible based on GW availability

Block	Provision for Future Domestic and Industrial Requirement	SOD% 2020	Category	Projected SOD (%)	GW draft at Projected SOD	Additional Resource Available	Unit Draft of STW	Additional Nos. of STW feasible based on GW availability
Amdabad	323.95	56.08	safe	70	3682.336	732.016	1.89	387
Azamnagar	610.78	69.21	safe	70	9056.257	102.387	1.89	54
Balrampur	307.66	57.64	safe	70	4980.584	879.454	1.89	465
Barari	552.28	34.14	safe	70	8509.69	4359.45	1.89	2307
Barsoi	690.57	59.47	safe	70	8001.616	1203.396	1.89	637
Dandkhora	131.7	76.75	Semi-critical	70	2774.037	0	-	0
Falka	301.24	65.46	safe	70	3445.708	223.548	1.89	118
Hasanganj	108.19	57.95	safe	70	1407.637	242.387	1.89	128
Kadwa	671.34	63.41	safe	70	9909.977	932.427	1.89	493
Katihar	1554.95	66.49	safe	70	2877.77	144.23	1.89	76
Korha	547.31	62.04	safe	70	8662.787	985.097	1.89	521
Kursela	123.72	40.22	safe	70	1113.756	473.876	1.89	251
Manihari	473.48	28.02	safe	70	4356.156	2612.366	1.89	1382
Manshi	163.06	67.66	safe	70	2621.486	87.556	1.89	46
Pranpur	279.25	68.10	safe	70	4894.652	132.652	1.89	70
Samoli	163.5	42.34	safe	70	2396.989	947.159	1.89	501
							Total	**7438**

The above calculation has been made based on Dynamic Ground Water Resources Assessment – March 2020. It is an empirical idea to develop ground water further. Since the Dynamic Ground Water Resources Assessment being calculated in 2 years (now planned for every year) depends on many factor including ground water draft, the development design should be considered accordingly.

6.2 Artificial Recharge

Although, 15 out of 16 blocks are in safe category the artificial recharge should be encouraged to arrest the decline of ground water level caused by the increasing demand of ground water.

By considering entire non-monsoon rainfall as committed, excess monsoon rainfall can be safely harnessed to replenish groundwater table without affecting surface water resource. For the present calculation for artificial recharge, 60% of the normal monsoon rainfall for identified feasible areas is considered as available non- committed surface runoff.

Table 15: Identified Area, Computed Storage Volume and Source Water availability for Artificial Recharge

Area	*Area Identified for AR*	*Volume of De-saturated Zone*	*Source Water Requirement*	*Total Surplus Runoff Available*
(sq.km.)	**(sq.km.)**	**(MCM)**	**(MCM)**	**(MCM)**
3302.84	999.55	425.41	655.13	2396.33

Considering hydrogeological and geomorphological set up and relative groundwater potentialities in the district, various types of artificial recharge/conservation structure has been recommended. Actual numbers of structures implementable may vary significantly based on scale of implementation. Based on available literature and previous experiences, unit cost of structures is also worked out. Block wise no and cost estimated are given in **Table 16.** Suitable area for artificial recharge has been identified where the post monsoon (2018) water level is more than 3 m bgl.

The number and type of the recharge structure is based on the published report on "Master Plan to Artificial Recharge".

Table 16: Block wise Number of Recharge Sturcture

SN	BLOCK	Nala Bunding		Lateral Recharge Shaft		Recharge Shaft		Percolation Tank		De-silting of existing tank /pond /talao		Injection Well in Village Tank		Total Cost
Unit cost (lakh)		**1**		**2**		**5**		**30**		**5**		**4**		
		No	**Cost**	**No**	**Cost**	**No**	**Cost**	**No**	**Cost**	**No**	**Cost**	**No**	**Cost**	
1	Amdabad	0	0	4	8	7	35	0	0	14	70	18	72	185
2	Azamnagar	1	1	7	14	15	75	1	30	27	135	35	140	395
3	Balrampur	1	1	4	8	9	45	0	0	16	80	22	88	222
4	Barari	0	0	0	0	0	0	0	0	0	0	0	0	0
5	Barsoi	1	1	7	14	14	70	1	30	26	130	35	140	385
6	Dandkhora	0	0	2	4	5	25	0	0	8	40	11	44	113
7	Falka	0	0	1	2	1	5	0	0	2	10	3	12	29
8	Hasanganj	0	0	0	0	0	0	0	0	0	0	0	0	0
9	Kadwa	1	1	9	18	17	85	2	60	32	160	42	168	492
10	Katihar	0	0	0	0	0	0	0	0	0	0	0	0	0
11	Korha	1	1	8	16	15	75	1	30	28	140	37	148	410
12	Kursela	0	0	0	0	0	0	0	0	0	0	0	0	0
13	Manihari	0	0	0	0	0	0	0	0	1	5	1	4	9
14	Mansahi	0	0	2	4	4	20	0	0	7	35	10	40	99
15	Pranpur	1	1	4	8	8	40	0	0	14	70	19	76	195
16	Samili	0	0	0	0	0	0	0	0	1	5	1	4	9
Total		6	6	48	96	95	475	5	150	176	880	234	936	2543

CHAPTER 7

7. BLOCK WISE AQUIFER MANAGEMENT PLANS

The **Amdabad, Manihari, Kursela, Mansahi, Barari and Sameli blocks** are not the part of present study however the recommendation for these block are incorporated here to present the entire Katihar district in this report and as per present ground water scenario more information has been added.

The previous published report (Phase IV) may be gone through for information in detail.

7.1 Amdabad block

7.1.1 General Information

1.	Area (ha)		:	18863
2.	No. of town		:	0
3.	No. of village		:	51
4.	Population	Total	:	167398
		Rural	:	167398
		Urban	:	0
5.	Average Annual Rainfall (District)		:	1281 mm
6.	Depth-range wise No. of ground structure (5^{th} MI Census)	< 20 m	:	134
		20-35 m	:	885
		35-40 m	:	0
		40-60 m	:	0
		60-70 m	:	0
		>70 m	:	31

7. Ground Water Resources - 2020

Recharge from Rainfall		*Recharge from Other Sources*		*Total Annual Ground Water Recharge*	*Total Natural Discharges*	*Annual Extractable Ground Water Resource*
Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*			
4287.36	551.4	599.67	406.54	5844.97	584.49	5260.48

Ground Water Extraction for Irrigation Use	*Ground Water Extraction for Domestic Use*	*Ground Water Extraction for Industrial Use*	*Total Extraction*	*Annual GW Allocation for Domestic Use as on 2025*	*Net Ground Water Availability for future use*	*Stage of Ground Water Extraction (%)*	*Category*
2526.93	288.39	135	2950.32	323.95	2274.6	56.08	safe

In Ha m

7.1.2 Aquifer Disposition

1. Aquifer disposition : Explored depth: ~94 m bgl
   Aquifer type : Unconfined
   Single aquifer system

2. Water level (Shallow aquifer):
   Pre-monsoon : Range 2 to 10 m bgl
   Post-monsoon : Range 2 to 5 m bgl
   Fluctuation : 2 m

3. Chemical quality of ground water : In general, Potable.

In mg/l

7.1.3 Aquifer Management Plan

1. *Ground water development :*

As per the GW resources Estimation -2020, stage of development of the block is 56.08% only hence categorized as 'safe'. There is a possibility for further development of ground water. Additional number of tube well by considering the SOD, upto 70% is calculated and given in table below:

Block	Provision for Future Domestic and Industrial Requirement	SOD% 2020	Category	Projected SOD (%)	GW draft at Projected SOD	Additional Resource Available	Unit Draft of STW	Additional Nos. of STW feasible based on GW availability
Amdabad	323.95	56.08	safe	70	3682.336	732.016	1.89	387

2. *Artificial recharge structures*

In previously published report of CGWB, Amdabad block was covered and artificial recharge structure was not proposed. But as per recent study and master plan artificial recharge structure has been proposed. The details is given in table.

As previousy published report of CGWB,extensive dewatering may increase the vertical depth of arsenic contamination. Shallow aquifer may because for irrigation purpose. Filtration and/or community based tube wells fitted with arsenic removal plants can be used for drinking water supply.

BLOCK	Nala Bunding	Lateral Recharge Shaft	Recharge Shaft	Percolation Tank	De-silting of existing tank /pond /talao	Injection Well in Village Tank
Amdabad	0	4	7	0	14	18

In ham

7.2 Azamnagar block

7.2.1 General Information

1.	Area (ha)		:	29077
2.	No. of town		:	0
3.	No. of village		:	234
4.	Population (2011)	Total	:	315610
		Rural	:	315610
		Urban	:	0
5.	Average Annual Rainfall (District)		:	1281 mm
6.	Depth-range wise No. of ground structure (5^{th} MI Census)	< 20 m	:	1775
		20-35 m	:	1474
		35-40 m	:	0
		40-60 m	:	0
		60-70 m	:	0

70-90 m : 0
>90 m : 0

7. Ground Water Resources - 2020

Recharge from Rainfall		*Recharge from Other Sources*		*Total Annual Ground Water Recharge*	*Total Natural Discharges*	*Annual Extractable Ground Water Resource*
Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*			
9913.35	849.98	2190.52	1421.17	14375.02	1437.51	12937.51

Ground Water Extraction for Irrigation Use	*Ground Water Extraction for Domestic Use*	*Ground Water Extraction for Industrial Use*	*Total Extraction*	*Annual GW Allocation for Domestic Use as on 2025*	*Net Ground Water Availability for future use*	*Stage of Ground Water Extraction (%)*	*Category*
7987.14	543.73	423	8953.87	610.78	3916.59	69.21	safe

In Ha m

7.2.2 Aquifer Disposition

1. Aquifer disposition : Explored depth:- ~45 m bgl
   Aquifer Type: Unconfined
   Single aquifer system
2. Water level
   Pre-monsoon : Range 2 to 5 m bgl
   Post-monsoon : Range 2 to 5 m bgl
   Fluctuation : 0 to 4 m
3. Chemical quality of ground water : In general, Potable.

In mg/l

7.2.3 Aquifer Management Plan

1. Ground water development :

Stage of development of the block is 69.21% only therefore categorized as 'safe'. There is a possibility for further development of ground water. Additional number of tube well upto the SOD, is 70% is calculated and given in table below:

Block	Provision for Future Domestic and Industrial Requirement	SOD% 2020	Category	Projected SOD (%)	GW draft at Projected SOD	Additional Resource Available	Unit Draft of STW	Additional Nos. of STW feasible based on GW availability
Azamnagar	610.78	69.21	safe	70	9056.257	102.387	1.89	54

3. Artificial recharge structures

As ground water development percentage is high, artificial recharge structure has been proposed as given in table.

BLOCK	Nala Bunding	Lateral Recharge Shaft	Recharge Shaft	Percolation Tank	De-silting of existing tank /pond /talao	Injection Well in Village Tank
Azamnagar	1	7	15	1	27	35

7.3 Balampur block

7.3.1 General Information

1. Area (ha) : 17428
2. No. of town : 0
3. No. of village : 155
4. Population (2011) Total : 158976
   Rural : 158976
   Urban : 0
5. Average Annual Rainfall (District) : 1281 mm
6. Depth-range wise No. of ground water abstraction structure (5^{th} MI Census)
   < 20 m : 5
   20-35 m : 196
   35-40 m : 0
   40-60 m : 0
   60-70 m : 0
   70-90 m : 0
   >90 m : 0
7. Ground Water Resources - 2020

Recharge from Rainfall		*Recharge from Other Sources*		*Total Annual Ground Water Recharge*	*Total Natural Discharges*	*Annual Extractable Ground Water Resource*
Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*			
5941.8	509.46	866.03	588.39	7905.68	790.56	7115.12

Ground Water Extraction for Irrigation Use	*Ground Water Extraction for Domestic Use*	*Ground Water Extraction for Industrial Use*	*Total Extraction*	*Annual GW Allocation for Domestic Use as on 2025*	*Net Ground Water Availability for future use*	*Stage of Ground Water Extraction (%)*	*Category*
3638.25	273.88	189	4101.13	307.66	2980.21	57.64	safe

7.3.2 Aquifer disposition

1. Aquifer disposition : Explored depth:- ~45 m bgl
   Aquifer Type: Unconfined
   Single aquifer system
2. Water level Pre- : Range 2 to 5 m bgl
   Post- : Range 2 to 5 m bgl
   Fluctuation : 0 to 4 m
3. Chemical quality of ground : In general, Potable.

In mg/l

7.3.3 Aquifer Management Plan

1. Ground water development :

Stage of development of the block is 57.64% only therefore categorized as 'safe'. There is a possibility for further development of ground water. Additional number of tube well upto the SOD, is 70% is calculated and given in table below

Block	Provision for Future Domestic and Industrial Requirement	SOD% 2020	Category	Projected SOD (%)	GW draft at Projected SOD	Additional Resource Available	Unit Draft of STW	Additional Nos. of STW feasible based on GW availability
Balrampur	307.66	57.64	safe	70	4980.584	879.454	1.89	465

In ham

12. Artificial recharge structures

As ground water development percentage is 57.64%, artificial recharge structure has been proposed as given in table.

BLOCK	Nala Bunding	Lateral Recharge Shaft	Recharge Shaft	Percolation Tank	De-silting of existing tank /pond /talao	Injection Well in Village Tank
Balrampur	1	4	9	0	16	22

7.4 Barari Block

7.4.1 General Information

1. Area (ha) : 32780
2. No. of town : 0
3. No. of village : 88
4. Population (2011) Total : 285381
   Rural : 285381
   Urban : 0
5. Average Annual Rainfall (District) : 1281 mm
6. Depth-range wise No. of ground water abstraction structure (5^{th} MI Census)
   < 20 m : 89
   20-35 m : 1875
   35-40 m : 0
   40-60 m : 0
   60-70 m : 0
   >70m : 0
7. Ground Water Resources - 2020

Recharge from Rainfall		*Recharge from Other Sources*		*Total Annual Ground Water Recharge*	*Total Natural Discharges*	*Annual Extractable Ground Water Resource*
Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*			
11175.83	958.22	819.1	554.29	13507.44	1350.74	12156.7

Ground Water Extraction for Irrigation Use	*Ground Water Extraction for Domestic Use*	*Ground Water Extraction for Industrial Use*	*Total Extraction*	*Annual GW Allocation for Domestic Use as on 2025*	*Net Ground Water Availability for future use*	*Stage of Ground Water Extraction (%)*	*Category*
3460.59	491.66	198	4150.24	552.28	7945.84	34.14	safe

7.4.2 Aquifer Disposition

1. Aquifer disposition : Explored depth: ~88.34 m bgl
   Aquifer type: Unconfined
   Single aquifer system
2. Water level behavior
   Pre-monsoon : Range 2 to 5 m bgl
   Post-monsoon : Range 2 to 5 m bgl
   Fluctuation : 0 to 4 m
3. Chemical quality of ground : In
2. Water level behavior Pre-monsoon : Range 2 to 5 m bgl

In mg/l

Block	Location	Sample Source	Lat	Long	pH	EC	TH	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	NO_3^{-}	SO_4^{2-}	F^{-}	PO_4^{3-}	TDS
Barari	Uchhla	SW	25.470	87.380	5.63	220	90	22	9	7	0.06	0	31	32	38	0	0	0	143
Barai	Dumer	DW	25.530	87.320	4.97	793	250	64	22	63	3.3	0	275	53	85	26	0.1	0	515

7.4.3 Aquifer Management Plan

1. Ground water development :

Stage of development of the block is 34.14% only hence categorized as 'safe'. There is a possibility for further development of ground water. Additional number of tube well upto the SOD, is 70% is calculated and given in table below

Block	Provision for Future Domestic and Industrial Requirement	SOD% 2020	Category	Projected SOD (%)	GW draft at Projected SOD	Additional Resource Available	Unit Draft of STW	Additional Nos. of STW feasible based on GW availability
Barari	552.28	34.14	safe	70	8509.69	4359.45	1.89	2307

2. Artificial Recharge structure

In previously published report of CGWB, Amdabad block was covered and artificial recharge structure was not proposed. But as per recent study and master plan artificial recharge structure may be contructed.

As previousy published report of CGWB,extensive dewatering may increase the vertical depth of arsenic contamination. Shallow aquifer may because for irrigation purpose. Filtration and/or community based tube wells fitted with arsenic removal plants can be used for drinking water supply.

7.5 Barsoi Block

7.5.1 General Information

1. Area (ha) : 27914

2. No. of town : 1
3. No. of village : 231
4. Population (2011) Total : 344133
   Rural : 337778
   Urban : 6355
5. Average Annual Rainfall (District) : 1281 mm
6. Depth-range wise No. of ground water abstraction structure structure

	< 20 m	:	111
	20-35 m	:	1610
(5th MI Census)	35-40 m	:	0
	40-60 m	:	0
	60-70 m	:	0
	70-90 m	:	0
	90-110	:	2
	>110 m	:	0

7. Ground Water Resources - 2020

Recharge from Rainfall		*Recharge from Other Sources*		*Total Annual Ground Water Recharge*	*Total Natural Discharges*	*Annual Extractable Ground Water Resource*
Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*			
9516.84	815.98	1407.18	960.98	12700.98	1270.1	11430.88

Ground Water Extraction for Irrigation Use	*Ground Water Extraction for Domestic Use*	*Ground Water Extraction for Industrial Use*	*Total Extraction*	*Annual GW Allocation for Domestic Use as on 2025*	*Net Ground Water Availability for future use*	*Stage of Ground Water Extraction (%)*	*Category*
5868.45	614.77	315	6798.22	690.57	4556.86	59.47	safe

7.5.2 Aquifer Disposition

1. Aquifer disposition : Explored depth: ~45 m bgl
   Aquifer type: Unconfined
   Single aquifer system
2. Water level behavior
   Pre-monsoon : Range 2 to 5 m bgl
   Post-monsoon : Range 2 to 5 m bgl
   Fluctuation : 0 to 4 m
3. Chemical quality of ground : In
2. Water level behavior Pre-monsoon : Range 2 to 5 m bgl

7.5.3 Aquifer Management Plan

1. Ground water development :

Stage of development of the block is 59.47% only therefore categorized as 'safe'. There is a possibility for further development of ground water. Additional number of tube well upto 70% SOD, is calculated and given in table below:

Block	Provision for Future Domestic and Industrial Requirement	SOD% 2020	Category	Projected SOD (%)	GW draft at Projected SOD	Additional Resource Available	Unit Draft of STW	Additional Nos. of STW feasible based on GW availability
Barsoi	690.57	59.47	safe	70	8001.616	1203.396	1.89	637

2. Artificial Recharge structure

As ground water development percentage is 59.47, artificial recharge structure has been proposed as given in table.

BLOCK	Nala Bunding	Lateral Recharge Shaft	Recharge Shaft	Percolation Tank	De-silting of existing tank /pond /talao	Injection Well in Village Tank
Barsoi	1	7	14	1	26	35

7.6 Dandkhora Block

7.6.1 General Information

1. Area (ha) : 8921
2. No. of town : 0
3. No. of village : 50
4. Population (2011) Total : 68055
   Rural : 68055
   Urban : 0
5. Average Annual Rainfall (District) : 1281 mm
6. Depth-range wise No. of tube wells (5^{th} MI Census)
   < 20 m : 865
   20-35 m : 258
   35-110 m : 0
   110-130 m : 1
   >130 m : 0
7. Ground Water Resources - 2020

Recharge from Rainfall		*Recharge from Other Sources*		*Total Annual Ground Water Recharge*	*Total Natural Discharges*	*Annual Extractable Ground Water Resource*
Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*			
3041.48	260.78	656.95	444.02	4403.23	440.32	3962.91

Ground Water Extraction for Irrigation Use	*Ground Water Extraction for Domestic Use*	*Ground Water Extraction for Industrial Use*	*Total Extraction*	*Annual GW Allocation for Domestic Use as on 2025*	*Net Ground Water Availability for future use*	*Stage of Ground Water Extraction (%)*	*Category*
2780.19	117.25	144	3041.44	131.7	907.02	76.75	Semi_critical

In ham

7.6.2 Aquifer disposition

1. Aquifer disposition : Explored depth: ~45 m bgl
   Aquifer type: Unconfined
   Single aquifer system
2. Water level
   Pre- : Range 2 to 5 m
   Post- : Range 2 to 5 m
   Fluctuation : 0 to 4 m
3. Chemical : In
2. Water level Pre- : Range 2 to 5 m

7.6.3 Aquifer Management Plan

1. Ground water development :

Stage of development of the block is 76.75% only therefore categorized as 'semi critical'. There is no possibility for further development of ground water. Hence, additional number of tube well is suggested as 'Nil'.

Block	Provision for Future Domestic and Industrial Requirement	SOD% 2020	Category	Projected SOD (%)	GW draft at Projected SOD	Additional Resource Available	Unit Draft of STW	Additional Nos. of STW feasible based on GW availability
Dandkhora	131.7	76.75	Semi-critical	70	2774.037	0	-	0

4. Artificial Recharge structure

As ground water development percentage is high, and the block categorised as "semi critical" artificial recharge structure has been proposed as given in table.

BLOCK	Nala Bunding	Lateral Recharge Shaft	Recharge Shaft	Percolation Tank	De-silting of existing tank /pond /talao	Injection Well in Village Tank
Dandkhora	0	2	5	0	8	11

7.7 Falka Block

7.7.1 General Information

1. Area (ha) : 16948
2. No. of town : 0
3. No. of village : 72
4. Population (2011) Total : 155663
   Rural : 155663
   Urban : 0
5. Average Annual Rainfall (District) : 1281 mm

6. Depth-range wise No. of ground < 20 m : 244

water abstraction structure (5th MI Census)

20-35 m	:	1003
35-150 m	:	0
>150m	:	0
60-70 m	:	0

7. Ground Water Resources - 2020

Recharge from Rainfall		*Recharge from Other Sources*		*Total Annual Ground Water Recharge*	*Total Natural Discharges*	*Annual Extractable Ground Water Resource*
Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*			
3852.1	495.42	667.72	454.13	5469.37	546.93	4922.44

Ground Water Extraction for Irrigation Use	*Ground Water Extraction for Domestic Use*	*Ground Water Extraction for Industrial Use*	*Total Extraction*	*Annual GW Allocation for Domestic Use as on 2025*	*Net Ground Water Availability for future use*	*Stage of Ground Water Extraction (%)*	*Category*
2800.98	268.18	153	3222.16	301.24	1667.22	65.46	safe

7.7.2 Aquifer Disposition

1. Aquifer disposition : Explored depth: ~26.24 m bgl
   Aquifer type: Unconfined
   Single aquifer system
2. Water level behavior
   Pre-monsoon : 3.38 m bgl
   Post-monsoon : ~3.02 m bgl
   Fluctuation : ~0.36 m
3. Chemical quality of Ground and contamination : In general, Potable.

Block	Location	Sample Source	Lat	Long	pH	EC	TH	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	NO_3^{-}	SO_4^{2-}	F^{-}	PO_4^{3-}	TDS
Falka	Barandi dhar	SW	25.620	87.390	5.66	297	135	44	6	7	0.3	0	73	18	49	22	0.1	0	193

7.7.3 Aquifer Management Plan

1. Ground water development :

Stage of development of the block is 65.46% only therefore categorized as 'safe. It is not recommended for further development of ground water. Additional number of tube well upto the 70%SOD, is calculated and given in table below

Block	Provision for Future Domestic and Industrial Requirement	SOD% 2020	Category	Projected SOD (%)	GW draft at Projected SOD	Additional Resource Available	Unit Draft of STW	Additional Nos. of STW feasible based on GW availability
Falka	301.24	65.46	safe	70	3445.708	223.548	1.89	118

3. Artificial Recharge structure

As ground water development percentage is high, artificial recharge structure has been proposed as given in table.

BLOCK	Nala Bunding	Lateral Recharge Shaft	Recharge Shaft	Percolation Tank	De-silting of existing tank /pond /talao	Injection Well in Village Tank
Falka	0	1	1	0	2	3

7.8 Hasanganj Block

7.8.1 General Information

1. Area (ha) : 7111
2. No. of town : 0
3. No. of village : 41
4. Population (2011) Total : 55906
   Rural : 55906
   Urban : 0
5. Average Annual Rainfall (District) : 1281 mm
6. Depth-range wise No. of ground water abstraction structure (5^{th} MI Census)
   < 20 m : 147
   20-35 m : 131
   35-90 m : 0
   90-110 m : 8
   >110 m : 0
7. Ground Water Resources - 2020

Recharge from Rainfall		*Recharge from Other Sources*		*Total Annual Ground Water Recharge*	*Total Natural Discharges*	*Annual Extractable Ground Water Resource*
Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*			
1616.26	207.87	243.67	166.54	2234.34	223.43	2010.91

Ground Water Extraction for Irrigation Use	*Ground Water Extraction for Domestic Use*	*Ground Water Extraction for Industrial Use*	*Total Extraction*	*Annual GW Allocation for Domestic Use as on 2025*	*Net Ground Water Availability for future use*	*Stage of Ground Water Extraction (%)*	*Category*
1014.93	96.31	54	1165.25	108.19	833.78	57.95	safe

7.8.2 Aquifer Disposition

1. Aquifer disposition : Explored depth: ~32 m bgl
   Aquifer type: Unconfined
   Single aquifer system
2. Water level behavior
   Pre-monsoon : Range 2 to 5 m bgl
   Post-monsoon : Range 2 to 5 m bgl
   Fluctuation : 0 to 4 m
3. Chemical quality of ground : In
2. Water level behavior Pre-monsoon : Range 2 to 5 m bgl

7.8.3 Aquifer Management Plan

1. Ground water development :

Stage of development of the block is 57.95% only therefore categorized as 'safe'. There is a possibility for further development of ground water. Additional number of tube well upto the 70% SOD, is calculated and given in table below

Block	Provision for Future Domestic and Industrial Requirement	SOD% 2020	Category	Projected SOD (%)	GW draft at Projected SOD	Additional Resource Available	Unit Draft of STW	Additional Nos. of STW feasible based on GW availability
Hasanganj	108.19	57.95	safe	70	1407.637	242.387	1.89	128

5. Artificial Recharge structure

Artificial recharge structure may be constructed.

7.9 Kadwa Block

7.9.1 General Information

1. Area (ha) : 33992
2. No. of town : 0
3. No. of village : 264
4. Population (2011) Total : 346902
   Rural : 346902
   Urban : 0
5. Average Annual Rainfall (District) : 1281 mm
6. Depth-range wise No. of ground water abstraction structure (5th MI Census)
   < 20 m : 1358
   20-35 m : 2524
   >35 m : 0
7. Ground Water Resources - 2020

Recharge from Rainfall		*Recharge from Other Sources*		*Total Annual Ground Water Recharge*	*Total Natural Discharges*	*Annual Extractable Ground Water Resource*
Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*			
11589.04	993.65	1878.54	1268.9	15730.13	1573.02	14157.11

Ground Water Extraction for Irrigation Use	*Ground Water Extraction for Domestic Use*	*Ground Water Extraction for Industrial Use*	*Total Extraction*	*Annual GW Allocation for Domestic Use as on 2025*	*Net Ground Water Availability for future use*	*Stage of Ground Water Extraction (%)*	*Category*
7956.9	597.64	423	8977.55	671.34	5105.86	63.41	safe

In ha m

7.9.2 Aquifer Disposition

1. Aquifer disposition : Explored depth: ~45 m bgl
   Aquifer type: Unconfined
   Single aquifer system

2.	Water level	Pre-	:	~2.3 m bgl
		Post-	:	~2.58 m bgl
		Fluctuation	:	~-0.2 m
3.	Chemical quality of		:	In general, Potable.

7.9.3 Aquifer Management Plan

1. Ground water development :

Stage of development of the block is 63.41% only therefore categorized as 'safe'. There is a possibility for further development of ground water. Additional number of tube well upto 70% SOD, is calculated and given in table below

Block	Provision for Future Domestic and Industrial Requirement	SOD% 2020	Category	Projected SOD (%)	GW draft at Projected SOD	Additional Resource Available	Unit Draft of STW	Additional Nos. of STW feasible based on GW availability
Kadwa	671.34	63.41	safe	70	9909.977	932.427	1.89	493

2. Artificial Recharge structure

As ground water development percentage is high, artificial recharge structure has been proposed as given in table.

BLOCK	Nala Bunding	Lateral Recharge Shaft	Recharge Shaft	Percolation Tank	De-silting of existing tank /pond /talao	Injection Well in Village Tank
Kadwa	1	9	17	2	32	42

7.10 Katihar Block

7.10.1 General Information

1.	Area (ha)		:	11005
2.	No. of town		:	2
3.	No. of village		:	31
4.	Population (2011)	Total	:	321817
		Rural	:	80979
		Urban	:	240838
5.	Average Annual Rainfall (District)		:	1281 mm
6.	Depth-range wise No. of water abstraction (5^{th} MI Census)	< 20 m	:	35
		20-35 m	:	169
		35-90 m	:	0
		90-110 m	:	1
		110-130 m	:	0
		130-150 m	:	2
		>150 m	:	8
7.	Ground Water Resources -2020			

Recharge from Rainfall		*Recharge from Other Sources*		*Total Annual Ground Water Recharge*	*Total Natural Discharges*	*Annual Extractable Ground Water Resource*
Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*			
3751.98	321.7	294.06	200.14	4567.88	456.78	4111.1

Ground Water Extraction for Irrigation Use	*Ground Water Extraction for Domestic Use*	*Ground Water Extraction for Industrial Use*	*Total Extraction*	*Annual GW Allocation for Domestic Use as on 2025*	*Net Ground Water Availability for future use*	*Stage of Ground Water Extraction (%)*	*Category*
1232.28	1384.26	117	2733.54	1554.95	1206.87	66.49	safe

In ha m

7.10.2 Aquifer Disposition

1. Aquifer disposition : Explored depth: ~32 m bgl
   Aquifer type: Unconfined
   Single aquifer system
2. Water level behavior Pre-monsoon : 3.77 m bgl
   Post-monsoon : 2.23 m bgl
   Fluctuation : 1.54 m
3. Chemical quality of Ground water : In general, Potable.

7.10.3 Aquifer Management Plan

1. Ground water development :

Stage of development of the block is 66.49% only therefore categorized as 'safe'. There is a possibility for further development of ground water. Additional number of tube well upto 70% SOD, is calculated and given in table below

Block	Provision for Future Domestic and Industrial Requirement	SOD% 2020	Category	Projected SOD (%)	GW draft at Projected SOD	Additional Resource Available	Unit Draft of STW	Additional Nos. of STW feasible based on GW availability
Katihar	1554.95	66.49	safe	70	2877.77	144.23	1.89	76

2. Artificial Recharge structure

Artificial recharge structure may be constructed.

7.11 Korha Block

7.11.1 General Information

1. Area (ha) : 29848
2. No. of town : 0
3. No. of village : 84
4. Population (2011) Total : 282813
   Rural : 282813
   Urban : 0

5. Average Annual Rainfall (District) : 1281 mm

6. Depth-range wise No. of Tube wells (5^{th} MI Census)

< 20 m	:	586
20-35 m	:	1737
35-90 m	:	0
90-110 m	:	1
>110 m	:	0

7. Ground Water Resources -2020

Recharge from Rainfall		*Recharge from Other Sources*		*Total Annual Ground Water Recharge*	*Total Natural Discharges*	*Annual Extractable Ground Water Resource*
Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*			
10176.21	872.52	1612.54	1089.19	13750.46	1375.05	12375.41

Ground Water Extraction for Irrigation Use	*Ground Water Extraction for Domestic Use*	*Ground Water Extraction for Industrial Use*	*Total Extraction*	*Annual GW Allocation for Domestic Use as on 2025*	*Net Ground Water Availability for future use*	*Stage of Ground Water Extraction (%)*	*Category*
6830.46	487.23	360	7677.69	547.31	4637.64	62.04	safe

In ha m

7.11.2 Aquifer Disposition

1. Aquifer disposition : Explore depth: ~42.67 m bgl
   Aquifer type: ~Unconfined
   Single aquifer system
2. Water level behavior
   Pre-monsoon : ~4.74 m bgl
   Post-monsoon : ~2.98 m bgl
   Fluctuation : ~1.76m
3. Chemical quality of ground water : In general, Potable.

Block	Location	Sample Source	Lat	Long	pH	EC	TH	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	NO_3^{-}	SO_4^{2-}	F^{-}	PO_4^{3-}	TDS
Korha	Khiria	DW	25.600	87.450	5.45	1256	420	126	26	85	16	0	317	78	185	99	0.1	0	816
Korha	Korha	DW	25.610	87.400	5.49	1083	390	86	43	59	8.5	0	366	82	78	53	0	0	704
Korha	Tinpinia belai Chowk	SW	25.6	87.460	4.8	526	200	56	15	27	2.5	0	201	18	53	28	0.1	0	342

7.11.3 Aquifer Management Plan

1. Ground water development :

Stage of development of the block is 62.04 % only therefore categorized as 'safe'. There is a possibility for further development of ground water. Additional number of tube well upto the SOD, is 70% is calculated and given in table below

Block	Provision for Future Domestic and Industrial Requirement	SOD% 2020	Category	Projected SOD (%)	GW draft at Projected SOD	Additional Resource Available	Unit Draft of STW	Additional Nos. of STW feasible based on GW availability
Korha	547.31	62.04	safe	70	8662.787	985.097	1.89	521

2. Artificial Recharge structure

As ground water development percentage is high, artificial recharge structure has been proposed as given in table

BLOCK	Nala Bunding	Lateral Recharge Shaft	Recharge Shaft	Percolation Tank	De-silting of existing tank /pond /talao	Injection Well in Village Tank
Korha	1	8	15	1	28	37

7.12 Kursela Block

7.11.1 General Information

1. Area (ha) : 6106
2. No. of town : 0
3. No. of village : 30
4. Population (2011) Total : 63928
   Rural : 63928
   Urban : 0
5. Average Annual Rainfall (District) : 1281 mm
6. Depth-range wise No. of water abstraction (5^{th} MI Census)
   < 20 m : 100
   20-35 m : 69
   35-90 m : 0
   90-110 m : 19
   >110 m : 0
7. Ground Water Resources -2020

Recharge from Rainfall		*Recharge from Other Sources*		*Total Annual Ground Water Recharge*	*Total Natural Discharges*	*Annual Extractable Ground Water Resource*
Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*			
1387.83	178.49	119.94	81.61	1767.87	176.79	1591.08

Ground Water Extraction for Irrigation Use	*Ground Water Extraction for Domestic Use*	*Ground Water Extraction for Industrial Use*	*Total Extraction*	*Annual GW Allocation for Domestic Use as on 2025*	*Net Ground Water Availability for future use*	*Stage of Ground Water Extraction (%)*	*Category*
502.74	110.14	27	639.88	123.72	937.62	40.22	safe

In ha m

7.11.2 Aquifer Disposition

1. Aquifer disposition : Explored depth: ~26 m bgl
   Aquifer type: Unconfined
   Single aquifer system
2. Water level behavior
   Pre-monsoon : ~4.88 to 4.89 m bgl
   Post-monsoon : ~ 3.34 to 3.11 m bgl
   Fluctuation : ~1.54 to 1.78m

3. Chemical quality of ground water : In general, Potable.

7.11.3 Aquifer Management Plan

1. Ground water development :

Stage of development of the block is 40.22 % only therefore categorized as 'safe'. There is a possibility for further development of ground water. Additional number of tube well upto the SOD, is 70% is calculated and given in table below

Block	Provision for Future Domestic and Industrial Requirement	SOD% 2020	Category	Projected SOD (%)	GW draft at Projected SOD	Additional Resource Available	Unit Draft of STW	Additional Nos. of STW feasible based on GW availability
Kursela	123.72	40.22	safe	70	1113.756	473.876	1.89	251

2. Artificial Recharge structure

In previously published report of CGWB, Amdabad block was covered and artificial recharge structure was not proposed. But as per recent study and master plan artificial recharge structure may be contructed.

As previousy published report of CGWB,extensive dewatering may increase the vertical depth of arsenic contamination. Shallow aquifer may because for irrigation purpose. Filtration and/or community based tube wells fitted with arsenic removal plants can be used for drinking water supply.

7.13 Manihari Block

7.11.1 General Information

1. Area (ha) : 25012
2. No. of town : 1
3. No. of village : 62
4. Population (2011) Total : 191407
   Rural : 164778
   Urban : 26629
5. Average Annual Rainfall (District) : 1281 mm
6. Depth-range wise No. of water abstraction (5^{th} MI Census)
   < 20 m : 36
   20-35 m : 537
   >35 m : 0
7. Ground Water Resources -2020

Recharge from Rainfall		*Recharge from Other Sources*		*Total Annual Ground Water Recharge*	*Total Natural Discharges*	*Annual Extractable Ground Water Resource*
Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*			

5684.97	731.15	296.02	202.4	6914.54	691.46	6223.08

Ground Water Extraction for Irrigation Use	*Ground Water Extraction for Domestic Use*	*Ground Water Extraction for Industrial Use*	*Total Extraction*	*Annual GW Allocation for Domestic Use as on 2025*	*Net Ground Water Availability for future use*	*Stage of Ground Water Extraction (%)*	*Category*
1232.28	421.51	90	1743.79	473.48	4427.32	28.02	safe

In ha m

7.11.2 Aquifer Disposition

1. Aquifer disposition : Explored depth: ~94.48 m bgl
   Aquifer type: Unconfined
   Single aquifer system
2. Water level
   Pre- : ~5.78 m bgl
   Post- : ~6.64 m bgl
   Fluctuation : ~1.14 m
3. Chemical quality of ground water : In general, Potable.

7.11.3 Aquifer Management Plan

1. Ground water development :

Stage of development of the block is 28.02 % only therefore categorized as 'safe'. There is a possibility for further development of ground water. Additional number of tube well upto the SOD, is 70% is calculated and given in table below

Block	Provision for Future Domestic and Industrial Requirement	SOD% 2020	Category	Projected SOD (%)	GW draft at Projected SOD	Additional Resource Available	Unit Draft of STW	Additional Nos. of STW feasible based on GW availability
Manihari	473.48	28.02	safe	70	4356.156	2612.366	1.89	1382

2. Artificial Recharge structure

In previously published report of CGWB, Amdabad block was covered and artificial recharge structure was not proposed. But as per recent study and master plan artificial recharge structure has been proposed. The details is given in table.

As previousy published report of CGWB,extensive dewatering may increase the vertical depth of arsenic contamination. Shallow aquifer may because for irrigation purpose. Filtration and/or community based tube wells fitted with arsenic removal plants can be used for drinking water supply.

BLOCK	Nala Bunding	Lateral Recharge Shaft	Recharge Shaft	Percolation Tank	De-silting of existing tank /pond /talao	Injection Well in Village Tank
Manihari	0	0	0	0	1	1

7.14 Mansahi Block

7.11.1 General Information

1. Area (ha) : 7814
2. No. of town : 0
3. No. of village : 26
4. Population (2011) Total : 84257
   Rural : 84257
   Urban : 0
5. Average Annual Rainfall (District) : 1281 mm
6. Depth-range wise No. of water abstraction (5^{th} MI Census)
   < 20 m : 371
   20-35 m : 739
   35-150 m : 0
   >150 m : 2
7. Ground Water Resources -2020 :

Recharge from Rainfall		*Recharge from Other Sources*		*Total Annual Ground Water Recharge*	*Total Natural Discharges*	*Annual Extractable Ground Water Resource*
Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*			
2664.06	228.42	785.13	483.48	4161.09	416.11	3744.98

Ground Water Extraction for Irrigation Use	*Ground Water Extraction for Domestic Use*	*Ground Water Extraction for Industrial Use*	*Total Extraction*	*Annual GW Allocation for Domestic Use as on 2025*	*Net Ground Water Availability for future use*	*Stage of Ground Water Extraction (%)*	*Category*
2271.78	145.16	117	2533.93	163.06	1193.15	67.66	safe

In ha m

7.11.2 Aquifer Disposition

1. Aquifer disposition : Explored depth: ~33.5 m bgl
   Aquifer Type: Unconfined
   Single aquifer system
2. Water level
   Pre- : ~3.4 m bgl
   Post- : ~2.22 m bgl
   Fluctuation : ~1.18 m
3. Chemical quality of ground : In general, Potable.

7.11.3 Aquifer Management Plan :

1. *Ground water development*

In previously published report of CGWB, Amdabad block was covered and artificial recharge structure was not proposed. But as per recent study and master plan artificial recharge structure has been proposed. The details is given in table.

As previousy published report of CGWB, extensive dewatering may increase the vertical depth of arsenic contamination. Shallow aquifer may because for irrigation purpose. Filtration and/or community based tube wells fitted with arsenic removal plants can be used for drinking water supply.

Block	Provision for Future Domestic and Industrial Requirement	SOD% 2020	Category	Projected SOD (%)	GW draft at Projected SOD	Additional Resource Available	Unit Draft of STW	Additional Nos. of STW feasible based on GW availability
Mansahi	163.06	67.66	safe	70	2621.486	87.556	1.89	46

2. *Artificial Recharge structure*

BLOCK	Nala Bunding	Lateral Recharge Shaft	Recharge Shaft	Percolation Tank	De-silting of existing tank /pond /talao	Injection Well in Village Tank
Mansahi	0	2	4	0	7	10

7.15 Pranpur Block

7.11.1 General Information

1.	Area (ha)		:	15306
2.	No. of town		:	0
3.	No. of village		:	85
4.	Population (2011)	Total	:	144297
		Rural	:	144297
		Urban	:	0
5.	Average Annual Rainfall (District)		:	1281 mm
6.	Depth-range wise No. of water abstraction (5^{th} MI Census)	< 20 m	:	1215
		20-35 m	:	879
		35-90 m	:	0
		90-110 m	:	2
		>110 m	:	0
7.	Ground Water Resources	-2020	:	

Recharge from Rainfall	*Recharge from Other Sources*	*Total Annual Ground Water*	*Total Natural Discharges*	*Annual Extractable*

Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*	*Recharge*		*Ground Water Resource*
5218.34	447.42	1308.47	795.06	7769.29	776.93	6992.36

Ground Water Extraction for Irrigation Use	*Ground Water Extraction for Domestic Use*	*Ground Water Extraction for Industrial Use*	*Total Extraction*	*Annual GW Allocation for Domestic Use as on 2025*	*Net Ground Water Availability for future use*	*Stage of Ground Water Extraction (%)*	*Category*
4288.41	248.59	225	4762	279.25	2199.7	68.1	safe

In ha m

7.11.2 Aquifer Disposition

1. Aquifer disposition : Explored depth: ~45.7 m bgl
   Aquifer Type: Unconfined
   Single aquifer system
2. Water level
   Pre- : ~3.69 to 3.72 m bgl
   Post- : ~2.21 to 2.61 m bgl
   Fluctuation : ~1.48 to 1.11 m
3. Chemical quality of ground : In general, Potable.

7.11.3 Aquifer Management Plan

1. Ground water development :

Stage of development of the block is 68.1% only therefore categorized as 'safe'. There is a possibility for further development of ground water. Additional number of tube well upto the SOD, is 70% is calculated and given in table below

Block	Provision for Future Domestic and Industrial Requirement	SOD% 2020	Category	Projected SOD (%)	GW draft at Projected SOD	Additional Resource Available	Unit Draft of STW	Additional Nos. of STW feasible based on GW availability
Pranpur	279.25	68.10	safe	70	4894.652	132.652	1.89	70

2. Artificial Recharge structure

BLOCK	Nala Bunding	Lateral Recharge Shaft	Recharge Shaft	Percolation Tank	De-silting of existing tank /pond /talao	Injection Well in Village Tank
Pranpur	1	4	8	0	14	19

7.16 Sameli Block

7.11.1 General Information

1. Area (ha) : 12866
2. No. of town : 0
3. No. of village : 36
4. Population (2011) Total : 84486
   Rural : 84486

Urban : 0

5. Average Annual Rainfall (District) : 1281 mm

6. Depth-range wise No. of water abstraction (5^{th} MI Census)

< 20 m	:	No data
20-35 m	:	
35-40 m	:	
40-60 m	:	
60-70 m	:	

7. Ground Water Resources -2020 :

Recharge from Rainfall		*Recharge from Other Sources*		*Total Annual Ground Water Recharge*	*Total Natural Discharges*	*Annual Extractable Ground Water Resource*
Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*			
2924.31	376.1	298.76	205.58	3804.75	380.48	3424.27

Ground Water Extraction for Irrigation Use	*Ground Water Extraction for Domestic Use*	*Ground Water Extraction for Industrial Use*	*Total Extraction*	*Annual GW Allocation for Domestic Use as on 2025*	*Net Ground Water Availability for future use*	*Stage of Ground Water Extraction (%)*	*Category*
1232.28	145.55	72	1449.83	163.5	1956.49	42.34	safe

In ha m

7.11.2 Aquifer Disposition

1. Aquifer disposition : Explored depth: ~26 m bgl
   Aquifer Type: Unconfined
   Single aquifer system
2. Water level Pre- : ~2.84 m bgl
   Post- : ~0.78 m bgl
   Fluctuation : ~2.06 m
3. Chemical quality of ground : In general, Potable.

Block	Location	Sample Source	Lat	Long	pH	EC	TH	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	NO_3^{-}	SO_4^{2-}	F^{-}	PO_4^{3-}	TDS
Samoli	Barari-1	DW	25.500	37.370	5.7	295	140	50	4	3	0.03	0	116	11	36	3.2	0.1	0.05	192

7.11.3 Aquifer Management Plan

Ground water resource enhancement

As the stage of groundwater development is within the safe limits and there is no long-term water level decline in the area, the need for artificial recharge is not felt.

Demand side interventions

Extensive dewatering may increase the vertical depth of arsenic contamination. Filtration and/or community based tube wells fitted with arsenic removal plants can be used for drinking water supply. Artificial recharge may be thought to dilute arsenic contamination as well as to augment ground water resources

1. *Ground water development :*

Stage of development of the block is 42.34 % only therefore categorized as 'safe'. There is a possibility for further development of ground water. Additional number of tube well upto the SOD, is 70% is calculated and given in table below

Block	Provision for Future Domestic and Industrial Requirement	SOD% 2020	Category	Projected SOD (%)	GW draft at Projected SOD	Additional Resource Available	Unit Draft of STW	Additional Nos. of STW feasible based on GW availability
Samoli	163.5	42.34	safe	70	2396.989	947.159	1.89	501

2. *Artificial Recharge structure*

BLOCK	Nala Bunding	Lateral Recharge Shaft	Recharge Shaft	Percolation Tank	De-silting of existing tank /pond /talao	Injection Well in Village Tank
Samili	0	0	0	0	1	1

Summary

Katihar district has a geographical area of 3057 Sq.Km. and located in the eastern part of Bihar on the northern bank of the Ganga River. It lies between North Latitudes 25° 10' and 25° 55' and East Longitudes 87° 10' and 88° 05'. The district has 16 community development blocks under 3 civil sub divisions, covering 1540 revenue villages.

The district forms a part of vast low lying plain of Kosi alluvial fan and Kosi-Mahananda interfluve, intersected by numerous rivers originating in the Himalayas. The overall drainage pattern prevailing in the Kosi basin is sub parallel. The mighty Ganga River occupies the southern part of the district and forms the natural boundary between Katihar and Sahebganj districts. Major part of the district is covered with the coarse loamy soil and fine loamy soil. The district has population of 3071029 (2011 census) out of which 91% are rural and 9% urban. About 88% of urban population is concentrated in Katihar only. In 2011, Katihar had population of 3,071,029 of which male and female were 1,600,430 and 1,470,599 respectively.

The area experiences sub-tropical climate with three well marked seasons, i.e. winter, summer and monsoon. Winter begins, in November and continues upto February, though March is also somewhat cool. Westerly wind and dust storms begin to blow in the second half of March and temperature rises considerably. May is the hottest month when temperature goes up to 43° Celsius

The elevation in the area ranges from 17.9 to 45.2 m above mean sea level (SRTM data with WGS 84 Spheroid). It shows that general slop of the area is towards north to south direction. The Katihar district occupies the part of Kosi mega fan deposits gently sloped towards south. Numerous active and inactive channels in the area run from north to south.

The principal utilisation of land is under agriculture and almost evenly distributed in the district. It occupies nearly 95% of the area reported for LUC (291349 ha). Area under uncultivable land excluding fallow land includes 3.8% of the area and forest cover only 0.6% of the area reported. Other major land utilisations are the lands put under non-agriculture use. The Katihar district has agrarian economy. The district is part of Agro-climatic zone (NARP) of North East Alluvial Plain Zone (BI-2) II. Rice, Maize, Potato, Wheat etc. are is the main crop of Katihar district. Major area engaged in rice cultivation. The net sown area during the year is 128078 ha only whereas the Area Sown More Than Once is 401099 ha.

Geologically, the district forms a part of vast monotonous alluvial terrain of Kasi-alluvial fan and Kosi-Mahananda interfluve, in Kosi and Mahananda Sub-basins, consisting of a thick pile

of unconsolidated Quaternary sediments. Major area covered by Ganga-Kosi formation of Holocene age which constitutes alternate layer of sand and clay.

The exploratory drilling has been carried out in Katihar district. Drilling depths of these exploratory wells are between 104 to ~300 m bgl. The zone tapped below the depth from 42 to 208 m bgl. Transmissivity value calculated to be 153 to 5643 m^2/day and storativity value ranged from 1.9×10^{-3} to 6.3×10^{-3}.

As per the cross section/fence diagram prepared and data from lithologs of tube wells it seems that, in general, the district have single aquifer system which is unconfined in nature.

During pre-monsoon period, the water level varied from 2.3 to 5.78 m bgl. Major part of the district is categorized in the depth range of 2-5 m bgl water level. Some small patches in the district comprising parts of Manihari and Amdabad block has shown depth to water level in the range of 5 to 10 m bgl. During post-monsoon period, Depth to water level ranged from 1.72 to 4.64 m bgl. Almost entire area has shown water level between 2 and 5 m bgl. Only a small patch covering small patch of Katihar and Mansahi block has shown water level less than 2 m. Water table contour is more or less following slope of the area. Map reveals that the general flow of groundwater in phreatic aquifer towards south-eastern direction.

The ground water quality in the area is, in general, potable but for domestic purpose it is mostly found 'very hard' in nature. The ground water is suitable for irrigation purpose.

The Dynamic Ground Water Resources Assessment 2020 indicates the further scope for ground water development except the Dandkhora block which is categorised as 'Semi-critical'.

The report National Aquifer Mapping of **Amdabad, Manihari, Kursela, Mansahi, Barari and Sameli blocks** has already been published and hence not the part of present study but incorporated here to present entire Katihar block in a single report. The previous report may be gone through for more information on these blocks.

As per the study it has been recommended that total 7438 nos. of wells may be constructed by considering the unit draft of a well is 1.89 ham. Suitable artificial recharge structures are also suggested for blocks except Kursela, Hasanganj and Barari. As the ground water is the main source of irrigation and in many blocks Stage of Ground Water Extraction is reaching up to 70% in many blocks therefore judicious use of ground water may be encouraged in the area. The demand side management may also be implemented in the area however not discussed in this report.

Annexure I

Water Level Data (2019)

SN	District	Block	Latitude	Longitude	May_19 (m bgl)	Nov_19 (m bgl)	Monsoon Fluctuation (m)	Water Table May-2018 (m amsl)
1	Dumaria	Kursela	25.491	87.2427	4.88	3.34	1.54	31.52
2	Kursela	Kursela	25.4494	87.2545	4.89	3.11	1.78	31.31
3	Paranpur	Pranpur	25.4716	87.72	3.72	2.21	1.51	27.08
4	Narahaiya	Sameli	25.521	87.2509	2.84	2.06	0.78	34.16
5	Kadwa	Kadwa	25.6628	87.7153	4.31	2.82	1.49	35.89
6	Sonauli	Kadwa	25.6116	87.7163	2.3	2.58	-0.2	34.6
7	Hafla1	Mansahi	25.4911	87.589	4	1.72	2.28	30.3
8	Katihar	Katihar	25.5381	87.5662	3.77	2.23	1.54	31.93
9	Khiria	Korha	25.6066	87.455	4.74	2.98	1.76	33.26
10	Korha	Falka	25.6236	87.3997	3.38	3.02	0.36	35.62
11	Manihari	Manihari	25.3392	87.622	5.78	4.64	1.14	32.82
12	Basantpur	Mansahi	25.465	87.601	3.4	2.22	1.18	29.4
13	Bastaul1	Pranpur	25.5191	87.6727	3.69	2.61	1.08	30.51
				Average	3.98	2.73	1.25	32.18
				Minimum	2.3	1.72	-0.2	27.08
				Maximum	5.78	4.64	2.28	35.89

Annexure II

Results of Chemical Analysis of Ground Water (May 2019)

In mg/l

Block	Location	pH	EC(ms /cm)	TDS	F^-	C^{l-}	HCO_3^-	CO_3^{2-}	SO_4^{2-}	NO_3^-	PO_4^{3-}	TH	Ca_2^+	Mg_2^+	Na^+	K^+
Barari	Barari	8.17	570	370.5	0	31.9	190.65	0	41.06	18.95	0	180	24	29.16	35.67	2.81
Pranpur	Basantpur	8.26	535	347.75	0.11	61.5	172.2	0	17.31	19.44	0	205	62	12.15	39.83	6.83
Pranpur	Bastaul	7.6	574	373.1	0.02	70.92	184.5	0	38.71	11.78	0	185	24	30.37	43.27	1.98
Kathihar	Hafla	7.92	432	280.8	0.22	38.99	129.15	0	45.39	25.32	0	169	38	18	31.3	8.36
Kathihar	Kathihar	8.14	850	552.5	0.69	95.742	311.1	0	5.36	29.78	0	272	28	49.2	56.93	8.64
Korha	Khiria	7.45	925	601.25	0.14	120.53	311.66	0	14.32	43.84	0	70	18	6	19.4	15.34
Korha	Korha	7.76	1143	742.95	0	88.62	473.55	0	12.24	15.43	0	405	64	59.53	61.98	7.21
Falka	Mahendrapur	8.13	911	592.15	0.81	120.53	325.95	0	16.26	9.32	0	300	44	46.17	67.24	12.54
Falka	Narhaiya	7.23	334	217.1	0.03	35.45	123	0	7.95	29.45	0	90	14	13.36	39.23	2.03
Pranpur	Pranpur	7.66	1148	746.2	0	104.55	430.5	0	10.25	41.94	0.03	427	74	58.8	38.67	7.18
Korha	Routara	7.82	349	226.85	0.61	21.27	141.45	0	23.05	0.07	0	115	24	13.36	30.06	3.22

Annexure IIII

Results of Chemical Analysis of Ground Water (November 2020)

In mg/l

Block	Location	Sample Source	Lat	Long	pH	EC	TH	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	NO_3^{-}	SO_4^{2-}	F^{-}	PO_4^{3-}	TDS
Samoli	Barari-1	DW	25.500	37.370	5.7	295	140	50	4	3	0.03	0	116	11	36	3.2	0.1	0.05	192
Korha	Khiria	DW	25.600	87.450	5.45	1256	420	126	26	85	16	0	317	78	185	99	0.1	0	816
Korha	Korha	DW	25.610	87.400	5.49	1083	390	86	43	59	8.5	0	366	82	78	53	0	0	704
Falka	Barandi dhar	SW	25.620	87.390	5.66	297	135	44	6	7	0.3	0	73	18	49	22	0.1	0	193
Barari	Uchhla	SW	25.470	87.380	5.63	220	90	22	9	7	0.06	0	31	32	38	0	0	0	143
Korha	Tinpinia belai Chowk	SW	25.6	87.460	4.8	526	200	56	15	27	2.5	0	201	18	53	28	0.1	0	342
Barai	Dumer	DW	25.530	87.320	4.97	793	250	64	22	63	3.3	0	275	53	85	26	0.1	0	515

Annexure IV

Lithological Log of Tube Wells

SN : **1**
Village : Baida
Block : Pranpur
Latitude : 25.4167
Longitude : 87.7208
Litholog :

Depth range (m bgl)		Thickness (m)	Litholog
from	to		
0	3.04	3.04	Surficial silty soil underlain by an alternation of silt and very fine sand.
3.04	6.09	3.05	Very find sand.
6.09	18.28	12.19	Medium to coarse sand

SN : **2**
Village : Baidibari
Block : Manihari
Latitude : 25.3500
Longitude : 87.6333
Litholog :

Depth range (m bgl)		Thickness (m)	Litholog
from	to		
0	3.04	3.04	Surficial clayey loam underlain by an alternation of silt, clay and very fine sand
3.04	9.14	6.1	Fine·and very fine sand
9.14	18.28	9.14	Fine to medium sand
18.28	21.33	3.05	Clay and silt
21.33	24.33	3	Fine sand mixed with silt and clay
24.33	45.72	21.39	Fine sand with intervening layers of medium sand
45.72	57.91	12.19	Coarse sand mixed with pebbles
57.91	70.09	12.18	Fine sand with intervening layers of medium sand
70.09	91.44	21.35	Coarse sand with pebbles
91.44	94.48	3.04	Fine sand

SN : **3**
Village : Barsoi
Block : Barsoi
Latitude : 25.6500
Longitude : 87.9278
Litholog :

Depth range (m bgl)		Thickness (m)	Litholog
from	to		
0	18.3	18.3	Surficial clayey loam underlain by an alternation of silt, clay and very fine sand
18.3	29	10.7	Fine·and very fine sand

SN : **4**
Village : Budhuchak
Block : Korha
Latitude : 25.54170
Longitude : 87.55000
Litholog :

Depth range (m bgl)		Thickness (m)	Litholog
from	to		
0	3.04	3.04	Surficial sandy clay underlain by alternation of very fine sand and silt
3.04	9.14	6.1	Fine to medium sand
9.14	12.19	3.05	Fine to medium sand with small pebble
12.19	30.48	18.29	Fine to medium sand
30.48	33.52	3.04	Medium sand with pebble
33.52	36.59	3.07	Medium sand
36.59	42.67	6.08	Medium to coarse sand with pebbles

SN : **5**
Village : Chatar
Block : Korha
Latitude : 25.66670
Longitude : 87.37000
Litholog :

Depth range (m bgl)		Thickness (m)	Litholog
from	to		
0	4.5	4.5	Surficial silty and clayey loam underlain by silt and ; very fine sand layers
4.5	15.2	10.7	Coarse sand
15.2	17.3	2.1	Sticky clay
17.3	19.3	2	Coarse with pebble

SN : **6**
Village : Dhanetha
Block : Falka
Latitude : 25.64440

Longitude : 87.34860
Litholog :

Depth range (m bgl) from	to	Thickness (m)	Litholog
0	12.2	12.2	Surficial silty and clayey loam underlain by silt and ; very fine sand layers
12.2	18.3	6.1	Coarse sand with pebbles

SN : **7**
Village : Dighari
Block : Korha
Latitude : 25.6000
Longitude : 87.5000
Litholog :

Depth range (m bgl) from	to	Thickness (m)	Litholog
0	16.76	16.76	Surficial sandy loam underlain by fine sand with partings of silt
16.76	32	15.24	Coarse sand

SN : **8**
Village : Kabar Krishan Dev
Block : Barari
Latitude : 25.46940
Longitude : 87.50280
Litholog :

Depth range (m bgl) from	to	Thickness (m)	Litholog
0	3.04	3.04	Surficial sandy loam underlain by an alternation of fine sand and silt
3.04	45.72	42.68	Alternation of sandy silt and clay
5.72	51.81	46.09	Medium to coarse sand
51.81	60.95	9.14	Fine sand
60.95	85.33	24.38	Coarse sand
85.33	88.34	3.01	Fine to medium sand

SN : **9**
Village : Kumaripur
Block : Manihari
Latitude : 25.44170
Longitude : 87.62500
Litholog :

Depth range (m bgl) from	to	Thickness (m)	Litholog
0	12.19	12.19	Surficial sandy loam underlain by an alternation of fine sand and silt
12.19	17.07	4.88	Medium sand
17.07	29.26	12.19	Coarse sand

SN : **10**
Village : Lalia
Block : Korha
Latitude : 25.57920
Longitude : 87.35000
Litholog :

Depth range (m bgl)		Thickness (m)	Litholog
from	to		
0	2.1	2.1	Surficial silty clay underlain by alternation of silt and clay
2.1	18.3	18.3	Coarse sand

SN : **11**
Village : Madansah
Block : Pranpur
Latitude : 25.48330
Longitude : 87.70080
Litholog :

Depth range (m bgl)		Thickness (m)	Litholog
from	to		
0	12.19	12.19	Surficial sandy loam underlain by an alternation of very fine sand and fine sand
12.19	17.07	4.88	Medium sand
17.07	29.26	12.19	Coarse sand

SN : **12**
Village : Madhura
Block : Korha
Latitude : 25.56670
Longitude : 87.40000
Litholog :

Depth range (m bgl)		Thickness (m)	Litholog
from	to		
0	15.2	15.2	Surficial sandy loam underlain by very fine sand and fine sand
15.2	30.4	15.2	Medium sand
30.4	44.2	13.8	Coarse sand

SN : **13**
Village : Mahadeopur
Block : Pranpur
Latitude : 25.43750
Longitude : 87.74170
Litholog :

Depth range (m bgl)		Thickness (m)	Litholog
from	to		

0	18.3	18.3	Dark grey clay underlain by anlternation of silt and sandy silt
18.3	22.9	4.6	Fine sand
22.9	27.4	4.5	Coarse sand
27.4	29.6	2.2	Fine sand
29.6	45.7	16.1	Coarse sand

SN : **14**
Village : Majbartal
Block : Manihari
Latitude : 25.36670
Longitude : 87.71670
Litholog :

Depth range (m bgl)		Thickness (m)	Litholog
from	to		
0	13.7	13.7	Dark grey silty loam underlain by an alternation of silt and clay
13.7	30.48	16.78	Alternation of silt and very fine sand
30.48	39.6	9.12	Fine sand
39.6	54.8	15.2	Coarse sand with gravel

SN : **15**
Village : Mabia
Block : Katihar
Latitude : 25.52920
Longitude : 87.60420
Litholog :

Depth range (m bgl)		Thickness (m)	Litholog
from	to		
0	3.04	3.04	Dark grey clay
3.04	7.6	4.56	Silt and fine sand
7.6	15.2	7.6	Fine sand
15.2	32	16.8	Coarse sand

SN : **16**
Village : Manshahi
Block : Mansahi
Latitude : 25.46670
Longitude : 87.56670
Litholog :

Depth range (m bgl)		Thickness (m)	Litholog
from	to		
0	3.04	3.04	Surficial sandy loam underlain by very fine sand
3.04	15.2	12.16	Fine sand
15.2	33.5	18.3	Coarse sand

SN : **17**
Village : Mahinathpur

Block : Korha
Latitude : 25.65830
Longitude : 87.40000
Litholog :

Depth range (m bgl) from	to	Thickness (m)	Litholog
0	6.1	6.1	Surficial clayey loam underlain by an alternation of silt and fine sand
6.1	12.5	6.4	Fine sand
12.5	28	15.5	Coarse sand

SN : **18**
Village : Mirciiaillari
Block : Katihar
Latitude : 25.55420
Longitude : 87.56670
Litholog :

Depth range (m bgl) from	to	Thickness (m)	Litholog
0	16.8	16.8	Surficial sandy soil underlain by fine sand
16.8	32	15.2	Coarse sand

SN : **19**
Village : Morsanda
Block : Falka
Latitude : 25.65830
Longitude : 87.33190
Litholog :

Depth range (m bgl) from	to	Thickness (m)	Litholog
0	1.5	1.5	Surficial clayey loam underlain by silt
1.5	3	1.5	Alternation of fine to very fine sand
3	4.5	1.5	Alternation of very fine sand and clay
4.5	15.2	10.7	Coarse sand

SN : **20**
Village : Muhammad Nagar
Block : Falka
Latitude : 25.60420
Longitude : 87.31670
Litholog :

Depth range (m bgl) from	to	Thickness (m)	Litholog
0	2.7	2.7	Surficial silty loam underlain by fine sand
2.7	12.2	9.5	Coarse sand
12.2	18.3	6.1	Coarse sand with pebble

SN : **21**
Village : Musapur
Block : Falka
Latitude : 25.63330
Longitude : 87.40000
Litholog :

Depth range (m bgl)		Thickness (m)	Litholog
from	to		
0	6.1	6.1	Surficial silty loam underlain by an alternation of very fine sand and silt
6.1	10.6	4.5	Fine sand
10.6	26.24	15.64	Coarse sand

SN : **22**
Village : Nawabganj
Block : Korha
Latitude : 25.57500
Longitude : 87.39170
Litholog :

Depth range (m bgl)		Thickness (m)	Litholog
from	to		
0	6.1	6.1	Surficial silty loam underlain by an alternation of very fine sand and silt
6.1	10.6	4.5	Fine sand
10.6	26.24	15.64	Coarse sand

SN : **23**
Village : Pachma
Block : Korha
Latitude : 25.55000
Longitude : 87.40830
Litholog :

Depth range (m bgl)		Thickness (m)	Litholog
from	to		
0	3.04	3.04	Surficial sandy loam under by very fine and fine sand
3.04	9.14	6.1	Fine sand
9.14	18.3	9.16	Medium sand
18.3	32.92	14.62	Coarse sand

SN : **24**
Village : Rounia
Block : Barari
Latitude : 25.51940
Longitude : 87.46940
Litholog :

Depth range (m bgl)		Thickness (m)	Litholog
from	to		
0	3.04	3.04	Surficial sandy loam under by very fine and fine sand

3.04	9.14	6.1	Fine sand
9.14	18.3	9.16	Medium sand
18.3	32.92	14.62	Coarse sand

SN : **25**
Village : Semapur
Block : Barari
Latitude : 25.53060
Longitude : 87.46940
Litholog :

Depth range (m bgl)		Thickness (m)	Litholog
from	to		
0	3.04	3.04	Surficial clayey loam underlain by alternation of silt, clay and fine sand
3.04	6.09	3.05	Fine sand
6.09	12.19	6.1	Dark grey semi-plastic clay
12.19	30.48	18.29	Fine sand
30.48	42.67	12.19	Fine to medium sand
42.67	73.15	30.48	Medium to coarse sand with pebbles
73.15	76.19	3.04	Medium sand
76.19	79.24	3.05	Dark grey semi-plastic clay

SN : **26**
Village : Siranda
Block : Pranpur
Latitude : 25.49720
Longitude : 87.71390
Litholog :

Depth range (m bgl)		Thickness (m)	Litholog
from	to		
0	6.09	6.09	Surficial sandy loam underlain by fine sand
6.09	9.14	3.05	Fine sand
9.14	12.19	3.05	Medium sand
12.19	26.52	14.33	Coarse sand

SN : **27**
Village : Kishanpur
Block : Amdabad
Latitude : 25.325011
Longitude : 87.719808
Litholog :

Depth range (m bgl)		Thickness (m)	Litholog
from	to		
0	6	6	Top soil with sand fine grained ,greyish brown in

			colour
6	8.4	2.4	Silt mixed with sand, fine grained, greyish brown in colour
8.4	18	9.6	Silt mixed sand, fine grained , greyish brown colour and few mica
18	24	6	Fine grained sand , greyish brown colour mixed with few mica
24	52	28	Silt mixed sand, fine grained , greyish brown colour and few mica
52	60	8	Fine grained sand , greyish colour mixed with few mica
60	74	14	Silt mixed with sand ,medium grained ,greyish colour and few gravel & mica
74	80	6	Fine grained sand, greyish colour mixed with gravel & kankar
80	84	4	Silt mixed with sand, medium to fine grained, greyish brown colour and few mica
84	92	8	Fine grained sand, greyish brown colour mixed with few mica
92	106	14	Silt mixed with sand, medium to fine grained, greyish brown colour and few mica
106	112	6	Fine grained sand, greyish brown colour mixed with few mica
112	154	42	Silt mixed with sand, medium to fine grained, greyish brown colour and few mica
154	158	4	Fine grained sand, greyish brown colour mixed with few mica and gravel, kankar
158	176	18	Silt mixed with sand, medium to fine grained, greyish colour and few kankar
176	190	14	Clay, brackish red mixed with sand ,coarse to medium grained, yellowish grey colour and few gravel & kankar
190	196	6	Very fine grained sand, yellowish grey mixed with few gravel & kankar
196	208	12	Clay, brackish red colour mixed with fine grained sand
208	214	6	Fine grained sand,brickish yellow colour
214	222	8	Clay mixed with sand, coarse to medium grained , yellowish colour
222	224	2	Fine grained sand, yellowish colour
224	230	6	Clay mixed with sand, coarse to medium grained , yellowish colour
230	236	6	Fine grained sand, yellowish colour
236	244.4	8.4	Clay mixed with sand, medium grained , yellowish colour
244.4	250.4	6	Fine grained sand, yellowish colour
250.4	252.4	2	Clay mixed with sand, medium grained , yellowish colour
252.4	254	1.6	Fine grained sand, yellowish colour
254	262.4	8.4	Clay mixed with sand, medium grained , yellowish colour
262.4	264	1.6	Fine grained sand, light yellowish colour

264	276.8	12.8	Clay mixed with sand, fine grained , light yellowish colour
276.8	286.2	9.4	Fine grained sand, light yellowish colour
286.2	288	1.8	Clay mixed with sand, medium grained , light yellowish colour
288	291.2	3.2	Fine grained sand, light yellowish colour
291.2	294	2.8	Clay mixed with sand, medium grained , greyish yellow colour
294	297.2	3.2	Fine grained sand, greyish yellow colour
297.2	300	2.8	Clay mixed with sand, medium grained , greyish yellow colour

SN : **28**
Village : Krishna Nagar
Block : Sameli
Latitude : 25.325011
Longitude : 87.268794
Litholog :

Depth range (m bgl)		Thickness	Litholog
from	to	(m)	
0	5	5	Sand: Fine grained sand, greyish yellow colour and mixed with mica
5	15	10	Sand: Fine grained sand, greyish colour & mixed with mica
15	50	35	Sand: Medium to fine grained sand, greyish colour & mixed with mica
50	80	30	Sand: Medium to fine grained colour, greyish yellow colour & mixed with mica
80	85	5	Sand: Very fine grained sand, greyish colour & mixed with Clay
85	115	30	Sand: Medium to fine grained sand, greyish colour& mixed with mica & gravel
115	120	5	Sand: Medium to fine grained sand, greyish colour& mixed with mica & gravel
120	140	20	Sand: Fine grained sand, greyish colour & mixed with mica & gravel
140	150	10	Sand: Fine grained sand, greyish colour & mixed with mica
150	160	10	Sand: Fine grained sand, greyish colour & mixed with mica
160	190	30	Sand: Fine grained sand, greyish colour & mixed with mica
190	195	5	Sand: Fine grained sand, greyish colour & mixed with mica
195	200	5	Sand: Fine grained sand, greyish colour & mixed with mica
200	205	5	Sand: Fine grained sand, greyish colour & mixed with mica
205	210	5	Sand: Fine grained sand, greyish colour & mixed with mica
210	217	7	Sand: Fine grained sand, greyish colour & mixed with mica

217	225	8	Sand: Fine grained sand, greyish colour & mixed with mica
225	230	5	Sand: Medium to fine grained sand, light greyish colour & mixed with mica
230	237	7	Sand: Medium to fine grained sand, light greyish colour & mixed with mica
237	245	8	Sand: Medium to fine grained sand, light greyish colour & mixed with mica
245	250	5	Sand: Medium to fine grained sand, greyish colour & mixed with mica & gravel
250	260	10	Sand: Medium to fine grained sand, greyish colour & mixed with mica & gravel
260	265	5	Sand: Fine grained sand, greyish colour & mixed with mica
265	288	23	Sand: Medium to fine grained sand, light greyish colour & mixed with mica
288	296	8	Sand: Medium to fine grained sand, light greyish colour & mixed with mica
296	300	4	Sand: Fine grained sand, greyish colour & mixed with mica

SN : **29**
Village : Kumaripur
Block : Sameli
Latitude : 25.440296
Longitude : 87.61374
Litholog :

Depth range (m bgl)		Thickness	Litholog
from	to	(m)	
0	5	5	Top soil ,yellowish
5	20	15	Sand: Fine grained sand, greyish & mixed with mica
20	50	30	Sand: Medium to fine grained sand, greyish & mixed with mica
50	80	30	Fine grained sand, greyish & mixed with few mica
80	90	10	Sand: Medium to fine grained sand, greyish & mixed with mica
90	104	14	Sand: Fine grained sand, greyish & mixed with mica & clay
104	110	6	Clay, reddish yellow intermixed with fine sand
110	120	10	Sand: Medium to fine grained sand, greyish & mixed with mica
120	145	25	Sand: Fine grained sand, greyish & mixed with few mica
145	165	20	Sand: Medium to fine grained sand, greyish & mixed with mica & few gravel
165	194	29	Sand: Fine grained sand, greyish & mixed with few mica
194	198	4	Sand: Coarse grained sand, yellowish & mixed with few mica & fine sand
198	202	4	Clay ,brackish red

202	208	6	Sand: Coarse to medium grained sand, light greyish mixed with few mica & gravel
208	210	2	Sand: Fine grained sand, light yellowish & mixed with few mica
210	240	30	Sand: Medium grained sand, light yellowish & mixed with mica
240	255	15	Clay, reddish yellow

SN : **30**
Village : Manihari
Block : Manihari
Latitude : 25.344506
Longitude : 87.625203
Litholog :

Depth range (m bgl)		Thickness	Litholog
from	to	(m)	
0	20	20	Top soil, brownish colour
20	35	15	Fine grained sand, greyish colour mixed with mica and clay
35	40	5	Clay dark ,greyish colour
40	45	5	Sand: Fine grained sand, greyish colour & mixed with few mica & gravel
45	48	3	Sand: Fine grained sand, greyish colour & mixed with mica & clay
48	60	12	Sand: Medium to fine grained colour, greyish colour & mixed with mica
60	70	10	Clay , greyish colour & mixed with kankar
70	78	8	Clay ,yellowish colour
78	80	2	Claystone, reddish brown in colour
80	88	8	Clay, brownish yellow colour & mixed with kankar
88	94	6	Clay reddish brown mixed with kankar
94	100	6	Gravel & Kankar

SN : **31**
Village : Semapur
Block : Barari
Latitude : 25.344506
Longitude : 87.625203
Litholog :

Depth range (m bgl)		Thickness	Litholog
from	to	(m)	
0	5	5	Top soil, yellowish brown colour
5	15	10	Sand Fine grained, greyish colour mixed with mica and clay
15	25	10	Sand Fine grained, greyish colour mixed with mica and clay
25	30	5	Sand Fine grained, greyish colour mixed with mica
30	34	4	Sand Fine grained, greyish colour mixed with mica and clay

34	39	5	Sand Fine grained, greyish colour mixed with mica
39	42	3	Sand Fine grained, greyish colour mixed with mica and clay
42	46	4	Sand Fine grained, greyish colour mixed with mica
46	70	24	Sand Fine grained, greyish colour mixed with mica
70	82	12	Sand Fine to medium grained sand, dark greyish colour mixed with few gravel & mica
82	95	13	Sand Fine grained, dark greyish colour mixed with few gravel & mica
95	99	4	Clay mixed with fine sand and few gravel
99	116	17	Sand Fine to medium grained sand, light greyish colour mixed with mica
116	120	4	Sand Very Fine to fine sand, light greyish colour mixed with clay
120	142	22	Sand Fine to medium grained sand, light greyish colour mixed with mica
142	180	38	Sand Fine to medium grained sand, dark greyish colour mixed with clay & mica
180	203	23	Sand Fine grained greyish colour mixed with mica
203	250	47	Sand Fine grained, greyish colour mixed with mica & few clay
250	255	5	Sand Fine grained, greyish colour mixed with mica
255	260	5	Sand Fine grained, greyish colour mixed with mica & clay
260	280	20	Sand Fine grained, greyish yellow colour mixed with few mica
280	290	10	Sand Medium to coarse grained sand, yellowish grey colour mixed with few mica

References:

1. Ground Water Year Book – 2018-19 and 2019-20
2. Hydrogeology and Ground Water Development Potential of Katihar district, Bihar
3. Ground Water Exploration Report – Bihar
4. National Aquifer Mapping in Parts of Bhojpur, Buxar, Patna, Bhagalpur and Katihar Districts, Bihar (2016-17 & 2017-18)

Disclaimer:

This Report has been prepared based on the available data, observations from fields and discussion with the local farmers. Additional data, incorporated in future, may change the understanding of hydrogeological scenario of the area.

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