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

Saharsa District
Bihar

मध्य पूर्वी क्षेत्र, पटना

Mid Eastern Region, Patna

जल शक्ति मंत्रालय

Ministry of Jal Shakti

नदीविकासऔरगंगासंरक्षणविभाग

Department of Water Resources, River Development & Ganga Rejuvenation

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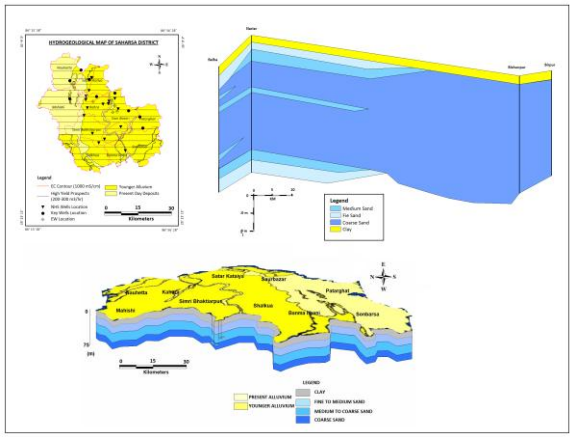
Central Ground Water Board

Aquifer Maps and Ground Water Management Plan of Saharsa district, Bihar

जलभृतनक्शेतथाभूजलप्रबंधनयोजना सहरसा जिला, बिहार



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Aquifer Maps and Ground Water Management Plan of Saharsa district, Bihar

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CONTENTS FOR REPORT ON AQUIFER MAPS AND GROUND WATER MANAGEMENT PLAN, SAHARSA DISTRICT, BIHAR STATE (AAP 2020-21)

LIST OF TABLES

LIST OF FIGURES

LIST OF ANNEXURE

CHAPTER - I

INTRODUCTION

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. During 2020-2021 under National Aquifer Mapping programme, all the 10 blocks of Saharsa district covering an area of 1661 Sqkm have been taken up for detailed hydrogeological survey and preparation of Aquifer maps and Management plan. The aquifer maps and management plans will be shared with the administration of Saharsa 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:

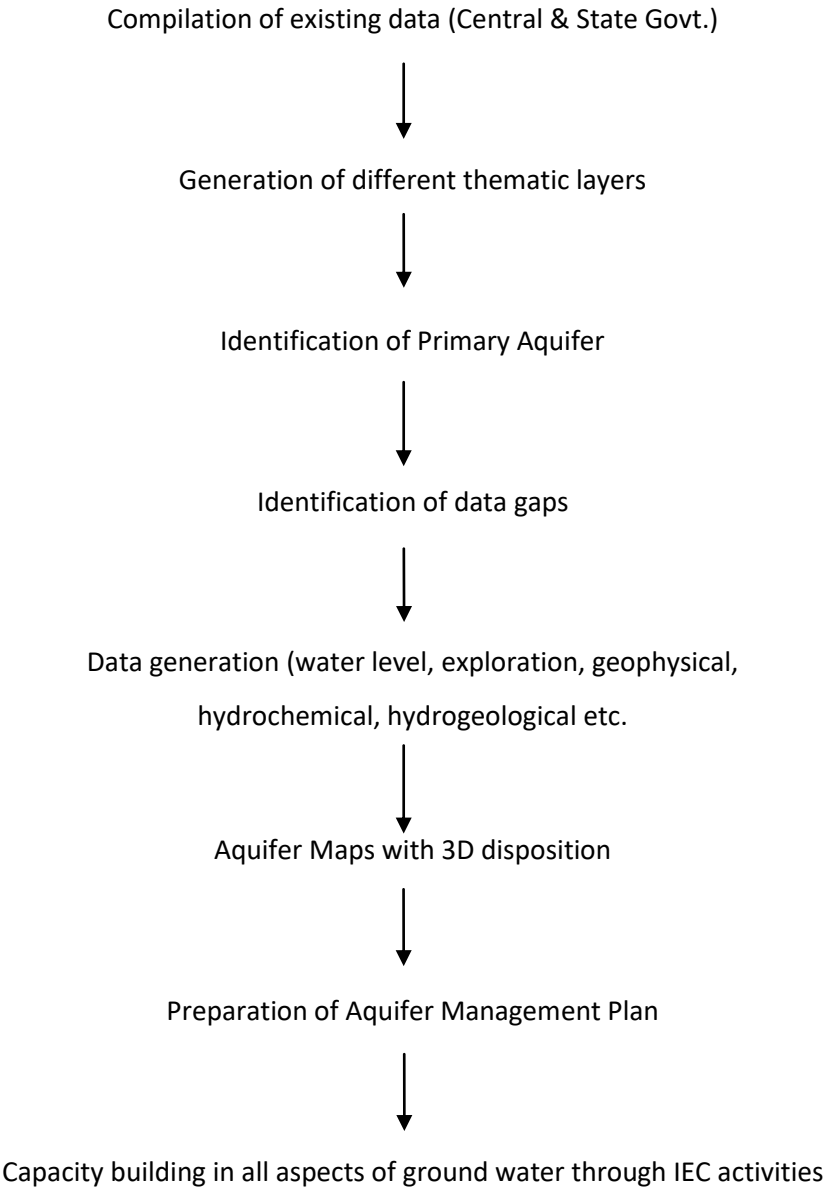
- Identifying the aquifer geometry
- Aquifer characteristics and their yield potential
- Quality of water occurring at various depths
- Aquifer wise assessment of ground water resources
- Preparation of aquifer maps and formulate ground water management plan.

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. With this background the following aspects are identified as most significant in the context of present study area:

- To understand the aquifer disposition of the area.
- The entire district, which is part of Kosi megafan with huge groundwater potential. Therefore, extensive groundwater development exists.
- The district is reported with seasonal flooding and rapid shifting of river course. In order to address the quality issues, suitable remedial measures are to be recommended.
- By considering groundwater quantity and sustainability aspects suitable groundwater management strategies to be adopted.

1.2 Approach and Methodology

The ongoing activities of NAQUIM include hydrogeological data acquisition supported by geophysical and hydro-chemical investigations supplemented with ground water exploration down to the depths of 200 meters in hard rocks and 300m in soft rock. 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:



In order to achieve Aquifer Mapping objectives, present study incorporated collection and compilation of available information on aquifer systems. The work has been approached through demarcation of aquifer extents, characterization and finally compilation of this information in form of aquifer maps at 1:50000 scale along with block-wise groundwater management plan. Artificial recharge measures are proposed based on the feasibility in the area based upon earlier prepared Master Plan for Artificial Recharge of Groundwater.

For the purpose, groundwater flow system has been conceptualized based on collected data, keeping in view of sustainable groundwater development. Groundwater quality data has been analyzed and quality affected area were demarcated. Methodologies adopted include preparation of various thematic maps like land use and land cover map, geomorphologic map, geologic & hydrogeologic map by using various GIS tools. Hydrogeological sections, panel diagrams, 3-D aquifer disposition, hydro-chemical diagrams were prepared. Data from concerned agencies/departments

were also collected for preparation of status of data gap. Groundwater resource data has been taken from 'Report on Dynamic Groundwater Resources of Bihar State-2020' by CGWB. Groundwater level has been monitored from existing NHS wells as well as from newly established key wells. Groundwater quality data is based on water samples collected from existing NHS wells during May-2021. Based on outcome of various analyses, block-wise groundwater management plan has been prepared.

1.3 Area Details

Saharsa district consists of 10 administrative blocks with geographic area of 1661 sq.km. The district is bounded in north by Madhubani and Supaul districts, in east by Madhepura district, in south by Khagaria district, in west by Darbhanga district. Administrative map of the study area is given in Fig. 1.3. As per Govt. of India Population Census (2011), total population of the district is 19,00,661 with decadal growth rate of 26%. Projected population as on 30th June 2021 is 21,84644 (Bihar Statistical Handbook, 2016). Demographic details of the administrative blocks are given in Table 1.1.

Table 1.1 Demographic details of the administrative blocks of Saharsa district

District	Block	Total Area (Sq. km.)	Rural Population	Urban Population	Total Population
Saharsa	Banma Itahri	75	90,943	0	90,943
	Kahara	134	141,805	156,540	298,345
	Mahishi	223	206,774	0	206,774
	Nauhatta	170	161,784	0	161,784
	Patarghat	119	128,322	0	128,322
	Salkhua	177	132,844	0	132,844
	Satar Kataiya	151	151,060	0	151,060
	Saur Bazar	188	214,166	0	214,166
	Simri Bakhtiarpur	214	280,582	0	280,582
	Sonbarsa	210	235,841	0	235,841
District Total		1661	17,44,121	156,540	**19,00,661**

(as per 2011 population census)

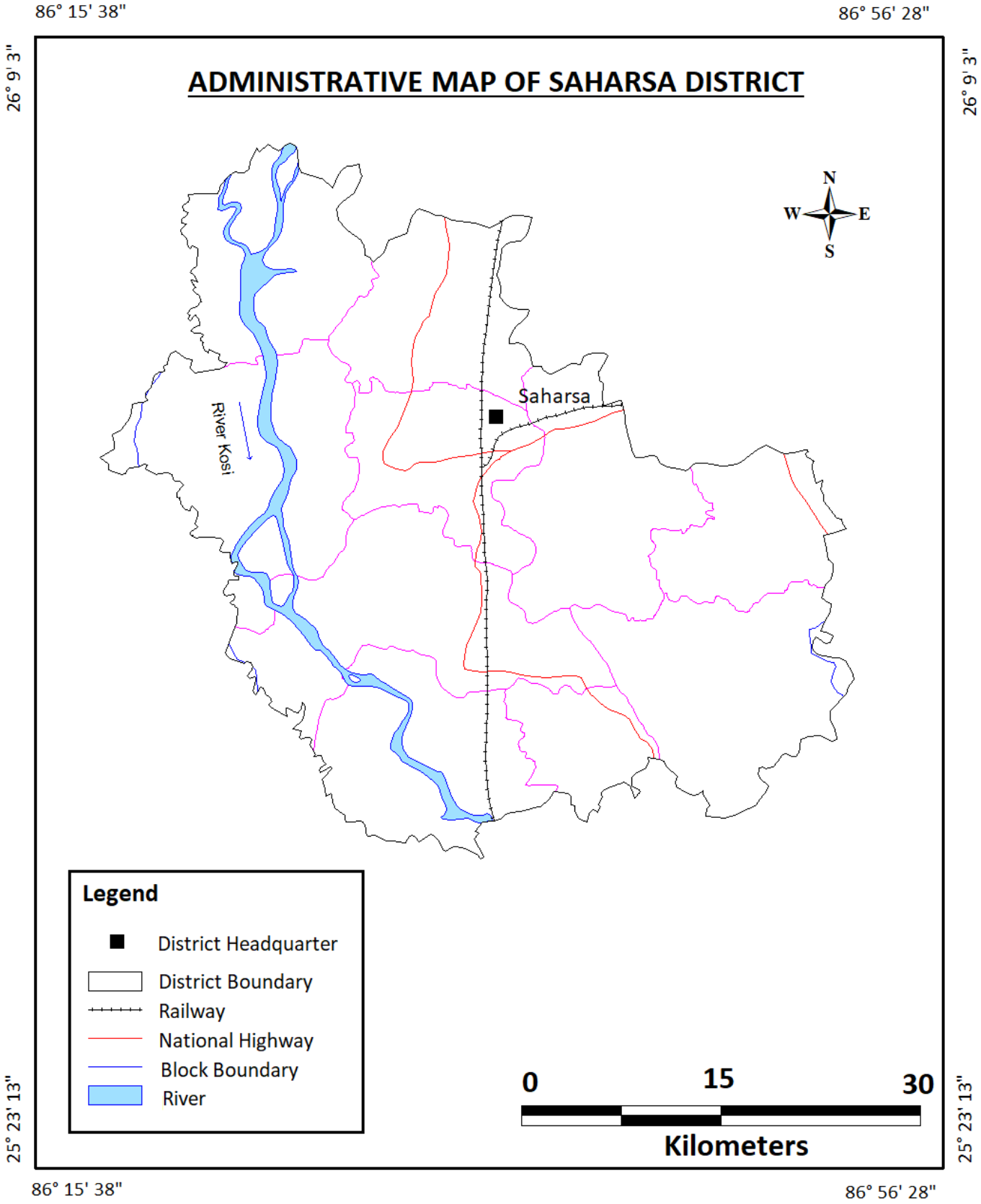


Fig. 1.1: Administrative Map of Saharsa District

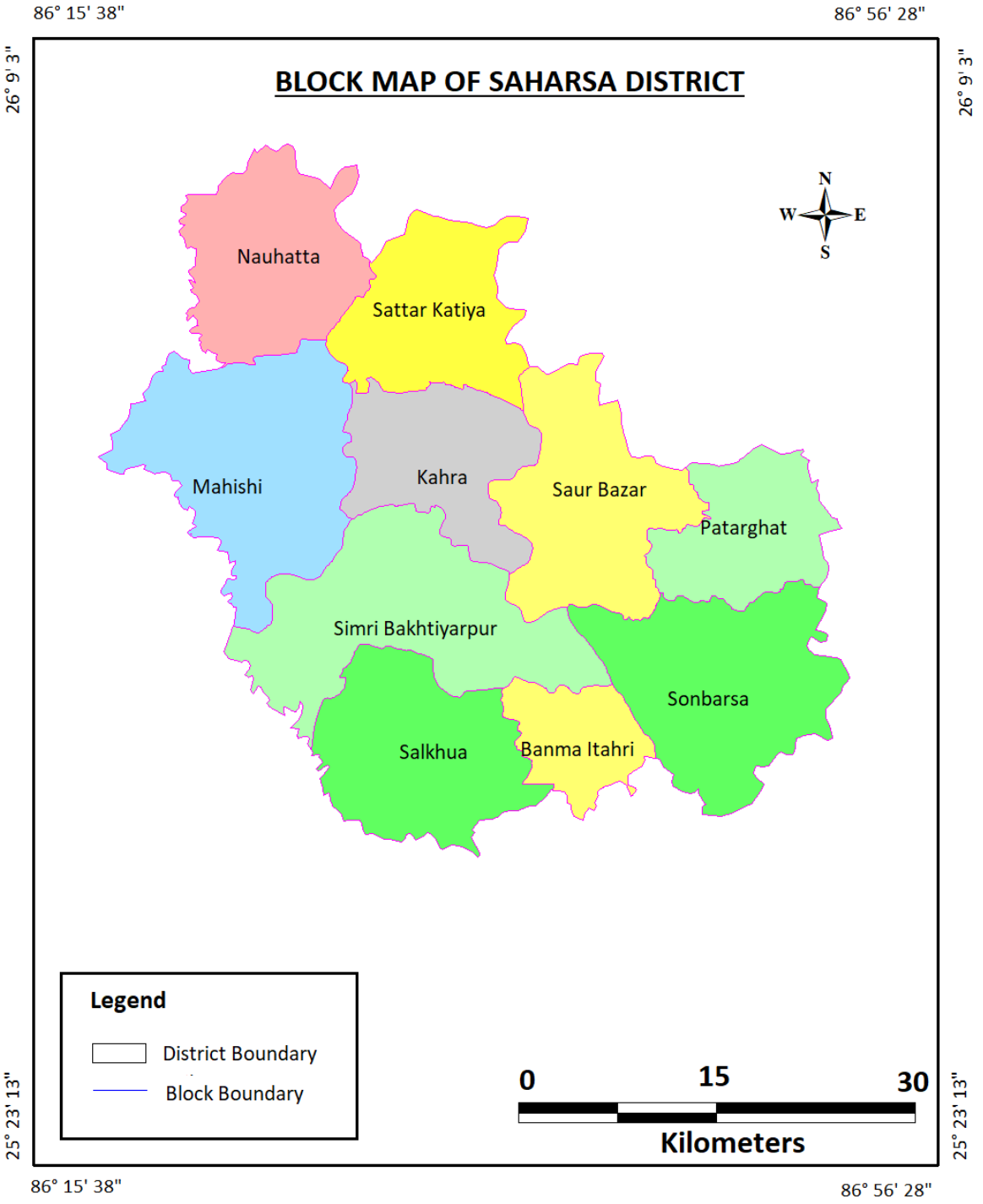


Fig. 1.2: Block Map of Saharsa district

1.4 Brief Description

Saharsa district comes under the Kosi Division of north Bihar, with district headquarter at Saharsa. The district is drained by Kosi and its tributaries. The river Kosi has its catchment area near Indiao-Nepal province. The river brings enormous sediment load during rainy season not only to

spread the new sheets of fertile sediments but also alter their beds and their channel courses. This river has severe shifting tendencies resulting in large tract of Diara land.

1.5 Data Availability

Central Ground Water Board carried out hydrogeological surveys, reappraisal surveys and groundwater exploration in different parts of the district. Ground water regime monitoring is carried out on a regular frequency during January, May, August and November every year. The data available from the earlier surveys have been compiled and data gap analysis has been carried out for working out the need for additional data generation in the study area.

1.6 Rainfall and Climate

The climate of Saharsa district may be described as a mixture of climate of Bihar and West Bengal. The rainfall begins earlier than other parts of the State. Saharsa is among eastern district of Bihar which distinctly experiences dry and hot seasons. Moisture laden breezes from West Bengal cause heavy rainfall during monsoon. Winter commences by the end of October and continues till the beginning of April. Thus winter commences earlier and lasts longer than rest of the parts of the State. Hoar-frost are often found in the morning. May is the hottest month of the district with temperature raises more than 36 degrees. The rainy season starts from June and continues up to October. The winter initiates from mid of October and continues up to February. January is the coldest month of the district with night temperature fall below 8 degrees.

The district annual rainfall of 1206.3 mm during year 2020. The maximum amount of rain occurs from June to September, from the south west monsoon. Most quantum of ground water recharge and replenishment of the resource occur during monsoon season. Normal rainfall (from 1961 to 2010) of the district is 1514.7 mm. Month-wise rainfall pattern for previous nine years from 2013 to 2020 is given in table 1.2.

Table 1.2: Month-wise rainfall from 2013 to 2020 (Source: IMD Website)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total	M	NM
2013	0	10.6	3.2	132.4	22.4	191.6	225.5	173	285.8	144.6	0	0	1189.1	875.9	313.2
2014	0	7.4	0	0	80.4	24.8	175.4	182.5	42.5	6	0	0	519	425.2	93.8
2015	6	0	13	28	36	119.7	176.6	243.7	162.8	0	0	0	785.8	702.8	83
2016	0	0	0	0	106.2	87.4	298.7	70.7	444.1	60.9	0	0	1068	900.9	167.1
2017	0	0	83.1	0	124.7	120.2	510.5	307.2	81.7	30.2	0	0	1257.6	1019.6	238
2018	0	0	0	6.1	22.7	117.2	141.3	271.6	73.2	35.1	0	2.1	669.3	603.3	66
2019	5.8	7.7	1.3	20.2	29	93	403.3	155.2	376.7	7.2	0	7.2	1106.6	1028.2	78.4
2020	5.2	18.2	25.5	72.3	30.6	255.1	360	161.8	235.1	42.5	0	0	1206.3	1012	194.3

(Note: M-Monsoon, NM-Non Monsoon)

Trend and distribution of rainfall in the district (Figure 1.3, 1.4 & 1.5) show that maximum rainfall occurs in the monsoon season. Monsoonal and non-monsoonal rainfall shows sort of cyclicity during the taken period. From the monthly distribution of rainfall of the year 2020, it can be observed that actual monthly rainfall is less than normal rainfall in the district during the monsoon period. The district has received highest rainfall during the year 2017 as compared to rest of the taken years.

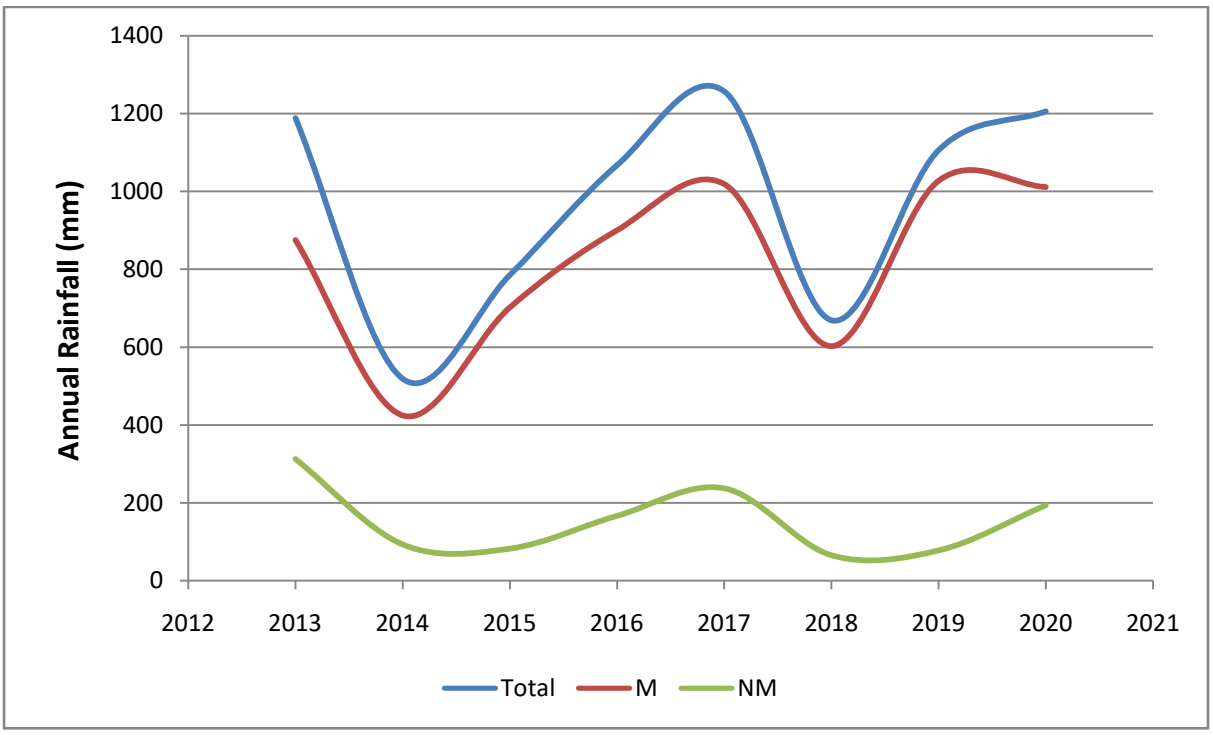


Fig. 1.3: Rainfall trend in Saharsa district during 2013 to 2020

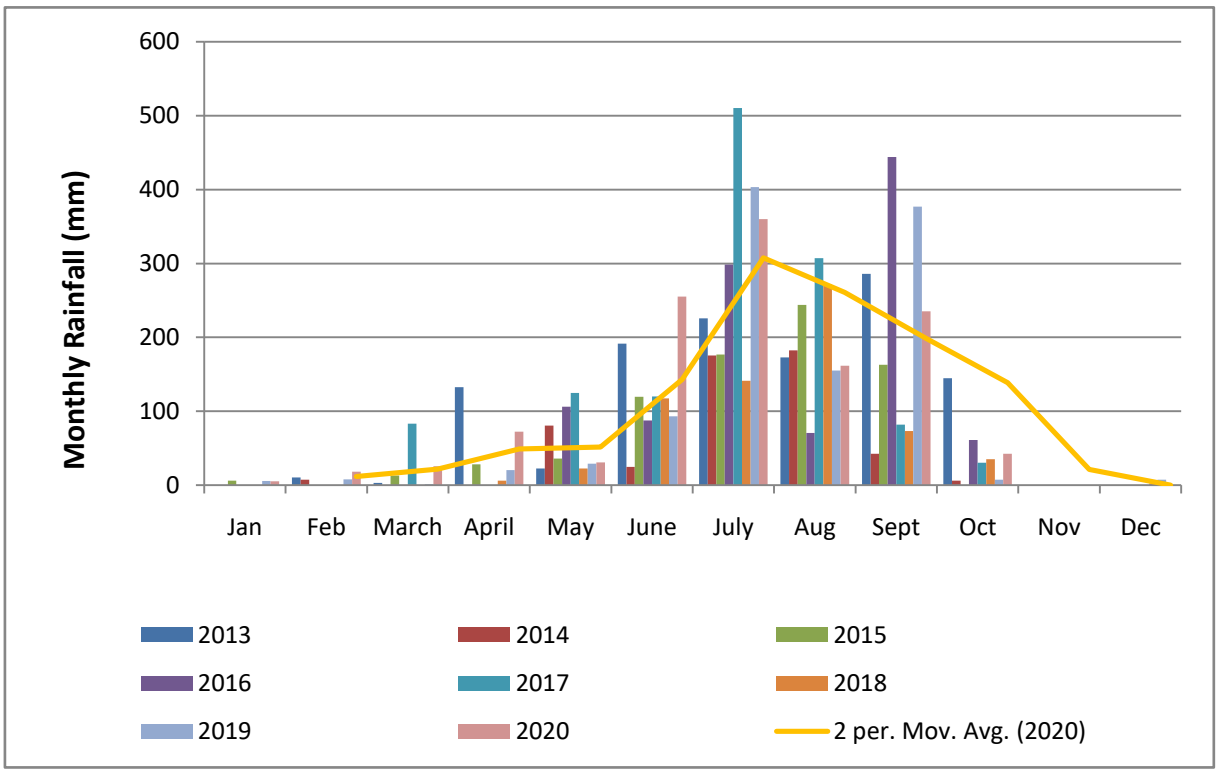


Fig. 1.4: Monthly rainfall pattern of Saharsa district during 2013 to 2020

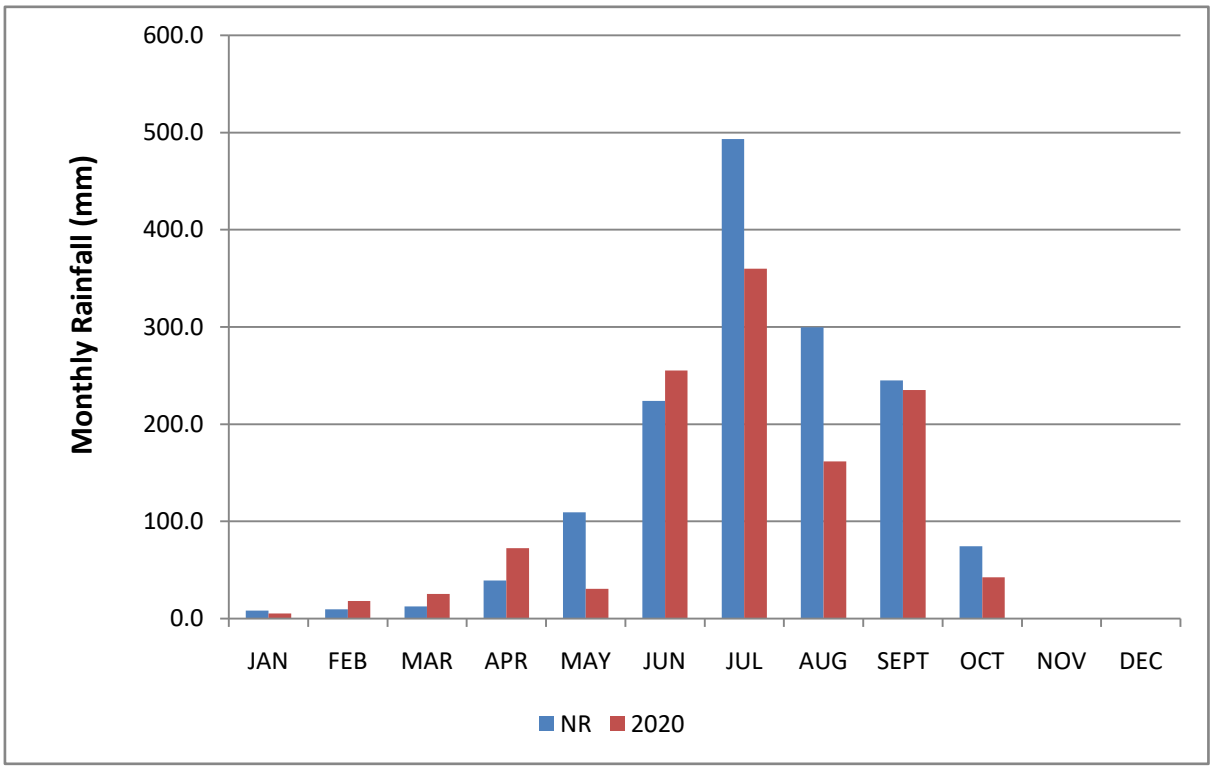


Fig. 1.5: Figure showing Normal rainfall & monthly rainfall during 2020

1.7 Physiographic Setup

The Kosi river emerging from an altitude of 7000 m above mean sea level in the Trans-Himalayan region covering parts of Nepal and Tibet, and forms a mega-fan while it enters in north Bihar plain. Consequently the emergent physiographic setup is the vast alluvial plain with gentle slope towards south. In Saharsa district 100% of its total geographic area is covered by Kosi mega-fan. The Kosi mega-fan is the largest inland alluvial fan in south-eastern Asia. North Ganga Plain is the physiographic unit covering the landmass in north of Bihar State. The total catchment area drained by the river Kosi and its tributaries is 740030 km^2, out of which only 11010 km^2 is flowing through India. The river enters into Indian territory near Hanuman Nagar in Nepal.

1.8 Geomorphology

In Saharsa district, more than 88% of the land area is covered by alluvial plain, out of which 31.65 % of the area is covered by the flood plain of Kosi river. The district is characterised by monotonous flat topography with elevation ranging from 30 to 60 m above mean sea level. The district is mainly drained by river Kosi and its tributaries. The river Kosi left behind a number of palaeochannels and Ox-Bow lakes along its old river courses (fig. 1.6). The district forms part of the mid to lower end of Kosi mega-fan and is characterized by fertile flat area which is highly prone to flood during the monsoon season. The Saharsa district is situated at the south-eastern parts of the megafan. The dimensions of the fan are 154 km by 147 km with fan slope of 0.89 to 0.06 m/km (0.1 to 0.25 m/km cross-fan) (Wells and Dorr, 1987).

Table 1.3: Showing area coverage of various landform units in Saharsa district

Landform Unit	Area (Sq. Km)	Percentage Area (%)
Ponds/Tanks	63.62	3.83
River	6.24	0.38
Younger Alluvial plain	941.06	56.66
Palaeochannel	34.78	2.09
Active Flood plain	525.77	31.65
Back Swamps/Ox-bow Lake	33.37	2.01
Channel Bar	56.16	3.38
Total	**1661**	**100**

1.9 Land-use Land-cover Pattern

Most of the geographical area of the district comprises of agricultural crop land (75.08 %) followed by wetlands/water bodies (13.22%). As per records of Agriculture Department, Govt. of Bihar, the gross cropped area of the district is 192558 ha and net sown area is 98692 ha. The cropping intensity of the district is 195%. A map showing land use pattern in the district is given in figure -1.7

Table. 1.4: Land use land cover data of Saharsa district (source: Bhuvan)

Landuse type	Area (Sq. Km)	Percentage area (%)
Agriculture, Crop land	1247.13	75.08
Forest	0.00	0.00
Agriculture, Fallow	26.26	1.58
Builtup, Rural	90.56	5.45
Wetlands/Water Bodies, River/Stream/canals	219.54	13.22
Barren/Wastelands/Gullied/Ravenous Land	12.10	0.73
Agriculture, Plantation	49.14	2.96
Builtup, Urban	10.97	0.66
Mining	5.29	0.32
Total	**1661.00**	**100.00**

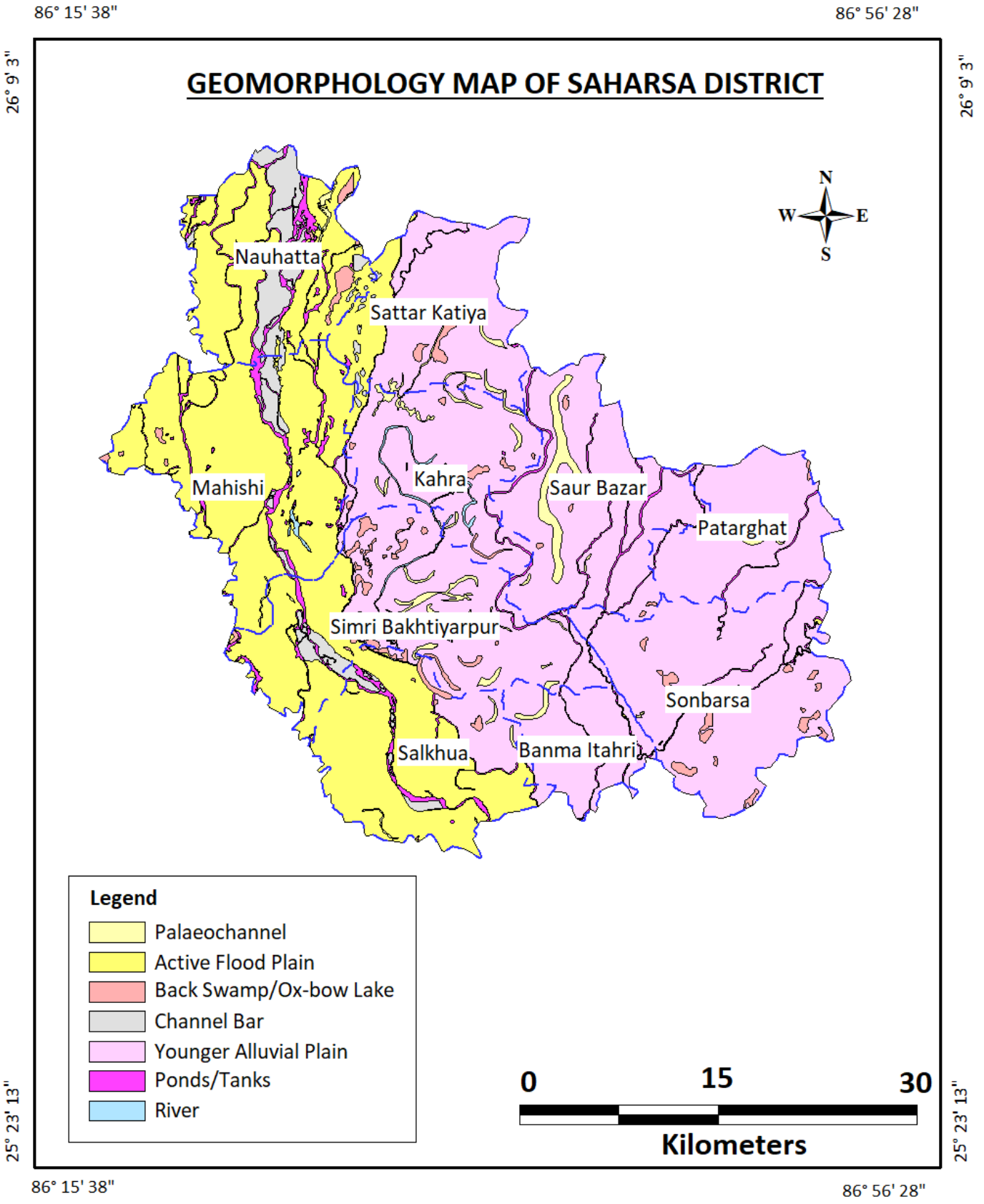


Fig. 1.6: Simplified geomorphological map of Saharsa District (Source: GSI-Published maps)

1.10 Soil

Major soil class in the district are loam to silt loam, loam to loamy clay, clay loam, sandy, sandy clay & sandy loam. In upland plain, 52,884 hectare soil is under loam to silt loam while 45,827 hectare of land is under deep water logged area. Within the Kosi embankments, the district has 41,094 hectare of soil classified under sandy clay to sandy loam category. Soils of the district are highly suitable for cultivation of food crops and horticulture crops such as rice, wheat, maize, pulses, oilseeds, sugarcane, potato, jute, banana, etc. Soil of Saharsa district comes under three slope classes. Majority of area of the district comes under nearly level to very gentle slope (0-2%).

Table 1.5: Area covered under various soil types (Source: Agriculture Contingency Plan, Saharsa)

Sl. No.	Soil Type	Area in Sq. Km	Percentage of area covered	Remarks
1	Loam to Silt Loam	533	32.1%	Plain Upland
2	Loam to loamy clay	458	27.6%	Deep water and waterlogged area
3	Clay loam, Loam to Silt loam	256	15.4%	Mid upland to low land
4	Sandy, Sandy clay & Sandy loam	414	24.9%	Area within the Kosi Embankments

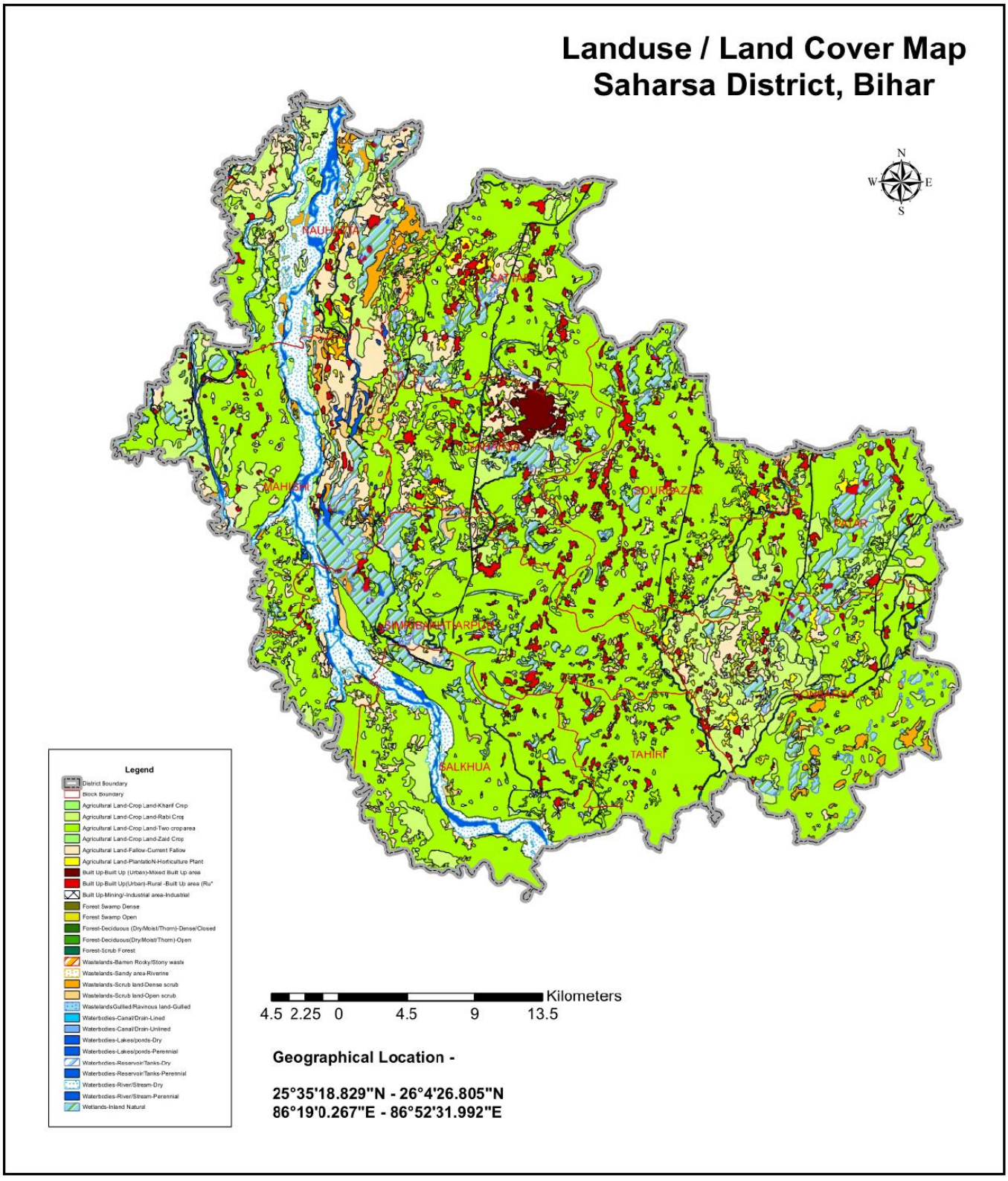


Fig. 1.7: Landuse map of Saharsa district (Source: District Irrigation Plan-Saharsa district)

1.11 Hydrology and Drainage

The district is by and large drained by Kosi and its tributaries. Kosi bring enormous sediment load during the monsoon season and deposit along the megafan area. Its tributaries, Sub Kosi, Arun Kosi and Tamur Kosi meet at Triveni and form the Sapt Kosi. The river enters the plains at Chatra. A number of rivers such, as the Tiljuga, Bhuthi Balan, Sugarwe, Sonior, Jangar, Balan, Kamal and Bagmati join the kosi on its right bank of the plain. The Kosi is notorious for its flooding, and is known as “Sorrow of Bihar”. It has changed its course a number of times and at present it has shifted to the west and flows near Nirmali and Madhepur, the latter being a part of Madhubani district (Fig 1.9). Other important rivers of the district are These rivers are the tiljuga, Bati, Dhimra, Talabe, Parwan, Dhusan, Chalausi, Loran, Daus and Ghagri.

It is to be noted that the river Kosi has migrated from its channel to about 113 km westward in last 228 years at the rate of 19 km/year (Fig.1.8). There are multiple causes for shifting of the river channel which include deposition and avulsion during major flood cycles, regional tilting, deflection of flow by fan head tilting, derangement of drainages by earthquakes, neo-tectonic activities etc.

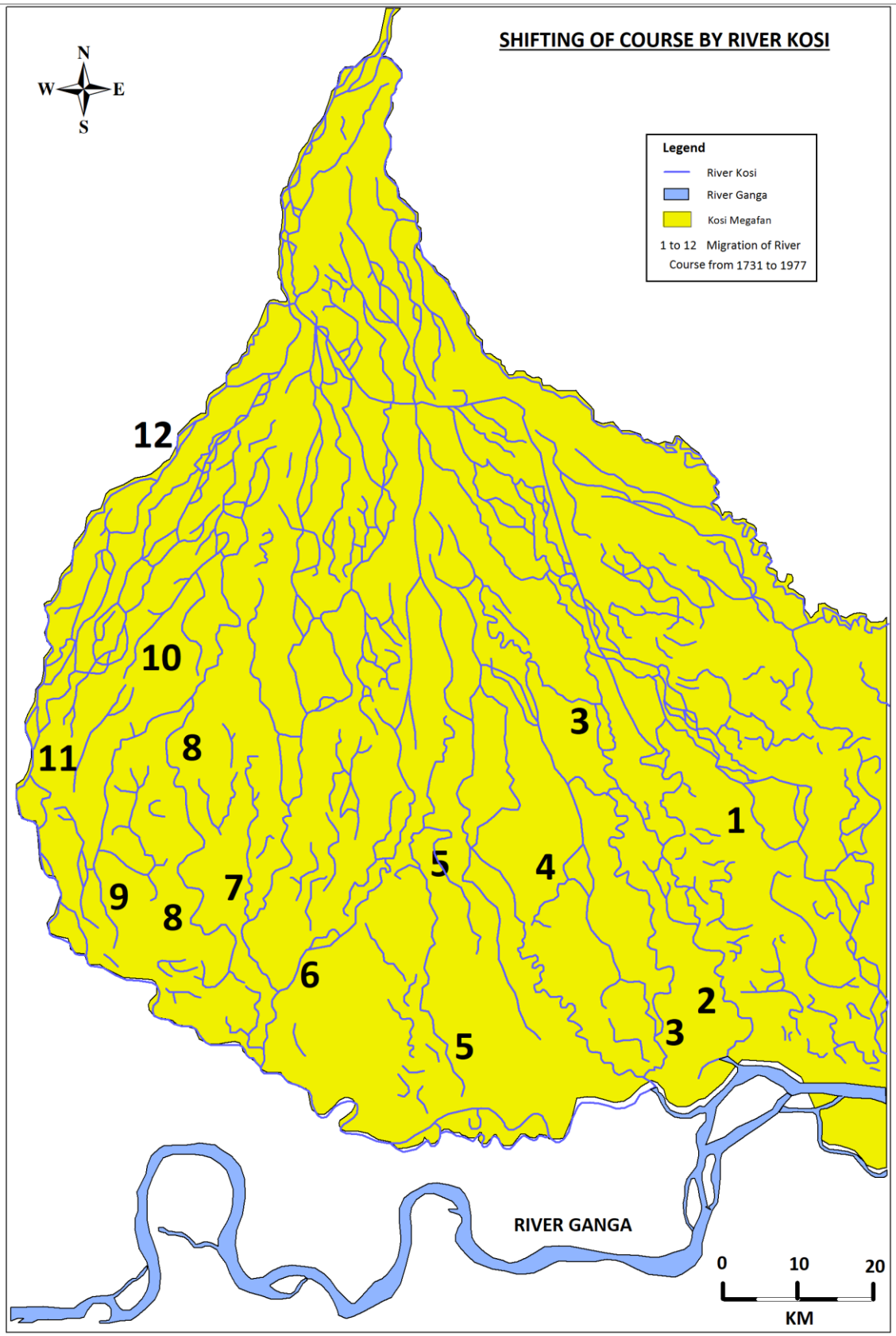


Fig. 1.8: Shifting of course by river Kosi from 1731 to 1977 (after Well N A & Dorr J A, 1987). Dates of occupation of channels: 1. 1731, 2. 1770-75, 3. 1807-39, 4. 1840-73, 5. 1873-93, 6. 1893-1921, 7. 1921-26, 8. 1926-30, 9. 1930-36, 10. 1936-42, 11. 1942-48, 12. 1977

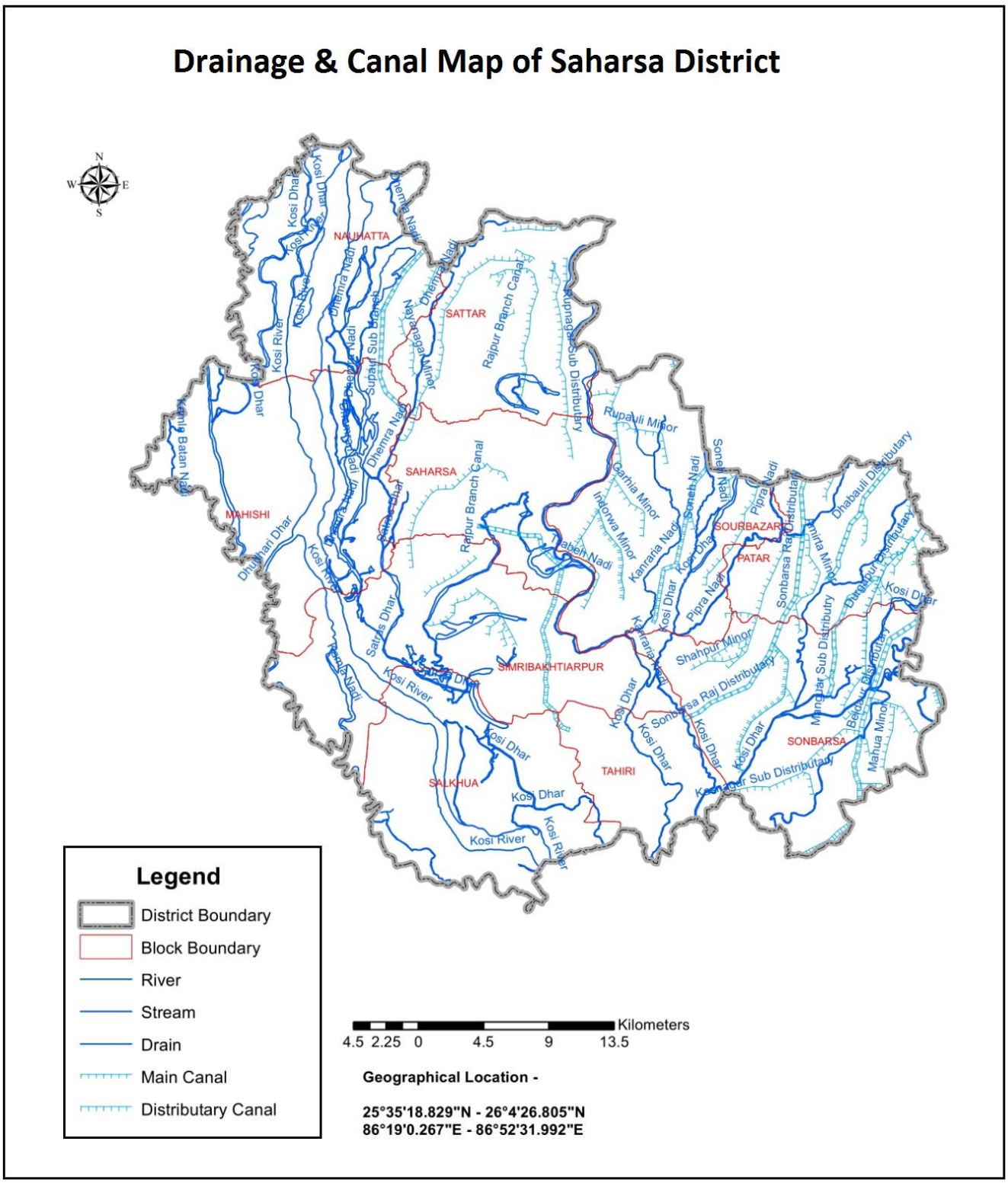


Fig. 1.9: Drainage and Canal map of Saharsa district (Source: District Irrigation Plan-Saharsa district)

1.12 Agriculture

Saharsa is one of the agrarian district Bihar. The district comes under agro-climatic zone II. As per NARP classification, the district comes under North East Alluvial Zone (II). Paddy, Wheat, Maize, Gram, Masoor, Rape & Mustard, Sorghum, Meth, Mango, Guava, Banana, Litchi, Makhana, Potato, Cabage, onion, Tomato, Bhindi, Cucurbits etc. are the major crops grown in the district. There is a shift in cultivation of subsistence crops to value crops in the past few years in the district.

The net sown area of the district is 98692 ha and cropping intensity is 195 %. (District Irrigation Plan-Saharsa). Out of the total area under cultivation in the district, 33.9 percent area (74,380 ha) is covered by cereals crop during Kharif season, 29.7 percent (65,214 ha) during Rabi season and 33.2 percent (33,347 ha) during summer season.

1.13 Irrigation

Irrigation in Saharsa district is mainly done through Tube wells (88%). The gross irrigated area of the district during 2013-'14 is 119000 ha. In the district, irrigation is done from both surface and groundwater. Though the district falls in the Eastern Kosi Command Area, irrigation from canal system is comparatively low. In summer, canal system remains dry and the irrigation demand is catered by groundwater sources. Development is commonly done through shallow tube-wells and bamboo borings. Since water level remains shallow and cost of making a shallow tube well is low, people try to have their own bore well in their agriculture fields. Bamboo borings are of shallow depth and are extensively used for irrigation mainly due to low cost of the structures.

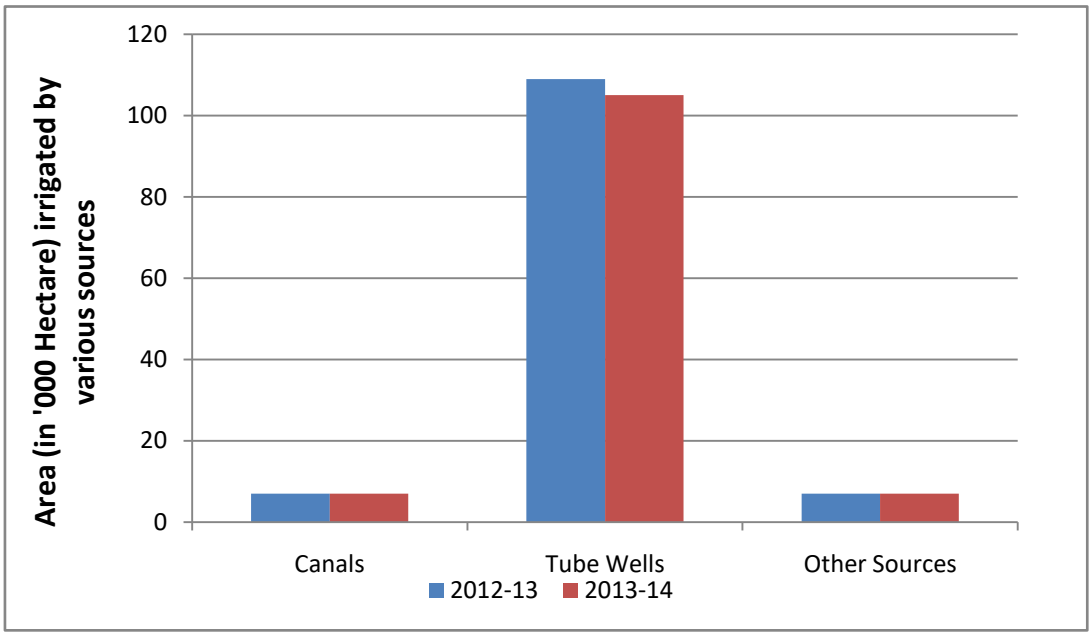


Fig. 1.10: Graph showing area irrigated by various sources in Saharsa district

Table 1.6: Area-wise, crop-wise irrigation status of Saharsa district (Source: DIP- Saharsa)

Crop Type	Kharif Area (ha)		Rabi Area (ha)		Summer area	
	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed
Cereals	49409	24971	40468	24746	19341	14006
Coarse cereals	1534	1255	1345	1100	687.8	562.7
Pulses	3580	2929	3138	3138	1605	1313
Oil Seeds	306.8	251	269	269	137.6	112.5
Other crops	5007	3733	4414	4414	2155	1763
Horticrop/Plantation	0	0	0	0	1114	2283
Total	**59836.8**	**33139**	**49634**	**33667**	**25040.4**	**20040.2**

Table 1.7: Irrigation based classification in Saharsa district (Source: DIP- Saharsa)

S.No.	Name of Block	Irrigated area (ha)		Rainfed Area (ha)		
		Gross Irrigated Area	Net Irrigated Area	Partially Irrigated / Protective Irrigation	Un-Irrigated or Totally Rain fed	Total
1	Banma Itarhi	7998	3677	132	1815	1947
2	Kahara	9678	5619	83	2382	2465
3	Mahishi	23355	9447	55	4124	4179
4	Nauhatta	10535	7786	80	4796	4876
5	Patarghat	9729	6175	4	3464	3468
6	Salkhua	13143	8420	379	4020	4399
7	Satar Katiya	12924	7465	79	4262	4341
8	Saurbazar	17025	7873	65	4685	4750
9	Simri Bakhtiyarpur	12819	8403	84	4237	4321
10	Sonbarsa	16190	9109	113	3702	3815
Saharsa		**133396**	**73974**	**1074**	**37487**	**38561**

Table 1.8: Block level statistics of tube wells in Saharsa district (as per 5th MI census)

Sl. No.	Block	DW	STW (0 to 35 m)	MDTW (35 to 70 m)	DTW (70 to 150 m)	SW Flow	SW Lift	Small Tank	Large Tank
1	Banma Itarhi	0	191	67	0	0	0	0	0
2	Kahara	2	590	106	1	1	0	1	0
3	Mahishi	3	818	120	0	0	1	0	0
4	Nauhatta	2	655	174	1	0	0	0	0
5	Patarghat	0	51	446	0	0	0	0	0
6	Salkhua	0	674	45	0	1	7	0	0
7	Satar Katiya	0	504	104	1	0	0	0	0
8	Saurbazar	0	1462	287	10	0	0	0	0
9	Simri Bakhtiyarpur	0	191	67	0	0	0	0	0
10	Sonbarsa	2	590	106	1	1	0	1	0
Saharsa		7	4945	1349	13	2	8	1	0

DW: Dug Well, STW: Shallow Tube Well, MDTW: Medium Depth Tube Well, DTW: Deep Tube Well, AL: Alluvium, HR: Hard Rock

In Saharsa district, irrigation is mainly done through shallow tube wells and medium depth tube wells. Deep tube wells are rare in the district, most probably because of the high yielding aquifer at shallow depth. It is to be noted that Patarghat block is having the highest number of medium depth tube wells while Saur Bazar block is having the highest number of shallow tube wells.

1.14 Cropping Pattern

The cropping calendar starts from the month of July and continue to the month of June of the succeeding year before the onset of monsoon. Thus a calendar year is divided into four crop season viz., Kharif, Rabi and Garma. Rabi season starts in October or November and harvesting is done in March and April. Kharif season starts in July and the harvesting is done in October or November. Garma crops which are of relatively little importance, occupy the fields from April to July. These crops are synchronized with the winter, rainy and summer seasons respectively. During Kharif season, irrigation in the district is mainly dependent on monsoon rainfall. However, both rabi and garma crops are mainly depended groundwater. The season-wise major crops under irrigation in the district is given in table 1.8.

1.15 Prevailing Water Conservation/Recharge Practices

In Saharsa district, the existing village pond/Tanks are the traditional water conservation structures. Major water conservation measures are not necessary in the district by considering the resource availability except in some blocks.

1.16 Geology

Geologically, the entire Saharsa district is covered by Quaternary alluvium deposits comprising of various grades of sand, silt and clay. As per the surface geological map, the oldest group of lithounits exposed in the district is Newer Alluvium, comprising three formations viz the Kosi-Ganga Formation overlain by Purnea Formation, and Jaynagar Formation on the top. All these formations are of Holocene age. The youngest age group of lithounits are the present day deposits which are confined to the river channels. A generalised statigraphic chart of the district is given below. A simplified geological map is given under fig. 1.11.

Age	Group	Formation	Lithology
Meghalayan	Newer Alluvium	Present Day Deposits	Sand, Silt and Clay
Holocene	Newer Alluvium	Jaynagar Formation	Sand, Silt and Clay
Holocene	Newer Alluvium	Purnea Formation	Sand, Silt and Clay
Holocene	Newer Alluvium	Kosi-Ganga Formation	Sand, Silt and Clay

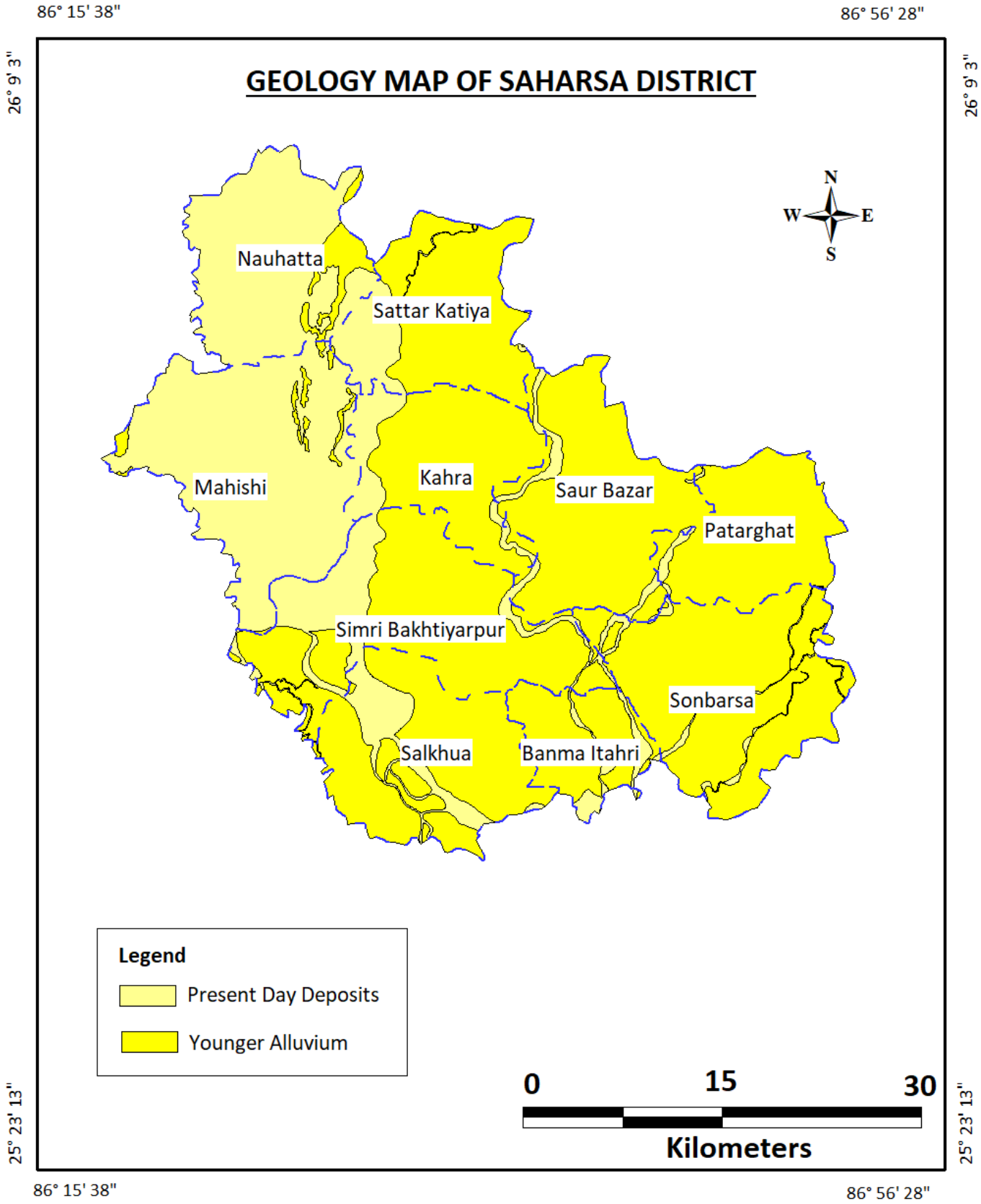


Fig. 1.11: Simplified Geological Map of Saharsa District (Source: GSI-Published Maps)

CHAPTER-II

DATA COLLECTION AND GENERATION

The primary data such as water level, quality, 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. 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 hydro-meteorological, land use, cropping pattern etc. were collected from concerned State and Central Govt. Departments and compiled.

2.1 Hydrogeology

Geologically, Saharsa district is characterised by the Younger alluvium to present day sediments transported and deposited by river Kosi. Since the Himalayan river brings huge quantum of sediments during monsoon season, it gets deposited along the flat north Bihar Plain forming a megafan, This alluvial fan forms the proliferous aquifer system in the district. Based on the available data, it is inferred that the district is covered by thick pile of alluvium sediments of Quaternary age comprising various grades of clay, silt and sand. The top most layer comprises of clay mixed with kankar and silt and, in many places with fine sand. The top layer is semi pervious, which is followed by fairly thick sands of various grades forming potential aquifer system. Available data indicates presence of prolific mono-aquifer system up to the explored depth of 165 mbgl.

2.2 Water Level

2.2.1 Depth to Water Level and Water Table

Ground water monitoring had been carried out at in the district during the course of study (2019-20) (**Annexure – 2**). A map showing location of the established NHS monitoring stations and key wells in Saharsa district is prepared and given under Fig. 2.1. The depth to water level map representing the shallow aquifer has been prepared for pre and post monsoon seasons (Fig. 2.2 & 2.3). Depth to water level map of the district shows that majority of the area has water level between 2 to 5 m bgl during pre monsoon. In some patches of Kahra block, it varies from 5 to 10 m bgl. During post monsoon season, it varies from 0 to 2 m bgl in northern blocks and 2 to 5 m bgl in the southern blocks of the district. A water table fluctuation map has also been prepared and given

in fig. 2.4. From the fluctuation map, it can be seen that depth to water level of the majority of the area fluctuates between 1 to 3 m.

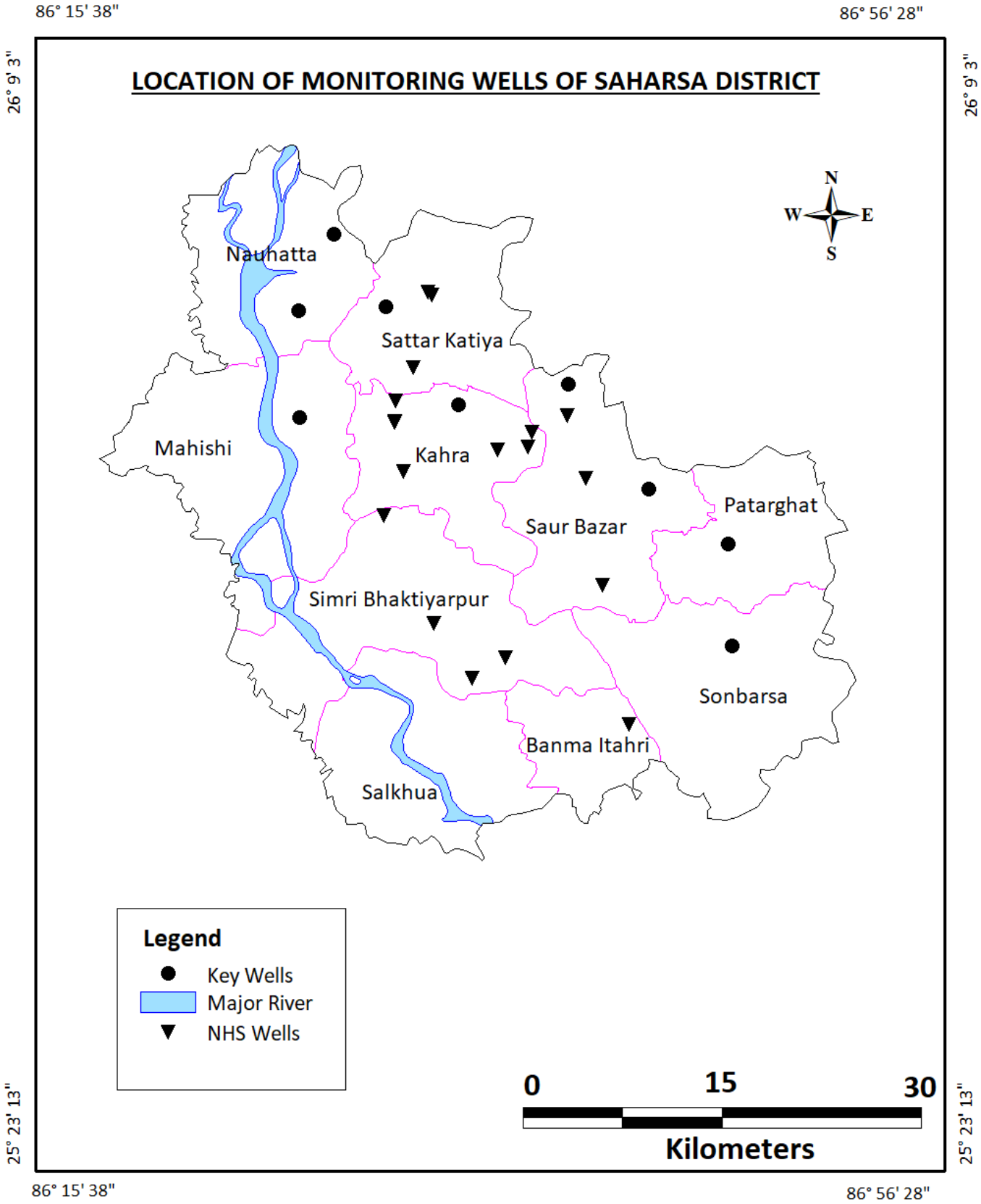


Fig. 2.1: Location of monitoring Wells in Saharsa District

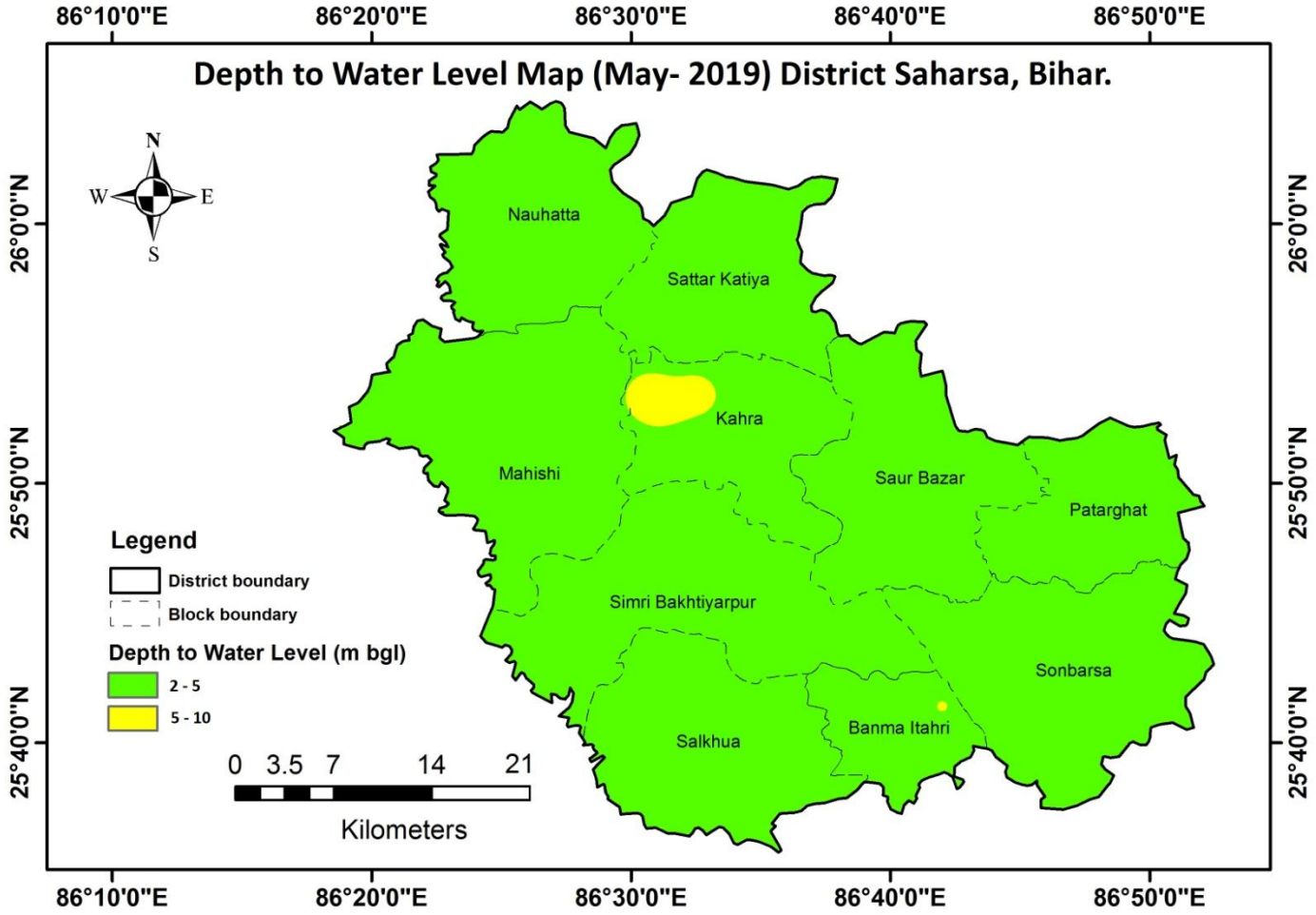


Fig. 2.2: Pre-Monsoon (May 2019) depth to water level map of Saharsa district

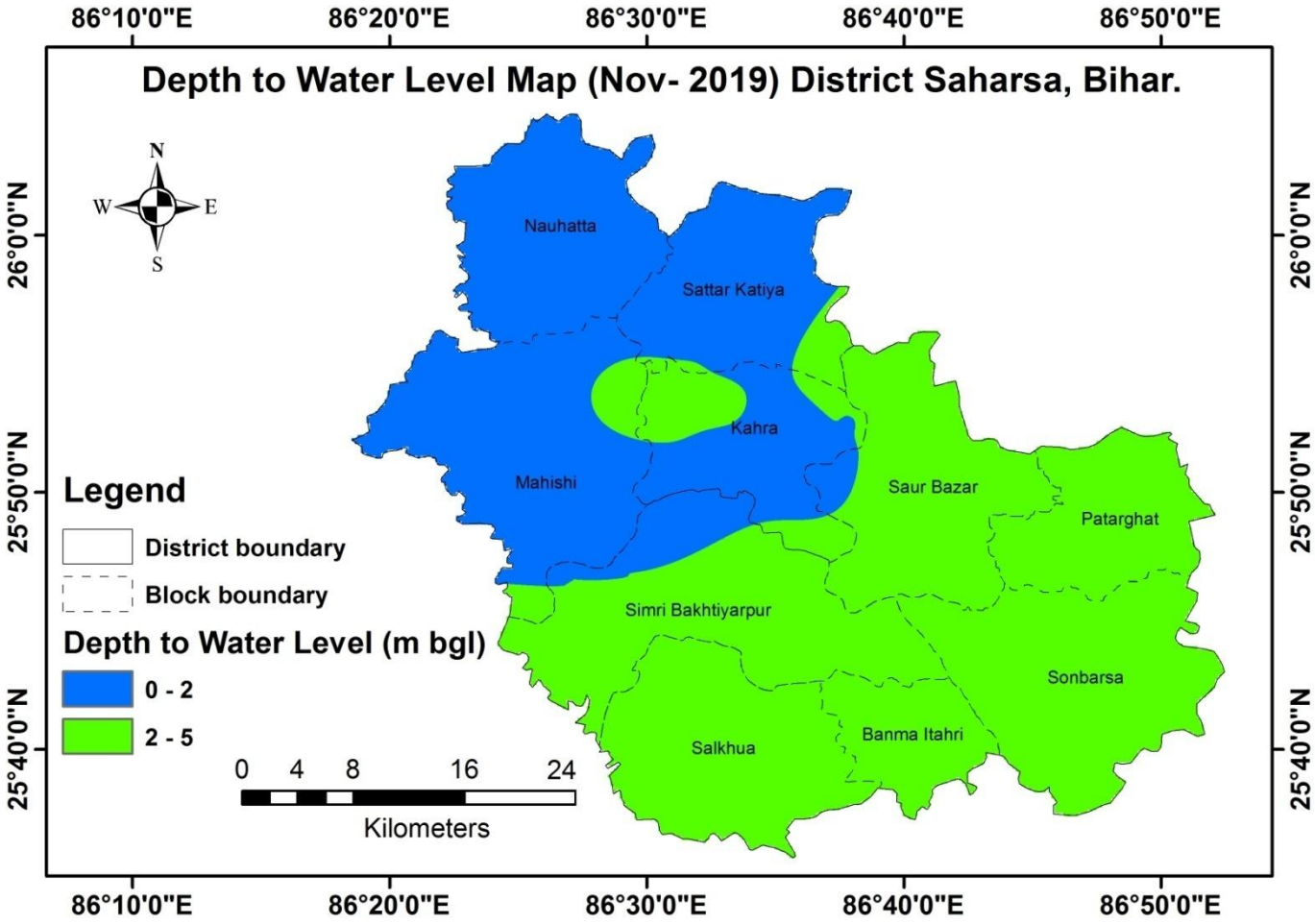


Fig 2.3: Post-monsoon (November 2019) depth to water level map of Saharsa district

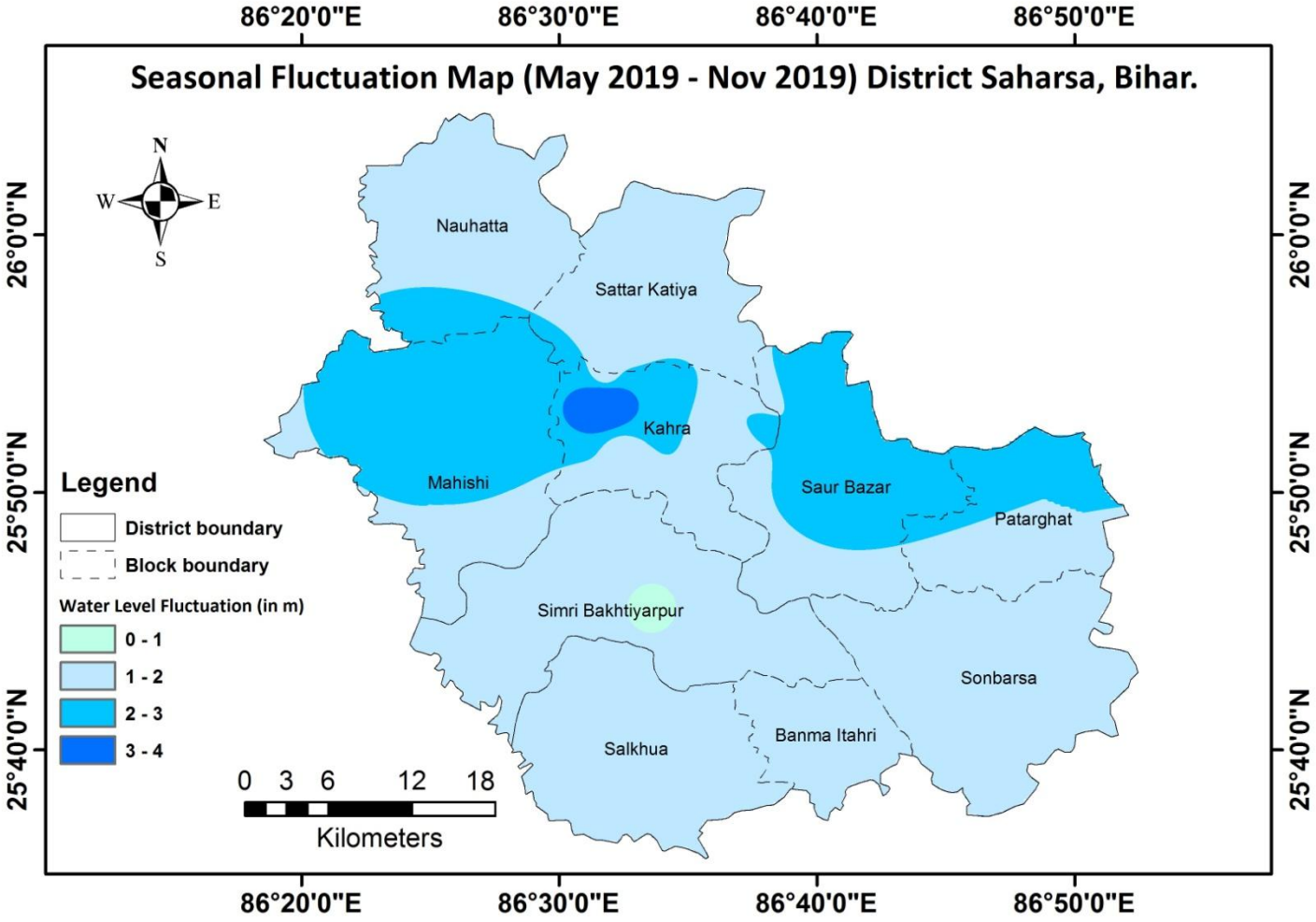


Fig 2.4: Water level fluctuation map of Saharsa district

2.2.2 Long Term Groundwater Level

Long term groundwater level trend over ten years (from 2010 to 2019) has been analysed by using data from 19 network monitoring stations in Saharsa district. Depth to water level during January, May, August and November months has been enumerated over this period and hydrographs were prepared (Fig.2.5 to 2.8). From the hydrographs, it can be seen that there is no significant variation in groundwater level in the district over long term.

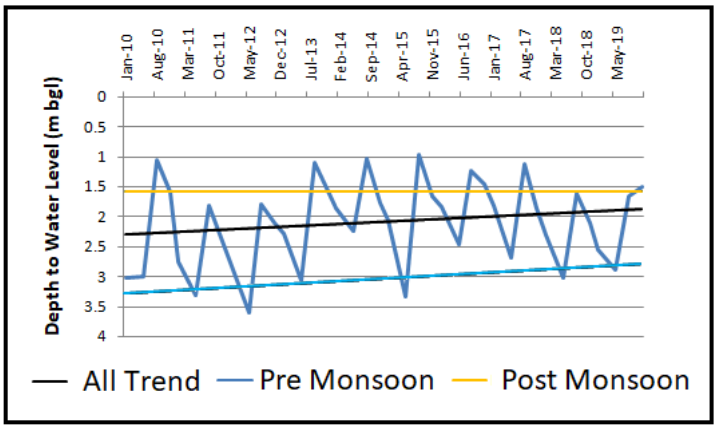


Fig. 2.5: Hydrograph of NHS monitoring Well at Bangaon

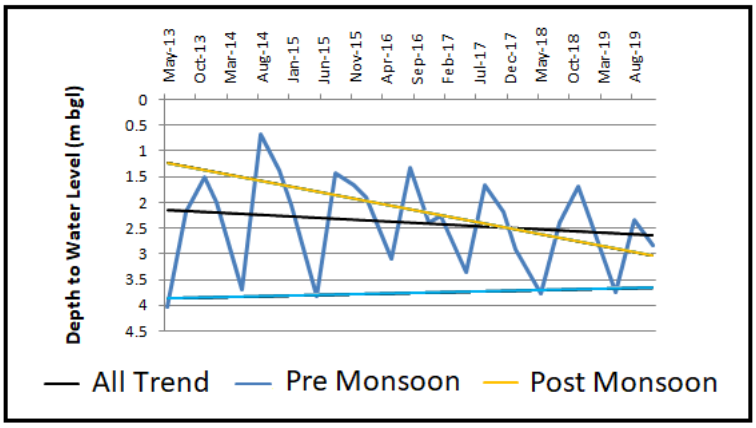


Fig. 2.6: Hydrograph of NHS monitoring Well at Jamunia

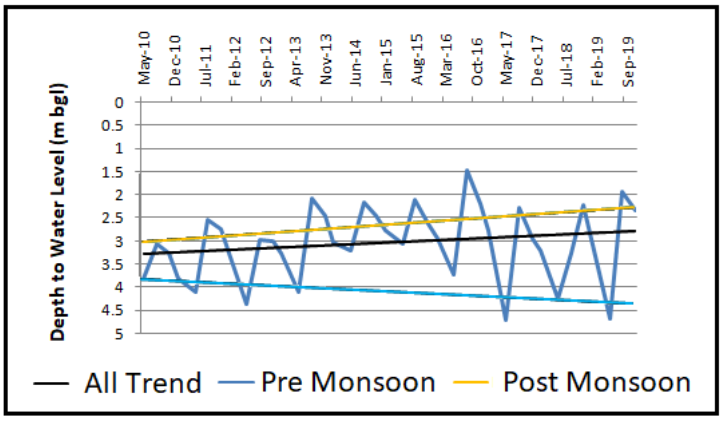


Fig. 2.7: Hydrograph of NHS monitoring Well at Baidnathpur

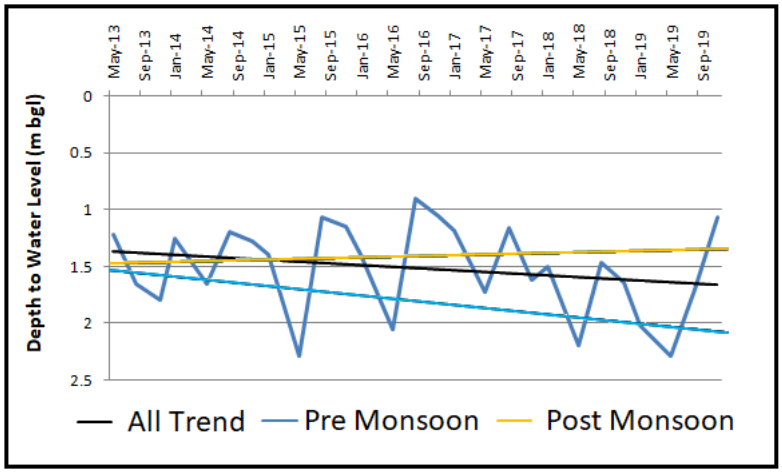


Fig. 2.8: Hydrograph of NHS monitoring Well at Tulsiyahi

Table 2.1: Showing long term groundwater level trend of some NHS wells in Saharsa district

Sl. No.	NHS Well	Pre-monsoon Trend (cm/year)	Post Monsoon Trend (cm/year)	Pre/Post Trend
1	Bangaon	0.01	0.0	Flat/Flat
2	Jamunia	0.01	0.05	Flat/Flat
3	Baidnathpur	-0.01	0.02	Flat/Flat
4	Tulsiyahi	-0.03	0.0009	Flat/Flat

2.3 Hydrogeochemical Investigation

Water Quality Sampling, Number of Samples and Analysis Mechanism

Groundwater quality of an area is a function of physical and chemical parameters that are greatly influenced by geochemical characteristics of the formations and anthropogenic activities. The concentration of the major ions and other dissolved ions in ground water are function of the availability of the constituents in the aquifer matrices and their solubility. Quality of ground water is as much demanding as its quantity. Suitability of ground water for drinking and irrigational purpose is important for its safe and effective use. In Saharsa district, both irrigation and domestic requirement are mostly depended on groundwater.

Groundwater quality studies have been done based on the samples collected from the study area during May-2019 and February-2021. A total number of 17 samples were collected for analysis. Water samples were collected and stored in 01 litre capacity clean high-density polyethylene bottles with poly-seal caps. Before collection of samples, bottles were properly washed and were rinsed by

the water to be sampled. The hand-pumps were pumped for sufficient duration before collecting ground water sample so that the stagnant water, if any, is completely removed.

These water samples were analysed in chemical laboratory of CGWB MER-Patna. Besides these, available previous year data of chemical analysis of ground water were also studied to have an understanding of ground water chemistry of the area. From the chemical data it can be observed that pH of the analysed samples vary from 7.90 to 8.57 indicating that waters are slightly alkaline. Concentration of major parameters has been plotted in Box and Whisker diagram and given in fig. 2.9. The prominent hydro chemical facies has been identified from Hill-Piper diagram and Durov plot (fig. 2.10 & 2.11). From the diagram, it can be observed that majority of the analysed samples comes under 'Magnesium/Sodium Bicarbonate Type' facies. Analytical results of ground water samples are given in **Annexure III**.

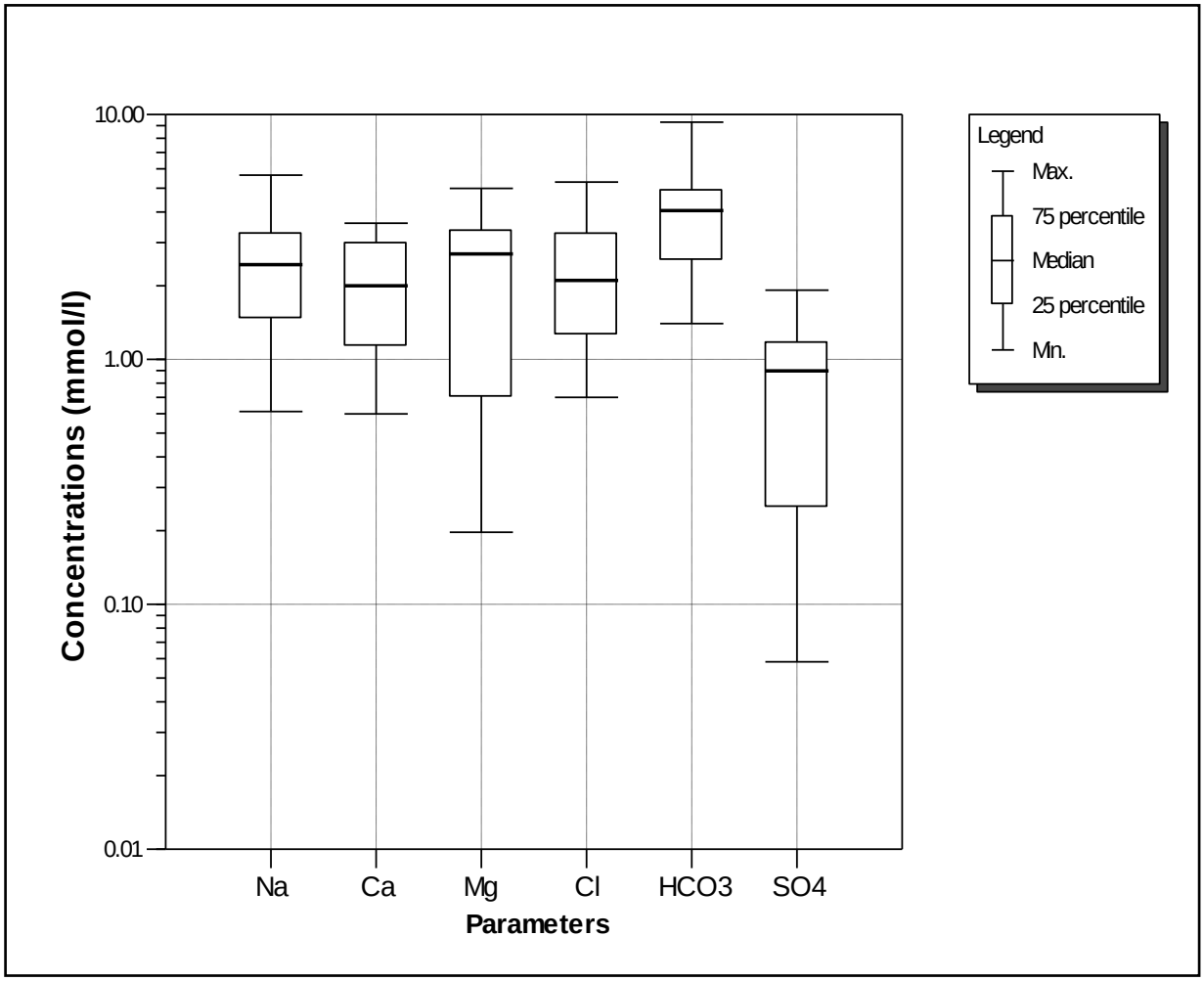


Fig. 2.9: Box-Whisker plot showing concentration of major parameters in the analyzed samples

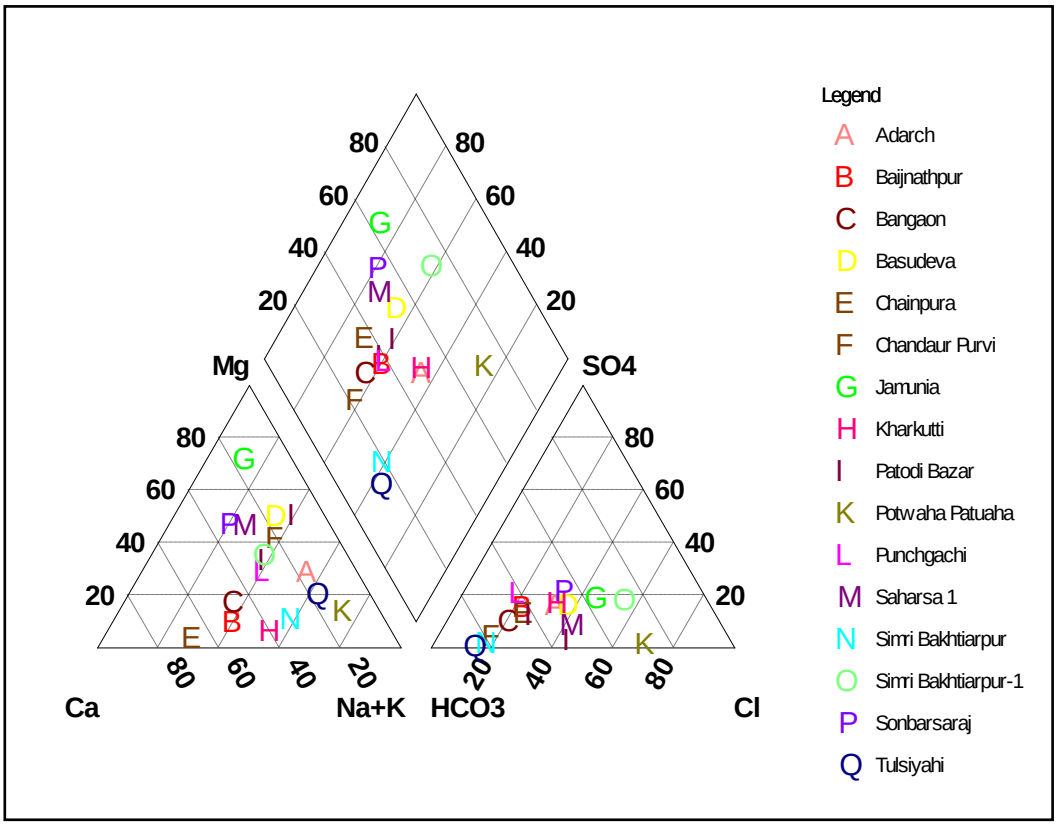


Fig. 2.10: Hill-Piper Trilinear Diagram showing hydro-chemical facies of the analyzed samples

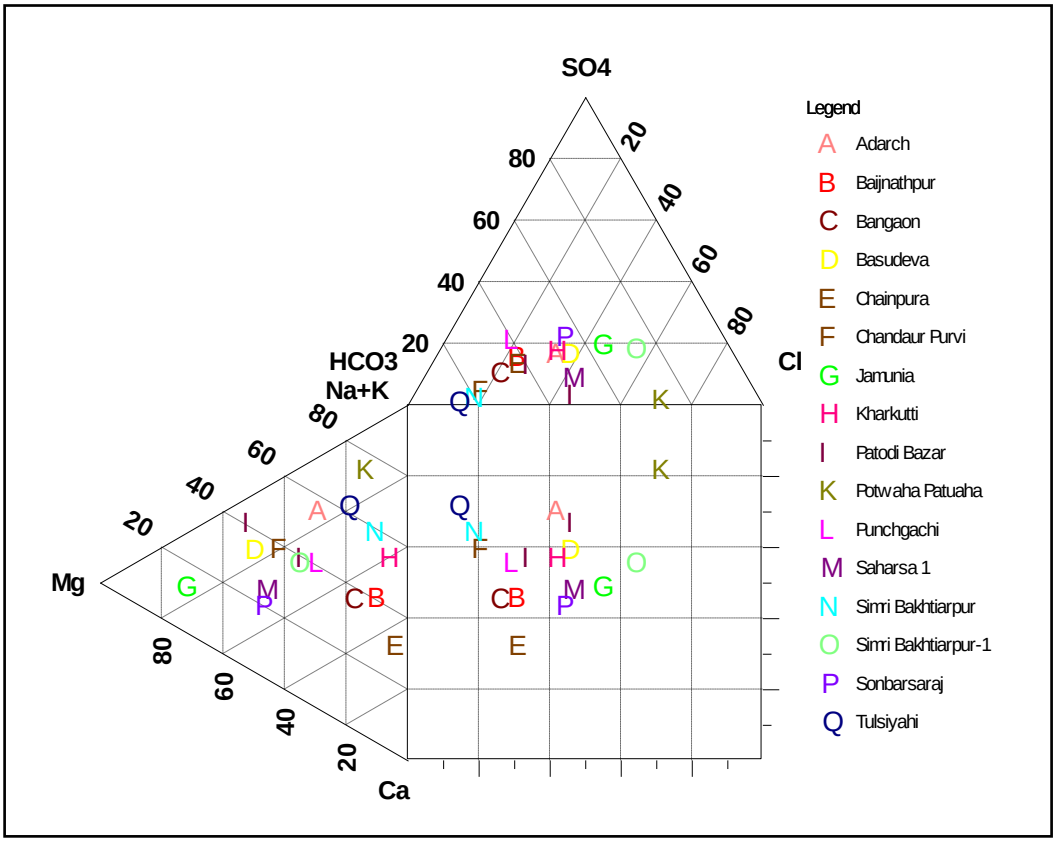


Fig. 2.11: Durov plot showing hydro-chemical facies of the analyzed samples

Quality of irrigation water varies significantly based on its dissolved salts. The salts may originate from dissolution or weathering of rocks and soil. From the analysis data it can be seen that TDS values ranges from 115.76 mg/L (Jamunia) to 755.3 mg/L (Saharsa), which is within the permissible limit as per Bureau of Indian Standards (BIS) for drinking purpose. Corresponding EC values of analyzed samples ranges from 178.10 (Jamunia) to 1162 (Saharsa) µS/cm @ 25°. The results obtained from chemical analysis were plotted in USSL diagram as shown in figure 2.12. From the figure, it can be observed that all samples have low SAR value and come under low-high salinity hazard zone. Therefore, the water is suitable for irrigation purpose.

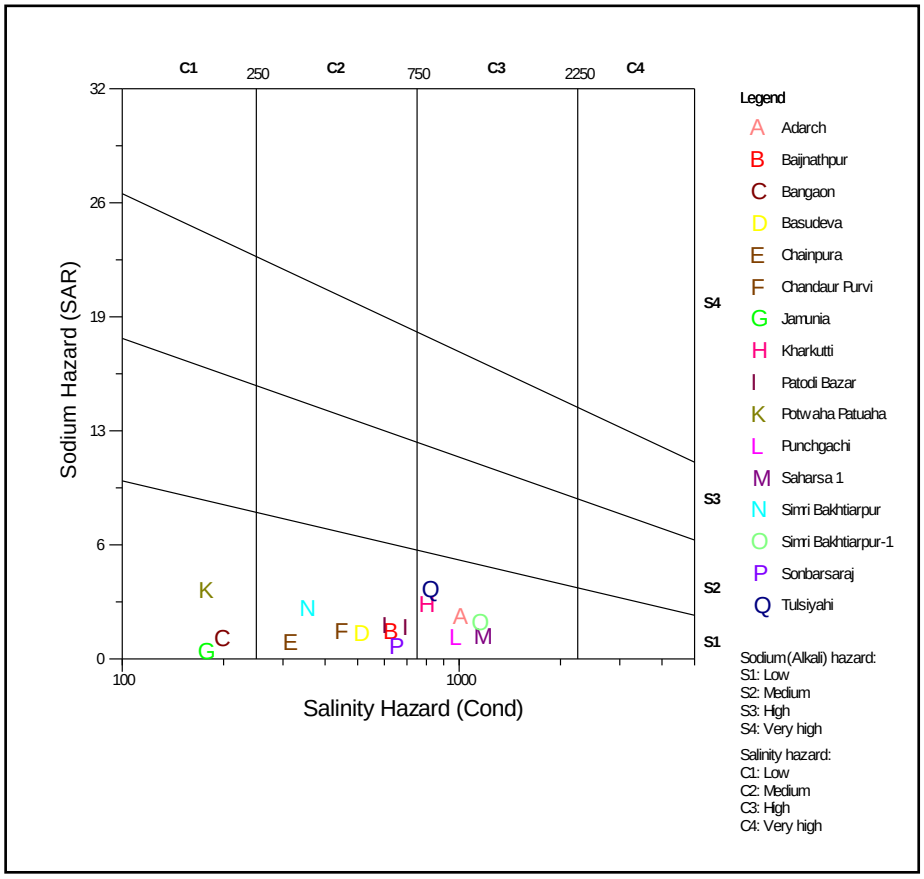


Fig. 2.12: US Salinity Diagram showing suitability of groundwater for irrigation

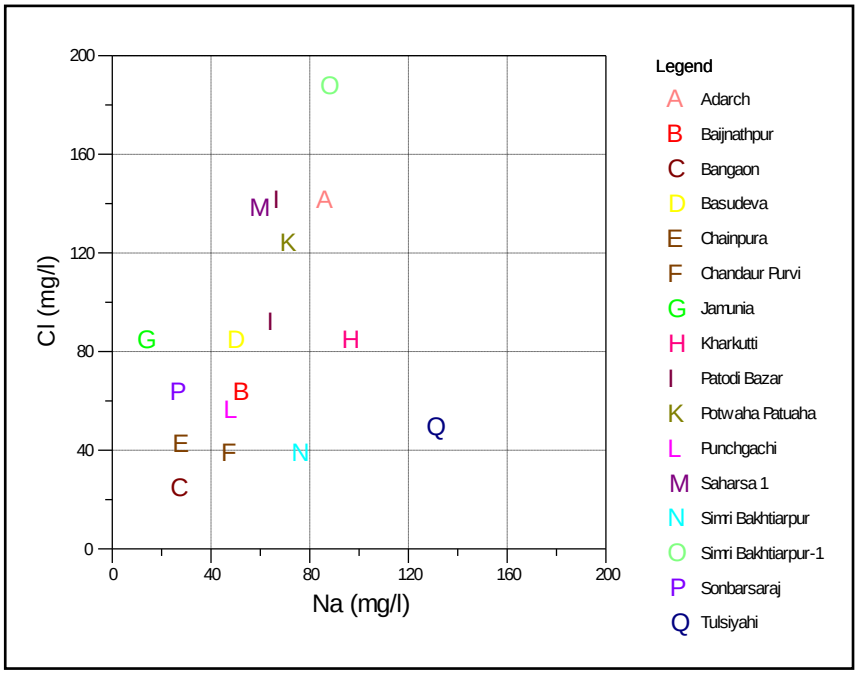


Fig. 2.13: Scatter plot showing variation of sodium v/s chloride in the analyzed samples

2.4 Exploratory Drilling - CGWB and Other Agencies

CGWB has drilled two exploratory wells in Simri Bhaktiyarpur block down to depth of 165 m. The drilling data shows that the granular zones have been encountered right from 10 m bgl and continuing throughout with limited clay lenses between them. Both the wells were abandoned due to caving. Sub-surface lithological information from the available drilling records of wells constructed by other agencies, and the same have been tabulated in Table 2.2. A map showing locations of exploratory wells constructed in the district has been given in Fig. 2.14. Corresponding lithologs are given in **Annexure-IV**.

Table 2.2: Location Details of Exploratory Wells Drilled by other agencies

Sl. No.	Location	Block	Latitude	Longitude	Elevation (m amsl)	Depth Drilled (m bgl)
1	Baijnathpur	Saur Bazar	25.8888	86.6463	47.9	70.15
2	Belha	Saur Bazar	25.8662	86.6594	45.8	67.1
3	Maheshpur	Saur Bazar	25.8407	86.6498	42.5	67.1
4	Nariar	Kahra	25.8834	86.5623	45.2	73.2
5	Patuaha	Kahra	25.8746	86.6362	46.2	61
6	Sakhua	Saur Bazar	25.8422	86.6691	43.9	79.3

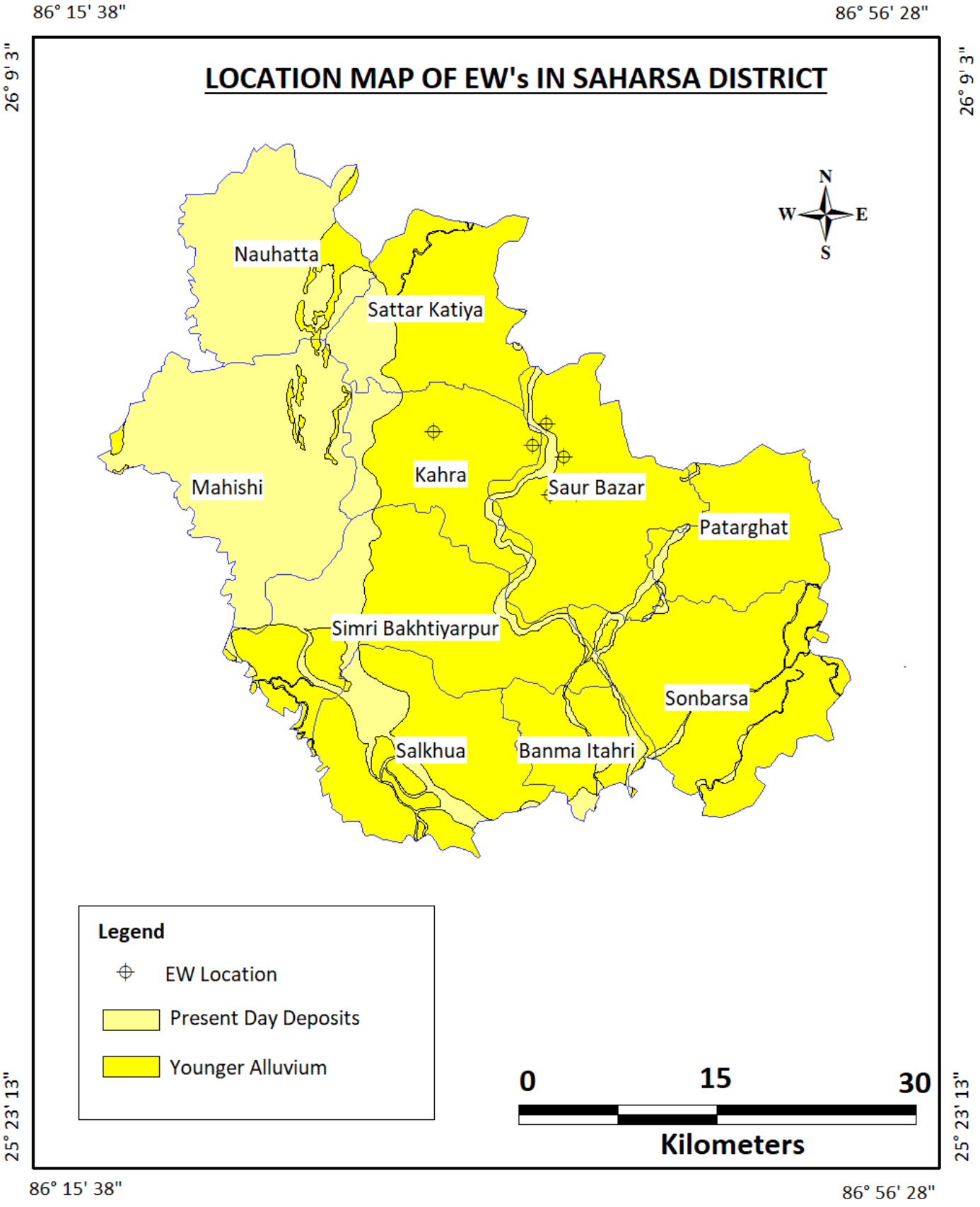


Fig. 2.14: Location map of exploratory wells constructed by State Govt. agencies in Saharsa district

2.5 Hydrogeological Map

Hydrogeological map of the study area has been generated by integrating hydrogeological, chemical data obtained through the study. The map generated has been given under fig. 2.15.

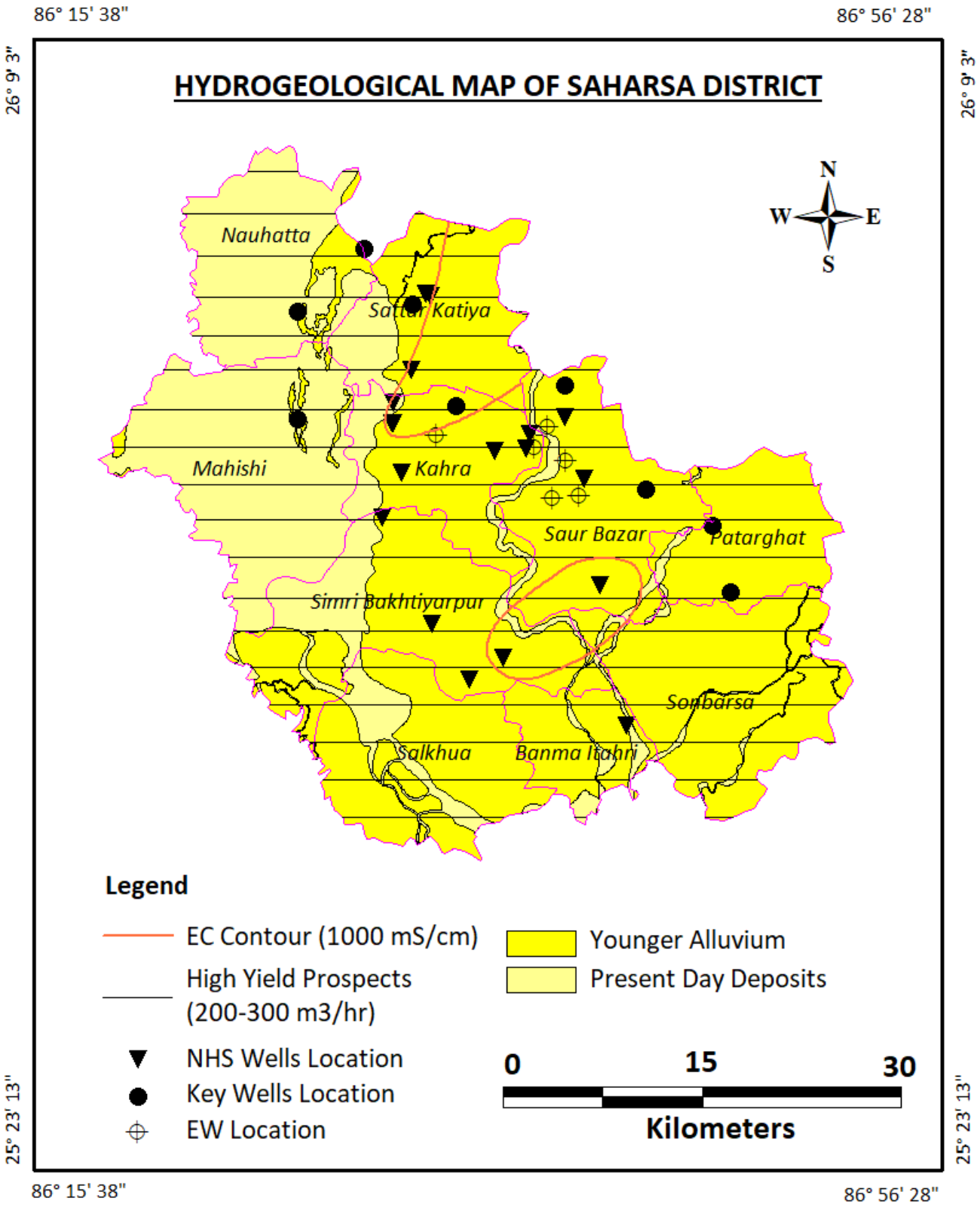


Fig. 2.15: Hydrogeological map of Saharsa district

CHAPTER-III

GENERATION OF AQUIFER MAP

3.1 Hydrogeology

The entire district forms part of mid to lower part of Kosi mega fan. The entire district is covered by thick Quaternary alluvium deposits of various grades of sands with lenses of clay layers with limited extend. The thickly bedded sand forms groundwater reservoir of the area. The top most layer comprises of clay mixed with kankar and silt and, in many places with fine sand and is semi pervious in nature. The top layer is followed by a prolific mono-aquifer system down to the explored depth of 165 m bgl. Groundwater occurs under phreatic to unconfined conditions in the district. However, in deeper wells, localized patches of clay layer have been encountered in some bore holes indicating semi-confined nature of the aquifer.

3.2 Aquifer disposition

Aquifer disposition of the district has been studied through prepared sections based on the lithologs obtained through exploratory drilling done by CGWB and other agencies. Based on this, detailed aquifer geometry on regional scale has been established in the study area. Principal aquifer in the area has been delineated by grouping the fine to medium sand, coarse sand as aquifers. The granular zones encountered at different depths are grouped into an aquifer system based on its lateral continuity.

As per surface geological map, more than 90% of area of the district is occupied by Younger alluvium deposits. While present day deposits are limited to the river channels. Based on the available borehole data, major sand horizons are delineated and geological sections are prepared. As per drilling data, the sand horizon extends upto explored depth of 165 m. A correlation of the lithologs of other wells clearly shows that there is no any intervening, regionally continuous aquitard layer in the basin. Therefore, the various sands down to depth of 165 m bgl can be considered as mono-aquifer system. There is a surface clay layer of thickness 5 to 10 m which caps the mono-aquifer system in the area. It is to be noted that the water level observed are within 5m, and the area also does not have many deep wells. The common depth of boring is restricted within 80-100 m. Disposition of aquifer through the study of different lithological sections, fence diagrams based on borehole data are given in Fig 3.1.

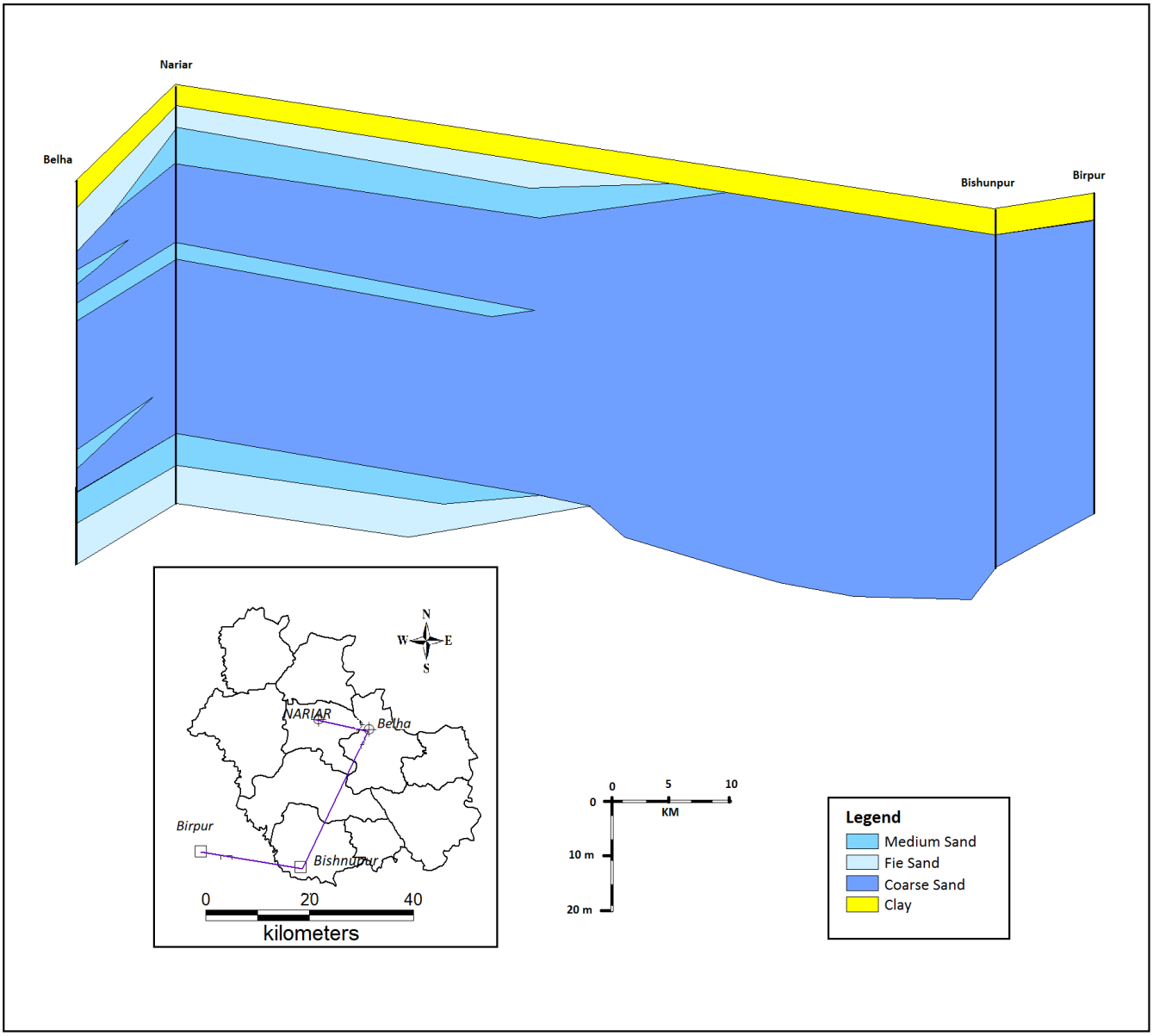


Fig. 3.1: Panel diagram from Belha to Birpur area.

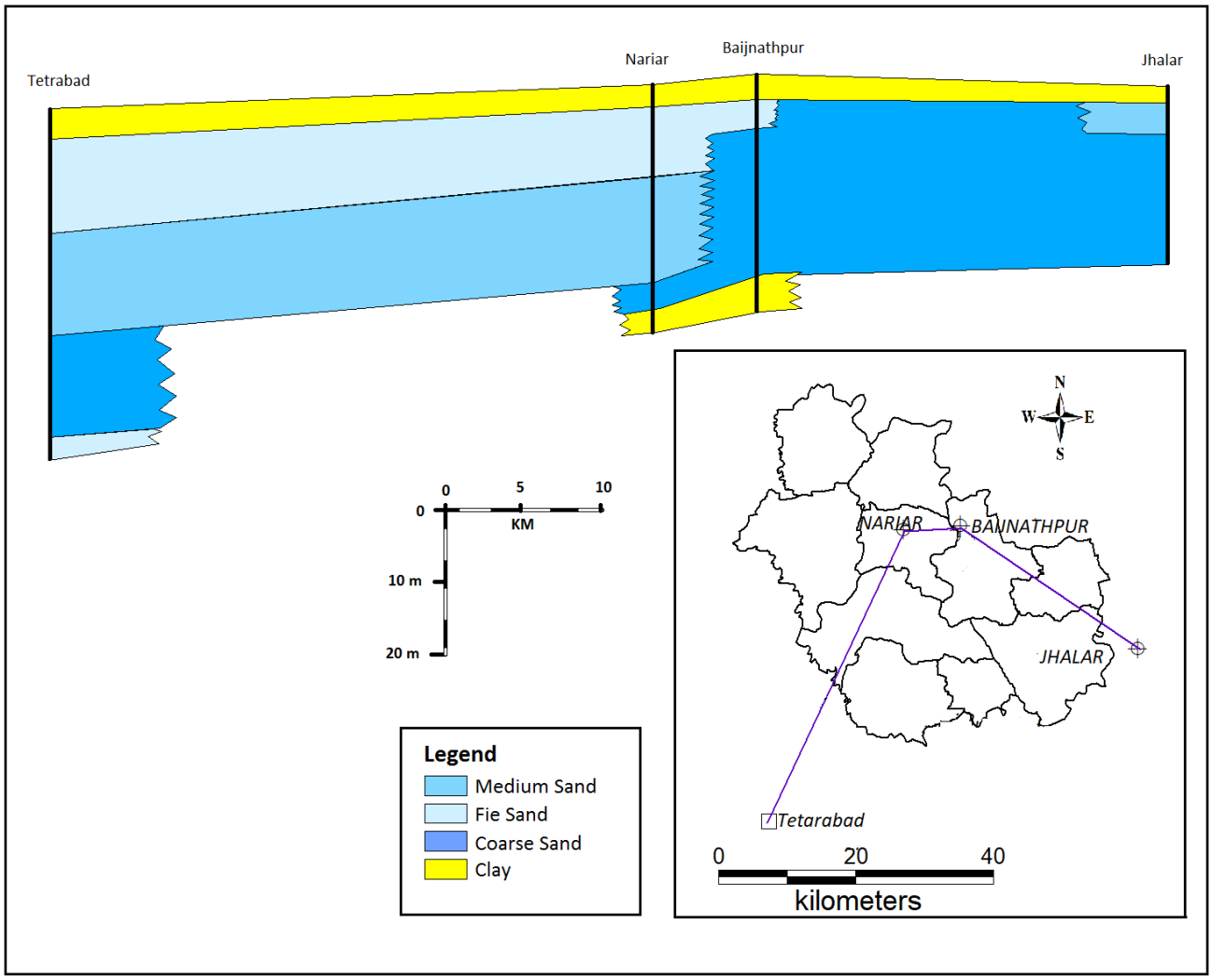


Fig. 3.2: Hydrogeological section from Tetrabad to Jhalar (Madhepura district) area

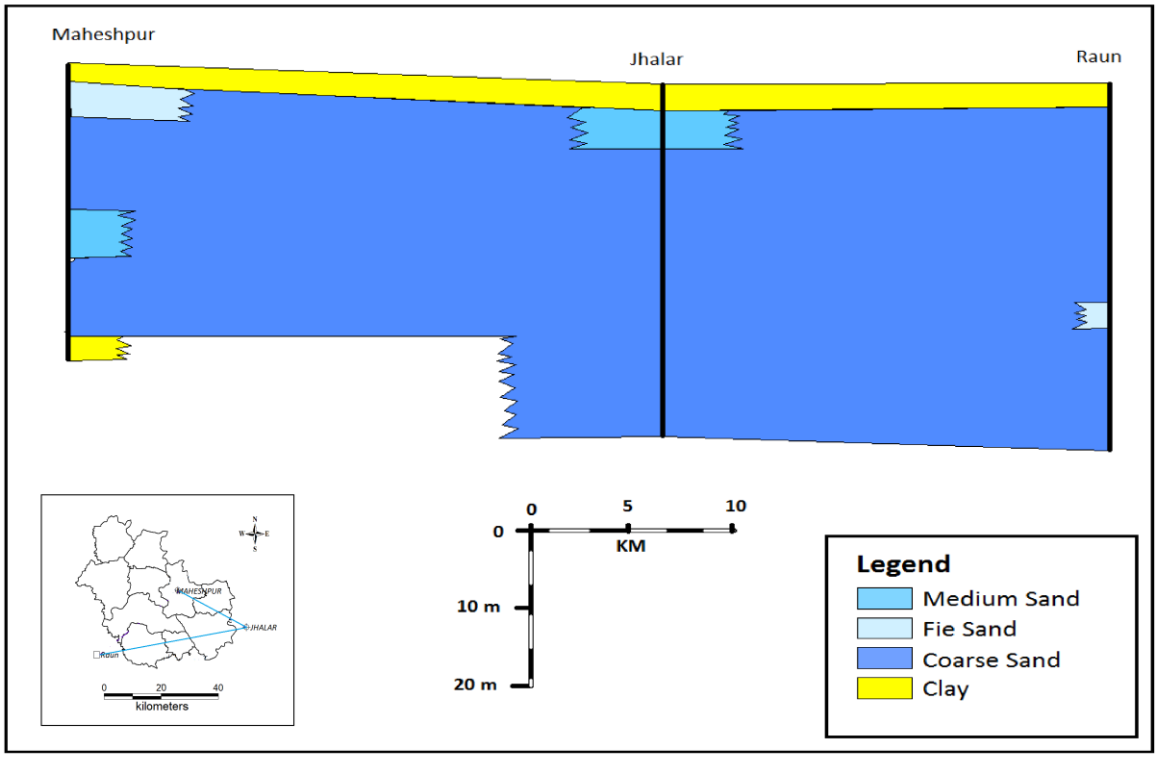


Fig. 3.3: Hydrogeological section from Maheshpur to Raun area

3.2.1 Hydrogeological sections

Aquifer disposition of the study area has been deciphered through hydrogeological sections and panel diagram plotted by connecting exploratory wells drilled from Belha to Birpur area. The top capping semi-pervious clay layer has been encountered in all bore holes, which is followed by extensively thick sand layers of various grades. The aquifer is regionally extensive and highly potential upto the explored depth of 165 m bgl. Thus it can be inferred that mono-aquifer system exists in the district with localised patches of clay indicating change in facies during sedimentation. The medium to coarse grained sand constitutes major part of the aquifer system, as the entire district forms part of the mid-fan area.

3.2.2 3-D Aquifer Disposition

Aquifer disposition of Saharsa district in 3-D has been generated based on the available borehole data and other subsurface information and is given in fig. 3.4. From the 3-D disposition, single-aquifer system in the district can be well demarcated. The aquifer system is characterised by predominance of medium to coarse-grained sand. The basin slopes towards the south and forms part of the Himalayan foreland. The aquifer system forms the mid-fan area of the Kosi mega-fan.

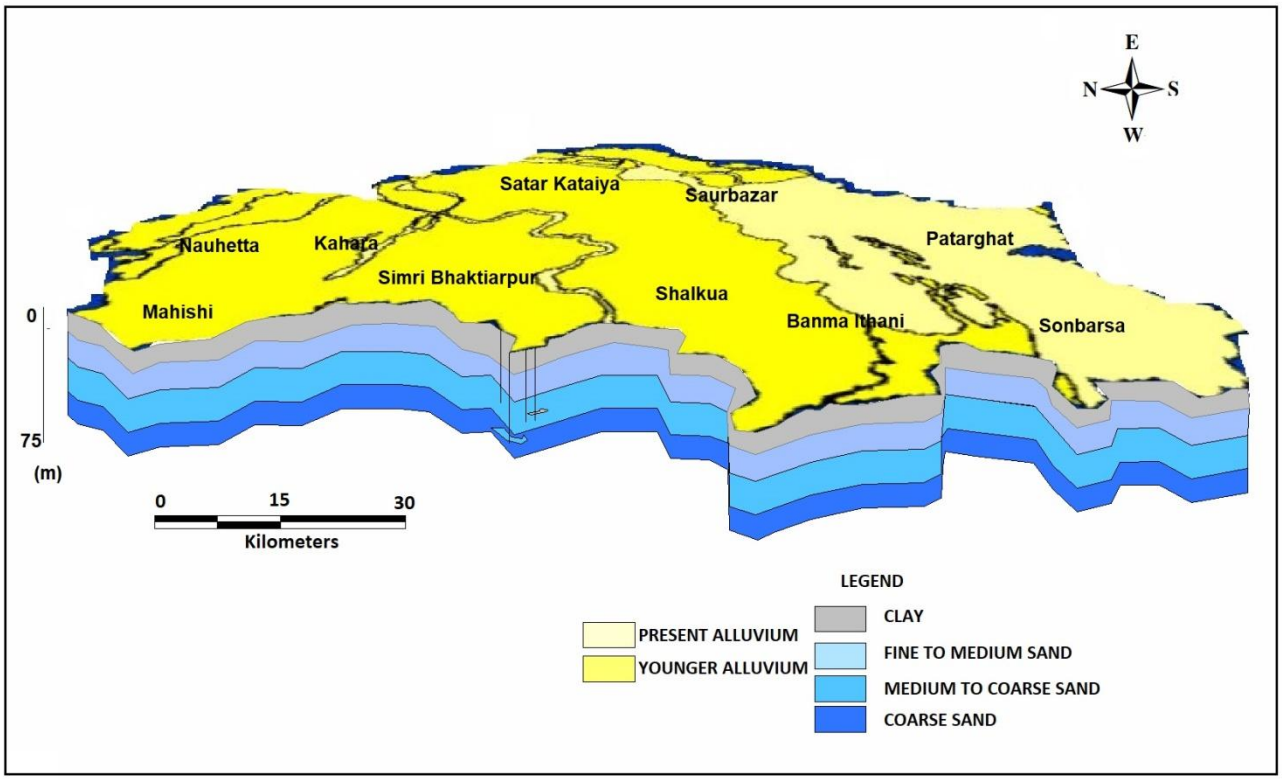


Fig. 3.4: 3-D aquifer disposition of Saharsa district

3.2.3 Ground Water Dynamics

CGWB has drilled very few wells in the area and therefore there is a general paucity of data. Pumping test data of CGWB wells have been analyzed to arrive at the hydraulic characteristics of the aquifers. Data of wells constructed by State Government indicate that shallow tube wells tapping aquifer (within 110 m bgl) can yield 200 to 300 m3/hr for a drawdown of 2- 5 m. Groundwater occurs under water table to unconfined condition in the district. However, in some boreholes, patches of clay are encountered below the granular zone indicating semi-confined condition of the aquifer. The disposition and hydraulic properties shows that aquifer in the district is heterogeneous both vertically and laterally.

3.3 Ground Water Exploration

As mentioned earlier, there is a general paucity of data as exploratory wells drilled by CGWB in the district is limited (02 no. s). However, wells drilled by State Govt. and other agencies are used for preparation of aquifer disposition and in order to decipher the hydraulic properties of the aquifers. Exploratory drilling has been conducted down to the depth of 165 m bgl in order to decipher the subsurface aquifer configuration. Lithologs of CGWB and State Govt. agencies were

compiled, correlated and hydrogeological sections, and 3 D aquifer disposition of the district has been prepared.

3.4 Ground Water Quality

A perusal of the groundwater quality data shows that pH of the analysed samples vary from 7.90 to 8.57 indicating that waters are slightly alkaline. Majority of the analysed samples comes under 'Magnesium/Sodium Bicarbonate Type' facies. Quality of irrigation water varies significantly based on its dissolved salts. The salts may originate from dissolution or weathering of rocks and soil. From the analysis data it can be seen that TDS values ranges from 115.76 mg/L (Jamunia) to 755.3 mg/L (Saharsa), which is within the permissible limit as per Bureau of Indian Standards (BIS) for drinking purpose. Corresponding EC values of analyzed samples ranges from 178.10 (Jamunia) to 1162 (Saharsa) µS/cm @ 25°. Data plotted in USSL diagram shows that all samples have low SAR value and come under low-high salinity hazard zone. Therefore, the water is suitable for irrigation purpose.

3.5 Aquifer Map

Aquifer map of the district is generated by integrating the hydrogeological sections, panel diagrams, hydrogeological map and 3-D aquifer disposition of the area and is given in fig. 3.5. The map provides a holistic view of the aquifer systems of the district in a single view.

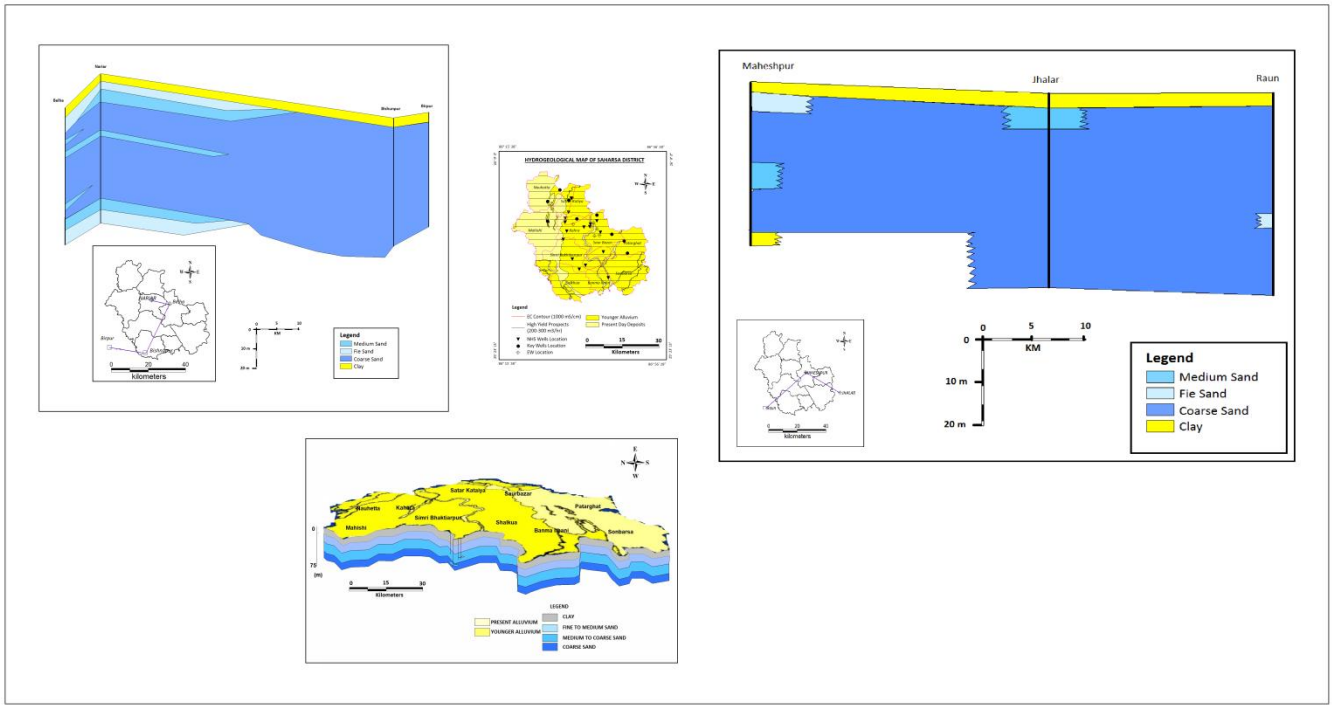


Fig. 3.5: Aquifer map of Saharsa district

CHAPTER-IV

GROUND WATER RESOURCES

4.1 Dynamic Ground Water Resources

Dynamic ground water resources of 10 blocks of Saharsa district has been assessed, as on March 2020. A summary of same is given in Table 4.1. Dynamic groundwater resource assessment of Bihar State has been jointly carried out by Minor Water Resource Department, Govt. of Bihar and Central Ground Water Board, Ministry of Jal Shakti, Govt. of India, as on March 2020. Dynamic resource of the study area has been estimated by using the norms prescribed under GEC-15. As on March 2020, estimated annual extractable groundwater resource of Saharsa district is 0.56 BCM and gross extraction is 0.25 BCM with stage of extraction of 46.15 %.

Table 4.1: Summary of Dynamic Groundwater Resource Assessment in Saharsa district (as on 31st March, 2020)

	Dynamic GW Resource
	(in BCM)
Total Ground Water Recharge	**0.60**
Provision for Natural Ground Water Discharge	**0.04**
Net Ground Water Availability	**0.56**
Gross Ground Water Draft for All Uses	**0.25**
Current Annual GW Draft for Irrigation	**0.21**
Current Annual GW Draft for Domestic and Industrial uses	***0.04***
Stage of G.W. Extraction (%)	**46.15%**
Future allocation of GW for Domestic and Industrial use	**0.04**
Net GW Availability for 'Future Use'	**0.29**

Overall stage of groundwater extraction (SOE) in the district is 46.15 %. In the district, all the 10 blocks comes under safe category on the basis of the status of ground water utilisation. However, spatial variation in SOE exists. The SOE in the district varies between 35.06 % (Salkhua Block) and 69.49% (Saur Bazar Block). Considering the resource availability in the high yielding aquifer system, the district can be extensively developed.

As per GWRE-2020, irrigation consumes about 81.49% (district total) of total groundwater requirement in the district which varies from 61.69 % in Kahara block to 89.31% in Saur Bazar block. Domestic and industrial use accounts for the rest 18.51% (district total) requirement. The block-wise groundwater requirement in Saharsa district is shown in figure 4.1.

In the supply side, on the other hand, 69.65 % of the total dynamic resource is constituted by monsoon rainfall recharge, whereas non-monsoon rainfall recharge contributes to about 7.59 %. Recharge from other sources constitutes the rest 22.74% (monsoon and non-monsoon combined).

It is to be noted that the entire district covered under thick Quaternary alluvium. The district is bestowed with mono-aquifer system with high groundwater yield potential. From the graph, it can be observed that blocks with lower usage for irrigation such as Banma Itarhi, Patarghat, Kahara, Satar Katiya, Mahishi can be extensively developed by groundwater resource rather than canals.

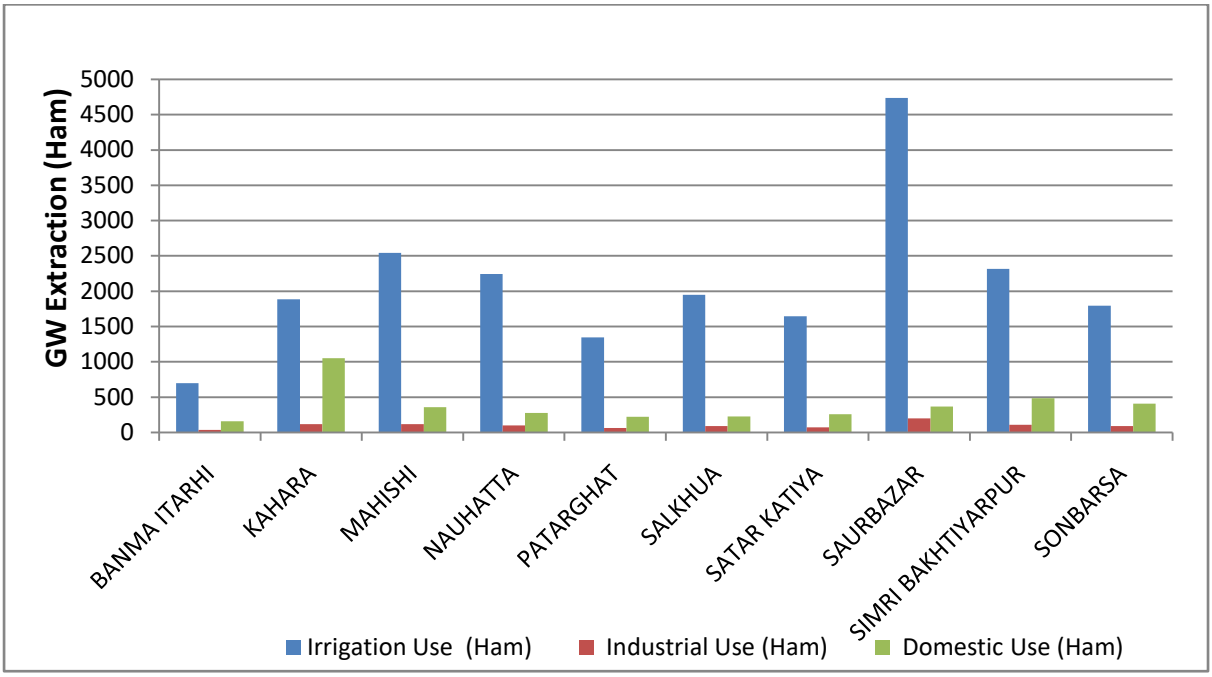


Fig. 4.1: Graph showing sector-wise groundwater draft, as per GWRE-2020

Table 4.2: Dynamic groundwater resource of Saharsa district as per GWRE-2020

Sl. No.	Blocks	Recharge from Rainfall during Monsoon (ham)	Recharge from Rainfall during Non Monsoon (ham)	Recharge from Other Sources- Monsoon (ham)	Recharge from Other Sources- Non Monsoon (ham)	Total Annual Ground Water Recharge (ham)	Provision for Natural Discharges (ham)	Net Annual Ground Water Availability (ham)
1	Banian Itarhi	2077.64	208.8	132.31	131.93	2550.68	127.54	2423.14
2	Kahara	3197.86	373.31	1268.57	680.63	5520.37	552.03	4968.34
3	Mahishi	6920.75	618.98	481.52	480.17	8501.42	425.07	8076.35
4	Nauhatta	4369.48	471.68	428.33	427.52	5697.01	284.85	5412.16
5	Patarghat	2945.33	329.47	340.18	320.31	3935.29	196.77	3738.52
6	Salkhua	4200.63	490.37	1626.37	866.04	7183.41	718.34	6465.07
7	Satar Katiya	3925.94	418.54	316	315.67	4976.15	248.81	4727.34
8	Saurbazar	4483.19	523.35	2111.34	1359.09	8476.97	847.69	7629.28

9	Simri Bakhtiyarpur	5086.37	593.77	937.8	813	7430.94	743.1	6687.84
10	Sonbarsa	5093.7	584.38	394.65	380.95	6453.68	322.69	6130.99

Blocks	Existing Gross Ground Water Extraction for irrigation (ham)	Existing Gross Ground water Extraction for Domestic and Industrial use (ham)	Existing Gross Ground Water Extraction for All Uses (ham)	Annual GW Allocation for Domestic Use as on 2025 (ham)	Net Ground Water Availability for future use (ham)	Stage of Ground Water Development (ham)	Category: Safe / Semi-critical/ Critical/ Over-exploited
Banma Itarhi	697.5	192.68	890.18	176	1513.64	36.74	safe
Kahara	1885	1170.36	3055.36	1183.25	1783.09	61.50	safe
Mahishi	2542.5	473.23	3015.73	400.16	5016.69	37.34	safe
Nauhatta	2245	377.72	2622.72	313.09	2755.07	48.46	safe
Patarghat	1345	284.07	1629.07	248.33	2082.19	43.58	safe
Salkhua	1947.5	318.86	2266.36	257.08	4170.49	35.06	safe
Satar Katiya	1647.5	332.25	1979.75	292.34	2715.5	41.88	safe
Saurbazar	4735	566.97	5301.96	414.46	2281.83	69.49	safe
Simri Bakhtiyarpur	2317.5	591.39	2908.89	542.99	3719.35	43.50	safe
Sonbarsa	1795	496.31	2291.31	456.41	3789.58	37.37	safe

4.2 Static Ground Water Resources

In-storage groundwater resource of unconfined aquifer has been estimated and given in table 4.3. The exercise has been carried out block-wise based on available data. Specific yield has been taken as per the prescribed norms in GWRE-2020. Static resource of Saharsa district is estimated to be 11.15 BCM. Highest static resource is estimated in Mahishi, Simri Bhaktiyarpur, Sonbarsa blocks and lowest static resource is estimated in Banma Itarhi block due to its less area coverage.

Table 4.3: Estimated In-storage resource of unconfined aquifer in Saharsa district

Sl. No.	Block	Lithology	GW Worthy Area (ha)	Bottom of Unconfined Aquifer (m bgl)	Pre-Monsoon Water Level (m bgl)	Specific Yield	In-Storage Resource (ham)	In-Storage Resource (BCM)
1	Banma Itarhi	Alluvium	7520	80	4.9	0.10	56475.2	0.56
2	Kahara	Alluvium	13445	75	3.52	0.10	96104.86	0.96
3	Mahishi	Alluvium	22293	70	4.24	0.10	146598.8	1.47
4	Nauhatta	Alluvium	16988	80	4.42	0.10	128395.3	1.28
5	Patarghat	Alluvium	11866	75	4.06	0.10	84177.4	0.84

6	Salkhua	Alluvium	17661	75	4.42	0.10	124651.3	1.25
7	Satar Katiya	Alluvium	15074	70	3.74	0.10	99880.32	1.00
8	Saurbazar	Alluvium	18849	45	4.05	0.10	77186.66	0.77
9	Simri Bakhtiyarpur	Alluvium	21385	75	3.37	0.10	153180.8	1.53
10	Sonbarsa	Alluvium	21047	75	4.59	0.10	148191.9	1.48
Total							**1114843**	**11.15**

CHAPTER - V

GROUND WATER RELATED ISSUES

5.1 Identification of issues

Issues related to groundwater in the study area are basically focused on the aspect of quality, quantity and sustainability. The major issue of the district is seasonal flooding and water logging. As per earlier records of CGWB, iron contamination has been reported in shallow tube wells in some pockets. In the case of quantity, all the blocks of the district comes under safe category as per GWRE-2020. Major groundwater issues in the district are detailed below:

5.1.1 Seasonal flooding and water logging

The district forms part of middle to lower end of Kosi mega fan and experiences seasonal flooding and water logging in many parts. The river enters into plains of north Bihar, the velocity of flow is dropped leading to reduction of sediment carrying capacity. Thus sediments deposited into river beds, resulting into rise of river bed and bank erosion. The mouth of the channels also gets choked causing shift in river courses. This further contributed to the rise in the river water level, which ultimately leads to overtopping and breaches of banks and flooding in the basin area.

This potentially arrest agriculture activities and crop productivity. Water logging in vast flood plains of Kosi persists till October and this delays agriculture activities during Rabi season. Flooding and water logging coupled with demographic pressure put farmers to go for subsistence crops rather than value crops in many parts of the district. A map showing inundated area of Kosi belt during 2008 flood is given in fig. 5.1

5.1.2 Irrigation demand for groundwater

Irrigation in the district is mainly dependent on groundwater. From agriculture statistics, and minor irrigation census data it can be observed that about 88% of the district's irrigation needs are catered by groundwater. A comparison of groundwater resource position of the district as on 2017 and 2020 has been given in the following table. It is to be noted that, irrigation draft of the district has been increased by about 28%. The stage of extraction has been increased by about 5.34% in assessment year 2020 as compared with GWRE-2017.

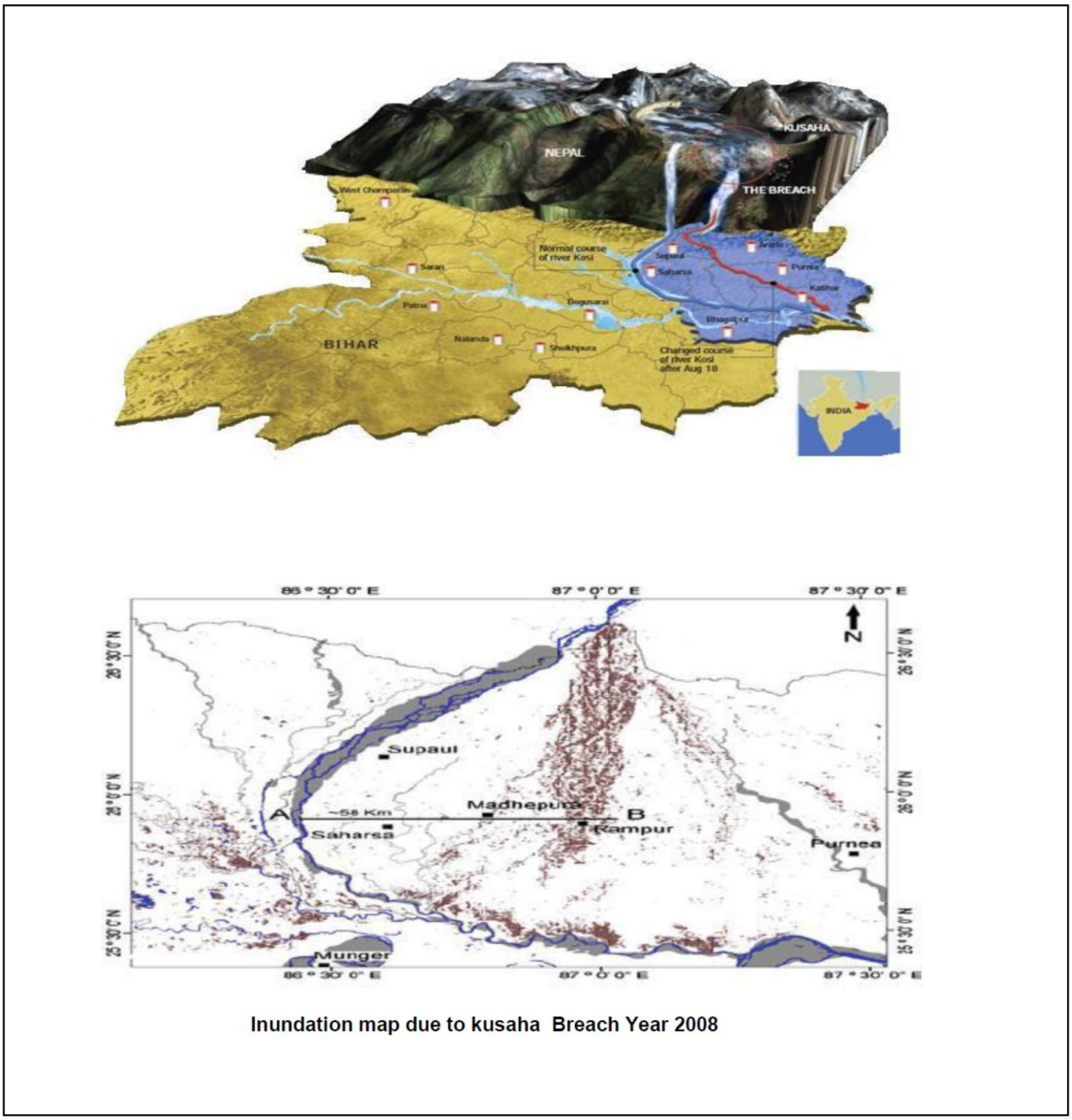


Fig. 5.1: Inudation map of river Kosi due to breach at Kusaha, Sunsari district, Nepal during 2008 flood (Source: Report on flood and sediment management in Kosi river, FMISC, Patna)

Table 5.1: Resource position of the district as per GWRE-2017 & GWRE-2020

Assessment Year	Annual Ground Water Recharge (ham)					Total Natural Discharges (ham)	Annual Extractable Ground Water Resource (ham)
	Monsoon Season		Non-monsoon Season		Total Annual Ground Water Recharge		
	Recharge from rainfall	Recharge from other sources	Recharge from rainfall	Recharge from other sources			
2017	38572.31	4997.73	6107.21	4159.38	53836.63	3340.88	50495.74
2020	42300.89	8037.07	4612.65	5775.31	60725.92	4466.89	56259.03

Assessment Year	Annual Ground Water Extraction (ham)				Annual GW Allocation for Domestic Use as on 2025 (ham)	Net Ground Water Availability for future use (ham)	Stage of Ground Water Extraction (%)
	Irrigation	Industrial	Domestic	Total			
2017	16507.2	997.48	3102.99	20607.68	3103.05	29888.01	40.81
2020	21157.50	990.00	3813.83	25961.33	4284.11	29827.43	46.15

Table 5.2: Block-wise comparison of draft as per GWRE-2017 & GWRE-2020

Block	Net Resource		Gross Draft irrigation		Percentage Increase Irrigation Draft (%)	Gross Draft Domestic		Percentage Increase Domestic Draft (%)	SOE (%)		Difference (%)
	2017	2020	2017	2020		2017	2020		2017	2020	
Banma Itarhi	2131.32	2423.14	544.05	697.5	28.21	149.71	156.68	4.66	34.18	36.74	2.56
Kahara	5287.03	4968.34	1471.5	1885	28.10	465.35	1053.36	126.36	38.79	61.50	22.71
Mahishi	5022.49	8076.35	1983	2542.5	28.21	340.38	356.23	4.66	48.57	37.34	-11.23
Nauhatta	3862.22	5412.16	1752.3	2245	28.12	266.32	278.72	4.66	54.88	48.46	-6.42
Patarghat	2798.25	3738.52	1049.1	1345	28.21	211.24	221.07	4.65	47.29	43.58	-3.71
Salkhua	7746.14	6465.07	1519.05	1947.5	28.21	218.68	228.86	4.66	23.56	35.06	11.5
Satar Katiya	4209.65	4727.34	1285.05	1647.5	28.21	248.67	260.25	4.66	38.26	41.88	3.62
Saurbazar	7411.83	7629.28	3693.3	4735	28.21	352.55	368.97	4.66	57.32	69.49	12.17
Simri Bakhtiyarpur	6861.33	6687.84	1809.75	2317.5	28.06	461.88	483.39	4.66	34.76	43.50	8.74
Sonbarsa	5165.43	6130.99	1400.1	1795	28.21	388.23	406.31	4.66	36.35	37.37	1.02
Saharsa	**50495.74**	**56259.03**	**16507.2**	**21157.50**	**28.17**	**3102.99**	**3813.83**	**22.91**	**40.81**	**46.15**	**5.34**

From table 5.2, it can be seen that except Mahishi, Nauhatta and Patarghat, in all other blocks the stage of groundwater extraction shows growth from assessment year 2017 to 2020. Highest increase is estimated in Kahara block (22.71% increase in SOE), where domestic draft shows a steep hike of 126.36% as compared to domestic draft of 2017. In case of domestic draft, except Kahara block, in all of the remaining blocks domestic demand of resource increased by 4.66%. (Fig. 5.2).

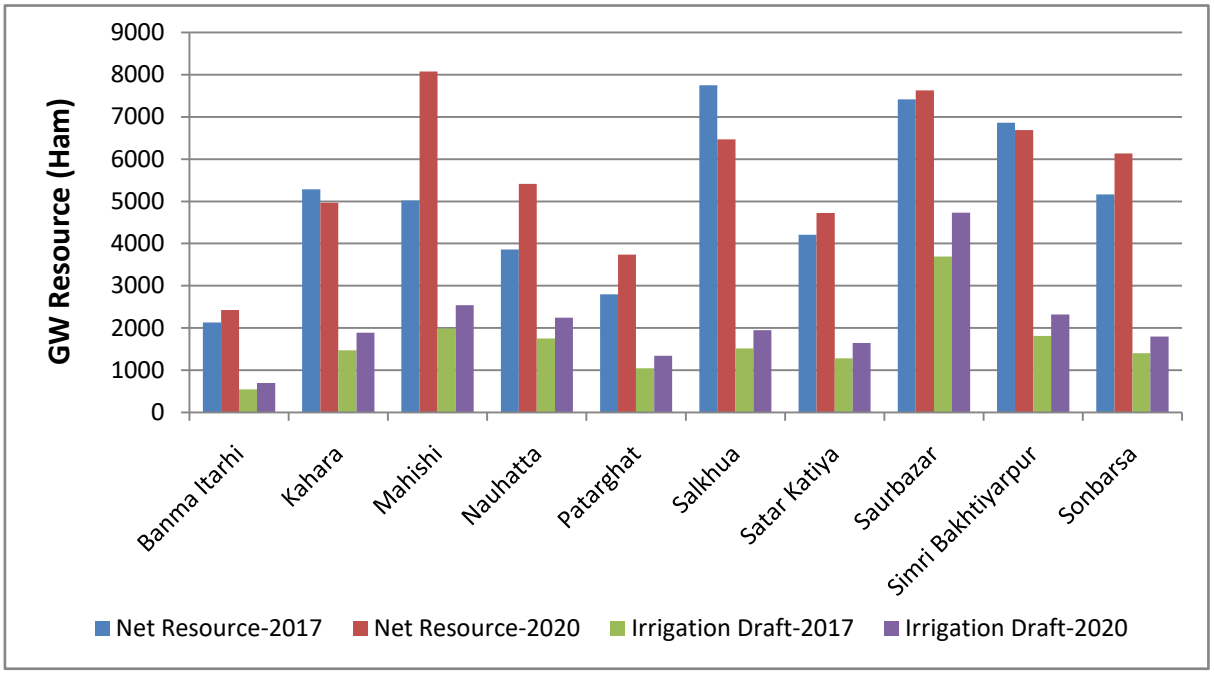


Fig. 5.2: Graph showing variation of net resource and Irrigation draft in Saharsa district

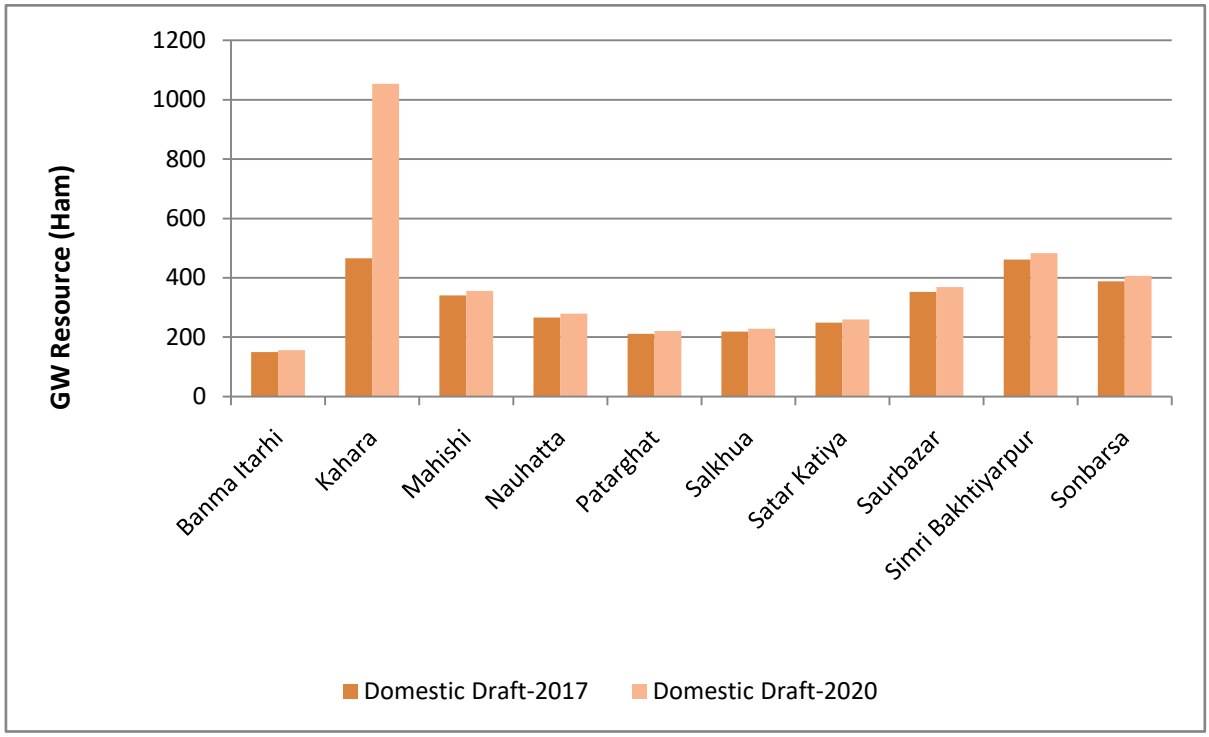


Fig. 5.3: Graph showing variation of Domestic draft in Saharsa district

CHAPTER - VI

MANAGEMENT STRATEGIES

Management plan for groundwater resource of the district is made in order to address the issues detailed in Chapter-V. The plan has been prepared in such a way that groundwater resource shall be optimally utilised ensuring quality, equitability and sustainability. It is observed from the field survey that irrigation practices in the district are mainly dependent on groundwater, and major canal systems are not developed in the district (DIP-Saharsa). Thick alluvium sedimentation by Kosi and its tributaries in the district resulted in formation of potential mono-aquifer system. The alluvium aquifer is characterised by various grades of sand and lenses of clay and groundwater is at unconfined condition. With this background, management strategies are proposed considering quality and quantity aspects.

6.1 Management plan for drinking and domestic sectors

The National Rural Drinking Water Programme (NRDWP) was launched by Govt. of India in 2009 with the objective of "enable all households to have access to and use safe & adequate drinking water within premises to the extent possible". During 2019, the Government has restructured and subsumed this ongoing program into Jal Jeevan Mission (JJM) in order to provide Functional Household Tap Connection (FHTC) to every rural household i.e., Har Ghar Nal Se Jal (HGNSJ) by 2024. The goal of JJM is to provide drinking water to every rural household at the rate of 55 lpcd.

In Saharsa district, under JJM-HGJ, out of 3.31 lakhs households, 2.39 lakhs are equipped with tap water supply as on 30th September 2021, with district coverage of 72.29%. Various schemes under which tap water supply is provided to habitations in the district is via groundwater source. A table showing annual groundwater requirement for present and projected population has been prepared and given below in order to cater 100% population.

Table 6.1: Annual Resource required to cover 100% population under JJM in Saharsa

Sl. No.	Block	Rural population as per census 2011	Present population	Projected population as on 2026	Present annual resource required to cater 100% of population @55 lpcd (mcm)	Projected annual resource required to cater 100% of population @55 lpcd @2026 (mcm)
1	Banma Itarhi	90,943	114588	129485	2.30	2.60
2a	Kahara Rural	1,41,805	178674	201902	3.59	4.05
2b	Kahara Urban	1,56,540	197240	222882	8.64	9.76

Sl. No.	Block	Rural population as per census 2011	Present population	Projected population as on 2026	Present annual resource required to cater 100% of population @55 lpcd (mcm)	Projected annual resource required to cater 100% of population @55 lpcd @2026 (mcm)
3	Mahishi	2,06,774	260535	294405	5.23	5.91
4	Nauhatta	1,61,784	203848	230348	4.09	4.62
5	Patarghat	1,28,322	161686	182705	3.25	3.67
6	Salkhua	1,32,844	167383	189143	3.36	3.80
7	Satar Katiya	1,51,060	190336	215079	3.82	4.32
8	Saurbazar	2,14,166	269849	304930	5.42	6.12
9	Simri Bakhtiyarpur	2,80,582	353533	399493	7.10	8.02
10	Sonbarsa	2,35,841	297160	335790	5.97	6.74
Saharsa		**19,00,661**	**2394833**	**2706161**	**52.76**	**59.61**

Total groundwater requirement for drinking/domestic sector for the entire district is estimated to be 52.76 mcm which will further rise to about 59.619 mcm as on 2026 at the present per capita rate of allocation. Based on the yield of wells, average discharges of blocks are considered and accordingly unit draft of one tube well has been calculated. Considering the potentiality of the aquifer system in the district, average discharge of deep tube wells is taken as 100 m3/hr. It is to be noted that groundwater development for tap water supply is proposed from deep tube wells. Based on the resource requirement estimated in table 6.2, the number of tube wells required for catering the drinking/domestic needs has been calculated for present scenario. It is observed that total 181 number of deep tube wells are required in order to serve the purpose. The details are given under table 6.2.

Table 6.2: Table showing requirement of TW's for catering the drinking/domestic requirement of Saharsa district

Sl.No.	CD Block/Town	Geology	Present annual resource (mcm) required to cater 100% of population	Average discharge of TW (m3/hr)	Unit draft of one TW in MCM (considering average discharge and 8 hrs/day pumping)	No of Deep Tube well/bore wells
1	Banma Itarhi	Alluvium	2.30	100	0.29	8
2	Kahara Rural	Alluvium	3.58	100	0.29	12
3	Kahara Urban	Alluvium	8.63	100	0.29	30

Sl.No.	CD Block/Town	Geology	Present annual resource (mcm) required to cater 100% of population	Average discharge of TW (m3/hr)	Unit draft of one TW in MCM (considering average discharge and 8 hrs/day pumping)	No of Deep Tube well/bore wells
4	Mahishi	Alluvium	5.23	100	0.29	18
5	Nauhatta	Alluvium	4.09	100	0.29	14
6	Patarghat	Alluvium	3.24	100	0.29	11
7	Salkhua	Alluvium	3.36	100	0.29	12
8	Satar Katiya	Alluvium	3.82	100	0.29	13
9	Saurbazar	Alluvium	5.41	100	0.29	19
10	Simri Bakhtiyarpur	Alluvium	7.09	100	0.29	24
11	Sonbarsa	Alluvium	5.96	100	0.29	20
12	**Saharsa**	**Alluvium**	**52.75**	**100**	**0.29**	**181**

6.2 Management Plan for Irrigation Sector

Major crops cultivated in Saharsa district are Paddy, Wheat, Jute, Maize. Pulses, and Potato. Cereals and coarse cereals constitute 81.05 percentage of the total cropped area of the district. While pulses and oil seeds together constitute only 7.70% of the total cropped area. The cultivation of value crops and horti-crops are scanty in the district. The gross cropped area of the district is 216176 ha and net sown area is 112551 ha with cropping intensity of the district is 193% and 88% of the area under irrigation is catered by groundwater resources. From table 6.3, it can be seen that 65.72% of total cultivable land in the district is under assured irrigation. A total of 38577 ha cultivable land is to be brought under irrigation within the safe limit of exploitation of the resource.

Table 6.3: Irrigated area and area to be brought under irrigation

Block	Cultivable area/Net Sown area (ha)	Net Irrigated Area (ha)	Total area to be brought under Irrigation (ha)	% of cultivable area under assured irrigation
Banma itahari	5594	3677	1917	65.73
Kahara	8549	5619	2930	65.73
Mahishi	14374	9447	4927	65.72
Nauhatta	11847	7786	4061	65.72
Patarhgat	9395	6175	3220	65.73
Salakhua	11979	7873	4106	65.72
Satar katya	11358	7465	3893	65.72
Saurbazar	12786	8403	4383	65.72
Simari Bakhtiyarpur	12810	8420	4390	65.73

Block	Cultivable area/Net Sown area (ha)	Net Irrigated Area (ha)	Total area to be brought under Irrigation (ha)	% of cultivable area under assured irrigation
Sonbarsa	13859	9109	4750	65.73
Saharsa	**112551**	**73974**	**38577**	**65.72**

The additional area available for cultivation is proposed for pulses and oil seeds based on its lower water requirement. Water requirement for pulses and oilseeds are taken as 50 cm, which is less as compared to requirement for cereals crops. Thus volume of additional water required to extend irrigation to the remaining area has been calculated from crop water requirement taking delta factor 0.5 m (Table 6.4). To bring the entire cropped area under assured irrigation through ground water, an additional 12833.5 ham. Cumulative requirement for drinking-domestic and irrigation sector is estimated to be 18923.5 ham (Table 6.4).

Table 6.4: Total groundwater requirement in drinking/domestic and irrigation sectors

Block	Total cultivable area (ha)	Additional area to be brought under Irrigation (ha)	Additional irrigation Water Requirement (Delta factor:50 cm) for Pulses/oilseeds (ham)	Drinking and domestic sector requirement (ham)	Total requirement (ham)
Banma Itarhi	5594	1917	958.5	230	1188.5
Kahara	8549	2930	1465	1223	2688
Mahishi	14374	4927	2463.5	523.02	2986.52
Nauhatta	11847	4061	2030.5	409.22	2439.72
Patarghat	9395	3220	1610	324.58	1934.58
Salkhua	11979	4106	2053	336.02	2389.02
Satar Katiya	11358	3893	1946.5	382.10	2328.60
Saurbazar	12786	4383	2191.5	541.72	2733.22
Simri Bakhtiyarpur	12810	4390	2195	709.72	2904.72
Sonbarsa	13859	4750	2375	596.55	2971.55
Saharsa	**112551**	**38577**	**19288.5**	**5275.94**	**24564.44**

As per the Dynamic Ground Water Resource Assessment, 2020, total annual extractable ground water resource in Saharsa district is 56259.03 ham with SOD of 46.15%. Considering the safe limit of development, at 70% of SOD, the additional resource available is estimated to be 11957.88 ham, after allocating for drinking and domestic requirement (Table 6.5). The additional resource therefore can be utilized for creation of additional irrigation potential for less water intense crops like pulses, oilseeds etc. As per the block wise availability of ground water, 23971.30 ha irrigation potential may

further be created which on an average constitute 62.14% of uncovered area under irrigation. Effective management in surface irrigation network is required to bring the remaining 14605.70 ha area under assured irrigation. The available ground water resource may be effectively utilized to create significant irrigation potential in Mahishi, Salkhua, Sonbarsa blocks (Table 6.5). Surface irrigation network may be practiced in the resource deficit blocks such as Sourbazar, Kahra for further enhancement of irrigation potential. It is to be noted that the additional resource allocated for irrigation is 11985.65ham (Table 6.6).

Table 6.5: Additional area brought under Irrigation with available groundwater resources

Block	Area to be brought under Irrigation (ha)	Additional resource required (ham) for pulses/oil seeds	Total Annual Extractable Ground Water (ham)	Present Gross Draft for all uses (ham)	Annual resource availability considering 70% development	Water available for further development (ham)	Additional drinking/domestic requirement	Additional resource available for irrigation (ham)	Area to bring under irrigation for pulses/oilseeds with additional resources (ha)	Remaining Area (ha)	% area to be brought under irrigation by additional resources
Banma Itarhi	1917	958.5	2423.14	890.18	1696.20	806.02	73.32	732.69	1465.39	451.61	76.44
Kahara	2930	1465	4968.34	3055.36	3477.84	422.48	169.64	252.84	505.68	2424.32	17.26
Mahishi	4927	2463.5	8076.35	3015.73	5653.45	2637.72	166.79	2470.92	4941.84	0.00	100.00
Nauhatta	4061	2030.5	5412.16	2622.72	3788.51	1165.79	130.50	1035.29	2070.58	1990.42	50.99
Patarghat	3220	1610	3738.52	1629.07	2616.96	987.89	103.51	884.38	1768.77	1451.23	54.93
Salkhua	4106	2053	6465.07	2266.36	4525.55	2259.19	107.16	2152.03	4304.06	0.00	100.00
Satar Katiya	3893	1946.5	4727.34	1979.75	3309.14	1329.39	121.85	1207.54	2415.07	1477.93	62.04
Saurbazar	4383	2191.5	7629.28	5301.96	5340.50	38.54	172.76	0.00	0.00	4383.00	0.00
Simri Bakhtiyarpur	4390	2195	6687.84	2908.89	4681.49	1772.60	226.33	1546.27	3092.53	1297.47	70.44
Sonbarsa	4750	2375	6130.99	2291.31	4291.69	2000.38	190.24	1810.14	3620.28	1129.72	76.22
Saharsa	**38577**	**19288.5**	**56259.03**	**25961.33**	**39381.32**	**13419.99**	**1462.11**	**11957.88**	**23971.30**	**14605.70**	**62.14**

The additional irrigation potential may be created through construction of shallow/medium depth tube wells. The unit draft of STW/MDTW is considered 2.5 ham/year based on the norms taken for GWRE-2020. The block wise requirement of additional STW/MDTW has been estimated. 4794 STW/MDTW may be required for the purpose (Table 6.6). However, installation of proposed structures should always be implemented in phases as per the actual site specific feasibility. Proposed structures can bring additional 11985.65 ha irrigation potential in the district which accounts for about 62.14% additional irrigation potential to the uncovered cultivable area.

Table 6.6: Number of feasible tube wells proposed in order to achieve additional irrigation potential

Block	Volume of water available for future Irrigation development (ham) within 'safe' limit	Additional resource required for future irrigation (ham) within safe limit	Actual additional resource available 3 = (Lowest of 1 and 2)	Unit draft of STW/MDTW (ham)	Required no of STW/MDTW
	1	2	3	4	5
Banma Itarhi	958.5	732.69	732.69	2.5	293
Kahara	1465	252.84	252.84	2.5	101
Mahishi	2463.5	2470.92	2463.5	2.5	985
Nauhatta	2030.5	1035.29	1035.29	2.5	414
Patarghat	1610	884.38	884.38	2.5	354
Salkhua	2053	2152.03	2053	2.5	821
Satar Katiya	1946.5	1207.54	1207.54	2.5	483
Saurbazar	2191.5	0.00	0.00	2.5	0
Simri Bakhtiyarpur	2195	1546.27	1546.27	2.5	619
Sonbarsa	2375	1810.14	1810.14	2.5	724
Saharsa	**19288.5**	**11957.88**	**11985.65**	**2.5**	**4794**

6.3 Demand-side Management

In demand side management, micro/precision irrigation is proposed in the district. Micro irrigation intended to effectively utilize water by various techniques such as drips, sprinklers, pivots, rain-guns etc. in the farm. Under Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), popularization of micro irrigation plans is one of the focus areas in order to ensure 'Per drop-More crop'. Under the scheme additional irrigation potential will be created by installing drips, sprinklers, pivots, rain-guns and other application devices. It is proposed that 10% of the command area should be brought under micro/precision irrigation for efficient water management (District Irrigation Plan-Saharsa). The scheme will be implemented in phase-wise.

CHAPTER-VII

SUMMARY

Saharsa district with geographic area cover of 1661 Sq. km have been taken up during AAP 2020-21 as a part of NAQUIM studies. The district has agrarian economy and comes under agro-climatic zone II (North East Alluvial Zone-II). The district is characterized by monotonous flat topography with elevation ranging from 30 to 60 m above mean sea level. The district forms part of the middle fan area of Kosi mega fan. The district is mainly drained by river Kosi and its tributaries. Most of the geographical area of the district comprises of agricultural crop land (75.08 %) followed by wetlands/water bodies (13.22%).

With this background, NAQUIM studies have been done in the district in order to decipher the aquifer characterization, resource scenario, identification of major groundwater related issues and preparation of suitable management plans. Data collected and generated involves hydrogeological data, and hydro-chemical data. Meteorological and hydrological data has been collected from concerned Central and State Govt. Departments. Depth to water level (DTWL) map and water level fluctuation maps has been prepared based on Key wells and NHS data. Depth to water level map of the district shows that majority of the area has water level between 2 to 5 m bgl during pre monsoon. In some patches of Kahra block, it varies from 5 to 10 m bgl. During post monsoon season, it varies from 0 to 2 m bgl in northern blocks and 2 to 5 m bgl in the southern blocks of the district. From the fluctuation map, it can be seen that depth to water level of the majority of the area fluctuates between 1 to 3 m. Long term groundwater level trend over ten years (from 2010 to 2019) has been analysed by using data from 19 network monitoring stations in Saharsa district. Depth to water level during January, May, August and November months has been enumerated over this period and hydrographs were prepared. From the hydrographs, it can be seen that there is no significant variation in groundwater level in the district over long term.

The entire district forms part of mid to lower part of Kosi mega fan. The entire district is covered by thick Quaternary alluvium deposits of various grades of sands with lenses of clay layers with limited extend. The thickly bedded alluvium deposit forms groundwater reservoir of the area. The top most layer comprises of clay mixed with kankar and silt and, in many places with fine sand and is semi pervious in nature. The top layer is followed by a prolific mono-aquifer system down to the explored depth of 165 m bgl. Groundwater occurs under phreatic to unconfined conditions in the district. However, in deeper wells, localized patches of clay layer have been encountered in some bore holes indicating semi-confined nature of the aquifer.

As per surface geological map, more than 90% of area of the district is occupied by Younger alluvium deposits. While present day deposits are limited to the river channels. Based on the available borehole data, major sand horizons are delineated and geological sections are prepared. As per drilling data, the sand horizon extends upto explored depth of 165 m. A correlation of the lithologs of other wells clearly shows that there is no any intervening, regionally continuous aquitard layer in the basin. Therefore, the various sands down to depth of 165 m bgl can be considered as mono-aquifer system. The medium to coarse grained sand constitutes major part of the aquifer system, as the entire district forms part of the mid-fan area. There is a surface clay layer of thickness 5 to 10 m which caps the mono-aquifer system in the area. It is to be noted that the water level observed are within 5m, and the area also does not have many deep wells. The common depth of boring is restricted within 80-100 m.

CGWB has drilled very few wells in the area and therefore there is a general paucity of data. Pumping test data of CGWB wells have been analyzed to arrive at the hydraulic characteristics of the aquifers. Data of wells constructed by State Government indicate that shallow tube wells tapping aquifer (within 110 m bgl) can yield 200 to 300 m3/hr for a drawdown of 2- 5 m. The disposition and hydraulic properties shows that aquifer in the district is heterogeneous both vertically and laterally.

A perusal of the groundwater quality data shows that pH of the analysed samples vary from 7.90 to 8.57 indicating that waters are slightly alkaline. Majority of the analysed samples comes under 'Magnesium/Sodium Bicarbonate Type' facies. Quality of irrigation water varies significantly based on its dissolved salts. The salts may originate from dissolution or weathering of rocks and soil. From the analysis data it can be seen that TDS values ranges from 115.76 mg/L (Jamunia) to 755.3 mg/L (Saharsa), which is within the permissible limit as per Bureau of Indian Standards (BIS) for drinking purpose. Corresponding EC values of analyzed samples ranges from 178.10 (Jamunia) to 1162 (Saharsa) µS/cm @ 25°. Data plotted in USSL diagram shows that all samples have low SAR value and come under low-high salinity hazard zone. Therefore, the water is suitable for irrigation purpose.

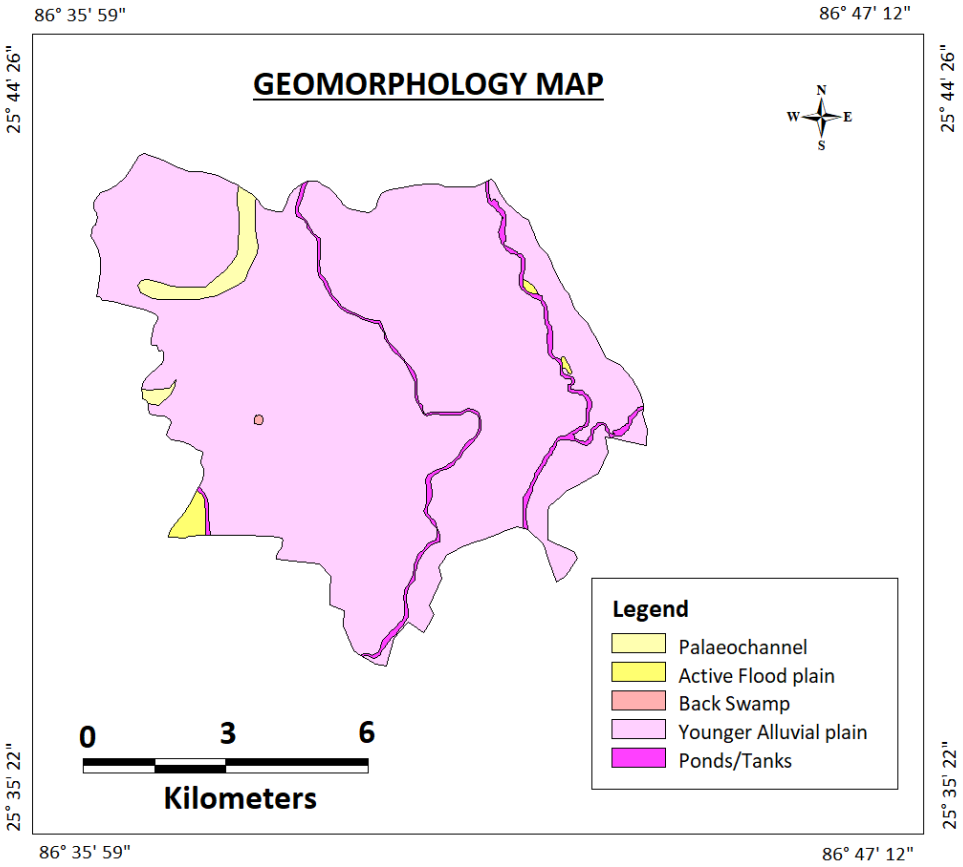
Dynamic ground water resources of 10 blocks of Saharsa district has been assessed, as on March 2020. Dynamic groundwater resource assessment of Bihar State has been jointly carried out by Minor Water Resource Department, Govt. of Bihar and Central Ground Water Board, Ministry of Jal Shakti, Govt. of India, as on March 2020. Dynamic resource of the study area has been estimated by using the norms prescribed under GEC-15. As on March 2020, estimated annual extractable groundwater resource of Saharsa district is 0.56 BCM and gross extraction is 0.25 BCM with stage of extraction of 46.15 %.

The major groundwater issues in the study area are seasonal flooding and water logging and increased demand of groundwater for irrigation sector. Management plans prepared involves management plan for irrigation sector and artificial recharge to groundwater. Apart from these, demand side interventions are also discussed such as installation of drip/sprinkler irrigation system etc. in order to improve the groundwater resource of the district. Crop diversification can also be practiced by projecting the SOE to 60% in the district as per the plan detailed in Chapter-VI.

BLOCK WISE
AQUIFER MAPS AND MANAGEMENT PLANS

1. Salient Information

Name of the Block of Aquifer (in Km²)	**Banma Itahari** (75.20 Sq. Km.)
District/State	**Saharsa/Bihar**
Population	Rural: 90,943 Urban: 0
Rainfall	Normal Monsoon: 1137.5 mm/ Non-monsoon rainfall: 222.7 mm
Agriculture and Irrigation	The block falls in the Argo-climatic Zone II. The cropping sequence followed in this zone is Rice – Wheat – Moong. The soils in this zone are sandy loam, clayey loam with pH in the range of 6.5 – 7.8. The gross irrigated area is 7998 ha and net irrigated area is 3677 ha.
Geology & Geomorphology	Geomorphologically, most of the area is covered by younger alluvial plain and active flood plain. Back swamps and palaeochannels can also be observed in the vicinity of older river course of Kosi River. Geologically the entire district is covered by alluvium deposits of Quaternary age.
Ground water resource availability and extraction	The dynamic ground water resource of Banma Itahari block has been assessed as 24.23 MCM. The gross ground water draft for all uses stands at 8.90 MCM. The stage of Development is 36.74%.
Existing and future water demand	Irrigation: 697.5 ham Domestic & Industrial: 192.68 ham
Water level behaviour	The depth to water level During pre-monsoon: 2-5 m bgl During post monsoon: 2-5 m bgl


86° 35' 59"
86° 47' 12"
25° 44' 26"
25° 35' 22"
GEOMORPHOLOGY MAP
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Legend
Palaeochannel
Active Flood plain
Back Swamp
Younger Alluvial plain
Ponds/Tanks
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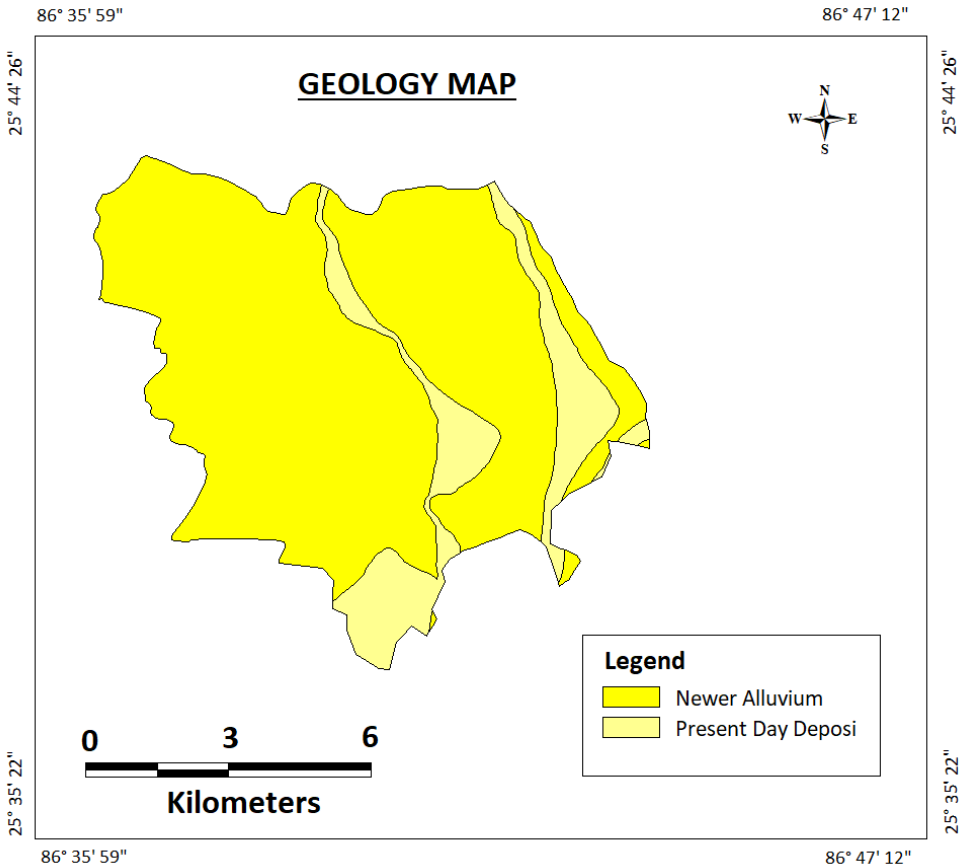
Kilometers


86° 35' 59"
86° 47' 12"
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GEOLOGY MAP
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Newer Alluvium
Present Day Deposi
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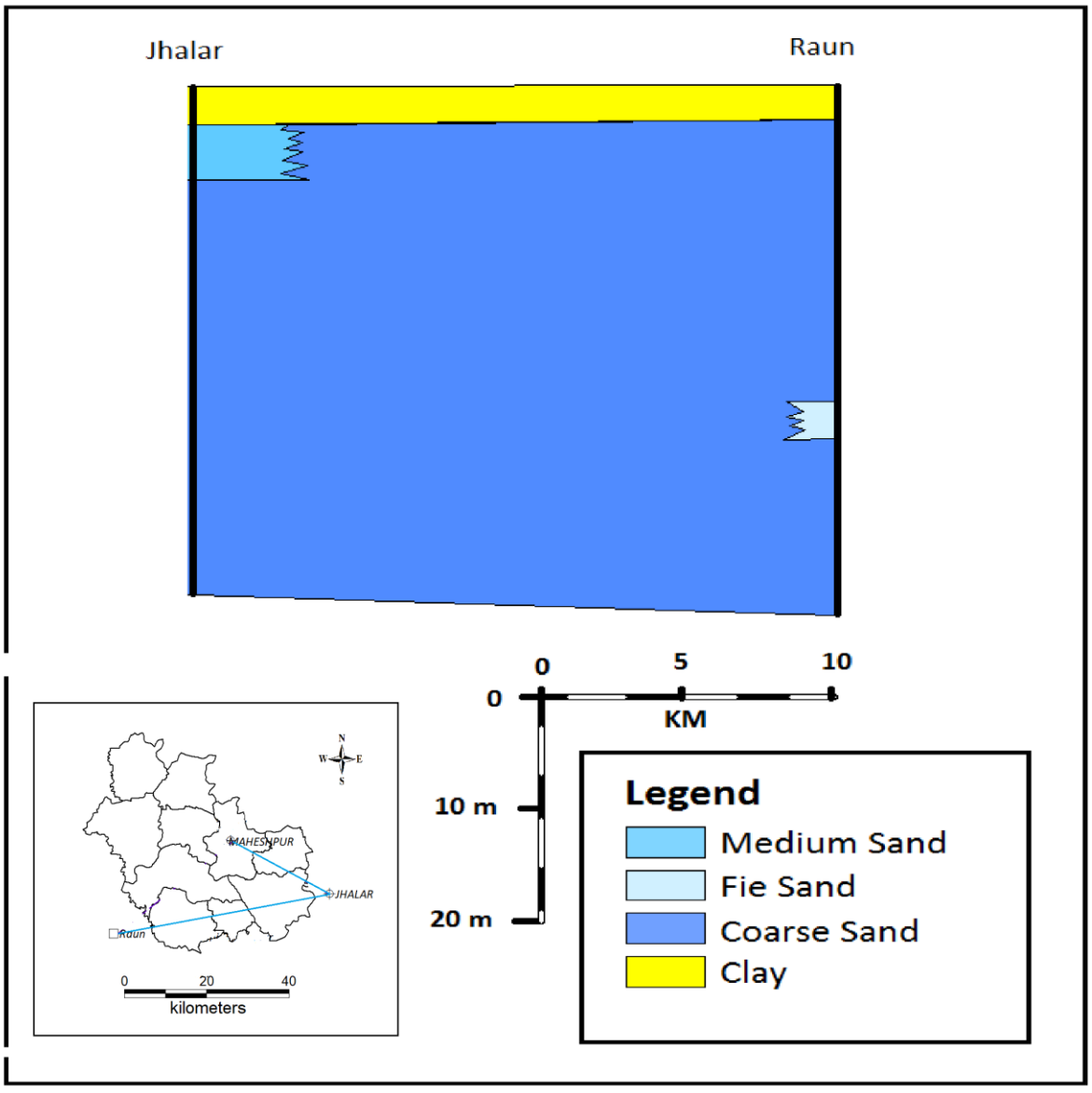
2. Aquifer Disposition

The area is bestowed with mono- aquifer system. The section depicting the aquifer disposition is shown in district report. The block forms part of potential groundwater reservoir which gets replenished after every monsoon



3. Chemical Quality of Ground Water and Contamination

On the basis of Piper diagram and Durov plot, groundwater of the block is potable and based on USSL plot, groundwater is suitable for irrigational purposes. No arsenic contamination has been reported in the district. The flood plains of Kosi river experiences seasonal flooding and water logging during monsoon and remission of water occurs in late October/November. This affects rabi productivity and impart stress on agriculture.

4. 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.

5. Demand Side Interventions

It is recommended to use deeper part of the aquifer for meeting the drinking water supply requirement. Development for irrigation and other uses may be restricted within first 60 m. Requirement of groundwater resource and number of TW's to cater the drinking/domestic demand of the population is estimated and given below.

CD Block/Town	Geology	Present annual resource (mcm) required to cater 100% of population	Average discharge of TW (m3/hr)	Unit draft of one TW in MCM (considering average discharge and 8 hrs/day pumping)	No of Deep Tube well/bore wells
Banma Itarhi	Alluvium	2.3	100	0.29	8

The additional resource available may be utilized for creation of additional irrigation potential for less water intense crops like pulses, oilseeds etc by projecting SOD to 70%. The additional irrigation potential created and required number of TW's are estimated and given below.

Block	Area to be brought under Irrigation (ha)	Additional resource required (ham) for pulses/oil seeds	Total Annual Extractable Ground Water (ham)	Present Gross Draft for all uses (ham)	Annual resource availability considering 70% development	Water available for further development (ham)	Additional drinking/domestic requirement	Additional resource available for irrigation (ham)	Area to bring under irrigation for pulses/oilseeds with additional resources (ha)	Remaining Area (ha)	% area to be brought under irrigation by additional resources
Banma Itarhi	1917	958.5	2423.14	890.18	1696.2	806.02	73.32	732.69	1465.39	451.61	76.44

Block	Volume of water available for future Irrigation development (ham) within 'safe' limit	Additional resource required for future irrigation (ham) within safe limit	Actual additional resource available 3 = (Lowest of 1 and 2)	Unit draft of STW/MDTW (ham)	Required no of STW/MDTW
	1	2	3	4	5
Banma Itarhi	958.5	732.69	732.69	2.5	293

6. Demand Side Interventions

In demand side management, micro/precision irrigation is proposed in the block. Micro irrigation intended to effectively utilize water by various techniques such as drips, sprinklers, pivots, rain-guns etc. in the farm. Under Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), popularization of micro irrigation plans is one of the focus areas in order to ensure 'Per drop-More crop'. Under the scheme additional irrigation potential can be created by installing drips, sprinklers, pivots, rain-guns and other application devices. It is proposed that 10% of the command area should be brought under micro/precision irrigation for efficient water management (District Irrigation Plan-Saharsa). The scheme shall be implemented in phase-wise.

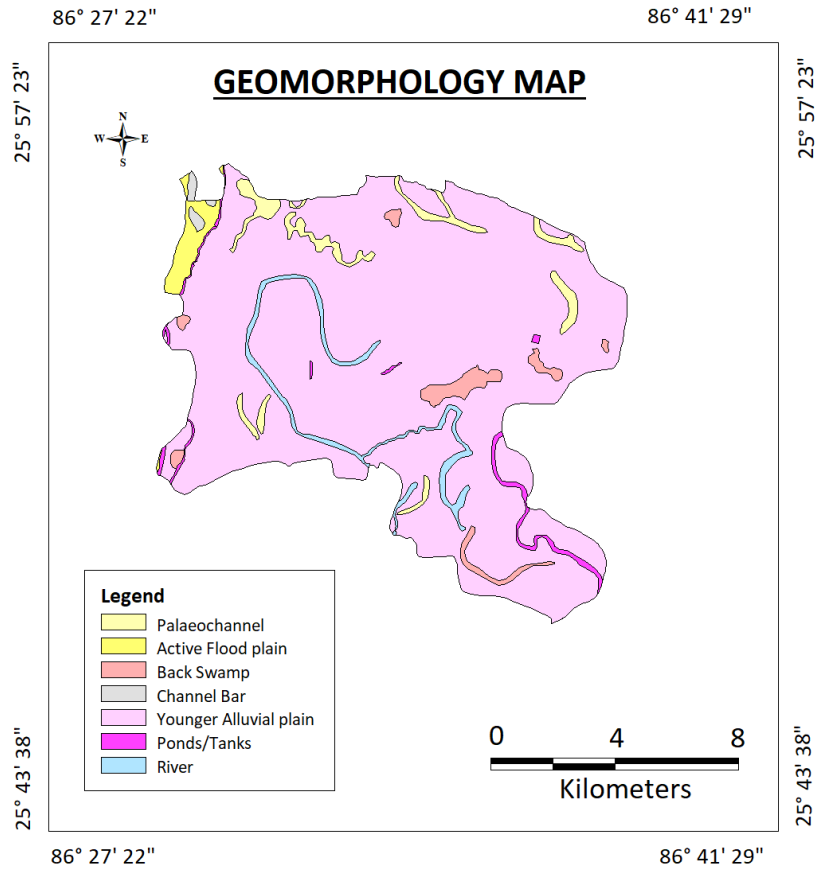
Table 1: Dynamic Ground Water Resource (as on 31st March, 2020)

District	Block	Recharge from Rainfall during Monsoon season	Recharge from Rainfall during Non Monsoon season	Recharge from Other Sources during Monsoon season	Recharge from Other Sources during Non Monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharges	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for irrigation	Existing Gross Ground water Draft for Domestic and Industrial Water Supply	Existing Gross Ground Water Draft for All Uses	Provision for Domestic and Industrial Requirement for Next 25 years	Net GW Availability for Future Irrigation Development	Stage of Ground Water Development	Category: Safe / Semi-critical/ Critical/ Over-exploited
		(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	
Saharsa	Banma Itahari	2077.64	208.8	132.31	131.93	2550.68	127.54	2423.14	697.5	192.38	890.18	176.00	1513.64	36.74	**Safe**

BLOCK WISE
AQUIFER MAPS AND MANAGEMENT PLANS

1. Salient Information

Name of the Block of Aquifer (in Km²)	**KAHARA** (134.45 Sq. Km.)
District/State	**Saharsa/Bihar**
Population	Rural: 141,805 Urban: 156,540
Rainfall	Normal Monsoon: 1137.5 mm/ Non-monsoon rainfall: 222.7 mm
Agriculture and Irrigation	The block falls in the Argo-climatic Zone II. The cropping sequence followed in this zone is Rice – Wheat – Moong. The soils in this zone are sandy loam, clayey loam with pH in the range of 6.5 – 7.8. The gross irrigated area is 9678 ha and net irrigated area is 5619 ha.
Geology & Geomorphology	Geomorphologically, most of the area is covered by younger alluvial plain and active flood plain. Back swamps and palaeochannels can also be observed in the vicinity of older river course of Kosi River. Geologically the entire district is covered by alluvium deposits of Quaternary age.
Ground water resource availability and extraction	The dynamic ground water resource of Kahara block has been assessed as 49.68 MCM. The gross ground water draft for all uses stands at 30.55 MCM. The stage of Development is 61.50%.
Existing and future water demand	Irrigation: 1885 ham Domestic & Industrial: 1170.36 ham
Water level behaviour	The depth to water level During pre-monsoon: 2-5 m bgl During post monsoon: 0-2 m bgl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86° 41' 29"
GEOMORPHOLOGY MAP
25° 57' 23"
25° 43' 38"
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Palaeochannel
Active Flood plain
Back Swamp
Channel Bar
Younger Alluvial plain
Ponds/Tanks
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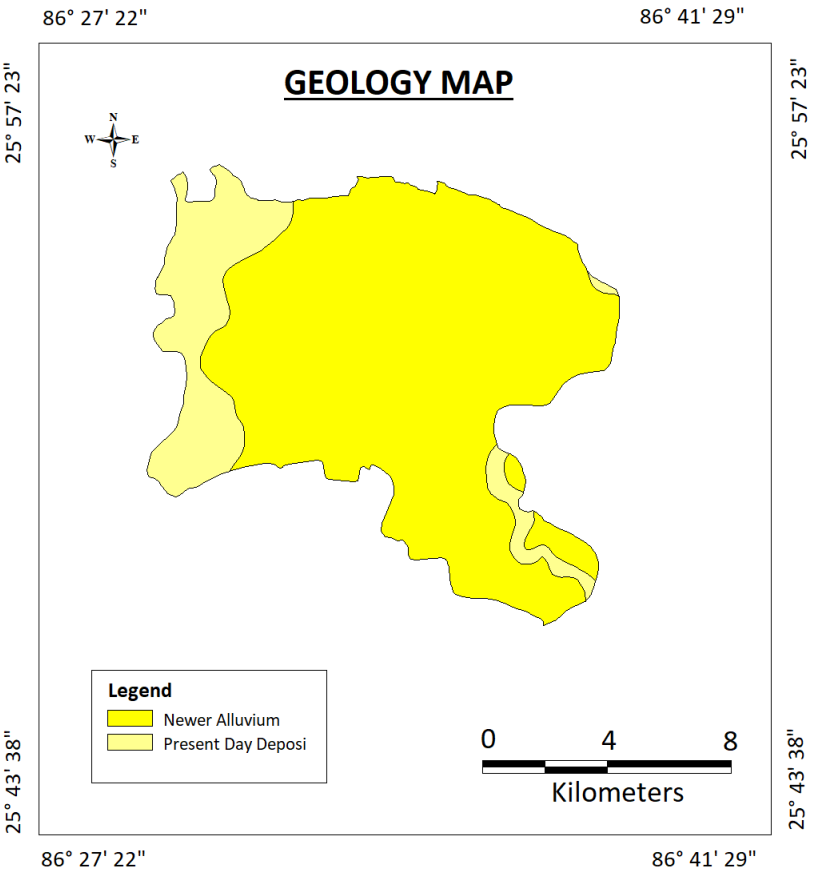
86° 27' 22"
86° 41' 29"
GEOLOGY MAP
25° 57' 23"
25° 43' 38"
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Legend
Newer Alluvium
Present Day Deposi
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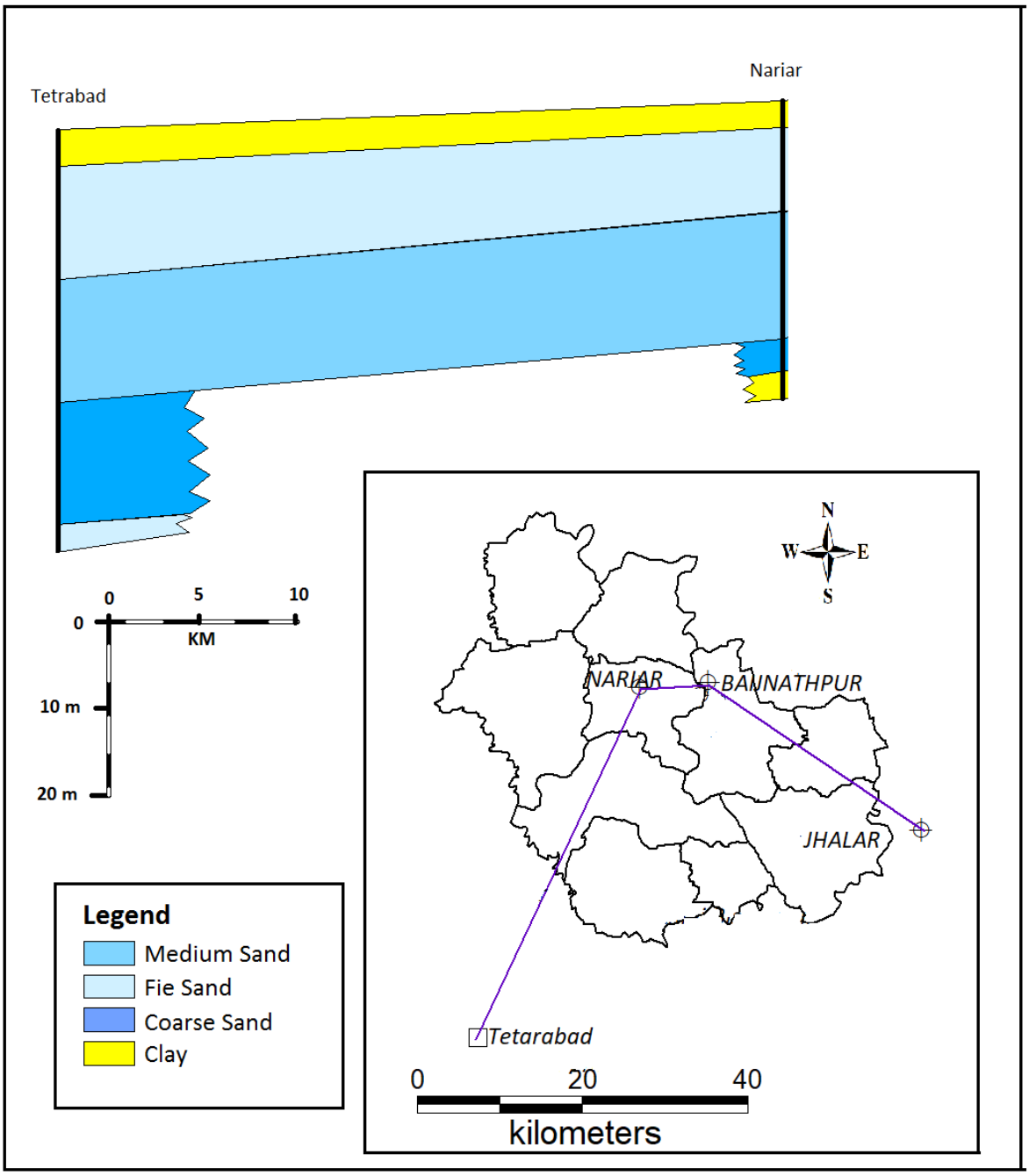
Kilometers

2. Aquifer Disposition

The area is bestowed with mono- aquifer system. The section depicting the aquifer disposition is shown in district report. The mono-aquifer system extends upto the investigated depth of 165 m. The block forms part of potential groundwater reservoir which gets replenished after every monsoon.



3. Chemical Quality of Ground Water and Contamination

On the basis of Piper diagram and Durov plot, groundwater of the block is potable and based on USSL plot, groundwater is suitable for irrigational purposes. No arsenic contamination has been reported in the district. The flood plains of Kosi river experiences seasonal flooding and water logging during monsoon and remission of water occurs in late October/November. This affects rabi productivity and impart stress on agriculture.

4. 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.

5. Demand Side Interventions

It is recommended to use deeper part of the aquifer for meeting the drinking water supply requirement. Development for irrigation and other uses may be restricted within first 60 m. Requirement of groundwater resource and number of TW's to cater the drinking/domestic demand of the population is estimated and given below.

CD Block/Town	Geology	Present annual resource (mcm) required to cater 100% of population	Average discharge of TW (m3/hr)	Unit draft of one TW in MCM (considering average discharge and 8 hrs/day pumping)	No of Deep Tube well/bore wells
Kahara Rural	Alluvium	3.58	100	0.29	12
Kahara Urban	Alluvium	8.63	100	0.29	30

The additional resource available may be utilized for creation of additional irrigation potential for less water intense crops like pulses, oilseeds etc by projecting SOD to 70%. The additional irrigation potential created and required number of TW's are estimated and given below.

Block	Area to be brought under Irrigation (ha)	Additional resource required (ham) for pulses/oil seeds	Total Annual Extractable Ground Water (ham)	Present Gross Draft for all uses (ham)	Annual resource availability considering 70% development	Water available for further development (ham)	Additional drinking/domestic requirement	Additional resource available for irrigation (ham)	Area to bring under irrigation for pulses/oilseeds with additional resources (ha)	Remaining Area (ha)	% area to be brought under irrigation by additional resources
Kahara	2930	1465	4968.34	3055.36	3477.84	422.48	169.64	252.84	505.68	2424.32	17.26

Block	Volume of water available for future Irrigation development (ham) within 'safe' limit	Additional resource required for future irrigation (ham) within safe limit	Actual additional resource available 3 = (Lowest of 1 and 2)	Unit draft of STW/MDTW (ham)	Required no of STW/MDTW

	1	2	3	4	5
Kahara	1465	252.84	252.84	2.5	101

6. Demand Side Interventions

In demand side management, micro/precision irrigation is proposed in the block. Micro irrigation intended to effectively utilize water by various techniques such as drips, sprinklers, pivots, rain-guns etc. in the farm. Under Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), popularization of micro irrigation plans is one of the focus areas in order to ensure 'Per drop-More crop'. Under the scheme additional irrigation potential can be created by installing drips, sprinklers, pivots, rain-guns and other application devices. It is proposed that 10% of the command area should be brought under micro/precision irrigation for efficient water management (District Irrigation Plan-Saharsa). The scheme shall be implemented in phase-wise.

Table 1: Dynamic Ground Water Resource (as on 31st March, 2020)

District	Block	Recharge from Rainfall during Monsoon season	Recharge from Rainfall during Non Monsoon season	Recharge from Other Sources during Monsoon season	Recharge from Other Sources during Non Monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharges	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for irrigation	Existing Gross Ground water Draft for Domestic and Industrial Water Supply	Existing Gross Ground Water Draft for All Uses	Provision for Domestic and Industrial Requirement for Next 25 years	Net GW Availability for Future Irrigation Development	Stage of Ground Water Development	Category: Safe / Semi-critical/ Critical/ Over-exploited
		(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	
Saharsa	Kahara	3197.86	373.31	1268.57	680.63	5520.37	552.03	4968.34	1885.00	1170.36	3055.36	1183.25	4968.34	61.50	Safe

Result of Chemical Analysis of Ground Water Samples

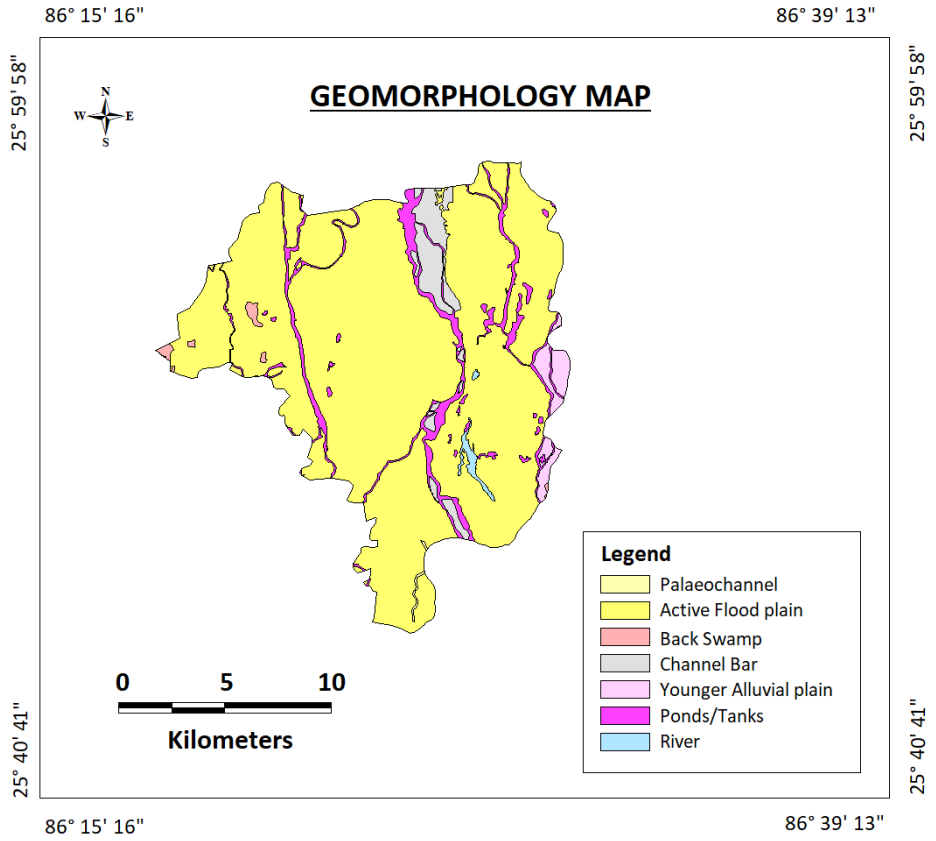
Sl.	Block	Location	pH	EC	TDS	TH	Ca	Mg	Na	K	CO3	HCO3	Cl	SO4	NO3	F
1	Kahara	Basudeva	8.45	513.30	333.645	225	22.02	41.25146	50.11	5.34	15	183.1464	85.08	49.4284	0.895	0.47
2	Kahara	Kharkutti	8.36	801.90	521.235	185	64.05	6.036893	96.67	3.16	3	219.7757	85.08	59.1501	10.8672	1.2
3	Kahara	Tulsiyahi	8.39	805.30	523.445	210	40.03	26.67961	129.86	38.63	30	567.7538	49.63	3.2941	1.7924	1.2
4	Kahara	Chainpura	8.57	320.30	208.195	190	72.06	2.392233	28.71	15.26	30	183.1464	42.54	30.0237	0.3463	0.51

(Source: NHS data)

BLOCK WISE
AQUIFER MAPS AND MANAGEMENT PLANS

1. Salient Information

Name of the Block of Aquifer (in Km²)	**Mahishi** (222.93 Sq. Km.)
District/State	**Saharsa/Bihar**
Population	Rural: 206,774 Urban: 0
Rainfall	Normal Monsoon: 1137.5 mm/ Non-monsoon rainfall: 222.7 mm
Agriculture and Irrigation	The block falls in the Argo-climatic Zone II. The cropping sequence followed in this zone is Rice – Wheat – Moong. The soils in this zone are sandy loam, clayey loam with pH in the range of 6.5 – 7.8. The gross irrigated area is 23355 ha and net irrigated area is 9447 ha.
Geology & Geomorphology	Geomorphologically, most of the area is covered by younger alluvial plain and active flood plain. Back swamps and palaeochannels can also be observed in the vicinity of older river course of Kosi River. Geologically the entire district is covered by alluvium deposits of Quaternary age.
Ground water resource availability and extraction	The dynamic ground water resource of Mahishi block has been assessed as 80.76 MCM. The gross ground water draft for all uses stands at 30.15 MCM. The stage of Development is 37.34 %.
Existing and future water demand	Irrigation: 2542.5 ham Domestic & Industrial: 473.23 ham
Water level behaviour	The depth to water level During pre-monsoon: 2-5 m bgl During post monsoon: 0-2 m bgl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86° 39' 13"
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GEOMORPHOLOGY MAP
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Kilometers
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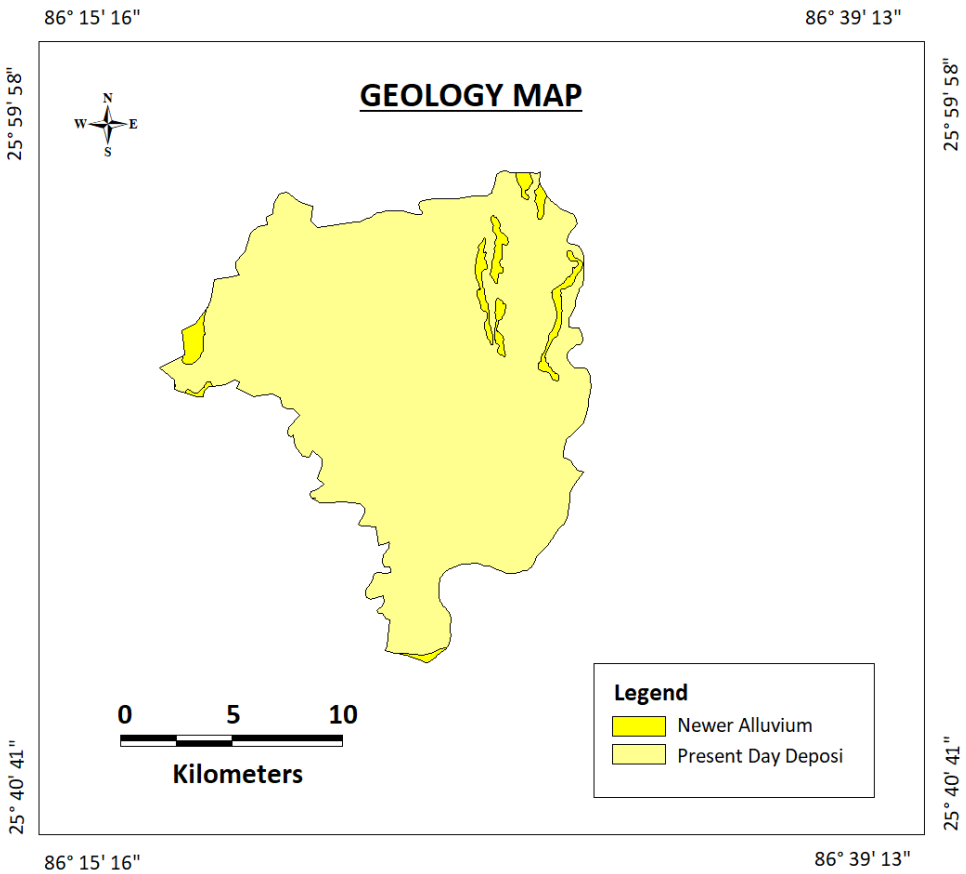
Palaeochannel
Active Flood plain
Back Swamp
Channel Bar
Younger Alluvial plain
Ponds/Tanks
River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Legend
Newer Alluvium
Present Day Deposi

2. Aquifer Disposition

The area is bestowed with mono- aquifer system. The section depicting the aquifer disposition is shown in district report. The mono-aquifer system extends upto the investigated depth of 165 m. The block forms part of potential groundwater reservoir which gets replenished after every monsoon.

3. Chemical Quality of Ground Water and Contamination

On the basis of Piper diagram and Durov plot, groundwater of the block is potable and based on USSL plot, groundwater is suitable for irrigational purposes. No arsenic contamination has been reported in the district. The flood plains of Kosi river experiences seasonal flooding and water logging during monsoon and remission of water occurs in late October/November. This affects rabi productivity and impart stress on agriculture.

4. 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.

5. Demand Side Interventions

It is recommended to use deeper part of the aquifer for meeting the drinking water supply requirement. Development for irrigation and other uses may be restricted within first 60 m. Requirement of groundwater resource and number of TW's to cater the drinking/domestic demand of the population is estimated and given below.

CD Block/Town	Geology	Present annual resource (mcm) required to cater 100% of population	Average discharge of TW (m3/hr)	Unit draft of one TW in MCM (considering average discharge and 8 hrs/day pumping)	No of Deep Tube well/bore wells
Mahishi	Alluvium	5.23	100	0.29	18

The additional resource available may be utilized for creation of additional irrigation potential for less water intense crops like pulses, oilseeds etc by projecting SOD to 70%. The additional irrigation potential created and required number of TW's are estimated and given below.

Block	Area to be brought under Irrigation (ha)	Additional resource required (ham) for pulses/oil seeds	Total Annual Extractable Ground Water (ham)	Present Gross Draft for all uses (ham)	Annual resource availability considering 70% development	Water available for further development (ham)	Additional drinking/domestic requirement	Additional resource available for irrigation (ham)	Area to bring under irrigation for pulses/oilseeds with additional resources (ha)	Remaining Area (ha)	% area to be brought under irrigation by additional resources
Mahishi	4927	2463.5	8076.35	3015.73	5653.45	2637.72	166.79	2470.92	4941.84	0	100

Block	Volume of water available for future Irrigation development (ham) within 'safe' limit	Additional resource required for future irrigation (ham) within safe limit	Actual additional resource available 3 = (Lowest of 1 and 2)	Unit draft of STW/MDTW (ham)	Required no of STW/MDTW
	1	2	3	4	5
Mahishi	2463.5	2470.92	2463.5	2.5	985

6. Demand Side Interventions

In demand side management, micro/precision irrigation is proposed in the block. Micro irrigation intended to effectively utilize water by various techniques such as drips, sprinklers, pivots, rain-guns etc. in the farm. Under Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), popularization of micro irrigation plans is one of the focus areas in order to ensure 'Per drop-More crop'. Under the scheme additional irrigation potential can be created by installing drips, sprinklers, pivots, rain-guns and other application devices. It is proposed that 10% of the command area should be brought under micro/precision irrigation for efficient water management (District Irrigation Plan-Saharsa). The scheme shall be implemented in phase-wise.

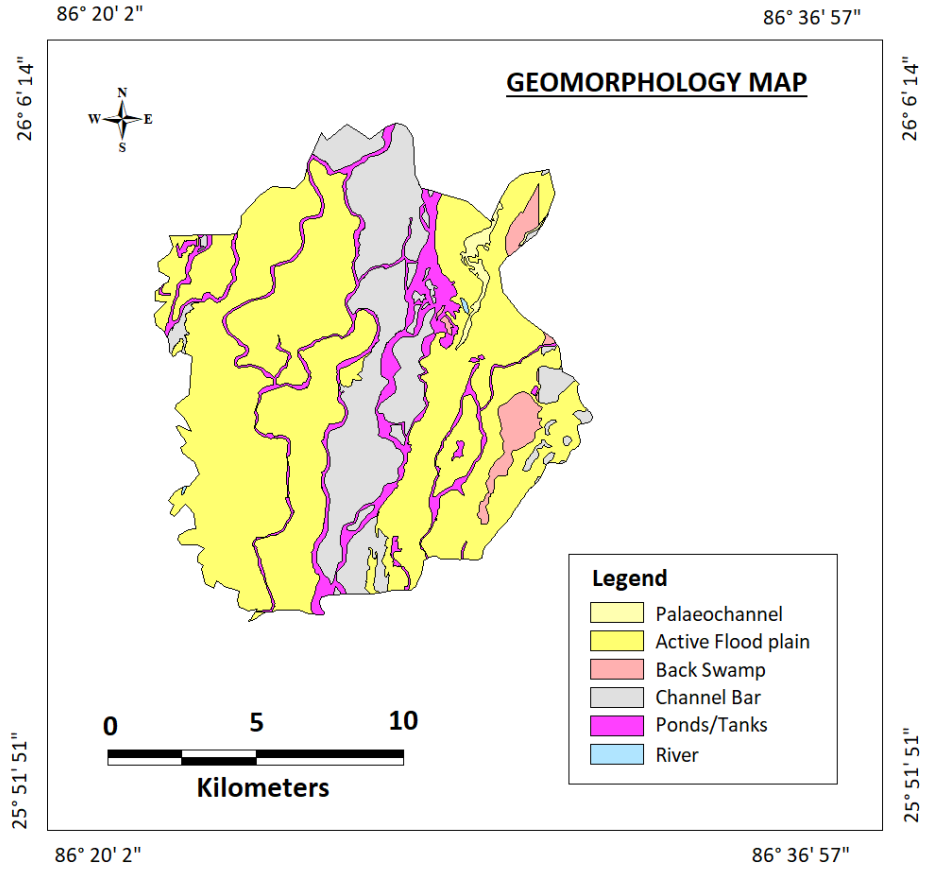
Table 1: Dynamic Ground Water Resource (as on 31st March, 2020)

District	Block	Recharge from Rainfall during Monsoon season	Recharge from Rainfall during Non Monsoon season	Recharge from Other Sources during Monsoon season	Recharge from Other Sources during Non Monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharges	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for irrigation	Existing Gross Ground water Draft for Domestic and Industrial Water Supply	Existing Gross Ground Water Draft for All Uses	Provision for Domestic and Industrial Requirement for Next 25 years	Net GW Availability for Future Irrigation Development	Stage of Ground Water Development	Category: Safe / Semi-critical/ Critical/ Over-exploited
		(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	
Saharsa	Mahishi	6920.75	618.98	481.52	480.17	8501.42	425.07	8076.35	2542.50	473.23	3015.73	400.16	5016.69	37.34	Safe

BLOCK WISE
AQUIFER MAPS AND MANAGEMENT PLANS

1. Salient Information

Name of the Block of Aquifer (in Km²)	**Nauhatta** (169.88 Sq. Km.)
District/State	**Saharsa/Bihar**
Population	Rural: 161,784 Urban: 0
Rainfall	Normal Monsoon: 1137.5 mm/ Non-monsoon rainfall: 222.7 mm
Agriculture and Irrigation	The block falls in the Argo-climatic Zone II. The cropping sequence followed in this zone is Rice – Wheat – Moong. The soils in this zone are sandy loam, clayey loam with pH in the range of 6.5 – 7.8. The gross irrigated area is 10535 ha and net irrigated area is 7786 ha.
Geology & Geomorphology	Geomorphologically, most of the area is covered by younger alluvial plain and active flood plain. Back swamps and palaeochannels can also be observed in the vicinity of older river course of Kosi River. Geologically the entire district is covered by alluvium deposits of Quaternary age.
Ground water resource availability and extraction	The dynamic ground water resource of Nauhatta block has been assessed as 54.12 MCM. The gross ground water draft for all uses stands at 26.22 MCM. The stage of Development is 48.46%.
Existing and future water demand	Irrigation: 2245 ham Domestic & Industrial: 377.72 ham
Water level behaviour	The depth to water level During pre-monsoon: 2-5 m bgl During post monsoon: 0-2 m bgl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Active Flood plain
Back Swamp
Channel Bar
Ponds/Tanks
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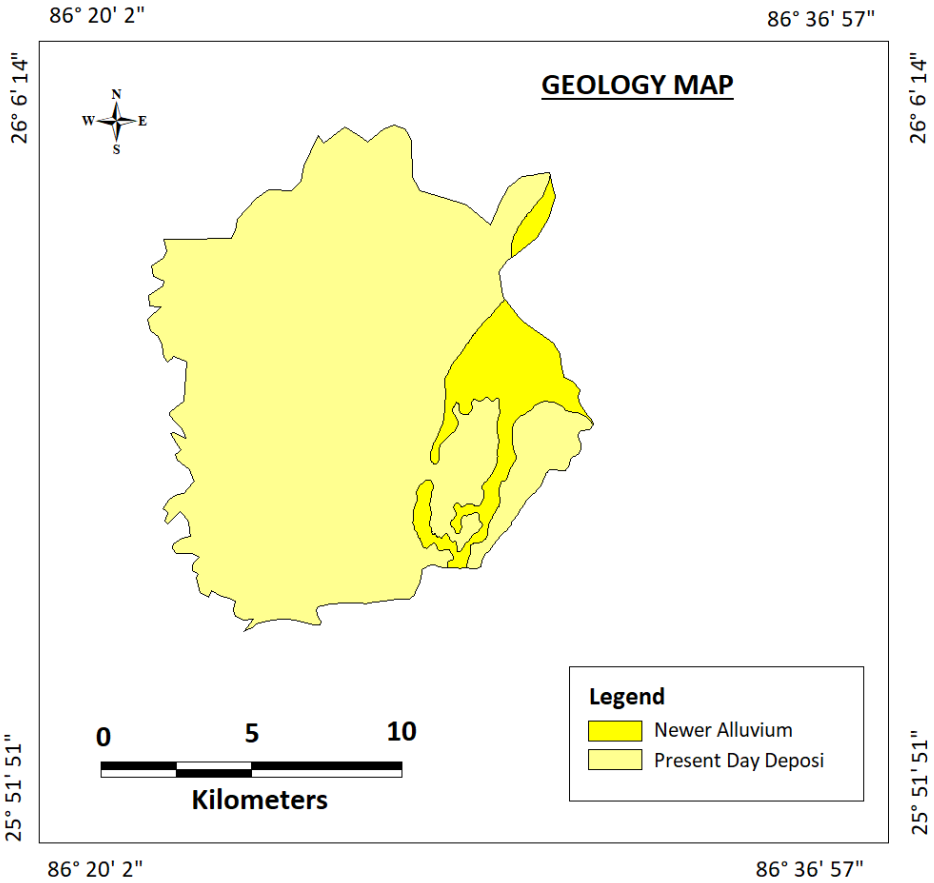
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2. Aquifer Disposition

The area is bestowed with mono- aquifer system. The section depicting the aquifer disposition is shown in district report. The mono-aquifer system extends upto the investigated depth of 165 m. The block forms part of potential groundwater reservoir which gets replenished after every monsoon.

3. Chemical Quality of Ground Water and Contamination

On the basis of Piper diagram and Durov plot, groundwater of the block is potable and based on USSL plot, groundwater is suitable for irrigational purposes. No arsenic contamination has been reported in the district. The flood plains of Kosi river experiences seasonal flooding and water logging during monsoon and remission of water occurs in late October/November. This affects rabi productivity and impart stress on agriculture.

4. 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.

5. Demand Side Interventions

It is recommended to use deeper part of the aquifer for meeting the drinking water supply requirement. Development for irrigation and other uses may be restricted within first 60 m. Requirement of groundwater resource and number of TW's to cater the drinking/domestic demand of the population is estimated and given below.

CD Block/Town	Geology	Present annual resource (mcm) required to cater 100% of population	Average discharge of TW (m3/hr)	Unit draft of one TW in MCM (considering average discharge and 8 hrs/day pumping)	No of Deep Tube well/bore wells
Nauhatta	Alluvium	4.09	100	0.29	14

The additional resource available may be utilized for creation of additional irrigation potential for less water intense crops like pulses, oilseeds etc by projecting SOD to 70%. The additional irrigation potential created and required number of TW's are estimated and given below.

Block	Area to be brought under Irrigation (ha)	Additional resource required (ham) for pulses/oil seeds	Total Annual Extractable Ground Water (ham)	Present Gross Draft for all uses (ham)	Annual resource availability considering 70% development	Water available for further development (ham)	Additional drinking/domestic requirement	Additional resource available for irrigation (ham)	Area to bring under irrigation for pulses/oilseeds with additional resources (ha)	Remaining Area (ha)	% area to be brought under irrigation by additional resources
Nauhatta	4061	2030.5	5412.16	2622.72	3788.51	1165.79	130.5	1035.29	2070.58	1990.42	50.99

Block	Volume of water available for future Irrigation development (ham) within 'safe' limit	Additional resource required for future irrigation (ham) within safe limit	Actual additional resource available 3 = (Lowest of 1 and 2)	Unit draft of STW/MDTW (ham)	Required no of STW/MDTW
	1	2	3	4	5
Nauhatta	2030.5	1035.29	1035.29	2.5	414

6. Demand Side Interventions

In demand side management, micro/precision irrigation is proposed in the block. Micro irrigation intended to effectively utilize water by various techniques such as drips, sprinklers, pivots, rain-guns etc. in the farm. Under Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), popularization of micro irrigation plans is one of the focus areas in order to ensure 'Per drop-More crop'. Under the scheme additional irrigation potential can be created by installing drips, sprinklers, pivots, rain-guns and other application devices. It is proposed that 10% of the command area should be brought under micro/precision irrigation for efficient water management (District Irrigation Plan-Saharsa). The scheme shall be implemented in phase-wise.

Table 1: Dynamic Ground Water Resource (as on 31st March, 2020)

District	Block	Recharge from Rainfall during Monsoon season	Recharge from Rainfall during Non Monsoon season	Recharge from Other Sources during Monsoon season	Recharge from Other Sources during Non Monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharges	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for irrigation	Existing Gross Ground water Draft for Domestic and Industrial Water Supply	Existing Gross Ground Water Draft for All Uses	Provision for Domestic and Industrial Requirement for Next 25 years	Net GW Availability for Future Irrigation Development	Stage of Ground Water Development	Category: Safe / Semi-critical/ Critical/ Over-exploited
Saharsa	Nauhatta	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	Safe
		4369.48	471.68	428.33	427.52	5697.01	284.85	5412.16	2245.00	377.72	2622.72	313.09	2755.07	48.46	

Result of Chemical Analysis of Ground Water Samples

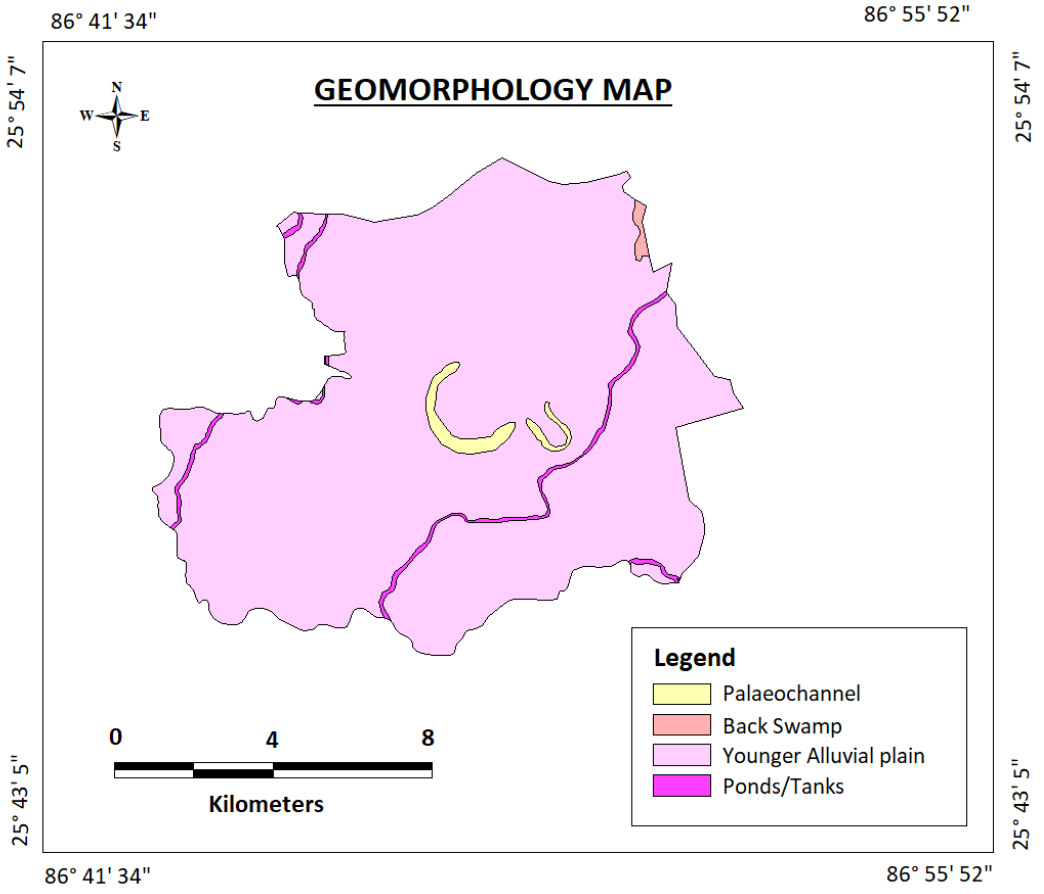
Sl.	Block	Locatio	pH	EC	TDS	TH	Ca	Mg	Na	K	CO3	HCO3	Cl	SO4	NO3	F
1	Nauhatta	Bangao	8.30	199.	129.545	110	32.0	7.26	27.5	2.5	9	140.4	24.81	16.00	0.299	0.5

(Source: NHS data)

BLOCK WISE
AQUIFER MAPS AND MANAGEMENT PLANS

1. Salient Information

Name of the Block of Aquifer (in Km²)	**Patarhgat** (118.66 Sq. Km.)
District/State	**Saharsa/Bihar**
Population	Rural: 128,322 Urban: 0
Rainfall	Normal Monsoon: 1137.5 mm/ Non-monsoon rainfall: 222.7 mm
Agriculture and Irrigation	The block falls in the Argo-climatic Zone II. The cropping sequence followed in this zone is Rice – Wheat – Moong. The soils in this zone are sandy loam, clayey loam with pH in the range of 6.5 – 7.8. The gross irrigated area is 9729 ha and net irrigated area is 6175b ha.
Geology & Geomorphology	Geomorphologically, most of the area is covered by younger alluvial plain and active flood plain. Back swamps and palaeochannels can also be observed in the vicinity of older river course of Kosi River. Geologically the entire district is covered by alluvium deposits of Quaternary age.
Ground water resource availability and extraction	The dynamic ground water resource of Patarhgat block has been assessed as 37.38 MCM. The gross ground water draft for all uses stands at 16.29 MCM. The stage of Development is 43.58 %.
Existing and future water demand	Irrigation: 1345 ham Domestic & Industrial: 284.07 ham
Water level behaviour	The depth to water level During pre-monsoon: 2-5 m bgl During post monsoon: 2-5 m bgl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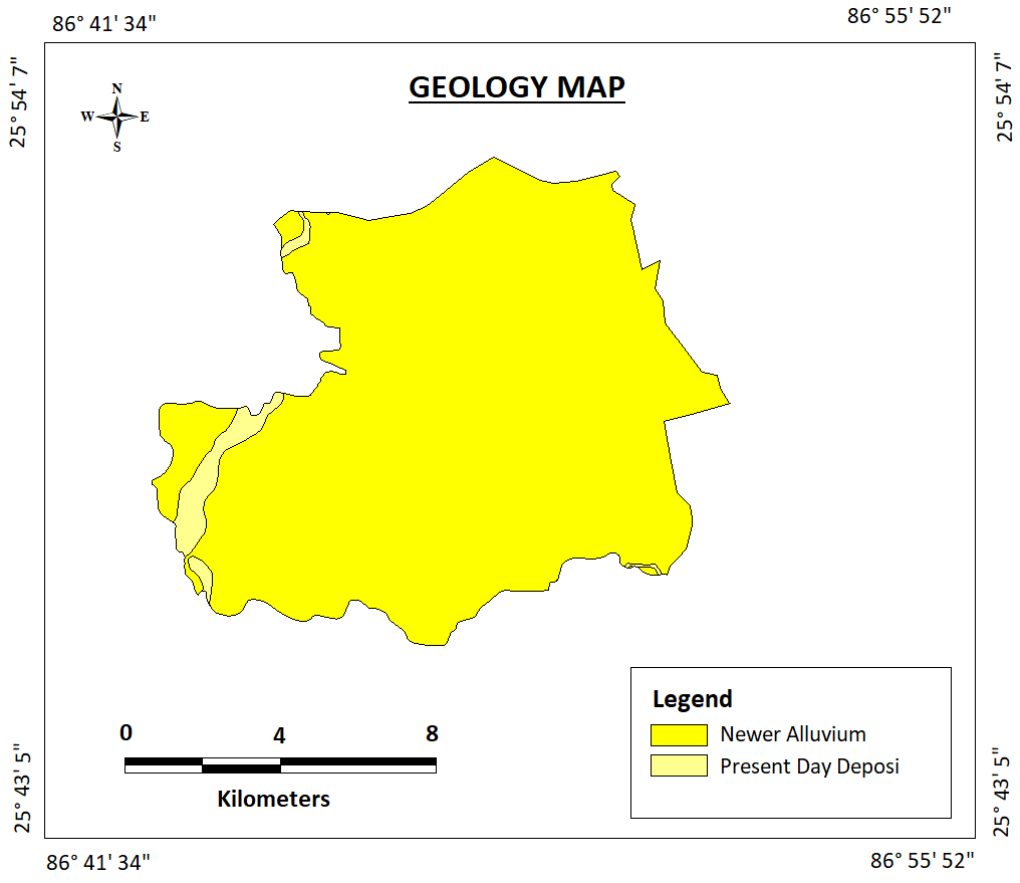
Palaeochannel
Back Swamp
Younger Alluvial plain
Ponds/Tanks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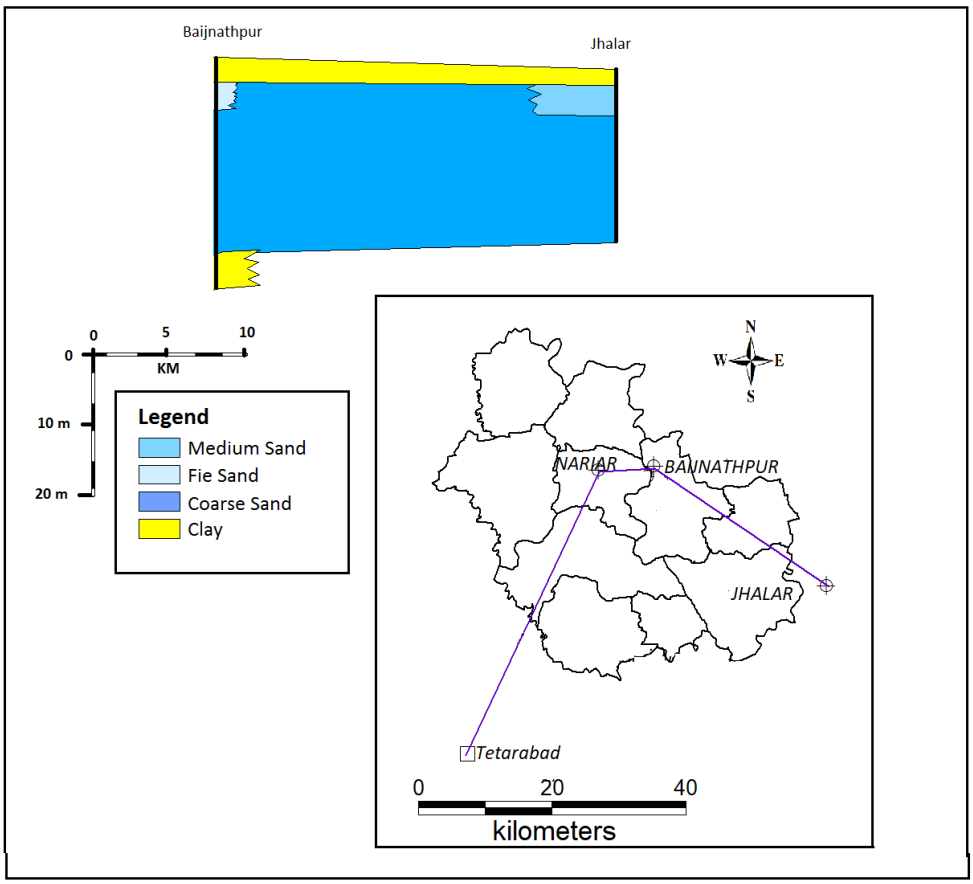
Legend
Newer Alluvium
Present Day Deposi

2. Aquifer Disposition

The area is bestowed with mono- aquifer system. The section depicting the aquifer disposition is shown in district report. The mono-aquifer system extends upto the investigated depth of 165 m. The block forms part of potential groundwater reservoir which gets replenished after every monsoon.



3. Chemical Quality of Ground Water and Contamination

On the basis of Piper diagram and Durov plot, groundwater of the block is potable and based on USSL plot, groundwater is suitable for irrigational purposes. No arsenic contamination has been reported in the district. The flood plains of Kosi river experiences seasonal flooding and water logging during monsoon and remission of water occurs in late October/November. This affects rabi productivity and impart stress on agriculture.

4. 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.

5. Demand Side Interventions

It is recommended to use deeper part of the aquifer for meeting the drinking water supply requirement. Development for irrigation and other uses may be restricted within first 60 m. Requirement of groundwater resource and number of TW's to cater the drinking/domestic demand of the population is estimated and given below.

CD Block/Town	Geology	Present annual resource (mcm) required to cater 100% of population	Average discharge of TW (m3/hr)	Unit draft of one TW in MCM (considering average discharge and 8 hrs/day pumping)	No of Deep Tube well/bore wells
Patarghat	Alluvium	3.24	100	0.29	11

The additional resource available may be utilized for creation of additional irrigation potential for less water intense crops like pulses, oilseeds etc by projecting SOD to 70%. The additional irrigation potential created and required number of TW's are estimated and given below.

Block	Area to be brought under Irrigation (ha)	Additional resource required (ham) for pulses/oil seeds	Total Annual Extractable Ground Water (ham)	Present Gross Draft for all uses (ham)	Annual resource availability considering 70% development	Water available for further development (ham)	Additional drinking/domestic requirement	Additional resource available for irrigation (ham)	Area to bring under irrigation for pulses/oilseeds with additional resources (ha)	Remaining Area (ha)	% area to be brought under irrigation by additional resources
Patarghat	3220	1610	3738.52	1629.07	2616.96	987.89	103.51	884.38	1768.77	1451.23	54.93

Block	Volume of water available for future Irrigation development (ham) within 'safe' limit	Additional resource required for future irrigation (ham) within safe limit	Actual additional resource available 3 = (Lowest of 1 and 2)	Unit draft of STW/MDTW (ham)	Required no of STW/MDTW
	1	2	3	4	5
Patarghat	1610	884.38	884.38	2.5	354

6. Demand Side Interventions

In demand side management, micro/precision irrigation is proposed in the block. Micro irrigation intended to effectively utilize water by various techniques such as drips, sprinklers, pivots, rain-guns etc. in the farm. Under Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), popularization of micro irrigation plans is one of the focus areas in order to ensure 'Per drop-More crop'. Under the scheme additional irrigation potential can be created by installing drips, sprinklers, pivots, rain-guns and other application devices. It is proposed that 10% of the command area should be brought under

micro/precision irrigation for efficient water management (District Irrigation Plan-Saharsa). The scheme shall be implemented in phase-wise.

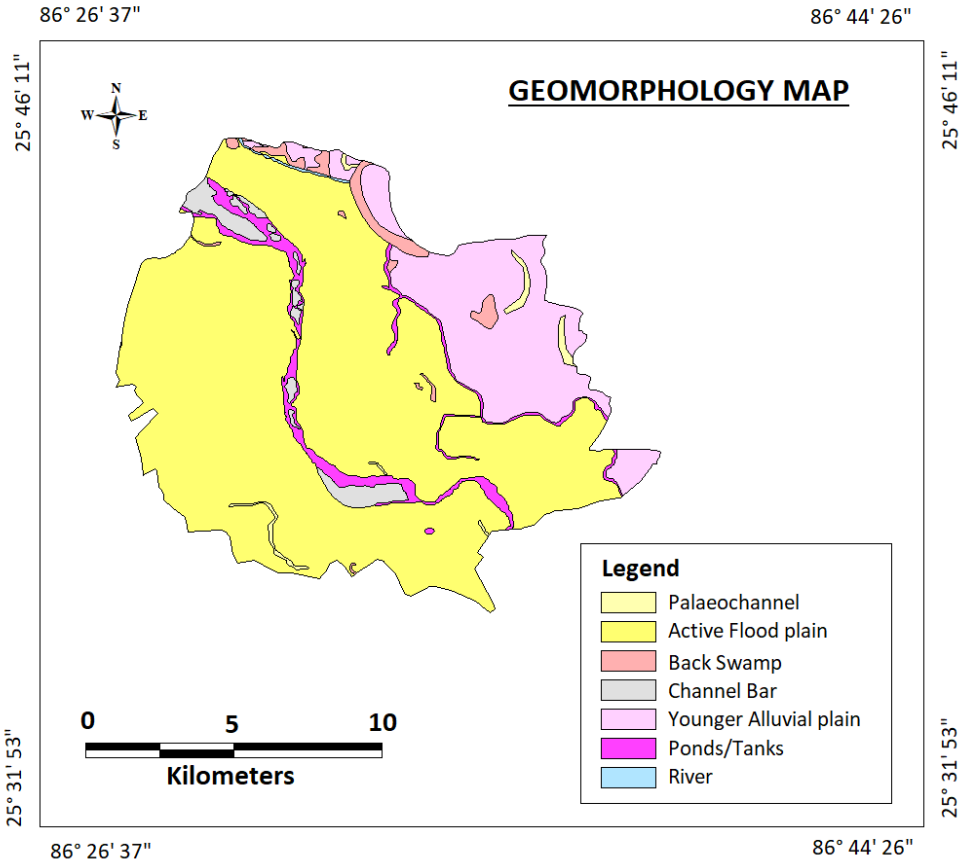
Table 1: Dynamic Ground Water Resource (as on 31st March, 2020)

District	Block	Recharge from Rainfall during Monsoon season	Recharge from Rainfall during Non Monsoon season	Recharge from Other Sources during Monsoon season	Recharge from Other Sources during Non Monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharges	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for irrigation	Existing Gross Ground water Draft for Domestic and Industrial Water Supply	Existing Gross Ground Water Draft for All Uses	Provision for Domestic and Industrial Requirement for Next 25 years	Net GW Availability for Future Irrigation Development	Stage of Ground Water Development	Category: Safe / Semi-critical/ Critical/ Over-exploited
		(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	
Saharsa	Patarhgat	2945.33	329.47	340.18	320.31	3935.29	196.77	3738.52	1345.00	284.07	1629.07	248.33	2082.19	43.58	Safe

BLOCK WISE
AQUIFER MAPS AND MANAGEMENT PLANS

1. Salient Information

Name of the Block of Aquifer (in Km²)	**Salakhua** (176.61Sq. Km.)
District/State	**Saharsa/Bihar**
Population	Rural: 132,844 Urban: 0
Rainfall	Normal Monsoon: 1137.5 mm/ Non-monsoon rainfall: 222.7 mm
Agriculture and Irrigation	The block falls in the Argo-climatic Zone II. The cropping sequence followed in this zone is Rice – Wheat – Moong. The soils in this zone are sandy loam, clayey loam with pH in the range of 6.5 – 7.8. The gross irrigated area is 17025 ha and net irrigated area is 7873 ha.
Geology & Geomorphology	Geomorphologically, most of the area is covered by younger alluvial plain and active flood plain. Back swamps and palaeochannels can also be observed in the vicinity of older river course of Kosi River. Geologically the entire district is covered by alluvium deposits of Quaternary age.
Ground water resource availability and extraction	The dynamic ground water resource of Salakhua block has been assessed as 64.65 MCM. The gross ground water draft for all uses stands at 22.66 MCM. The stage of Development is 35.06%.
Existing and future water demand	Irrigation: 1947.5 ham Domestic & Industrial: 318.86 ham
Water level behaviour	The depth to water level During pre-monsoon: 2-5 m bgl During post monsoon: 2-5 m bgl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Active Flood plain
Back Swamp
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Younger Alluvial plain
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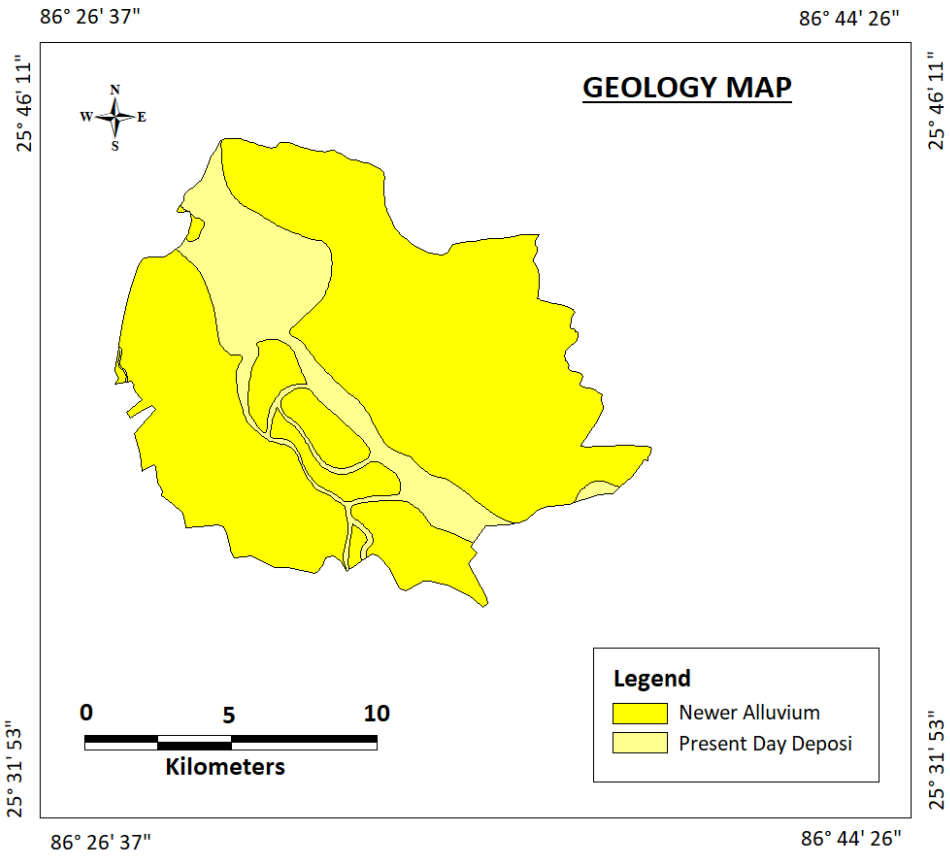
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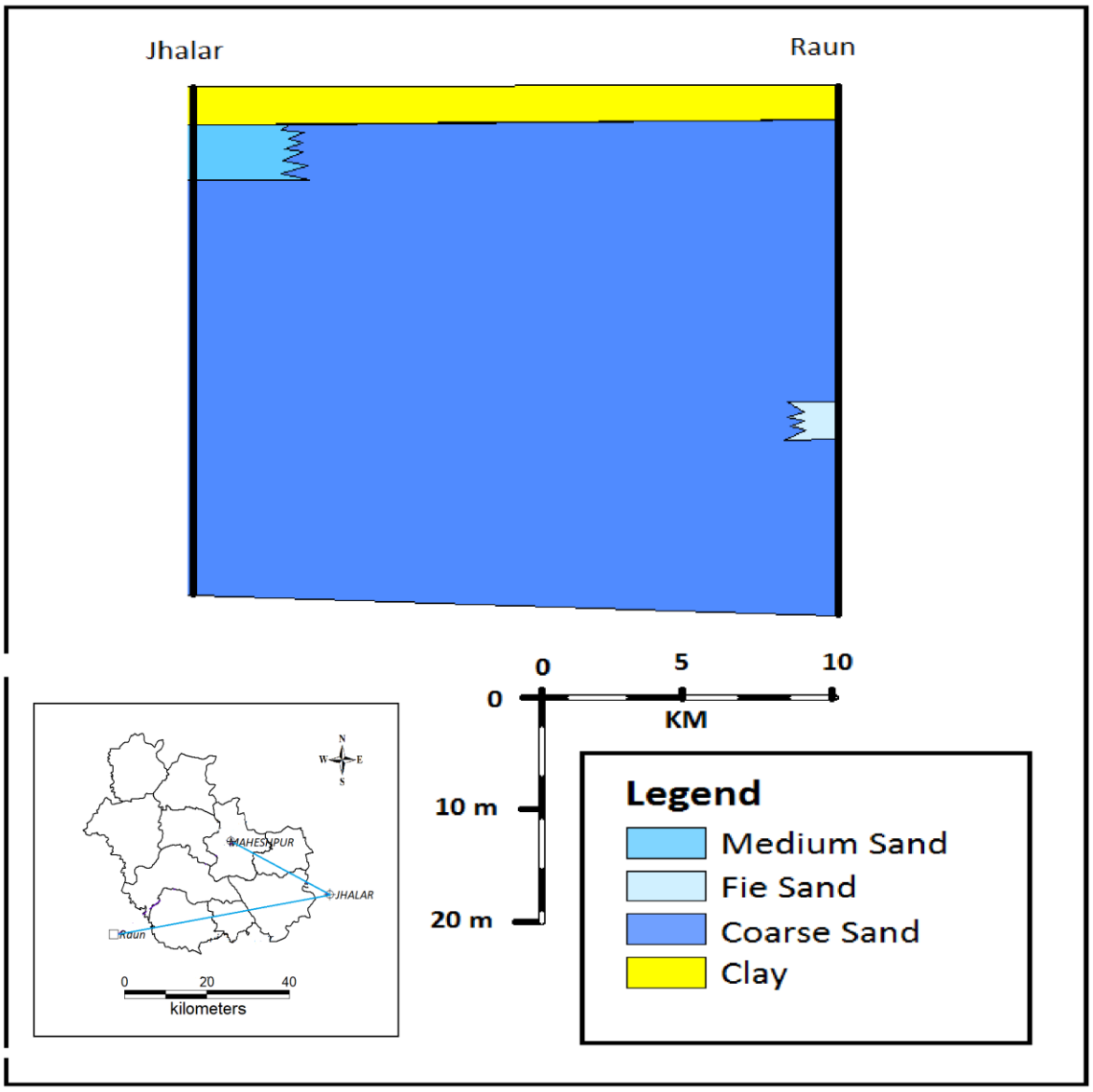
2. Aquifer Disposition

The area is bestowed with mono- aquifer system. The section depicting the aquifer disposition is shown in district report. The mono-aquifer system extends upto the investigated depth of 165 m. The block forms part of potential groundwater reservoir which gets replenished after every monsoon.



3. Chemical Quality of Ground Water and Contamination

On the basis of Piper diagram and Durov plot, groundwater of the block is potable and based on USSL plot, groundwater is suitable for irrigational purposes. No arsenic contamination has been reported in the district. The flood plains of Kosi river experiences seasonal flooding and water logging during monsoon and remission of water occurs in late October/November. This affects rabi productivity and impart stress on agriculture.

4. 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.

5. Demand Side Interventions

It is recommended to use deeper part of the aquifer for meeting the drinking water supply requirement. Development for irrigation and other uses may be restricted within first 60 m. Requirement of groundwater resource and number of TW's to cater the drinking/domestic demand of the population is estimated and given below.

CD Block/Town	Geology	Present annual resource (mcm) required to cater 100% of population	Average discharge of TW (m3/hr)	Unit draft of one TW in MCM (considering average discharge and 8 hrs/day pumping)	No of Deep Tube well/bore wells
Salkhua	Alluvium	3.36	100	0.29	12

The additional resource available may be utilized for creation of additional irrigation potential for less water intense crops like pulses, oilseeds etc by projecting SOD to 70%. The additional irrigation potential created and required number of TW's are estimated and given below.

Block	Area to be brought under Irrigation (ha)	Additional resource required (ham) for pulses/oil seeds	Total Annual Extractable Ground Water (ham)	Present Gross Draft for all uses (ham)	Annual resource availability considering 70% development	Water available for further development (ham)	Additional drinking/domestic requirement	Additional resource available for irrigation (ham)	Area to bring under irrigation for pulses/oilseeds with additional resources (ha)	Remaining Area (ha)	% area to be brought under irrigation by additional resources
Salkhua	4106	2053	6465.07	2266.36	4525.55	2259.19	107.16	2152.03	4304.06	0	100

Block	Volume of water available for future Irrigation development (ham) within 'safe' limit	Additional resource required for future irrigation (ham) within safe limit	Actual additional resource available 3 = (Lowest of 1 and 2)	Unit draft of STW/MDTW (ham)	Required no of STW/MDTW
	1	2	3	4	5
Salkhua	2053	2152.03	2053	2.5	821

6. Demand Side Interventions

In demand side management, micro/precision irrigation is proposed in the block. Micro irrigation intended to effectively utilize water by various techniques such as drips, sprinklers, pivots, rain-guns etc. in the farm. Under Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), popularization of micro

irrigation plans is one of the focus areas in order to ensure ‘Per drop-More crop’. Under the scheme additional irrigation potential can be created by installing drips, sprinklers, pivots, rain-guns and other application devices. It is proposed that 10% of the command area should be brought under micro/precision irrigation for efficient water management (District Irrigation Plan-Saharsa). The scheme shall be implemented in phase-wise.

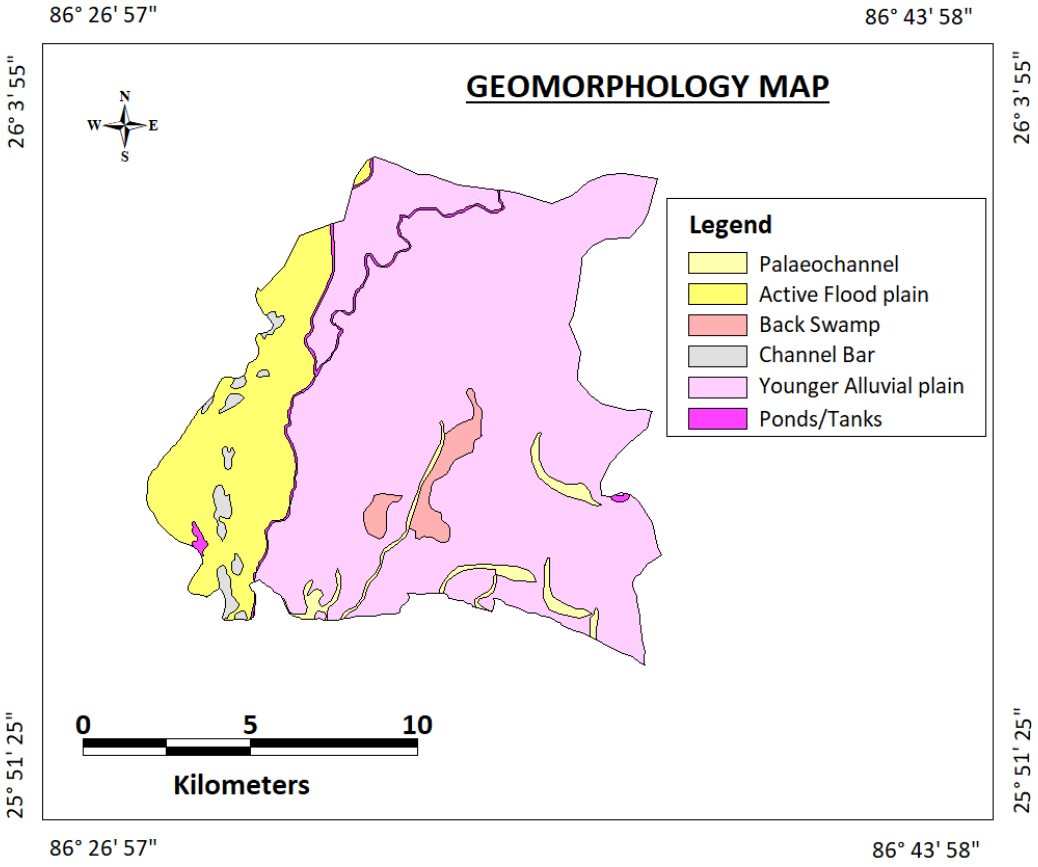
Table 1: Dynamic Ground Water Resource (as on 31st March, 2020)

District	Block	Recharge from Rainfall during Monsoon season	Recharge from Rainfall during Non Monsoon season	Recharge from Other Sources during Monsoon season	Recharge from Other Sources during Non Monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharges	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for irrigation	Existing Gross Ground water Draft for Domestic and Industrial Water Supply	Existing Gross Ground Water Draft for All Uses	Provision for Domestic and Industrial Requirement for Next 25 years	Net GW Availability for Future Irrigation Development	Stage of Ground Water Development	Category: Safe / Semi-critical/ Critical/ Over-exploited
		(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	
Saharsa	Salakhua	4200.63	490.37	1626.37	866.04	7183.41	718.34	6465.07	1947.50	318.86	2266.36	257.08	4170.49	35.06	Safe

BLOCK WISE
AQUIFER MAPS AND MANAGEMENT PLANS

1. Salient Information

Name of the Block of Aquifer (in Km²)	**Satar Katiya** (150.74 Sq. Km.)
District/State	**Saharsa/Bihar**
Population	Rural: 151,060 Urban: 0
Rainfall	Normal Monsoon: 1137.5 mm/ Non-monsoon rainfall: 222.7 mm
Agriculture and Irrigation	The block falls in the Argo-climatic Zone II. The cropping sequence followed in this zone is Rice – Wheat – Moong. The soils in this zone are sandy loam, clayey loam with pH in the range of 6.5 – 7.8. The gross irrigated area is 12924 ha and net irrigated area is 7465 ha.
Geology & Geomorphology	Geomorphologically, most of the area is covered by younger alluvial plain and active flood plain. Back swamps and palaeochannels can also be observed in the vicinity of older river course of Kosi River. Geologically the entire district is covered by alluvium deposits of Quaternary age.
Ground water resource availability and extraction	The dynamic ground water resource of Satar Katiya block has been assessed as 47.27 MCM. The gross ground water draft for all uses stands at 19.79 MCM. The stage of Development is 41.88%.
Existing and future water demand	Irrigation: 1647.5 ham Domestic & Industrial: 332.25 ham
Water level behaviour	The depth to water level During pre-monsoon: 2-5 m bgl During post monsoon: 0-2 m bgl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Palaeochannel
Active Flood plain
Back Swamp
Channel Bar
Younger Alluvial plain
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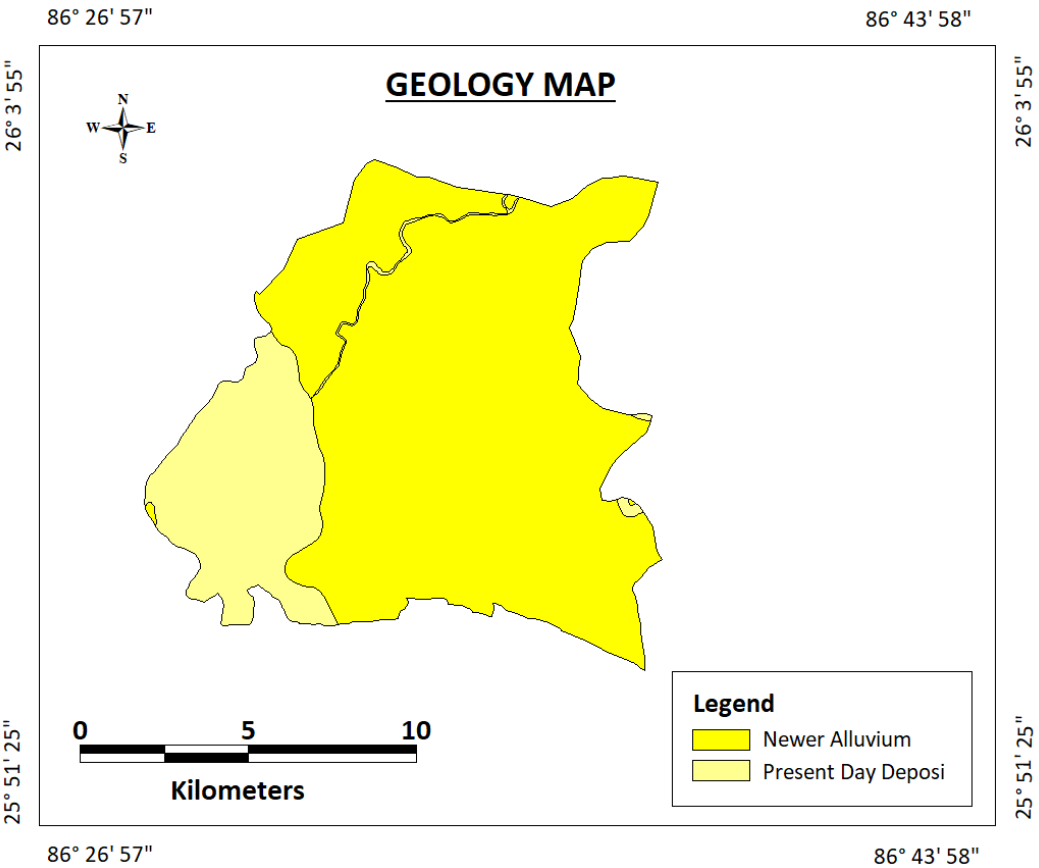
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2. Aquifer Disposition

The area is bestowed with mono- aquifer system. The section depicting the aquifer disposition is shown in district report. The mono-aquifer system extends upto the investigated depth of 165 m. The block forms part of potential groundwater reservoir which gets replenished after every monsoon.

3. Chemical Quality of Ground Water and Contamination

On the basis of Piper diagram and Durov plot, groundwater of the block is potable and based on USSL plot, groundwater is suitable for irrigational purposes. No arsenic contamination has been reported in the district. The flood plains of Kosi river experiences seasonal flooding and water logging during monsoon and remission of water occurs in late October/November. This affects rabi productivity and impart stress on agriculture.

4. 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.

5. Demand Side Interventions

It is recommended to use deeper part of the aquifer for meeting the drinking water supply requirement. Development for irrigation and other uses may be restricted within first 60 m. Requirement of groundwater resource and number of TW's to cater the drinking/domestic demand of the population is estimated and given below.

CD Block/Town	Geology	Present annual resource (mcm) required to cater 100% of population	Average discharge of TW (m3/hr)	Unit draft of one TW in MCM (considering average discharge and 8 hrs/day pumping)	No of Deep Tube well/bore wells
Satar Katiya	Alluvium	3.82	100	0.29	13

The additional resource available may be utilized for creation of additional irrigation potential for less water intense crops like pulses, oilseeds etc by projecting SOD to 70%. The additional irrigation potential created and required number of TW's are estimated and given below.

Block	Area to be brought under Irrigation (ha)	Additional resource required (ham) for pulses/oil seeds	Total Annual Extractable Ground Water (ham)	Present Gross Draft for all uses (ham)	Annual resource availability considering 70% development	Water available for further development (ham)	Additional drinking/domestic requirement	Additional resource available for irrigation (ham)	Area to bring under irrigation for pulses/oilseeds with additional resources (ha)	Remaining Area (ha)	% area to be brought under irrigation by additional resources
Satar Katiya	3893	1946.5	4727.34	1979.75	3309.14	1329.39	121.85	1207.54	2415.07	1477.93	62.04

Block	Volume of water available for future Irrigation development (ham) within 'safe' limit	Additional resource required for future irrigation (ham) within safe limit	Actual additional resource available 3 = (Lowest of 1 and 2)	Unit draft of STW/MDTW (ham)	Required no of STW/MDTW
	1	2	3	4	5
Satar Katiya	1946.5	1207.54	1207.54	2.5	483

6. Demand Side Interventions

In demand side management, micro/precision irrigation is proposed in the block. Micro irrigation intended to effectively utilize water by various techniques such as drips, sprinklers, pivots, rain-guns etc. in the farm. Under Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), popularization of micro irrigation plans is one of the focus areas in order to ensure 'Per drop-More crop'. Under the scheme additional irrigation potential can be created by installing drips, sprinklers, pivots, rain-guns and other application devices. It is proposed that 10% of the command area should be brought under micro/precision irrigation for efficient water management (District Irrigation Plan-Saharsa). The scheme shall be implemented in phase-wise.

Table 1: Dynamic Ground Water Resource (as on 31st March, 2020)

District	Block	Recharge from Rainfall during Monsoon season	Recharge from Rainfall during Non Monsoon season	Recharge from Other Sources during Monsoon season	Recharge from Other Sources during Non Monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharges	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for irrigation	Existing Gross Ground water Draft for Domestic and Industrial Water Supply	Existing Gross Ground Water Draft for All Uses	Provision for Domestic and Industrial Requirement for Next 25 years	Net GW Availability for Future Irrigation Development	Stage of Ground Water Development	Category: Safe / Semi-critical/ Critical/ Over-exploited
Saharsa	Satarkatya	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	Safe
		3925.94	418.54	316.00	315.67	4976.15	248.81	4727.34	1647.50	332.25	1979.75	292.34	2715.50	41.88	

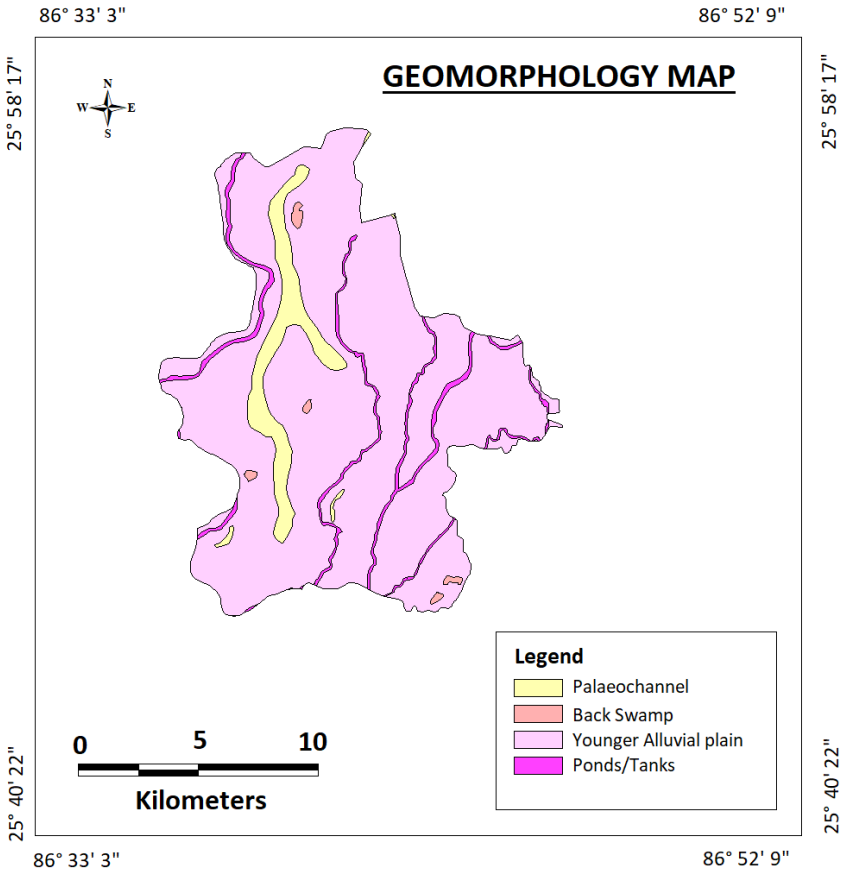
Result of Chemical Analysis of Ground Water Samples

Sl.	Block	Location	pH	EC	TDS	TH	Ca	Mg	Na	K	CO3	HCO3	Cl	SO4	NO3	F
1	Satarkatya	Patodi Bazar	8.32	719.50	467.675	270	48.04	36.38447	66.64	27.18	18	329.6635	92.17	54.5745	0.4457	0.8
2	Satarkatya	Patodi Bazar	8.33	625.10	406.315	250	14.01	52.17767	69	19.45	15	274.7196	141.8	11.6914	0.3715	0.58
3	Satarkatya	Punchga	8.37	993.9	646.035	295	60.05	35.16	48.98	75.	18	305.24	56.72	82.88	0.752	1.3

BLOCK WISE
AQUIFER MAPS AND MANAGEMENT PLANS

1. Salient Information

Name of the Block of Aquifer (in Km²)	**Saurbazar** (188.49 Sq. Km.)
District/State	**Saharsa/Bihar**
Population	Rural: 214,166 Urban: 0
Rainfall	Normal Monsoon: 1137.5 mm/ Non-monsoon rainfall: 222.7 mm
Agriculture and Irrigation	The block falls in the Argo-climatic Zone II. The cropping sequence followed in this zone is Rice – Wheat – Moong. The soils in this zone are sandy loam, clayey loam with pH in the range of 6.5 – 7.8. The gross irrigated area is 12819 ha and net irrigated area is 8403 ha.
Geology & Geomorphology	Geomorphologically, most of the area is covered by younger alluvial plain and active flood plain. Back swamps and palaeochannels can also be observed in the vicinity of older river course of Kosi River. Geologically the entire district is covered by alluvium deposits of Quaternary age.
Ground water resource availability and extraction	The dynamic ground water resource of Saurbazar block has been assessed as 76.29 MCM. The gross ground water draft for all uses stands at 53.01 MCM. The stage of Development is 69.49 %.
Existing and future water demand	Irrigation: 4735 ham Domestic & Industrial: 566.97 ham
Water level behaviour	The depth to water level During pre-monsoon: 2-5 m bgl During post monsoon: 2-5 m bgl


86° 33' 3"
86° 52' 9"
25° 58' 17"
25° 40' 22"
GEOMORPHOLOGY MAP
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Legend
Palaeochannel
Back Swamp
Younger Alluvial plain
Ponds/Tanks
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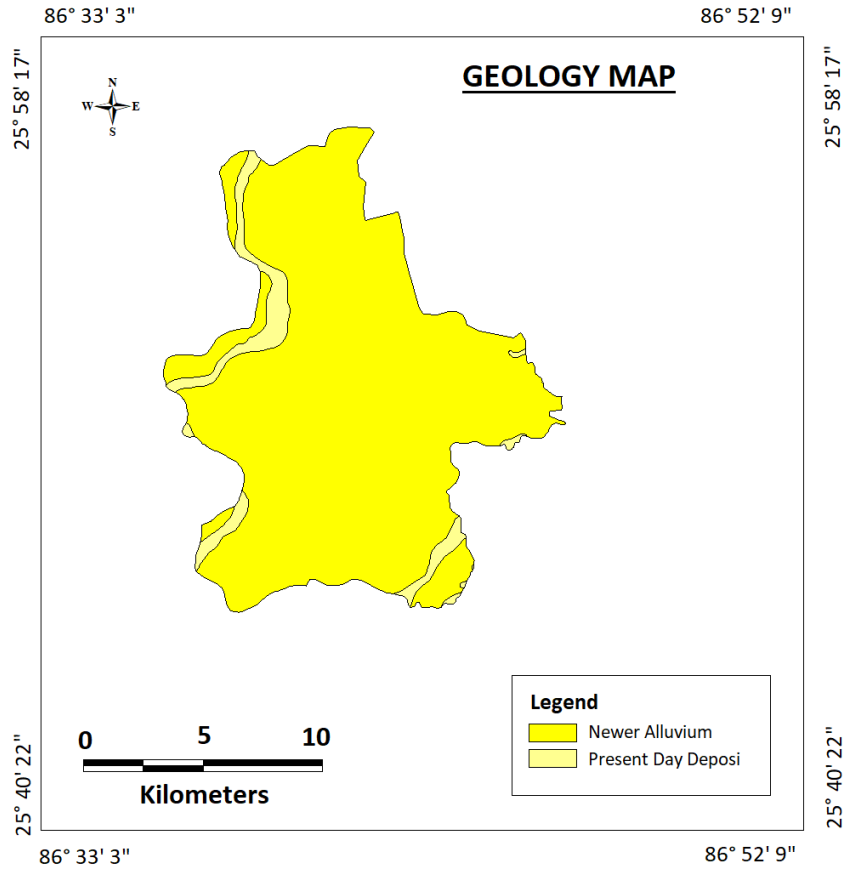
Kilometers


86° 33' 3"
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25° 58' 17"
25° 40' 22"
GEOLOGY MAP
N
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Legend
Newer Alluvium
Present Day Deposi
0
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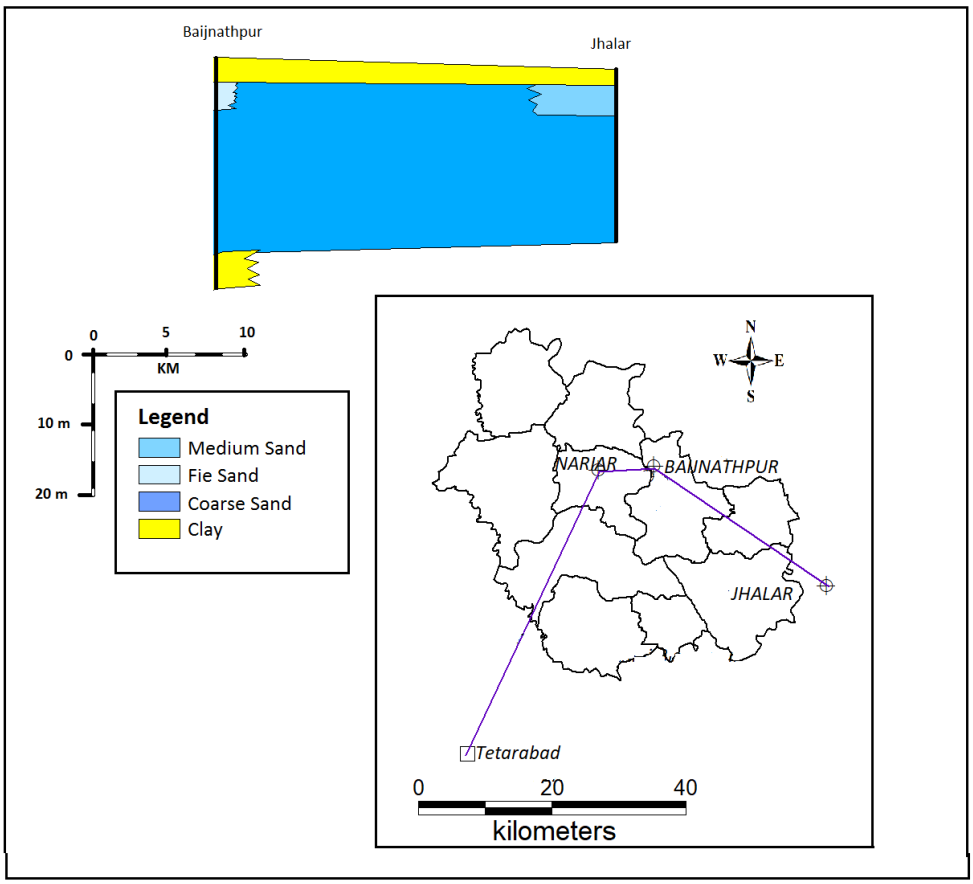
10
Kilometers

2. Aquifer Disposition

The area is bestowed with mono- aquifer system. The section depicting the aquifer disposition is shown in district report. The mono-aquifer system extends upto the investigated depth of 165 m. The block forms part of potential groundwater reservoir which gets replenished after every monsoon.



3. Chemical Quality of Ground Water and Contamination

On the basis of Piper diagram and Durov plot, groundwater of the block is potable and based on USSL plot, groundwater is suitable for irrigational purposes. No arsenic contamination has been reported in the district. The flood plains of Kosi river experiences seasonal flooding and water logging during monsoon and remission of water occurs in late October/November. This affects rabi productivity and impart stress on agriculture.

4. 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.

5. Demand Side Interventions

It is recommended to use deeper part of the aquifer for meeting the drinking water supply requirement. Development for irrigation and other uses may be restricted within first 60 m. Requirement of groundwater resource and number of TW's to cater the drinking/domestic demand of the population is estimated and given below.

CD Block/Town	Geology	Present annual resource (mcm) required to cater 100% of population	Average discharge of TW (m3/hr)	Unit draft of one TW in MCM (considering average discharge and 8 hrs/day pumping)	No of Deep Tube well/bore wells
Saurbazar	Alluvium	5.41	100	0.29	19

The additional resource available may be utilized for creation of additional irrigation potential for less water intense crops like pulses, oilseeds etc by projecting SOD to 70%. The additional irrigation potential created and required number of TW's are estimated and given below.

Block	Area to be brought under Irrigation (ha)	Additional resource required (ham) for pulses/oil seeds	Total Annual Extractable Ground Water (ham)	Present Gross Draft for all uses (ham)	Annual resource availability considering 70% development	Water available for further development (ham)	Additional drinking/domestic requirement	Additional resource available for irrigation (ham)	Area to bring under irrigation for pulses/oilseeds with additional resources (ha)	Remaining Area (ha)	% area to be brought under irrigation by additional resources
Saurbazar	4383	2191.5	7629.28	5301.96	5340.5	38.54	172.76	0	0	4383	0

Block	Volume of water available for future Irrigation development (ham) within 'safe' limit	Additional resource required for future irrigation (ham) within safe limit	Actual additional resource available 3 = (Lowest of 1 and 2)	Unit draft of STW/MDTW (ham)	Required no of STW/MDTW
	1	2	3	4	5
Saurbazar	2191.5	0	0	2.5	0

6. Demand Side Interventions

In demand side management, micro/precision irrigation is proposed in the block. Micro irrigation intended to effectively utilize water by various techniques such as drips, sprinklers, pivots, rain-guns etc. in the farm. Under Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), popularization of micro irrigation plans is one of the focus areas in order to ensure 'Per drop-More crop'. Under the scheme additional irrigation potential can be created by installing drips, sprinklers, pivots, rain-guns and other application devices. It is proposed that 10% of the command area should be brought under micro/precision irrigation for efficient water management (District Irrigation Plan-Saharsa). The scheme shall be implemented in phase-wise.

Table 1: Dynamic Ground Water Resource (as on 31st March, 2020)

District	Block	Recharge from Rainfall during Monsoon season	Recharge from Rainfall during Non Monsoon season	Recharge from Other Sources during Monsoon season	Recharge from Other Sources during Non Monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharges	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for irrigation	Existing Gross Ground water Draft for Domestic and Industrial Water Supply	Existing Gross Ground Water Draft for All Uses	Provision for Domestic and Industrial Requirement for Next 25 years	Net GW Availability for Future Irrigation Development	Stage of Ground Water Development	Category: Safe / Semi-critical/ Critical/ Over-exploited
		(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	
Saharsa	Saurbazar	4483.19	523.35	2111.34	1359.09	8476.97	847.69	7629.28	4735.00	566.97	5301.96	414.46	2281.83	69.49	Safe

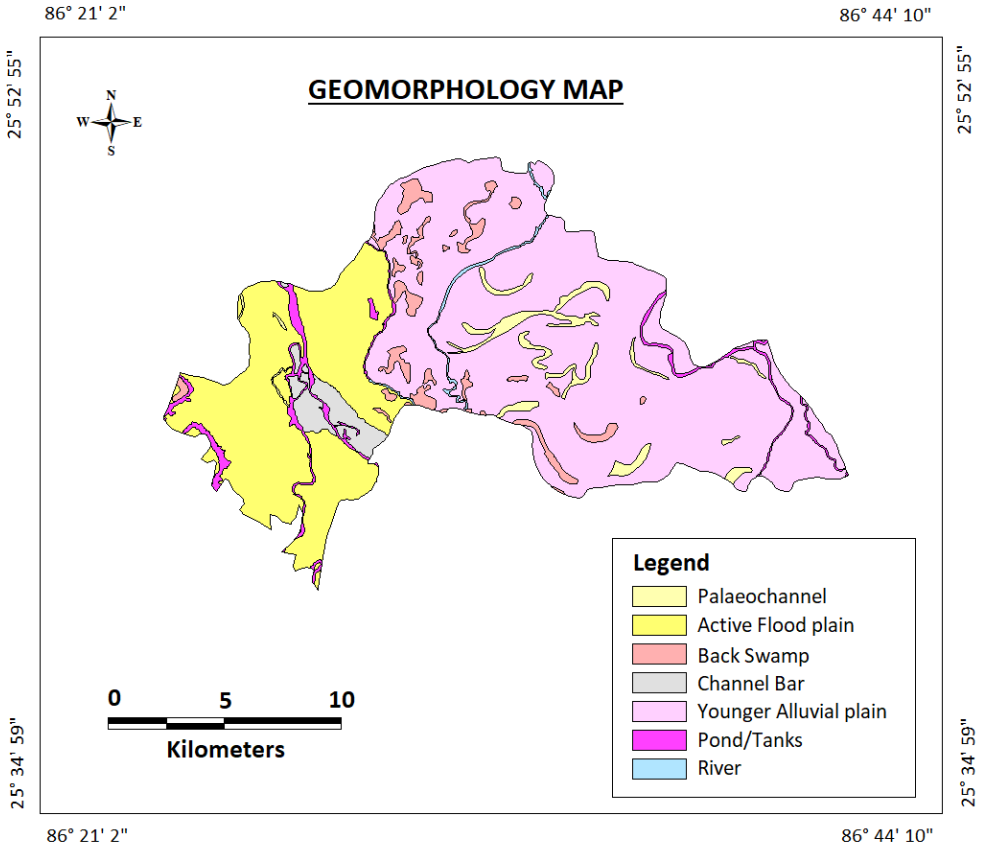
Result of Chemical Analysis of Ground Water Samples

Sl. No.	Block	Location	pH	EC	TDS	TH	Ca	Mg	Na	K	CO3	HCO3	Cl	SO4	NO3	F
1	Saurbazar	Adarch	8.46	1025.00	666.25	255	36.03	40.03107	86.92	100.7	18	360.1879	141.8	91.9521	5.6028	1
2	Saurbazar	Chandaur Purvi	8.30	454.10	295.165	185	24.02	30.32816	48.08	8.99	18	280.8245	38.995	12.3774	0.6019	1

BLOCK WISE
AQUIFER MAPS AND MANAGEMENT PLANS

1. Salient Information

Name of the Block of Aquifer (in Km²)	**Simari Bakhtiyarpur** (213.85 Sq. Km.)
District/State	**Saharsa/Bihar**
Population	Rural: 280,582 Urban: 0
Rainfall	Normal Monsoon: 1137.5 mm/ Non-monsoon rainfall: 222.7 mm
Agriculture and Irrigation	The block falls in the Argo-climatic Zone II. The cropping sequence followed in this zone is Rice – Wheat – Moong. The soils in this zone are sandy loam, clayey loam with pH in the range of 6.5 – 7.8. The gross irrigated area is 13143 ha and net irrigated area is 8420 ha.
Geology & Geomorphology	Geomorphologically, most of the area is covered by younger alluvial plain and active flood plain. Back swamps and palaeochannels can also be observed in the vicinity of older river course of Kosi River. Geologically the entire district is covered by alluvium deposits of Quaternary age.
Ground water resource availability and extraction	The dynamic ground water resource of Simari Bakhtiyarpur block has been assessed as 66.87 MCM. The gross ground water draft for all uses stands at 29.08 MCM. The stage of Development is 43.50%.
Existing and future water demand	Irrigation: 2317.5 ham Domestic & Industrial: 591.39 ham
Water level behaviour	The depth to water level During pre-monsoon: 2-5 m bgl During post monsoon: 2-5 m bgl


86° 21' 2"
86° 44' 10"
25° 52' 55"
25° 34' 59"
GEOMORPHOLOGY MAP
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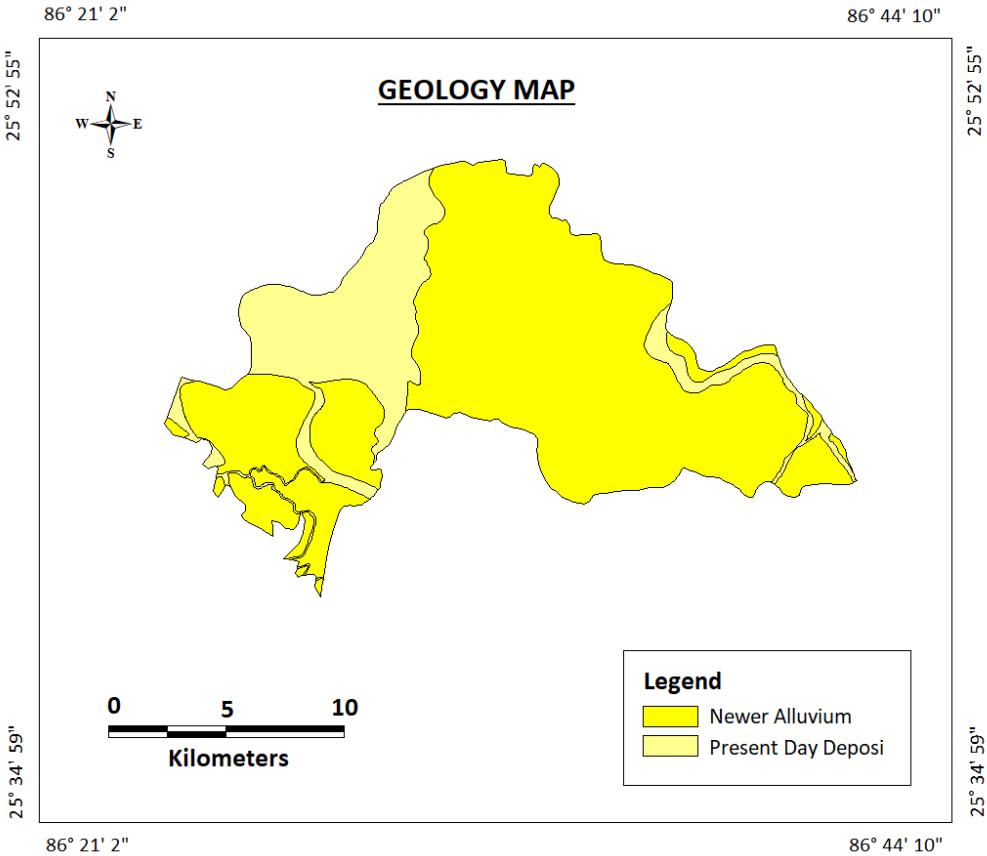
Kilometers
Legend
Palaeochannel
Active Flood plain
Back Swamp
Channel Bar
Younger Alluvial plain
Pond/Tanks
River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GEOLOGY MAP
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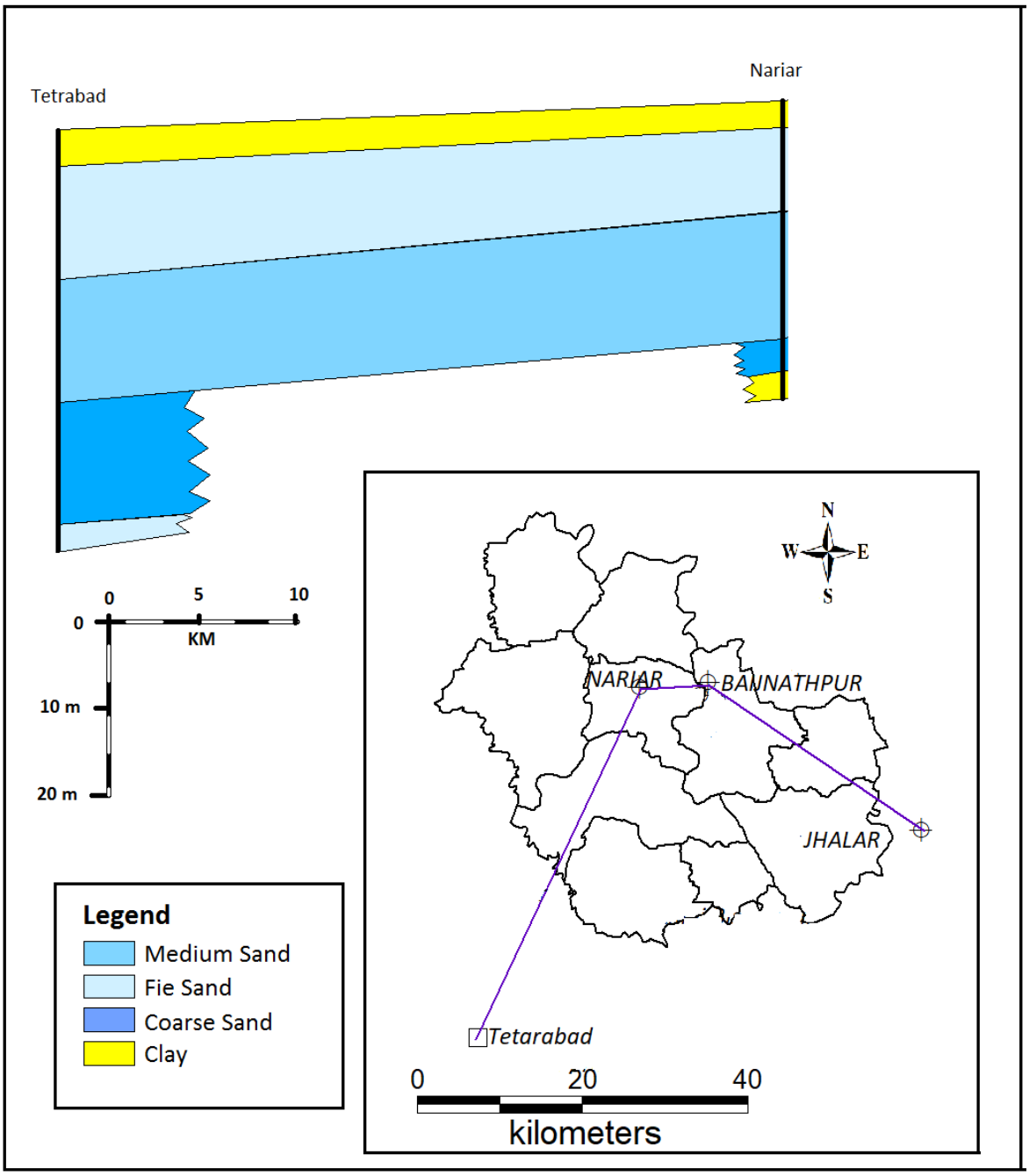
Kilometers
Legend
Newer Alluvium
Present Day Deposi

2. Aquifer Disposition

The area is bestowed with mono- aquifer system. The section depicting the aquifer disposition is shown in district report. The mono-aquifer system extends upto the investigated depth of 165 m. The block forms part of potential groundwater reservoir which gets replenished after every monsoon.



3. Chemical Quality of Ground Water and Contamination

On the basis of Piper diagram and Durov plot, groundwater of the block is potable and based on USSL plot, groundwater is suitable for irrigational purposes. No arsenic contamination has been reported in the district. The flood plains of Kosi river experiences seasonal flooding and water logging during monsoon and remission of water occurs in late October/November. This affects rabi productivity and impart stress on agriculture.

4. 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.

5. Demand Side Interventions

It is recommended to use deeper part of the aquifer for meeting the drinking water supply requirement. Development for irrigation and other uses may be restricted within first 60 m. Requirement of groundwater resource and number of TW's to cater the drinking/domestic demand of the population is estimated and given below.

CD Block/Town	Geology	Present annual resource (mcm) required to cater 100% of population	Average discharge of TW (m3/hr)	Unit draft of one TW in MCM (considering average discharge and 8 hrs/day pumping)	No of Deep Tube well/bore wells
Simri Bakhtiyarpur	Alluvium	7.09	100	0.29	24

The additional resource available may be utilized for creation of additional irrigation potential for less water intense crops like pulses, oilseeds etc by projecting SOD to 70%. The additional irrigation potential created and required number of TW's are estimated and given below.

Block	Area to be brought under Irrigation (ha)	Additional resource required (ham) for pulses/oil seeds	Total Annual Extractable Ground Water (ham)	Present Gross Draft for all uses (ham)	Annual resource availability considering 70% development	Water available for further development (ham)	Additional drinking/domestic requirement	Additional resource available for irrigation (ham)	Area to bring under irrigation for pulses/oilseeds with additional resources (ha)	Remaining Area (ha)	% area to be brought under irrigation by additional resources
Simri Bakhtiyarpur	4390	2195	6687.84	2908.89	4681.49	1772.6	226.33	1546.27	3092.53	1297.47	70.44

Block	Volume of water available for future Irrigation development (ham) within 'safe' limit	Additional resource required for future irrigation (ham) within safe limit	Actual additional resource available 3 = (Lowest of 1 and 2)	Unit draft of STW/MDTW (ham)	Required no of STW/MDTW

	1	2	3	4	5
Simri Bakhtiyarpur	2195	1546.27	1546.27	2.5	619

6. Demand Side Interventions

In demand side management, micro/precision irrigation is proposed in the block. Micro irrigation intended to effectively utilize water by various techniques such as drips, sprinklers, pivots, rain-guns etc. in the farm. Under Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), popularization of micro irrigation plans is one of the focus areas in order to ensure 'Per drop-More crop'. Under the scheme additional irrigation potential can be created by installing drips, sprinklers, pivots, rain-guns and other application devices. It is proposed that 10% of the command area should be brought under micro/precision irrigation for efficient water management (District Irrigation Plan-Saharsa). The scheme shall be implemented in phase-wise.

Table 1: Dynamic Ground Water Resource (as on 31st March, 2020)

District	Block	Recharge from Rainfall during Monsoon season	Recharge from Rainfall during Non Monsoon season	Recharge from Other Sources during Monsoon season	Recharge from Other Sources during Non Monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharges	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for irrigation	Existing Gross Ground water Draft for Domestic and Industrial Water Supply	Existing Gross Ground Water Draft for All Uses	Provision for Domestic and Industrial Requirement for Next 25 years	Net GW Availability for Future Irrigation Development	Stage of Ground Water Development	Category: Safe / Semi-critical/ Critical/ Over-exploited
		(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	
Saharsa	SimariBakhtiyarpur	5086.37	593.77	937.80	813	7430.94	743.10	6687.84	2317.50	591.39	2908.89	542.99	3719.35	43.50	Safe

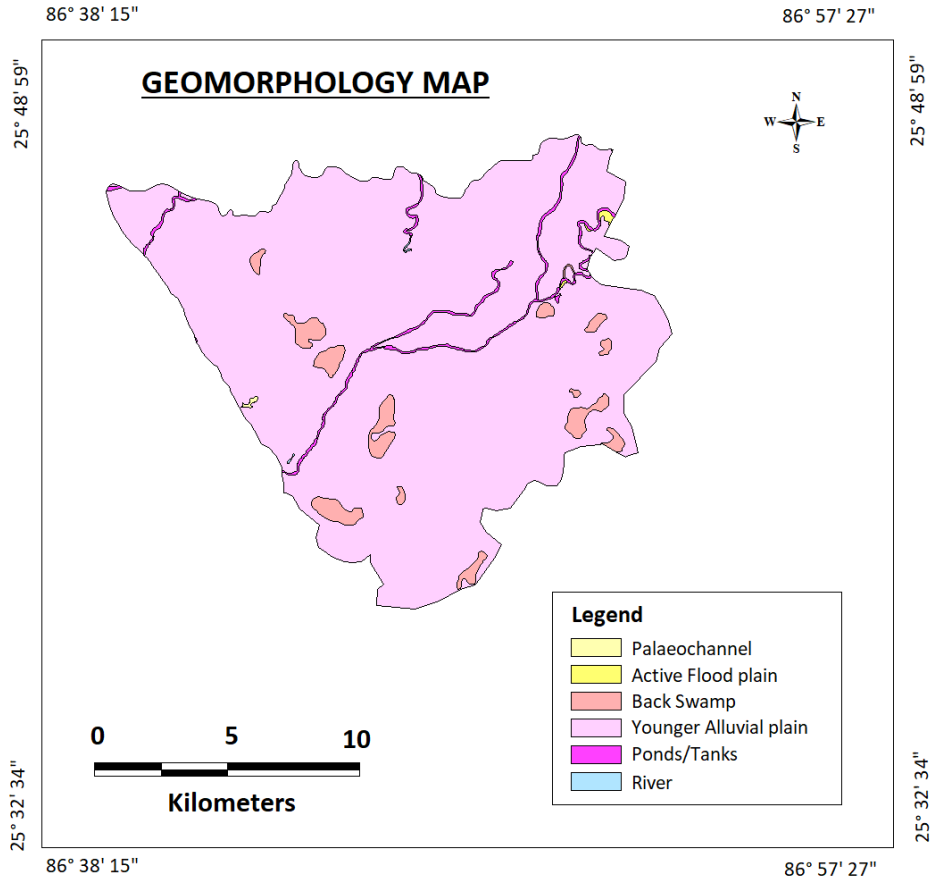
Result of Chemical Analysis of Ground Water Samples

Sl.	Block	Location	pH	EC	TDS	TH	Ca	Mg	Na	K	CO3	HCO3	Cl	SO4	NO3	F
1	S. Bakhtiyarpur	Jamunia	7.90	178.10	115.765	225	16.01	44.89515	14.07	1.78	0	115.9927	85.08	48.303	3.716	0.4
2	S. Bakhtiyarpur	S.Bakhtiarpur	8.33	357.10	232.115	135	40.03	8.475728	76.62	19.88	27	305.244	38.995	5.3398	0.4423	0.49
3	S. Bakhtiyarpur	Simri Bakhtiar	8.43	1156.00	751.4	345	60.05	47.30097	88.18	12.65	18	158.7269	187.885	82.8554	1.207	1

BLOCK WISE
AQUIFER MAPS AND MANAGEMENT PLANS

1. Salient Information

Name of the Block of Aquifer (in Km²)	**Sonbarsa** (210.47 Sq. Km.)
District/State	**Saharsa/Bihar**
Population	Rural: 235,841 Urban: 0
Rainfall	Normal Monsoon: 1137.5 mm/ Non-monsoon rainfall: 222.7 mm
Agriculture and Irrigation	The block falls in the Argo-climatic Zone II. The cropping sequence followed in this zone is Rice – Wheat – Moong. The soils in this zone are sandy loam, clayey loam with pH in the range of 6.5 – 7.8. The gross irrigated area 16190 ha and net irrigated area is 9109 ha.
Geology & Geomorphology	Geomorphologically, most of the area is covered by younger alluvial plain and active flood plain. Back swamps and palaeochannels can also be observed in the vicinity of older river course of Kosi River. Geologically the entire district is covered by alluvium deposits of Quaternary age.
Ground water resource availability and extraction	The dynamic ground water resource of Sonbarsa block has been assessed as 61.30 MCM. The gross ground water draft for all uses stands at 22.91 MCM. The stage of Development is 37.37%.
Existing and future water demand	Irrigation: 1795 ham Domestic & Industrial: 496.31 ham
Water level behaviour	The depth to water level During pre-monsoon: 2-5 m bgl During post monsoon: 2-5 m bgl


86° 38' 15"
86° 57' 27"
GEOMORPHOLOGY MAP
25° 48' 59"
25° 32' 34"
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Palaeochannel
Active Flood plain
Back Swamp
Younger Alluvial plain
Ponds/Tanks
River
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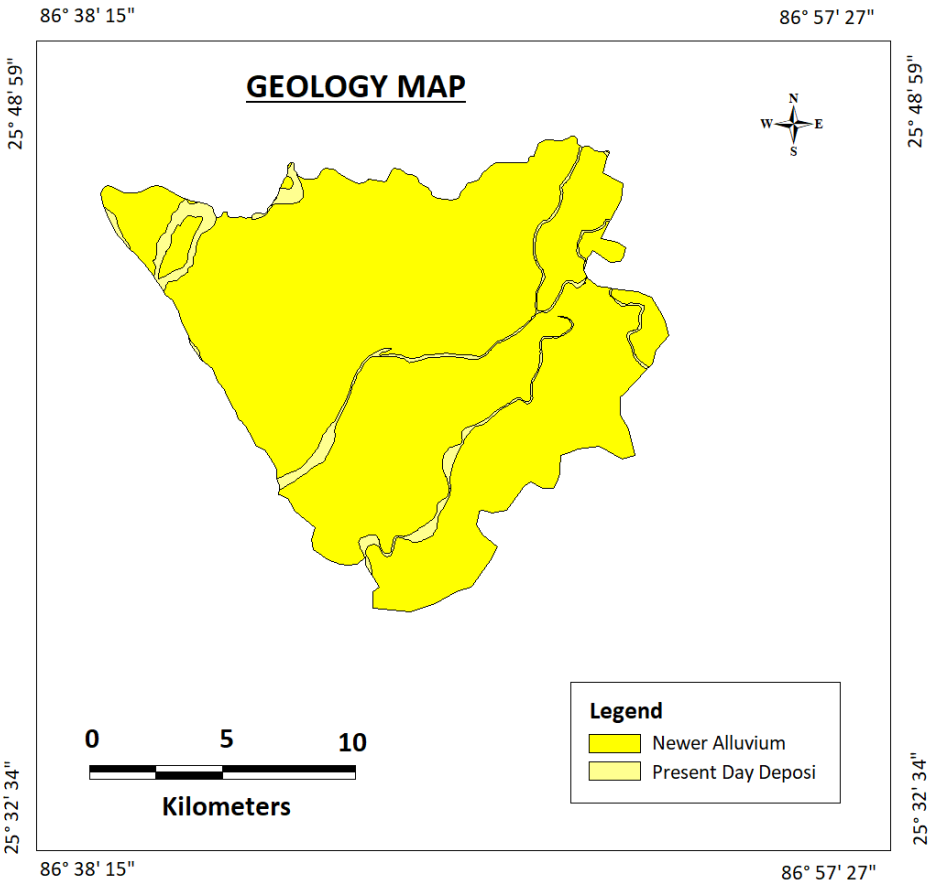
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Newer Alluvium
Present Day Deposi
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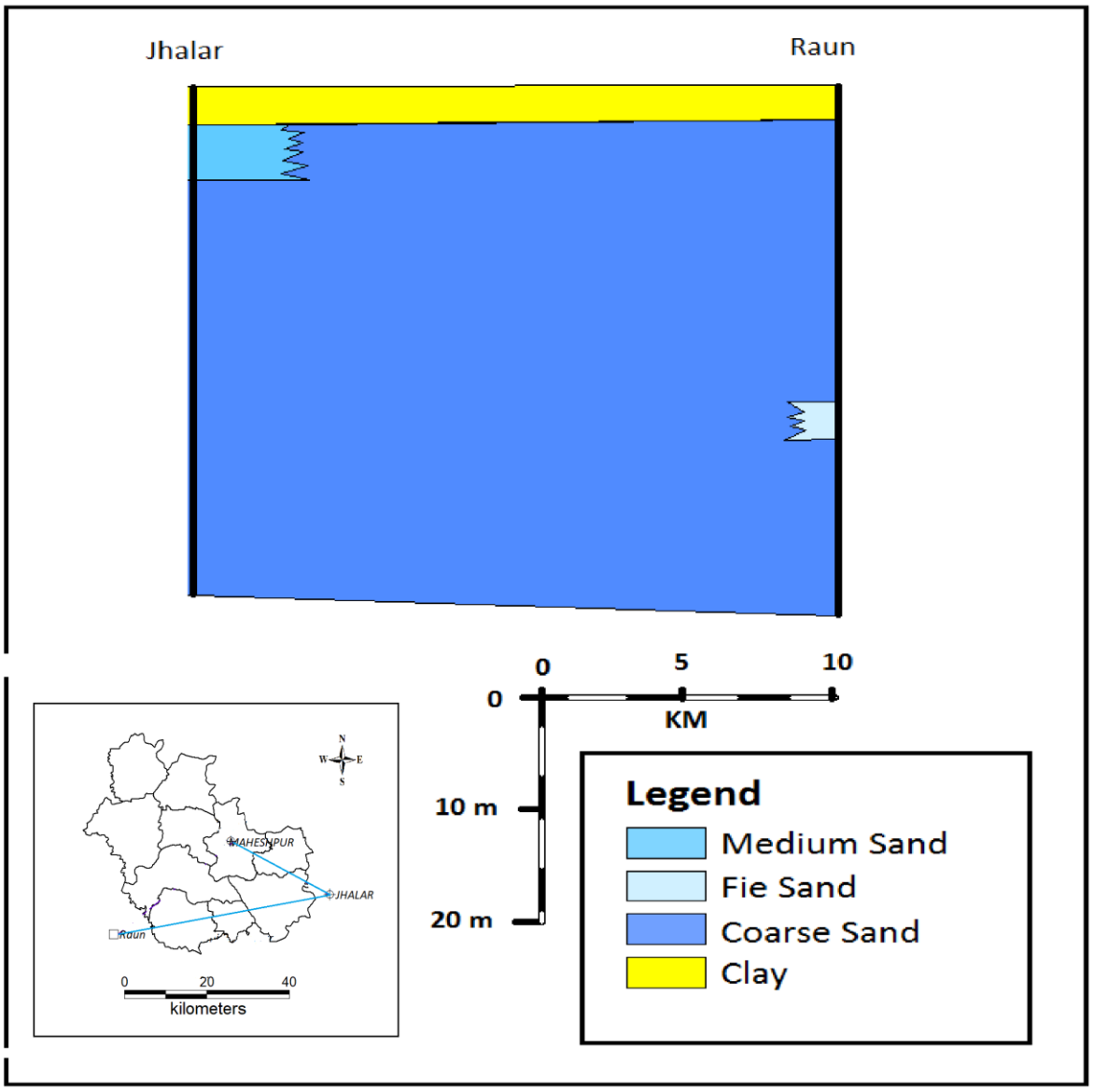
Kilometers

2. Aquifer Disposition

The area is bestowed with mono- aquifer system. The section depicting the aquifer disposition is shown in district report. The mono-aquifer system extends upto the investigated depth of 165 m. The block forms part of potential groundwater reservoir which gets replenished after every monsoon.



3. Chemical Quality of Ground Water and Contamination

On the basis of Piper diagram and Durov plot, groundwater of the block is potable and based on USSL plot, groundwater is suitable for irrigational purposes. No arsenic contamination has been reported in the district. The flood plains of Kosi river experiences seasonal flooding and water logging during monsoon and remission of water occurs in late October/November. This affects rabi productivity and impart stress on agriculture.

4. 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.

5. Demand Side Interventions

It is recommended to use deeper part of the aquifer for meeting the drinking water supply requirement. Development for irrigation and other uses may be restricted within first 60 m. Requirement of groundwater resource and number of TW's to cater the drinking/domestic demand of the population is estimated and given below.

CD Block/Town	Geology	Present annual resource (mcm) required to cater 100% of population	Average discharge of TW (m3/hr)	Unit draft of one TW in MCM (considering average discharge and 8 hrs/day pumping)	No of Deep Tube well/bore wells
Sonbarsa	Alluvium	5.96	100	0.29	20

The additional resource available may be utilized for creation of additional irrigation potential for less water intense crops like pulses, oilseeds etc by projecting SOD to 70%. The additional irrigation potential created and required number of TW's are estimated and given below.

Block	Area to be brought under Irrigation (ha)	Additional resource required (ham) for pulses/oil seeds	Total Annual Extractable Ground Water (ham)	Present Gross Draft for all uses (ham)	Annual resource availability considering 70% development	Water available for further development (ham)	Additional drinking/domestic requirement	Additional resource available for irrigation (ham)	Area to bring under irrigation for pulses/oilseeds with additional resources (ha)	Remaining Area (ha)	% area to be brought under irrigation by additional resources
Sonbarsa	4750	2375	6130.99	2291.31	4291.69	2000.38	190.24	1810.14	3620.28	1129.72	76.22

Block	Volume of water available for future Irrigation development (ham) within 'safe' limit	Additional resource required for future irrigation (ham) within safe limit	Actual additional resource available 3 = (Lowest of 1 and 2)	Unit draft of STW/MDTW (ham)	Required no of STW/MDTW
	1	2	3	4	5
Sonbarsa	2375	1810.14	1810.14	2.5	724

6. Demand Side Interventions

In demand side management, micro/precision irrigation is proposed in the block. Micro irrigation intended to effectively utilize water by various techniques such as drips, sprinklers, pivots, rain-guns etc. in the farm. Under Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), popularization of micro

irrigation plans is one of the focus areas in order to ensure ‘Per drop-More crop’. Under the scheme additional irrigation potential can be created by installing drips, sprinklers, pivots, rain-guns and other application devices. It is proposed that 10% of the command area should be brought under micro/precision irrigation for efficient water management (District Irrigation Plan-Saharsa). The scheme shall be implemented in phase-wise.

Table 1: Dynamic Ground Water Resource (as on 31st March, 2020)

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Saharsa	Sonbarsa	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	Safe
		5093.7	584.38	394.65	380.95	6453.68	322.69	6130.99	1795	406.31	2291.31	456.41	3789.58	37.37	

Result of Chemical Analysis of Ground Water Samples

Sl.	Block	Location	pH	EC	TDS	TH	Ca	Mg	Na	K	CO3	HCO3	Cl	SO4	NO3	F
1	Sonbarsa	Sonbarsaraj	8.40	648.10	421.265	255	42.03	36.38738	26.19	4.86	9	152.622	63.81	56.7914	0.6347	0.71

Annexure - I

Block-wise Land-use Land-cover Details (in ha)

Sl No.	Name of Block	Geographical area (Sq km)	Forest	Area under waste land	Land under other uses	Gross cropped area	Net sown area	Area sown more than one time	Cropping intensity (%)
	1	2	3	4	5	6	7	8	9
1	Banma Itahri	75	29	84	1371	12178	5594	6584	218
2	Kahara	134	7	338	5637	15234	8549	6685	178
3	Mahishi	223	6	0	6677	34282	14374	19908	239
4	Nauhatta	170	126	246	4018	19155	11847	7308	162
5	Patarghat	119	116	575	2016	17689	9395	8294	188
6	Simri Bakhtiarpur	214	0	117	10164	26773	12810	10178	179
7	Satar Kataiya	151	0	29	2954	22043	11358	10684	194
8	Salkhua	177	0	349	5619	22216	11979	14795	224
9	Saur Bazar	188	0	809	4800	22988	12786	9430	174
10	Sonbarsa	210	31	1369	5833	23618	13859	9759	170
Saharsa		**1661**	**314**	**3917**	**49087**	**192558**	**98692**	**93866**	**195**

Annexure - II

Details of Monitoring Wells in Saharsaa District with Water Level

District	Location	Latitude	Longitude	01-05-2019 (m bgl)	01-11-2019 (m bgl)	Fluctuation (m)
SAHARSA	Bangaon	25.86	86.54	2.88	1.5	1.38
SAHARSA	Basudeva	25.87	86.61	2.5	0.93	1.57
SAHARSA	Chainpur	25.83	86.52	2.84	1.38	1.46
SAHARSA	Kharakuti	25.89	86.63	4.87	3.32	1.55
SAHARSA	Panchgachhi	25.98	86.56	3.55	1.93	1.62
SAHARSA	Patodi Bazar	25.91	86.53	3.58	2.18	1.4
SAHARSA	Patodibazar	25.98	86.55	2.77	1.61	1.16
SAHARSA	Potwaha	25.88	86.63	4.12	1.81	2.31
SAHARSA	Saharsa1	25.89	86.53	9	3.16	5.84
SAHARSA	Tulsiyahi	25.93	86.54	2.49	1.07	1.42
SAHARSA	Sonbarsaraj1	25.69	86.7	5.01	3.28	1.73
SAHARSA	Jamunia	25.76	86.56	3.74	2.84	0.9
SAHARSA	Semribaktiarpur	25.73	86.61	4.35	2.55	1.8
SAHARSA	Adrahch	25.78	86.68	4.14	2.11	2.03
SAHARSA	Baidnathpur	25.9	86.66	4.67	2.34	2.33
SAHARSA	Chandaur Purbi	25.85	86.67	4.5	2.29	2.21

Annexure - III

Results of Chemical Analysis Groundwater Samples of Saharsa District

Sl.	Block	Location	pH	EC	TDS	TH	Ca	Mg	Na	K	CO3	HCO3	Cl	SO4	NO3	F
1	Kahara	Basudeva	8.45	513.30	333.645	225	22.02	41.25146	50.11	5.34	15	183.1464	85.08	49.4284	0.895	0.47
2	Kahara	Kharkutti	8.36	801.90	521.235	185	64.05	6.036893	96.67	3.16	3	219.7757	85.08	59.1501	10.8672	1.2
3	Kahara	Tulsiyahi	8.39	805.30	523.445	210	40.03	26.67961	129.86	38.63	30	567.7538	49.63	3.2941	1.7924	1.2
4	Kahara	Chainpura	8.57	320.30	208.195	190	72.06	2.392233	28.71	15.26	30	183.1464	42.54	30.0237	0.3463	0.51
5	Nauhatta	Bangaon	8.30	199.30	129.545	110	32.03	7.266019	27.55	2.59	9	140.4122	24.815	16.0053	0.2993	0.5
6	Satarkatya	Patodi Bazar	8.32	719.50	467.675	270	48.04	36.38447	66.64	27.18	18	329.6635	92.17	54.5745	0.4457	0.8
7	Satarkatya	Patodi Bazar	8.33	625.10	406.315	250	14.01	52.17767	69	19.45	15	274.7196	141.8	11.6914	0.3715	0.58
8	Satarkatya	Punchgachi	8.37	993.90	646.035	295	60.05	35.16505	48.98	75.04	18	305.244	56.72	82.8832	0.7526	1.3
9	Saurbazar	Adarch	8.46	1025.00	666.25	255	[illegible]	40.03107	86.92	100.7	18	360.1879	141.8	91.9521	5.6028	1
10	Saurbazar	Chandaur	8.30	454.10	295.165	185	24.02	30.32816	48.08	8.99	18	280.8245	38.995	12.3774	0.6019	1
11	S.Bakhtiyarpur	Jamunia	7.90	178.10	115.765	225	16.01	44.89515	14.07	1.78	0	115.9927	85.08	48.303	3.716	0.4
12	S.Bakhtiyarpur	S.Bakhtiarpur	8.33	357.10	232.115	135	40.03	8.475728	76.62	19.88	27	305.244	38.995	5.3398	0.4423	0.49
13	S.Bakhtiyarpur	S.Bakhtiarpur-	8.43	1156.00	751.4	345	60.05	47.30097	88.18	12.65	18	158.7269	187.885	82.8554	1.207	1
14	Sonbarsa	Sonbarsaraj	8.40	648.10	421.265	255	42.03	36.38738	26.19	4.86	9	152.622	63.81	56.7914	0.6347	0.71
15	Kahra	Baijnathpur	8.09	636.60	413.79	215	72.06	8.460194	53.17	24.48	0	286.9294	63.81	55.7787	1.0693	0.92
16	Kahra	Potwaha	7.93	178.90	116.285	65	12.01	8.48932	71.84	27.03	0	85.46832	124.075	2.7947	0.7933	0.56
17	Kahra	Saharsa 1	8.48	1162.00	755.3	405	62.05	60.64951	58.84	3.4	15	286.9294	138.255	37.8159	4.0273	0.8

(All in mg/L except pH, EC, TH)

Annexure IV

Unique ID		1
Location		MAHESHPUR
Taluka/Block		Sonbarsa
District		Saharsa
Lat		25.8407
Long		86.6498
RL (m amsl)		42.5
Drilled Depth		67.1
Depth range (m)		Lithology
0	3.05	clay
3.05	6.1	fine sand and clay
6.1	12.2	fine sand
12.2	15.25	medium to coarse sand
15.25	18.3	coarse sand
18.3	27.45	coarse sand and pebbles
27.45	33.55	coarse sand
33.55	42.7	medium sand
42.7	61	coarse sand
61	64.05	clay
64.05	67.1	sandy clay

Unique ID		2
Location		BAIJNATHPUR
Taluka/Block		Sour Bazar
District		Saharsa
Lat		25.8888
Long		86.6463
RL (m amsl)		47.9
Drilled Depth		70.15
Depth range (m)		Lithology
0	6.1	clay & fine sand
6.1	9.15	fine sand
9.15	12.2	med sand
12.2	15.25	fine sand
15.25	57.95	coarse sand
57.95	70.15	clay

Unique ID		3
Location		SAKHUA
Taluka/Block		Sour Bazar
District		Saharsa
Lat		25.8422
Long		86.6691
RL (m amsl)		43.9
Drilled Depth		79.3
Depth range (m)		Lithology
0	3.05	supper clay
3.05	6.1	fine sand
6.1	12.2	medium sand
12.2	18.3	medium sand
18.3	27.45	clay
27.45	33.55	medium sand
33.55	36.6	coarse sand
36.6	38.735	medium sand
38.735	41.785	hand clay
41.785	51.85	medium sand
51.85	54.9	coarse sand
54.9	57.95	medium sand
61	64.05	coarse sand

64.05	67.1	medium sand
67.1	70.15	hard clay
70.15	73.2	medium sand
73.2	76.25	coarse sand
76.25	79.3	fine sand to medium sand

Unique ID	4
Location	PATUAHA
Taluka/Block	Kahra
District	Saharsa
Lat	25.8746
Long	86.6362
RL (m amsl)	46.2
Drilled Depth	61

Depth range (m)		**Lithology**
0	3.05	clay
3.05	12.2	medium sand
12.2	58.865	coarse sand
58.865	61	fine sand

Unique ID	5
Location	NARIAR
Taluka/Block	Kahra
District	Saharsa
Lat	25.8834
Long	86.5623
RL (m amsl)	45.2
Drilled Depth	73.2

Depth range (m)		**Lithology**
0	3.05	clay
3.05	6.1	fine sand
6.1	12.2	medium sand
12.2	27.45	fine sand
27.45	30.5	medium sand
30.5	61	medium sand
61	67.1	medium to coarse sand with pebbles
67.1	73.2	clay

Unique ID	6
Location	BELHA
Taluka/Block	Sour Bazar
District	Saharsa
Lat	25.8662
Long	86.6594
RL (m amsl)	45.8
Drilled Depth	67.1

Depth range (m)		**Lithology**
0	3.05	clay
3.05	12.2	fine sand
12.2	15.25	coarse sand
15.25	18.3	medium sand
18.3	21.35	coarse sand
21.35	24.4	medium sand
24.4	48.8	coarse sand
48.8	51.85	fine sand
51.85	61	coarse sand
61	67.1	hard clay