केन्द्रीय भूमि जल बोर्ड

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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

Purnea District
Bihar

मध्य पूर्वी क्षेत्र, पटना

Mid Eastern Region, Patna

Report on

जलभृत मानचित्रण और भूजल प्रबंधन योजना
पूर्णिया जिला, बिहार
Aquifer Mapping and Ground Water Management Plan
Purnea District, Bihar

AAP – 2020-21

Under Overall Guidance of

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Aquifer Mapping and Management Plan
(2020-21)
Purnea district, Bihar

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CHAPTER 1

INTRODUCTION

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

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

1.1 Objective and Scope

The major objectives of aquifer mapping are

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

The groundwater management plan includes Ground Water recharge, conservation, harvesting, development options and other protocols of managing groundwater. These protocols will be the real derivatives of the aquifer mapping exercise and will find a place in the output i.e, the aquifer map and management plan.

The main activities under NAQUIM are as follows:

a. Identifying the aquifer geometry

b. Aquifer characteristics and their yield potential

c. Quality of water occurring at various depths

e. Preparation of aquifer maps and

f. Formulate ground water management plan.

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

1.2 Approach and Methodology

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

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

Compilation of existing data (Central & State Govt.)

↓

Generation of different thematic layers

↓

Identification of Primary Aquifer

↓

Identification of data gaps

↓

Data generation (water level, exploration, geophysical, hydrochemical, hydrogeological etc.

↓

Aquifer Maps with 3D disposition

↓

Preparation of Aquifer Management Plan

↓

Capacity building in all aspects of ground water through IEC Activities

1.3 Area details and brief description

Purnea district has a total geographical area of 3229 Km² lying in between north latitudes 25°21'00" and 26°05'26", and east longitudes 86°59'30" and 87°51'18". The area covers part of Survey of India topo-sheet no. 72 0 and 22 N. The district is flanked by other four districts of Bihar. In the east lies Kishanganj, in the west Madhepura, in the north Araria and in the south Katihar.

The district town Purnea is connected by Meter Gauge railway line with Katihar Junction of N.E. Railway. The same meter gauge line connects Purnea with Banmankhi town, from where the line bifurcates to Bihariganj and Murliganj sides. The district headquarter is connected to the capital, Patna by National Highway No. 31. Block headquarters are connected with district headquarters by all-weather metal road. There are good network of roads connecting various remote localities with block and district headquarters (**Figure-1**)

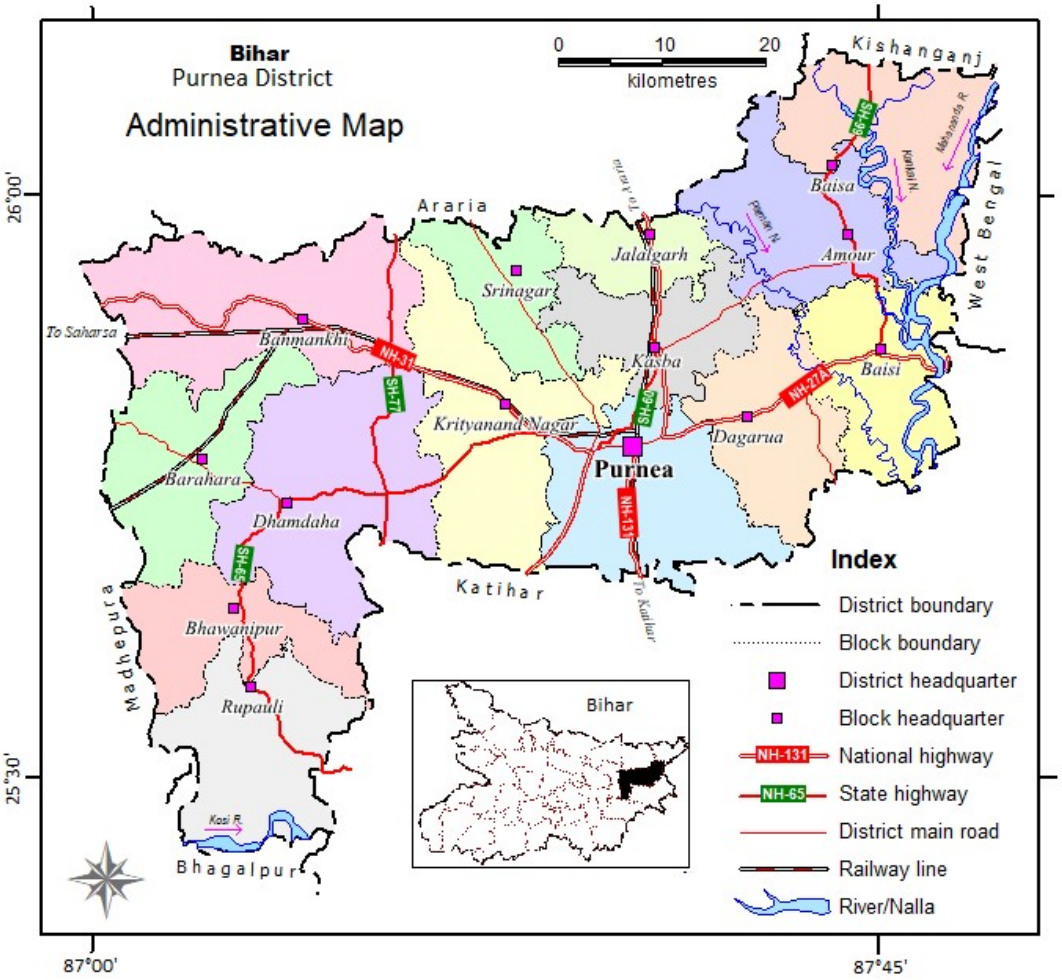


Figure 1: Administrative map

The district has eleven community development blocks under four civil sub divisions, covering 1280 revenue villages. These sub divisions are namely Purnea Subdivisions, Banmankhi Sub-divisions, Vaisi Sub-divisions , and Damdaha SubDivision (Table-1.2).

Table 1: Subdivisions and Blocks

Sub Division	No	Block
Purnea Sadar	1	Purnea east
	2	Jalalgarh
	3	kasba
	4	Krityanand Nagar
	5	Srinagar
Dhamdaha	6	Dhamdaha
	7	Rupauli
	8	Bhawanipur
	9	Barhara
Baisi	10	Amour
	11	Baisa
	12	Baisi
	13	Dagarua
Banmankhi	14	Banmankhi

purnea.nic.in/subdivision-blocks

1.4 **Demography**

The district has population of 3264619 (2011 census) out of which 90% are rural and 10 % urban. About 81% of urban population is concentrated in Purnea only and in two other small clusters, namely Banmankhi and Kasba, where it is nearly over five thousand. Scheduled caste population is 390991 (12%) and scheduled tribe population is 139490 (4%) **(Table-2).** Population wise districts constitute 3% of the state population. It has a population density of 1011 persons/Km^2. The district has 1699370 male and 1565249 female populations with sex ratio of 921 females per 1000 males. The district has a total work force of 1143318 persons. Out of which 197424 are cultivator, 745015 are agriculture labours and 28840 are household industry worker thereby, that 82% of the total workforce is dependent upon agriculture activities.

Table 2: Demographic Data

SN	Name	Geographical Area (Ha)	Total	Rural	Urban	SC Population	ST Population
1	Banmankhi	36884	351415	321079	30336	66622	18776
2	Barhara	22971	209000	209000	0	41162	16253
3	Bhawanipur	16064	161720	161720	0	16403	3415
4	Rupauli	24836	234686	234686	0	24376	3985
5	Dhamdaha	36254	288084	288084	0	42639	25756
6	Krityanand Nagar	28470	230504	230504	0	43891	12837
7	Purnea East	25727	445326	163078	282248	49626	26687
8	Kasba	16797	188341	157920	30421	13799	12711
9	Srinagar	14221	110058	110058	0	19941	5650
10	Jalalgarh	11320	112951	112951	0	20613	2059
11	Amour	24505	290559	290559	0	7022	1520
12	Baisa	20732	193127	193127	0	12803	1930
13	Baisi	20463	227706	227706	0	12469	1201
14	Dagarua	20995	221142	221142	0	19625	6710
	Total	320239	3264619	2921614	343005	390991	139490

1.5 Data Availability and Data Adequacy

1.4 Data Availability

The drilling data (Lithologs) has been taken from total 15 tube wells drilled by the State Govt. and other agency. Total 19 permanent observation well (National hydrograph Network Station) has been taken to represent ground water scenario of the area. These are being monitored by Central Ground Water Board 04 times in a year for ground water regime of phreatic (shallow) aquifer and one time ground water sampling for chemical analysis (Pre-monsoon) to assess its chemical quality. The water samples are taken from total 20 locations which have collected during May 2019. In addition to that 7 samples from ground water and 3 samples from surface water, collected during Nov. 2020, are also taken to know the chemical quality of ground water.

1.6 Climate and Rainfall

In general sub-tropical climate prevails in the district. The district experiences summer during the month of April to June and winter during December to January. During the month of January and February the climate is pleasant and salubrious. Monsoon sets during mid of June and ends in 1st week of October. The temperature varies from 25°C to 47°C in summer months and reduces to 4°C to 25°C in winter months. The humidity varies from 41% in summer month to 70% in winter month.

The rainfall is largely confined to the southwest monsoon. The district receives about 82% of the annual rainfall from southwest monsoon. In general, July is the month with the highest rainfall with an average value of 434.2 mm. On an average, there are 54 rainy days (i.e. days with rainfall of 2.5 mm or more) in a year in the district. Month-wise normal rainfall is presented in **Figure 2**

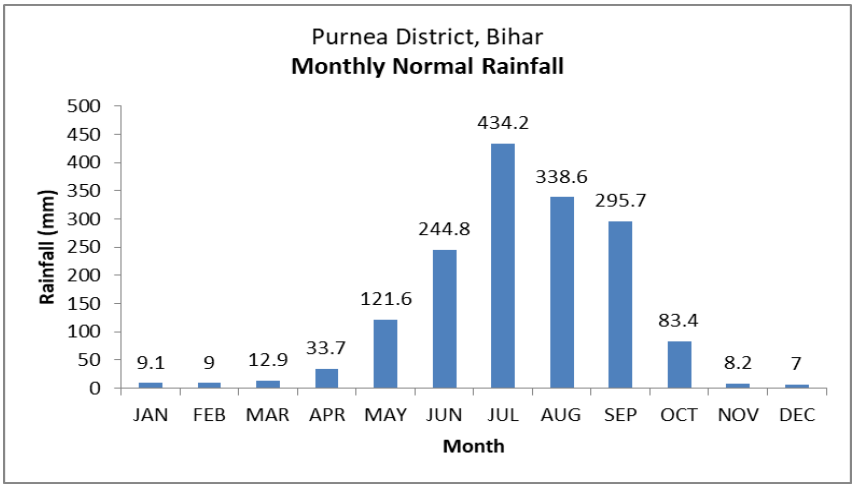


Figure 2: Monthly normal rainfall

In comparison to normal rainfall (1951-2000) pattern, it is observed that the rainfall occurring in the districts depicts that there is an absolute departure of last five years average rainfall from normal rainfall. **(Table-3).** There is a decrease in rainfall in the month of June and July except the year 2020. The rainy season is considerably delayed in the district. Thereby it affects the timely-sowing of Kharif crops.

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

YEAR	JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEPT		OCT		NOV		DEC	
	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP
2016	6.0	-34	1.2	-87	24.3	88	22.0	-35	280.3	131	217.6	**-11**	396.8	**-9**	113.6	-66	333.2	13	71.5	-14	0.0	-100	0.0	-100
2017	4.9	-47	0.0	-100	75.9	488	120.1	256	221.5	82	112.4	**-54**	404.6	**-7**	529.4	56	152.7	-48	147.0	76	0.0	-100	0.0	-100
2018	0.0	-100	0.0	-100	0.0	-100	84.7	151	75.6	-38	214.8	**-12**	244.2	**-44**	394.3	16	159.8	-46	23.4	-72	0.0	-100	11.1	59
2019	0.1	-99	40.0	371	0.0	-100	64.8	59	73.3	-46	251.5	**-12**	352.2	**-29**	193.6	-48	528.3	72	38.3	-61	0.0	-100	3.6	-39
2020	13.4	57	7.1	-16	80.6	555	114.0	180	218.0	61	535.3	**87**	516.9	**4**	330.0	-11	603.0	96	43.3	-55	0.0	-100	0.1	-98

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

1.6 Physiographic setup

The district forms part of Kosi mega alluvial fan. Physiographically, it represents gently sloping flat monotonous land with regional slope varying from 0.2 m/Km to as low as 0.08 m/Km. The regional slope is towards south-east direction. The relief of the landform varies from 43.2 m amsl (near Bausi) in north to 35.1 m (near Hardi) in south. On regional scale it represents a flat topography. On micro level, there are a series of undulations present in the

area. These undulations have come into existence during shifting of river Kosi westward and degradation and aggradation processes simultaneously working on it.

1.7 Physiographic DEM

The elevation in the area ranges from 30 to 57.8 m above mean sea level (SRTM data with WGS 84 Spheroid).The generated elevation map by SRTM map is given in **fig-3.** It shows that general slop of the area is towards north to south direction.

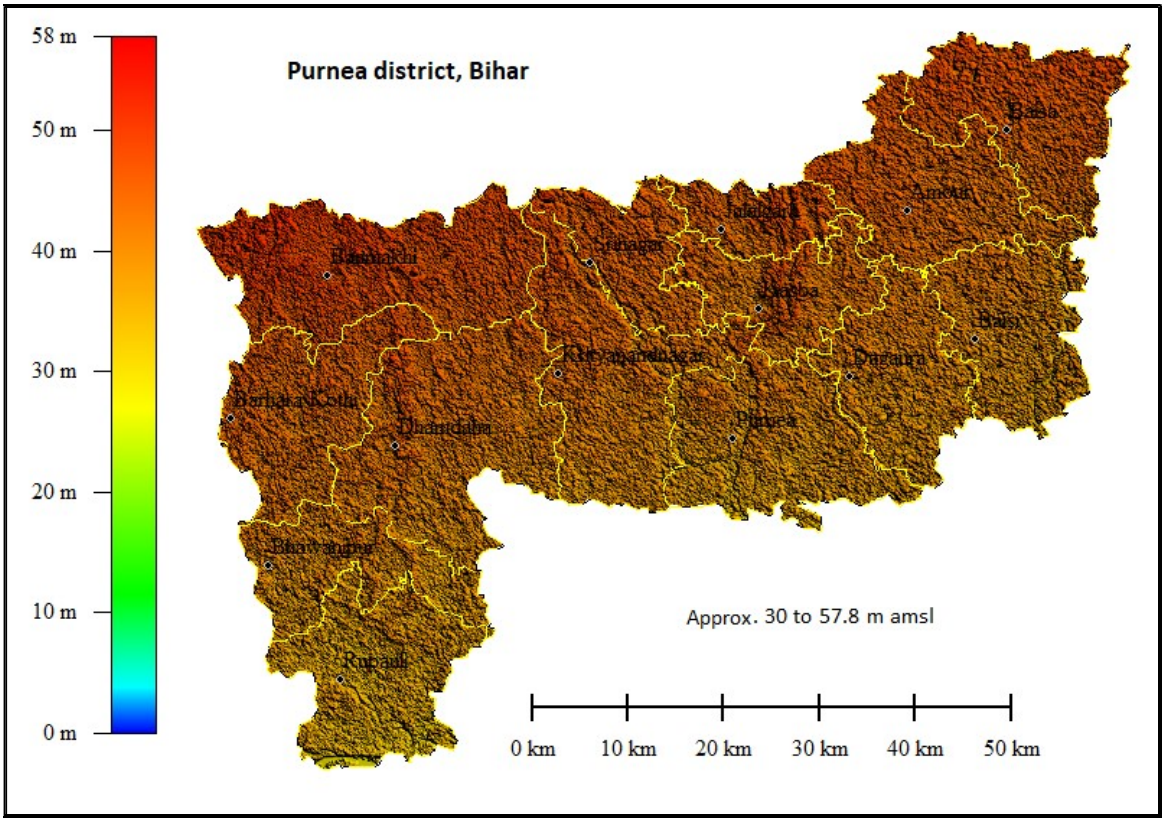


Figure 3: DEM of the area based on SRTM Data

1.8 Geomorphology

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

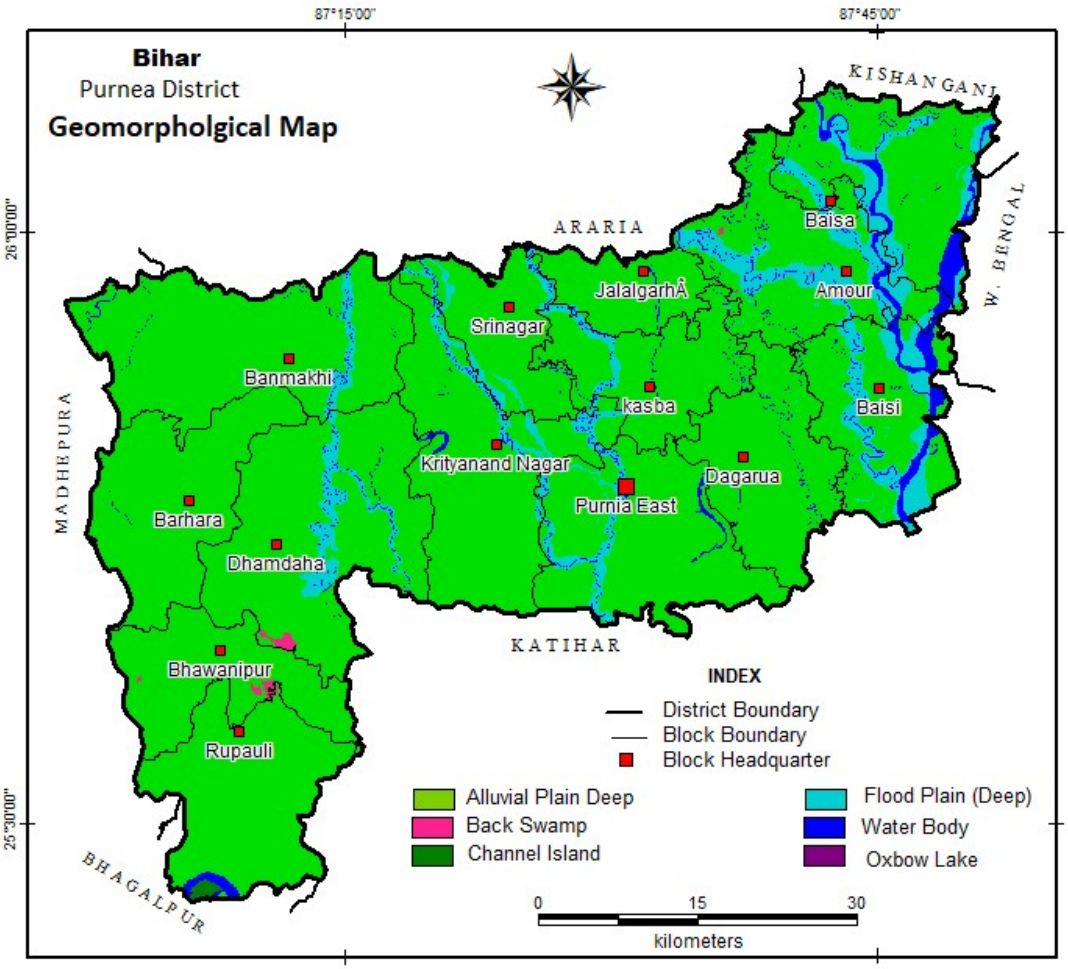


Figure 4: Geomorphology

1.9 Land Use

To know the spatial distribution of the '**land use Land Cover (10K): SIS-DP**, a map obtains (on 20 April. 2020) from the website https://bhuvan-app1.nrsc.gov.in/ and given in **Figure 5**. The data of land use has also been collected from the website of 'Web Based Land Use Statistics System' and presented in table. Based on the data presented in table a pie chart has also been prepared and given as **figure 6.** The table inferred that the principal utilisation of land is under agriculture and almost evenly distributed in the district. It occupies nearly 52% of the area reported for LUC (313883 ha). Fallow lands include 24 % of the area and forest cover only 0.04% of the area reported. Other major land utilisations are the lands put under non-agriculture use

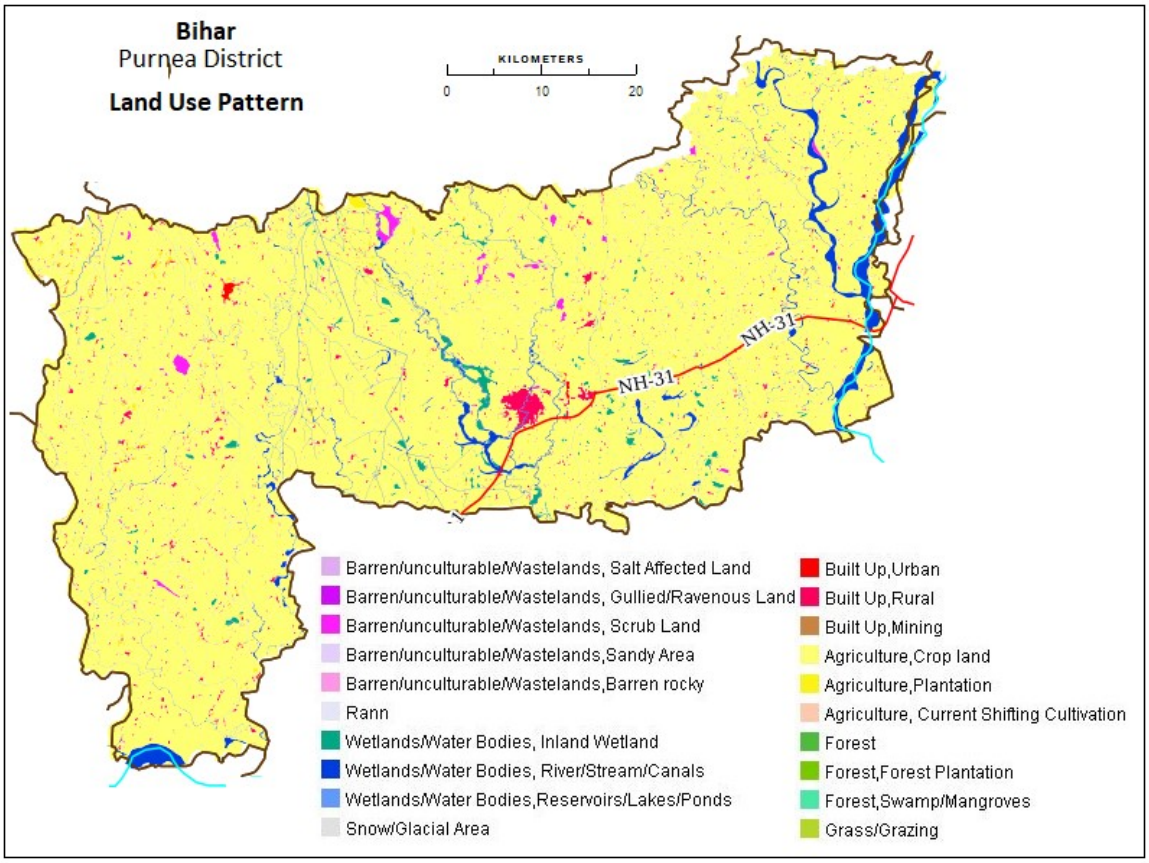
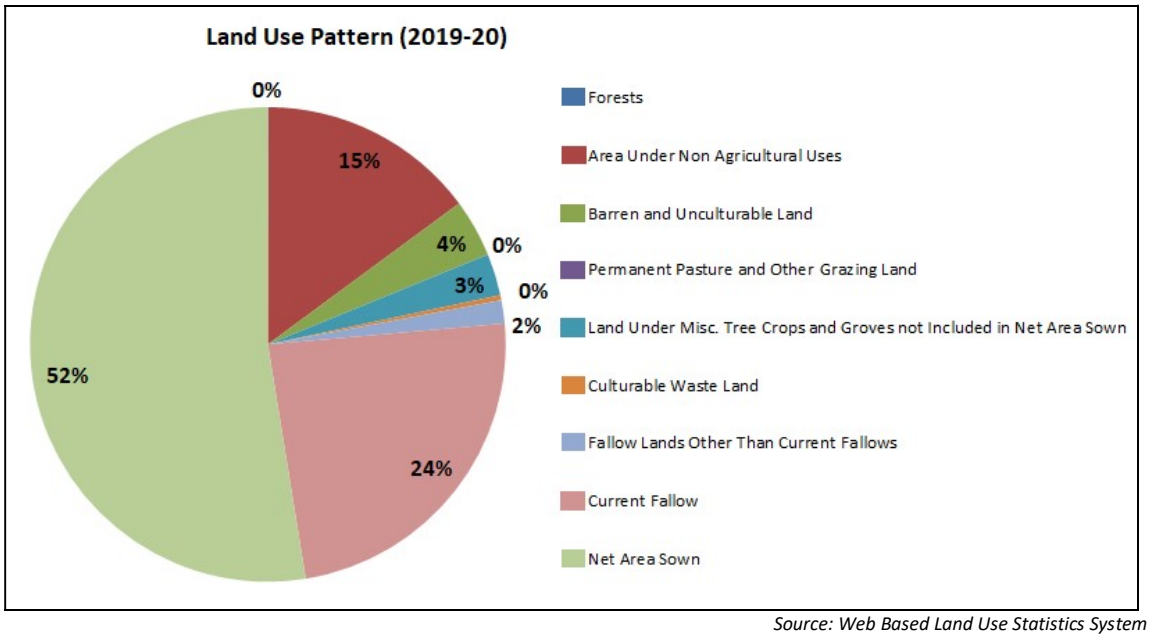


Figure 5: Land use map



Source: Web Based Land Use Statistics System

Figure 6: Land use pattern

Table 4: Land use pattern (2017-18)

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

Reporting Area for LUS			313883
Classification of Reporting Area	Forests		113
	Not Available for Cultivation	Area Under Non Agricultural Uses	46581
		Barren and Unculturable Land	12329
		Total	**58910**
	Other Uncultivated Land Excluding Fallow Land	Permanent Pasture and Other Grazing Land	42
		Land Under Misc. Tree Crops and Groves not Included in Net Area Sown	8927
		Culturable Waste Land	1104
		Total	**10073**
	Fallow Land	Fallow Lands Other Than Current Fallows	4950
		Current Fallow	74891
		Total	**79841**
Net Area Sown			164946
Cropped Area			181171
Area Sown More Than Once			16225

In Hactare

Source: Web Based Land Use Statistics System

1.10 Soil

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

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

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

The GIS layer of soil has been downloaded from 'GSI' and its 'classes' are grouped based on the soil texture and presented in **figure 7.** The map reveals that major part of the district is covered with the coarse loamy soil and fine loamy soil. The fine soil can be seen only near eastern boundary of the district. No area has been classified as 'clayey'. It indicates that overall the area has good infiltration rate.

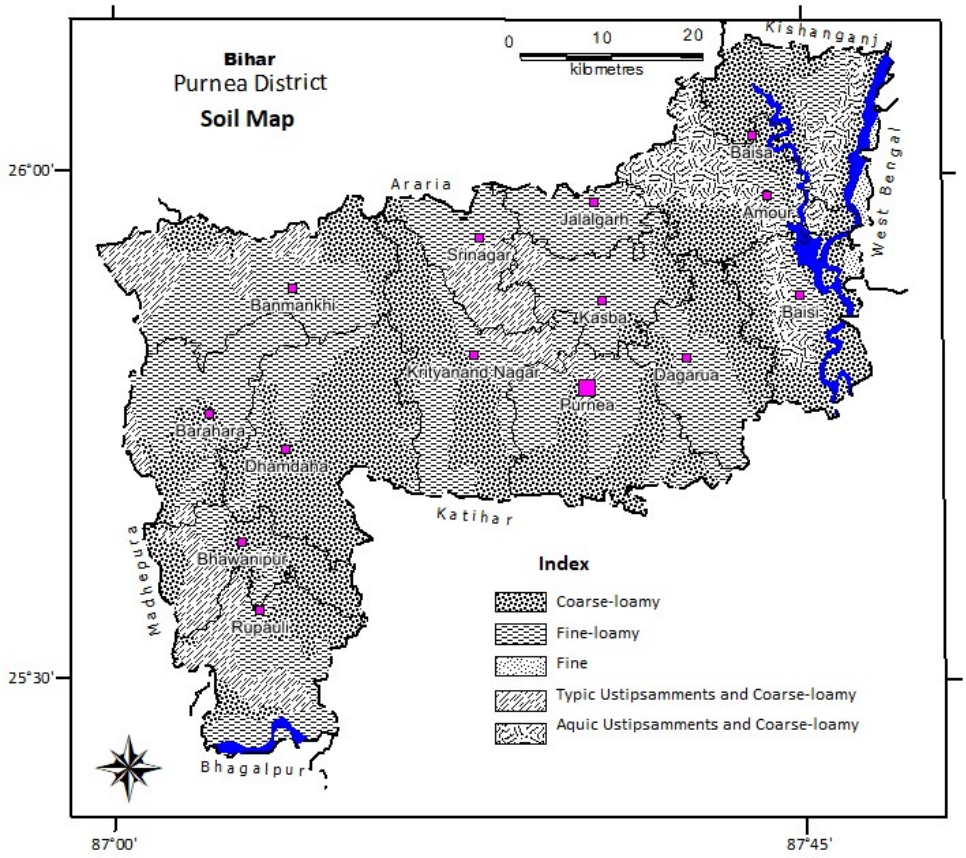


Figure 7 : Soil map

1.11 Hydrology and Drainage

As per the 'Watershed Atlas of India (CGWB)' the district is a part of Lr. Ganga basin. In the district there are two distinct sub-basins which drain the water of the area into river Ganga These are – Gandak and Others river sub-basin occupying about 35% of the area and drained into the Kosi river, the other is Bhagirathi and Others river sub-basin occupying nearly 65% of the area drained into Mahananda river. The drainage map shown in **Figure-8** has been reproduced after downloading from http://gis.bih.nic.in/

Drainage in parts of Kosi basin in the district is marked by presence of 'Dhars'. These Dhars are abandoned channels of river Kosi, left behind in the course of its migration. They originate at different places in the plain and flow in north south direction. The rivers are effluents in nature with wide variation of discharges during lean and flush period. Some the dhars are locally known as Katua Dhar, Saura Nala, Kankai nala, Riga nadi. In the eastern part of the district flows Mahanda river. The river Kosi and its tributaries exhibit copy book dichotomic drainage pattern. In the remaining part of the district the drainage pattern in sub-parallel to sub-dentritic.

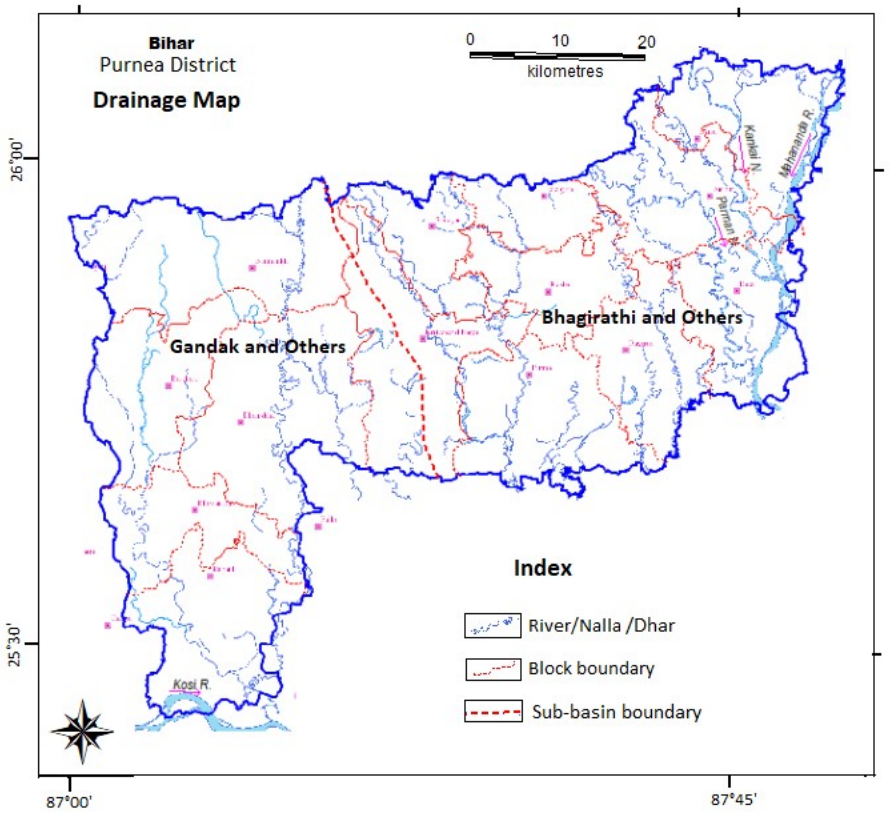


Figure 8: Drainage Map

1.12 Agriculture

The Purnea district has agrarian economy. About 82% of the total workforce is engaged in agriculture as principal economic activity in Purnea district. The district is part of Agro-climatic zone (NARP) of North East Alluvial Plain Zone (BI-2) II. Fertile alluvial plain of the district is coupled with favourable climate boosted agricultural activity. The main crops of the district are Jute, Rice and Potato. The **tables-7** shows the production and productivity of major crops for the year 2019-20.

Table 5: Crop Production Statistics for the Year 2019-20

Crops	Area (Hectare)	Production (Tonnes)	Yield (Tonnes/Hectare)
Groundnut	1	1	1.00
Horse-gram	42	39	0.93
Jute	1309	27461	20.98
Linseed	13	11	0.85
Maize	46659	405348	8.69
Masoor	576	490	0.85
Mesta	2	6	3.00
Moong (Green Gram)	865	756	0.87
Onion	53	708	13.36
Peas & beans (Pulses)	9	9	1.00
Potato	10572	160525	15.18
Rapeseed &Mustard	383	436	1.14

Rice	104459	184691	1.77
Sesamum	1	1	1.00
Sugarcane	2	121	60.50
Sunflower	15	22	1.47
Urad	15	14	0.93
Wheat	10421	25735	2.47

https://Purnea.kvk4.in/

1.13 Cropping Pattern

Rice, Maize, Potato, Wheat etc. are is the main crop of Purnea district. The season wise areas under different crops are given in Table. **(Table 6).** The net sown area during the year is 164946 ha only whereas the Area Sown More Than Once is 16225 ha. The cropping intensity of the district is calculated to be 109.8% (2019-20). About 0.79% area also included for Jute in net sown area. This crop requires about 20 days soaking in water. **Table 7** shows the sowing and harvesting period of major crops of the district.

Table 6: Table 8: Area under major crops in Purnea district, Bihar for the year ending 2016-17

Crops	Season	Area (Hectare)
Groundnut	Kharif	1
Horse-gram	Kharif	42
Jute	Kharif	1309
Linseed	Rabi	13
Maize	Autumn	1069
	Rabi	45267
	Summer	323
	Total	**46659**
Total - Maize		46659.00
Masoor	Rabi	576
Mesta	Kharif	2
Moong (Green Gram)	Kharif	348
	Summer	517
	Total	**865**
Total - Moong(Green Gram)		865.00
Onion	Rabi	53
Peas & beans (Pulses)	Rabi	9
Potato	Rabi	258
	Winter	10314
	Total	**10572**
Total - Potato		10572.00
Rapeseed &Mustard	Rabi	383
Rice	Autumn	150
	Summer	463
	Winter	103846
	Total	104459
Total - Rice		**104459**
Sesamum	Kharif	1
Sugarcane	Whole Year	2
Sunflower	Rabi	15
Urad	Kharif	15
Wheat	Rabi	10421

Source: Web Based Land Use Statistics Information System

Table 7: Sowing and harvesting period of some major crops

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

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

1.14 Irrigation

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

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

	Depth Range in m below ground level					
Block	0-20	20 to 35	35 to 40	40 to 60	60 to 70	>70
Amour	2041	1398	0	0	0	0
Baisa	2105	1343	0	0	0	0
Baisi	981	1034	0	0	0	0
Banmankhi	745	1074	0	0	0	0
Barharakothi	253	1080	0	0	0	0
Bhawanipur	563	861	0	0	0	0
Dagarua	2414	985	0	0	0	0
Dhamdaha	235	1334	0	0	0	0
Jalalgarh	1045	121	0	0	0	0
Kasba	94	877	0	0	0	0
K. Nagar	354	1443	0	0	0	0
Purnea E	1278	856	0	0	0	0
Rupouli	12	1627	0	0	0	0
Total	**12120**	**14033**				

The data of 5th MI census reveals that no well has been found to be categorised above the depth range of 35 m bgl. Hence all the wells in the district are shallow tube wells only. **Figure 9** shows that in Amour, Baisa, Dagarua, Jalalgarh and Purnea block, depth of majority of the wells are less than 20 m bgl which indicates the presence of productive aquifer at shallow depth. The next depth range of 20 to 35 m bgl is more common in Srinagar, Rupouli, Barharakothi, Dhamdaha, Kasba and Krityanand Nagar block.

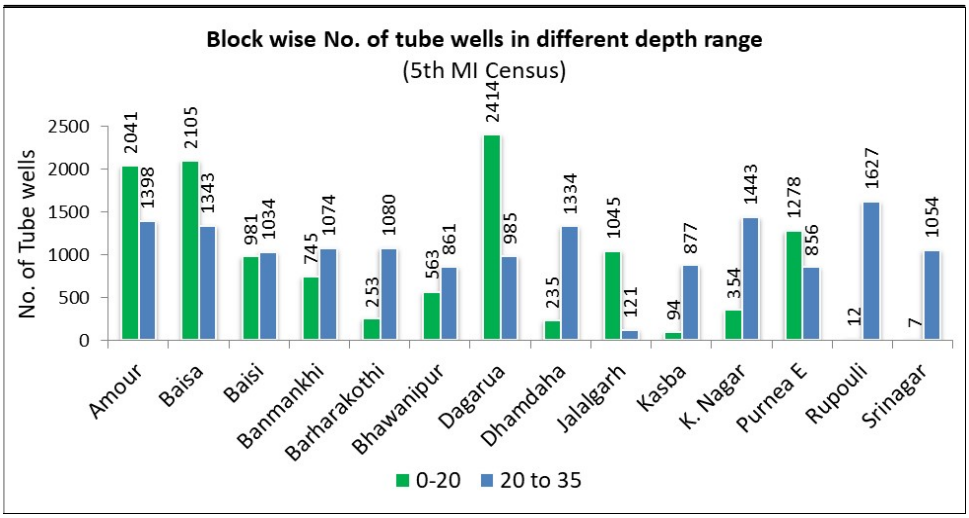


Figure 9: Block wise and depth wise Number of tube wells in 5th Minor Irrigation Census

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

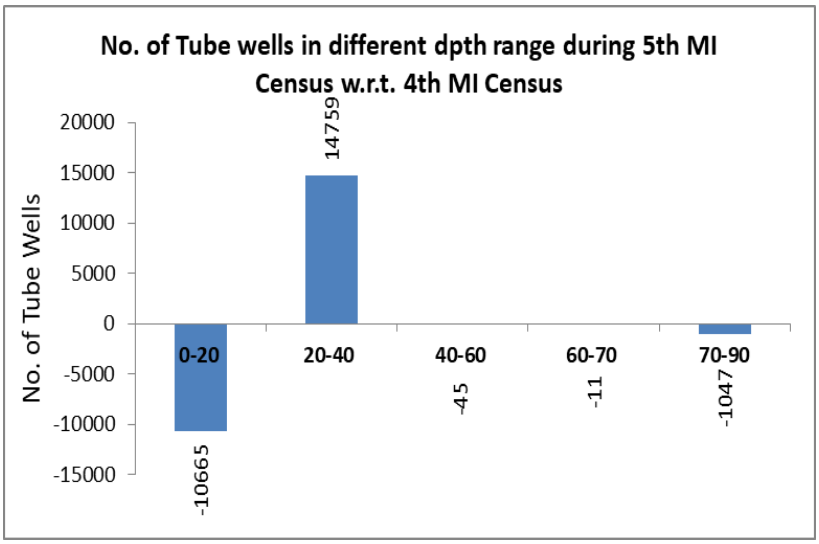


Figure 10: No. of Tube Wells in 5th MI Census w.r.t. 4th MI Census

Number of tube wells categorised under different depth range are remarkably changed in 5th MI census. Total 10665 number of tube well from 4th MI census (2006-07) to

5th MI (2013-14) census has been decreased within the depth of 20 m bgl and whereas 14794 number of tube wells increased in the next depth range of 20 to 40 (35) m bgl. **(Figure -10**). It indicates that there may be drying up the shallow aquifer, availability of power energy for ground water exploitation from deeper depth and/or a sense of surety of groundwater availability for a long time.

Figure 11 shows that in every block, number of tube well in the depth range of 20 to 40 m bgl is increased. The number of tube well in the range of down to 20 m bgl is remarkably decreased in Baisi, Barhara kothi, Bhawanipur, Dhamdaha, Kasba, K. Nagar, and Ropouli block whereas in Amour, Baisi and Purnea E block it is increased.

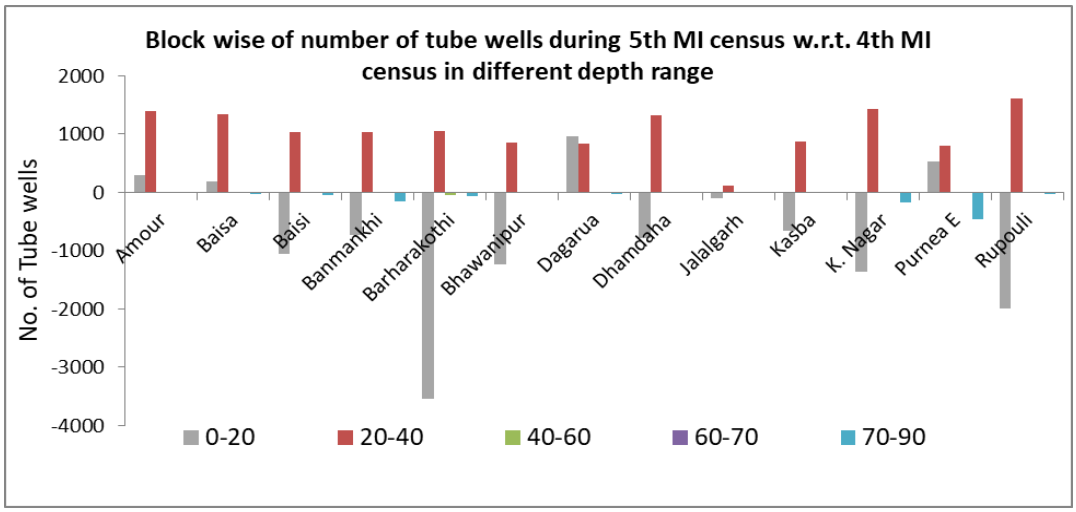


Figure 11: Block wise Number of Tube Well during 5th MI Census w.r.t. 4th MI Census

Canal (Surface water) is the second major source of irrigation after ground water. This canal irrigation system is a part of Kosi Irrigation Project. The Kosi Irrigation project was conceived in 1953-54. Under this project a Barrage at Birpur over river Kosi was constructed as a joint Indo-Nepal venture. Two main canal viz East and West Kosi canal takes off providing irrigation to Supaul, Madhepura, Saharsa, Araria, Purnea, Darbhanga and Madhubani district. Purnea district forms tail-end area of Eastern Kosi Canal Command area. The Canal Command irrigation in Purnea district is 154,631 Ha. Eastern Kosi Canal System consists of a main canal, four branch canals and a number of its distributaries and minors. The length of the main canal is about 43.4 km and length of its Purnea branch canal is 64 km. It has been assumed that the availability of irrigation facilities from Eastern Kosi Canal is not dependent upon rainfall.

As the **figure 12** shows that Amour, Baisa and Baisis block have negligible facility of canal irrigation system.

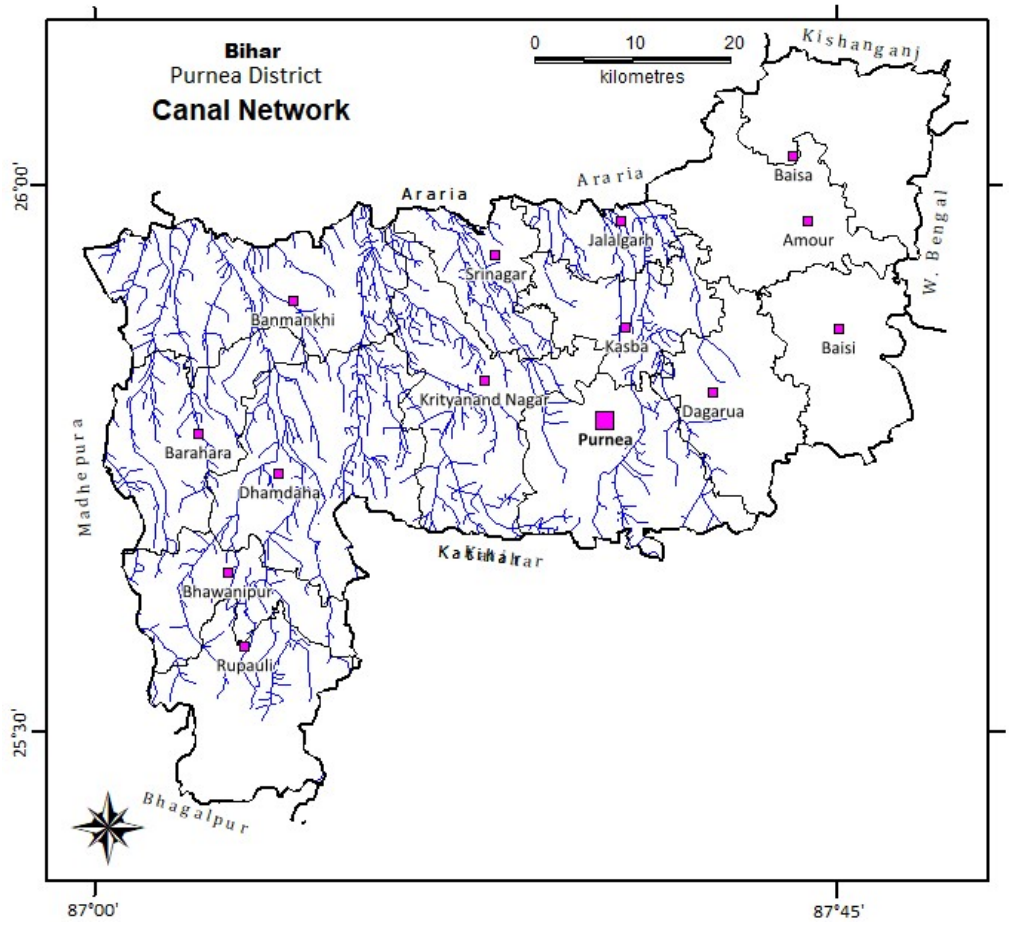


Figure 12: Canal Network

Table 9: Length of Some Major Canal

Name of Canal	Unit in Km	
	Length of Canal	Length upto Water Reached
Banmankhi Distributory	28.2	28.2
Dhamdaha Distributory	52.73	52.73
Srinagar Distributory	48.92	38.41
Kursela Distributory	56.58	17.68
Katihar Distributory	68.37	68.37

An analysis of the contribution of major sources for irrigation has been done after downloading the data from 'Web Based Land Use Statistics Information System'. Downloaded data is presented in **Table – 10.**

The reference year of 4th (2006-07) and 5th (2013-14) MI census, study period (2020-21) and a previous year (2019-20) have been taken for analysis. The contribution of Tank in irrigation is nil and in comparison to wells and canals, contribution of other sources is very less.

Table 10: Year wise and Source wise Irrigated Area (ha)

Year			2006-07	2013-14	2019-20	2020-21
Net Irrigated Area	Canal	Government	18135	8034	16545	8896
		Private	-	-	-	-
		Total	18135	8034	16545	8896
	Tank		-	-	-	-
	Well	Tube well	59050	45170	93024	50019
		Other Well	-	-	-	-
		Total	59050	45170	93024	50019
	Other Source		-	1159	2373	1275
	Total		77185	54363	111942	60190
Gross Irrigated Area	Canal	Government	18135	33393	25393	18155
		Private	-	-	-	-
		Total	18135	33393	25393	18155
	Tank		-	-	-	-
	Well	Tube well	153925	110650	143278	102386
		Other Well	-	-	-	-
		Total	153925	110650	143278	102386
	Other Source		-	1779	3473	2481
	Total		172060	145822	172144	123022

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

The source wise irrigated area has been taken for the preparation of **figure 13.** It indicates that in comparison to the canal (surface water), tube well (ground water) covers the major part of the area irrigated. Year wise, total irrigated area is varied. In the given figure, during the year 2019-20 largest area is irrigated. The figure also indicates that the tube wells and canal do not compensate each other. Hence it may be inferred that demand of water for irrigation is dependent on rainfall and the availability of water in canal may not affects the exploitation of ground water for irrigation.

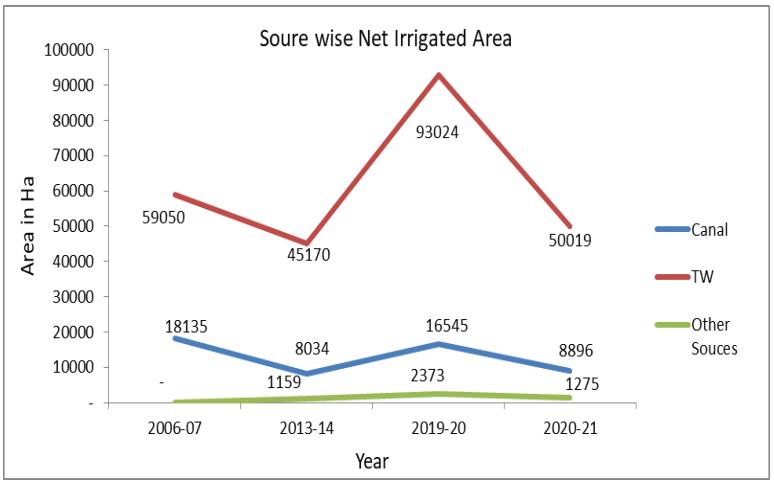


Figure 13: Year wise and Source wise Irrigated Area (ha)

The **figure 14** represents the source wise and year wise net irrigated area (NIA) and gross irrigated area (GIA) in the district. The figure 13 reveals that canal water may not fulfil irrigation demand for second (Rabi) crops (yr 2006-07) but tube well is reliable source for irrigation and covers larger part of irrigated area. It reveals that the groundwater, as already in practice, can be easily exploited in the area as a reliable source from shallow depth.

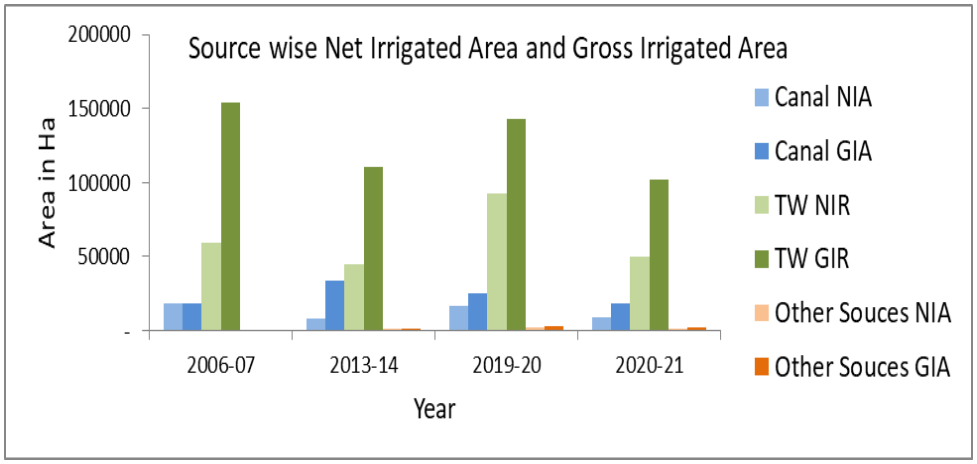


Figure 14: Source wise Net Irrigated Area and Gross Irrigated Area

CHAPTER 2

2. DATA COLLECTION AND COMPILATION

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

2.1 Data collection and Compilation:

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

i. Hydrogeological Data: Water level data of 19 key wells and historical water level trend of monitoring wells were collected and compiled representing phreatic aquifer.

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

*iii. Tube Wells data***:** The data of exploratory wells from 15 locations of state agencies drilled has been taken.

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

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

2.2 Data Generation:

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

2.2.1 Ground water Monitoring Wells

Total 19 NHNS monitored to assess the ground water scenario of shallow aquifer (Aquifer-I) of the area. The depth of these dug well varies from 2.10 to 13.00 mbgl. Similarly, the diameters of key wells (dug wells) ranges from 1.60 to 4.80 m. During 2018, the pre monsoon (May) depth to water level in these wells was between 2.24 to 5.58 m bgl. The post monsoon depth to water level (Nov. 2018) in the dug wells ranges from 1.8 to 4.06 mbgl. Average pre-monsoon water level was calculated 3.89 m bgl and in post monsoon 2.66 m bgl respectively. A detail of key wells and water level data is presented in **Annexure – I**

2.2.2 Ground Water Exploration

On perusal of **table- 11**, total 10 exploratory wells drilled in Araria and Katihar district have been taken to assess the aquifer characteristics of the area.

2.2.3 Ground Water Quality

To assess the quality of ground water, 20 samples were collected from dug wells representing Aquifer – I

2.2.5 Micro Level Hydrogeological Data Acquisition

The micro level study has been badly affected by the Covid-19 pandemic. However post monsoon survey in limited area has been carried out and 7 ground water samples and 3 surface water samples have been collected.

2.2.6 Thematic Layers

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

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

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

3. DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING

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

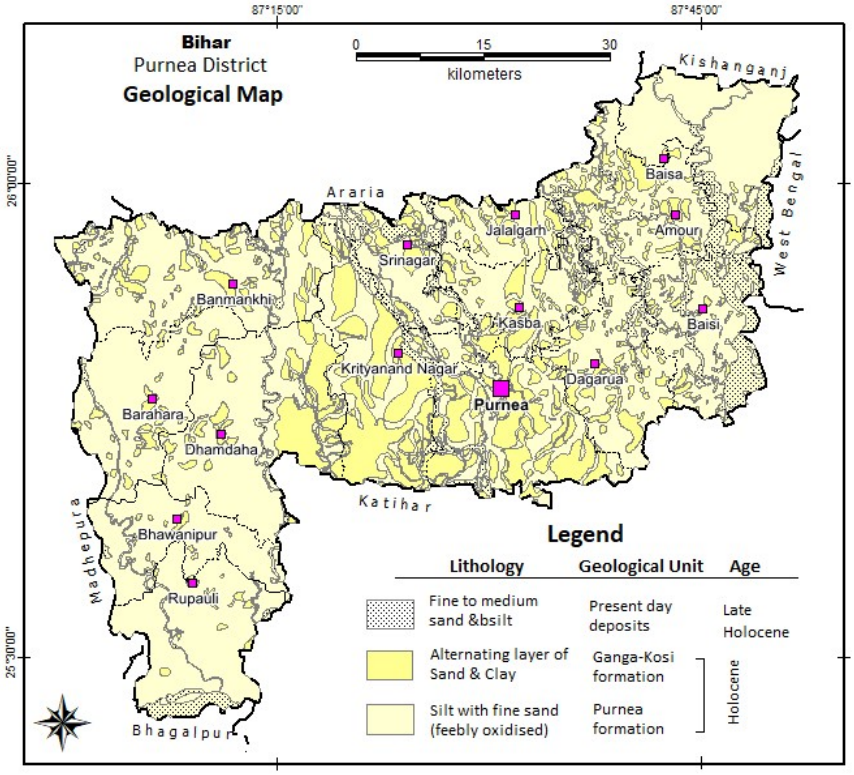
3.1 Geological set up

The entire area of Purnea district is occupied by alluvial sediments of Quaternary age, constituting three morphostratigraphic units classified on the basis of relief, state of preservation of landforms, degree of dissection of surface and the degree of oxidation of alluvial fill. The three units, in order of decreasing antiquity, are named as

(1) Purnea formation

(2) Ganga-Kosi-Mahananda formation and

(3) Present day flood plain deposit.



Source:-Geological Survey of India

Figure 15: Geological map

The dissected outcrop of Purnea formation occupies the highest elevation of 35m to 40 m amsl in the alluvial landscape. It is represented by yellow to brownish yellow silty loam with fine sand, occasional clay partings and with coarse sand and pebbles at depth. Dissected outcrops of this formation are scattered all over the area. The Ganga-Kosi-Mahananda formation occupies the elevation between 30m to 35m above m.s.l. The sediments comprise alternating layers of un-oxidised to feebly oxidised very fine to fine sand, silt and clay. These are unconsolidated to semi-consolidated sediments, except clay horizons which are more compact in nature. The un-oxidised present day flood plain deposits usually occur at the elevation of 30 m amsl or less. It is constituted of light grey to white, fine to medium grained micaceous sand, silt and clay.

3.2 Hydrogeology

The occurrence and movement of ground water in the area is variable, which depends on geomorphology, structure, geological setting, hydraulic properties, tectonic setup etc. The Purnea district comprises one of the most prolific aquifer systems in the Gangetic alluvial of North Bihar Plain. The quaternary unconsolidated sediments consisting of sand, grave, pebbles constitute the potential aquifer though facies-change is a common phenomenon in the area, by and large. The aquifer is regionally extensive it is found to occur continuously down to the depth of exploration of 80 meters, at places capped by thin veneer of clay of 3-6 metres thickness. As observed from the field study and the lithological logs of the exploratory wells, the clay capping is not persistent over the entire area making the aquifer unconfined in nature. The whole area can be considered to be a single aquifer system to the depth of 80 meter.

3.3 Ground Water Dynamics

The present study has been taken under Annual Actin Plan 2020-21. In the Year 2019-20 and 2020-21 Covid -19 pandemic has affected ground water monitoring therefore pre and post monsoon data for the same year is not available to represent the ground water scenario of the area. Hence, water level data for the year 2018 has been taken. However, the field work has been carried out during the year 2020 in post monsoon and collected the water sample for chemical analysis. The data of total 19 NHS (National Hydrograph Station) wells have been taken for analysis.

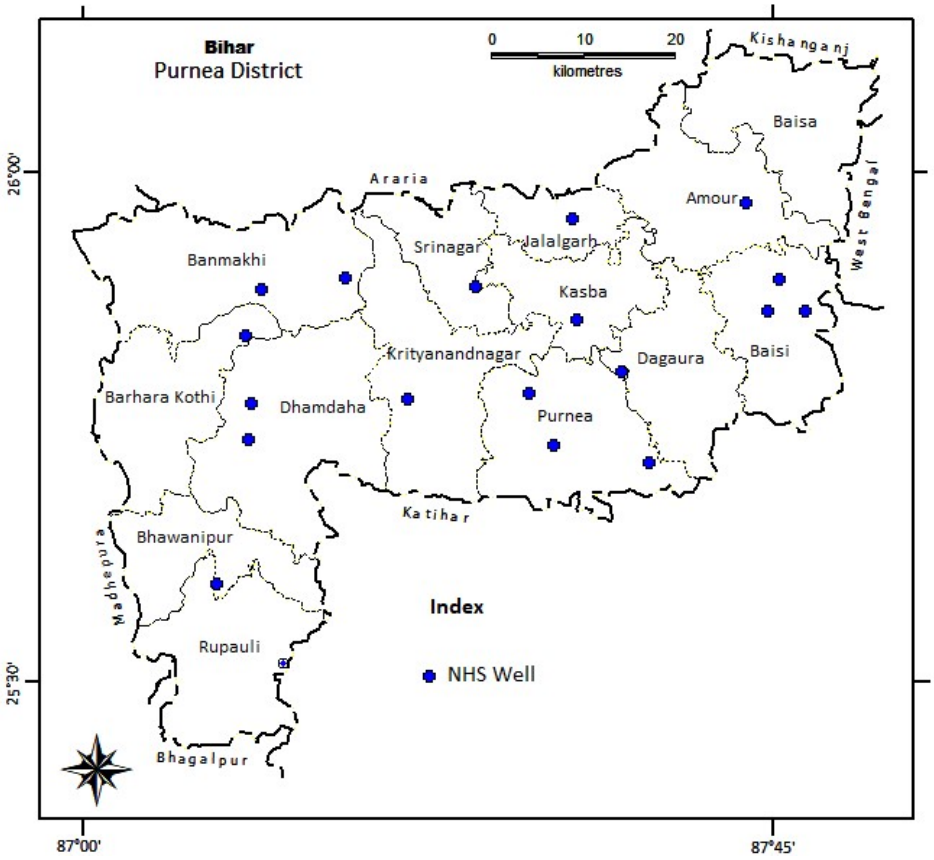


Figure 16: Location of monitoring well

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

3.3.1 Depth to water level – May 2018

During pre-monsoon period, the water level varied from 2.24 to 5.58 m bgl. Major part of the district is categorized in the depth range of 2-5 m bgl water level. Some small patches in the district comprising parts of Baisa, Amour, Banmankhi, and Dhamdaha blocks has shown depth to water level in the range of 5 to 10 m bgl. **(Figure 17)**.

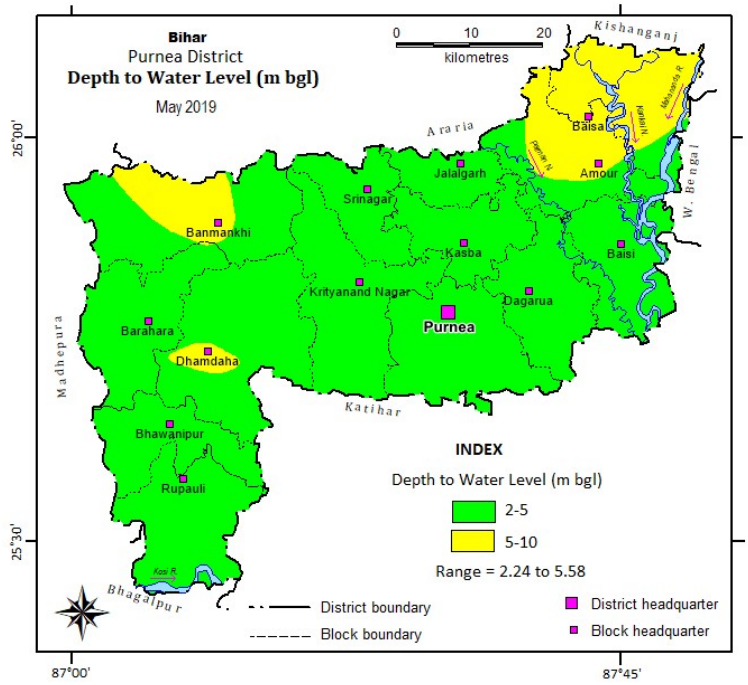


Figure 17: Depth to water level- May 2018

3.3.2 Depth to water level – November 201

During post-monsoon period, Depth to water level ranged from 1.8 to 4.06 m bgl. Almost entire area has shown water level between 2 and 5 m bgl. Only a small patch in Banmankhi block has shown water level less than 2 m. (**Figure 18)**

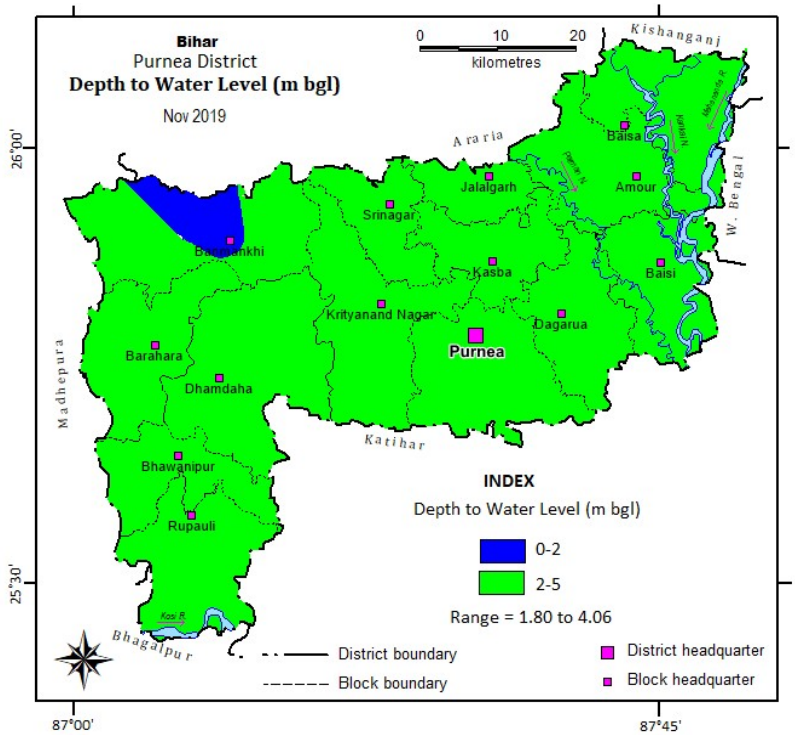


Figure 18: Depth to water level - Nov. 2018

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

The water level fluctuation during November w.r.t. May 2019 has been calculated between -0.7 to 3.78 m. Major part of the district water level fluctuation within 2 m only. In one NHS well fall in water has been observed due to some localised reason. Remarkably the north-eastern part of the district and parts of Banmankhi, Dhamdaha and K. Nagar block are categorised under the water level fluctuation range between 2 to 4 m. No area has shown water level fluctuation more than 4 m. **(figure 19).**

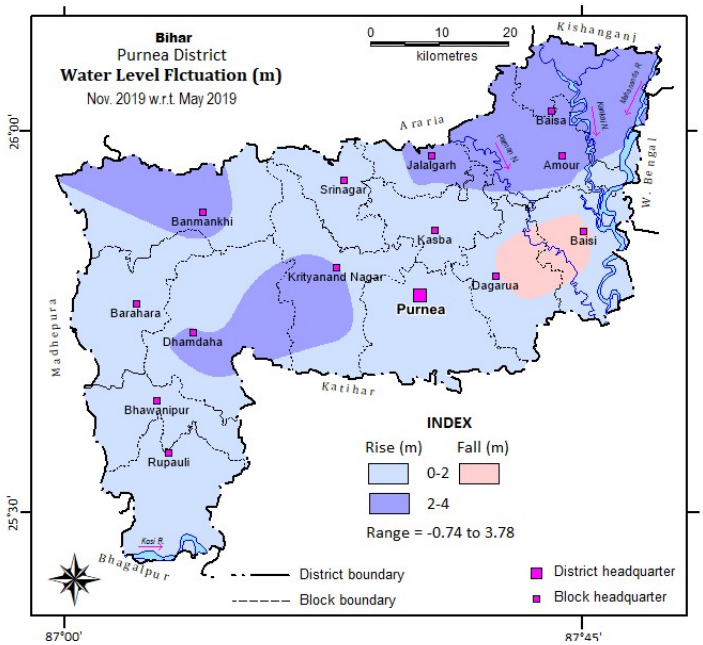


Figure 19: Water level fluctuation map (Nov.2018 w.r.t. May 2018)

3.3.4 Water Table Contour

The water table contour has been shown in **Fig. 20.** Water table contour is more or less following slop of the area. Map reveals that the general flow of groundwater in phreatic aquifer towards south-eastern direction. There is a remarkable change in regional flow pattern that in Srinagar block where flow-direction are converging. Influence of river in flow direction is seems to be negligible.

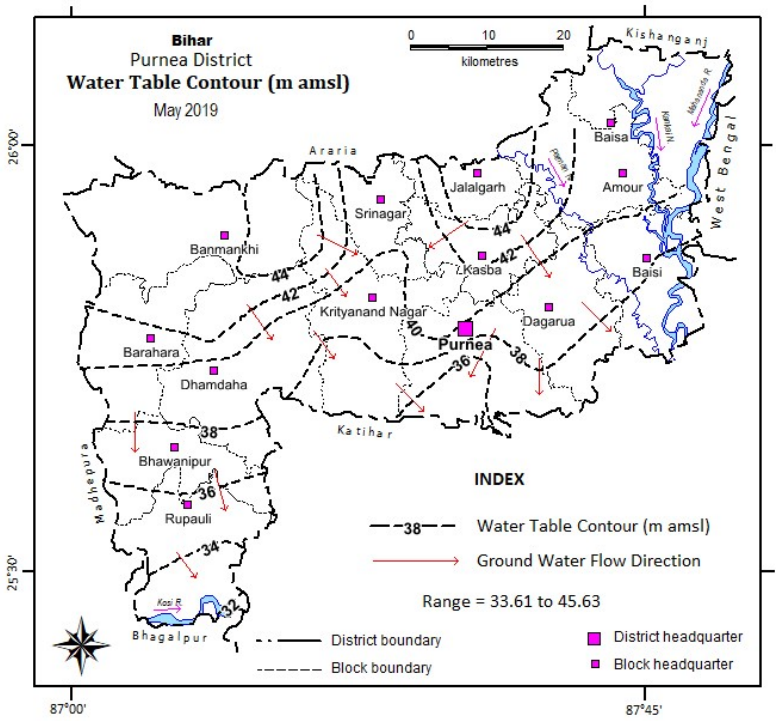


Figure 20: Water Table Contour map

3.3.4 Water Level Trend

Analysis of four (04) hydrograph network stations located at Purnea, Banmankhi, and Dhamdaha and Kajha were carried out using GEMS software (**Figure-21-24**) and analysed for the period from 2000-2019. It is observed that out of four hydrograph analysed for long-term water level trends during pre and post-monsoon seasons, three (03) are not showing any significant trend.

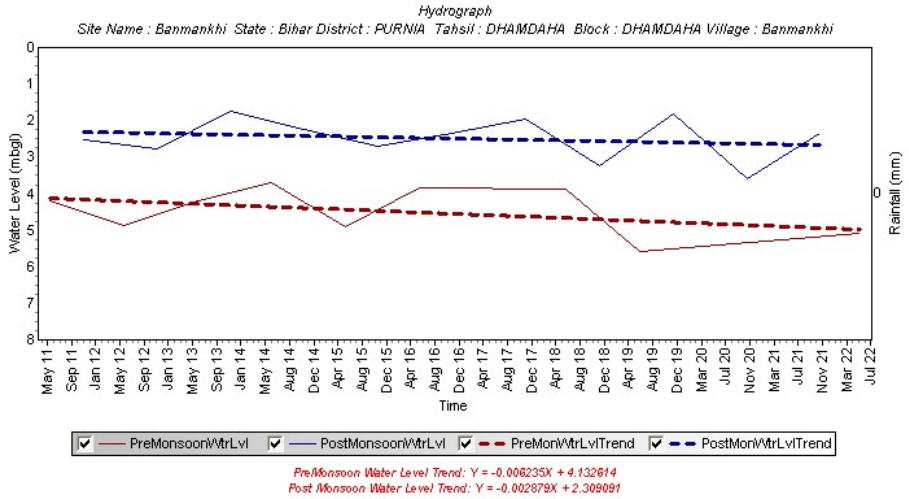


Figure 21: Water Level Trend at Banmankhi

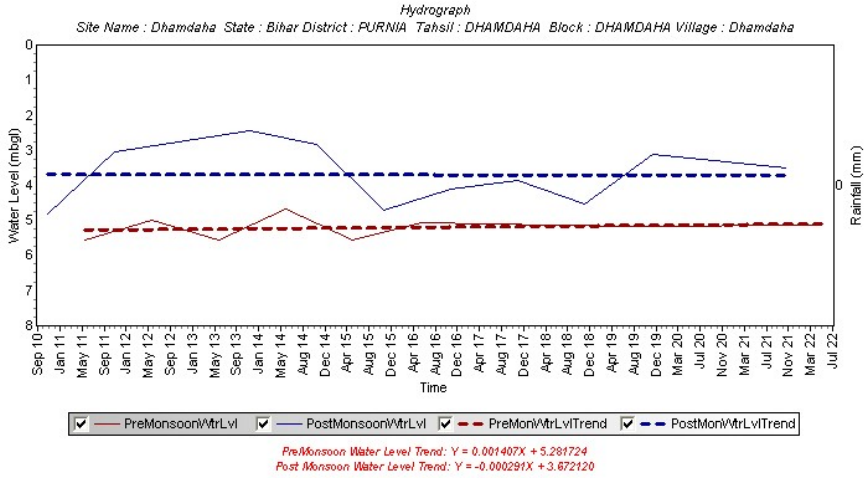


Figure 22: Water Level Trend at Dhamdaha

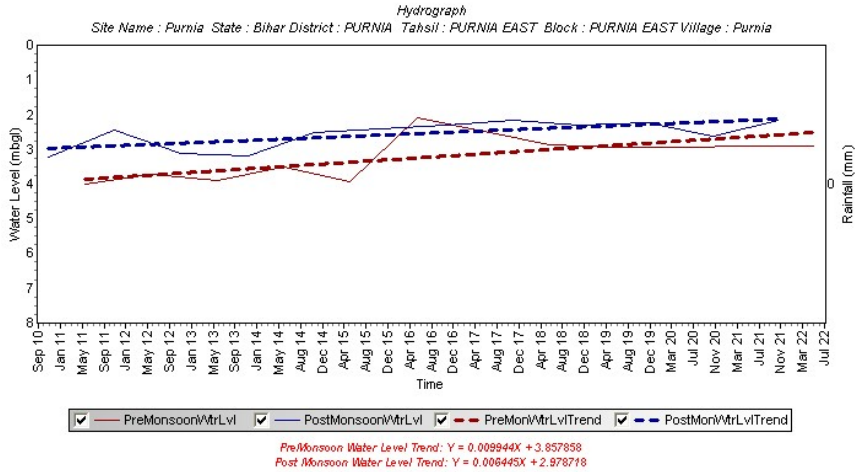


Figure 23: Water Level Trend at Purnea

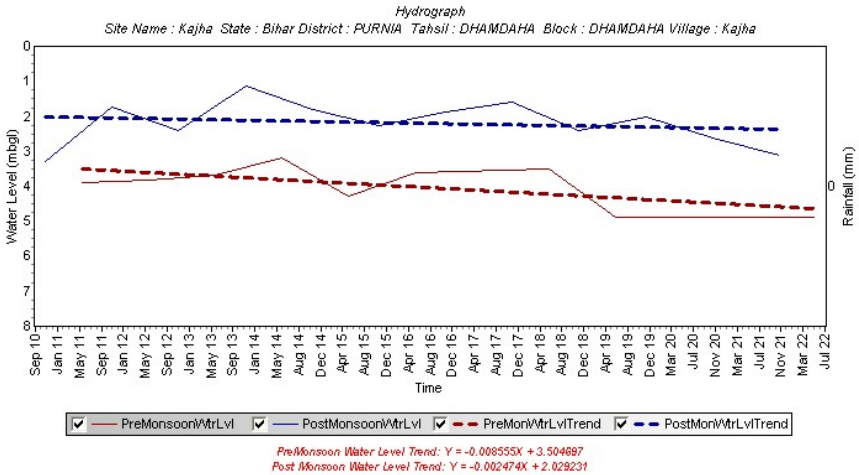


Figure 24: Water Level Trend at Purnea

3.5 Ground Water Exploration

The exploratory drilling is yet to be started, however, proposed to initiate shortly in Purnea district. Therefore, to know the aquifer characteristics in the district, exploratory well of the neighbouring district has been taken. These two districts are also part of the 'Kosi Mega fan' deposits where the Araria district lie on the north and Katihar in the south. (**Figure 25, Table 11).** Drilling depths of these exploratory wells are between 104 to 311 m bgl. The zone tapped below the depth from 42 to 208 m bgl. Transmissivity value calculated to be 153 to 5643 m^2/day and storativity value ranged from 3.7×10^{-3} to 2.5×10^{-1}.

The table shows that considerable thickness of clay layer may not be encountered but if so, there may be possibility of the presence of semi-confined or confined aquifer. However, in general, the district may have single aquifer system.

Table 11: Pumping test details

SN	Name	Lat	Long	Depth drilled (m bgl)	Zone tapped from (m bgl)	Clay (Hard or sticky) encoun-Tered ?	Discharge m^3/day	Discharge (lps)	Transm-issivity	Storativity
1	Madhura_N	26.33581	87.11993	120	70	No	3990	46.18	802	2.5×10^{-1}
2	Araria	26.14306	87.453333	237	149	No	3990	46.18	1460	-
3	Forbeseganj	26.29028	87.2575	310	146	yes	3957	45.80	703	-
4	Raniganj	26.09505	87.232404	311.5	145	No	4017	104	1081	3.7×10^{-3}
5	Sikti	26.4075	87.550833	245	142	Yes	3706	42.89	543	4.3×10^{-2}
6	Kishanpur	25.32501	87.719808	304	208	Yes	1662	19.24	153	-
7	Krishna Nagar	25.49429	87.269352	304	154	No	3380	39.12	5643	-
8	Kumaripur	25.4403	87.61243	309	145	Yes	3640	42.13	1190	7.4×10^{-1}
9	Manihar	25.33617	87.625203	104	42	Yes	1902	22.01	3164	2.5×10^{-2}
10	Semapur	25.52542	87.460444	304	135	No	3313	38.34	4331	-

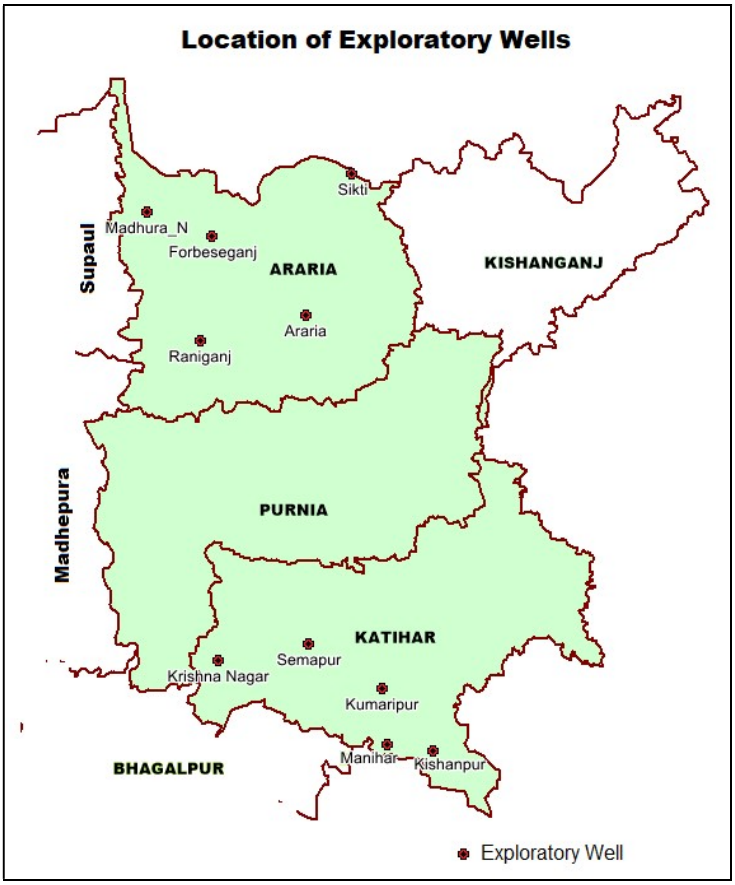


Figure 25: Location of Exploratory Wells

3.6 Ground Water Quality

To study the groundwater chemistry of the area, data of chemical sample collected during pret-monsoon period of May 2018 from National Hydrograph Network Station has been taken. The detailed field work could not be carried out due to Covid-19 pandemic. The samples are collected from ground water and surface water. Analytical results of ground water samples are given in **Annexure II.**

3.6.1 Classification of Ground Water

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

The plot prepared by using percentage of major cationns data on X axis and major anoions in Y axis plotted and **figure 26** has been prepared.

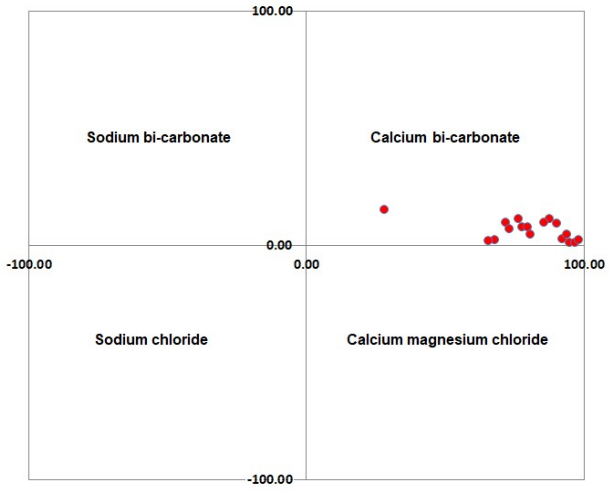


Figure 26: Classification of ground water

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

3.6.2 Suitability for Drinking Purpose

Since water is a good solvent, it always contains some essential minerals in nature. But excess mineralisation of water is not good for health. Bureau of Indian Standard (BIS) has recommended extent of mineralisation suitable for drinking purpose. The recommendation of BIS (2012) and concentration of each chemical constituent are presented in **Table 12.**

Table 12: Chemical Quality Data

SN	Location	Site Type	pH	TH	Ca^{2+}	Mg^{2+}	HCO_3^-	Cl	SO_4^{2-}	NO_3^-	F^-
1	Amour	Dug well	8.1	415	150	10	323	75	62	73	0.85
2	Amri Kukran E	Dug well	7.9	305	102	12	250	53	54	65	0.8
3	Amri Kukran W	Dug well	7.8	605	188	33	610	75	55	70	0.82
4	Baisi2	Dug well	8	225	62	17	153	53	12	32	0.35
5	Banmankhi	Dug well	8.1	650	210	30	610	39	8	23	0.15
6	Bansbari	Dug well	8.1	490	150	28	433	64	5	50	0.41
7	Barsoni	Dug well	8	420	128	24	317	50	26	44	0.54
8	Budhia Gola	Dug well	7.7	190	42	21	153	21	30	38	0.23
9	Chadia	Dug well	7.9	660	220	27	610	50	10	8	0
10	Dargaha	Dug well	8.1	105	34	5	67	4	45	36	0.87
11	Dhamdaha	Dug well	8.2	385	120	21	336	64	15	13	0.13
12	Jalalgarh	Dug well	8	415	126	24	433	46	22	35	0.17
13	Kajha	Dug well	7.9	415	118	29	256	21	10	50	0
14	Kasba	Dug well	8.1	925	300	43	671	67	30	12	0
15	Khata Hat	Dug well	7.6	410	130	21	494	64	65	69	0.94
16	Mangujan	Dug well	7.9	205	62	12	140	11	52	39	0.61
17	Purnea	Dug well	7.7	550	162	35	482	50	0	8	0
18	Ranipatra	Dug well	7.9	335	92	26	214	75	0	15	0
19	Tikapatti	Dug well	8.2	100	30	6	73	14	17	25	0.15
20	Tikapatti Chowk	Dug well	7.6	515	146	36	451	4	42	65	0.23
BIS (2012)	*Acceptable limit*		***<6.5***	***200***	***75***	***30***	***200***	***250***	***200***	***NA***	***1***
	Permissible limit (in the absence of alternate source)		***>8.5***	***600***	***200***	***100***	***600***	***1000***	***400***	***45***	***1.5***

Value in mg/l

From the above table it can be inferred that in general, water is potable. However, slighted elevated concentrations (shaded value) of calcium, bi-carbonate and nitrate have been found at few locations.

3.6.3 Hardness

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

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

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

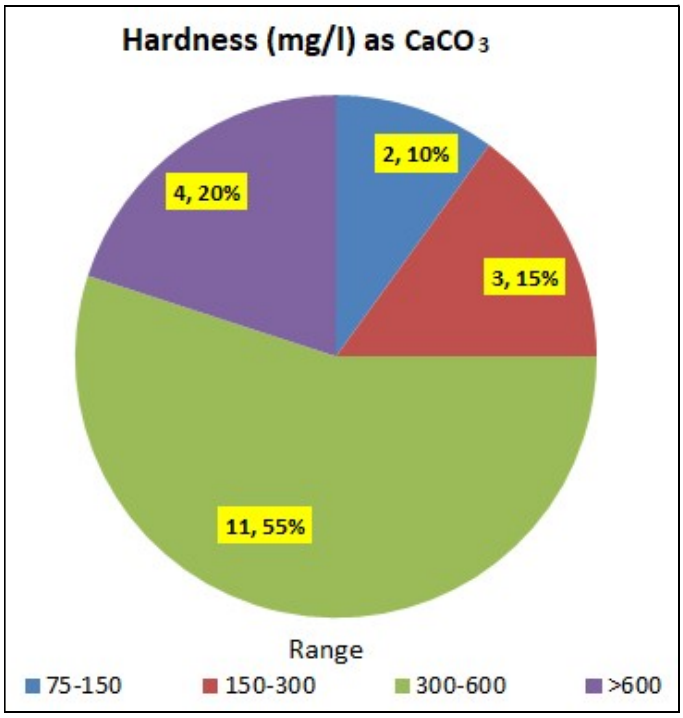


Figure 27: Hardness of ground water

As per the water samples collected from Purnea district, hardness ranged from 100 to 925 mg/l (as $CaCO_3$). Majority of the samples (55%) have been categorised as very hard out of 20 sample analysed. Only 2 samples are categorised as 'moderate hardness' and 3 samples are 'hard'. **(Figure 27).** Rest 4 sample are 'extremely hard' have shown hardness value more than 600 mg/l (as $CaCO_3$).

3.6.4 Suitability for Irrigation

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

1. Salinity :- Total concentration of soluble salt.

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

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

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

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

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

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

Table 13: Suitability of ground water for irrigation purpose

SN	District	Sodium Adsoption Ratio	Sodium Soluble Percentage	Residual Sodium Carbonate	Kelley's Index	Permeability Index
		Na/ sqrt(Ca+Mg/2)	Na*100/ Ca+Mg+Na	(HCO_3+Co3)/ (Ca+Mg))	Na/ (Ca+Mg)	Na+sqrtHCO_3)/ (Ca+Mg+Na)*100
1	Amour	2.0	17.5	0.08	0.2	19.9
2	Amri Kukran E	2.3	19.2	0.07	0.2	21.5
3	Amri Kukran W	1.7	14.3	0.16	0.2	18.0
4	Baisi2	0.6	4.9	0.04	0.1	6.8
5	Banmankhi	5.8	37.8	0.23	0.6	41.1
6	Bansbari	1.4	11.8	0.11	0.1	14.9
7	Barsoni	1.8	14.4	0.08	0.2	16.8
8	Budhia Gola	1.5	10.8	0.05	0.1	12.7
9	Chadia	1.4	12.4	0.15	0.1	15.9
10	Dargaha	0.0	0.0	0.01	0.0	1.0
11	Dhamdaha	0.3	2.7	0.07	0.0	5.4
12	Jalalgarh	1.1	10.1	0.11	0.1	13.2
13	Kajha	0.9	7.1	0.06	0.1	9.1
14	Kasba	1.4	11.2	0.15	0.1	14.5
15	Khata Hat	1.3	12.0	0.13	0.1	15.5
16	Mangujan	0.9	7.0	0.03	0.1	8.5
17	Purnea	0.7	6.1	0.12	0.1	9.3
18	Ranipatra	0.3	2.9	0.05	0.0	5.0
19	Tikapatti	0.0	0.0	0.01	0.0	1.2
20	Tikapatti Chowk	1.7	13.1	0.11	0.2	16.0
Suitable		**<10**	**<50**	**1.25**	**<1**	**25-75**
Marginal		**NA**	**NA**	**1.25-2.5**	**1.2**	**NA**
Not suitable		**>10**	**>50**	**>2.5**	**>2**	**>75**

Ionic concentrations are calculated in milliequivalents per litre

The **table 13** shows that, the ground water quality of the area is within the range of 'suitable'. Thus based on the above table it can be inferred that the ground water of the phreatic aquifer is suitable for irrigation purpose.

3.6.5 USSL diagram

The United States Soil Laboratory Staff's (USSLS's) diagram classifies water quality into 16 zones to assess the degree of suitability of water for irrigation **(Figure 28)** in which waters have been divided into C1, C2 C3 and C4 types on the basis of salinity hazard and S1, S2, S3, S4 types on the basis of sodium hazard.

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

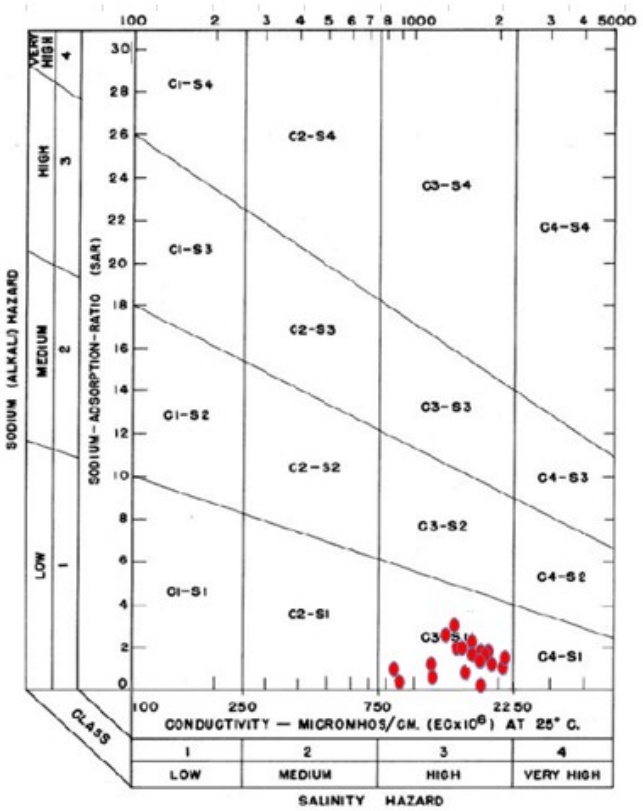


Figure 28: US Salinity Diagram

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

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

The **Figure 28** shows that all the samples have fall in low sodium hazard class and high salinity hazard.

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

3.6.6 Schoeller Diagrams

The field work has been carried out during **November 2020**, the period of Covid-19 Pandamic,i consequently field work is badly affected as to follow the guideline. However, the water samples from ground water as well as surface water have been collected from few locations. The result of the chemical analysis of these samples is given in **Table -14.**

Table 14: Results of Chemical Analysis (Nov. 2020)

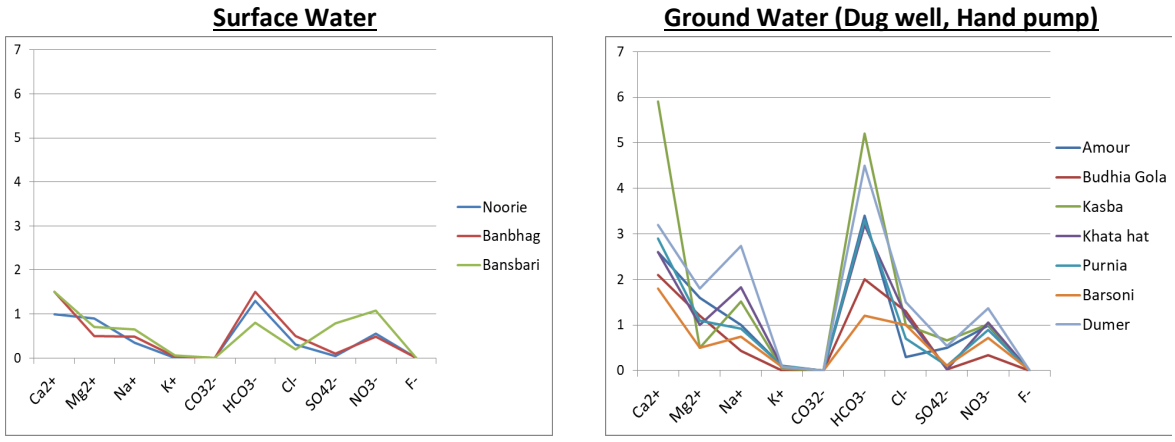
	Block	Location	Source	Lat.	Long	pH	EC	TH	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	NO_3^{-}	SO_4^{2-}	F^{-}	PO_4^{3-}	TDS
Ground Water	Amaur	Amour	HP	25.960	87.710	5.39	542	210	52	19	23	3.4	0	207	11	61	24	0.06	0.02	352
	Banmankhi	Budhia Gola	DW	25.890	87.280	5.11	378	165	42	15	10	0.06	0	122	46	21	1.3	0.06	0	246
	Kasba	Kasba	HP	25.850	87.530	4.59	862	320	118	6	35	1.5	0	317	36	63	32	0.03	0	560
	Srinagar	Khata hat	DW	25.890	87.400	5.22	563	180	52	12	42	3.2	0	195	43	65	1.3	0.01	0	366
	Purnea	Purnea	DW	25.770	87.510	4.88	502	200	58	13	21	4.1	0	201	25	55	4.9	0.03	0	326
	Banmakhi	Barsoni	HP	25.900	87.270	5.35	320	115	36	6	17	2.9	0	73	36	44	5.3	0.11	0.03	208
	Barai	Dumer	DW	25.530	87.320	4.97	793	250	64	22	63	3.3	0	275	53	85	26	0.13	0	515

	BLOCK	LOCATION	Source	Lat.	Long	pH	EC	TH	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	NO_3^{-}	SO_4^{2-}	F^{-}	PO_4^{3-}	TDS
Surface Water	Baisi	Noorie	SW	25.850	87.700	5.29	230	95	20	11	8	0.02	0	79	11	34	2.3	0.13	0.07	150
	Purnea	Banbhag	SW	25.790	87.430	5.26	254	100	30	6	11	1.3	0	92	18	30	4.6	0.16	0	165
	Amaur	Bansbari	SW	25.950	87.710	5.3	287	110	30	9	15	2.1	0	49	7	67	38	0	0	187

Value=mg/l *HP=Hand pump, DW=Dug well, SW=Surface water*

The values of above samples are converted in milliequivalents per liter to prepare Schoeller Diagrams for surface water and ground water which is presented in **figure 29.** The Schoeller diagrams are useful to show the relative concentrations of anions and cations from multiple sources.

Figure 29 shows relatively increased ionic concentration in ground water. The higher concentration of sodium may be caused by reuse of water for irrigation which commonly leaves residues resulting higher sodium concentration than it was in the original water. The elevated bicarbonate concentration in ground water, as stated above, is mainly due to rainfall-derived recharge, over decades to centuries.



Value in milliequivalents per liter

Figure 29: Schoeller Diagram

3.7 Aquifer Disposition

Fence and panel (2-D) diagrams are prepared to identify spatial disposition and vertical extent of Aquifer. The tube wells, drilled by Bihar State Development Authority before 1986 and other agency have been taken for the 2-D diagrams. Diagrams are also taken and re-prepared from the previous reports. Locations of these wells are shown with the diagram concerned.

3.1.1 Aquifer Disposition in the area

The aquifer geometry on regional scale has been attempted to establish in Purnea district to cover all administrative blocks as per the available data. Principal aquifers in the area have been delineated by grouping the fine to medium sand, coarse sand and gravelly sand as aquifers separated by considerable thickness of clay. These cross sections/fence diagrams are given below along with the map to locate the area concerned **(Figure 30 to 32).**

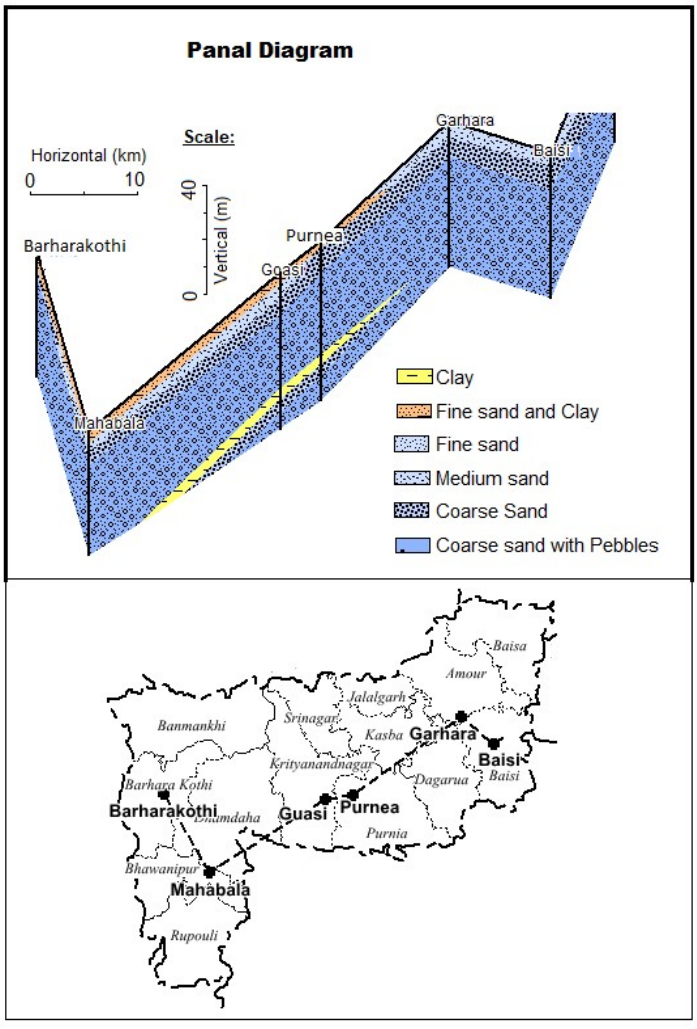


Figure 30: Cross section along the line A-B

The **figure 30** indicates that top layer in central and western part of the district is clayey. A considerable thickness but discontinued clay layers occurs in central part of the district down from the depth of ~30 m bgl. Besides this, the other layers are fine to medium. Hence the aquifer in the may be considered as 'un-confined'.

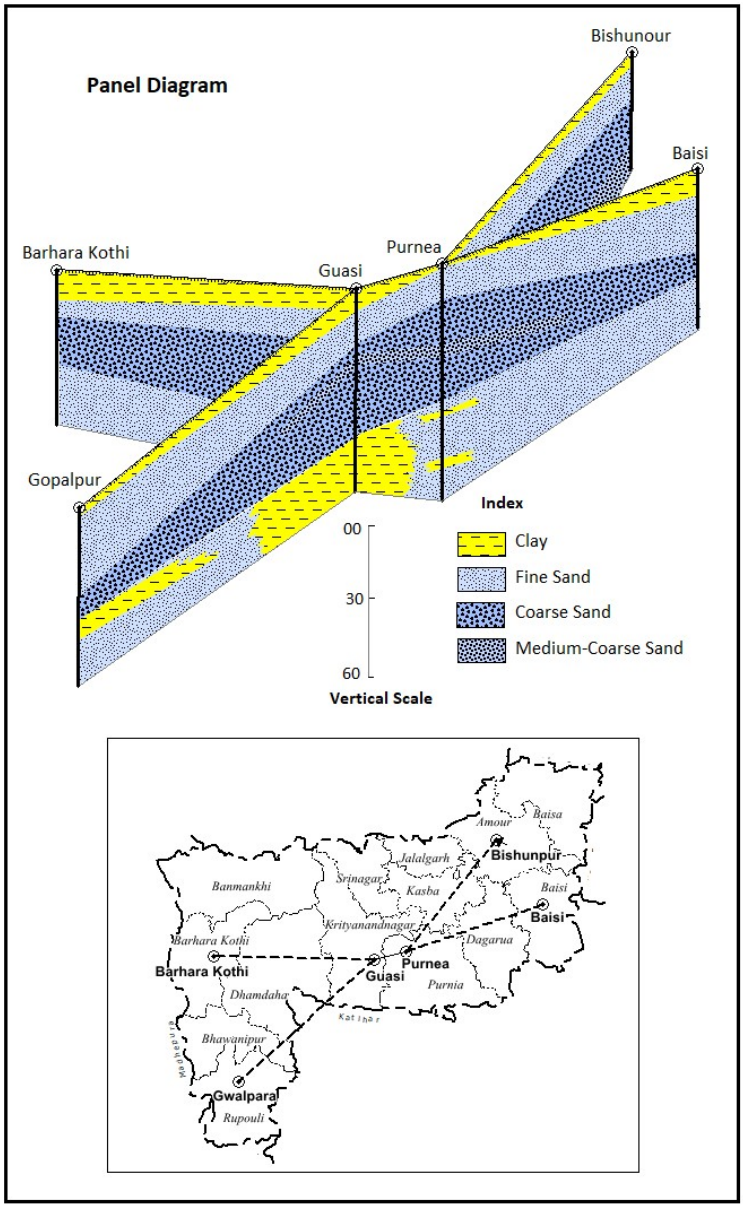


Figure 31: Cross section along the line C-D

The **figure 31** indicates that top layer in the area is clayey. A considerable thickness but discontinued clay layers occurs in central part which seems extended towards west of the district down from the depth of ~30 m bgl. Besides this, the other layers are of fine sand, medium sand or coarse sand. Hence the aquifer in the western area, below the depth of 60 m bgl may be semi-confined.

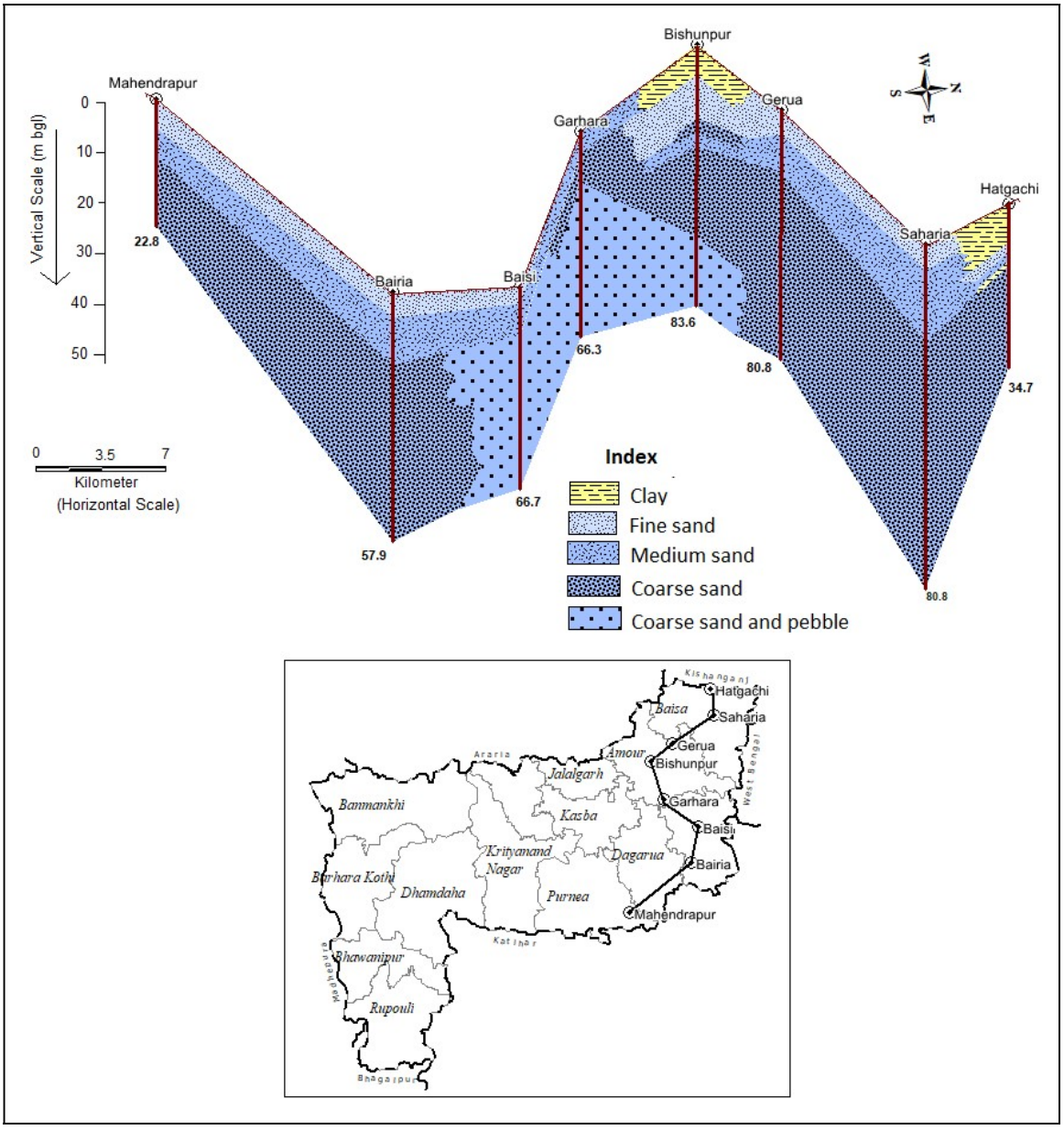


Figure 32: Fence diagram along the line G-H

This section covers eastern part of the district. (**Figure 32)** The cross section indicates that clay layers at the top in localized area only. In this part of the district the aquifers are seems to be unconfined.

3.2 Aquifer Characterisations

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

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

As per the available data collected from the wells drilled between 104 to 311 m bgl in neighbouring district (Araria and Katihar) **(Table 11)**. The yield of these wells is ranged from from 19 to 46.5 lps. The transmissivity value calculated to be 153 to 5600 m^2/day. The storativety value after tapping the aquifer below ~140 m bgl indicates that aquifer is unconfined in nature.

CHAPTER 4

4. GROUND WATER RESOURCES

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

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

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

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

The equation can be further elaborated as

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

Where,

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

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

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

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

The dynamic Ground Water Resources has been assessed by CGWB, MER, Patna in association with Minor Water Resources Department, Bihar for base year as on 2020 based on GEC, Methodology 2015. The summarized detail of Annually Replenishable or Dynamic Ground Water Resources of Purnea district is given in **Table-14 & 15.**

As per the assessment year 2020, all 11 block are categorised as ‘safe’ except Dagaura

block which is categorised as 'Semi-critical'. The table indicates that Dagaura block has highest percentage (88%) of ground water extraction for irrigation purpose.

The stage of ground water extraction has been ranged from 36% (Dhamdaha) to 84.38% (Dagaura). It indicates that still there is ample scope for ground water development in the district. The result of the assessment of Dynamic Ground Water Recourses is given in **Table 15 and Table 16.**

Table 15: Net ground water availability (GWRE - 2020)

SN	Administrative Units	Recharge from Rainfall		Recharge from Other Sources		Total Annual Ground Water Recharge	Total Natural Discharges	Annual Extractable Ground Water Resource
		Monsoon	Non-monsoon	Monsoon	Non-monsoon			
		(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)
1	Amaur	6215.37	736.15	1031.68	885.95	8869.15	443.46	8425.69
2	Baisa	4591.44	622.81	801.16	544.28	6559.69	655.97	5903.72
3	Baisi	4799.42	614.72	937.71	635	6986.85	349.35	6637.5
4	Banmankhi	8168.56	1108.02	1045.47	708.98	11031.03	1103.1	9927.93
5	Barhara	5087.3	690.07	646.15	437.13	6860.65	686.07	6174.58
6	Bhawanipur	3557.63	482.58	644.09	435.17	5119.47	511.95	4607.52
7	Dagaura	5082.86	630.71	1138.56	991.86	7843.99	392.2	7451.79
8	Damdaha	9015.27	1089.1	765.12	520.99	11390.48	569.52	10820.96
9	Jalalgarh	3452.29	340.06	566.5	383.43	4742.28	237.11	4505.17
10	Kasba	3719.97	504.6	502.89	346.8	5074.26	507.43	4566.83
11	Krityanand Nagar	6305.14	855.26	878.49	597.8	8636.69	863.67	7773.02
12	Purnea East	5697.66	772.86	941.69	636.18	8048.39	804.84	7243.55
13	Rupauli	6499.67	746.09	811.35	551.33	8608.44	430.42	8178.02
	Total	75342.05	9620.24.	11227.81	8025.4	104215.5	7999.51	96216.08

Table 16: Stage of ground water development

SN	*Administrative Units*	*Ground Water Extraction*			*Total Extraction*	*Annual GW Allocation for Domestic Use as on 2025*	*Net Ground Water Availability for future*	*Stage of Ground Water Extraction*	*Categorization*
		for Irrigation Use	*for Domestic Use*	*for Industrial Use*					
		(ham)	*(ham)*	*(ham)*	*(ham)*	*(ham)*	*(ham)*	*(%)*	
1	Amaur	4984.4	500.58	369.00	5853.97	562.3	2510	69.48	safe
2	Baisa	3366.09	332.72	180.00	3878.81	373.75	1983.88	65.70	safe
3	Baisi	3957.66	392.29	225.00	4574.95	440.66	2014.18	68.93	safe
4	Banmankhi	4403.7	709.94	261.00	5374.65	797.49	4465.73	54.14	safe
5	Barhara	2731.05	360.07	135.00	3226.12	404.46	2904.07	52.25	safe
6	Bhawanipur	2727.27	278.61	153.00	3158.88	312.97	1414.28	68.56	safe
7	Dagaura	5546.58	380.98	360.00	6287.57	427.96	1117.24	84.38	Semi-critical
8	Damdaha	3213	496.31	180.00	3889.31	557.51	6870.45	35.94	safe
9	Jalalgarh	2392.74	194.59	126.00	2713.34	218.59	1767.83	60.23	safe
10	Kasba	2067.66	429.29	135.00	2631.96	482.23	1881.93	57.63	safe
11	K.rityanand	3691.17	397.11	198.00	4286.29	446.08	3437.76	55.14	safe
12	Purnea East	3987.9	718.58	288.00	4994.49	807.19	2160.45	68.95	safe
13	Rupauli	3407.67	404.32	189.00	4000.99	454.17	4127.18	48.92	safe
	Total	48654.17	5785	2916	57355.22	6498.35	38147.51	59.61	

CHAPTER 5

GROUND WATER RELATED ISSUES

5.1 Identification of issues

The district is a part of Kosi mega fan deposits. Lithologs of the tube wells drilled in the area revels that there is thick pile of sediments having no significant clay layers down to the drilled depth of ~80 m bgl. The aquifer is seems to be 'unconfined'. As per 5th MI census no tube well is categorised in the categories of the depth more than 40 m bgl for irrigation. Ground water is the main source of irrigation. At places bamboo boring of 12-18 m depth is being used for irrigation.

The Stage of Ground Water Extraction of the assessment unit (administrative blocks) has been calculated between 36 to 84% (as on March 2020). It shows that in spite of irrigation practice by ground water as a main source, there is still a scope of further ground water exploitation except the Dagaura block which is categorised as 'semi-critical'.

Out of 13 districts, the Stage of Ground Water Extraction of 7 districts is more than 60%. The late monsoon is also affects to the exploitation of ground water. The canal irrigation, in general not depended on rainfall, not seems as supplementary source for irrigation. Hence, there is a need of artificial recharge to ground water.

5.2 Major Ground Water Issues

1. As per the ground water resources estimation – 2020, block wise estimated Stage of Ground Water Extraction of the district is 59.6 % only. It shows that there is a scope to develop ground water further to fulfil the demand of water.
2. Out of 13 administrative blocks, Stage of Ground Water Extraction of 7 blocks is more than 60%. Hence, although scope exists for ground water development there is a need of Artificial Recharge to ground water in the area.
3. Judicious use of ground water may be encouraged in the area to get the maximum benefits.

CHAPTER 6

MANAGEMENT STRATEGIES

6.1 Possibility of construction of additional shallow tube wells

On the basis of Ground Water Resource Estimation -2022, additional number shallow tube well for alluvium area for each block has been calculated within the safe limit of the Stage of Development up to 70% by considering unit draft for each tube well 1.69 ha m. As per the calculation, a total of 16618 number of tube wells can be constructed to fulfil the future demand of ground water. The block wise additional number of tube well is given in table.

Table 17: Additional Nos. of STW feasible based on GW availability

Block	Total Annual Recharge	Net Resource	Gross Draft All Uses	Provision for Future Domestic and Industrial Requirement	SOD% 2017	Cate gory	Projected SOD (%)	GW draft at Projected SOD	Additional Resource Available	Unit Draft of STW	Additional Nos. of STW feasible based on GW availability
Amaur	8869.15	8425.69	5853.97	562.3	69.48	safe	70	5897.98	44.01	1.89	23
Baisa	6559.69	5903.72	3878.81	373.75	65.70	safe	70	4132.60	253.79	1.89	134
Baisi	6986.85	6637.5	4574.95	440.66	68.93	safe	70	4646.25	71.30	1.89	38
Banmankhi	11031.03	9927.93	5374.65	797.49	54.14	safe	70	6949.55	1574.90	1.89	833
Barhara	6860.65	6174.58	3226.12	404.46	52.25	safe	70	4322.21	1096.09	1.89	580
Bhawanipur	5119.47	4607.52	3158.88	312.97	68.56	safe	70	3225.26	66.38	1.89	35
Dagaura	7843.99	7451.79	6287.57	427.96	84.38	Semi_ critical	70	5216.25	0.0	1.89	Nil
Damdaha	11390.48	10820.96	3889.31	557.51	35.94	safe	70	7574.67	3685.36	1.89	1950
Jalalgarh	4742.28	4505.17	2713.34	218.59	60.23	safe	70	3153.62	440.28	1.89	233
Kasba	5074.26	4566.83	2631.96	482.23	57.63	safe	70	3196.78	564.82	1.89	299
Krityanand	8636.69	7773.02	4286.29	446.08	55.14	safe	70	5441.11	1154.82	1.89	611
Purnea East	8048.39	7243.55	4994.49	807.19	68.95	safe	70	5070.49	76.00	1.89	40
Rupauli	8608.44	8178.02	4000.99	454.17	48.92	safe	70	5724.61	1723.62	1.89	912
Srinagar	4444.22	3999.8	2483.89	212.99	62.10	safe	70	2799.86	315.97	1.89	167

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

6.2 Artificial Recharge

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

Availability of non-committed source water for the purpose of artificial recharge to groundwater is the primary concern. Basin wise surface water availability with 75% dependability has been utilised from 2nd Bihar State Irrigation Commission Report (1994).

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

Table 18: Identified Area, Computed Storage Volume and Source Water availability for Artificial Recharge to Ground Water

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

Considering hydrogeological and geomorphological set up and relative groundwater potentialities in the district, various types of artificial recharge/conservation structure has been recommended. Actual numbers of structures implementable may vary significantly based on scale of implementation. Based on available literature and previous experiences, unit cost of structures is also worked out. Terrain-wise norms adopted along with unit cost estimates for different types of structures are given in **Table -18.** Suitable area for artificial recharge has been identified where the post monsoon (2018) water level is more than 3 m bgl

The urban area for in Purnea district for artificial recharge is identified as Banmankhi, Kasba and Dagarua blocks.

Table 19: Block wise Number of Recharge Sturcture

Block	**Nala Bunding**	**Lateral Recharge**	**Recharge Shaft**	**Percolation Tank**	**De-silting of existing tank**	**Injection Well in Village Tank**
Unit cost (Lakh)	**1**	**2**	**5**	**30**	**5**	**4**
Amour	1	6	12	1	22	29
Baisi	1	5	10	1	18	25
Dagarua	1	5	11	1	19	25
Total	**3**	**16**	**33**	**3**	**59**	**79**

CHAPTER 7

WISE BLOCK AQUIFER MANAGEMENT PLANS

7.1 Amour block

7.1.1 General Information

1.	Area (ha)		:	24505
2.	No. of town		:	0
3.	No. of village		:	150
4.	Population	Total	:	2,90,559
		Rural	:	2,90,559
		Urban	:	0
5.	Average Annual Rainfall (District)		:	1305 mm
6.	Depth-range wise No. of ground structure (5^{th} MI Census)	< 20 m	:	2041
		20-35 m	:	1398
		35-40 m	:	0
		40-60 m	:	0
		60-70 m	:	0

7. Ground Water Resources - 2020

Recharge from Rainfall		*Recharge from Other Sources*		*Total Annual Ground Water Recharge*	*Total Natural Discharges*	*Annual Extractable Ground Water Resource*
Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*			
6215.37	736.15	1031.68	885.95	8869.15	443.46	8425.69

Ground Water Extraction for Irrigation Use	*Ground Water Extraction for Domestic Use*	*Ground Water Extraction for Industrial Use*	*Total Extraction*	*Annual GW Allocation for for Domestic Use as on 2025*	*Net Ground Water Availability for future use*	*Stage of Ground Water Extraction (%)*	*Category*
4984.4	500.58	369.00	5853.97	562.3	2510	69.48	safe

In Ha m

7.1.2 Aquifer Disposition

1. Aquifer disposition : Explored depth: ~80 m bgl
   Aquifer type : Unconfined
   Single aquifer system

2. Water level (Shallow aquifer):
   Pre-monsoon : ~5.14 m bgl
   Post-monsoon : ~2.4 m bgl
   Fluctuation : `2.74 to 6.22 m

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

Location	pH	EC	TH	Ca	Mg	Na	K	CO3	HCO3	Cl	SO4	NO3	Fluoride	TDS
Amour	8.1	986	415	150	10	32	3.4	0	323	75	62	73	0.85	592

In mg/l

7.1.3 Aquifer Management Plan

1. *Ground water development :*

As per the GW resources Estimation -2020, stage of development of the block is 69.48% only hence categorized as 'safe'. There is a possibility for further development of ground water. Additional number of tube well by considering the SOD, upto 70% is calculated and given in table below:

Block	Total Annual Recharge	Net Resource	Gross Draft All Uses	Provision for Future Domestic and Industrial Requirement	SOD% 2017	Category	Projected SOD (%)	GW draft at Projected SOD	Additional Resource Available	Unit Draft of STW	Additional Nos. of STW feasible based on GW availability
Amaur	8869.15	8425.69	5853.97	562.3	69.48	safe	70	5897.98	44.01	1.89	23

In ham

2. *Artificial recharge structures*

Block	Nala Bunding	Lateral Recharge Shaft	Recharge Shaft	Percolation Tank	De-silting of existing tank /pond /talao	Injection Well in Village Tank
Amour	1	6	12	1	22	29

7.2 Baisa block

7.2.1 General Information

1. Area (ha) : 20732
2. No. of town : 0
3. No. of village : 118
4. Population (2011) Total : 1,93,127
   Rural : 1,93,127
   Urban : 0
5. Average Annual Rainfall (District) : 1305 mm
6. Depth-range wise No. of ground structure (5^{th} MI Census)
   < 20 m : 2105
   20-35 m : 1343
   35-40 m : 0
   40-60 m : 0
   60-70 m : 0
7. Ground Water Resources - 2020

Recharge from Rainfall		*Recharge from Other Sources*		*Total Annual Ground Water Recharge*	*Total Natural Discharges*	*Annual Extractable Ground Water Resource*
Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*			
4591.44	622.81	801.16	544.28	6559.69	655.97	5903.72

Ground Water Extraction for Irrigation Use	*Ground Water Extraction for Domestic Use*	*Ground Water Extraction for Industrial Use*	*Total Extraction*	*Annual GW Allocation for for Domestic Use as on 2025*	*Net Ground Water Availability for future use*	*Stage of Ground Water Extraction (%)*	*Category*
3366.09	332.72	180.00	3878.81	373.75	1983.88	65.70	safe

In Ha m

7.2.2 Aquifer Disposition

1. Aquifer disposition : Explored depth:- ~70 m bgl
   Aquifer Type: Unconfined
   Single aquifer system
2. Water level
   Pre-monsoon : ~5.14 m bgl
   Post-monsoon : ~2.4 m bgl
   Fluctuation : `2.74 to 6.22 m
3. Chemical quality of ground water : In general, Potable.

Location	pH	EC	TH	Ca	Mg	Na	K	CO3	HCO3	Cl	SO4	NO3	Fluoride	TDS
Amour	8.1	986	415	150	10	32	3.4	0	323	75	62	73	0.85	592

In mg/l

7.2.3 Aquifer Management Plan

1. *Ground water development :*

Stage of development of the block is 65.70% only therefore categorized as 'safe'. There is a possibility for further development of ground water. Additional number of tube well upto the SOD, is 70% is calculated and given in table below:

Block	Total Annual Recharge	Net Resource	Gross Draft All Uses	Provision for Future Domestic and Industrial Requirement	SOD% 2017	Cate gory	Projected SOD (%)	GW draft at Projected SOD	Additional Resource Available	Unit Draft of STW	Additional Nos. of STW feasible based on GW availability
Amaur	8869.15	8425.69	5853.97	562.3	69.48	safe	70	5897.98	44.01	1.89	23
Baisa	6559.69	5903.72	3878.81	373.75	65.70	safe	70	4132.60	253.79	1.89	134

2. Artificial recharge structures

Not prioritized

7.3 Baisi block

7.3.1 General Information

1.	Area (ha)		:	20463
2.	No. of town		:	0
3.	No. of village		:	112
4.	Population (2011)	Total	:	2,27,706
		Rural	:	2,27,706
		Urban	:	0
5.	Average Annual Rainfall (District)		:	1305 mm
6.	Depth-range wise No. of ground water abstraction structure (5^{th} MI Census)	< 20 m	:	981
		20-35 m	:	1034
		35-40 m	:	0
		40-60 m	:	0
		60-70 m	:	0

7. Ground Water Resources - 2020

Recharge from Rainfall		*Recharge from Other Sources*		*Total Annual Ground Water Recharge*	*Total Natural Discharges*	*Annual Extractable Ground Water Resource*
Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*			
4799.42	614.72	937.71	635	6986.85	349.35	6637.5

Ground Water Extraction for Irrigation Use	*Ground Water Extraction for Domestic Use*	*Ground Water Extraction for Industrial Use*	*Total Extracti on*	*Annual GW Allocation for for Domestic Use as on 2025*	*Net Ground Water Availability for future use*	*Stage of Ground Water Extraction (%)*	*Categ ory*
3957.66	392.29	225.00	4574.95	440.66	2014.18	68.93	safe

7.3.2 Aquifer disposition

1.	Aquifer disposition	:	Explored depth:- ~80 m bgl Aquifer Type: Unconfined Single aquifer system	
2.	Water level	Pre-	:	2.24 to 3.35 m bgl
		Post-	:	~2.7 m bgl

Fluctuation : ~0.60 m

3. Chemical quality of Ground : In general, Potable.

Location	pH	EC	TH	Ca	Mg	Na	K	CO3	HCO3	Cl	SO4	NO3	Fluoride	TDS
Baisi2	8	580	225	62	17	4.83	0.5	0	153	53	12	32	0.35	348
Bansbari	8.1	1185	490	150	28	26	8.5	0	433	64	5	50	0.41	711

In mg/l

7.3.3 Aquifer Management Plan

1. Ground water development :

Stage of development of the block is 68.93% only therefore categorized as 'safe'. There is a possibility for further development of ground water. Additional number of tube well upto the SOD, is 70% is calculated and given in table below

Block	Total Annual Recharge	Net Resource	Gross Draft All Uses	Provision for Future Domestic and Industrial Requirement	SOD% 2017	Cate gory	Projected SOD (%)	GW draft at Projected SOD	Additional Resource Available	Unit Draft of STW	Additional Nos. of STW feasible based on GW
Baisa	6559.69	5903.72	3878.81	373.75	65.70	safe	70	4132.60	253.79	1.89	134

In ham

12. Artificial recharge structures

Block	Nala Bunding	Lateral Recharge Shaft	Recharge Shaft	Percolati on Tank	De-silting of existing tank /pond /talao	Injection Well in Village Tank
Baisi	1	5	10	1	18	25

7.4 Banmankhi Block

7.4.1 General Information

1. Area (ha) : 36884
2. No. of town : 1
3. No. of village : 81
4. Population (2011) Total : 3,51,415
   Rural : 3,21,079
   Urban : 30,336
5. Average Annual Rainfall (District) : 1305 mm
6. Depth-range wise No. of ground water abstraction structure (5^{th} MI Census)

< 20 m	:	745
20-35 m	:	1074
35-40 m	:	0
40-60 m	:	0
60-70 m	:	0

7. Ground Water Resources - 2020

Recharge from Rainfall		*Recharge from Other Sources*		*Total Annual Ground Water Recharge*	*Total Natural Discharges*	*Annual Extractable Ground Water Resource*
Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*			
8168.56	1108.02	1045.47	708.98	11031.03	1103.1	9927.93

Ground Water Extraction for Irrigation Use	*Ground Water Extraction for Domestic Use*	*Ground Water Extraction for Industrial Use*	*Total Extraction*	*Annual GW Allocation for for Domestic Use as on 2025*	*Net Ground Water Availability for future use*	*Stage of Ground Water Extraction (%)*	*Category*
4403.7	709.94	261.00	5374.65	797.49	4465.73	54.14	safe

7.4.2 Aquifer Disposition

1. Aquifer disposition : Explored depth: ~60 m bgl
   Aquifer type: Unconfined
   Single aquifer system
2. Water level behavior
   Pre-monsoon : 3.67 to 5.58 m bgl
   Post-monsoon : 1.80 to 2.65 m bgl
   Fluctuation : 1.02 to 3.78 m
3. Chemical quality of ground water : In general, Potable.

Location	pH	EC	TH	Ca	Mg	Na	K	CO3	HCO3	Cl	SO4	NO3	Fluoride	TDS
Banmankhi	8.1	1838	650	210	30	124	11	0	610	39	8	23	0.15	1103
Budhia Gola	7.7	432	190	42	21	9.14	0.4	0	153	21	30	38	0.23	259

In mg/l

7.4.3 Aquifer Management Plan

1. Ground water development :

Stage of development of the block is 54.14% only hence categorized as 'safe'. There is a possibility for further development of ground water. Additional number of tube well upto the SOD, is 70% is calculated and given in table below

Total Annual Recharge	Net Resource	Gross Draft All Uses	Provision for Future Domestic and Industrial Requirement	SOD % 2017	Category	Projected SOD (%)	GW draft at Projected SOD	Additional Resource Available	Unit Draft of STW	Additional Nos. of STW feasible based on GW availability
11031.03	9927.9	5374.65	797.49	54.1	saf	70	6949.55	1574.90	1.89	833

2. Artificial Recharge structure

Not prioritized

7.5 Barhara kothi Block

7.5.1 General Information

1. Area (ha) : 22971
2. No. of town : 0
3. No. of village : 53
4. Population (2011) Total : 2,09,000
   Rural : 2,09,000
   Urban : 0
5. Average Annual Rainfall (District) : 1305 mm
6. Depth-range wise No. of ground water abstraction structure (5^{th} MI Census)
   < 20 m : 253
   20-35 m : 1080
   35-40 m : 0
   40-60 m : 0
   60-70 m : 0
7. Ground Water Resources - 2020

Recharge from Rainfall		*Recharge from Other Sources*		*Total Annual Ground Water Recharge*	*Total Natural Discharges*	*Annual Extractable Ground Water Resource*
Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*			
5087.3	690.07	646.15	437.13	6860.65	686.07	6174.58

Ground Water Extraction for Irrigation Use	*Ground Water Extraction for Domestic Use*	*Ground Water Extraction for Industrial Use*	*Total Extraction*	*Annual GW Allocation for for Domestic Use as on 2025*	*Net Ground Water Availability for future use*	*Stage of Ground Water Extraction (%)*	*Category*
2731.05	360.07	135.00	3226.12	404.46	2904.07	52.25	safe

7.5.2 Aquifer Disposition

1. Aquifer disposition : Explored depth: ~40 m bgl
   Aquifer type: Unconfined
   Single aquifer system
2. Water level behavior
   Pre-monsoon : ~3.98 m bgl
   Post-monsoon : ~3.04 m bgl
   Fluctuation : ~0.94 m
3. Chemical quality of Ground and contamination : In general, Potable.

Location	pH	EC	TH	Ca	Mg	Na	K	CO3	HCO3	Cl	SO4	NO3	Fluoride	TDS
Magurjan	7.9	442	205	62	12	5	3	0	140	11	52	39	0.61	265

7.5.3 Aquifer Management Plan

1. Ground water development :

Stage of development of the block is 52.25% only therefore categorized as 'safe'. There is a possibility for further development of ground water. Additional number of tube well upto 70% SOD, is calculated and given in table below:

Block	Total Annual Recharge	Net Resource	Gross Draft All Uses	Provision for Future Domestic and Industrial Requirement	SOD% 2017	Category	Projected SOD (%)	GW draft at Projected SOD	Additional Resource Available	Unit Draft of STW	Additional Nos. of STW feasible based on GW availability
Barhara	6860.65	6174.58	3226.12	404.46	52.25	safe	70	4322.21	1096.09	1.89	580

2. Artificial Recharge structure

Not prioritized

7.6 Bhawanipur Block

7.6.1 General Information

1. Area (ha) : 16064
2. No. of town : 0
3. No. of village : 66
4. Population (2011) Total : 1,61,720
   Rural : 1,61,720
   Urban : 0
5. Average Annual Rainfall (District) : 1305 mm
6. Depth-range wise No. of tube wells (5^{th} MI Census)
   < 20 m : 563
   20-35 m : 861
   35-40 m : 0
   40-60 m : 0
   60-70 m : 0
7. Ground Water Resources - 2020

Recharge from Rainfall		*Recharge from Other Sources*		*Total Annual Ground Water Recharge*	*Total Natural Discharges*	*Annual Extractable Ground Water Resource*
Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*			
3557.63	482.58	644.09	435.17	5119.47	511.95	4607.52

Ground Water Extraction for Irrigation Use	*Ground Water Extraction for Domestic Use*	*Ground Water Extraction for Industrial Use*	*Total Extraction*	*Annual GW Allocation for for Domestic Use as on 2025*	*Net Ground Water Availability for future use*	*Stage of Ground Water Extraction (%)*	*Category*
2727.27	278.61	153.00	3158.88	312.97	1414.28	68.56	safe

In ham

7.6.2 Aquifer disposition

1. Aquifer disposition : Explored depth: 50 m bgl
   Aquifer type: Unconfined
   Single aquifer system
2. Water level
   Pre- : ~3.13 m bgl
   Post- : ~2.3 m bgl
   Fluctuation : ~0.83 m
3. Chemical quality of and contamination : In general, Potable.

Location	pH	EC	TH	Ca	Mg	Na	K	CO3	HCO3	Cl	SO4	NO3	Fluoride	TDS
Dargaha	8.1	229	105	34	5	0	0.1	0	67	4	45	36	0.87	137

7.6.3 Aquifer Management Plan

1. Ground water development :

Stage of development of the block is68.56% only therefore categorized as 'safe'. There is a possibility for further development of ground water. Additional number of tube well upto the SOD, is 70% is calculated and given in table below:

Block	Total Annual Recharge	Net Resource	Gross Draft All Uses	Provision for Future Domestic and Industrial Requirement	SOD% 2017	Category	Projected SOD (%)	GW draft at Projected SOD	Additional Resource Available	Unit Draft of STW	Additional Nos. of STW feasible based on GW availability
Bhawanipu	5119.47	4607.5	3158.8	312.97	68.56	safe	70	3225.26	66.38	1.89	35

2. Artificial Recharge structure

Not prioritized.

7.7 Dagarua Block

7.7.1 General Information

1. Area (ha) : 20995
2. No. of town : 0
3. No. of village : 140
4. Population (2011) Total : 2,21,142
   Rural : 2,21,142
   Urban : 0
5. Average Annual Rainfall (District) : 1305 mm
6. Depth-range wise No. of ground water abstraction structure (5^{th} MI Census)

< 20 m	:	2414
20-35 m	:	985
35-40 m	:	0
40-60 m	:	0
60-70 m	:	0

7. Ground Water Resources - 2020

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

5082.86	630.71	1138.56	991.86	7843.99	392.2	7451.79

Ground Water Extraction for Irrigation Use	*Ground Water Extraction for Domestic*	*Ground Water Extraction for Industrial Use*	*Total Extraction*	*Annual GW Allocation for for Domestic Use as on 2025*	*Net Ground Water Availability for future use*	*Stage of Ground Water Extraction (%)*	*Category*
5546.58	380.98	360.00	6287.57	427.96	1117.24	84.38	semi_critical

7.7.2 Aquifer Disposition

1. Aquifer disposition : Explored depth: ~50 m bgl
   Aquifer type: Unconfined
   Single aquifer system
2. Water level behavior
   Pre-monsoon : 2.24 to 3.35 m bgl
   Post-monsoon : ~2.7 m bgl
   Fluctuation : ~0.60 m
3. Chemical quality of Ground and contamination : In general, Potable.

Location	pH	EC	TH	Ca	Mg	Na	K	CO3	HCO3	Cl	SO4	NO3	Fluoride	TDS
Barsoni	8	988	420	128	24	25	0.6	0	317	50	26	44	0.54	593
Purnea	7.7	1174	550	162	35	14	8.1	0	482	50	0	8	0	704
Ranipatra	7.9	695	335	92	26	3.99	4.1	0	214	75	0	15	0	417

7.7.3 Aquifer Management Plan

1. Ground water development :

Stage of development of the block is84.38% only therefore categorized as 'semi critical'. It is not recommended for further development of ground water. Hence, additional number of tube well is suggested as 'Nil'.

Total Annual Recharge	Net Resource	Gross Draft All Uses	Provision for Future Requirement	SOD% 2017	Cate gory	Projected SOD (%)	GW draft at Projected SOD	Additional Resource Available	Unit Draft of STW	Additional Nos. of STW feasible based on GW availability
7843.99	7451.79	6287.57	427.96	84.38	Semi_ critical	70	5216.25	0.0	1.89	Nil

3. Artificial Recharge structure

Block	Nala Bunding	Lateral Recharge Shaft	Recharge Shaft	Percolati on Tank	De-silting of existing tank /pond /talao	Injection Well in Village Tank
Dagarua	1	5	11	1	19	25

7.8 Dhamdaha Block

7.8.1 General Information

1. Area (ha) : 36254
2. No. of town : 0
3. No. of village : 72
4. Population (2011) Total : 2,88,084
   Rural : 2,88,084
   Urban : 0
5. Average Annual Rainfall (District) : 1305 mm
6. Depth-range wise No. of ground water abstraction structure (5^{th} MI Census)
   < 20 m : 235
   20-35 m : 1334
   35-40 m : 0
   40-60 m : 0
   60-70 m : 0
7. Ground Water Resources - 2020

Recharge from Rainfall		Recharge from Other Sources		Total Annual Ground Water Recharge	Total Natural Discharges	Annual Extractable Ground Water Resource
Monsoon	Non-monsoon	Monsoon	Non-monsoon			
9015.27	1089.1	765.12	520.99	11390.48	569.52	10820.96

Ground Water Extraction for Irrigation Use	Ground Water Extraction for Domestic Use	Ground Water Extraction for Industrial Use	Total Extraction	Annual GW Allocation for for Domestic Use as on 2025	Net Ground Water Availability for future use	Stage of Ground Water Extraction (%)	Category
3213	496.31	180.00	3889.31	557.51	6870.45	35.94	safe

7.8.2 Aquifer Disposition

1. Aquifer disposition : Explored depth: 50 m bgl
   Aquifer type: Unconfined
   Single aquifer system
2. Water level behavior
   Pre-monsoon : ~5.16 m bgl
   Post-monsoon : ~3.11 m bgl
   Fluctuation : ~2.05 m
3. Chemical quality of Ground and contamination : In general, Potable.

Location	pH	EC	TH	Ca	Mg	Na	K	CO3	HCO3	Cl	SO4	NO3	Fluoride	TDS
Dhamdaha	8.2	806	385	120	21	4.71	3.9	0	336	64	15	13	0.13	484

7.8.3 Aquifer Management Plan

1. Ground water development :

Stage of development of the block is 35.9% only therefore categorized as 'safe'. There is a possibility for further development of ground water. Additional number of tube well upto the 70%SOD, is calculated and given in table below

Block	Total Annual Recharge	Net Resource	Gross Draft All Uses	Provision for Future Domestic and Industrial Requirement	SOD% 2017	Category	Projected SOD (%)	GW draft at Projected SOD	Additional Resource Available	Unit Draft of STW	Additional Nos. of STW feasible based on GW availability
Damdaha	11390.48	10820.96	3889.31	557.51	35.94	safe	70	7574.67	3685.36	1.89	1950

2. Artificial Recharge structure

Not Prioritized.

7.9 Jalalgarh Block

7.9.1 General Information

1. Area (ha) : 11320
2. No. of town : 0
3. No. of village : 46
4. Population (2011) Total : 1,12,951
   Rural : 1,12,951
   Urban : 0
5. Average Annual Rainfall (District) : 1305 mm
6. Depth-range wise No. of ground water abstraction structure (5^{th} MI Census)
   < 20 m : 1045
   20-35 m : 121
   35-40 m : 0
   40-60 m : 0

60-70 m	:	0	

7. Ground Water Resources - 2020 :

Recharge from Rainfall		*Recharge from Other Sources*		*Total Annual Ground Water Recharge*	*Total Natural Discharges*	*Annual Extractable Ground Water Resource*
Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*			
3452.29	340.06	566.5	383.43	4742.28	237.11	4505.17

Ground Water Extraction for Irrigation Use	*Ground Water Extraction for Domestic Use*	*Ground Water Extraction for Industrial Use*	*Total Extraction*	*Annual GW Allocation for for Domestic Use as on 2025*	*Net Ground Water Availability for future use*	*Stage of Ground Water Extraction (%)*	*Category*
2392.74	194.59	126.00	2713.34	218.59	1767.83	60.23	safe

In ha m

7.9.2 Aquifer Disposition

1. Aquifer disposition : Explored depth: ~80 m bgl
   Aquifer type: Unconfined
   Single aquifer system

2. Water level
   Pre- : ~4.37 m bgl
   Post- : ~2.09 m bgl
   Fluctuation : ~2028 m

3. Chemical quality of : In general, Potable.

Location	pH	EC	TH	Ca	Mg	Na	K	CO3	HCO3	Cl	SO4	NO3	Fluoride	TDS
Jalalgarh	8	1193	415	126	24	20	4.8	0	433	46	22	35	0.17	716

7.9.3 Aquifer Management Plan

1. Ground water development :

Stage of development of the block is 60.23% only therefore categorized as 'safe'. There is a possibility for further development of ground water. Additional number of tube well upto 70% SOD, is calculated and given in table below

Block	Total Annual Recharge	Net Resource	Gross Draft All Uses	Provision for Future Domestic and Industrial Requirement	SOD% 2017	Category	Projected SOD (%)	GW draft at Projected SOD	Additional Resource Available	Unit Draft of STW	Additional Nos. of STW feasible based on GW availability
Jalalgarh	4742.28	4505.17	2713.34	218.59	60.23	safe	70	3153.62	440.28	1.89	233

2. Artificial Recharge structure

Not prioritized

7.10 Kasba Block

7.10.1 General Information

1. Area (ha) : 16797
2. No. of town : 1
3. No. of village : 59
4. Population (2011) Total : 1,88,341
   Rural : 1,57,920
   Urban : 30,421
5. Average Annual Rainfall (District) : 1305 mm
6. Depth-range wise No. of water abstraction (5^{th} MI Census)

< 20 m	:	94
20-35 m	:	877
35-40 m	:	0
40-60 m	:	0

	60-70 m	: 0

7. Ground Water Resources -2020 :

Recharge from Rainfall		*Recharge from Other Sources*		*Total Annual Ground Water Recharge*	*Total Natural Discharges*	*Annual Extractable Ground Water Resource*
Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*			
3719.97	504.6	502.89	346.8	5074.26	507.43	4566.83

Ground Water Extraction for Irrigation Use	*Ground Water Extraction for Domestic Use*	*Ground Water Extraction for Industrial Use*	*Total Extraction*	*Annual GW Allocation for for Domestic Use as on 2025*	*Net Ground Water Availability for future use*	*Stage of Ground Water Extraction (%)*	*Category*
2067.66	429.29	135.00	2631.96	482.23	1881.93	57.63	safe

In ha m

7.10.2 Aquifer Disposition

1. Aquifer disposition : Explored depth: ~70 m bgl
   Aquifer type: Unconfined
   Single aquifer system
2. Water level behavior
   Pre-monsoon : 3.31 to 4.36 m bgl
   Post-monsoon : 4.06 to 2.16 m bgl
   Fluctuation : 0.3 to 0.94 m
3. Chemical quality of Ground water : In general, Potable.

Location	pH	EC	TH	Ca	Mg	Na	K	CO3	HCO3	Cl	SO4	NO3	Fluoride	TDS
Kasba	8.1	1949	925	300	43	38	4.6	0	671	67	30	12	0	1169
Khata Hat	7.6	1298	410	130	21	27	3.2	0	494	64	65	69	0.94	779

In mg/l

7.10.3 Aquifer Management Plan

1. Ground water development :

Stage of development of the block is 57.63% only therefore categorized as 'safe'. There is a possibility for further development of ground water. Additional number of tube well upto 70% SOD, is calculated and given in table below

Block	Total Annual Recharge	Net Resource	Gross Draft All Uses	Provision for Future Domestic and Industrial Requirement	SOD% 2017	Category	Projected SOD (%)	GW draft at Projected SOD	Additional Resource Available	Unit Draft of STW	Additional Nos. of STW feasible based on GW availability
Kasba	5074.26	4566.83	2631.96	482.23	57.63	safe	70	3196.78	564.82	1.89	299

2. Artificial Recharge structure

Not prioritized.

7.11 Krityanand Nagar Block

7.11.1 General Information

1. Area (ha) : 28470
2. No. of town : 0
3. No. of village : 68
4. Population (2011) Total : 2,30,504
   Rural : 2,30,504
   Urban : 0
5. Average Annual Rainfall (District) : 1305 mm
6. Depth-range wise No. of Tube wells
   < 20 m : 354
   20-35 m : 1443

(5th MI Census)	35-40 m	:	0
	40-60 m	:	0
	60-70 m	:	0

7. Ground Water Resources -2020 :

Recharge from Rainfall		*Recharge from Other Sources*		*Total Annual Ground Water Recharge*	*Total Natural Discharges*	*Annual Extractable Ground Water Resource*
Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*			
6305.14	855.26	878.49	597.8	8636.69	863.67	7773.02

Ground Water Extraction for Irrigation Use	*Ground Water Extraction for Domestic Use*	*Ground Water Extraction for Industrial Use*	*Total Extraction*	*Annual GW Allocation for for Domestic Use as on 2025*	*Net Ground Water Availability for future use*	*Stage of Ground Water Extraction (%)*	*Category*
3691.17	397.11	198.00	4286.29	446.08	3437.76	55.14	safe

In ha m

7.11.2 Aquifer Disposition

1. Aquifer disposition : Explore depth: ~70 m bgl
   Aquifer type: ~Unconfined
   Single aquifer system
2. Water level behavior
   Pre-monsoon : ~4.88 m bgl
   Post-monsoon : ~2.01 m bgl
   Fluctuation : ~2.87m
3. Chemical quality of ground water : In general, Potable.

Location	pH	EC	TH	Ca	Mg	Na	K	CO3	HCO3	Cl	SO4	NO3	Fluoride	TDS
Kajha	7.9	871	415	118	29	10	8.7	0	256	21	10	50	0	523

7.11.3 Aquifer Management Plan

1. Ground water development :

Stage of development of the block is 55.14 % only therefore categorized as 'safe'. There is a possibility for further development of ground water. Additional number of tube well upto the SOD, is 70% is calculated and given in table below

Block	Total Annual Recharge	Net Resource	Gross Draft All Uses	Provision for Future Domestic and Industrial Requirement	SOD% 2017	Category	Projected SOD (%)	GW draft at Projected SOD	Additional Resource Available	Unit Draft of STW	Additional Nos. of STW feasible based on GW availability
Krityanand	8636.69	7773.02	4286.29	446.08	55.14	safe	70	5441.11	1154.82	1.89	611

2. Artificial Recharge structure

Not prioritized

7.12 Purnea East Block

7.11.1 General Information

1.	Area (ha)		:	25727
2.	No. of town		:	1
3.	No. of village		:	77
4.	Population (2011)	Total	:	4,45,326
		Rural	:	1,63,078
		Urban	:	2,82,248
5.	Average Annual Rainfall (District)		:	1305 mm
6.	Depth-range wise No. of water abstraction	< 20 m	:	68
		20-35 m	:	1076

(5th MI Census)	35-40 m	:	103
	40-60 m	:	510
	60-70 m	:	0

7. Ground Water Resources -2020 :

Recharge from Rainfall		*Recharge from Other Sources*		*Total Annual Ground Water Recharge*	*Total Natural Discharges*	*Annual Extractable Ground Water Resource*
Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*			
5697.66	772.86	941.69	636.18	8048.39	804.84	7243.55

Ground Water Extraction for Irrigation Use	*Ground Water Extraction for Domestic Use*	*Ground Water Extraction for Industrial Use*	*Total Extraction*	*Annual GW Allocation for for Domestic Use as on 2025*	*Net Ground Water Availability for future use*	*Stage of Ground Water Extraction (%)*	*Category*
3987.9	718.58	288.00	4994.49	807.19	2160.45	68.95	safe

In ha m

7.11.2 Aquifer Disposition

1. Aquifer disposition : Explored depth: ~70 m bgl
   Aquifer type: Unconfined
   Single aquifer system
2. Water level behavior
   Pre-monsoon : ~3.59 m bgl
   Post-monsoon : ~2.55 m bgl
   Fluctuation : ~1.03 m
3. Chemical quality of ground water : In general, Potable.

Location	pH	EC	TH	Ca	Mg	Na	K	CO3	HCO3	Cl	SO4	NO3	Fluoride	TDS
Purnea	7.7	1174	550	162	35	14	8.1	0	482	50	0	8	0	704
Ranipatra	7.9	695	335	92	26	3.99	4.1	0	214	75	0	15	0	417
Barsoni	8	988	420	128	24	25	0.6	0	317	50	26	44	0.54	593

7.11.3 Aquifer Management Plan

1. Ground water development :

Stage of development of the block is 68.95 % only therefore categorized as 'safe'. There is a possibility for further development of ground water. Additional number of tube well upto the SOD, is 70% is calculated and given in table below

Block	Total Annual Recharge	Net Resource	Gross Draft All Uses	Provision for Future Domestic and Industrial Requirement	SOD% 2017	Category	Projected SOD (%)	GW draft at Projected SOD	Additional Resource Available	Unit Draft of STW	Additional Nos. of STW feasible based on GW availability
Purnea East	8048.39	7243.55	4994.49	807.19	68.95	safe	70	5070.49	76.00	1.89	40

2. Artificial Recharge structure

Not prioritized

7.13 Rupauli Block

7.11.1 General Information

1.	Area (ha)		:	24836
2.	No. of town		:	0
3.	No. of village		:	44
4.	Population (2011)	Total	:	2,34,686
		Rural	:	2,34,686
		Urban	:	0
5.	Average Annual Rainfall (District)		:	1305 mm
6.	Depth-range wise No. of	< 20 m	:	12

water abstraction (5^{th} MI Census)	20-35 m	:	1627
	35-40 m	:	0
	40-60 m	:	0
	60-70 m	:	0

7. Ground Water Resources -2020 :

Recharge from Rainfall		*Recharge from Other Sources*		*Total Annual Ground Water Recharge*	*Total Natural Discharges*	*Annual Extractable Ground Water Resource*
Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*			
6499.67	746.09	811.35	551.33	8608.44	430.42	8178.02

Ground Water Extraction for Irrigation Use	*Ground Water Extraction for Domestic Use*	*Ground Water Extraction for Industrial Use*	*Total Extraction*	*Annual GW Allocation for for Domestic Use as on 2025*	*Net Ground Water Availability for future use*	*Stage of Ground Water Extraction (%)*	*Category*
3407.67	404.32	189.00	4000.99	454.17	4127.18	48.92	safe

In ha m

7.11.2 Aquifer Disposition

1. Aquifer disposition : Explored depth: ~50 m bgl
   Aquifer type: Unconfined
   Single aquifer system
2. Water level
   Pre- : ~3.99 m bgl
   Post- : ~3.14 m bgl
   Fluctuation : ~0.85 m
3. Chemical quality of ground water : In general, Potable.

Location	pH	EC	TH	Ca	Mg	Na	K	CO3	HCO3	Cl	SO4	NO3	Fluoride	TDS
Tikapatti	8.2	203	100	30	6	0	0	0	73	14	17	25	0.15	122
Tikapatti Chowk	7.6	1178	515	146	36	27	3.6	0	451	4	42	65	0.23	707

7.11.3 Aquifer Management Plan

1. Ground water development :

Stage of development of the block is 48.92 % only therefore categorized as 'safe'. There is a possibility for further development of ground water. Additional number of tube well upto the SOD, is 70% is calculated and given in table below

Block	Total Annual Recharge	Net Resource	Gross Draft All Uses	Provision for Future Domestic and Industrial Requirement	SOD% 2017	Cate gory	Projected SOD (%)	GW draft at Projected SOD	Additional Resource Available	Unit Draft of STW	Additional Nos. of STW feasible based on GW availability
Rupauli	8608.44	8178.02	4000.99	454.17	48.92	safe	70	5724.61	1723.62	1.89	912

2. Artificial Recharge structure

Not prioritized

7.14 Srinagar Block

7.11.1 General Information

1. Area (ha) : 14221
2. No. of town : 0
3. No. of village : 27
4. Population (2011) Total : 1,10,058
   Rural : 1,10,058
   Urban : 0
5. Average Annual Rainfall (District) : 1305 mm

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

< 20 m	:	68
20-35 m	:	1076
35-40 m	:	0
40-60 m	:	0
60-70 m	:	0

7. Ground Water Resources -2020 :

Recharge from Rainfall		*Recharge from Other Sources*		*Total Annual Ground Water Recharge*	*Total Natural Discharges*	*Annual Extractable Ground Water Resource*
Monsoon	*Non-monsoon*	*Monsoon*	*Non-monsoon*			
3149.47	427.21	516.95	350.59	4444.22	444.42	3999.8

Ground Water Extraction for Irrigation Use	*Ground Water Extraction for Domestic Use*	*Ground Water Extraction for Industrial Use*	*Total Extraction*	*Annual GW Allocation for for Domestic Use as on 2025*	*Net Ground Water Availability for future use*	*Stage of Ground Water Extraction (%)*	*Category*
2177.28	189.61	117.00	2483.89	212.99	1492.53	62.10	safe

In ha m

7.11.2 Aquifer Disposition

1. Aquifer disposition : Explored depth: ~60 m bgl
   Aquifer Type: Unconfined
   Single aquifer system
2. Water level
   Pre- : ~3.94 m bgl
   Post- : ~2.77 m bgl
   Fluctuation : ~1.17 m
3. Chemical quality of ground : In general, Potable.

Location	pH	EC	TH	Ca	Mg	Na	K	CO_3	HCO_3	Cl	SO_4	NO_3	Fluoride	TDS
Jalalgarh	8	1193	415	126	24	20	4.8	0	433	46	22	35	0.17	716
Kasba	8.1	1949	925	300	43	38	4.6	0	671	67	30	12	0	1169
Khata Hat	7.6	1298	410	130	21	27	3.2	0	494	64	65	69	0.94	779

7.11.3 Aquifer Management Plan

1. Ground water development :

Stage of development of the block is 62.1 % only therefore categorized as 'safe'. There is a possibility for further development of ground water. Additional number of tube well upto the SOD, is 70% is calculated and given in table below

Block	Total Annual Recharge	Net Resource	Gross Draft All Uses	Provision for Future Domestic and Industrial Requirement	SOD% 2017	Category	Projected SOD (%)	GW draft at Projected SOD	Additional Resource Available	Unit Draft of STW	Additional Nos. of STW feasible based on GW availability
Srinagar	4444.22	3999.8	2483.89	212.99	62.10	safe	70	2799.86	315.97	1.89	167

2. Artificial Recharge structure

Not prioritized

Summary

The district with a geographical area of 3229 Km^2 lying in between north latitudes 25°21'00" and 26°05'26", and east longitudes 86°59'30" and 87°51'18" in the North Bihar Plains (NBP) occupies part of Kosi Mega Fan Deposits. The district has eleven community development blocks under four civil sub divisions, covering 1280 revenue villages.

There are two distinct sub-basins which drain the water of the area into river Ganga These are – Gandak and Others river sub-basin occupying about 35% of the area and drained into the Kosi River, the other is Bhagirathi and Others river sub-basin occupying nearly 65% of the area drained into Mahananda River.

The district has population of 3264619 (2011 census) out of which 90% are rural and 10 % urban. About 81% of urban population is concentrated in Purnea only. It has a population density of 1011 persons/Km^2. About 82% of the total workforce is dependent upon agriculture activities.

The rainfall is largely confined to the southwest monsoon. The district receives about 82% of the annual rainfall from southwest monsoon. On an average, there are 54 rainy days (i.e. days with rainfall of 2.5 mm or more). The average annual rainfall in the district is 1305 mm. However, shifting of rainy season has been observed in the district. Physiographically, it represents gently sloping towards south a flat monotonous land with regional slope varying from 0.2 m/Km to as low as 0.08 m/Km. On micro level, there are a series of undulations present in the area. These undulations have come into existence during shifting of river Kosi westward and degradation and aggradation processes simultaneously working on it. About 52% land of the area is being utilised for agriculture whereas fallow land is 24% only. In terms of soil texture, the soil is mainly sandy caused the higher infiltration rate.

Potato, wheat, rice and maize etc. are the main crops of the district. The cropping intensity of the district is calculated to be 109.8% (2019-20). Groundwater is the major source of irrigation in the district. As per 5th MI census (2013-14) total 26153 tube wells are being utilised for irrigation purpose. The depth of these tube wells is not more than 35 m bgl. The canal is a second major source of irrigation. The district has good canal network as a tail-end area of Eastern Kosi Canal Command area but do not covers Baisa, Baisi and Amour blocks. Although the canal water availability may not dependent on rainfall but these two sources of irrigation are affected by the rainfall but do not seem supplements each other.

Geologically, the entire area of Purnea district is occupied by alluvial sediments of Quaternary age. The sediments comprise alternating layers of un-oxidised to feebly oxidised very fine

to coarse sand, silt and clay. The sand layers constitute the potential aquifer though facies-change is a common phenomenon in the area. The aquifer is regionally extensive it is found to occur continuously down to the depth of exploration of 80 meters, at places capped by thin veneer of clay of 3-6 metres thickness. The clay capping is not persistent over the entire area making the aquifer unconfined in nature. A significant but discontinued clay layer occurs in the central and south western part of the district. The tube wells by tapping the aquifer below 140 m bgl depth may yield ~40 lps.

During pre-monsoon period, the water level varied from 2.24 to 5.58 m bgl. Major part of the district is categorized in the depth range of 2-5 m bgl water level whereas during post-monsoon period, depth to water level ranged from 1.8 to 4.06 m bgl. The monsoon fluctuation has been observed up to 3.78 m. The water table contours almost follow the topography as its general flow of ground water is towards south-eastern direction. In general the water level trend is not significant.

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

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

As per the study it has been recommended that total 5855 nos. of wells may be constructed by considering the unit draft of a well is 1.89 ham. Suitable artificial recharge structures are also suggested for blocks of priority basis viz. Amour, Baisi and Dagarua. As the ground water is the main source of irrigation and in many blocks Stage of Ground Water Extraction is reaching up to 70% in many blocks therefore judicious use of ground water may be encouraged in the area. The demand side management may also be implemented in the area however not discussed in this report.

Annexure I

Monitoring Well Details

SN	Name	Block	Latitude	Longitude	Altitude	May-19	Nov-19	Fl_Pre_Post
1	Amour	Amour	25.9703	87.7198	46.2	5.14	2.4	2.74
2	Bansbari	Baisi	25.8945	87.7561	42.9	3.35	2.76	0.59
3	Baisi2	Baisi	25.8639	87.7439	40.5	2.24	2.98	-0.74
4	Chadia	Baisi	25.8635	87.7841	40.9	3.32	2.74	0.58
5	Budhia Gola	Banmankhi	25.8958	87.2837	49	3.67	2.65	1.02
6	Mangujan	Barhara Kothi	25.8388	87.1752	47.9	3.98	3.04	0.94
7	Dargaha	Bhawanipur	25.5957	87.1446	39.2	3.13	2.3	0.83
8	Amri Kukran W	Dhamdaha	25.773	87.181	45.6	3.35	3.06	0.29
9	Banmankhi	Banmankhi	25.8842	87.192	48.4	5.58	1.8	3.78
10	Dhamdaha	Dhamdaha	25.7379	87.1789	44.7	5.16	3.11	2.05
11	Kajha	K. Nagar	25.7765	87.3524	42.8	4.88	2.01	2.87
12	Jalalgarh	Jalalgarh	25.9546	87.5304	50	4.37	2.09	2.28
13	Kasba	Kasba	25.8552	87.5357	46.4	4.36	4.06	0.3
14	Khata Hat	Kasba	25.8871	87.4262	43	3.1	2.16	0.94
15	Barsoni	Purnea	25.8035	87.5838	42.1	3.17	2.87	0.3
16	Purnea	Purnea	25.7821	87.4832	43.4	2.95	2.22	0.73
17	Ranipatra	Purnea	25.732	87.5113	39.5	4.21	2.48	1.73
18	Tikapatti Chowk	Rupouli	25.5182	87.2164	37.6	3.99	3.14	0.85
19	Barar	Purnea	25.5047	87.3751	36	4.03	2.65	1.38
				Minimum	2.24	1.8		
				Maximum	5.58	4.06		
				Average	3.89	2.66		

Annexure II

Results of Chemical Analysis of Ground Water

May 2019

Location	Site Type	pH	EC	TH	Ca	Mg	Na	K	CO3	HCO3	Cl	SO4	NO3	Fluoride
Amour	Dug well	8.1	986	415	150	10	32	3.4	0	323	75	62	73	0.85
Amri Kukran E	Dug well	7.9	734	305	102	12	27	2.1	0	250	53	54	65	0.8
Amri Kukran W	Dug well	7.8	1390	605	188	33	42	8.2	0	610	75	55	70	0.82
Baisi2	Dug well	8	580	225	62	17	4.83	0.5	0	153	53	12	32	0.35
Banmankhi	Dug well	8.1	1838	650	210	30	124	11	0	610	39	8	23	0.15
Bansbari	Dug well	8.1	1185	490	150	28	26	8.5	0	433	64	5	50	0.41
Barsoni	Dug well	8	988	420	128	24	25	0.6	0	317	50	26	44	0.54
Budhia Gola	Dug well	7.7	432	190	42	21	9.14	0.4	0	153	21	30	38	0.23
Chadia	Dug well	7.9	1498	660	220	27	35	12	0	610	50	10	8	0
Dargaha	Dug well	8.1	229	105	34	5	0	0.1	0	67	4	45	36	0.87
Dhamdaha	Dug well	8.2	806	385	120	21	4.71	3.9	0	336	64	15	13	0.13
Jalalgarh	Dug well	8	1193	415	126	24	20	4.8	0	433	46	22	35	0.17
Kajha	Dug well	7.9	871	415	118	29	10	8.7	0	256	21	10	50	0
Kasba	Dug well	8.1	1949	925	300	43	38	4.6	0	671	67	30	12	0
Khata Hat	Dug well	7.6	1298	410	130	21	27	3.2	0	494	64	65	69	0.94
Mangujan	Dug well	7.9	442	205	62	12	5	3	0	140	11	52	39	0.61
Purnea	Dug well	7.7	1174	550	162	35	14	8.1	0	482	50	0	8	0
Ranipatra	Dug well	7.9	695	335	92	26	3.99	4.1	0	214	75	0	15	0
Tikapatti	Dug well	8.2	203	100	30	6	0	0	0	73	14	17	25	0.15
Tikapatti Chowk	Dug well	7.6	1178	515	146	36	27	3.6	0	451	4	42	65	0.23

November 2020

BLOCK	LOCATION	Source	Lat	Long	pH	EC	TH	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	NO_3^{-}	SO_4^{2-}	F^{-}	PO_4^{3-}	TDS
Amaur	Amour	HP	25.960	87.710	5.39	542	210	52	19	23	3.4	0	207	11	61	24	0.06	0.02	352
Banmankhi	Budhia Gola	DW	25.890	87.280	5.11	378	165	42	15	10	0.06	0	122	46	21	1.3	0.06	0	246
Kasba	Kasba	HP	25.850	87.530	4.59	862	320	118	6	35	1.5	0	317	36	63	32	0.03	0	560
Srinagar	Khata hat	DW	25.890	87.400	5.22	563	180	52	12	42	3.2	0	195	43	65	1.3	0.01	0	366
Purnea	Purnea	DW	25.770	87.510	4.88	502	200	58	13	21	4.1	0	201	25	55	4.9	0.03	0	326
Banmakhi	Barsoni	HP	25.900	87.270	5.35	320	115	36	6	17	2.9	0	73	36	44	5.3	0.11	0.03	208
Barai	Dumer	DW	25.530	87.320	4.97	793	250	64	22	63	3.3	0	275	53	85	26	0.13	0	515
Baisi	Noorie	SW	25.850	87.700	5.29	230	95	20	11	8	0.02	0	79	11	34	2.3	0.13	0.07	150
Purnea	Banbhag	SW	25.790	87.430	5.26	254	100	30	6	11	1.3	0	92	18	30	4.6	0.16	0	165
Amaur	Bansbari	SW	25.950	87.710	5.3	287	110	30	9	15	2.1	0	49	7	67	38	0	0	187

Annexure III

Lithological Log of the Tube Well

1. Village : **Guasi**
   Coordinate : 25.765978 87.41498
   Block : Krityanand Nagar
   Lithological Log :

Description	*Depth range (m bgl)*		*Thickness (m)*
Clay, hard	3.04	9.1	6.06
Sand, fine	9.1	15.2	6.1
Sand, medium	15.2	24.4	9.2
Sand, coarse	24.4	28.9	4.5
Sand, medium	28.9	33.5	4.6
Sand, coarse	33.5	62.5	29
Sand, fine and clay	62.5	67	4.5
Sand, medium and clay	67	83.8	16.8

2. Village : **Mahabala**
   Coordinate : 25.638472 87.18794
   Block : Rupauli
   Lithological Log :

Description	*Depth range (m bgl)*		*Thickness (m)*
Sand	0	7.62	7.62
Sand, fine	7.62	10.7	3.08
Sand, medium	10.7	16.7	6
Sand, coarse	16.7	68.6	51.9

3. Village : **Thari**
   Coordinate : 25.743967 87.13042
   Block : Barhara
   Lithological Log :

Description	*Depth range (m bgl)*		*Thickness (m)*
Sand	0	6.1	6.1
Sand, fine	6.1	12.2	6.1
Sand, coarse	12.2	67	54.8

4. Village : **Saharia**
Coordinate : 26.062428 87.77876
Block : Baisa
Lithological Log :

Description	*Depth range (m bgl)*		*Thickness (m)*
Sand	0	7.6	7.6
Sand, medium	7.6	22.9	15.3
Sand, coarse	22.9	80.8	57.9

5. Village : **Gerua**
Coordinate : 26.011239 87.69603
Block : Amour
Lithological Log :

Description		*Depth range (m bgl)*		*Thickness (m)*
Sand	:	0	7.6	7.6
Sand, medium	:	7.6	19.8	12.2
Sand, coarse	:	19.8	80.8	61

6. Village : **Maranga**
Coordinate : 25.754562 87.46197
Block : Purnea
Lithological Log :

Description	*Depth range (m bgl)*		*Thickness (m)*
Sand, fine	0	3	3
Sand, fine to medium	3	24.3	21.3
Caly	24.3	27.4	3.1
Sand, medium to coarse	27.4	42.7	15.3
Sand, coarse with pebbles	42.7	48.8	6.1
Clay	48.8	51.8	3
Sand, fine and gravel	51.8	54.8	3
Sand, medium and pebbles	54.8	60.9	6.1
Sand, medium	60.9	73.1	12.2
Sand, fine	73.1	74.7	1.6

7. Village : **Purnea Town**
Coordinate : 25.754562 87.46197
Block : Purnea
Lithological Log :

Description	*Depth range (m bgl)*		*Thickness*
Clay	0	0.91	0.91
Sand, medium	0.91	15.24	14.33
Sand, coarse	15.24	18.29	3.05
Sand, coarse with pebbles	18.29	24.38	6.09
Sand, coarse	24.38	36.58	12.2

Sand, medium	36.58	42.67	6.09
Sand, coarse	42.67	60.96	18.29
Sand, medium	60.96	62.48	1.52

8. Village : **Bhandartal**
Coordinate : 25.754562 87.46197
Block : Purnea
Lithological Log :

Description	*Depth range (m bgl)*		*Thickness*
Top soil	0	4.7	4.7
Sand, fine	4.7	18.3	13.6
Sand, medium	18.3	35	16.7
Sand, coarse with pebble	35	51.8	16.8

9. Village : **Gwalpara**
Coordinate : 25.754562 87.46197
Block : Purnea
Lithological Log :

Description	*Depth range (m bgl)*		*Thickness*
Clay	0	3	3
Sandy clay	3	6.1	3.1
Sand, fine	6.1	33.5	27.4
Sand, fine to medium	33.5	36.6	3.1
Sand, medium to coarse	36.6	46.3	9.7
Caly	46.3	51.8	5.5
sand, medium to coarse	51.8	76.2	24.4
Sand, fine	76.2	79.2	3

10. Village : **Hatgachi**
Coordinate : 25.754562 87.46197
Block : Purnea
Lithological Log :

Description	*Depth range (m bgl)*		*Thickness*
Clay	0	1.8	1.8
Clay, hard	1.8	12.3	10.5
Sand, fine	12.3	15.3	3
Sand, medium	15.3	18.3	3
Clay	18.3	19.2	0.9
Sand, fine	19.2	19.8	0.6
Sand, coarse	19.8	34.7	14.9

11. Village : **Kasba**
Coordinate : 25.754562 87.46197
Block : Purnea
Lithological Log :

Description	*Depth range (m bgl)*		*Thickness*
Sand	0	33.5	33.5
Sand, coarse to fine	33.5	39.6	6.1

12. Village : **Rangpura**
Coordinate : 25.754562 87.46197
Block : Purnea
Lithological Log :

Description	*Depth range (m bgl)*		*Thickness*
Sand and clay	0	4.6	4.6
Sand, fine	4.6	18	13.4
Sand medium	18	21.4	3.4
Sand, coarse	21.4	36.6	15.2

13. Village : **Bairia**
Coordinate : 25.803006 87.733615
Block : Baisi
Lithological Log :

Description	*Depth range (m bgl)*		*Thickness*
Sand	0	7.6	7.6
Sand, medium	7.6	22.9	15.3
Sand, coarse	22.9	80.8	57.9

14. Village : **Mahendrapur**
Coordinate : 25.714681 87.611607
Block : Baisi
Lithological Log :

Description	*Depth range (m bgl)*		*Thickness*
Sand	0	9.1	9.1
Sand, medium	9.1	18.3	9.2
Sand, coarse	18.3	41.1	22.8

14. Village : **Baisi**
Coordinate : 25.864084 87.747213
Block : Baisi
Lithological Log :

Description	*Depth range (m bgl)*		*Thickness*
Sand, medium	0	5.4	5.4
Sand, coarse	5.4	16.7	10.7

Sand, coarse with pebbles	16.7	66.7	50

15. Village : **Garhara**
Coordinate : 25.912724 87.680966
Block : Amour
Lithological Log :

Description	*Depth range (m bgl)*		*Thickness*
Sand, medium	0	7.1	7.9
Sand, coarse	7.1	16	8.9
Sand, coarse with pebbles	16	66.3	50.3

15. Village : **Bishunpur**
Coordinate : 25.979266 87.654564
Block : Amour
Lithological Log :

Description	*Depth range (m bgl)*		*Thickness*
Clay	0	9.1	9.1
Sand, fine	9.1	23.3	14.2
Sand, coarse	23.3	27.7	4.4
Sand, medium	27.7	32.8	5.1
Sand, coarse	32.8	60.9	28.1
Sand, coarse with pebbles	60.9	83.6	22.7

References:

1. Ground Water Year Book – 2018-19 and 2019-20
2. Hydrogeology and Ground Water Development Potential of Purnea district, Bihar
3. Ground Water Exploration Report – Bihar

Disclaimer:

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