केन्द्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण

विभाग, जल शक्ति मंत्रालय

भारत सरकार

Central Ground Water Board

Department of Water Resources, River Development and Ganga Rejuvenation,

Ministry of Jal Shakti

Government of India

AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES

BAREILLY DISTRICT
UTTAR PRADESH

उत्तरी क्षेत्र, लखनऊ

Northern Region, Lucknow

Azadi Ka Amrit Mahotsav

Govt. of India
Ministry of Jal Shakti
CENTRAL GROUND WATER BOARD

AQUIFER MAPPING AND MANAGEMENT PLAN, BAREILLY DISTRICT, UTTAR PRADESH

By
Dr. Fakhre Alam
Assistant Hydrogeologist

Northern Region
Lucknow, Uttar Pradesh

AAP: 2020-21

Government of India
Ministry of Jal Shakti
Central Ground Water Board
Northern Region, Bhujal Bhawan
Sector-B, Sitapur Road Yojana
Aliganj, Lucknow-226 021
Phone : (0522)-2363812
e-mail : rdnr-cgwb@nic.in

Foreword

Groundwater has emerged as the preferred water source and poverty reduction tool in India's rural areas due to its near universal availability, dependability and low capital cost. It has made significant contributions to the growth of India's Economy and has been an important catalyst for its socio economic development. Its importance as a precious natural resource in the Indian context can be gauged from the fact that more than 85 % of India's rural domestic water requirements, 50 % of its urban water require- ments and more than 50 % of its irrigation requirements are being met from ground water resources.

The increasing dependence on ground water as a reliable source of water has resulted in its large-scale and often indiscriminate development in various parts of the country, without due regard to the recharging capacities of aquifers and other environmental factors. The unplanned and non-scientific development of ground water resources, mostly driven by individual initiatives has led to an increasing stress on the available resources.

Central Ground Water Board has taken up task of Aquifer Mapping and Ground Water Management Plan under NAQUIM in the Bareilly district during the AAP 2020-21 with an objective to (i) Delineation and characterization of aquifers in three dimensions (ii) Identification and quantification of issues and (iii) Development of management plans to ensure sustainability of ground water resources. Under the initiative, management plans for each aquifer system are being prepared suggesting various interventions to optimize ground water withdrawal and identifying aquifers with portable groundwater for drinking purpose in quality affected areas. The management options also includes identification of feasible area for artificial recharge to ground water and water conservation which help in arresting declining water levels besides demand side management option including crop diversification, increasing water use efficiency etc.

The sincere efforts of Dr. Fakhre Alam, Assistant Hydrogeologist, Central Ground Water Board, Northern Region, Lucknow is highly appreciated. I am sure that these aquifer maps and Ground Water Management Plan of Bareilly district would be of immense help in formulating scientifically viable implementable strategies for efficient management of ground water resources ensuring sustainability.

(S. G. Bhartariya)
Regional Director

Acknowledgement

"Success is not a place at which one arrives but rather the spirit with which one undertakes and continues the journey".

I am heartily thankful to Shri S. G. Bhartariya, Regional Director, Central Ground Water Board, Northern Region Lucknow for his guidance and immense support throughout the completion of this report.

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Last but not least, I would like to acknowledge my family members for their unselfish sacrifices, constant blessing and moral support at every stage in my life.

(Dr. Fakhre Alam)

Assistant Hydrogeologist

DISTRICT BAREILLY AT A GLANCE

1.		**GENERAL INFORMATION**		
	i.	Geographical Area (Sq. Km.)	:	4120
	ii.	Administrative Divisions Number of Tehsil/Block Number of Gram Panchayats/Villages	: 	 6/15 1193/2072
	iii.	Population (as on 2011 census) Male Female	: : :	4448359 2357665 2090694
	iv.	Average Annual Rainfall (mm)	:	1135
2.		**GEOMORPHOLOGY**		
		Major Physiographic Units	:	(i) Lower piedmont plain of tarai (ii) Older alluvial plain or upland (iii) Younger alluvial plain or lowland (iv) meander flood plain
		Major Drainages	:	Ram Ganga, Bahagul, Kiccha, Sonka, Deorania, Naktia, Deshara etc.
3.		**LAND USE (Hect.)**	:	406915
	a)	Forest area	:	352
	b)	Net area sown	:	326527
	c)	Area sown more than once	:	210272
	d)	Gross sown area	:	534758
4.		**MAJOR SOIL TYPES**	:	Bareilly Type-1 (Tarai soils) Bareilly Type-2 (Khadar or low-land soils) Bareilly Type-3 (Upland or Bangar soils)
5.		**LITERATE (2011) (in Percentage)**	:	
	a)	Literate person	:	58.49%
	b)	Male	:	67.50%
	c)	Female	:	48.30%
6.		**IRRIGATION BY DIFFERENT SOURCES (2019-20)**		
		Canal length	:	3265Km.
		Govt. tubewell	:	2685
		Private tubewell & pumps	:	421723
		Net Irrigated Area	:	308904 Ha
		Gross Irrigated Area	:	500733 Ha
7.		**NUMBER OF GROUND WATER MONITORING**		

		WELLS OF CGWB (As on 31-3-2020)		
		No. of Dugwells	:	7
		No. of Piezometers (GWD Govt. of U.P.)	:	9
		Total monitoring stations	:	16
8.		**PREDOMINANT GEOLOGICAL FORMATIONS**		
		HYDROGEOLOGY		
		Major water bearing formation	:	Sand medium to coarse
		(Pre-monsoon Depth to water level during 2020)	:	0.74-19.85 mbgl
		(Post-monsoon Depth to water level during 2020)	:	0.6-19.77 mbgl
9.		**GROUND WATER EXPLORATION BY CGWB (As on 31-3-2020)**		
		No of wells drilled (EW, OW, PZ, SH, Total)	:	EW-9, OW-NIL, SH-1
		Depth range (m)	:	201.50-752.73 mbgl
		Discharge (litres per second)	:	1627-4100 lpm
		Storativity (S)	:	4.15×10^{-4}
		Transmissivity (m^2/day)	:	1185 to 2841 m^2/day
10.		**GROUND WATER QUALITY**		
		Presence of Chemical constituents more than permissible limit (e.g. EC, F, As, Fe)	:	NO_3 (Above permissible limit at Ramnagar places)
		Type of water	:	Good
11.		**DYNAMIC GROUND WATER RESOURCES (2020)-in HAM**		
		Existing Gross Ground Water Draft for All Uses	:	85236
		Net Annual Ground Water Availability	:	125453
		Stage of Ground Water Development	:	67.94%
12.		**EFFORTS OF ARTIFICIAL RECHARGE & RAINWATER HARVESTING**	:	Nil
		Projects completed by CGWB (No & Amount spent)		
		Projects under technical guidance of CGWB (Numbers)		
13.		**GROUND WATER CONTROL AND REGULATION**	:	
		Number of Safe Blocks		11
		No of Semi Critical blocks		4
		Over Exploited		1
14.		**MAJOR GROUND WATER PROBLEMS AND ISSUES**	:	
		WATER SUPPLY BY TAPS / HANDPUMPS	:	Declining trend in few blocks
		Developed village	:	1865
		Total village	:	2070
		Rural water supply by taps / handpumps	:	1865
		Urban water supply	:	23

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AQUIFER MAPPING AND MANAGEMENT PLAN OF BAREILLY DISTRICT, UTTAR PRADESH

(A.A.P: 2020-2021)

By:

Dr. Fakhre Alam, Assistant Hydrogeologist
(fakhrealam-cgwb@gov.in)

1.INTRODUCTION

1.1 GENERAL

The district of Bareilly (also known as Bareli or Bans Bareilly) forms a part of Rohil Khand division and is named after its headquarter city i.e., Bareilly which was founded in 1537 by Bans Deo and Bareldeo the two sons of Jagat Singh Katehriya a Rohela Rajput. In the last few decades, with the rapid urbanisation, expending inclustrialisation and increased agricultural activities in the district, the demand of water has increased manifold. Since ground water is the most dynamic natural resource for a dependable urban/rural water supply and assured irrigation. It has been extensively exploited in the recent past in the entire district apart from the traditional surface water resources. In some part i.e. Aonla and part at Bahari tehsil it has been so much exploited, due to non-availability of surface water resources, that the whole ground water regime in the area has been affected resulting is a continuos depletion of ground water level. The multifarous ground water development programme has necessitated quantative as well as qualitative assessment of the resources for its proper utilisation on a long-term basis and keeping this aspect in mind an attempt has been made in the present report to compile all the hydrogeological, hydrological, hydrometrological, hydrochemical and other related data of the district up to 2002, and make suitable synthesis of same.

Central Ground Water Board (CGWB) implemented the National Aquifer Mapping Programme in Bareilly district, Uttar Pradesh with broad objective of preparing an aquifer wise and block wise management plan for the district. The present report is based upon the integration of existing data of CGWB & various Departments of State Government during A.A.P. 2020-21. The report prepared on “Aquifer Mapping and Management Plan, Bareilly District, U.P.” will be very useful for the planners and various executive agencies engaged in the development and management of ground water for agricultural, industrial and drinking purposes.

1 SCOPE OF STUDY

The scope of the present study is broadly outlined within the framework of National Aquifer Management Programme (NAQUIM) being implemented by CGWB. In the present report an effort has been made to consider the four major activities viz

1. Data collection / compilation- Compilation includes collection of data and maps from concerned Agencies, such as the Survey of India, Geological Survey of India, State Ground Water Department, U.P. Jal Nigam, Revenue Department., computerization and analysis of all acquired data and preparation of a data base.

2. Data gap analysis- Identification of Data Gap included ascertaining requirement for further data generation in respect of hydrometeorological, hydrogeological, geophysical & chemical studies**.**

3. Data generation- Data generation includes those of hydrometeorological, soil infiltration, and sub-surface geophysics, chemical quality of ground water, lithologs and aquifer parameters. Generation of ground water chemical quality data was accomplished by collection of water samples and their laboratory analysis for all major parameters and heavy metals. Sub-surface geophysical studies are incorporated borehole logging. The data pertaining to sub-surface lithology and aquifer parameters are obtained through studies of lithological logs of exiting exploratory wells, pumping tests and their analysis.

4. Preparation of aquifer maps and management plan- by using several GIS and other softwares, establish aquifer maps and other GIS Layers, their interpretation and sustainable management plan of the district for future time. Compilation of all the interpretations and publication as a form of report. Sharing of the report to grass wood level and various state govt agencies for implementation.

2 STUDY AREA

Bareilly district is located in the north western part of Uttar Pradesh and lies between latitude $28^0$01' and $28^0$54' north and longitude $78^0$58' and $78^0$47' east falling in survey of India toposheet No.-53 P. Its' maximum length from North to south is about 96 Km. and breadth from east to west is about 75 Km. The northern boundary of the district encounters Udham Singh Nagar of Uttaranchal. On the east lies the Pilibhit district and on the south east Shahjhanpur district on the south and south west it is bounded by Badaun district.

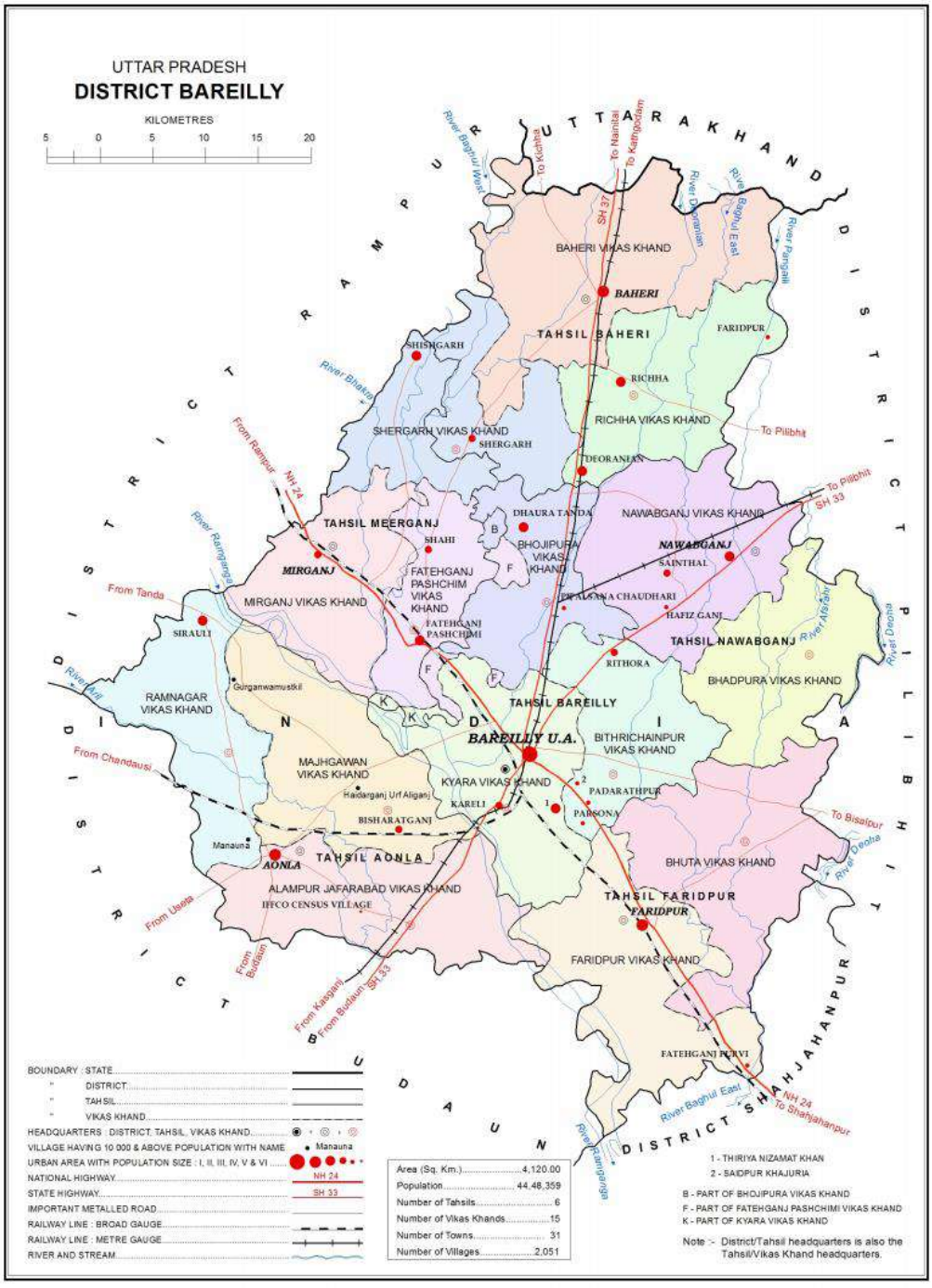


Fig.1.1: Administrative map of Bareilly district.

The Ramganga river forming the natural boundry between the two district for about 30 Km. On the west with Rampur district. The district encompasses a geographical area of 4120 Sq. Km. For the administrative convenience the Bareilly district, a segment of the Rohal Khand commissionery (HQ-Bareilly), has been divided into six tehsils and fifteen blocks. The details are given in table 1.1.

Table: 1.1: Name of Tehsil/block their geographical area and distance from district head quarter

Tehsil	Block	Area in (Sq. Km.)	Block headquarters	Distance from head quarters (Km.)
Baheri	Bahari	403.12	Bahari	50
	Richha	243.89	Richha	46
	Shergarh	267.79	Shergarh	42
Mirganj	Mirganj	230.64	Meerganj	33
	Fatehgarh West	178.80	Fatehgarh	17
Bareilly	Bhojipura	195.19	Bhojipura	17
	Kiyara	175.94	Kiyara	8
	Birthi Chainpur	223.47	Birthi Chainpur	13
Aonla	Alampur Jafrabad	278.82	Alampur Jafrabad	22
	Ram Nagar	220.26	Ram Nagar	51
	Majhgawan	300.28	Majhagawan	16
Nawabganj	Nawabganj	335.88	Nawabganj	33
	Bhadpura	242.37	Bhadpura	55
Faridpur	Faridpur	298.38	Faridpur	22
	Bhuta	323.84	Bhuta	34
Total area	-	3908.22	-	-
Total urban area	-	211.78	-	-
Total district area	-	4120.00	-	-

The rural area of the district has also a good network of all weathered roads connection almost each and every village with the district headquarter.

3 DEMOGRAPHY

The total population of the Bareilly district is 4448359 (As per 2011 census) out of which about 13% is Urban and remaining is rural population. Total Male population is 2357665 and Female population is 2090694. Average population density of the district is 904 persons/ Sq.Km.

Block wise population of Bareilly district given in Table 1.2 and density population map given in Fig 1.2.

Table 1.2: Block wise population of Barelly District, UP

Sl No	Block Name	Total	Male Population	Female Population
1	Baheri	236649	124259	112390
2	Shergarh	226130	119706	106424
3	Richha	182167	96016	86151
4	Meerganj	165295	87467	77828
5	Fatehganj	157576	83784	73792
6	Bhojipura	189661	99490	90171
7	Kiyara	127393	68640	58753
8	Ram Nagar	161170	86275	74895
9	Majhgawan	224467	120159	104308
10	Alampur Zafarabad	220066	118039	102027
11	Bithri Chanpur	192003	101288	90715
12	Nawabganj	250055	131864	118191
13	Bhadpura	162681	86561	76120
14	Bhutah	208985	111915	97070
15	Faridpur	175652	94893	80759
	Bareilly-City	1568409	827309	741100
	Total	**4448359**	**2357665**	**2090694**

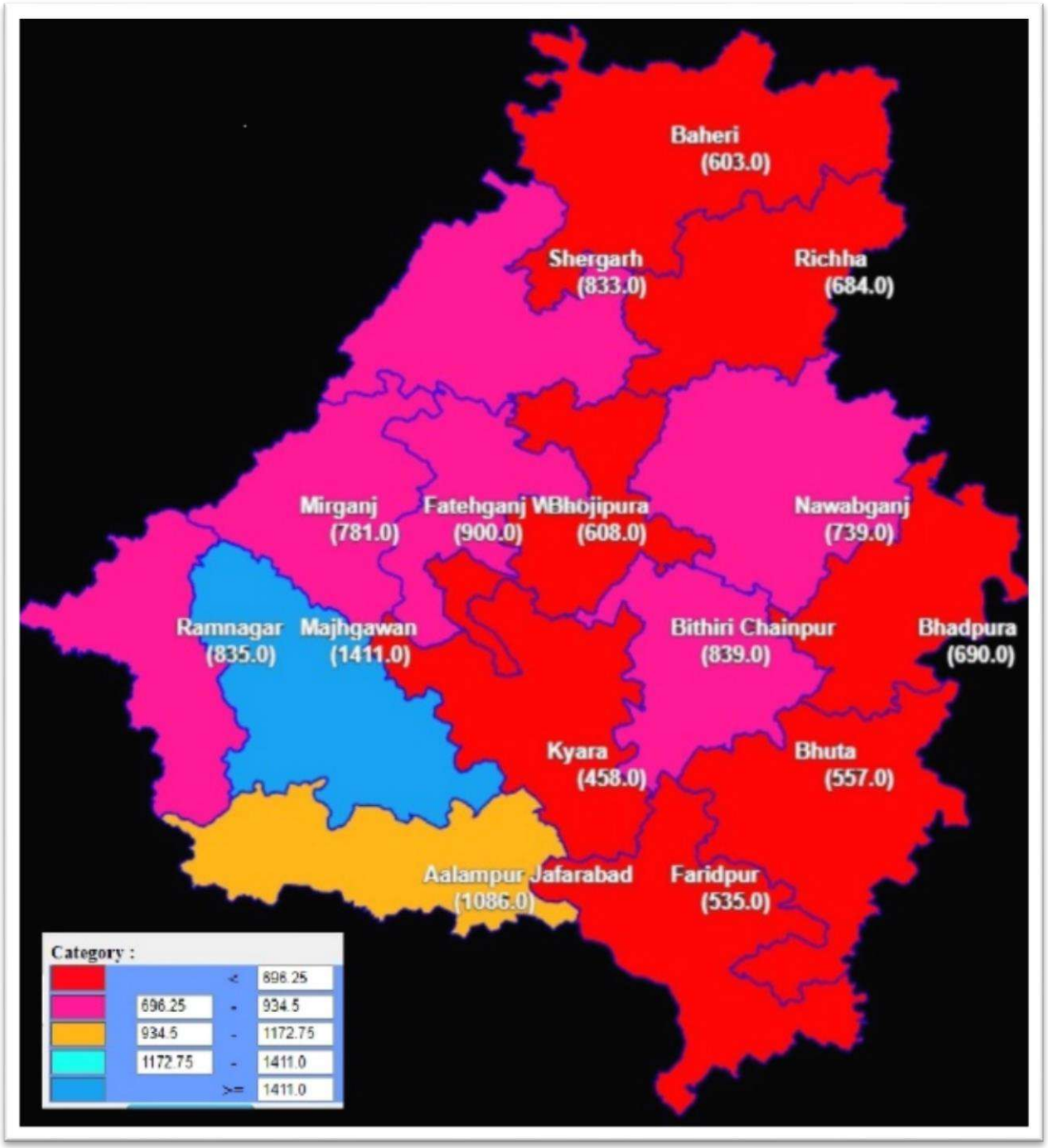


Fig. 1.2: Density of Population (per Sq.Km) in Bareilly District (source: District Statistical Report, UP)

4 RAINFALL AND CLIMATE

With hot and dry summers, humid monsoon season and dry winters, the district comes under sub-tropical sub-humid climate zone. There are 9 meteorological stations of IMD in the district. The maximum mean monthly atmospheric temperature, 40.50C has been recorded during the

month of May and minimum (8.60C) in January. The average annual maximum being 31.50C and 18.90C respectively. Temperature generally starts increasing from February and reaches to a maximum in May/June (Mean highest temperature 44.20C). The highest annual normal of rainfall has been recorded 1329.6 mm and lowest 590.2 mm, the average of the district being 957 mm (Monsoon-839.5 mm and nonmonsoon-117.5 mm). The southwest monsoon is active from mid-June to September, with maximum rainfall (~87%) taking place during this period, August being the wettest month. There is average 45 rainy days (days with rainfall of 2.5 mm or more) in a year. Average humidity remains considerably high from July to September (74.5% - 80.5%) and is highest during the month of August (Table 1.3).

Table 1.3. Rainfall data of Bareilly district for the years 2011-2020.

Year	**Annual**	**Monsoon (June to Sept)**	**Non-Monsoon (Oct to May)**
2011	1196.1	1109.8	86.3
2012	617.5	575.9	41.6
2013	1288.5	1135.2	153.3
2014	590.2	427.6	162.6
2015	820.9	663.7	157.2
2016	1210.9	1111.7	99.2
2017	926.8	863.6	63.2
2018	1329.6	1245.4	84.2
2019	839.3	714.0	125.3
2020	750.6	548.1	202.6
Average	***957***	***839.5***	***117.5***

1.6 PHYSIOGRAPHY AND GEOMORPHOLOGY

Bareilly district forms a part of Ramganga sub-basin in the central Indo-Gangetic plain. The Ramganga river divides the district into two unequal parts. Topographically, the area is almost an open plain with slight undulations which are more pronounced in the southern parts of the district where the ground surface is being dissected by numerous river valleys. In the area lying north of Ramganga river, the general slope of land surface its from north to south, as in south of Ramganga i.e. Aonla tehsil it is from west to east. The highest elevation of land surface above mean sea level, as recorded on the extreme northern border of the district, is 202 metres and the lowest as recorded in the south eastern part of Fatehgarh (east) is 158 metres. A number of elevated structures i.e. mounds have been observed in Shergarh, Faridpur and Aonla area. The gradient of the slope at land surface generally varies between 0.65-1.00 metres per Km throughout the area.

The general area shows the following distinctive geomorphic units as depicted from I.R.S. Imagery, Survey of India toposheet and selective field checks.

1. Lower piedmont plain of Tarai
2. Older alluvial plain or upland
3. Younger alluvial plain or low land
4. Meander flood plain

1. Lower Piedmont Plain of Tarai :

A narrow 5-10 Km wide tract locally brown as "Mar" extends along the northern border of the district in Baheri tehsil. It is southern extension of Tarai belt of Udham Singh Nagar. The tract exhibits almost flat to gentle slope and is mainly comprised of unconsolidated sediments of sand, silt clay and gravel. In the area shallow water level or water logged conditions, rich forest cover has been converted into most fertile and productive land of the area.

2. Older Alluvial Plain or Upland :

The south of "DES" upto Ramganga river lies the extensive tract of older alluvial plain or upland (covering 72% of the total district area) locally known as "BANGAR", which is much higher than the younger alluvial plain and forms the inter-stream divide or water sheds. It is light in texture towards the south and south east predominating in Faridpur tehsil, in the northern parts at Aonla tehsil to the south of Ramganga Khadar.

3. Younger Alluvial Plain or Low-Land :

These plains are locally known as "Khadar". It is usually very fertile tract and is commonly utilised for growing vegetables, wheat and sugarcane. The Khadar of Ramganga is generally 6 to 8

Km wide as about 20 Km. in the tract between Bareilly and Aonla. It generally merges on "BANGAR" upland except near Sirauli where the banks are well defined, the cliff actually overhanging the river. The "Khadar" of Deoha is also very fertile and is a strip of about 1.5 Km. wide which extends about 16 Km. along the eastern border of Nawabganj and 6.5 km. along eastern boundary of tehsil Faridpur. The "Khadar" in the lower reaches of the Bahgul (East) in Faridpur tehsils is about 1.5 Km wide and locally known as "Chanda". The Khadar of the Nakatia near Bareilly and that of the Bhagul (West) near Shahi are also extensive and fertile. The fluvial landforms such as paleo-channel, meander, scars and oxbow, lakes are common feature especially is Ramganga Khadar.

4. Meander Flood Plain :

It is low-lying, poorly drained, flat area of little or no relief and is confined to all along the meandering river course of Ramganga, Bhagul, Kichha and Deoha, spreading few metres to few kilometers in width. The characteristics landform occurring in these plains are point bars, channel bars and meander scars which are resulted due to meandering and braided course of rivers.

1.6.1 Drainage :

Bareilly district occupies a part of the Ramganga sub-basin of Ganga basin being close to the complex watershed of the main Himalayas. The area exhibits innumerable drainage lines. The overall drainage system as controlled by River Ramganga and it's tributes (all are perennial) like Sidha, Dojora, Bahgul (West), Kichha, Sonka, Deorania, Nakatia, Bahgul (East), Deoha, Airil etc. (Fig 1.3) and their sub-tributaries which mostly rise in the Tarai. The drainage density of the district is moderately high. It is very high in the northern part as compared to that of southern part. The description of major rivers of the district is as follows :

1. Ramganga :

The Ramganga a great tributary of Ganga, rising in the Mountains of Garhwal of Uttaranchal, enters the district from its western border near Dhemar Patti, a deserted village in tehsil Meerganj. It flows in south eastern direction separating tehsil Aonla from the rest of district as far as Sipahia village (In Faridpur tehsil) and thereafter it forms the boundary between Bareilly and Badaun district.

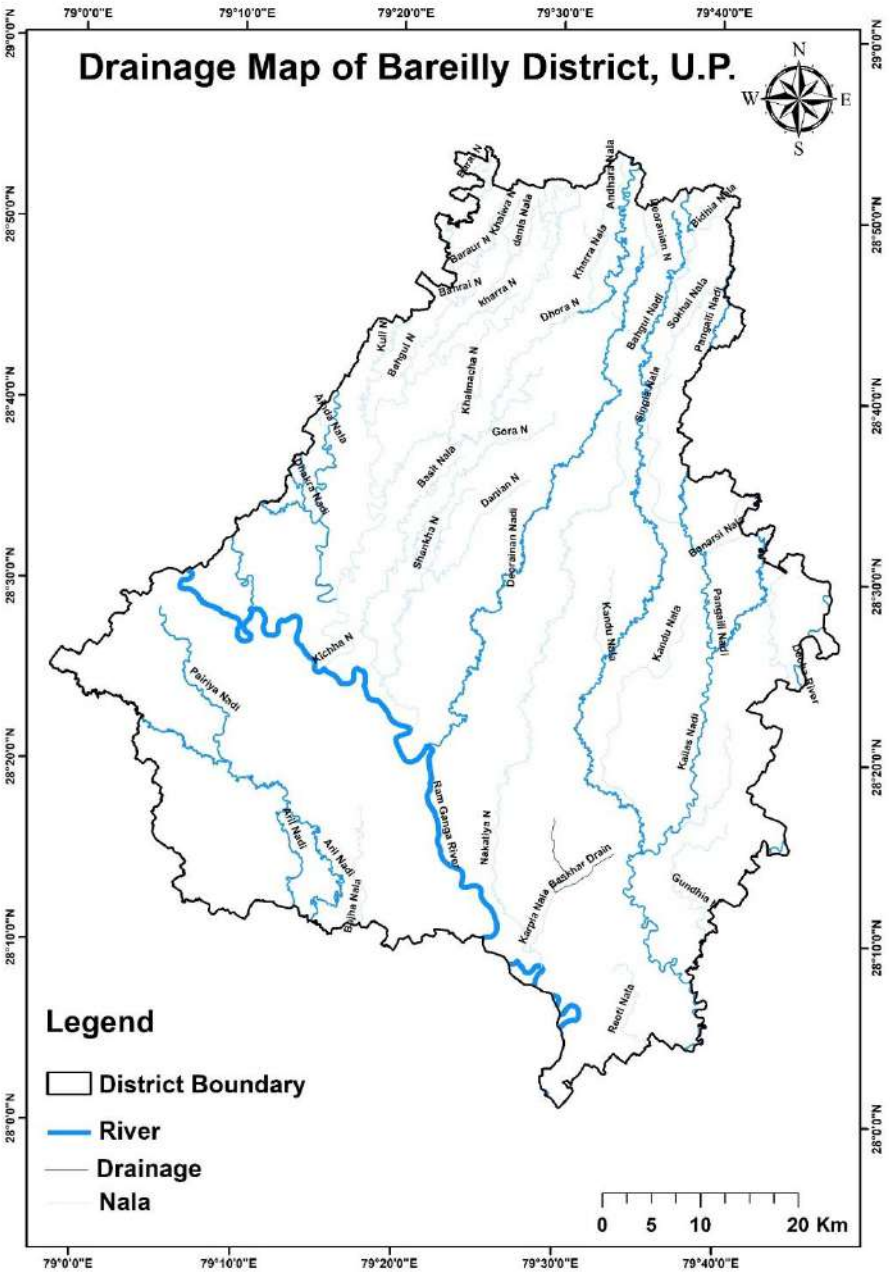


Fig. 1.3: Drainage map of Bareilly district.

2. Siddha River :

The Siddha river is first tributary of Ramganga in the district. It rises in Shahbad block of Rampur district and enters in the district from western border near village Shamshpur (Meerganj tehsil) flowing in a south easterly direction and join the Ramganga near village Purohit (Meerganj tehsil).

3. Dojara River :

The Dojora river is formed about 1.5 Km. west of (Khirka, Meeganj tehsil) by the Union of Bhakra and its tributary. Flowing southwards for few Kilometers it joins the Ramganga near Bazpur village (Meerganj tehsil).

4. Bahgul (west) River :

It rises in the Tarai area and enters near Mandaiyan village and flows intermittently along the Bareilly-Rampur border till Dhakia village where it finally enters the district. It is joined by Barai river near Narowa, Baraur river at Rustam Nagar and further flowing in south-westerly direction, it is first joined by the Kichha and than by the Kuli river near Lakshmipur and Basai villages and flows in southerly direction and joined by Dhora river at bajri Abdul Nabipur from where it again runs south-west ward till it meets the Bhakra near Khirka village to form the Dojora river.

5. Nakatia Stream :

It rises near the village of Khamaria Gopadandi in the south-eastern part of Baheri tehsil and flowing southward through the western part of Nawabganj tehsil and eastern parts of Bareilly tehsil it reaches south of Harauria village (Close to Ramganga) and thereafter enters in Faridpur tehsil, through which the river runs in south easterly direction to join the Ramganga near Khalpur village. It almost dries up during the summer. The banks of river are gently sloping and its bed consists of alluviam with clay and kankar deposits. The water of river is utilised for irrigation through out it course.

6. Bahgul (East) River :

The Bahgul east rises in Nainital district at Uttaranchal and after touching the northern border of district near village Chitauna Malhpur, and traverses southward through eastern part of Bareilly and central part of Nawabganj, passing through Mundia, Nabi, Atania Manpuria, Junki, Faiz Nagar, Imalia and Bhadpura villages. The riverbed is sandy and in its lower reaches it has a highly fertile Khadar area, locally known as Chanda.

7. Aril River :

It is an important right bank tributary of Ramganga, rises in district Moradabad and touches the Bareilly district in the south-west of Gularia Aral village and flows through Aonla tehsil in southeast direction. Near Deokala villages it is joined by Pairiya river. It is extensively utilised for irrigation near Aonla. The riverbed is clayey mixed with sand and kankar.

Lakes :

There are several lakes locally known as "Dabris" along the Ramganga and the Baghul (west) rivers, the largest being Lilaur Buzurg (Aonla tehsil) and Surla (Bareilly tehsil). Each of them covering about 100 acres area. Other lake of moderate size are existing in Ashokpur, Jerhard, Richha in Faridpur tehsil, there are some minor lakes which are Ballia, Kiana, Mustakil and Guntara in the Bareilly tehsil, Daulatpur in Faridpur tehsil. These lakes are generally filled water throughout the year and used for irrigation purposes and for the cultivation at Silgana, Bhagenda and Piswas.

1.6.2 Soils :

According to the classification followed by the State soil survey organisation, the soil of the district, can be classified into three major groups, based on its texture and composition characteristics.

Bareilly Type-1 (Tarai soils)

Bareilly Type-2 (Khadar or low-land soils)

Bareilly Type-3 (Upland or Bangar soils)

Bareilly Type-1 (Tarai soils) :

This type of soils are found in Tarai belt of Baheri tehsil and locally known as "Mar". The soil is characterised by fine texture, rich in organic matter, dark to grey in colour and rich is clay contents, especially in upper layers, the lower layers being lighter in texture, they are calcareous in nature. These soils posses the capacity of retaining moisture for larger period.

Bareilly Type-2 (Khadar or low-land soils) :

This type of soils is found in all tehsils developing in younger alluvial plain or low land along the river courses. These soils are characterised by generally ash-grey to brownish-grey on

the surface and their texture is sometime silty loamy sand and sometime sandy, the clay contents being low.

Bareilly Type-3 (Upland or Bangar soils) :

These soils occur in upland tract of older alluvial plain. The soil profile is generally mature, showing good development and illuviation of clay and sesquioxides. It can be sub-grouped depending upon its topographic occurrence and textural nature into sandy soil, clayey soils and loamy soil.

The sandy soil (Bareilly Type-3A) being found at top most leavel of upland, varying in composition, slightly acidic in nature, brown to yellowish brown in colour, are poorly fertile. The loamy soil of upland, called Bareilly type are found in the tehsil of Faridpur, Aonla and southern parts at Baheri & to some extent in Bareilly.

The clayey soil (Bareilly type-3-C) are found in depressions and are more common in Bareilly and Aonla tehsil, its representative site being Gopalpur. It is clay loam to clay in texture and its surface layers range from light grey to grey in colour, the lower horizon having a yellowish tinge. The soil is mature in profile, slightly acidic in reaction and very much suitable for Paddy crop.

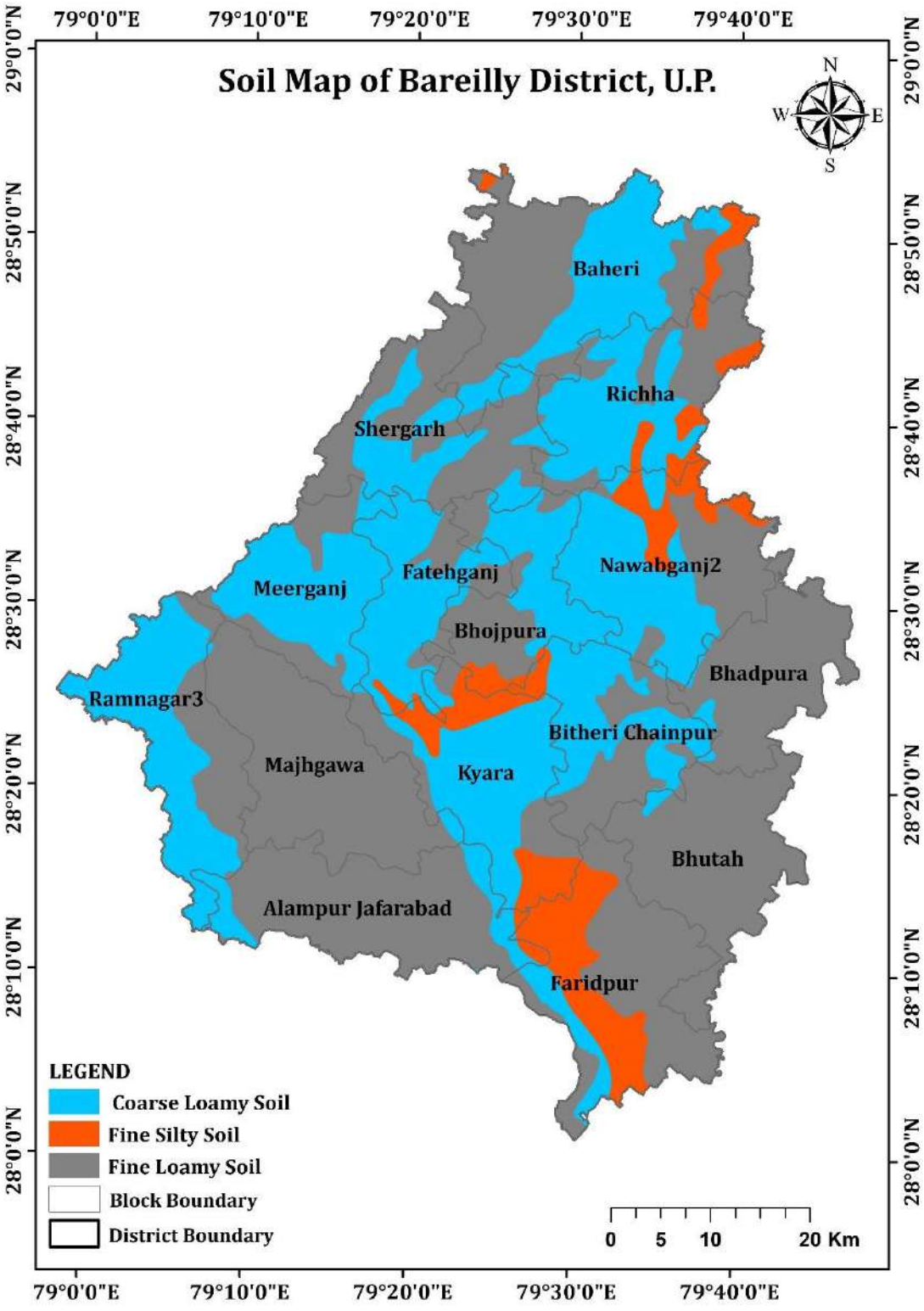


Fig 1.4: Soil Map of Bareilly District (UP)

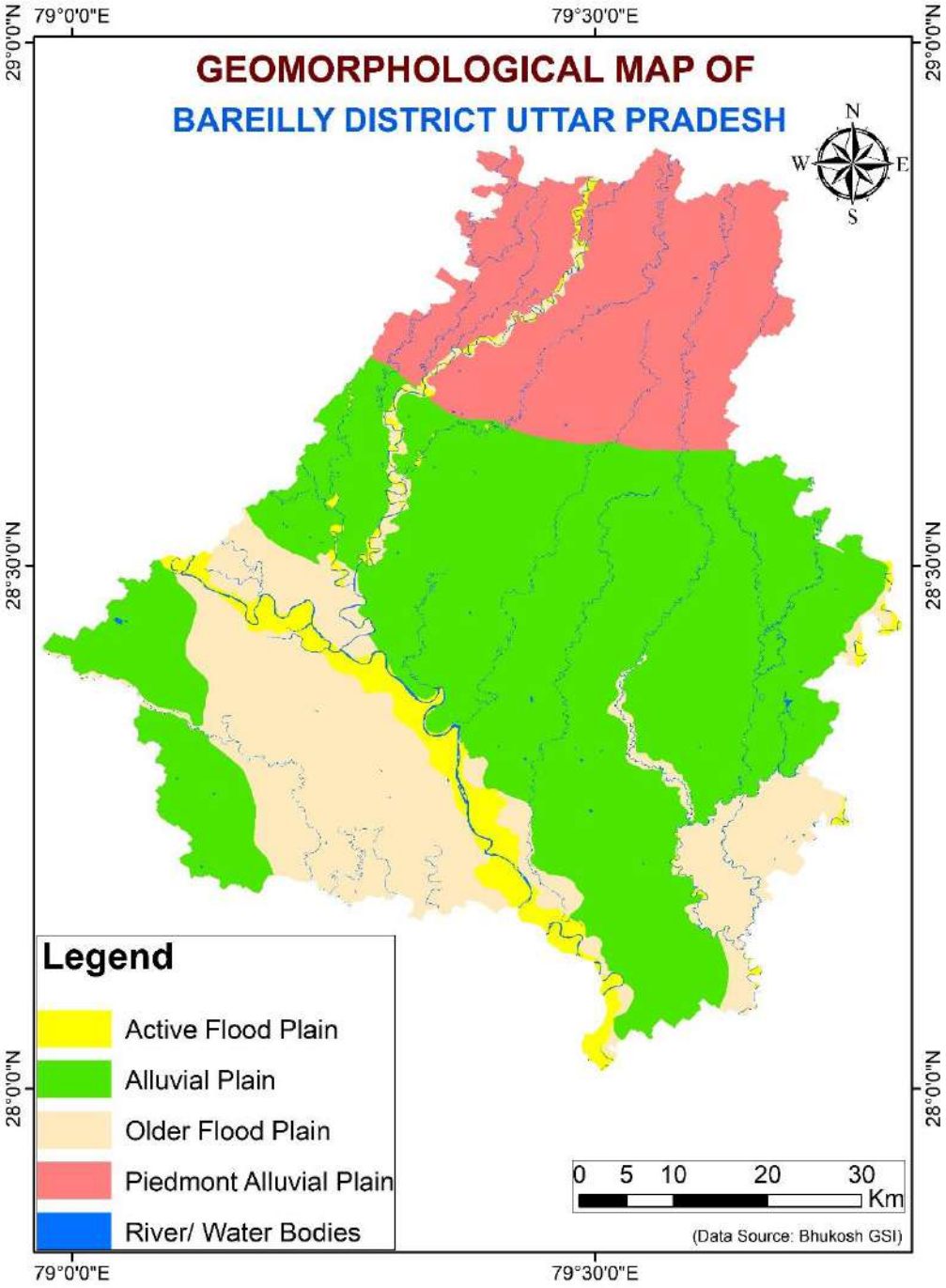


Fig 1.5: Geomorphological Map of Bareilly District (U.P)

1.7 LAND USE, AGRICULTURAL, IRRIGATION AND CROPPING PATTERN

1.7.1 Land Use Pattern:

Based on the available statistical data for the year 2018-19 and land utilisation pattern of the district are given in table 1.4.

Table: 1.4 Land utilisation pattern of the district

Total Reporting Area	:	406915 ha. (100%)
Forest	:	352 ha. (0.08%)
Barren land suitable for agriculture	:	1711 ha. (0.42%)
Current fallow land	:	7570 ha. (1.86%)
Other fallow land	:	2313 ha. (0.568%)
Usar and land unsuitable for agriculture	:	7456 ha. (1.83%)
Land under misc. uses except agriculture	:	60986 ha. (1.83%)
Net area sown	:	326527 ha. (80.24%)
Gross area sown in Rabi, Kharif and Jayed	:	534758 ha. (131.42%)

From the above data it is inferred that most of the land of the district is put into active cultivation i.e. about 80% leaving almost negligible land under forest cover which is only 0.08% of total area of district. The barren land which is unsuitable for agriculture is only 0.42% of total area may however be brought under afforestation scheme to maintain the ecological balance of area which may help in development of ground water.

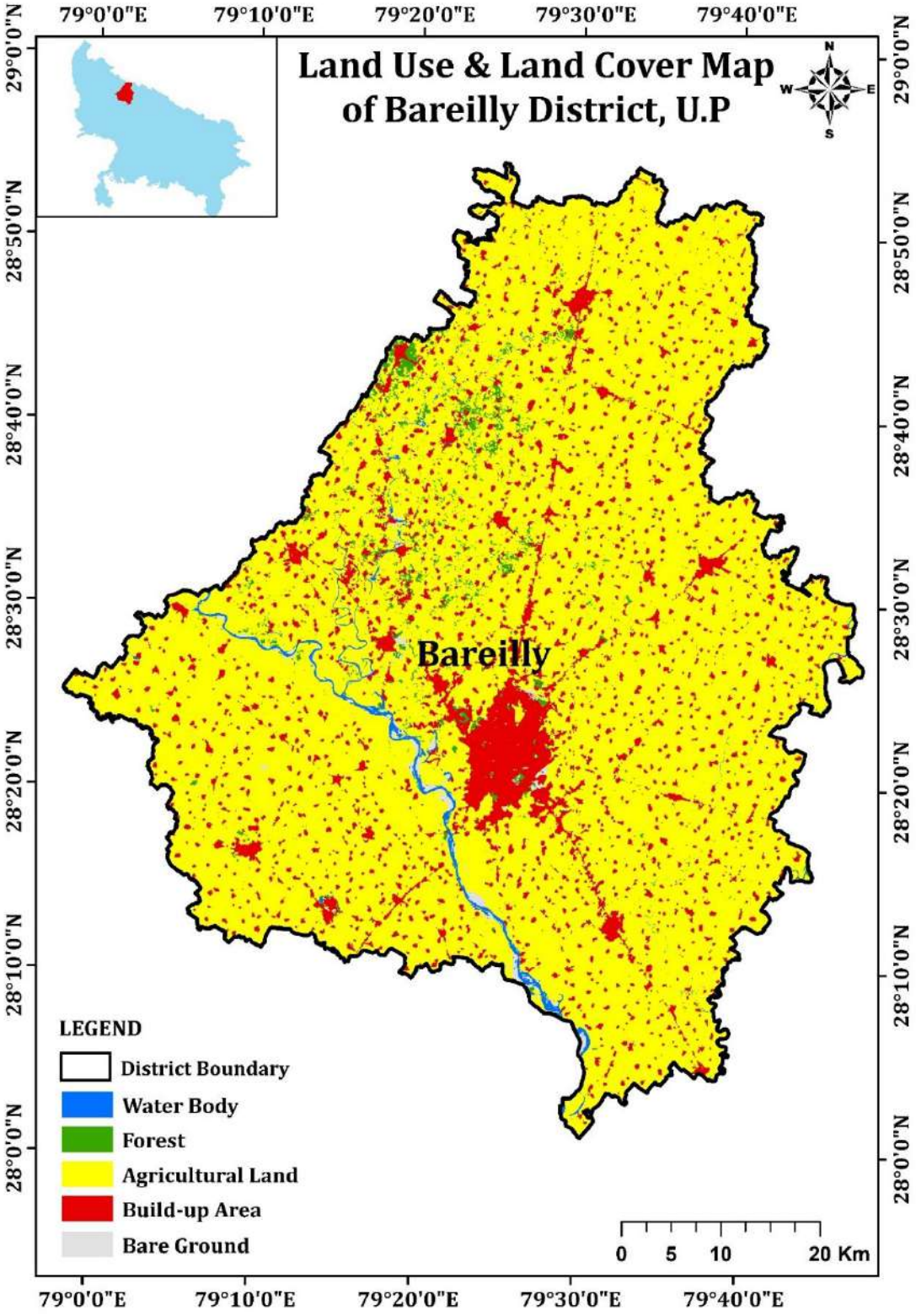


Fig 1.6: Land Use & Land Cover Map of Bareilly District (U.P.)

1.7.2 Agricultural Statistic

Bareilly is one of the most agriculturally developed district of Rohilkhand. About 326527 ha. (80.24%) of the total geographical area of district, is under active cultivation. The area sown more than once is 210272 ha. which indicates about 51.67% of the net cultivated area is utilised for double cropping. The salient features of agriculture in the district for the year 2018-2019 are given in table 1.5.

Table 1.5: Agricultural statistic in Bareilly district.

Total Reporting Area	:	406915 ha.
Net area under cultivation	:	326527 ha.
Area sown more than once	:	210272 ha.
Gross area sown, Rabi, Kharif and Jayed	:	534758 ha.
Area sown under Rabi crops	:	237879 ha.
Area sown under Kharif crops	:	276559 ha.
Area sown under Jayed crops	:	20320 ha.

The Wheat, Paddy and Sugar Cane are the Principal Crops sown in the area while the crops of the second order are masoor, mustard, millet, potato, jawar, arhar, ground rusts etc.
Source: http://updes.up.nic.in/

1.7.3 Irrigation

Irrigation is the most important aspect which affects the productivity of any crop. In broad sense, irrigation can be classified in two types- 1) Surface Irrigation- in which source of irrigation water is surface water bodies like Canal, River, Pond etc, 2) Sub-surface irrigation- in which source of irrigation is Ground water like Well, Tubewell etc. In India nearly 80% of total irrigation water used is from ground water, which is the highest in the world.

The Surface as well as Ground Water Resources are in the use for the irrigation purposes. The net irrigated area in the district is 308904 hect. out of which only about 13135 hect. area is under canal irrigation which is about 4.25% of the total net irrigated area. The remaining about 295769 hect net area is irrigated by ground water resources, which is about 95.75% of the total net irrigated area. The Gross Irrigated area in the district is 500733 hect. Block wise Net Sown Area, Gross Sown Area, Irrigated-Net & Gross along with Cropping Intensity and Irrigation

intensity is given below in Table 1.6.

Table 1.6.Details of Area under Different Crops

Block	Net area sown	Area sown more than once	Gross area sown				Sugarcane land	Net irrigated area	Gross irrigated area	Cropping intensity	Irrigation Intensity
			Total	Rabi	Kharif	Zayed					
Baheri	33565	22552	56117	16303	33054	6440	320	30632	57546	167.19	187.86
Shergarh	21524	14694	36218	13874	21446	835	63	19504	34029	168.27	174.47
Richha	20434	15051	35485	15326	19596	523	40	20255	31873	173.66	157.36
Meerganj	18107	11536	29643	13372	14956	1090	225	15802	25587	163.71	161.92
Fatehganj	13763	9577	23340	11955	10049	1242	94	11470	23284	169.59	203.00
Bhojipura	15333	11805	27138	12112	14061	910	55	14832	25188	176.99	169.82
Kiyara	10842	8014	18856	10215	7734	862	45	10603	14033	173.92	132.35
Ram Nagar	18961	12193	31154	16012	13332	1769	41	18409	29262	164.31	158.95
Majhgawan	27242	13940	41182	19682	20587	860	53	25882	41143	151.17	158.96
Alampur Zafarabad	22840	17435	40275	21304	17904	968	99	22841	40750	176.34	178.41
Bithri Chanpur	19543	7230	26773	13175	12656	811	131	20711	26031	137.00	125.69
Nawabganj	27398	18893	46291	20034	25198	979	80	26629	47159	168.96	177.10
Bhadpura	20141	12444	32585	12848	19078	540	119	19616	27724	161.78	141.33
Bhutah	27392	15844	43236	20138	21887	923	288	24411	36960	157.84	151.41
Faridpur	23789	17245	41034	20025	19574	1150	285	21730	32449	172.49	149.33
Village Total	320874	208453	529327	236375	271112	19902	1938	303327	493018	164.96	162.54
Urban Total	5653	1819	7472	1504	5447	418	103	5577	7715	132.18	138.34
District Total	326527	210272	536799	237879	276559	20320	2041	308904	500733	164.40	162.10

(Area in ha)

As per statistical analysis of data collected from http://updes.up.nic.in/spideradmin website of govt. of UP, Dugwell is the most important method of irrigation in the district. An area of 167767 ha is irrigated by Dugwell which comprises 51.37% of Net Sown Area. Second most important method or source of irrigation is tubewell. A total of 115642 ha i.e. 35.41% of Net Sown Area is irrigated by this method. Tubewell and Dugwell together contributes to 86.78 % of total irrigation in the district. It shows very high dependency of irrigation on groundwater. Canal, although present, contribute very less (4.02%) in irrigation. Details of Block wise sources of irrigation and their contribution is given below in the Table 1.7.

Table 1.7. Details of the Distribution of Surface and Ground Water for Irrigation

S.No.	Block Name	Blockwise Irrigated area in hectare						
		Canal	Tubewell		Dugwell	Pond	Other	Total
			State	Private				
1	Baheri	2770	270	15495	11185	8	904	30632
2	Shergarh	1414	309	7268	9471	12	1030	19504
3	Richha	2066	216	6262	10882	14	815	20255
4	Meerganj	24	215	5693	8987	6	877	15802
5	Fatehganj	118	416	6023	4042	8	863	11470
6	Bhojipura	709	307	7914	5031	6	865	14832
7	Kiyara	0	289	2883	6673	18	740	10603
8	Ram Nagar	0	781	6835	9888	5	900	18409
9	Majhgawan	0	314	8724	16082	2	760	25882
10	Alampur Zafarabad	0	263	6116	15859	4	599	22841
11	Bithri Chanpur	967	254	8657	10271	3	559	20711
12	Nawabganj	2089	544	9507	13451	33	1005	26629
13	Bhadpura	982	143	6717	11098	2	674	19616
14	Bhutah	1494	585	5657	15685	4	986	24411
15	Faridpur	502	633	5704	14297	6	588	21730
16	**Village Total**	13135	5539	109455	162902	131	12165	303327
17	**Urban Total**	0	40	608	4865	0	64	5577
18	**District Total**	13135	5579	110063	167767	131	12229	308904

(Area in ha)

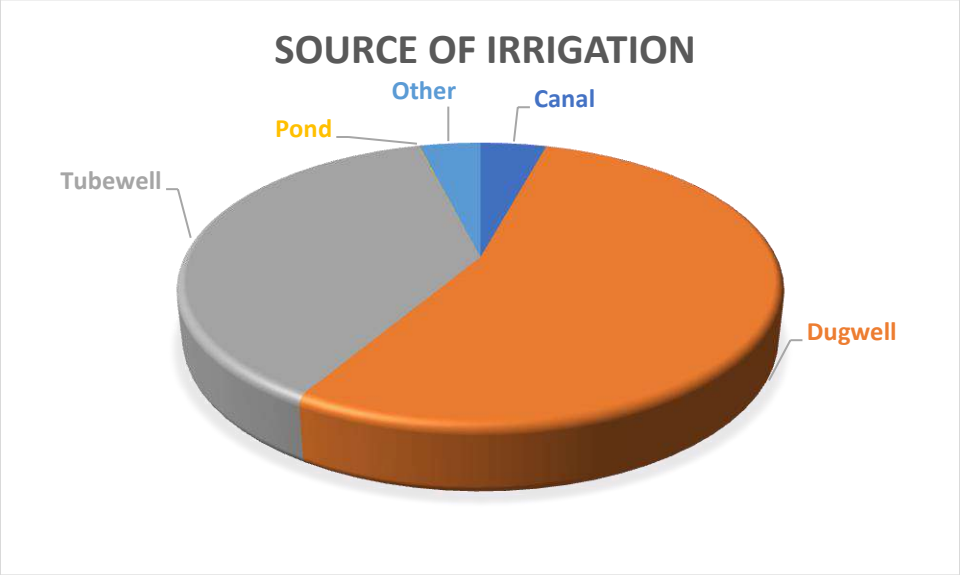


Fig 1.7: Percentage Distribution showing Methods of Irrigation in Bareilly District

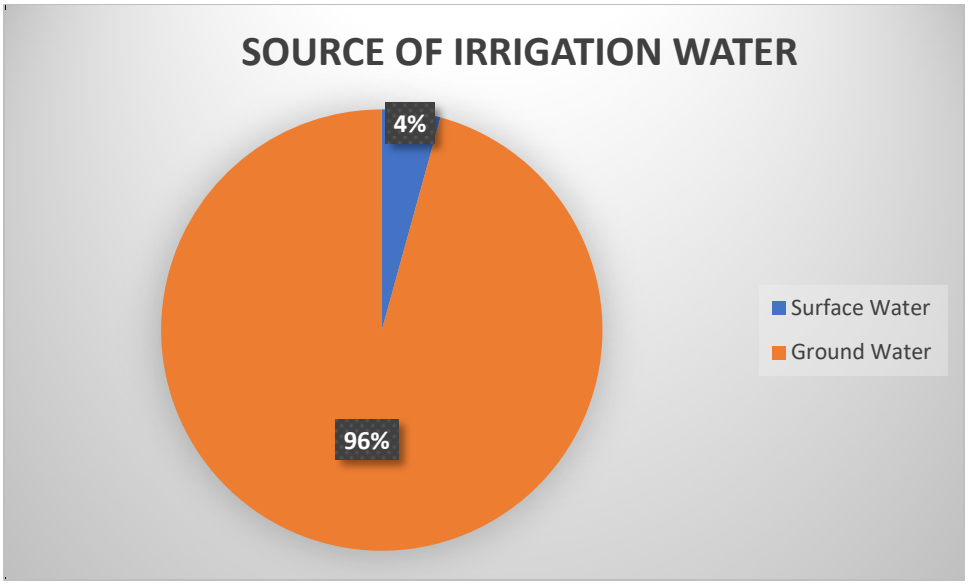


Fig 1.8: Source of Irrigation Water in Bareilly District (U.P.)

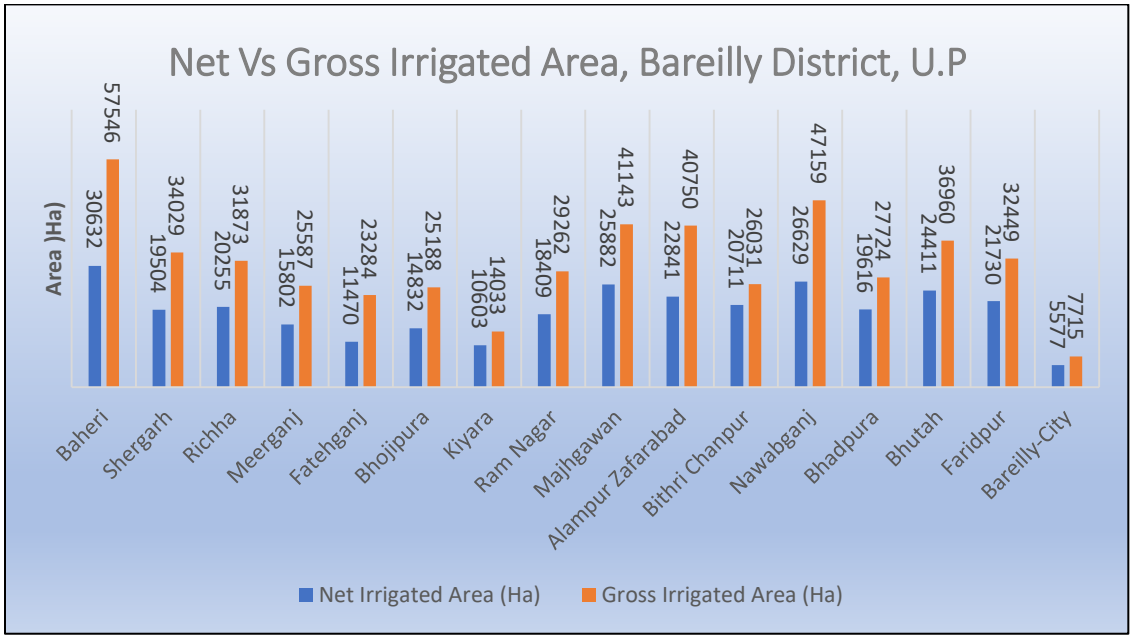


Fig 1.9: Block wise irrigation, Bareilly District, UP

1.7.4 Cropping Pattern:

The topography, soil characteristics, drainage, irrigation facilities and climatic cycles are the factors, which directly control the cropping pattern of any region. The two principal harvest in the area are Kharif and Zaid. As per agriculture statistical record 2018-19 the Kharif crops marginally dominate over Zaid crops as these are cultivated in 167853 ha and 1010 ha respectively (Table 8a&b).

The economy of the district depends predominantly on agriculture. Kharif and Rabi are the two main harvests grown in the district. Wheat occupies the predominant place followed by paddy, both in terms of area and production. Other main crops of the district are Barley, Jowar, Bajra, Maize, Pulses, Ground nut, Sesamum, Soyabean, Gram, Pea, Mustard.

Table 1.8a: Blockwise area under main crops in hectare

S.No.	Block Name	Blockwise area under main crops in hactare							
		Rice Kharif		Rice Zaid		Total Rice		Wheat	
		Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated
1	Baheri	16670	16670	670	670	17340	17340	19390	19390
2	Shergarh	10926	10926	3	3	10929	10929	11192	11192
3	Richha	13492	13492	28	28	13520	13520	12940	12940
4	Meerganj	11628	11628	4	4	11632	11632	10467	10467
5	Fatehganj	8023	8023	18	18	8041	8041	8750	8750
6	Bhojipura	8510	8510	5	5	8515	8515	10064	10064
7	Kiyara	4969	4969	0	0	4969	4969	7400	7400
8	Ram Nagar	5878	5878	0	0	5878	5878	14345	14345
9	Majhgawan	13299	13299	0	0	13299	13299	18647	18647
10	Alampur Zafarabad	13981	13981	1	1	13982	13982	20290	20290
11	Bithri Chanpur	8720	8720	6	6	8726	8726	10003	10003
12	Nawabganj	17062	17062	154	154	17216	17216	15283	15283
13	Bhadpura	10019	10019	51	51	10070	10070	9182	9182
14	Bhutah	12746	12746	65	65	12811	12811	17331	17331
15	Faridpur	7732	7732	1	1	7733	7733	16083	16083
16	**Village Total**	163655	163655	1006	1006	164661	164661	201367	201367
17	**Urban Total**	4198	4198	4	4	4202	4202	5182	5182
18	**District Total**	167853	167853	1010	1010	168863	168863	206549	206549

Table 1.8b: Blockwise area under main crops in hectare

S.No.	Block Name	Blockwise area under main crops in hactare											
		Barley		Jawar		Bajra		Makka Kharif		Makka Zaid		Makka Total	
		Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated
1	Baheri	8	6	5	2	2	0	10	1	29	27	42	31
2	Shergarh	0	0	2	0	20	0	0	0	10	10	10	10
3	Richha	0	0	4	2	19	0	0	0	11	11	13	13
4	Meerganj	6	5	4	1	165	0	0	0	2	2	2	2
5	Fatehganj	2	2	3	1	22	0	0	0	38	37	41	40
6	Bhojipura	0	0	0	0	81	0	0	0	19	19	19	19
7	Kiyara	3	3	6	0	327	0	0	0	3	3	3	3
8	Ram Nagar	6	4	16	4	2571	62	31	16	15	15	52	37
9	Majhgawan	0	0	3	0	2412	18	18	5	13	13	31	18
10	Alampur Zafarabad	0	0	7	2	1245	4	12	4	19	19	34	26
11	Bithri Chanpur	3	3	0	0	43	0	0	0	0	0	0	0
12	Nawabganj	0	0	3	0	17	0	0	0	3	3	3	3
13	Bhadpura	0	0	0	0	4	0	0	0	1	1	1	1
14	Bhutah	0	0	2	0	379	0	0	0	0	0	0	0
15	Faridpur	0	0	0	0	1109	0	0	0	5	5	5	5
16	Village Total	28	23	55	12	8416	84	71	26	168	165	256	208
17	Urban Total	1	1	0	0	119	0	5	3	2	2	7	5
18	District Total	29	24	55	12	8535	84	76	29	170	167	263	213

4.8 AQUIFER MAPPING

Aquifer mapping is a process wherein a combination of geologic, geophysical, hydrologic and chemical field and laboratory analyses are applied to characterize the quantity, quality and

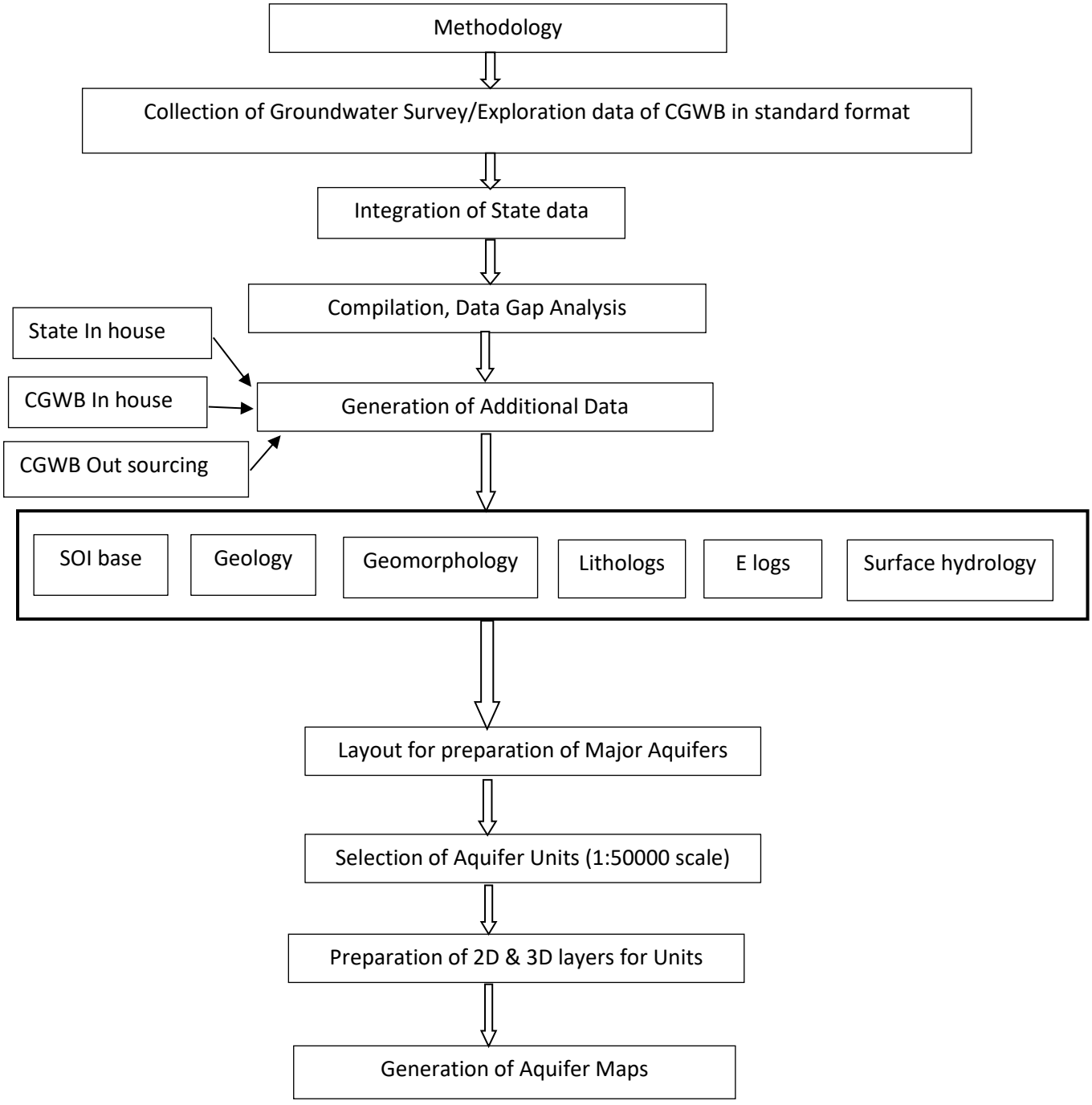
sustainability of ground water in aquifers. There has been a paradigm shift from “groundwater development” to “groundwater management”. An accurate and comprehensive micro-level picture of groundwater in India through aquifer mapping in different hydrogeological settings will enable robust groundwater management plan at the appropriate scale to be devised and implemented for this common-pool resource. This will help achieving drinking water security, improved irrigation, facility and sustainability in water resources development in large parts of rural India, and many parts of urban India as well. The aquifer mapping program is important for planning suitable adaptation strategies to meet climate change also. Thus, the crux of NAQUIM is not merely mapping but reaching the goal of groundwater management through community participation.

1.8.1 Objective

The primary objective of the Aquifer Mapping can be summed up as “Know your Aquifer, Manage your Aquifer”. Demystification of science and thereby involvement of stake holders is the essence of the entire project. The involvement and participation of the community will infuse a sense of ownership amongst the stake holders. This is an activity where the Government and the Community work in tandem. Greater the harmony between the two, greater will be the chances of successful implementation and achievement of goals of the Project. As per the Report of the Working Group on Sustainable Ground Water Management, “It is imperative to design an aquifer mapping programme with a clear-cut groundwater management purpose”. This will ensure that aquifer mapping does not remain an academic exercise and that it will seamlessly flow into a participatory groundwater management programme. The aquifer mapping approach can help integrate ground water availability with ground water accessibility and quality aspects.

1.8.2 Methodology

Various activities under NAQUIM are as follows



2. DATA COLLECTION AND GENERATION

2.1 HYDROGEOLOGICAL DATA

2.1.1 GEOLOGY

Geologically, the Ramganga sub-basin is sub-divided into two main units, the mountainous region holding Siwalik ranges and the alluvial plain. The area lies south of Siwalik foot hills. The alluvial plain includes Bhabar formation (piedmont fan deposit), Tarai formation and the flood plains deposits. The area at Bareilly district occupies a small part of southern fringe of Tarai formation and flood plain deposits, these are underlain by Quaternary sediment brought from Himalayas (Fig 4). The alluvial sediments mainly comprising clay, sand and gravel in varied proportion and grades, are deposited is well stratified formation consisting of alternate bed of clay, silty clay and granular material where clay is often associated with kankar.

The general geological sequence of at formation in the district is given in table 2.1.

Table 2.1 Geological succession

System	Age	Formation	Lithology
Quaternary	Recent to upper pliestocene	Lower piedmont plain (Tarai)	Clay sandy sand clay & gravel
	Recent to upper pleistocene	Younger alluvium	Fine sand, silt clay mixed with gravel
	Upper pliestocene	Older alluvium	Clay with kankar and sand

Tarai Formation :

The southern limit of main Tarai belt of Udham Singh Nagar district, Uttaranchal extends downwards upto Baheri town occupying 4 to 10 Km. wide stripe in Bareilly district running along its northern border. The southern limit of Tarai formation is not well defined as it imperceptibly merges into the flood plain deposits. The Tarai formation is dominantly of clay with intercalation of sand of various grades and occasional gravels.

(i) *Flood Plain Deposits :*

South of Tarai formation there spread a vast area of flood plain deposits covering almost 90% of the total district area. On the basic of topographical as well as lithological variation and on their relative maturity the area under flood plain deposits can be broadly sub-grouped into younger alluvial plain or low land deposits are older plain or upland deposits.

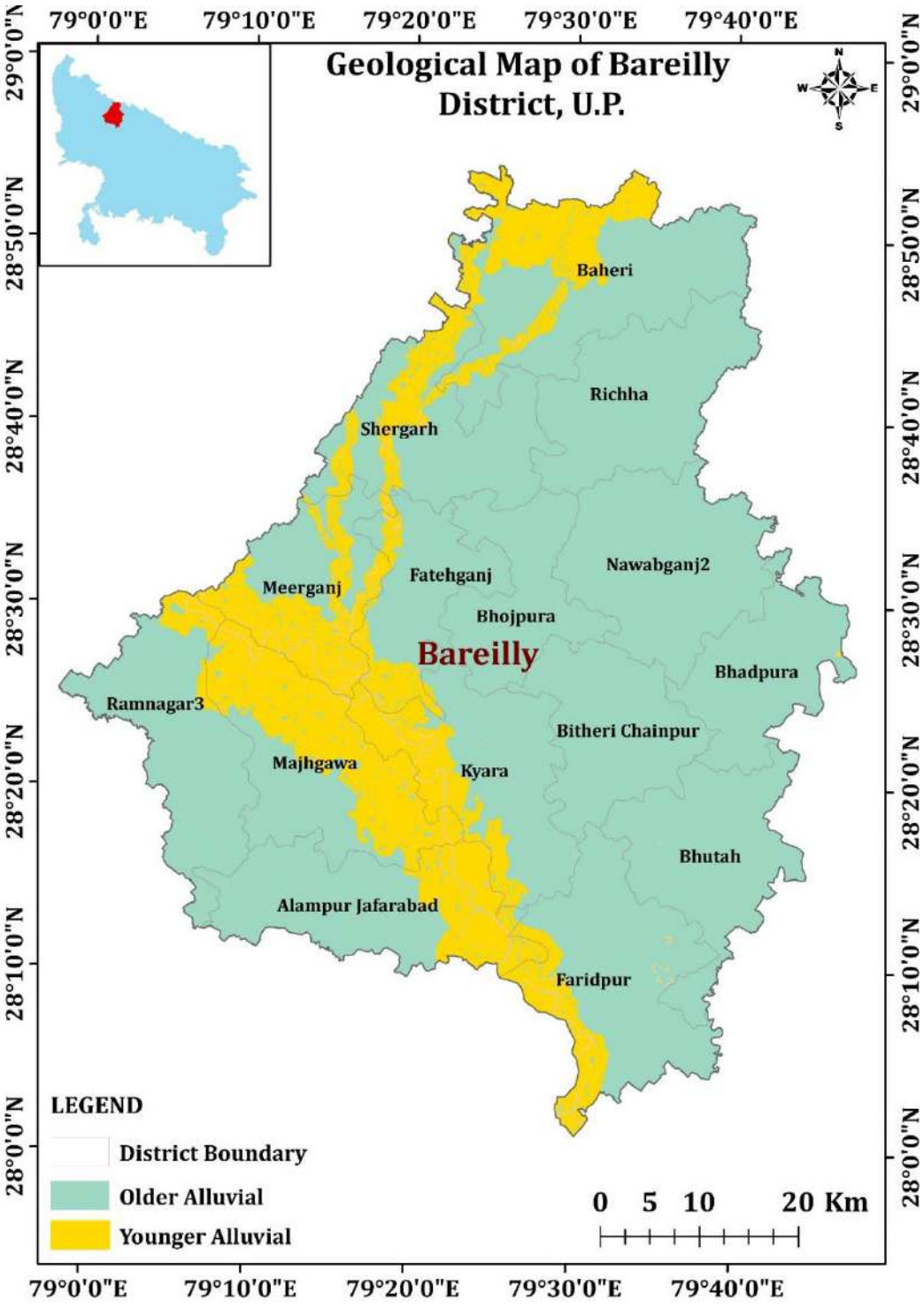


Fig. 2.1: Geologiocal Map of Bareilly district

(ii) *Younger Alluvial Plain :*

The sediments of this group are mainly loose, unconsolidated, arenaceous in nature and are found in topographically low regions. These are flood plain deposits varying from recent to upper pliestocene in age and are confined to narrow strips all along the drainage system.

(ii) Older Alluvial Plain :

Generally occupy the regions of higher elevation with constituting sediments being relatively compact argillaceous material comprising alternate beds of clay with kankar and sand of different grades. The clay predominate over sandy horizons. The older alluvial plains cover about 70-80% of the district area.

2.1.2 GROUNDWATER LEVEL VARIATION

Groundwater level in an unconfined aquifer is much sensitive to fluctuation. Thus error may introduce because of pumping influence in near by area, river stage and also because of groundwater movements. The data collected from observation wells of the study area were used in preparation of depth to water level maps and water table contour maps.

A network of 66 monitoring stations were used for preparation of Depth to water level and water table contour map of the study area. All the block-wise depth to water level data have also been analysed. The water level data of all Ground Water Monitoring Wells of 2011 to 2020 are shown in Table 6:

I Depth to Water Level

The depths to water level maps are useful in deciphering the area of recharge and discharge. Recharge areas are characterized by deeper water table while shallow water table below the land surface indicates discharge area (Fetter, 1988). The depths to water maps, thus, depict the regional variations of the water level with respect to land surface all over the area. In an unconfined aquifer, the water table is the upper surface of the zone of saturation where the pressure is atmospheric. It is defined by the level at which water stands in wells penetrating the aquifer, just enough to hold standing water.

In pre-monsoon seasons i.e. May 2020, the depth to water level ranges from 0.74 to 19.85 m bgl (Fig 2.2a). A perusal of the maps shows that the deep water table conditions occur in the south-western part of the area. Relatively shallow water levels are recorded toward north-eastern part of the area.

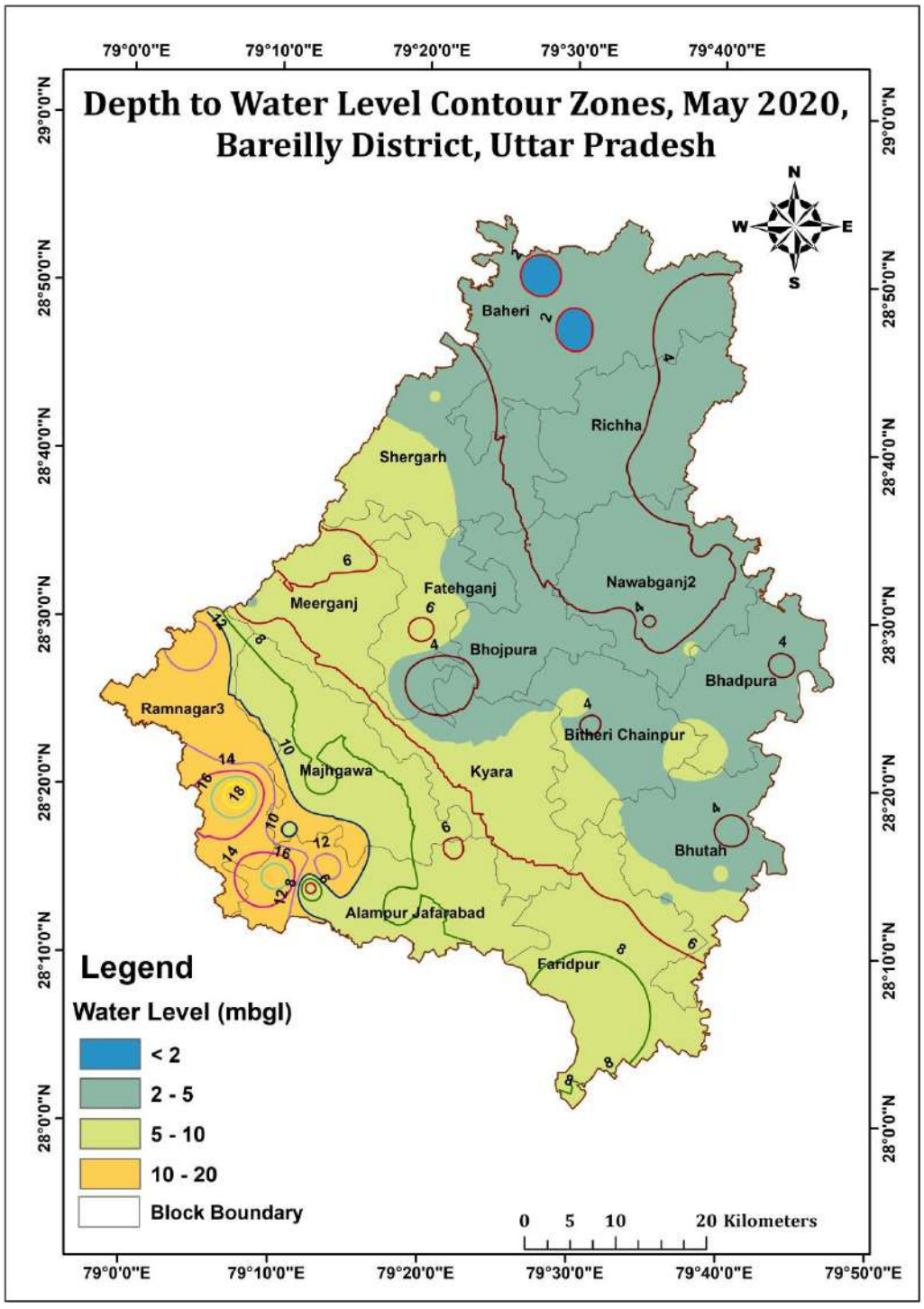


Fig 2.2a: Depth to Water level Map, Pre-Monsoon (May, 2020)

In post-monsoon seasons i.e. November 2020 (Fig 2.2b), the depth to water level ranges from 0.6 to 19.77 m bgl. A general rise of water table is indicated in post-monsoon period of 2020, resulting in noticeable changes in the contour pattern.

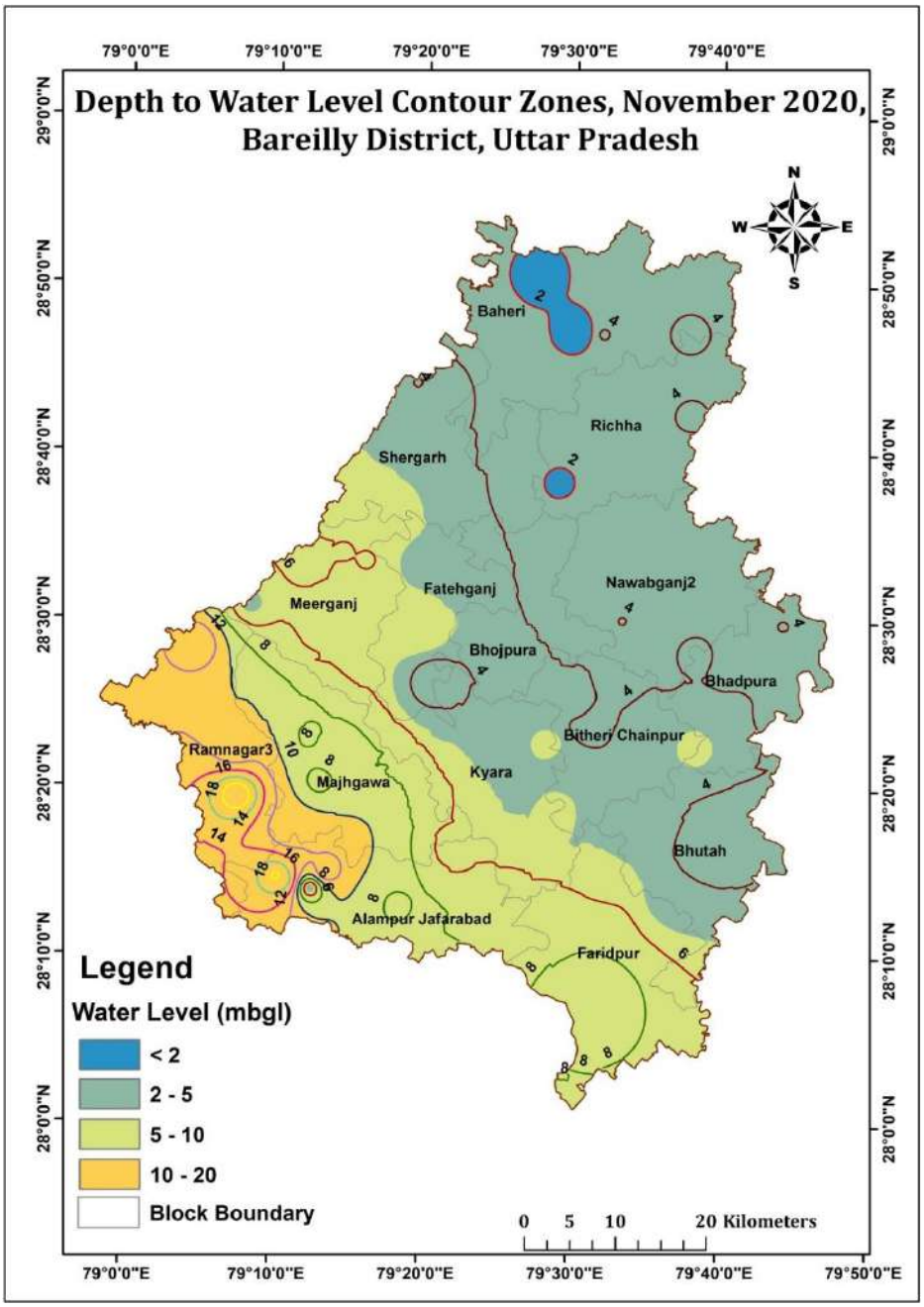


Fig 2.2b: Depth to Water level Map, Post-Monsoon (May, 2020)

Table 2.2: Water Level Data (2011-2020) of GWMW's of Bareilly District

Name of GWA Unit (Block)	Period	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
ALAMPURZA	Pre-monsoon	7.19	7.22	7.62	7.68	8.52	8.86	9.45	10.14	10.27	10.18
	Post-monsoon	4.82	6.96	6.77	7.84	8.22	7.33	9.06	9.41	9.71	10.28
BAHERI	Pre-monsoon	3.63	4.23	4.16	3.74	4.53	4.71	4.26	3.45	3.83	3.58
	Post-monsoon	2.39	3.24	2.67	3.90	4.39	3.77	2.38	1.59	2.86	2.52
BHADPURA	Pre-monsoon	3.89	4.51	4.56	4.00	4.48	4.99	4.83	5.24	5.44	4.59
	Post-monsoon	2.31	2.77	2.54	3.63	4.46	4.02	3.67	2.92	3.92	3.84
BHOJIPURA	Pre-monsoon	4.46	4.39	4.46	4.29	4.90	5.20	4.96	4.91	4.83	4.74
	Post-monsoon	3.64	3.69	3.65	4.31	4.57	3.79	4.21	4.20	4.27	4.11
BHUTAH	Pre-monsoon	3.71	4.21	4.48	4.14	4.89	5.15	4.79	5.31	5.47	4.86
	Post-monsoon	2.45	2.97	2.89	4.15	4.77	4.18	4.19	2.98	4.13	4.36
BITHRICHA	Pre-monsoon	4.54	4.77	4.84	4.46	5.20	5.51	5.43	5.51	5.29	4.96
	Post-monsoon	3.31	3.94	3.40	4.54	4.97	3.84	4.60	3.32	4.31	4.36
FARIDPUR	Pre-monsoon	6.08	6.52	7.22	6.88	7.64	8.24	8.40	9.07	9.17	8.60
	Post-monsoon	4.86	6.27	6.14	6.65	7.40	7.39	8.14	8.02	8.47	8.28
FATEHGANJ	Pre-monsoon	4.80	4.97	5.85	5.53	6.07	6.67	7.05	5.96	6.15	5.67
	Post-monsoon	3.07	4.73	3.97	5.21	5.61	5.28	4.90	3.69	4.87	5.14
KAYARA	Pre-monsoon	4.43	3.97	4.51	4.45	4.61	5.05	5.25	4.88	4.50	4.74
	Post-monsoon	2.93	3.38	3.23	3.97	4.25	3.75	3.89	3.45	4.02	4.39
MAJHGAWN	Pre-monsoon	5.85	5.40	6.20	6.54	6.76	7.26	7.73	8.03	8.22	8.56
	Post-monsoon	3.91	4.89	4.81	6.06	6.50	5.85	7.35	7.28	7.40	8.41
MEERGANJ	Pre-monsoon	5.65	5.08	6.01	6.09	6.33	7.05	7.48	6.72	6.92	6.11
	Post-monsoon	3.78	4.73	4.88	5.60	6.00	5.70	5.61	4.57	5.22	5.67
NAWABGANJ	Pre-monsoon	3.37	3.85	3.64	3.47	3.76	4.05	3.98	3.86	4.01	3.61
	Post-monsoon	2.25	2.46	2.54	3.15	3.56	2.92	2.67	1.91	2.91	3.34
RAMNAGAR	Pre-monsoon	10.81	10.61	11.44	11.45	12.08	12.53	13.27	14.26	14.52	14.61
	Post-monsoon	8.93	10.34	10.44	11.73	12.11	11.33	13.07	13.06	14.59	14.70
RICHHA	Pre-monsoon	5.19	5.74	5.56	4.69	5.35	5.58	5.55	5.44	5.59	4.70
	Post-monsoon	3.40	3.45	3.47	4.01	5.21	4.65	4.39	3.72	3.84	3.52
MIRZAPUR	Pre-monsoon	5.83	5.34	5.64	5.41	5.96	6.50	6.98	5.39	5.57	5.12
	Post-monsoon	3.69	4.91	3.78	5.15	5.65	5.27	4.65	3.80	4.63	4.75
BAREILLY CITY	Pre-monsoon	7.33	6.81	6.61	7.12	6.51	7.27	7.63	8.09	8.37	8.67
	Post-monsoon	5.98	6.11	6.32	6.21	6.34	6.96	7.43	7.29	8.24	8.26
District Average	**Pre-monsoon**	5.42	5.48	5.80	5.62	6.10	6.54	6.69	6.64	6.76	6.46
	Post-monsoon	3.86	4.68	4.47	5.38	5.87	5.38	5.64	5.08	5.84	6.12

II Water Level Fluctuation (Pre Monsoon and Post Monsoon, 2020)

The ground water storage, changes due to recharge or extraction from it through withdrawl. The change in storage is reflected through variation in water level. Water level rises during rainy season and stabilizes after monsoon season, whereas become deepest during pre monsoon season. To evaluate annual fluctuation between pre and post monsoon water level, water level fluctuation map has been prepared. Out of 66 monitoring stations, at 48 monitoring stations, water level has raised in post monsoon season in comparison to pre-monsoon.

In maximum part of the district, water level has raised in average between 1-2 m. In northern-western part of the district covering Baheri, Richha, Shergarh, Nawabganj, Fatehganj, Bhojpurwa, Badhpura, Chainpur, Kayara and Butha block, water level of phreatic aquifer has raised Overall, the water level of the district has raised in post monsoon season in comparison to pre monsoon ranges 0.01 (Nawabganj Block)- 1.83(Richa Block) m for the year 2020 (Fig. 2.2c).

III WATER TABLE CONTOURS AND GROUNDWATER MOVEMENT

The water table contour maps are used to decipher the groundwater flow direction, area of recharge and discharge, hydraulic gradient and nature of the river and stream draining the area. In such maps, convex contours and/or convergence of flow lines depict discharge related attributes and divergence of flow lines indicates recharge scenario. In addition, closely spaced contours depict low permeability conditions and relatively steep gradient whereas well spaced contours show an area of high permeability and flat gradient (Todd, 1980; Fetter, 1990).

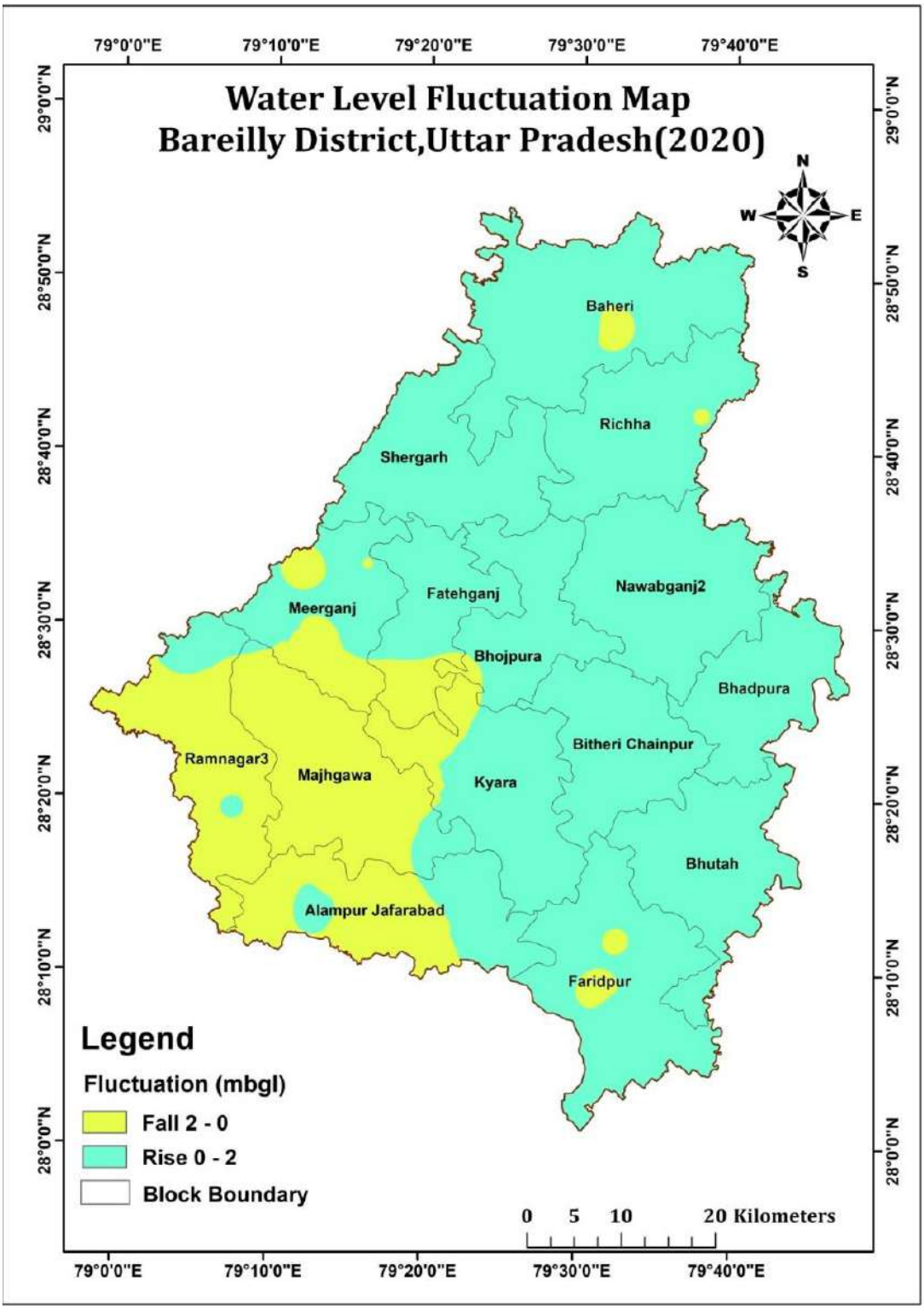


Fig 2.2c: Water Level Fluctuation Map-2020.

Water level data of wells collected during pre-monsoon and post-monsoon for the year 2020 were analyzed and altitude of water level with reference to the mean sea level (msl) was worked out for all the monitoring stations. These reduced levels were then used to generate water table contour maps.

In order to assess the flow direction of the ground water within unconfined aquifers and to establish hydrological behaviour of river and canal of the area. As per hydrological data analysis the behaviour of ground movement in the area lying north of Ramganga river is quite different from that of area occupying south of river. In the northern parts, the ground water flow is generally from north to south and north-northeast and south-southwest direction with an average gradient of 0.6 m/Km. The movement of ground water in the area lying south of Ramganga is from northwest to southeast and west to east direction with an average gradient of 0.37 m/Km. Most of the major canal in the area is influent in nature and Ramganga is effluent in the area fig a and b..

A perusal of pre-monsoon 2020 water table contour maps (Fig 2.3a) shows that the elevation of water table ranges from 190 m amsl in the northwest to 145 m amsl in the southwest. In the northen part of the area flow toward the Ramganga River has been observed.

Post-monsoon water table contour maps for years 2020 (Fig 2.3b), show trends similar to those of pre-monsoon water table contour maps. However, during post-monsoon 2020 few changes are noted in the contour behavior. These may possibly be the consequence of increase in groundwater storage during this period as a result of healthy monsoon.

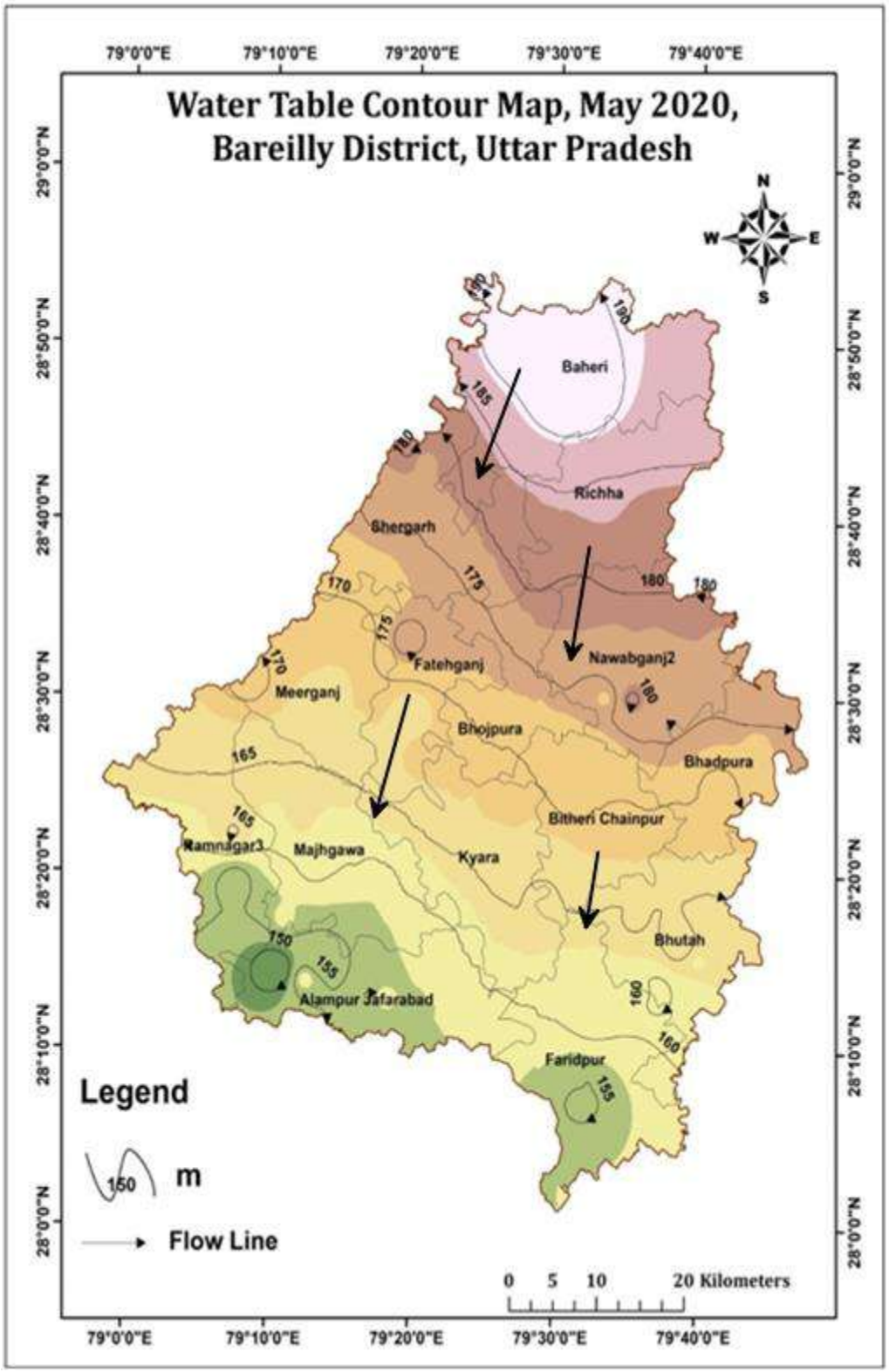


Fig 2.3a: Water Table contour map of the study area.

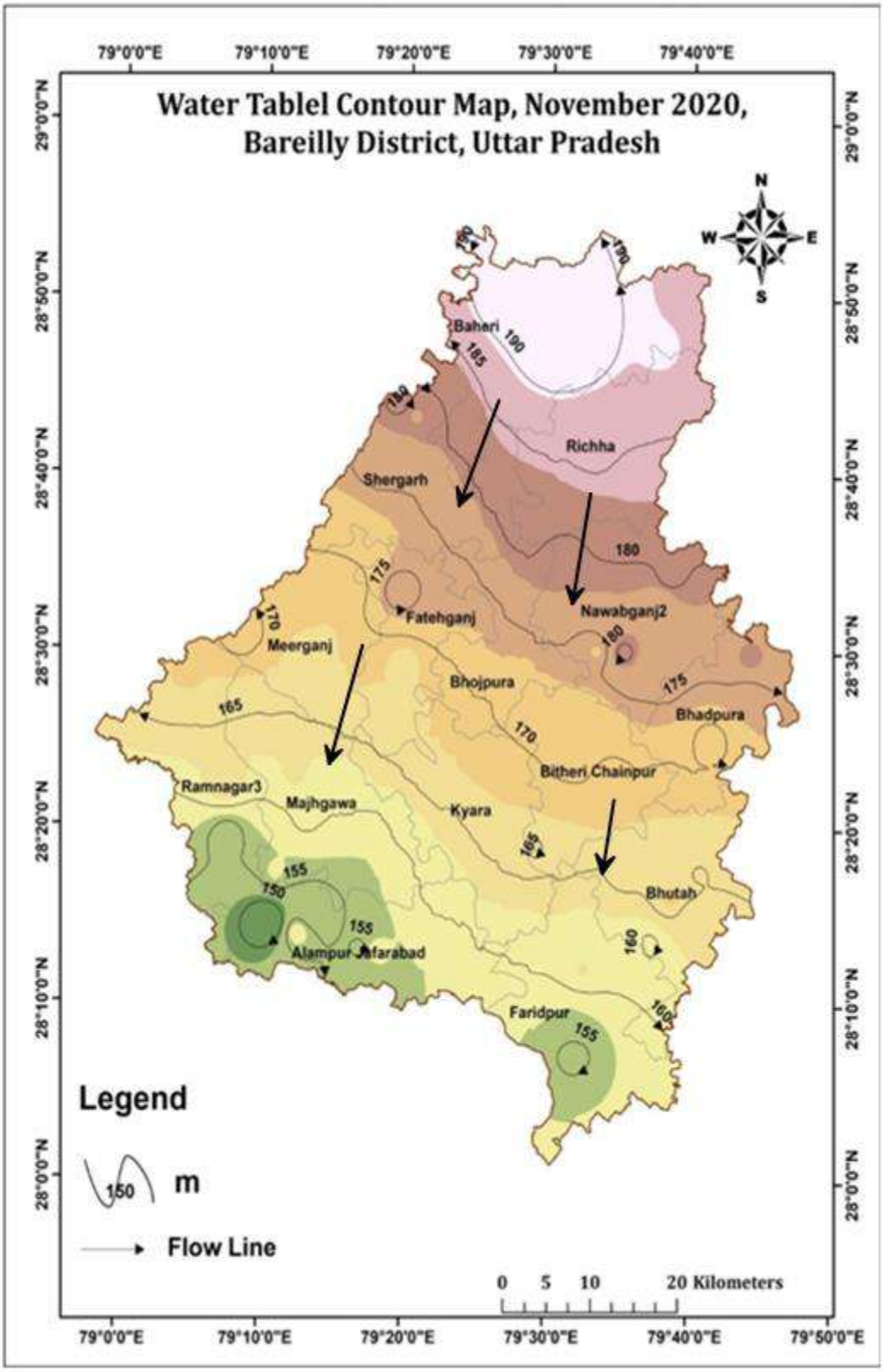


Fig 2.3b: Water Table contour map of the study area.

IV Long Term Water Level Trend Analysis

In order to study the behaviour of Water Level in space and time, block wise long-term (2011-2020) water level trend of CGWB and GWD monitoring stations for pre monsoon and post monsoon period has been worked out.

Pre Monsoon decadal (2011-20) ground water level trend analysis reveals that, Out of 16 block, 13 Block shows falling trend i.e. 0.04 to 0.35 cm/year.

Whereas, blockwise average decadal (2011-20) post monsoon water level trend except 1 block, also shows falling trend ranging from 0.03 cm/ year to 0.59 cm/ year. As the decadal trend of rise and decline for pre monsoon and post monsoon season except 3 block (Bareilly city, Majhgawn and Ramnagar block) rest are <20 cm/ year, no significant rise or decline in water level.

Table 1: Block-wise decadal ground water level trend analysis, Bareilly District.

S.No.	Block/ City	Pre Monsoon (2011-20)		Post Monsoon (2011-20)		Significant Rise/ Decline	
		Rise (m/year)	Fall (m/year)	Rise (m/year)	Fall (m/year)	Pre-Monsoon	Post Monsoon
1	Alampurza		0.40		0.51	No	Yes
2	Baheri	0.03		0.07		No	No
3	Bareilly city		0.2		0.27	Yes	Yes
4	Bhadpura		0.12		0.14	No	No
5	Bhojipura		0.06		0.06	No	No
6	Bhutah		0.15		0.15	No	No
7	Bithricha		0.08		0.06	No	No
8	Faridpur		0.11		0.08	No	No
9	Fatehganj		0.13		0.10	No	No
10	Kayara		0.07		0.1	No	No
11	Majhgawn		0.35		0.45	Yes	Yes
12	Meerganj		0.15		0.11	No	No
13	Nawabganj		0.04		0.05	No	No
14	Ramnagar		0.5		0.59	Yes	Yes
15	Richha	0.02			0.03	No	No
16	Shergarh	0.005			0.04	No	No

***More than 20cm implies significant rise/decline**

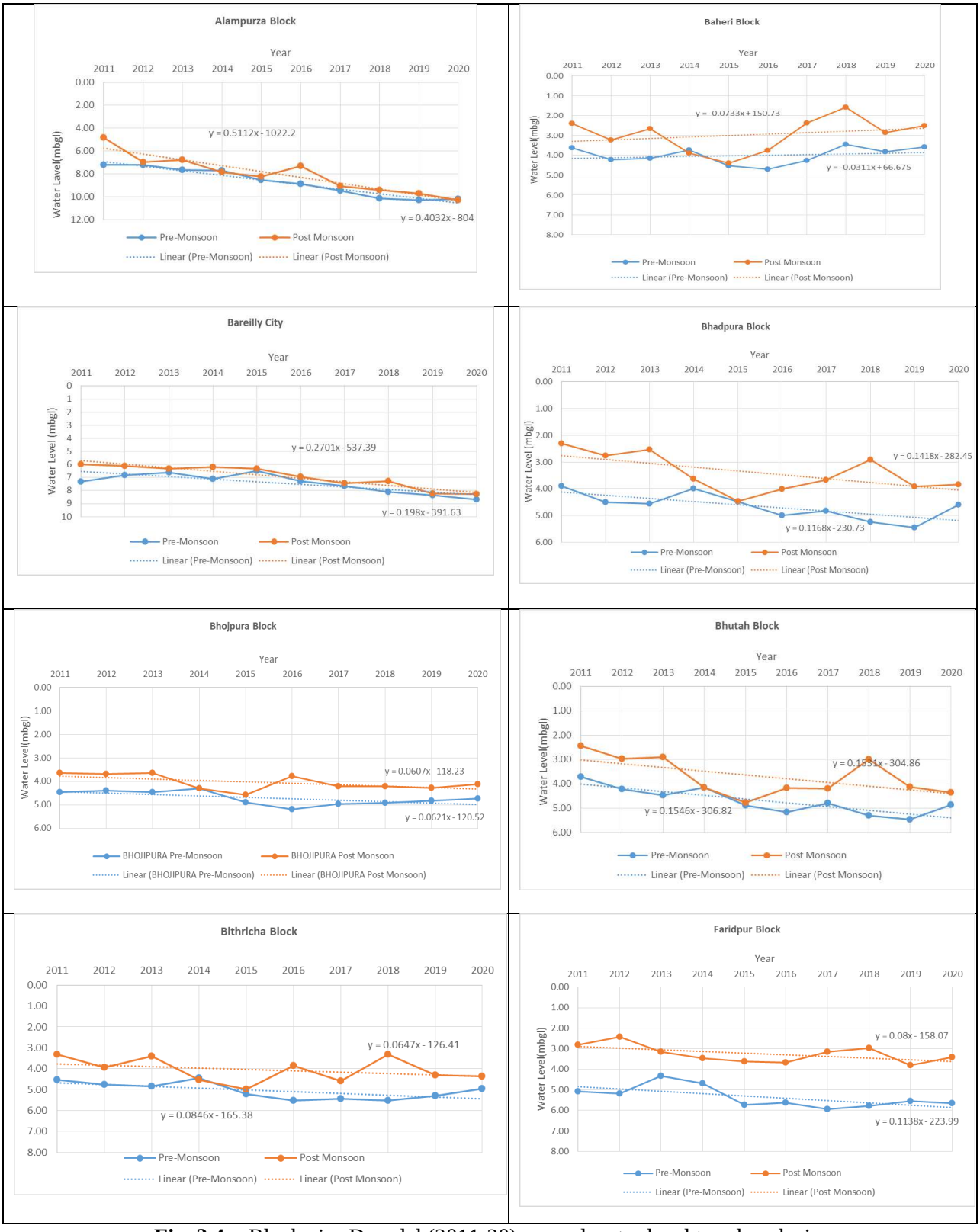


Fig 2.4a: Blockwise Decadal (2011-20) ground water level trend analysis.

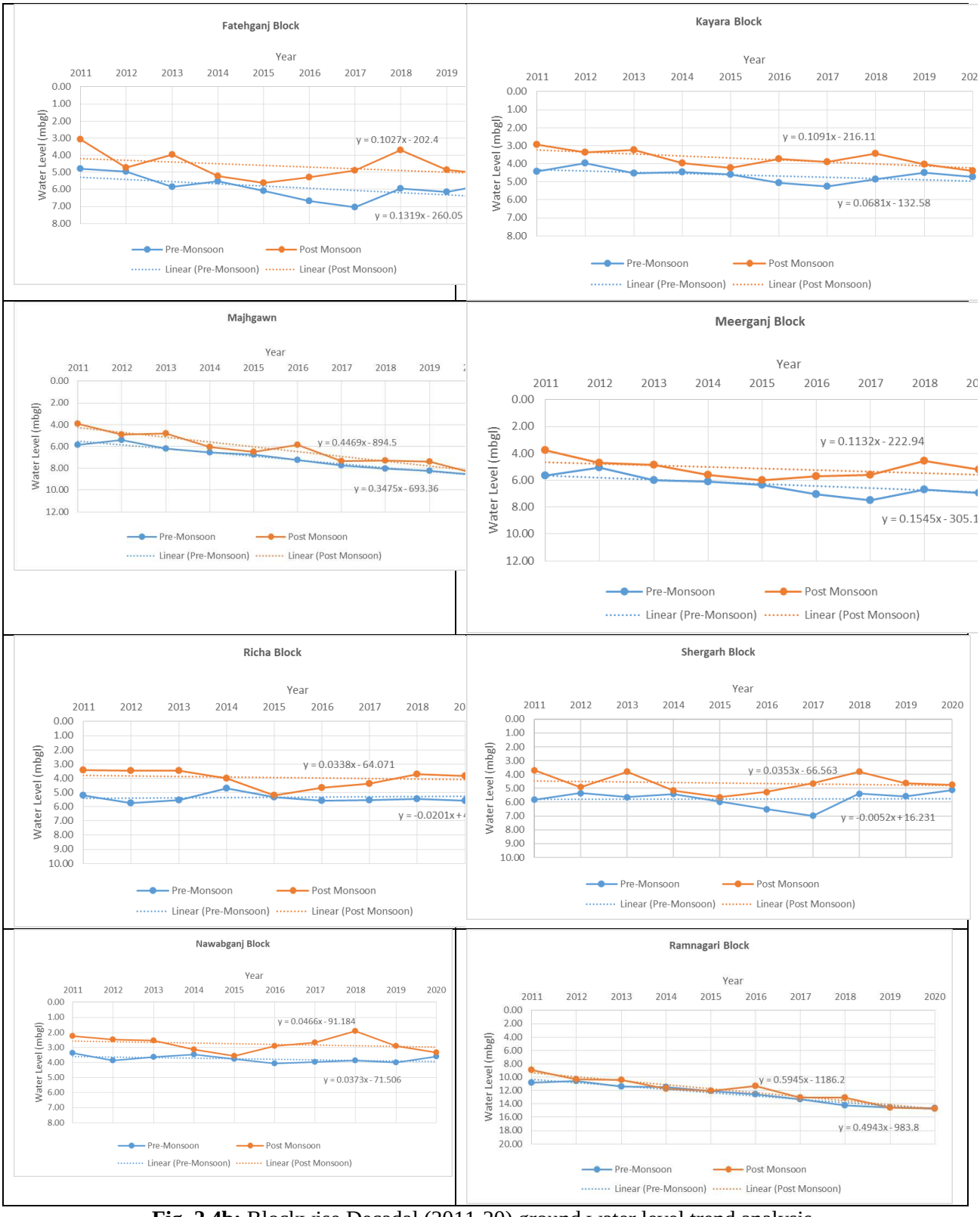


Fig 2.4b: Blockwise Decadal (2011-20) ground water level trend analysis.

2.2 EXPLORATORY DRILLING- CGWB, STATE AND PRIVATE WELL

The lithologs of Exploratory Well/Observation Well/Piezometer/ Productive wells of CGWB, and State departments have been collected and those supported electrical logs have been used to validate for the preparation of aquifer maps. Deeper well data of CGWB have also been utilized. The details are shown in Table 2.4. The compromised logs derived from lithologs and geophysical well loggings have been taken as reliable data base.

S.No	Source of data	Depth Range (m)			
		< 100	100-200	200-300	>300
1	CGWB	0	0	5	6
2	STATE	0	20	0	0
Total		**0**	**20**	**5**	**6**

Table 2.4: Data availability of exploration wells in Bareilly district

2.3 GEOPHYSICAL STUDIES

Total 09 E-logs of bore hole logging are available for the studies. No VES/TEM has been done in the district.

2.4 GROUNDWATER QUALITY

Chemical data of ground water from shallow aquifer indicates that grounds water is fresh. The ground water sampling is carried out through Ground Water Observation Wells every year during pre-monsoon period by CGWB. The chemical quality data of pre-monsoon 2019 is used in this report and the main observations are given as below. Generally, ground water is suitable for irrigation purposes and in some areas suitable for drinking purpose also. All the results of chemical analysis of GWOW, 2019 data is shown in Table-2.5a and b. The constituents, above permissible and acceptable limits of Bureau of Indian Standards (BIS), are highlighted in red.

Table 2.5a: Result of chemical analysis of water samples from sampling location 2019 in Bareilly district

Block	pH	EC (µS/cm at 25°C)	CO_3	HCO_3	Cl	F	NO_3	SO_4	TH	Ca	Mg	Na	K	SiO_2	PO_4	RSC	SAR
ALAMPUR	8.01	467	nil	232	28	BDL	BDL	BDL	60	12	7.2	75	8.7	49	Nd	2.6	4.2
BAHERI	8.22	302	nil	159	7.1	0.35	BDL	18	110	28	9.6	19	7.6	46	Nd	0.4	0.8
BHADPURA	8.14	392	nil	207	14	BDL	BDL	6	130	16	22	21	15	50	Nd	0.8	0.8
BHOJIPURA	7.82	512	nil	195	50	BDL	BDL	25	160	32	19	34	16	34	Nd	0	1.2
BHUTAH	7.97	403	nil	232	7.1	BDL	BDL	12	190	40	22	9	7.2	41	Nd	0	0.3
BITHRI CHAINPUR	8.07	353	nil	195	14	BDL	BDL	13	90	24	7.2	26	31	49	Nd	1.4	1.2
FARIDPUR	8.08	512	nil	244	35	0.25	BDL	29	230	48	26	15	10	55	Nd	-0.6	0.4
FATEHGANJ	8.17	477	nil	256	14	BDL	BDL	8.6	100	32	4.8	57	6.3	48	Nd	2.2	2.5
KIYARA	7.92	358	nil	134	28	BDL	BDL	26	130	28	14	14	11	51	Nd	-0.4	0.5
MAJHGAWA	8.13	630	nil	207	35	BDL	BDL	48	100	28	7.2	71	6.1	54	Nd	1.4	3.1
MEERGANJ	8.35	345	30	110	7.1	BDL	BDL	14	110	12	19	23	8.4	42	Nd	0.6	1
NAWABGANJ	8.38	389	36	122	14	0.35	BDL	20	130	32	12	27	6.9	49	Nd	0.6	1
RAM NAGAR	7.95	320	nil	98	14	0.27	49	9	130	36	9.6	6	5.6	48	Nd	-1	0.2
RICHHA	7.99	382	nil	195	7.1	0.39	BDL	24	120	28	12	29	6.4	31	Nd	0.8	1.2
SHERGARH	7.76	310	nil	159	7.1	0.33	BDL	22	130	32	12	7	12	49	nd	0	0.2

Table 2.5b.Result of Trace element analysis of water samples from sampling location 2019 in Bareilly district

Sl N	Block	Latitude	Longitude	Fe (ppm)	Mn (ppm)	Cu (ppm)	Zn (ppm)	As (ppb)	Pb (ppb)	U (ppb)	Cr (ppb)
1	ALAMPUR	28.2383	79.3336	1.34	0.11	0	0.09	1	2	7	0
2	BAHERI	28.7724	79.5088	0.66	0.04	0	0.03	1	1	3	0
3	BHADPURA	28.459	79.7014	0.48	0.03	0	0.03	0	1	21	0
4	BHOJIPURA	28.4977	79.4401	2.38	0.26	0	0.03	3	1	1	0
5	BHUTAH	28.3392	79.6317	1.79	0.27	0	0.44	3	1	1	0
6	BITHRI CHAINPUR	28.3545	79.5159	0.27	0.22	0	0.08	2	1	14	0
7	FARIDPUR	28.2068	79.5323	2.6	0.17	0	0.16	9	1	1	0
8	FATEHGANJ	28.4545	79.3162	0.81	0.09	0	0.04	7	1	0	0
9	KIYARA	28.2527	79.4381	1.2	0.16	0	0.09	5	1	1	0
10	MAJHGAWA	28.3527	79.265	0.08	0.21	0	0.26	1	1	2	0
11	MEERGANJ	28.5094	79.2107	4.16	0.33	0	0.75	7	1	0	0
12	NAWABGANJ	28.5265	79.6276	0.11	0.07	0	0.12	2	1	6	0
13	RAM NAGAR	28.3869	79.1226	0.13	0.01	0	0.13	3	1	0	0
14	RICHHA	28.7139	79.4811	0.86	0.11	0	0.02	1	1	3	0
15	SHERGARH	28.6544	79.3951	1.37	0.24	0	0.16	1	1	8	0

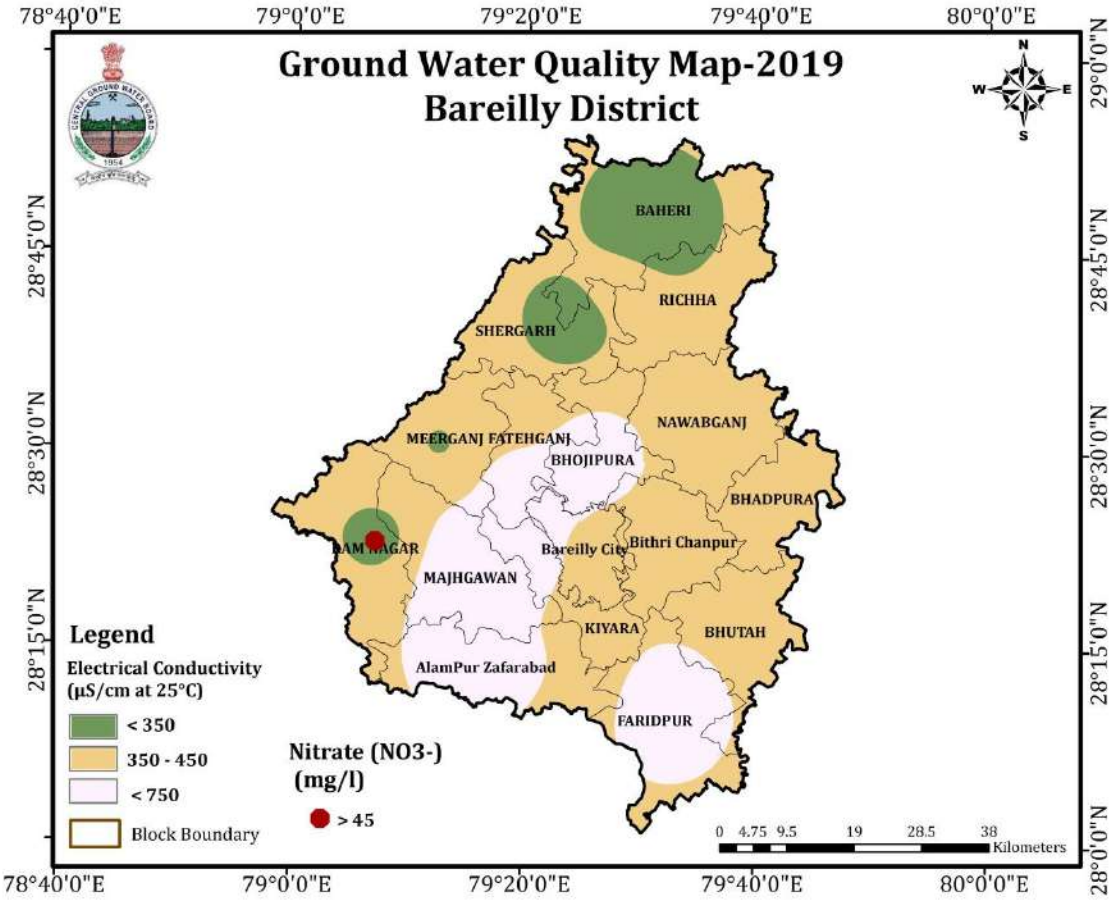


Fig 2.5: Ground Water Quality Map of Bareilly District

2.5 DATA GAP ANALYSIS

After compilation of the available data, a thorough Data Gap analysis as per the Manual on Aquifer Mapping published by Central Ground Water Board was done for Exploratory Data Gap Analysis and Geophysical Data Gap Analysis. The summarised results are presented here.

2.5.1 Data Availability and Data Gap Analysis

The data pertaining to various attributes of ground water were collected from available literatures of Central Ground Water Board, State Departments and other agencies. The compiled data were plotted on 1:50,000 scale map and analysis of Data Gap was carried out for ascertaining additional requirement of Hydrogeological, Hydrological, Hydrochemical, and Geophysical Studies. Data Requirement, Data Availability and Data Gap Analysis are summarized in table 2.6.

Table 2.6: Data Requirement, Data Availability and Data Gap Analysis for Aquifer Mapping

Sl. No.	Study Aspect	Data Requirement	Data Availability	Data Gap
1.	Rainfall and Other Climatic data	Normal Rainfall and Past 10 Years Rainfall	Rainfall data of study area available	-
2.	Soil	Soil Map and Soil Infiltration rate	Soil Map	Soil Infiltration test requires for Infiltration rate
3.	Land Use	Latest Land use Pattern in GIS Environment	Land Use available in Satellite data and UP Statistics Department 2015-16	No'-
4.	Geomorphology	Digitized Geomorphological Map	Digitized Geomorphological Map Available	No
5.	Geophysics	Geophysical Survey in all blocks	Not Available	VES Required & 2D Line imaging
6.	Exploration	Data of 8 Exploratory Wells Required up to depth of 300m	8 Exploratory wells available. Out of which 3 Exploratory wells of >300m and 5 Exploratory wells of 200m to 250 m	5 EW

3.HYDROGEOLOGY

The Gangetic alluvial plain occupies a structural through (Fore deep) infront of the Himalayan ranges. It was interpreted to be a fore deep (Sues, 1921-24) or great rift valley (Burrand, 1915) filled with alluvium of enormous thickness varying from 4500 metres (Old ham 1917) to as much as 25 Km (Pascoe, 1956). Aeromagnetic surveys (Agcos-1957), seismic and magnetic survey conducted by O.N.G.C have indicated that Ganga basin consists of several depression separated by sub-surface ridges and highs (i.e. spurs). Bareilly district falls in one of such depression known as Ramganga depression.

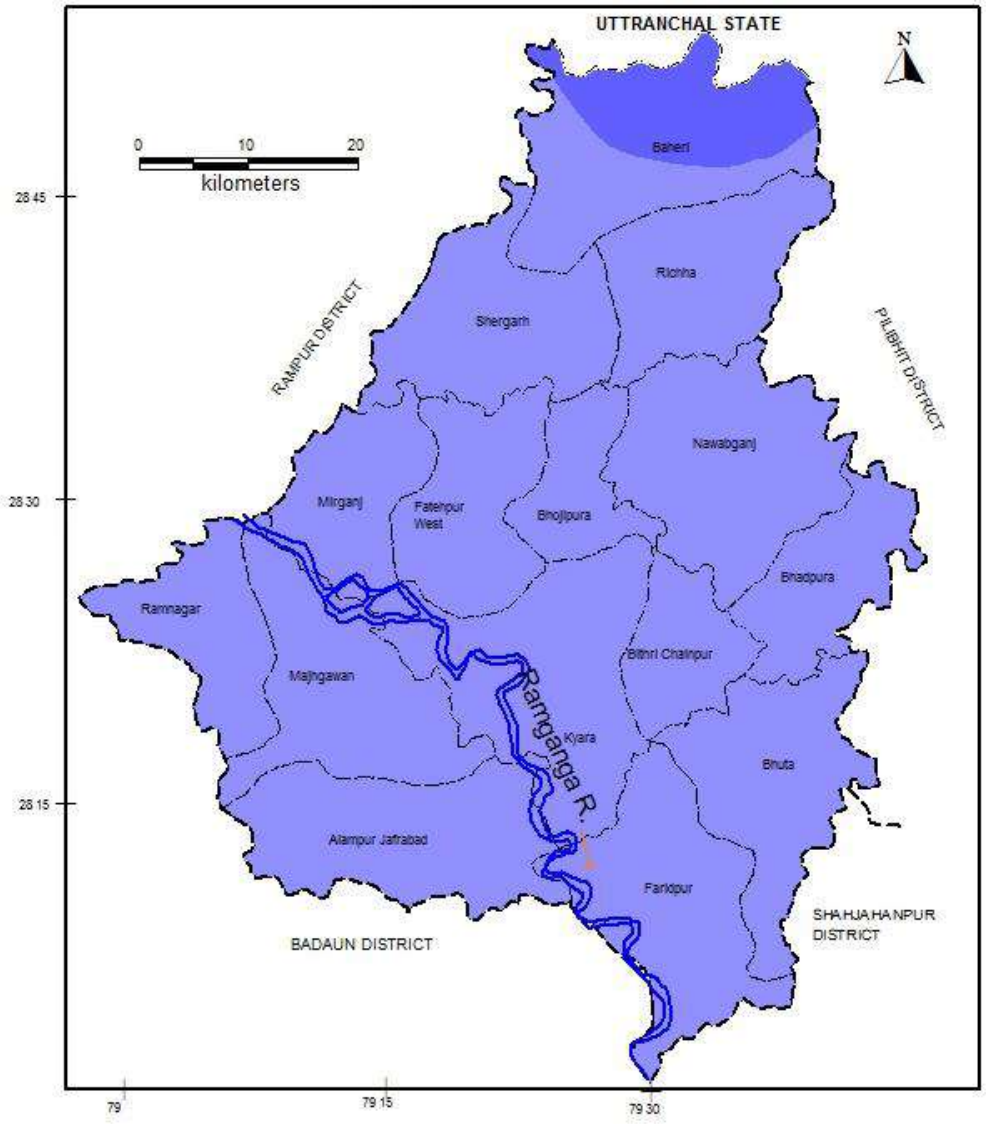
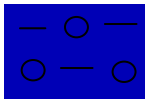
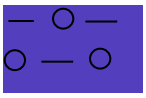
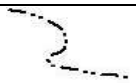
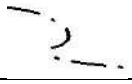


Fig. 3.1: Hydrogeological Map of Bareilly District.

LEGEND

	WELLS FEASIBLE	RIGS SUITABLE	DEPTH OF WELL (M)	DISCHARGE (LPM)	SUITABLE ARTIFICIAL RECHARGE STRUCTURES*
 Soft Rock Aquifer	Dug Wells / Hand Pump	Manual / Hand boring set	10 - 30	50 - 100	Recharge Shaft, Recharge Pit, Abandoned Hand-pumps / Tubewells, Roof Top Rain Water Harvesting Structures in urban areas.
	Shallow Tube Well	Rotary Rigs (Direct / Reverse)	30 - 100	1000 - 2000	
	Deep Tube Well	Rotary (Direct)	100 – 500**	> 3000	
 Soft Rock Aquifer	Dug Wells / Hand Pump	Manual / Hand boring set	10 - 30	50 - 100	
	Shallow Tube Well	Rotary Rigs (Direct / Reverse)	30 - 100	1000 - 1500	
	Deep Tube Well	Rotary (Direct)	100 - 300	2000 - 3000	
Major river 		 Block Boundary		 District Boundary	
 State Boundary					

* Applicable in alluvial area where depth to water level is > 8 m.

** Limited upto depth explored i.e. deeper prospects yet to be found.

3.1 EXPLORATORY SUMMARY OF BAREILLY DISTRICT

In Bareilly district, the exploration drillings were carried out by CGWB. 10 exploratory wells and 1 slim hole were constructed up to maximum depth of 750 mbgl. The aquifer parameters range extracted and is given in below Table-3.1. Salient features of selected state tubewells drilled in bareilly district are also given in table 3.2. All the exploratory wells are constructed prior to 2012 since (since NAQUIM) started.

Table 3.1: Summary of exploration and hydraulic details in Bareilly district.

S. No.	Location	Year of construction	Depth drilled Depth of tubewell (mbgl)	Granular zones encountered (mbgl)	Static water level (mbgl)	Discharge (lps) Maximum drawdown (m)	Specific capacity (lps/m)	Storativity (S)	Transmissivity (m^2/day) Hydraulic conductivity (m/day)
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
1.	**Ponderi Halwa** **(Exploratory well)**								
(A)	**Ma in well** Lat: 28.571885 Long: 79.44989	1985	507.17 495 m.	279.00-291.00 300.00-309.00 312.00-315.00 327.00-339.00 345.00-357.00 372.00-378.00 402.00-414.00 432.00-444.00 450.00-459.00 472.00-487.00	3.65	68.33 21.68 After 10,000 minutes pumping 36.83	3.15	4.15×10E-4	1555.00 14.95
(B)	**Well**	-		288.00-291.00	-		-	-	-

			493 m.	303.00-309.00 312.00-315.00 327.00-339.00 348.00-354.00 372.00-378.00 405.00-411.00 438.00-444.00 456.00-459.00 418.00-487.00		2.97			

1		*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
(C)	**Test Well**	1985	752.73 740.00	522.00-534.00 551.00-557.00 567.00-577.00 607.00-619.00 625.00-637.00 661.00-676.00 697.00-700.00 724.00-736.00	1.25	1.30	-	-	-
2.	**B.S.F. Camp**	1985	203.12	86.62-99.00	3.05	101.75	4.956	-	2683.00

	Bhitora deposit well Lat 28.471624 Long 79.31038		197.00	105.00-117.34 123.47-141.00 147.17-153.38 164.58-177.00 183.56-191.63		20.53 After 200 minutes of pumping			25.55
3.	**Nawabganj exploratory (A.C.P.)** Lat: 28.536651 Long: 79.63522	2002	207.70 195.00	102.00-108.00 114.00-126.00 147.00-153.00 159.00-171.00 177.00-189.00	2.23	1627 lpm or 27.12 lps 5.39	302 lpm/m -	---	1532.57
4.	**Fareedpur exploratory (A.C.P.)** Lat: 28.210504 Long: 79.53841	2001	204.50 144.50	75.50-87.50 96.50-108.50 114.50-126.50 132.50-138.50	5.16	1608 lpm or 26.8 lps 2.04	788 lpm/m -	-	2120 m^2/day
5.	**Model town exploratory (A.C.P.) (Bareilly town)** Lat: 28.374143 Long: 79.42786	2002	204.55 135.00	51.00-63.00 69.00-81.00 87.00-93.00 111.00-117.00 123.00-131.00	9.28	2416 lpm or 40.26 lps 2.78	869 lpm/m -	--	1447

1		*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
6.	**Sharma Nagar exploratory (A.C.P.) (Bareilly town)** Lat: 28.376012 Long: 79.46444	2002	201.5 155.00	66.00-84.00 99.00-117.00 138.00-150.00	6.75	2187 lpm or 36.45 lps -	2.58 -	--	1985
7.	**Gandhi Udhyan exploratory (A.C.P.) (Bareilly town)** Lat:28.345568 Long:79.42828	2002	451.37 255.00	117.00-126.00 132.00-144.00 180.00-192.00 201.00-207.00 222.00-228.00 243.00-249.00	8.45	1832 2.50	732.8 lpm	-	2811
8.	**Baheri exploratory** Lat: 28.778341 Long: 79.49673	2001	451.00 238.00	164.00-176.00 182.00-200.00 220.00-232.00	-	2800 3.66	480	-	-
9.	**Pachomi slimhole**	1988	750 -	Data not available	-	-	-	-	-

Table 3.2: Salient features of selected state tubewells drilled in bareilly district

Toposheet No. / Tubewell No.	Location	Block / Tehsil	Year of construction	Depth drilled / Depth of t/w (mbgl)	Granular zones tapped (mbgl)	Static water level (mbgl)	Discharge (lps) *Maximum*	Drawdown (m) *Recommended*
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
53P/5	Baheri	Baheri	1975	143.26	39.05-42.14	3.0	51.5	35.36
STW-2		Baheri		130.68	55.17-57.63 99.37-103.4 107.90-110.98 119.18-129.26		5.63	3.00
53P/6	Shishgarh	Shergarh	1978	105.21	28.74-47.21	3.0	96	37.90
STW-4		Baheri		80.88	53.31-78.81		9.15	2.5
53P/6	Shergarh	Shergarh	1977	97.53	41.54-60.71	-	-	-
STW-5		Baheri		90.81	67.96-89.31			
53P/10	Nawabganj	Nawabganj	1975	105.61	32.40-41.16	3.0	45.71	30.31
STW-7		Nawabganj		94.89	66.10-78.86 86.20-93.89		7.04	3.05
53P/2	Mirganj	Mirganj	1973	91.74	30.29-75.03	4.3	26.33	26.33
STW-9		Mirganj	1978	76.5			1.83	1.83
53P/7	Fatehgarh west	Fatehgarh west	1981	71.64	28.42-41.78	4.27	39.35	30.31
STW-10		Mirganj		65.82	47.57-64.54		-	4.0
53P/11	Rihtora (T/W-2)	Birthi Chainpur	1981	80.79	26.81-38.43	3.05	34.40	25.00
STW-11		Bareilly		74.40	46.13-56.05 67.28-72.88		2.10	1.83
53P/3	Jhagbazpur	Ramnagar	1972	96.01	34.90-37.82	7.62	51.60	-
STW-12		Aonla		92.81	43.84-65.76 69.11-91.41		2.74	
53P/7	Sisauna	Majhgawan	1981	86.87	38.38-69.34	4.88	64.78	-

STW-13		Aonla		84.96	73.99-83.38		2.79	
53P/2	Bareilly cantonment (TW-22 MES)	Birthi chainpur	1983	121.92	33.83-51.21	4.88	61.00	-
STW-9		Bareilly		115.21	55.70-60.35 64.62-79.25 109.73-112.78		2.75	
53P/11	Rawal Kalan	Bhutah	1979	88.39	33.15-60.81	-	54.59	-
STW-15		Faridpur		86.64	68.68-84.71		3.48	
53P/4	Rasula	Alampur	1968	106.68	34.39-35.66	-	-	-
STW-17		Aonla		90.00	56.87-87.20			
53P/8	Dalpatpur	Alampur	1967	100.58	41.10-54.84	-	-	-
STW-18		Aonla		94.00	68.71-85.34 88.21-90.98			
53P/12	Faridpur	Faridpur	1977	85.34	36.65-78.54	4.2	54.75	37.90
STW-19		Faridpur		80.24			4.00	3.0

3.2 AQUIFER GEOMETRY AND DISPOSITION

The entire district is underlain by a thick pile of alluvial sediments. The depth of the basement in the area is not known as not a single borehole could reach upto that extent. Geophysical survey carried out by various agencies, however, indicate the presence of deep and asymetrical trough over which the sediments are deposited. Seismic surveys and deep borehole drilling carried out by O.N.G.C. in Ujhani area of the Badaun district, however, reveals that the total thickness of the sediment is around 1500 metres overlying Siwaliks (After Hadi 1983).

The sub-surface geological configuration of sediments has been studied with the help of lithological log / electrical log of shallow, moderately deep and deep boreholes drilled by Central Ground Water Board and other State agencies . The location of these borehole have been shown in Fig 3.2 and salient features are given in table 3.1 and 3.2.

With an objective of sub-surface mapping for aquifer system and to determine their hydrological parameters Central Ground Water Board under its exploration tubewell programme, has drilled the boreholes upto year 2002, at Panderi Haluwa (Bhojpur block, Nine drilling depth-752.73 m) Pachomi (Faridpur block, drilling depth-750 m), B.S.F. campus Bhitaura (Fatehganj) west block drilling depth 203.12 m (Baheri block-drilling depth-450 m), Nawabganj (Block-Nawabganj-drilling depth 207.70 m) Gandhi Park, Bareilly town (Block-Bithrichainpur, drilling depth 451.37 m), Suresh Sharma Nagar Bareilly town (Block-Bithrichainpur, drilling

depth 201.5 m), Faridpur (Block-Faridpur, drilling depth 204.50 m), and model town (Block-Bithrichainpur drilling depth 204.55 m).

The perusal of sub-surface cross section reveals that four distinct groups of granular zones occur down to maximum drilling depth of 752.73 mbgl, inter-separated by poorly permeable/Impermeable horizons of varying thickness. Each group of granular zones represent a different set of depositional environment.

The 1st-group of granular zones is encountered just below the surface clay bed and extends downward upto depth varying from 136 to 212 metres below ground levels. A number of clay beds varying in thickness from 2 to 6 metres (at model Towri, Suresh Sharma Nagar, Gandhi Park as per litholog) are encountered within this group at different depths. .

The 2nd group of granular zones is encountred at varaible depths varying from 141 to 435 mbgl and extend downward. The granular material comprising of fine to medium sand (at places coarse sand, sometimes mixed with little clay). The local clay lenses ranging in thickness from 1.5 to 8 metres, are very common within this group also.

The 3rd group of granular zones which extends downward upto about 481 metres depth bgl. The granular material is consisted of fine to medium sand, predominantly fine sand.

The 4th group of granular zone is encountered at the depth of about 530 mbgl and extends downward upto the maximum drilling depth at 750 metres. The material at this group is dominated by fine sand & little clay, which appears to belong to another sedimentological facies.

It has been established that by and large, four major group of granular zones occur down to 750 metres depth below ground level. These granular zones having the tremendous capacity of storing water, constitute the four-tier aquifer system in the area and have been designated, starting from top as I Aquifer group, II Aquifer group, III Aquifer group and IV Aquifer group encountering at depths varying from 0 to 212 metre, 141-435 metres, 193-481 metres and 530 metres below ground level respectively.

In present study lithological data utilized up to III Aquifer group. 3D map prepared up to depth of 490 m bgl. Average thicknes of Aquifer I , II and III are 162 m, 186 and 263 m. Aquifer Group -1 which is phreatic in nature begins from the ground level and extends upto variable depths.

To understand the lithological frame work and aquifer disposition in the sub surface aquifers, the litholog data of wells drilled by CGWB (Annexure 1a) is used to compile,

optimized and modeled into 3D synoptic picture by using visual Modflow Flex software and Rock works also. The 3D model has been prepared along with distribution of wells are shown in Fig-3.2. The 3D lithological fence diagram has been prepared with the help of Visual Modflow Flex software along with distribution of wells in different blocks are shown Fig-3.3. The Stratigraphical and lithological fence diagram prepared with the help of Rock Works software. The stratigraphical fence diagram (Fig. 3.3b) reveals that the thickness of Aquifer groups as well as Clay horizon varies from place to place. The Lithological fence diagram (Fig 3.3c) reveals that the pinching of clay is common.

The major aquifer system of the Bareilly district is quaternary alluvial deposits, which are all considered as older alluvium in major aquifer group category and are mainly comprised of sand and clay. The major lithological formations are sand & clay and silt is found admixed with sand and clay.

The State irrigation department and U.P. Jal Nigam have also drilled a number of boreholes down to maximum depth of 166 mbgl. Based on the lithological logs (Annexure 1b) of some of the selected boreholes a fence diagram has been prepared for lithological correlation. The perusal of fence diagram reveals that the whole district has a capping of 1 to 20 metres thick clay/silty clay/sandy clay bed (Fig. 3.4).

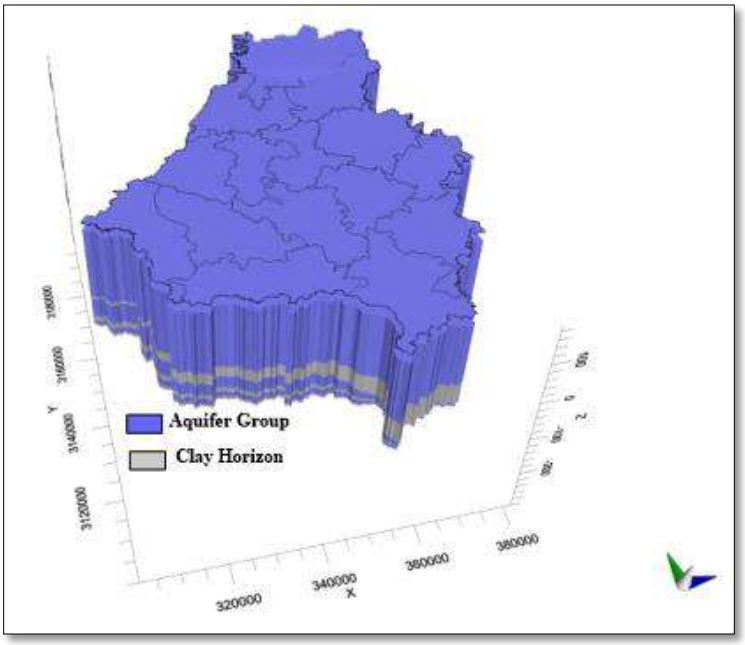


Fig 3.2: 3-D Aquifer Map of Bareilly District

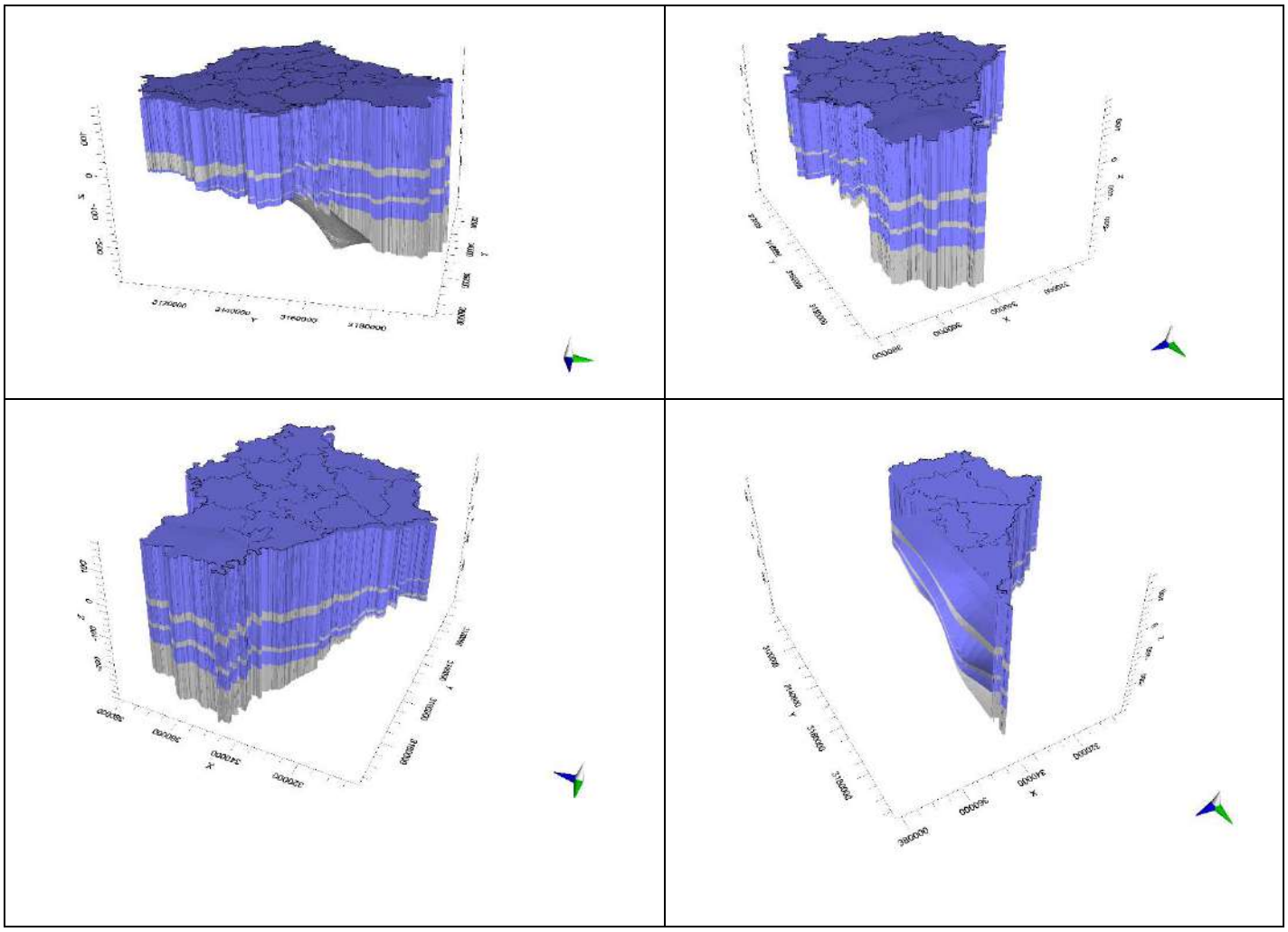
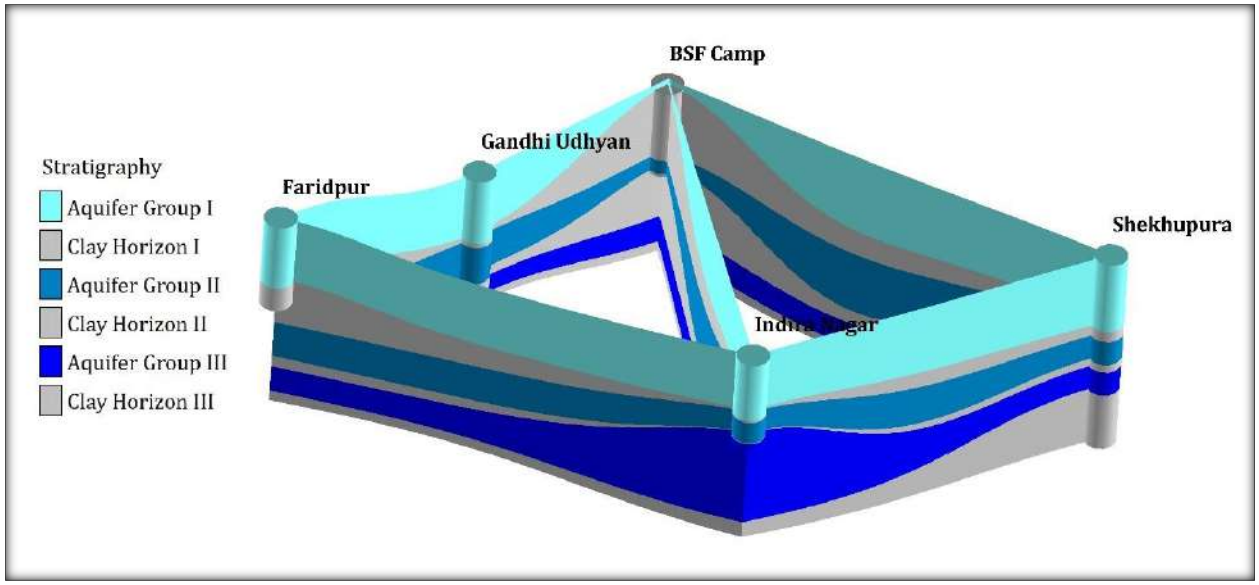


Fig 3.3a: 3-D Aquifer Map of Bareilly District in different orientation.

Table 3.3: Aquifers details of Bareilly District

Aquifer system	Depth Range (m bgl)	
	From	To
Aquifer Group -1	0	212
Aquifer Group -2	141	435
Aquifer Group -3	193	481



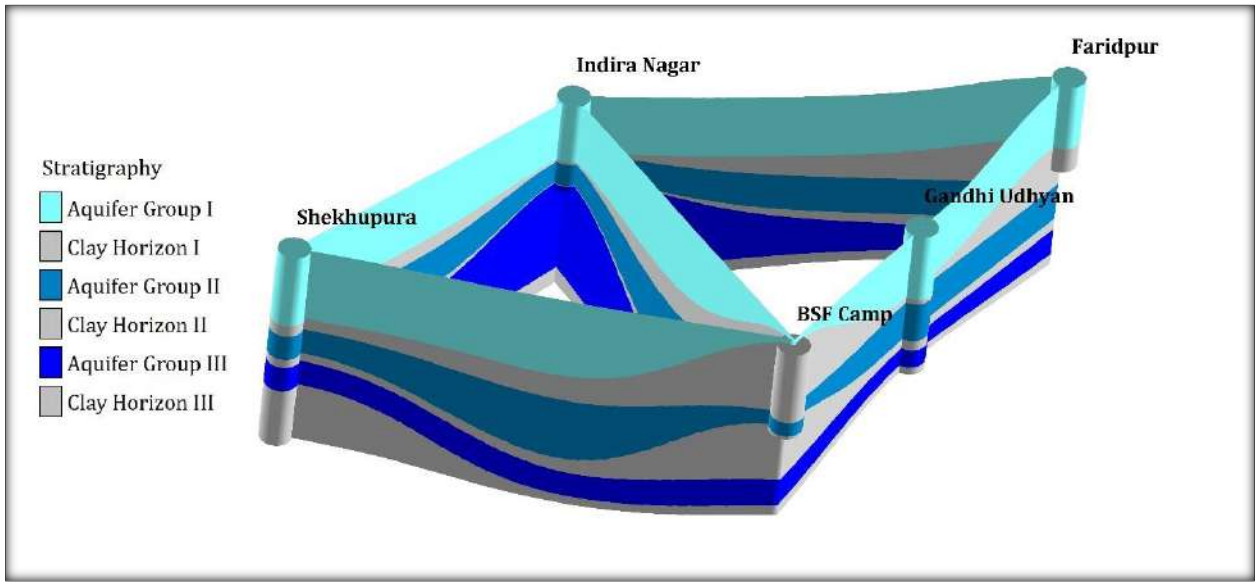


Fig 3.3b: Stratigraphic Fence diagram of Bareilly District

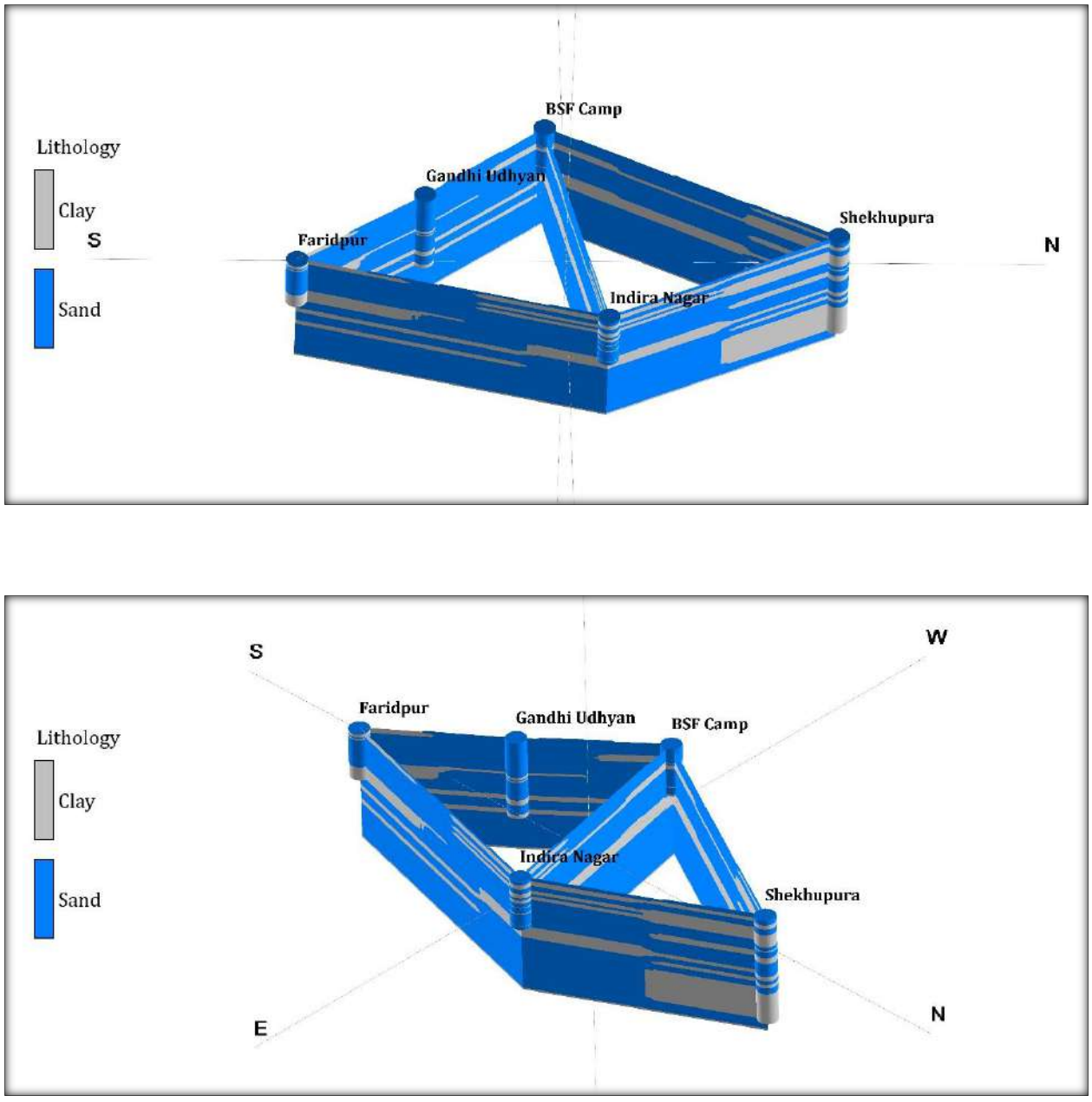


Fig 3.3c: Lithological Fence section of Bareilly District

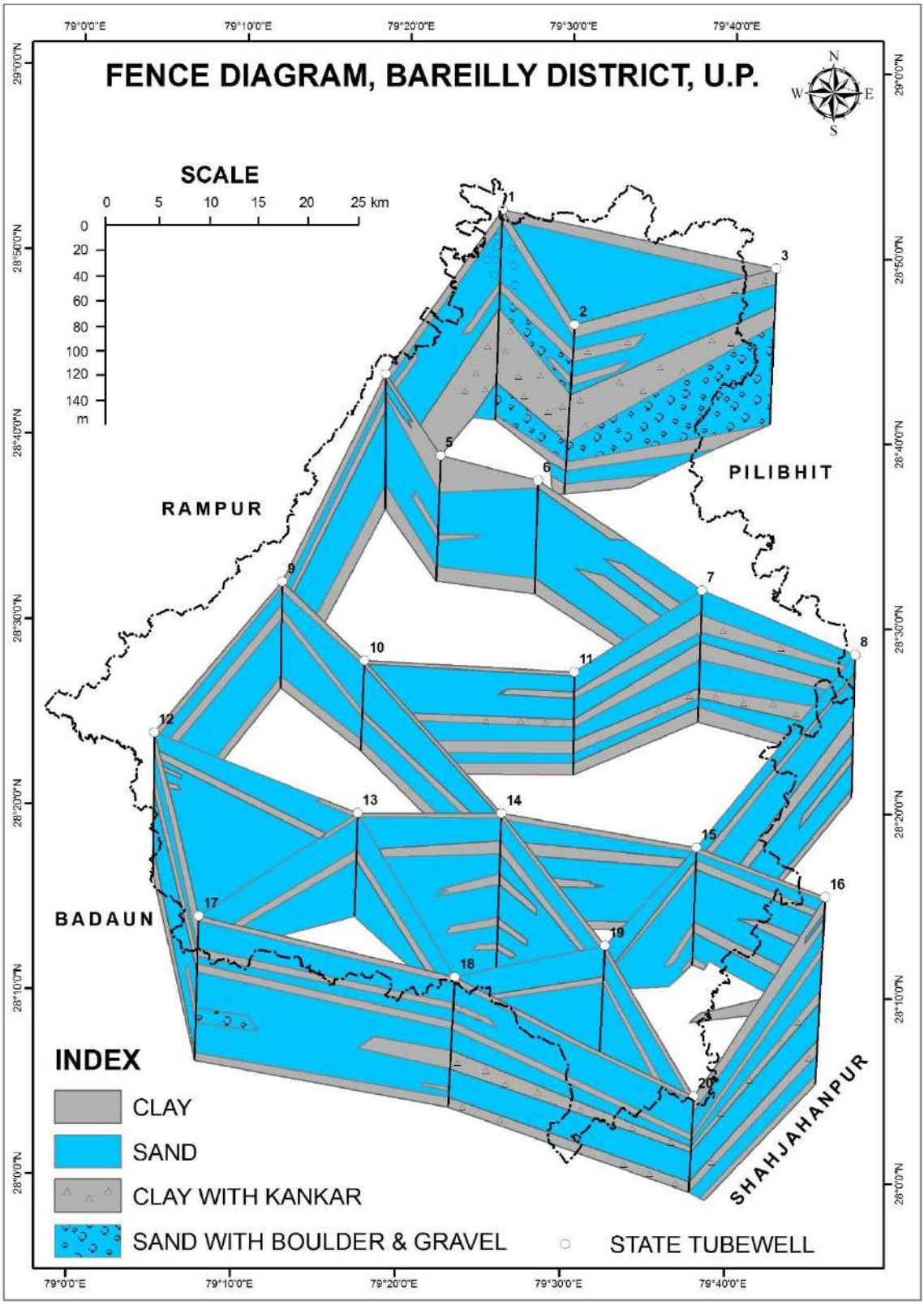


Fig. 3.4: Fence diagram of the Bareilly district prepared on the basis of State Tubewells.

4. GROUNDWATER RESOURCES

Ground water resource estimation of the area have been carried out by taking Dynamic and Static/In-storage resources of aquifer presented up to the depth of 212.6 m. The assessment of dynamic ground water resources of the Bareilly has been carried out jointly by CGWB and Ground Water Department, Uttar Pradesh on the basis of Ground Water Estimation Committee (2015) methodology based on data available and as per the revised methodology for the year as on 31st March 2020.

The occurrence of potential aquifers (granular zones) upto 212.6 m depth has been demarcated on basis of aquifer wise subsurface mapping. The total saturated thickness of granular zones was derived from the exploratory borehole data of a particular block. The granular zones occurring below the zone of water level fluctuation up to the first confined layer has been considered as static unconfined zone. The ground water resource of this zone has been calculated considering 16% specific yield of the formation. The major data elements considered in this estimation are thickness of granular zones, specific yield/Storativity.

4.1 SINGLE AQUIFER GROUP UPTO DEPTH OF 212.6 m

1.Dynamic Resources:

(A)- For Unconfined Aquifer-

Bareilly district being close to the Himalayas has tremendous water resource to be utilized for its agriculture needs. Ground water, due to its assured and timely supply has now become the most dependable source for irrigation but it’s over exploitation adversely affect its regime. For a better ground water management it is necessary to have a constant vigil on its overall reserve and status of utilization. As per Table-4.1, the 11 blocks are under safe category, Barelly city is in over-exploited and Alampur Zafarabad, Majhgawan, Ram Nagar and Fatehganj are in semi-critical Category.

Table 3. Dynamic Ground Water Resource & Development Potential (as on 31.03.2020)

Assessment Unit Name	Net Annual Ground Water Availability (in ham)	Existing Gross Ground Water Draft for irrigation	Existing Gross Ground Water Draft for domestic and industrial water supply	Existing Gross Ground Water Draft for all Uses (in ham)	Net Ground Water Availability for future use (in ham)	Stage of Ground Water Development (%)	Categorization (OE/Critical/Semi critical/Safe)
ALAMPUR JAFARABAD	6098.20	3874.84	566.30	4441.14	1598.22	72.83	**Semi_critical**
BAHERI	12751.23	7862.40	794.73	8657.13	4007.80	67.89	**Safe**
BAREILLY CITY	1780.92	0.00	4350.64	4350.64	0.00	244.29	**Over_exploited**
BHADPURA	8334.71	4983.96	416.17	5400.13	2886.99	64.79	**Safe**
BHOJPURA	9436.82	4951.52	610.66	5562.18	3765.16	58.94	**Safe**
BHUTAH	9325.54	5293.12	552.25	5845.37	3400.65	62.68	**Safe**
BITHERI CHAINPUR	8707.96	4874.00	450.16	5324.16	3362.75	61.14	**Safe**
FARIDPUR	9382.63	5053.12	689.97	5743.09	3545.85	61.21	**Safe**
FATEHGANJ	6296.08	4423.92	543.42	4967.34	1256.51	78.90	**Semi_critical**
KYARA	6195.29	3205.00	400.84	3605.84	2565.93	58.20	**Safe**
MAJHGAWA	5073.64	2795.60	759.97	3555.57	1428.91	70.08	**Semi_critical**
MEERGANJ	5837.61	3379.20	475.30	3854.50	1921.95	66.03	**Safe**
NAWABGANJ	10182.09	5442.64	795.41	6238.05	3859.97	61.27	**Safe**
RAMNAGAR	5919.37	4538.56	483.22	5021.78	832.85	84.84	**Semi_critical**
RICHHA	11159.12	6653.04	570.76	7223.80	3871.92	64.73	**Safe**
SHERGARH	8972.17	4753.88	690.95	5444.83	3444.03	60.69	**Safe**
TOTAL	**125453.4**	**72084.8**	**13150.76**	**85235.56**	**41749.49**	**67.94**	**Safe**

4.1.1 Net Annual Ground Water Availability for Future Uses and Annual GW allocation for domestic use as on 2025:

This component for the study area has been estimated block wise on the basis of net annual availability and gross annual extraction of ground water for all purposes. Thus the net annual ground water availability for all future uses has been estimated 41749.49 hamand allocation of GW for domestic purposes on 2025 as 14695.65 ham (Table 4.2).

Table 4: Net Annual Ground Water Availability for Future Uses and Annual GW allocation for domestic use as on 2025.

Sl No	Assessment Unit Name	Annual GW Allocation for Domestic Use as on 2025 (Ham)	Net Ground Water Availability for future use (Ham)
1	ALAMPUR JAFARABAD	625.14	1598.22
2	BAHERI	881.03	4007.8
3	BAREILLY CITY	4857.51	0
4	BHADPURA	463.76	2886.99
5	BHOJPURA	720.13	3765.16
6	BHUTAH	631.77	3400.65
7	BITHERI CHAINPUR	471.21	3362.75
8	FARIDPUR	783.66	3545.85
9	FATEHGANJ	615.65	1256.51
10	KYARA	424.36	2565.93
11	MAJHGAWA	849.13	1428.91
12	MEERGANJ	536.46	1921.95
13	NAWABGANJ	879.47	3859.97
14	RAMNAGAR	547.96	832.85
15	RICHHA	634.15	3871.92
16	SHERGARH	774.26	3444.03
	District Total	**14695.65**	**41749.49**

4.1.2 Categorization of Blocks

As per GEC-2015 norms, assement units categorized based on Stage of GW Extraction (SOGE).

If ,

1. SOGE <=70%, Safe,

2. SOGE >70% and <=90%, Semicritical,

3.SOGE >90% and <=100%, Critical,

4. >100%, Over-Exploited

In Bareilly District, 11 blocks are under safe category, Barelly city is in over-exploited and Alampur Zafarabad, Majhgawan, Ram Nagar and Fatehganj are in semi-critical Category (Fig. 4.1a & b).

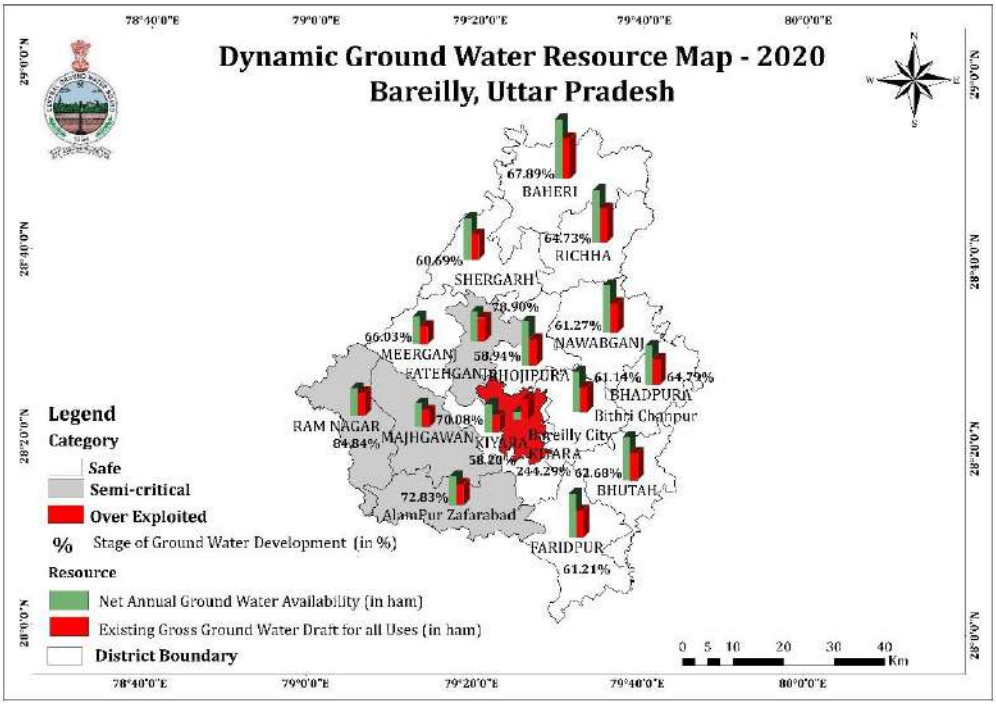


Fig 1a: Ground Water Availability, Extraction and Categorization Map, Bareilly district.

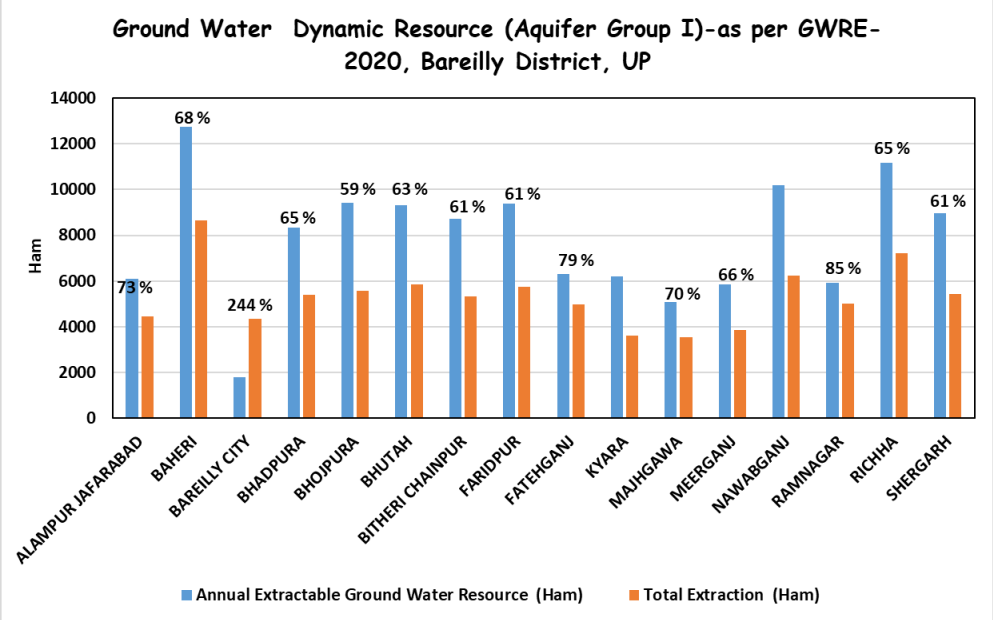


Fig. 4.1b: Dynamic Ground Water Resource of Aquifer Group-I, Bareilly district.

(B) For Confined Aquifer

Since, there is no piezometer available in the district tapping confined aquifer, so Dynamic Ground Water Resource of the confined aquifers cannot be estimated.

4.2 IN STORAGE GROUND WATER RESOURCES

(A)For Unconfined Aquifer

As per revised guidelines recommended by the Central Level Expert Group on ground water resources assessment, the resources are separately considered as dynamic and in-storage unconfined. In case of alluvial area, the in-storage resources of unconfined aquifer have been computed based on specific yield of the aquifer as detailed below:

Total Availability of Ground Water Resources = Dynamic Resources + In-storage Resources.

In-storage Ground Water resources (unconfined Aquifer)	=	Thickness of the aquifer (granular/productive zone) below the zone of water level fluctuation down to the bottom layer of unconfined aquifer	**x**	Sp. Yield of the aquifer	**x**	Areal extent of the aquifer

The computed in storage resource of the unconfined aquifer(block-wise) is given in Table 14.

(B) For Confined Aquifer-

Piezometer level of confined aquifer is not known; hence the Static Ground Water Resource of confined Aquifer cannot be estimated.

Table 5. Block wise in-storage ground water resources of fresh water in unconfined aquifer.

BLOCK WISE IN-STORAGE GROUND WATER RESOURCES OF FRESH WATER IN AQUIFER									
Sr. No.	**Name of Assessment Unit**	**Type of rock formation**	**Areal extent (Sq Km)**	**Average Pre-monsoon Water Level (m bgl)**	**Average Bottom depth in mbgl considered for isopach map.**	**Total Thickness of formation below Pre-monsoon Water Level (m) (9-8)**	**Total thickness of the Granular Zones up to the depth of Fresh Water Zones available (m)**	**Specific Yield % as taken for estimating Dyanamic Resource**	**In-Storage Ground Water Resources up to the depth of Fresh Water Aquifer (MCM) = 6*13*14**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	ALAMPUR JAFARABAD	Alluvium	202.68	10.34	149	138.66	104	16	3372.5952
2	BAHERI	Alluvium	392.14	4.62	163.5	158.88	97	16	6086.0128
3	BAREILLY CITY	Alluvium	106.47	8.94	173	164.06	121	16	2061.2592
4	BHADPURA	Alluvium	235.63	4.53	141	136.47	93	16	3506.1744
5	BHOJPURA	Alluvium	311.88	5.8	212.6	206.8	150	16	7485.12
6	BHUTAH	Alluvium	375.31	5.13	139	133.87	103	16	6185.1088
7	BITHERI CHAINPUR	Alluvium	228.9	4.21	155	150.79	102	16	3735.648
8	FARIDPUR	Alluvium	328.13	6.87	148.25	141.38	128	16	6720.1024
9	FATEHGANJ	Alluvium	175.08	6.33	175	168.67	138	16	3865.7664
10	KYARA	Alluvium	278.03	5.28	151	145.72	120	16	5338.176
11	MAJHGAWA	Alluvium	172.01	7.57	155	147.43	119	16	3275.0704
12	MEERGANJ	Alluvium	211.67	6.82	169	162.18	128	16	4335.0016
13	NAWABGANJ	Alluvium	345.09	3.87	136	132.13	85	16	4693.224
14	RAMNAGAR	Alluvium	193.06	12.41	155	142.59	110	16	3397.856
15	RICHHA	Alluvium	266.2	4.05	171	166.95	96	16	4088.832
16	SHERGARH	Alluvium	271.36	**5.51**	195	189.49	105	16	4558.848
	TOTAL	Alluvium	4093.64	**6.73**	155.37	112.43	16		4544.0497

5. GROUNWATER RELATED PROBLEMS

The following Ground Water related issues and problems have been identified in the district viz. (i) Depletion of Ground Water Resources due to excessive use in irrigation and resultant declining of water level in time and space, and (ii) The Quality problem of the Ground Water Resources.

5.1 DEPLETION OF GROUND WATER RESOURCES & MANAGEMENT

The major source of irrigation in the district is ground water, irrigating 295769 ha contributing about 95.75% of the total irrigation potentials of the district. The contribution of ground water irrigation is minimum in Bhutah block and maximum in Baheri block. Because of it being less susceptible to the influences of the changes in the weather phenomenon, which often cause drought and scarcity conditions, the reliance of the users on ground water resources is progressively increasing and new challenges are threatening the sustainability of the ground water resources. Negative impacts on replenishable ground water resources can be minimized by its proper and planned development and management.

a. Preparation of a master plan for ground water recharge and its implementation by construction of check dams, renovation of ponds, watershed treatment etc. in rural areas and Roof Top Rain Water Harvesting (RTRWH) in urban areas.

b. Promote surface water irrigation schemes instead of ground water-based irrigation.

c. Modify cropping pattern and adoption of less water requiring crops.

d. Promotion of modern piped and pressurized irrigation (Drip & Sprinkler) systems.

5.2. THE GROUND WATER QUALITY PROBLEMS

The Ground Water Quality problem may be grouped into two categories viz. Geogenic and Anthropogenic. The geogenic ground water quality problem mainly includes the occurrence of Iron, and Manganese concentration beyond the maximum permissible limit. The higher concentration of Nitrate may be due to Anthropogenic activities. The blocks having ground water quality problems in Shallow / Phreatic Aquifers have been identified in the district (Table 5.1).

Ramganga Block: Nitrate presence (49 mg/l) of more than permissible limit (40 mg/l) is reported in groundwater sample collected from the Block office premise.

Meerganj Block- Iron (Fe^{3+}) along with Manganese (Mn) is present in the Ground Water in excess quantity beyond permissible limits.

Alampur, Bhojipura, Bhutah, Faridpur, Kiyara, Meerganj & Shergarh Block- Presence of Iron (Fe^{3+}) beyond permissible limit has been reported from these blocks.

Table 5.1 Details of Quality problems in Groundwater of the study area.

Sl. No.	Chemical Constituent responsible for qualit yproblem	Maximum Permissible limitin the absence of alternate source (mg/lit)	Recorded concentration (mg/lit)	Affected Blocks	Possible adverse effects
1.	Nitrate (NO3)	45	49	Ram nagar	May cause "Methemoglobinemia" (Blue Baby) disease.
2.	Iron (Fe^{3+})	1	1.20 to 4.16	Alampur Bhojipura Bhutah Faridpur Kiyara Meerganj & Shergarh	May be used with caution after taking suitable treatment measures.
3.	Manganese (Mn)	0.3	.33	Meerganj	Change in appetite and reduction in metabolism of iron to form hemoglobin.

6. GROUNDWATER MANAGEMENT AND DEVELOPMENT STRATEGIES

6.1 GROUNDWATER DEVELOPMENT

The development of ground water resources is increasing over the years in order to meet drinking water, industrial and irrigation requirements. The stage of ground water development has changed from 66.95% in 2017 to 67.94% in 2020. As on 31.03.2020, it shows that block wise level of development of ground water potential in Bareilly district varies from 58.2% (Kyara) to 244.29% (Bareilly City). This increase in ground water utilization, for agriculture activity through adaption of bore wells / tube wells, has increased the ground water draft. Keeping in view the level of ground water development, growing needs, there is an urgent need for scientific approach for proper management of the available ground water resources for sustainability of this precious natural resource without having any adverse effect on the environment. At those places where water level is gradually going down, we should restrict or minimize the ground water for irrigation needs. Planned ground water development is possible only when availability of the ground water potential is precisely quantified and also the demand for various uses is properly estimated for the projected development scenario of urban as well as rural area for next 25 years.

6.2 GROUNDWATER MANAGEMENT STRATEGIES

Block wise management plan is prepared considering the present water level, water level trend, category of the block and further prioritized the blocks for interventions. Although out of 16 blocks, 11 blocks have been classified as Safe, 4 as a semi critical and 1 in Over exploitation category as per Ground Water Resource Estimation 2020. Thus, there is urgent need for taking up suitable water management interventions based on integrated approach, which on one hand includes augmentation of ground water resources through appropriate techniques, and on the other hand requires the adoption of suitable water conservation measures, such as ensuring water use efficiency through creation of additional water storage facility, maintenance / renovation of existing water bodies etc. water awareness and capacity building of the stakeholders are also the important attributes of water management interventions as envisaged in the National Water Policy.

6.3 GROUNDWATER MANAGEMENT OPTIONS

Ground water issues can be addressed mainly by focusing on measures to increase recharge and reducing the draft. It can be managed by a mix of measures such as supply side and demand side management.

6.3.1 Supply Side Management

It includes Artificial Recharge to ground water, Water conservation and On Farm Activities to increase storage capacity and conservation of rainfall. Based on available information about the area such as ground water scenario, hydrogeology, hydrology, topography, rainfall pattern, drainage, soil cover, utilizable rainfall, etc., scope for various interventions has been studied and assessment of suitable areas, tentative design and costs of structures has been worked out. By and large the methodology such as estimation of sub surface storage potential and availability of surface water for harvesting used for ground water conservation in Master Plan 2011 is kept same in this plan. However, the specific yield taken in Ground Water Resource Estimation 2017 in individual partly cultivated-various soils hence runoff coefficient is taken as 15%. The non-committed run off is considered 75 % of total runoff (Table 6.2).

I Artificial Recharge to ground water Recharge / Water Conservation

Water conservation structures such as check dams, farm ponds, nala bunds, Stream Development etc results in ground water recharge to the tune of about 50% of the storage capacity considering 3 annual fillings. Further construction of recharge trenches in the upstream side of the check dams is also proposed to enhance rate of infiltration by about 30 to 40%.

The existing ponds and tanks lose their storage capacity as well as the natural ground water recharge due to siltation and encroachment by farmers for agricultural purposes. Through desilting, coupled with providing proper waste weir, the village tanks can be converted into recharge structures.

Table 6.1: Block wise Unit Draft Calculation, Bareilly, UP

Sl No	Block	Draft For Irrigation (from Resource)	Net Irrigated Area (From Statistical Diary)	Unit Draft
1	ALAMPUR JAFARABAD	3874.84	22841	0.17
2	BAHERI	7862.4	30632	0.26
3	BAREILLY CITY	0	5577	0.00
4	BHADPURA	4983.96	19616	0.25
5	BHOJPURA	4951.52	14832	0.33
6	BHUTAH	5293.12	24411	0.22
7	BITHERI CHAINPUR	4874	20711	0.24
8	FARIDPUR	5053.12	21730	0.23
9	FATEHGANJ	4423.92	11470	0.39
10	KYARA	3205	10603	0.30
11	MAJHGAWA	2795.6	25882	0.11
12	MEERGANJ	3379.2	15802	0.21
13	NAWABGANJ	5442.64	26629	0.20
14	RAMNAGAR	4538.56	18409	0.25
15	RICHHA	6653.04	20255	0.33
16	SHERGARH	4753.88	19504	0.24
17	DISTRICT	72084.8	344715	0.21

6.3.2 Demand Side Management

It mainly includes adoption of techniques to enhance water use efficiency for reducing draft of ground water and on farm practices (Table 6.3).

On Farm Practices

Leveling of crop field is essential for uniform distribution of water. Laser leveling has been found very effective ensuring saving of 10 to 30% of applied irrigation. The in-situ farm activities such as contour bunding in, land leveling, bench terracing, water harvesting structures, afforestation and diversification of cropping pattern are other measures to increase recharge in the block.

Table 6.2: Supply Side Management, Bareilly District

Block	Check Dam				Stream Development				Nala Bunds				Ponds				Total Storage (MCM)	Annual Recharge (MCM) (~50 % of total storage)
	Check Dams (10000 cum)	Storage (MCM) 3 FILLINGS	Recharge from CHECK DAMS (MCM)	Supply for Irrigation (MCM)	Stream Development (Km)	Storage (MCM) 3 FILLINGS	Recharge Stream Dev (MCM)	Supply for Irrigation (MCM)	Nala Bunds (Capacity 7500 cub. m each)	Storage (MCM)	GW Recharge NALA BUNDS (MCM)	Supply for Irrigation (MCM)	Ponds (capacity 10000 cub. m each)	Storage (MCM)	GW Recharge from PONDS (MCM)	Supply for Irrigation (MCM)		
ALAMPUR JAFARABAD	1	0.03	0.02	0.02	1	0.05	0.02	0.02	1	0.02	0.01	0.01	2	0.06	0.03	0.03	0.16	0.08
BAHERI	2	0.06	0.03	0.03	2	0.09	0.04	0.04	2	0.04	0.02	0.02	4	0.12	0.06	0.06	0.31	0.15
BAREILLY CITY	1	0.02	0.01	0.01	1	0.02	0.01	0.01	1	0.01	0.01	0.01	1	0.03	0.02	0.02	0.08	0.04
BHADPURA	1	0.04	0.02	0.02	1	0.05	0.03	0.03	1	0.03	0.01	0.01	2	0.07	0.04	0.04	0.19	0.09
BHOJPURA	2	0.05	0.02	0.02	2	0.07	0.04	0.04	2	0.04	0.02	0.02	3	0.09	0.05	0.05	0.25	0.12
BHUTAH	2	0.06	0.03	0.03	2	0.08	0.04	0.04	2	0.04	0.02	0.02	4	0.11	0.06	0.06	0.30	0.15
BITHERI CHAINPUR	1	0.03	0.02	0.02	1	0.05	0.03	0.03	1	0.03	0.01	0.01	2	0.07	0.03	0.03	0.18	0.09
FARIDPUR	2	0.05	0.02	0.02	2	0.07	0.04	0.04	2	0.04	0.02	0.02	3	0.10	0.05	0.05	0.26	0.13
FATEHGANJ	1	0.03	0.01	0.01	1	0.04	0.02	0.02	1	0.02	0.01	0.01	2	0.05	0.03	0.03	0.14	0.07
KYARA	1	0.04	0.02	0.02	1	0.06	0.03	0.03	1	0.03	0.02	0.02	3	0.08	0.04	0.04	0.22	0.11
MAJHGAWA	1	0.03	0.01	0.01	1	0.04	0.02	0.02	1	0.02	0.01	0.01	2	0.05	0.03	0.03	0.14	0.07
MEERGANJ	1	0.03	0.02	0.02	1	0.05	0.02	0.02	1	0.02	0.01	0.01	2	0.06	0.03	0.03	0.17	0.08
NAWABGANJ	2	0.05	0.03	0.03	2	0.08	0.04	0.04	2	0.04	0.02	0.02	3	0.10	0.05	0.05	0.27	0.14
RAMNAGAR	1	0.03	0.01	0.01	1	0.04	0.02	0.02	1	0.02	0.01	0.01	2	0.06	0.03	0.03	0.15	0.08
RICHHA	1	0.04	0.02	0.02	1	0.06	0.03	0.03	1	0.03	0.01	0.01	3	0.08	0.04	0.04	0.21	0.10
SHERGARH	1	0.04	0.02	0.02	1	0.06	0.03	0.03	1	0.03	0.02	0.02	3	0.08	0.04	0.04	0.21	0.11
DISTRICT	**20**	**0.61**	**0.31**	**0.31**	**20**	**0.92**	**0.46**	**0.46**	20	**0.46**	**0.23**	**0.23**	**41**	**1.23**	**0.61**	**0.61**	**3.22**	**1.61**

Efficient Irrigation

In flood / furrow irrigation method more than 50% of applied water is wasted through seepage to deeper level, localized inundation causes loss through evaporation and it leaches out the nutrients from the plant, while through drip & sprinkler irrigation wastage of irrigational water could be minimized. The conveyance losses (mainly seepage & evaporation) can be saved upto 25 to 40% through utilization of HDPE pipes.

The Blockwise Summary Report for Ground Water Management of the study area is given in table 6.4. The Block wise expected outcomes from Ground Water Management interventions, Bareilly, UP are given in table 6.5. Figure 6.1 indicate the Projected Change of Ground Water Scenario after Management, Bareilly, UP.

Table 6. Demand side Management, Bareilly district

Blocks	On Farm Activities			Water Use Efficiency		Total Savingin Draft by Demand Side Management
	On-farm Area (ha)	Exp Rech (ham) On-farm	Saving in Draft (ham) On-farm	WUE Area (ha)	Saving in Draft (ham) WUE	
ALAMPUR JAFARABAD	2284	2.28	1.16	2284	1.16	2.40
BAHERI	3357	3.36	2.58	3357	2.58	5.32
BAREILLY CITY	565	0.57	0.00	565	0.00	0.04
BHADPURA	2014	2.01	1.54	2014	1.54	3.16
BHOJPURA	1533	1.53	1.54	1533	1.54	3.19
BHUTAH	2739	2.74	1.78	2739	1.78	3.71
BITHERI CHAINPUR	1954	1.95	1.38	1954	1.38	2.85
FARIDPUR	2379	2.38	1.66	2379	1.66	3.45
FATEHGANJ	1376	1.38	1.59	1376	1.59	3.25
KYARA	1084	1.08	0.98	1084	0.98	2.08
MAJHGAWA	2724	2.72	0.88	2724	0.88	1.83
MEERGANJ	1811	1.81	1.16	1811	1.16	2.41
NAWABGANJ	2740	2.74	1.68	2740	1.68	3.50
RAMNAGAR	1896	1.90	1.40	1896	1.40	2.88
RICHHA	2043	2.04	2.01	2043	2.01	4.13
SHERGARH	2152	2.15	1.57	2152	1.57	3.25
DISTRICT	**32653**	**32.65**	**22.93**	**32653**	20.48	45.03

Table 6.4: Blockwise Summary Report for Ground Water Management, Bareilly, UP

Block	CDs (Nos)	NBs (Nos)	Str Dev (Km)	Ponds (Nos)	On-farm (ha)	WUE (ha)	Rech frm Str MCM	Saving from Str MCM	Saving frm On-farm & WUE MCM	Total Rech MCM	Total Saving MCM	Present Stage of Ground Water Development (%)	Projected Stage of Development (%) After Interventions
ALAMPUR JAFARABAD	1	1	1	2	2284	2284	0.08	0.08	2.32	0.08	2.40	72.83	68.79
BAHERI	2	2	2	4	3357	3357	0.15	0.15	5.17	0.15	5.32	67.89	63.64
BAREILLY CITY	1	1	1	1	565	565	0.04	0.04	0.00	0.04	0.04	244.29	243.48
BHADPURA	1	1	1	2	2014	2014	0.09	0.09	3.07	0.09	3.16	64.79	60.93
BHOJPURA	2	2	2	3	1533	1533	0.12	0.12	3.07	0.12	3.19	58.94	55.48
BHUTAH	2	2	2	4	2739	2739	0.15	0.15	3.56	0.15	3.71	62.68	58.61
BITHERI CHAINPUR	1	1	1	2	1954	1954	0.09	0.09	2.76	0.09	2.85	61.14	57.81
FARIDPUR	2	2	2	3	2379	2379	0.13	0.13	3.32	0.13	3.45	61.21	57.46
FATEHGANJ	1	1	1	2	1376	1376	0.07	0.07	3.18	0.07	3.25	78.90	73.65
KYARA	1	1	1	3	1084	1084	0.11	0.11	1.97	0.11	2.08	58.20	54.76
MAJHGAWA	1	1	1	2	2724	2724	0.07	0.07	1.77	0.07	1.83	70.08	66.38
MEERGANJ	1	1	1	2	1811	1811	0.08	0.08	2.32	0.08	2.41	66.03	61.82
NAWABGANJ	2	2	2	3	2740	2740	0.14	0.14	3.36	0.14	3.50	61.26	57.75
RAMNAGAR	1	1	1	2	1896	1896	0.08	0.08	2.80	0.08	2.88	84.84	79.87
RICHHA	1	1	1	3	2043	2043	0.10	0.10	4.03	0.10	4.13	64.73	60.97
SHERGARH	1	1	1	3	2152	2152	0.11	0.11	3.15	0.11	3.25	60.69	56.99
DISTRICT	**20**	**20**	**20**	**41**	**32653**	**32653**	**1.61**	**1.61**	**45.86**	1.61	47.47	67.94	64.08

Table 6.5: Block wise expected outcomes from Ground Water Management interventions, Bareilly, UP

Blocks	**Area**	**Net Annual Ground Water Avail-ability (MCM)**	**Existing Gross Ground Water Draft for All Uses (MCM)**	**Present Stage of Ground Water Development (%)**	**TOT RECH through interventions (MCM)**	**Tot GW Saving through interventions (MCM)**	**Projected Net GW Availability (MCM)**	**Projected Gross GW Draft (MCM)**	Projected Stage of Development After Interventions
ALAMPUR JAFARABAD	489.92	60.98	44.41	72.83	0.08	2.40	61.06	42.01	**68.79**
BAHERI	469.61	127.51	86.57	67.89	0.15	5.32	127.67	81.25	**63.64**
BAREILLY CITY	283.14	17.81	43.51	244.29	0.04	0.04	17.85	43.46	**243.48**
BHADPURA	235.19	83.35	54.00	64.79	0.09	3.16	83.44	50.84	**60.93**
BHOJPURA	225.53	94.37	55.62	58.94	0.12	3.19	94.49	52.43	**55.48**
BHUTAH	231.39	93.26	58.45	62.68	0.15	3.71	93.40	54.74	**58.61**
BITHERI CHAINPUR	211.92	87.08	53.24	61.14	0.09	2.85	87.17	50.39	**57.81**
FARIDPUR	308.05	93.83	57.43	61.21	0.13	3.45	93.96	53.98	**57.46**
FATEHGANJ	219.97	62.96	49.67	78.90	0.07	3.25	63.03	46.42	**73.65**
KYARA	310	61.95	36.06	58.20	0.11	2.08	62.06	33.98	**54.76**
MAJHGAWA	292.12	50.74	35.56	70.08	0.07	1.83	50.80	33.72	**66.38**
MEERGANJ	231.22	58.38	38.55	66.03	0.08	2.41	58.46	36.14	**61.82**
NAWABGANJ	329.32	101.82	62.38	61.26	0.14	3.50	101.96	58.88	**57.75**
RAMNAGAR	458.19	59.19	50.22	84.84	0.08	2.88	59.27	47.34	**79.87**
RICHHA	243.54	111.59	72.24	64.73	0.10	4.13	111.70	68.11	**60.97**
SHERGARH		89.72	54.45	60.69	0.11	3.25	89.83	51.19	**56.99**
DISTRICT	4575.00	**1254.53**	**852.36**	**67.94**	**1.61**	**47.47**	**1256.15**	**804.89**	**64.08**

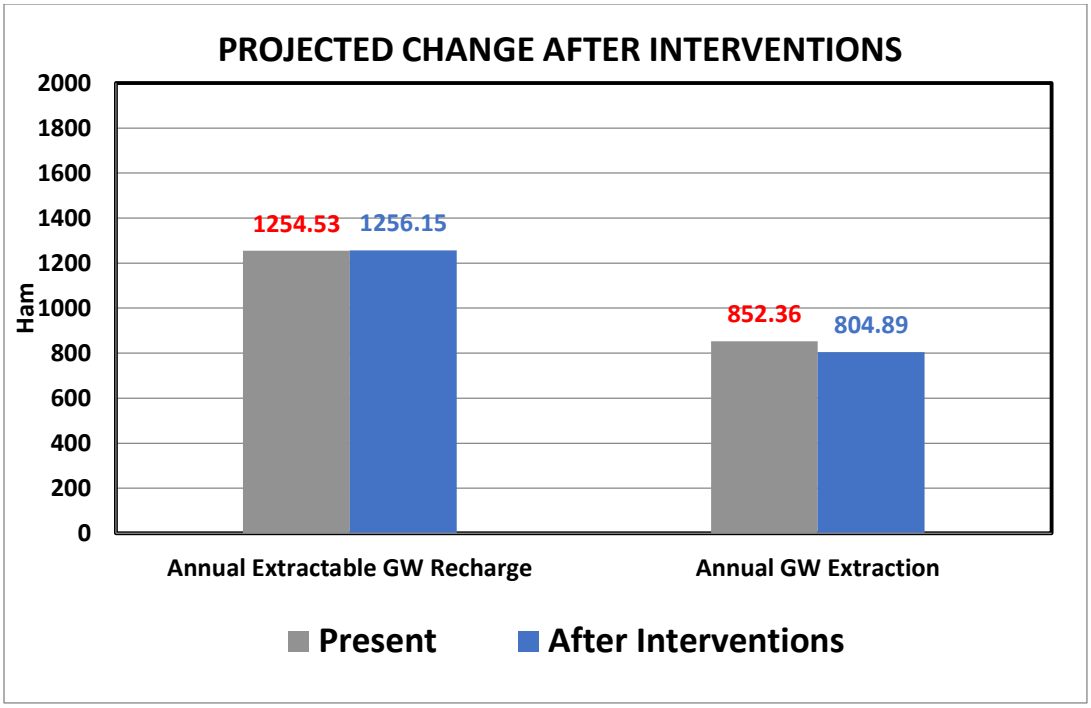


Fig 6.1. Projected Change of Ground Water Scenario after Management, Bareilly, UP

Overall, various interventions suggested for Ground water recharge and water conservation structures, based on the hydrogeology, geomorphology and extent of ground water abstraction, in different parts of the district. Nala bund is suggested on first order streams whereas check dams can hold comparatively large volume of surface water hence suggested on second order streams having considerable high discharge. On farm lands, water conservation and water use efficiency practices are suggested which are closer to the drainage as they will help in reducing runoff and recharging ground water. After implementation of management innervations in the study area, groundwater issues will resolve up to some extent.

7. BLOCK-WISE AQUIFER MAPS & MANAGEMENT PLANS

7.1 AQUIFER MAPPING AND MANAGEMENT PLAN OF ALAMPUR JAFARABAD BLOCK, BAREILLY DISTRICT, U.P.

1. Salient Information

Table 7.1a: Salient Information of ALAMPUR JAFARABAD Block, Bareilly District, UP

Area	202.68 Sq. Km					
Population	220066	**Male**	118039	**Female**	102027	
Population Density	1086 persons/sq km					
Annual Rainfall (2011-20)	***957*** mm	**Monsoon**	***839.***5mm	**Non-Monsoon**	***117.5*** mm	

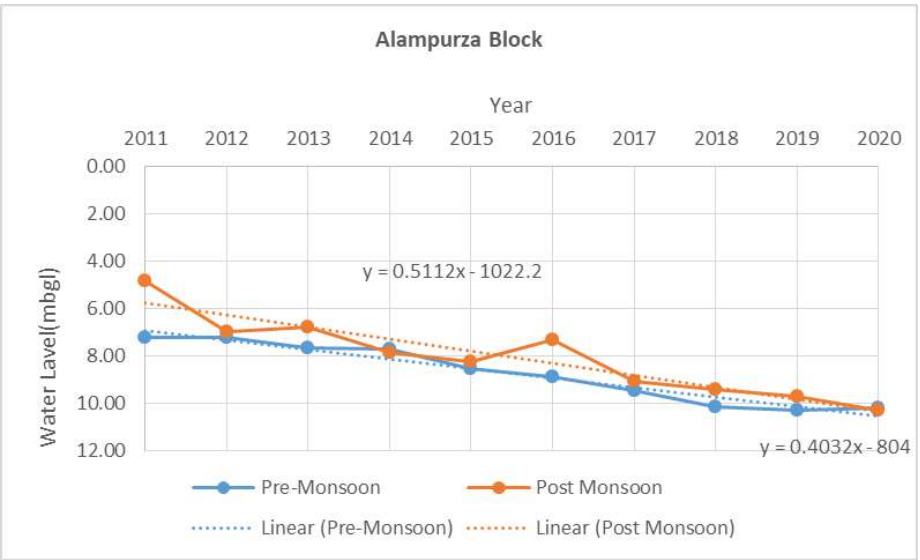
Table7.2b: Agriculture and Irrigation, ALAMPUR JAFARABAD, Bareilly District, UP

Net Sown Area	22840	**Gross Sown Area**	40275
Net Irrigated Area	22841	**Gross Irrigated Area**	40750
Irrigation Intensity	178.41 %	**Irrigation by GW**	97.36 %
Irrigation by SW	2.64 %		

*Area in Hectare

2. Water Level Behaviour

The average depth to water level has been observed as 10.18 mbgl during Pre-monsoon (2020) and 10.28 mbgl during post-monsoon (2020). For the period of 2011-2020 Pre-monsoon water level trend is 0.40 m/year and post-monsoon water level trend is 0.51m/year.



3. Aquifer Disposition

Three aquifer groups exist in the block:

Aquifer Group I: Ground level to 212 mbgl.

Aquifer Group II: 200mbgl to 305mbgl.

Aquifer Group III: 320 mbgl- 350mbgl.

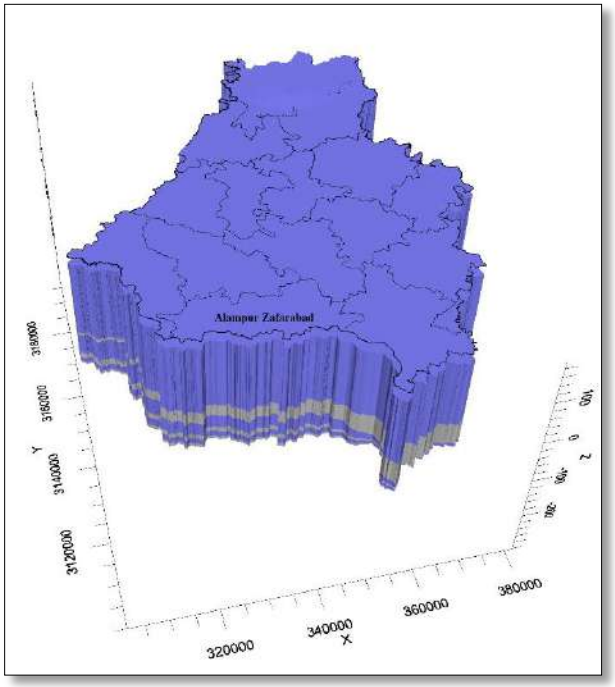


Fig: 7.1a: 3D disposition of Aquifer system

4. Ground water resource, extraction and other issues

Table 7: Ground Water Resource (Static+Dynamic), Extraction as on March, 2020, ALAMPUR JAFARABAD Block, Bareilly, UP

A	**FIRST AQUIFER SYSTEM**	
1	**Dynamic Resources (Fresh)**	60.98 MCM
2	**Total GW Extraction**	44.41 MCM
3	**Stage of Ground Water Extraction**	72.83%
4	**Category**	Semi critical
5	**Static Resources (Fresh)**	3372.59 MCM
7	**Total Resources Dynamic + Static (Fresh)**	3433.57 MCM

Issues: Dependency on Ground Water for Irrigation and declining trend of water level. Presence of Iron (Fe^{3+}) beyond permissible limit has been reported in the blocks.

5. Chemical Quality of ground water and contamination

Table 7.1d: Basic Chemical Quality of Phreatic Aquifer, ALAMPUR JAFARABAD Block , Bareilly, UP

Basic Parameter	Permissible Limit	Results
	BIS 10500:2012	
pH	6.5-8.5	8.01
EC (□S/cm) at 25^{0}C	3000	467
CO_3 mg/l	-	NIL
HCO_3 mg/l	-	232
Cl mg/l	1000	28
F mg/l	1.5	BDL
NO_3 mg/l	45	BDL
SO_4 mg/l	400	BDL
TH as $CaCO_3$ mg/l	600	60
Ca mg/l	200	12
Mg mg/l	100	7.2
Na mg/l	-	75
K mg/l	-	8.7
SiO_2 mg/l	-	49
PO_4 mg/l	-	ND

Table 8: Heavy Metal concentration of Shallow Aquifer, ALAMPUR JAFARABAD Block, Bareilly, UP

Heavy Metals		Fe in ppm	Mn in ppm	Cu in ppm	Zn in ppm	As in ppb	Pb in ppb	U in ppb	Cr in ppb
Permissible Limit	**BIS 10500:2012**	1	0.3	1.5	15	10	10	30	50
Results		1.34	0.11	0	0.09	1	2	7	0

6. Ground Water Management:

Table 9: Ground Water Management Strategies and Projected Stage of Extraction

Block	Check Dams (Nos)	Nala Bunds (Nos)	Stream Development (Km)	Ponds (Nos)	On-farm Activities (ha)	Water Use Efficiency (ha)	Recharge from Structure MCM	Saving from Structures MCM	Saving frm On-farm & WUE MCM	Total Recharge MCM	Total Saving MCM	Present Stage of Ground Water Extraction (%)	Projected Stage of Extraction (%) After Interventions
ALAMPUR JAFARABAD	1	1	1	2	2284	2284	0.08	0.08	2.32	0.08	2.40	72.83	68.79

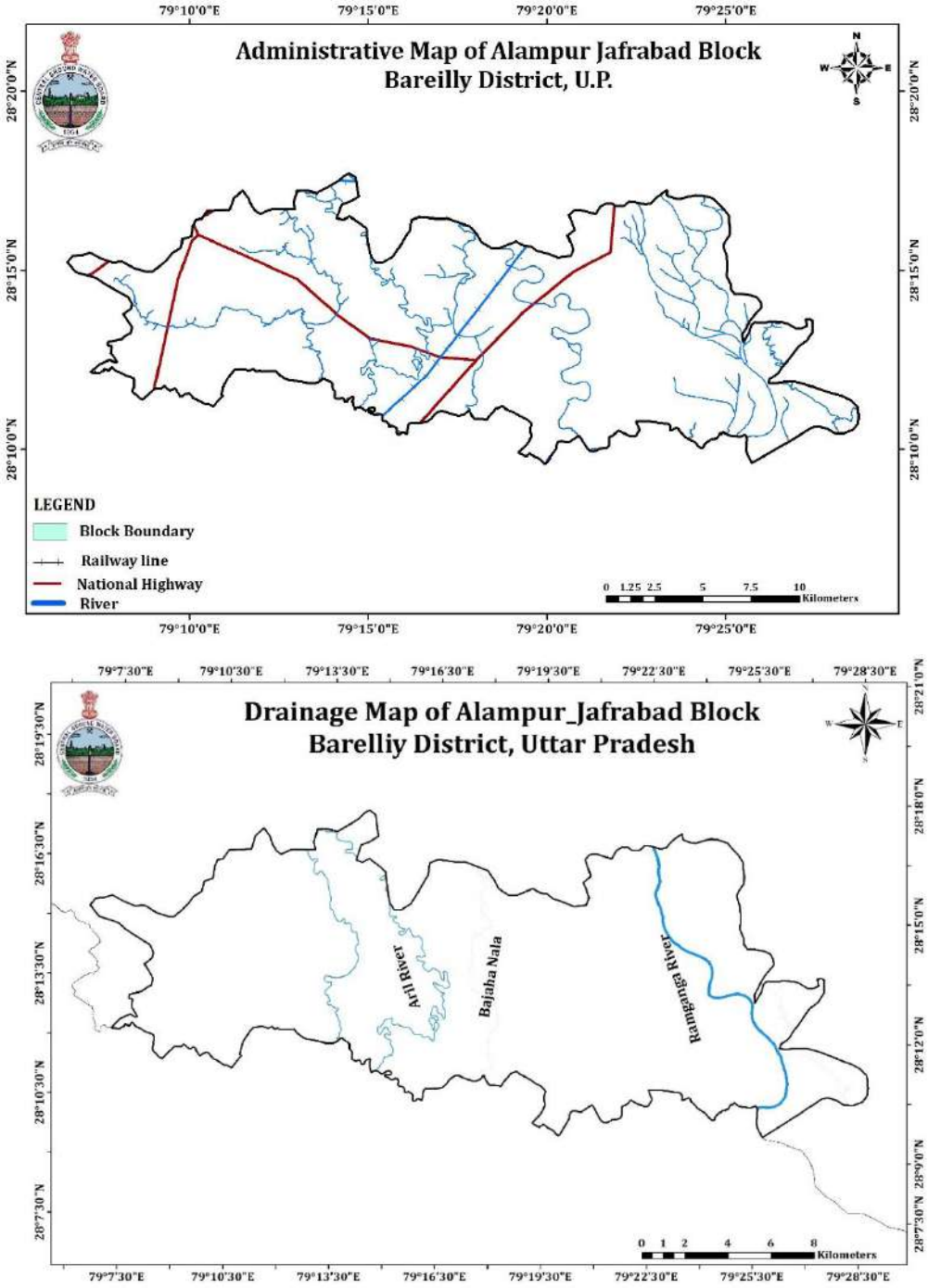


Fig 1: Administrative and Drainage map of ALAMPUR JAFARABAD Block, Bareilly District, UP

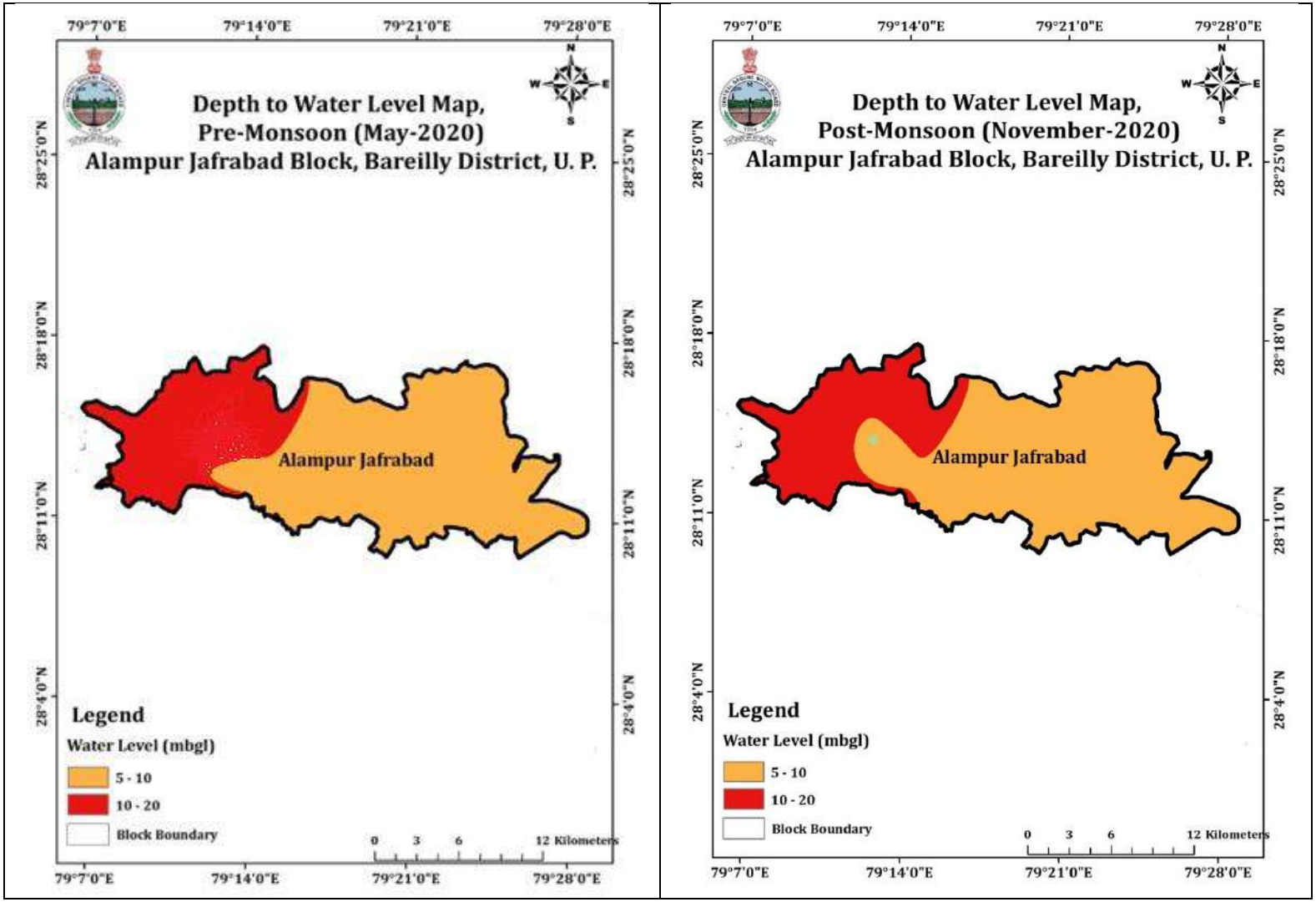


Fig 7.1c: Water Level map of pre-and post-monsoon 2020 of Alampur Jafarabad Block, Bareilly district, UP

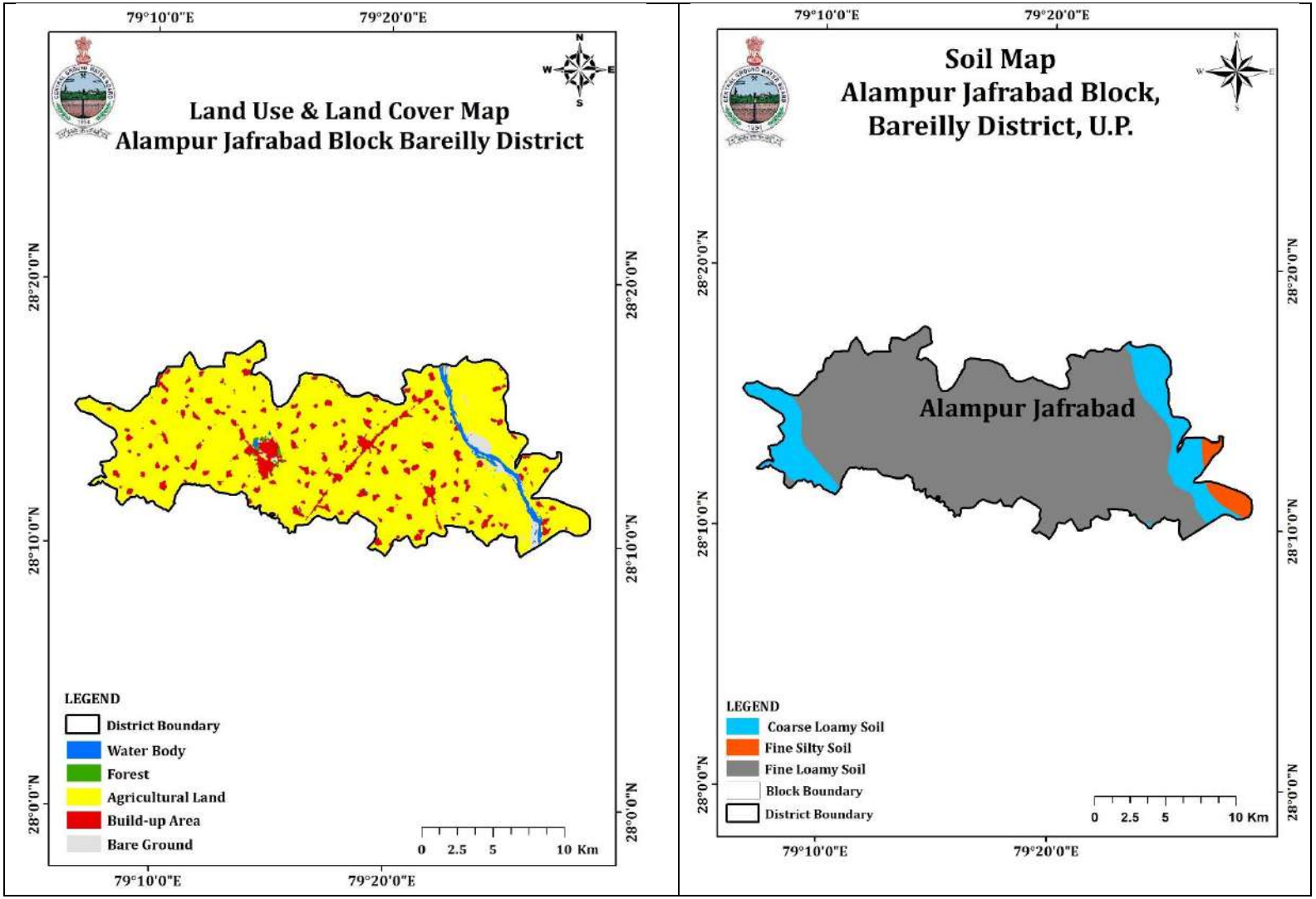


Figure 7.1d: Land use & Land cover and Soil Map of Alampur Jafarabad Block, Bareilly district, UP

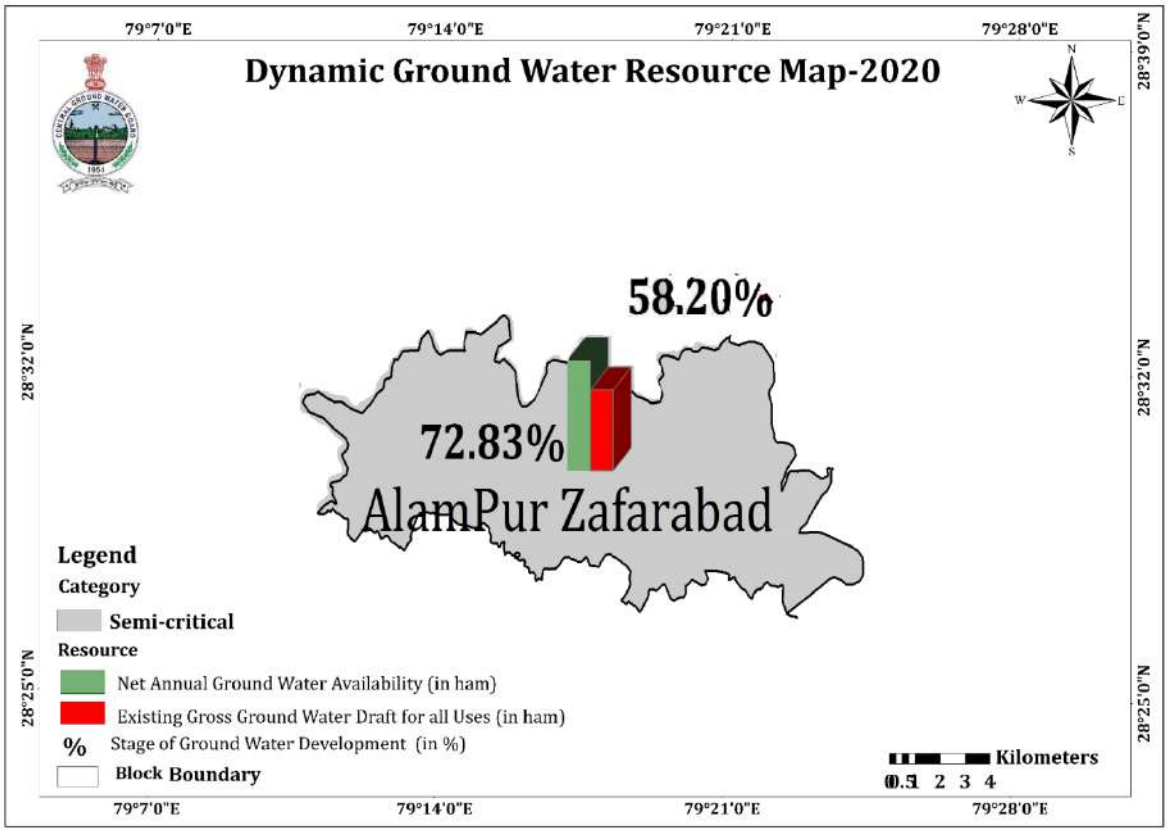


Figure 7.1e : Dynamic GW Resource Map of Alampur Jafarabad Block, Bareilly district, UP

7.2 AQUIFER MAPPING AND MANAGEMENT PLAN OF BAHERI BLOCK, BAREILLY DISTRICT, U.P.

1. Salient Information

Table 7.2a: Salient Information of BAHERI Block, Bareilly District, UP

Area	392.14 Sq. Km					
Population	236649	**Male**	124259	**Female**	112390	
Population Density	603 persons/sq km					
Annual Rainfall (2011-20)	***957*** mm	**Monsoon**	***839.***5mm	**Non-Monsoon**	***117.5*** mm	

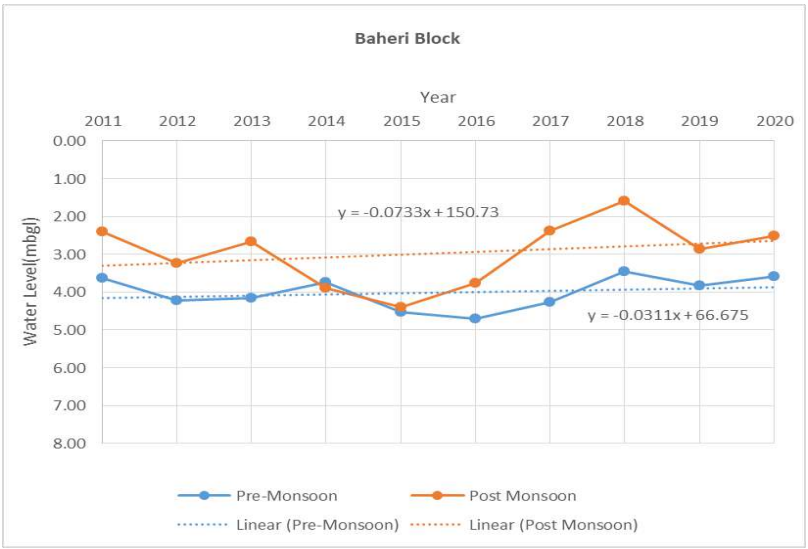
Table7.2b: Agriculture and Irrigation, BAHERI, Bareilly District, UP

Net Sown Area	33565	**Gross Sown Area**	56117
Net Irrigated Area	30632	**Gross Irrigated Area**	57546
Irrigation Intensity	187.86 %	**Irrigation by GW**	87.98 %
Irrigation by SW	12.02 %		

*Area in Hectare

2. Water Level Behaviour

The average depth to water level has been observed as 3.58 mbgl during Pre-monsoon (2020) and 2.58 mbgl during post-monsoon (2020). For the period of 2011-2020 Pre-monsoon water level trend is 0.03 m/year and post-monsoon water level trend is 0.07m/year.



3. Aquifer Disposition

Three aquifer groups exist in the block:

Aquifer Group I: Ground level to 200 mbgl.

Aquifer Group II: 230mbgl to 325mbgl.

Aquifer Group III: 330 mbgl- 350mbgl.

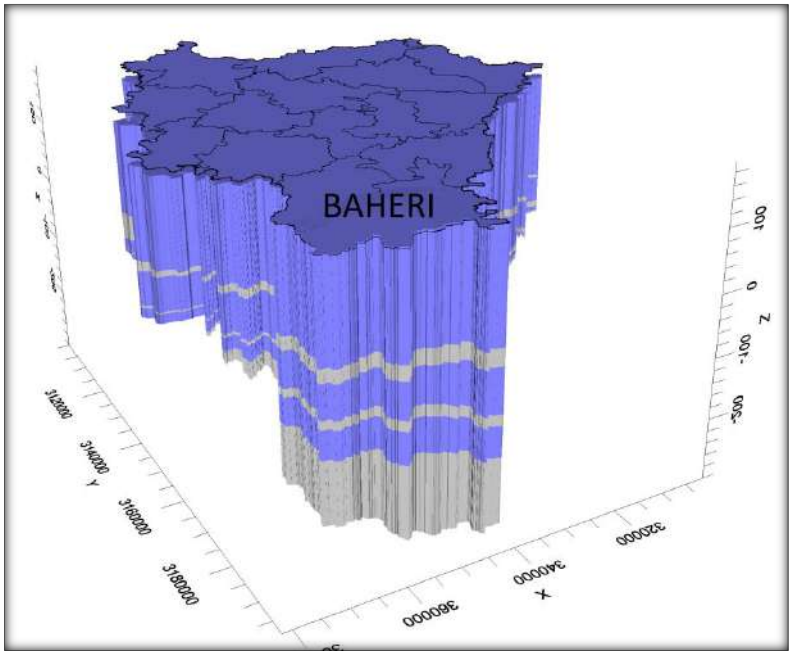


Fig: 7.2a: 3D disposition of Aquifer system

4. Ground water resource, extraction and other issues

Table 10: Ground Water Resource (Static+Dynamic), Extraction as on March, 2020, BAHERI Block, Bareilly, UP

A	**FIRST AQUIFER SYSTEM**	
1	**Dynamic Resources (Fresh)**	127.51 MCM
2	**Total GW Extraction**	86.57 MCM
3	**Stage of Ground Water Extraction**	67.89%
4	**Category**	Safe
5	**Static Resources (Fresh)**	6086.01 MCM
7	**Total Resources Dynamic + Static (Fresh)**	6213.52 MCM

Issues: Dependency on Ground Water for Irrigation and declining trend of water level. There is no issues.

5. Chemical Quality of ground water and contamination

Table 7.2d: Basic Chemical Quality of Phreatic Aquifer, BAHERI Block , Bareilly, UP

Basic Parameter	Permissible Limit	Results
	BIS 10500:2012	
pH	6.5-8.5	8.22
EC (□S/cm) at 25^{0}C	3000	302
CO_3 mg/l	-	nil
HCO_3 mg/l	-	159
Cl mg/l	1000	7.1
F mg/l	1.5	0.35
NO_3 mg/l	45	BDL
SO_4 mg/l	400	18
TH as $CaCO_3$ mg/l	600	110
Ca mg/l	200	28
Mg mg/l	100	9.6
Na mg/l	-	19
K mg/l	-	7.6
SiO_2 mg/l	-	46
PO_4 mg/l	-	**Nd**

Table 11: Heavy Metal concentration of Shallow Aquifer, BAHERI Block, Bareilly, UP

Heavy Metals		Fe in ppm	Mn in ppm	Cu in ppm	Zn in ppm	As in ppb	Pb in ppb	U in ppb	Cr in ppb
Permissible Limit	**BIS 10500:2012**	1	0.3	1.5	15	10	10	30	50
Results		0.66	0.04	0	0.03	1	1	3	0

6. Ground Water Management:

Table 12: Ground Water Management Strategies and Projected Stage of Extraction

Block	Check Dams (Nos)	Nala Bunds (Nos)	Stream Development (Km)	Ponds (Nos)	On-farm Activities (ha)	Water Use Efficiency (ha)	Recharge from Structure MCM	Saving from Structures MCM	Saving frm On-farm & WUE MCM	Total Recharge MCM	Total Saving MCM	Present Stage of Ground Water Extraction (%)	Projected Stage of Extraction (%) After Interventions
BAHERI	2	2	2	4	3357	3357	0.15	0.15	5.17	0.15	5.32	67.89	63.64

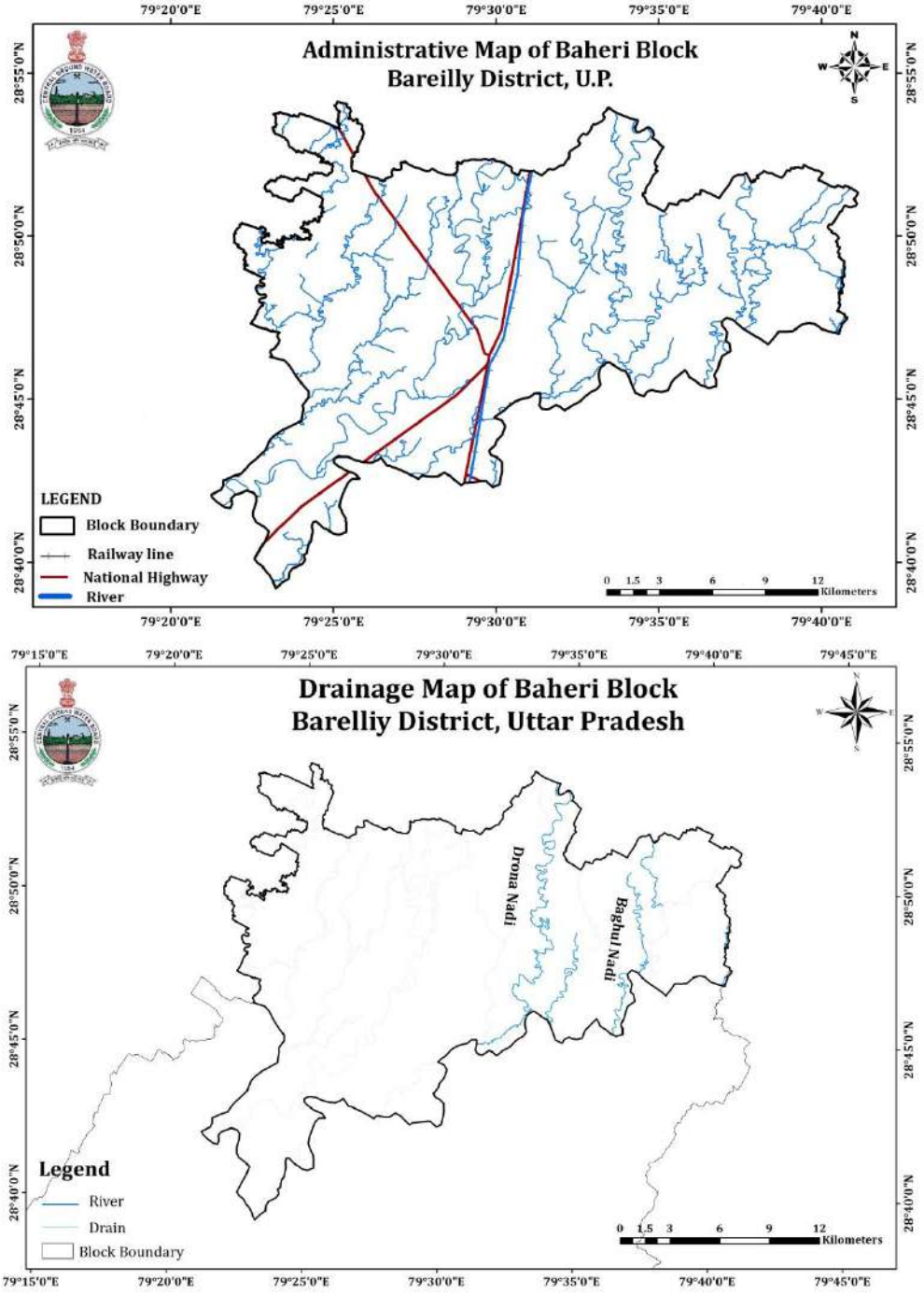


Fig 2: Administrative and Drainage map of BAHERI Block, Bareilly District, UP

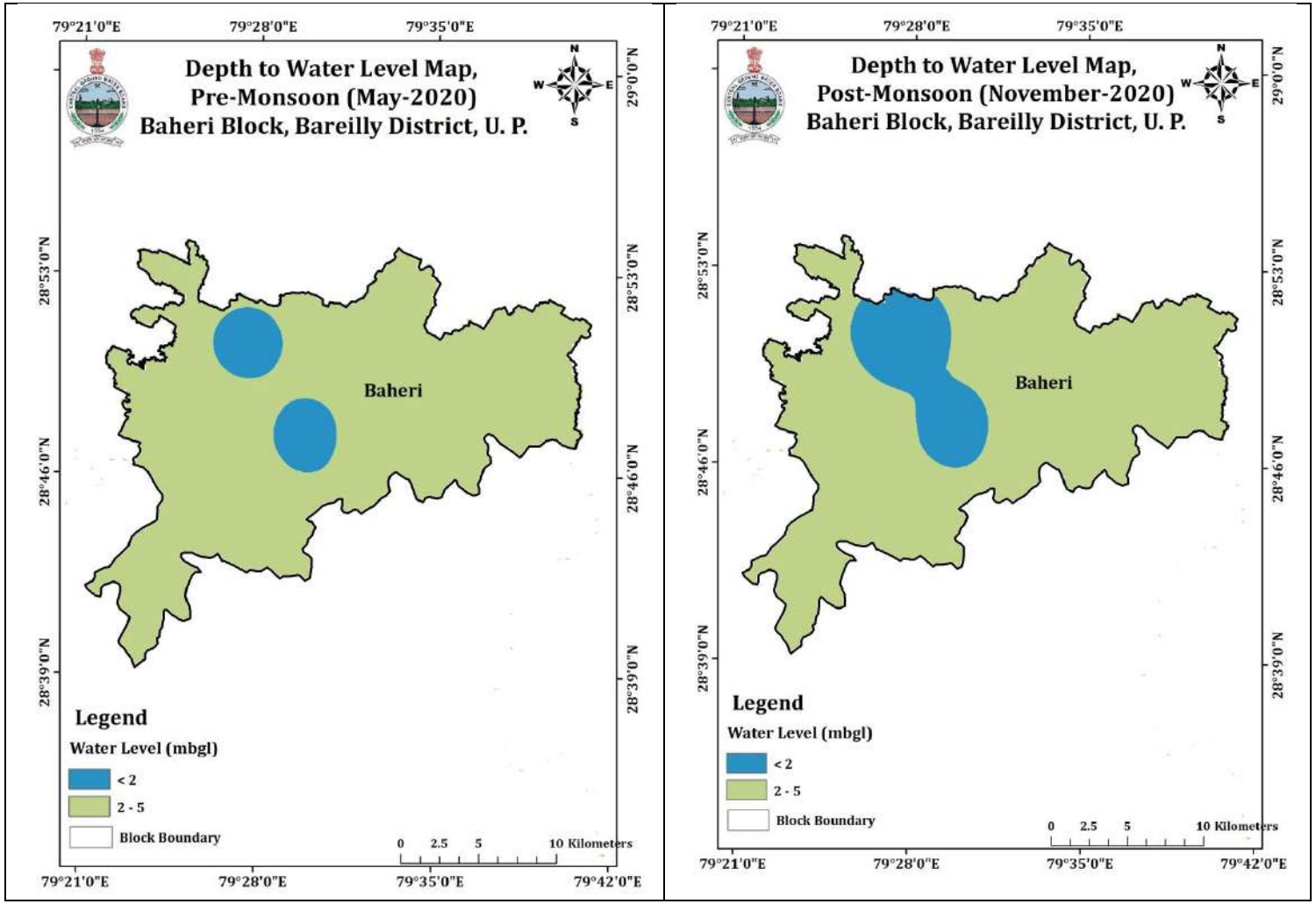


Fig 7.2c: Water Level map of pre-and post-monsoon 2020 of BAHERI Block, Bareilly district, UP

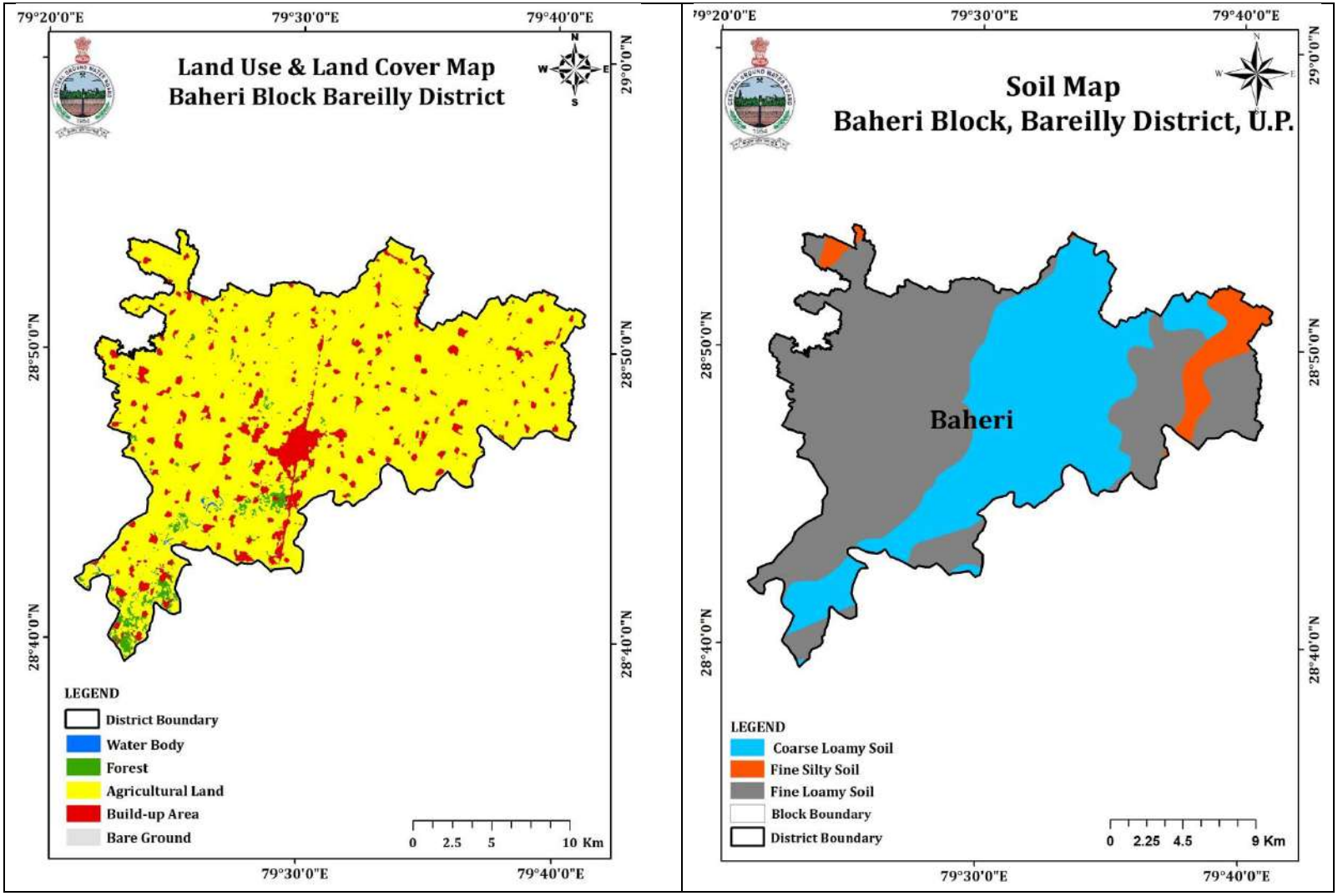


Figure 7.2d: Land use & Land cover and Soil Map of BAHERI Block, Bareilly district, UP

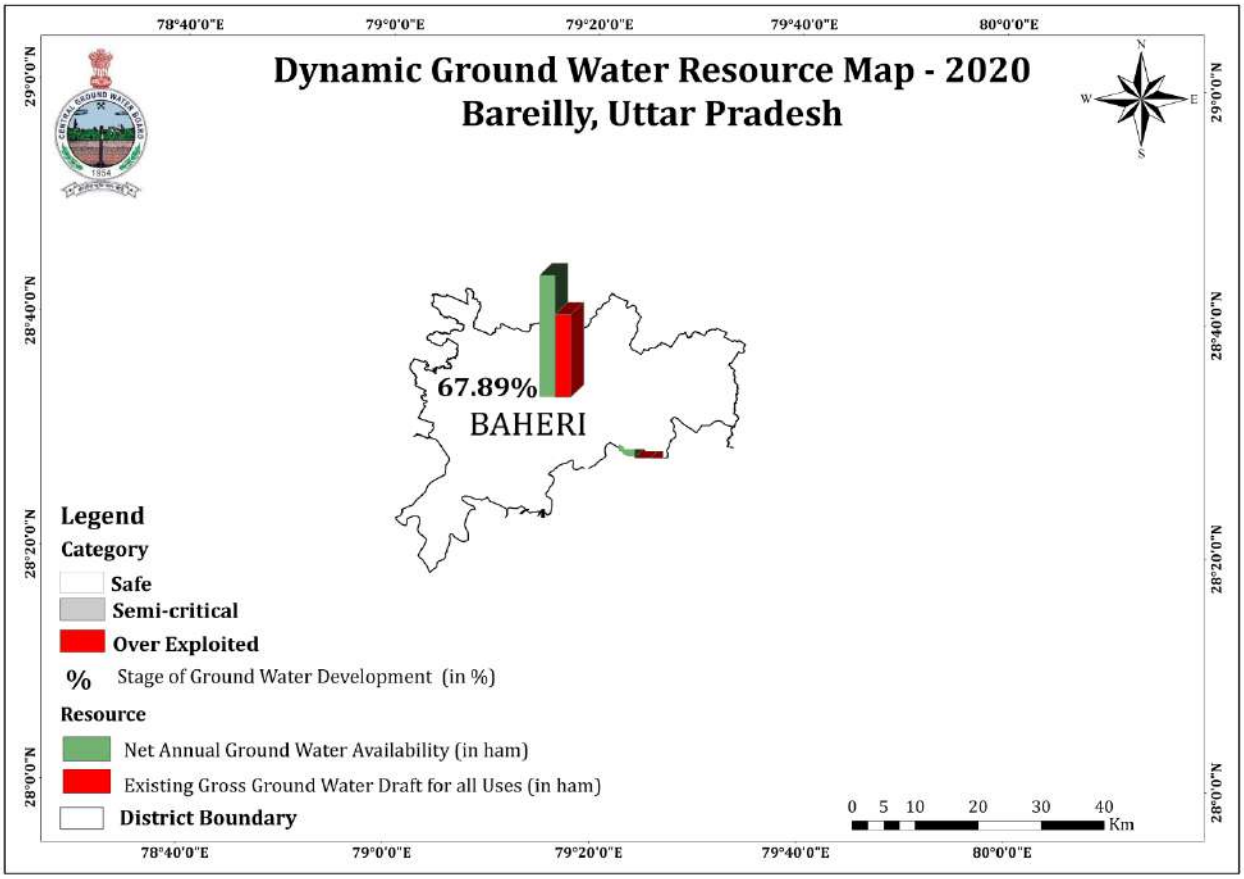


Figure 7.2e : Dynamic GW Resource Map of BAHERI Block, Bareilly district, UP

7.3 AQUIFER MAPPING AND MANAGEMENT PLAN OF BAREILLY CITY, BAREILLY DISTRICT, U.P.

1. Salient Information

Table 7.3a: Salient Information of BAREILLY CITY, Bareilly District, UP

Area	106.47Sq. Km					
Population	1568409	**Male**	827309	**Female**	741100	
Population Density	408 persons/sq km					
Annual Rainfall (2011-20)	***957*** mm	**Monsoon**	***839.***5mm	**Non-Monsoon**	***117.5*** mm	

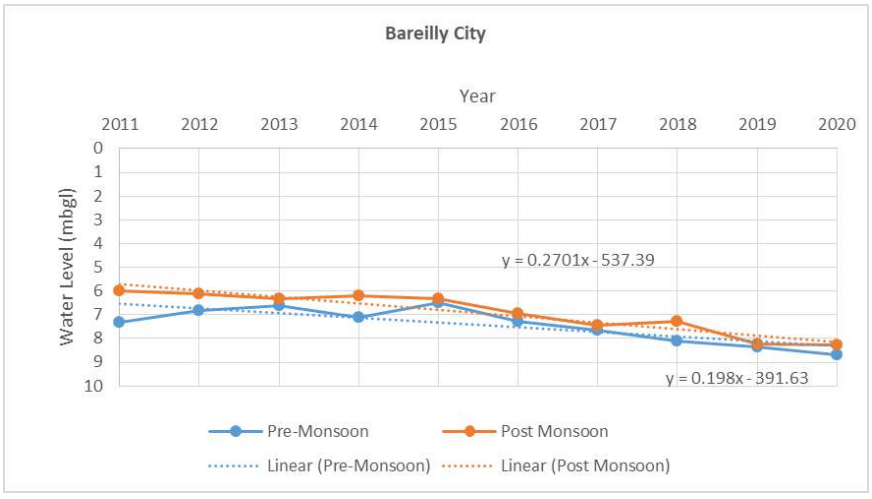
Table7.3b: Agriculture and Irrigation, BAREILLY CITY, Bareilly District, UP

Net Sown Area	5653	**Gross Sown Area**	7472
Net Irrigated Area	5577	**Gross Irrigated Area**	7715
Irrigation Intensity	138.34%	**Irrigation by GW**	98.85 %
Irrigation by SW	1.15 %		

*Area in Hectare

2. Water Level Behaviour

The average depth to water level has been observed as 8.67 mbgl during Pre-monsoon (2020) and 8.26 mbgl during post-monsoon (2020). For the period of 2011-2020 Pre-monsoon water level trend is 0.20 m/year and post-monsoon water level trend is 0.27m/year.



3. Aquifer Disposition

Three aquifer groups exist in the block:

Aquifer Group I: Ground level to 212 mbgl.

Aquifer Group II: 200mbgl to 305mbgl.

Aquifer Group III: 320 mbgl- 345mbgl.

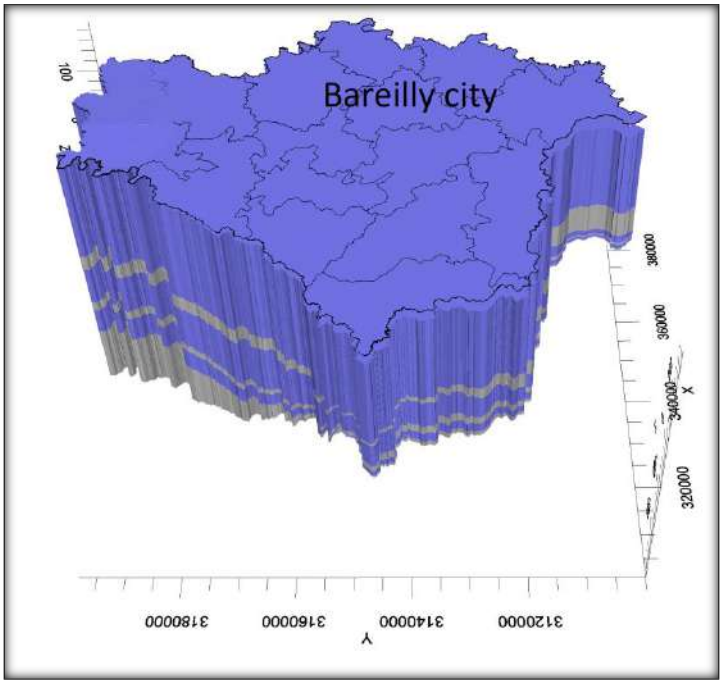


Fig: 7.3a: 3D disposition of Aquifer system

4. Ground water resource, extraction and other issues

Table 13: Ground Water Resource (Static+Dynamic), Extraction as on March, 2020, BAREILLY CITY, Bareilly, UP

A	**FIRST AQUIFER SYSTEM**	
1	**Dynamic Resources (Fresh)**	17.80 MCM
2	**Total GW Extraction**	43.50 MCM
3	**Stage of Ground Water Extraction**	244.29%
4	**Category**	Over Exploited
5	**Static Resources (Fresh)**	2061.25 MCM
7	**Total Resources Dynamic + Static (Fresh)**	2079.05 MCM

5. Chemical Quality of ground water and contamination

Table 7.3d: Basic Chemical Quality of Phreatic Aquifer, BAREILLY CITY, Bareilly, UP

Basic Parameter	Permissible Limit	Results
	BIS 10500:2012	
pH	6.5-8.5	8.07
EC (□S/cm) at 25^{0}C	3000	353
CO_3 mg/l	-	nil
HCO_3 mg/l	-	195
Cl mg/l	1000	14
F mg/l	1.5	BDL
NO_3 mg/l	45	BDL
SO_4 mg/l	400	13
TH as $CaCO_3$ mg/l	600	90
Ca mg/l	200	24
Mg mg/l	100	7.2
Na mg/l	-	26
K mg/l	-	31
SiO_2 mg/l	-	49
PO_4 mg/l	-	**Nd**

Table 14: Heavy Metal concentration of Shallow Aquifer, BAREILLY CITY, Bareilly, UP

Heavy Metals		Fe in ppm	Mn in ppm	Cu in ppm	Zn in ppm	As in ppb	Pb in ppb	U in ppb	Cr in ppb
Permissible Limit	**BIS 10500:2012**	1	0.3	1.5	15	10	10	30	50
Results		0.27	0.22	0	0.08	2	1	14	0

6. Ground Water Management:

Table 15: Ground Water Management Strategies and Projected Stage of Extraction

Block	Check Dams (Nos)	Nala Bunds (Nos)	Stream Development (Km)	Ponds (Nos)	On-farm Activities (ha)	Water Use Efficiency (ha)	Recharge from Structure MCM	Saving from Structures MCM	Saving frm On-farm & WUE MCM	Total Recharge MCM	Total Saving MCM	Present Stage of Ground Water Extraction (%)	Projected Stage of Extraction (%) After Interventions
BAREILLY CITY	1	1	1	1	565	565	0.04	0.04	0.00	0.04	0.04	244.29	243.48

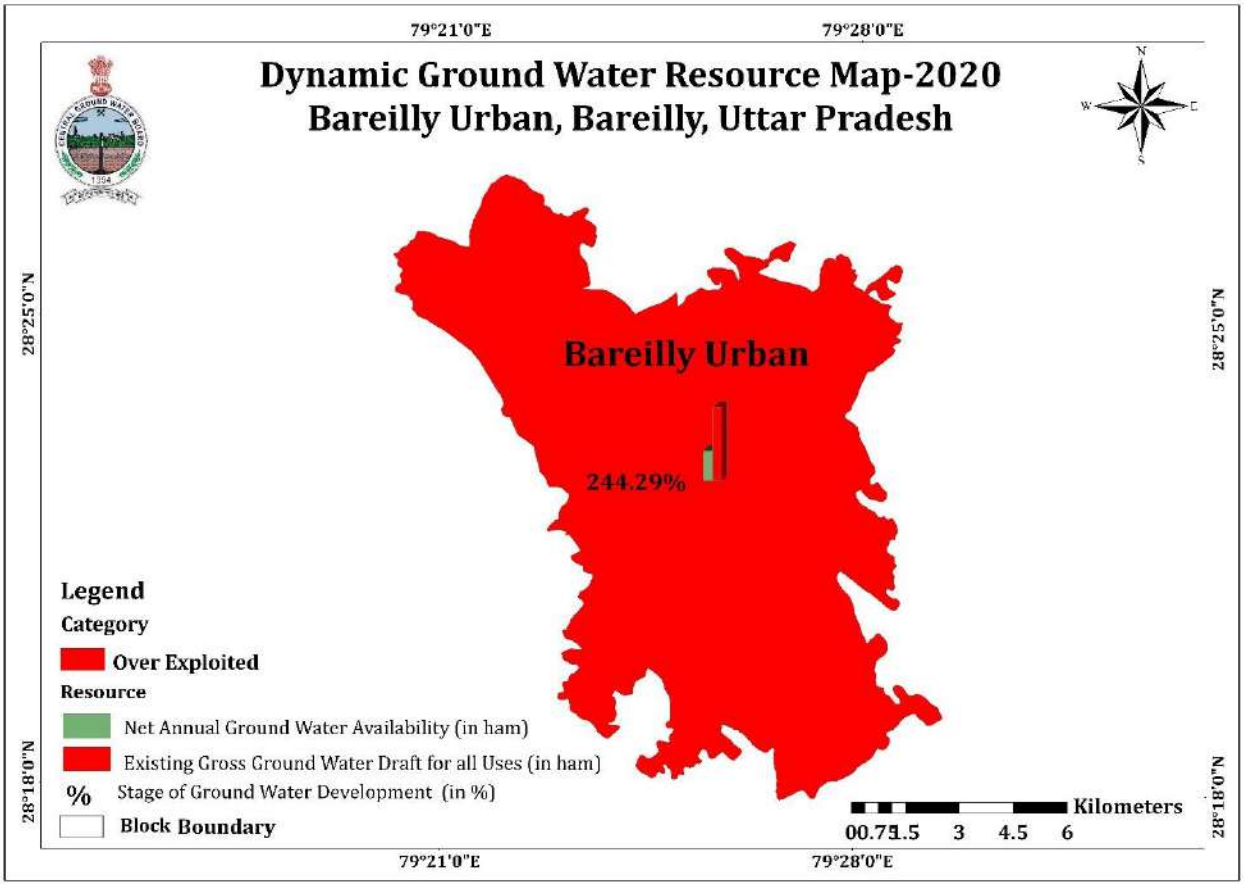


Figure 7.3a : Dynamic GW Resource Map of Bareilly Urban, Bareilly district, UP

7.4 AQUIFER MAPPING AND MANAGEMENT PLAN OF BHADPURA, BAREILLY DISTRICT, U.P.

1. Salient Information

Table 7.4a: Salient Information of BHADPURA, Bareilly District, UP

Area	235.63 Sq. Km					
Population	162681	**Male**	86561	**Female**	76120	
Population Density	690 persons/sq km					
Annual Rainfall (2011-20)	***957*** mm	**Monsoon**	***839.***5mm	**Non-Monsoon**	***117.5*** mm	

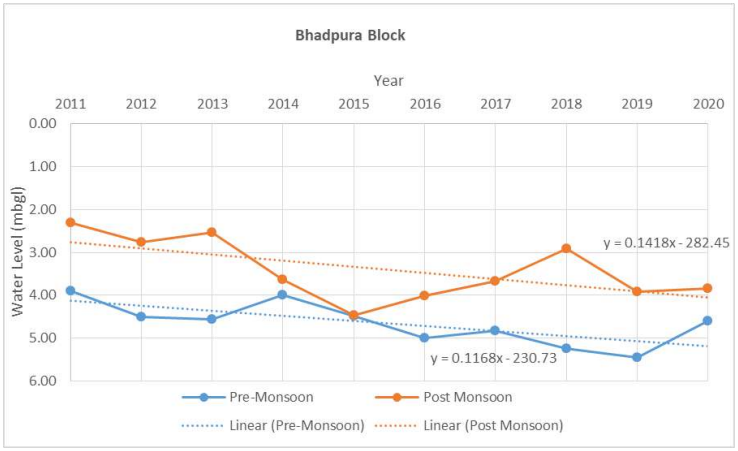
Table7.4b: Agriculture and Irrigation, BHADPURA, Bareilly District, UP

Net Sown Area	20141	**Gross Sown Area**	32585
Net Irrigated Area	19616	**Gross Irrigated Area**	27724
Irrigation Intensity	141.33 %	**Irrigation by GW**	91.55 %
Irrigation by SW	8.45 %		

*Area in Hectare

2. Water Level Behaviour

The average depth to water level has been observed as 4.59 mbgl during Pre-monsoon (2020) and 3.84 mbgl during post-monsoon (2020). For the period of 2011-2020 Pre-monsoon water level trend is 0.12 m/year and post-monsoon water level trend is 0.14m/year.



3. Aquifer Disposition

Three aquifer groups exist in the block:

Aquifer Group I: Ground level to 212 mbgl.

Aquifer Group II: 200mbgl to 405mbgl.

Aquifer Group III: 380 mbgl- 481mbgl.

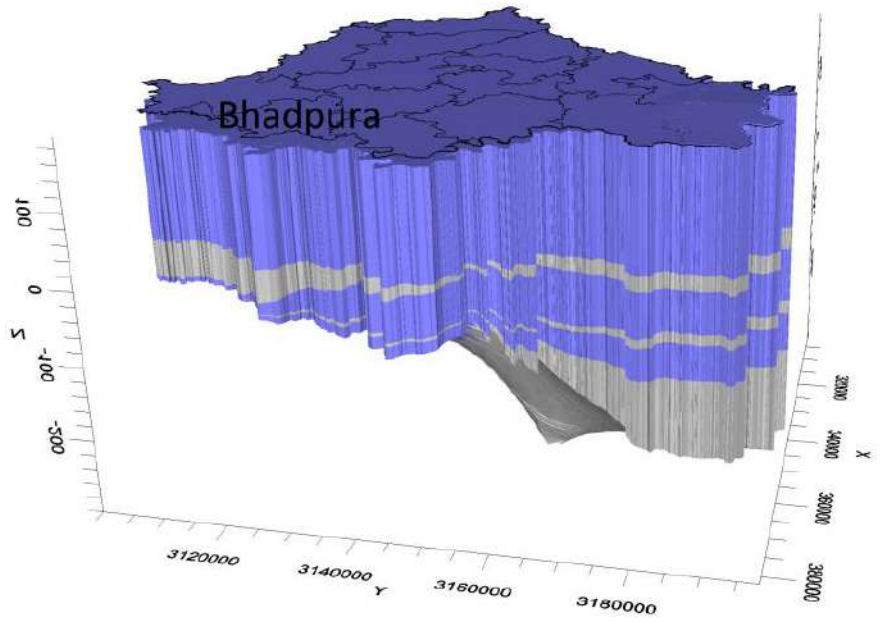


Fig: 7.4a: 3D disposition of Aquifer system

4. Ground water resource, extraction and other issues

Table 16: Ground Water Resource (Static+Dynamic), Extraction as on March, 2020, BHADPURA, Bareilly, UP

A	**FIRST AQUIFER SYSTEM**	
1	**Dynamic Resources (Fresh)**	83.34 MCM
2	**Total GW Extraction**	54 MCM
3	**Stage of Ground Water Extraction**	64.79%
4	**Category**	Safe
5	**Static Resources (Fresh)**	3506.17 MCM
7	**Total Resources Dynamic + Static (Fresh)**	3589.51 MCM

5. Chemical Quality of ground water and contamination

Table 7.4d: Basic Chemical Quality of Phreatic Aquifer, BHADPURA, Bareilly, UP

Basic Parameter	Permissible Limit	Results
	BIS 10500:2012	
pH	6.5-8.5	8.14
EC (□S/cm) at 25^{0}C	3000	392
CO_3 mg/l	-	nil
HCO_3 mg/l	-	207
Cl mg/l	1000	14
F mg/l	1.5	BDL
NO_3 mg/l	45	BDL
SO_4 mg/l	400	6
TH as $CaCO_3$ mg/l	600	130
Ca mg/l	200	16
Mg mg/l	100	22
Na mg/l	-	21
K mg/l	-	15
SiO_2 mg/l	-	50
PO_4 mg/l	-	**Nd**

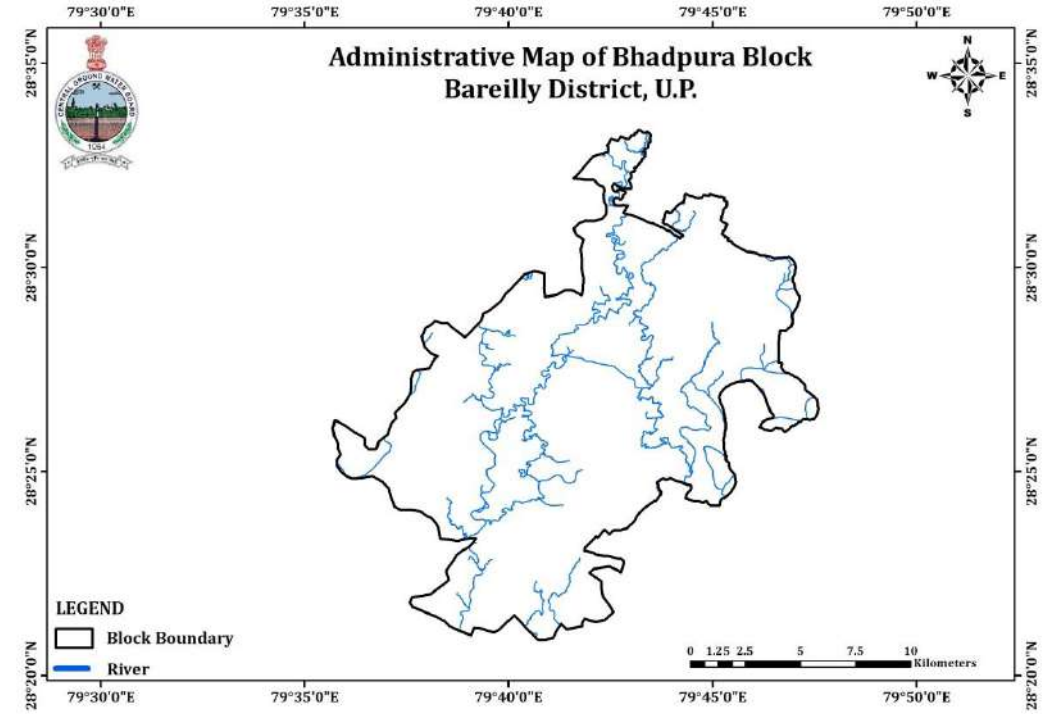
Table 17: Heavy Metal concentration of Shallow Aquifer, BHADPURA, Bareilly, UP

Heavy Metals		Fe in ppm	Mn in ppm	Cu in ppm	Zn in ppm	As in ppb	Pb in ppb	U in ppb	Cr in ppb
Permissible Limit	**BIS 10500:2012**	1	0.3	1.5	15	10	10	30	50
Results		0.48	0.03	0	0.03	0	1	21	0

6. Ground Water Management:

Table 18: Ground Water Management Strategies and Projected Stage of Extraction

Block	Check Dams (Nos)	Nala Bunds (Nos)	Stream Development (Km)	Ponds (Nos)	On-farm Activities (ha)	Water Use Efficiency (ha)	Recharge from Structure MCM	Saving from Structures MCM	Saving frm On-farm & WUE MCM	Total Recharge MCM	Total Saving MCM	Present Stage of Ground Water Extraction (%)	Projected Stage of Extraction (%) After Interventions
BHADPURA	1	1	1	2	2014	2014	0.09	0.09	3.07	0.09	3.16	64.79	60.93



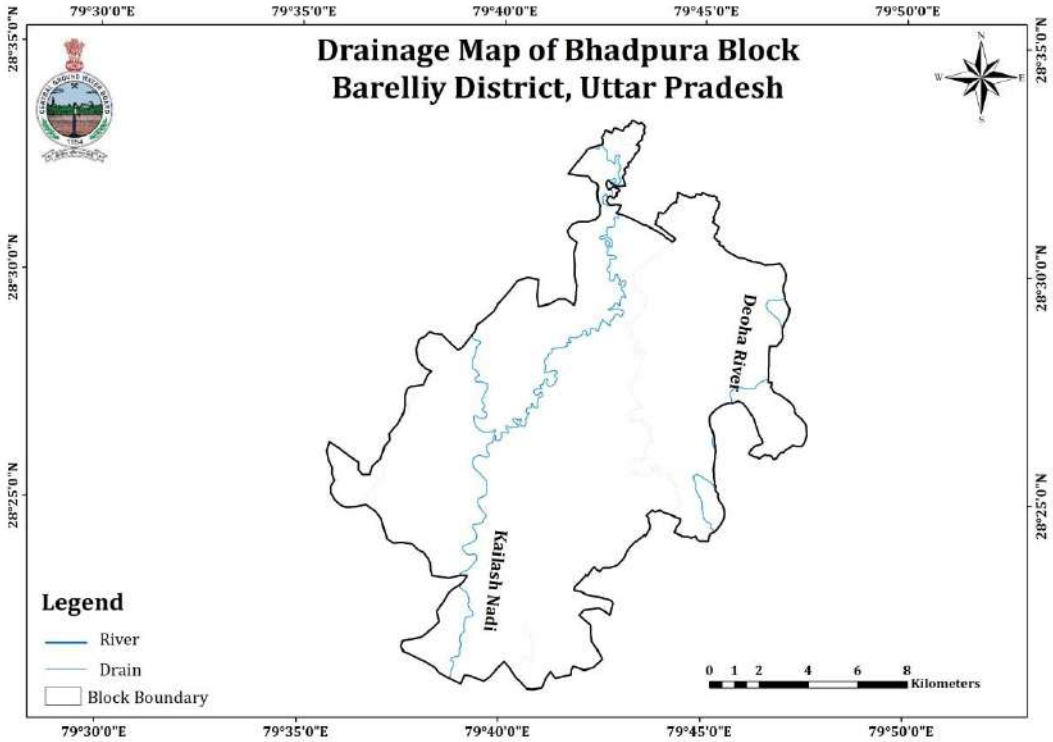


Fig 3: Administrative and Drainage map of BHADPURA, Bareilly District, UP

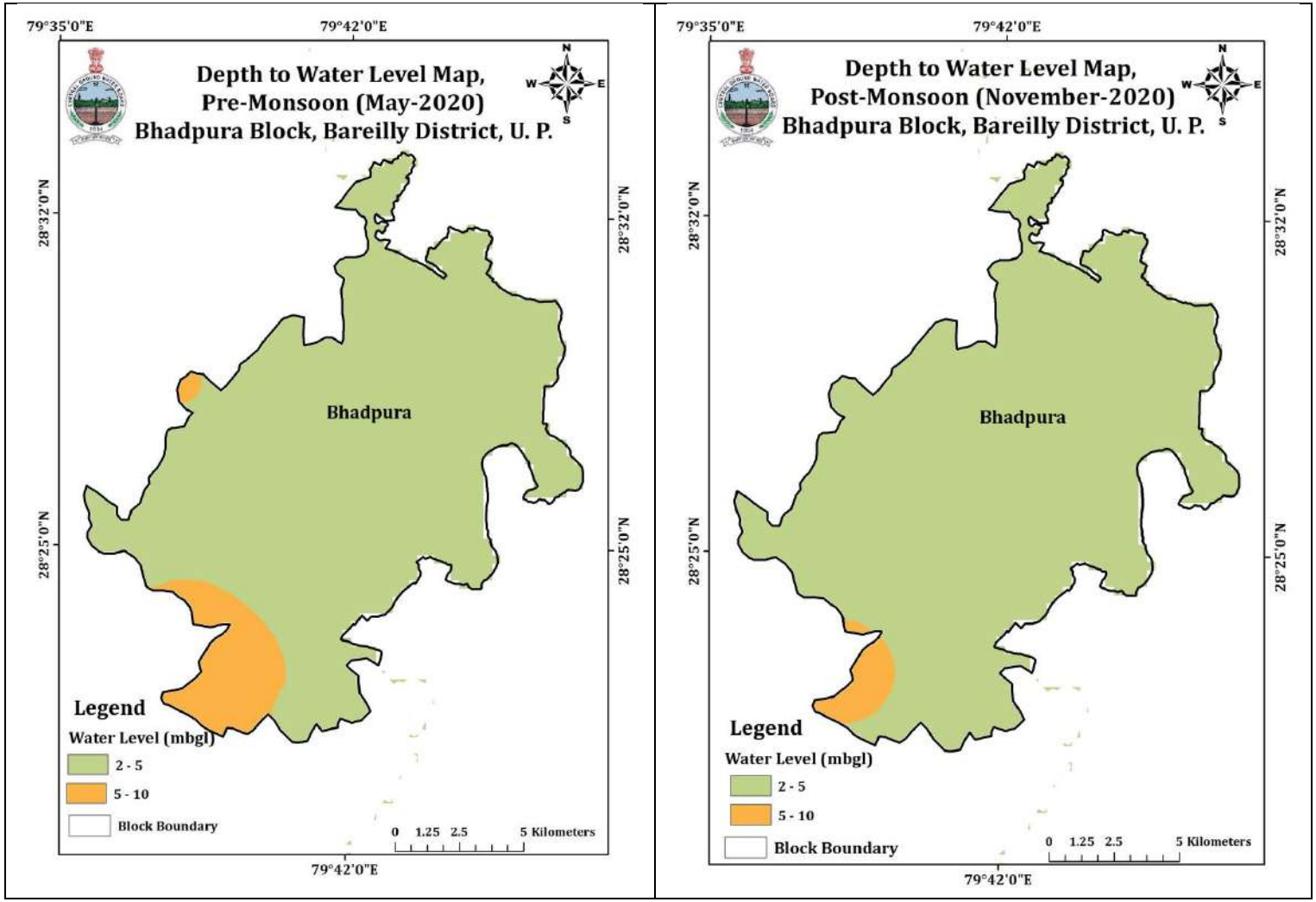


Fig 7.4c: Water Level map of pre-and post-monsoon 2020 of BHADPURA, Bareilly district, UP

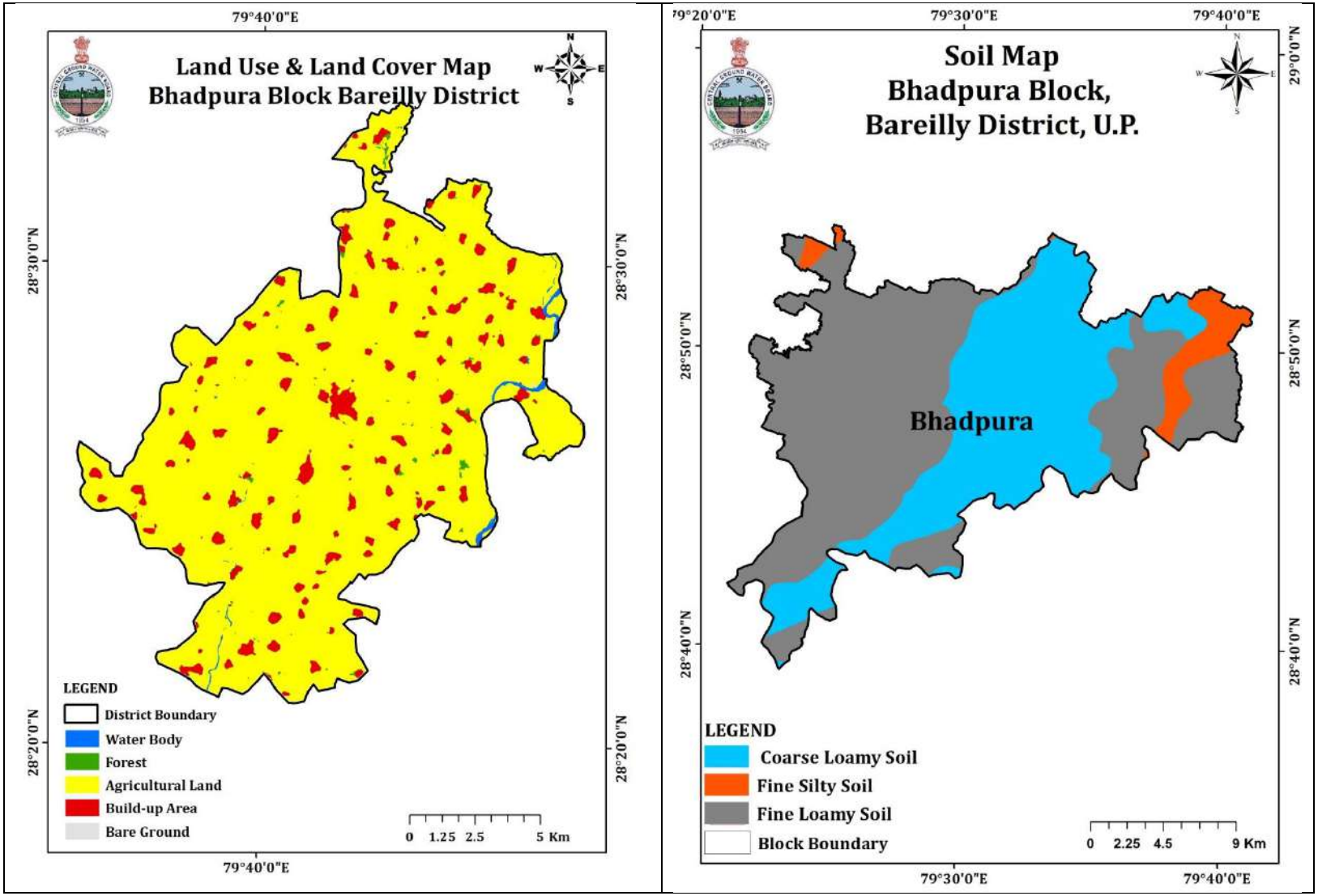


Figure 7.1d: Land use & Land cover and Soil Map of BHADPURA, Bareilly district, UP

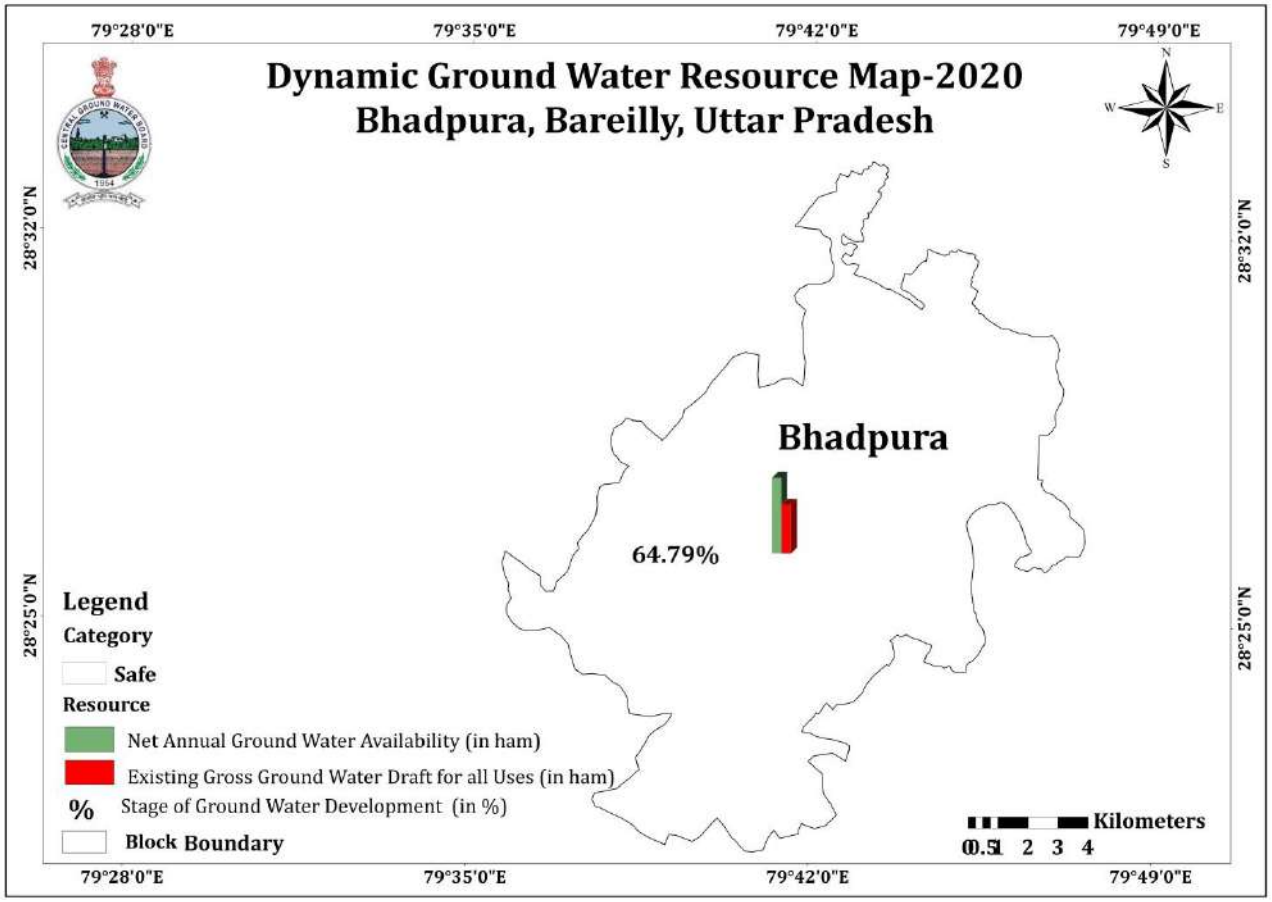


Fig 7.4e : Dynamic GW Resource Map of BHADPURA, Bareilly district, UP

7.5 AQUIFER MAPPING AND MANAGEMENT PLAN OF BHOJPURA, BAREILLY DISTRICT, U.P.

1. Salient Information

Table 7.5a: Salient Information of BHOJPURA, Bareilly District, UP

Area	311.88 Sq. Km					
Population	189661	**Male**	99490	**Female**	90171	
Population Density	608 persons/sq km					
Annual Rainfall (2011-20)	***957*** mm	**Monsoon**	***839.***5mm	**Non-Monsoon**	***117.5*** mm	

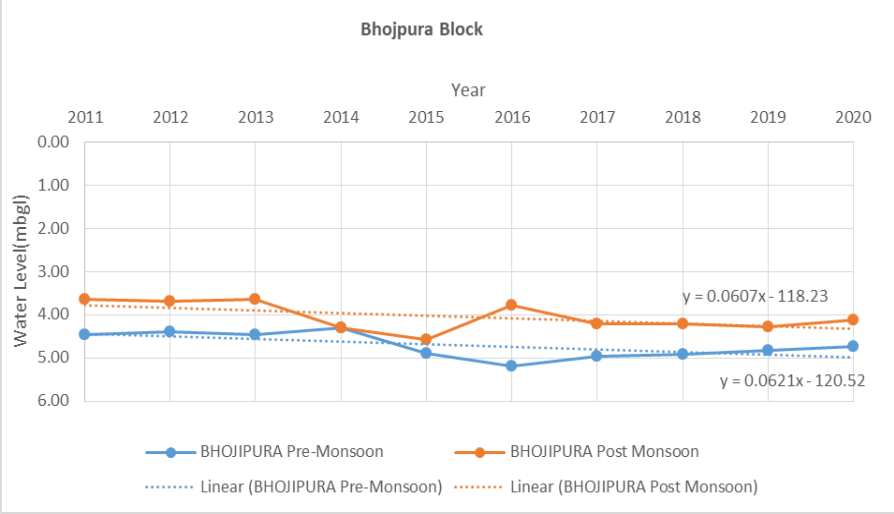
Table7.5b: Agriculture and Irrigation, BHOJPURA, Bareilly District, UP

Net Sown Area	15333	**Gross Sown Area**	27138
Net Irrigated Area	14832	**Gross Irrigated Area**	25188
Irrigation Intensity	169.82 %	**Irrigation by GW**	89.35 %
Irrigation by SW	10.65 %		

*Area in Hectare

2. Water Level Behaviour

The average depth to water level has been observed as 4.74 mbgl during Pre-monsoon (2020) and 4.11 mbgl during post-monsoon (2020). For the period of 2011-2020 Pre-and post-monsoon water level trend is 0.06 m/year.



3. Aquifer Disposition

Three aquifer groups exist in the block:

Aquifer Group I: Ground level to 212 mbgl.

Aquifer Group II: 195mbgl to 295mbgl.

Aquifer Group III: 310 mbgl- 370mbgl.

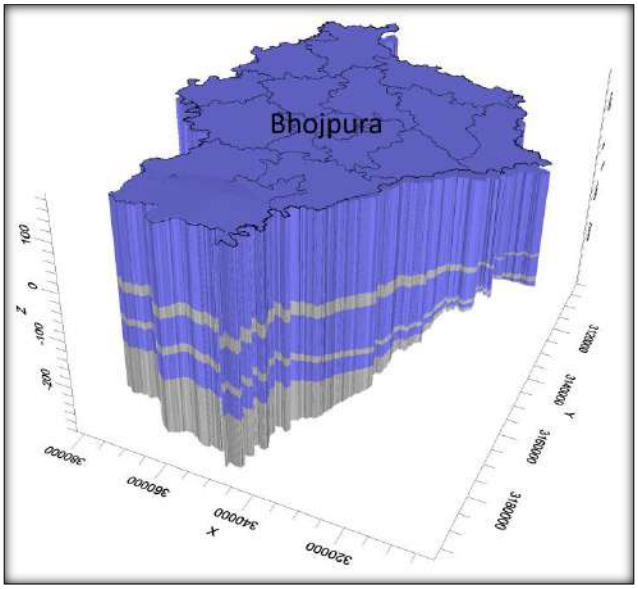


Fig: 7.5a: 3D disposition of Aquifer system

4. Ground water resource, extraction and other issues

Table 19: Ground Water Resource (Static+Dynamic), Extraction as on March, 2020 BHOJPURA, Bareilly, UP

A	**FIRST AQUIFER SYSTEM**	
1	**Dynamic Resources (Fresh)**	94.36 MCM
2	**Total GW Extraction**	44.41 MCM
3	**Stage of Ground Water Extraction**	58.94%
4	**Category**	Safe
5	**Static Resources (Fresh)**	7485.12MCM
7	**Total Resources Dynamic + Static (Fresh)**	7579.48 MCM

Issues: Dependency on Ground Water for Irrigation and declining trend of water level. Presence of Iron (Fe^{3+}) beyond permissible limit has been reported in the blocks.

5. Chemical Quality of ground water and contamination

Table 7.5d: Basic Chemical Quality of Phreatic Aquifer, BHOJPURA, Bareilly, UP

Basic Parameter	Permissible Limit	Results
	BIS 10500:2012	
pH	6.5-8.5	7.82
EC (□S/cm) at 25^{0}C	3000	512
CO_3 mg/l	-	nil
HCO_3 mg/l	-	195
Cl mg/l	1000	50
F mg/l	1.5	BDL
NO_3 mg/l	45	BDL
SO_4 mg/l	400	25
TH as $CaCO_3$ mg/l	600	160
Ca mg/l	200	32
Mg mg/l	100	19
Na mg/l	-	34
K mg/l	-	16
SiO_2 mg/l	-	34
PO_4 mg/l	-	**Nd**

Table 20: Heavy Metal concentration of Shallow Aquifer, BHOJPURA, Bareilly, UP

Heavy Metals		Fe in ppm	Mn in ppm	Cu in ppm	Zn in ppm	As in ppb	Pb in ppb	U in ppb	Cr in ppb
Permissible Limit	**BIS 10500:2012**	1	0.3	1.5	15	10	10	30	50
Results		2.38	0.26	0	0.03	3	1	1	0

6. Ground Water Management:

Table 21: Ground Water Management Strategies and Projected Stage of Extraction

Block	Check Dams (Nos)	Nala Bunds (Nos)	Stream Development (Km)	Ponds (Nos)	On-farm Activities (ha)	Water Use Efficiency (ha)	Recharge from Structure MCM	Saving from Structures MCM	Saving frm On-farm & WUE MCM	Total Recharge MCM	Total Saving MCM	Present Stage of Ground Water Extraction (%)	Projected Stage of Extraction (%) After Interventions
BHOJPURA	2	2	2	3	1533	1533	0.12	0.12	3.07	0.12	3.19	58.94	55.48

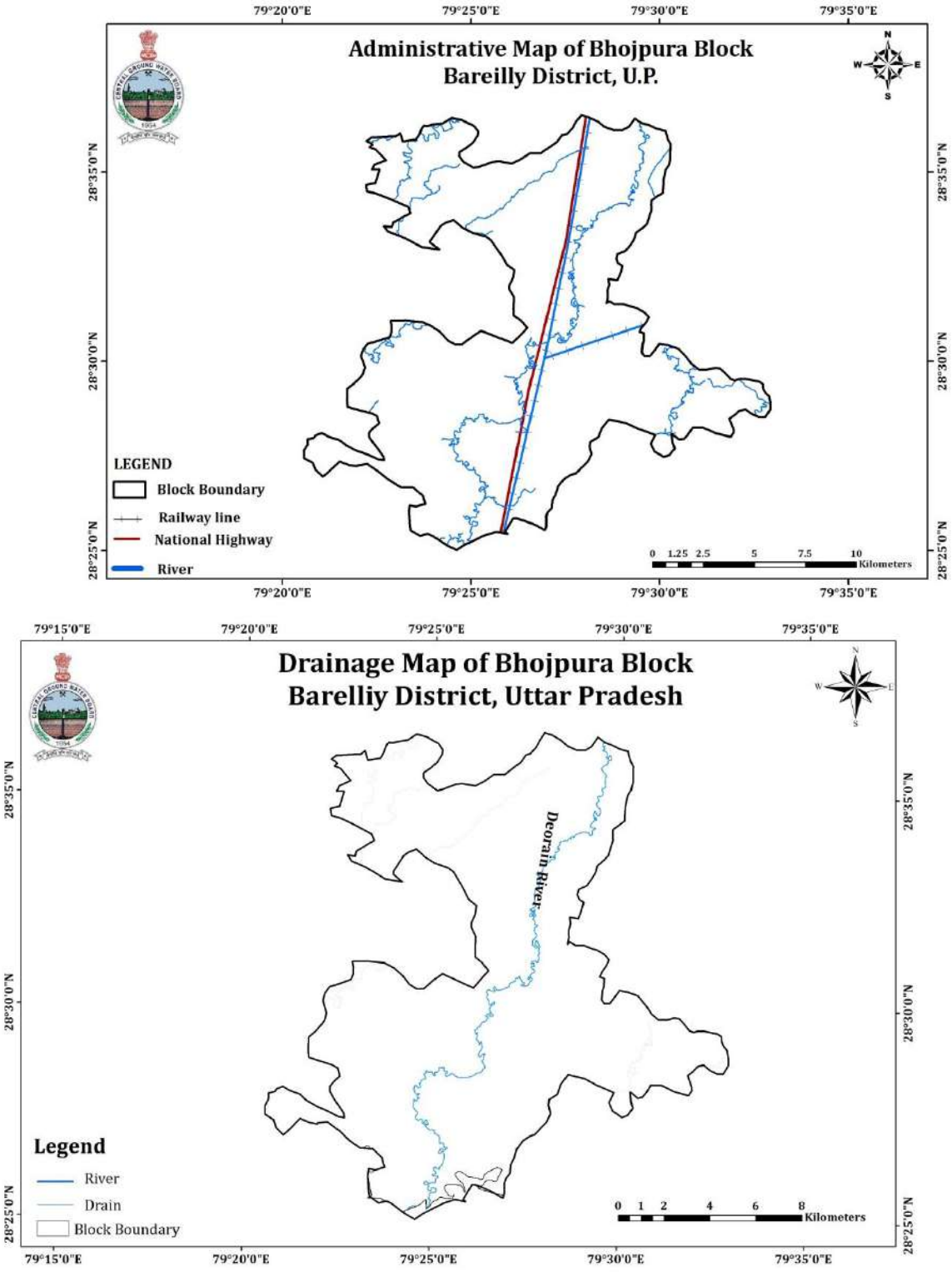


Fig 4: Administrative and Drainage map of BHOJPURA, Bareilly District, UP

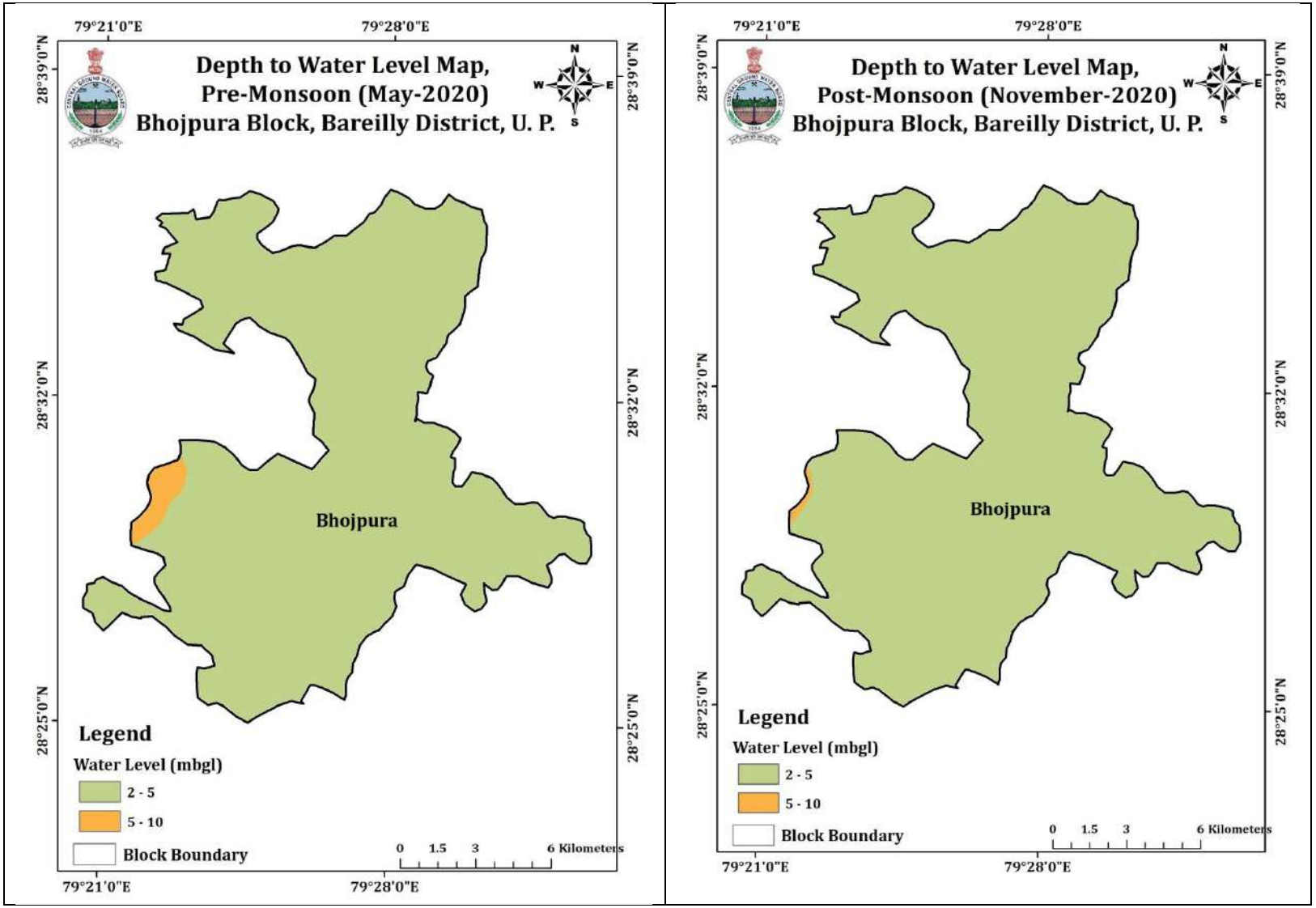


Fig 7.5c: Water Level map of pre-and post-monsoon 2020 of BHOJPURA, Bareilly district, UP

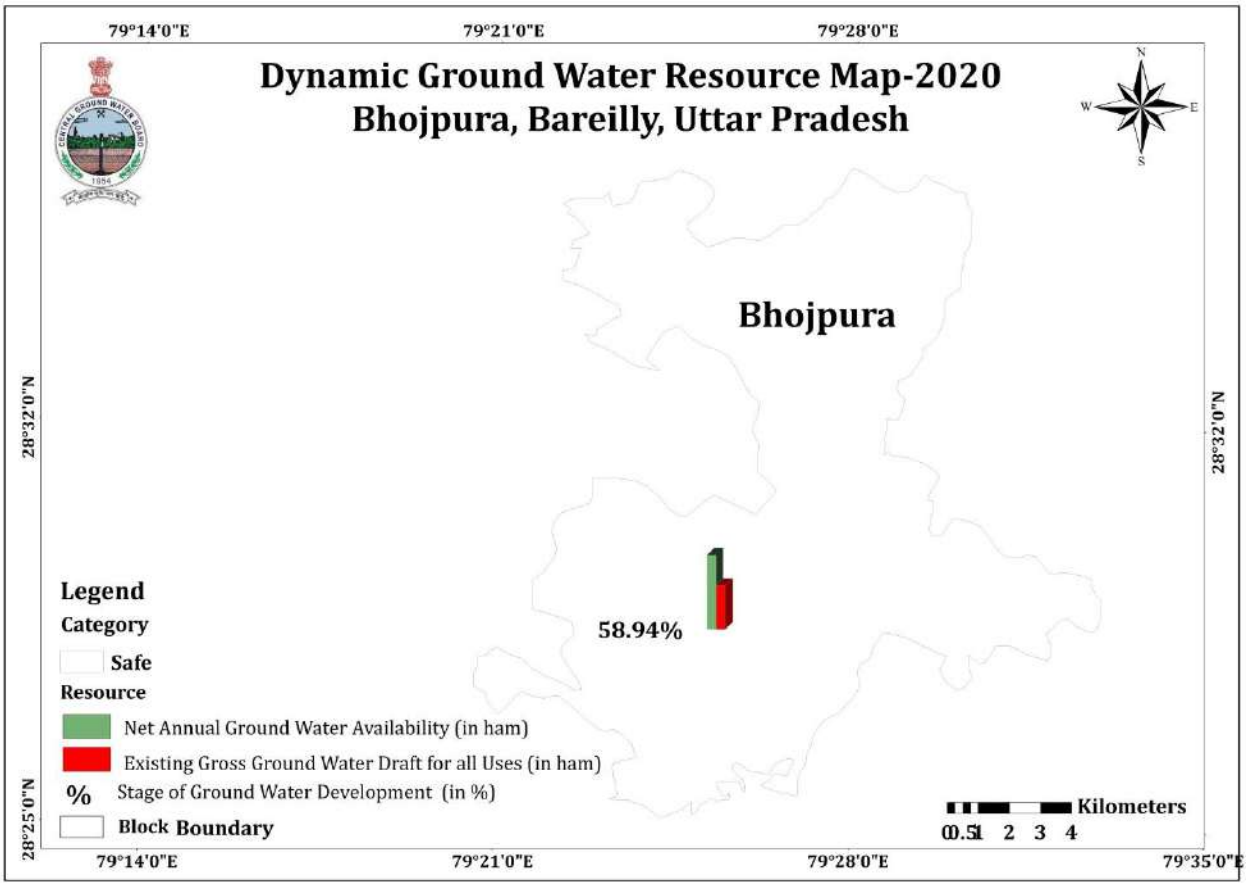


Figure 7.5d : Dynamic GW Resource Map of BHOJPURA, Bareilly district, UP

7.6 AQUIFER MAPPING AND MANAGEMENT PLAN OF BHUTAH, BAREILLY DISTRICT, U.P.

1. Salient Information

Table 7.6a: Salient Information of BHUTAH, Bareilly District, UP

Area	375.31 Sq. Km					
Population	208985	**Male**	111915	**Female**	97070	
Population Density	557 persons/sq km					
Annual Rainfall (2011-20)	***957*** mm	**Monsoon**	***839.***5mm	**Non-Monsoon**	***117.5*** mm	

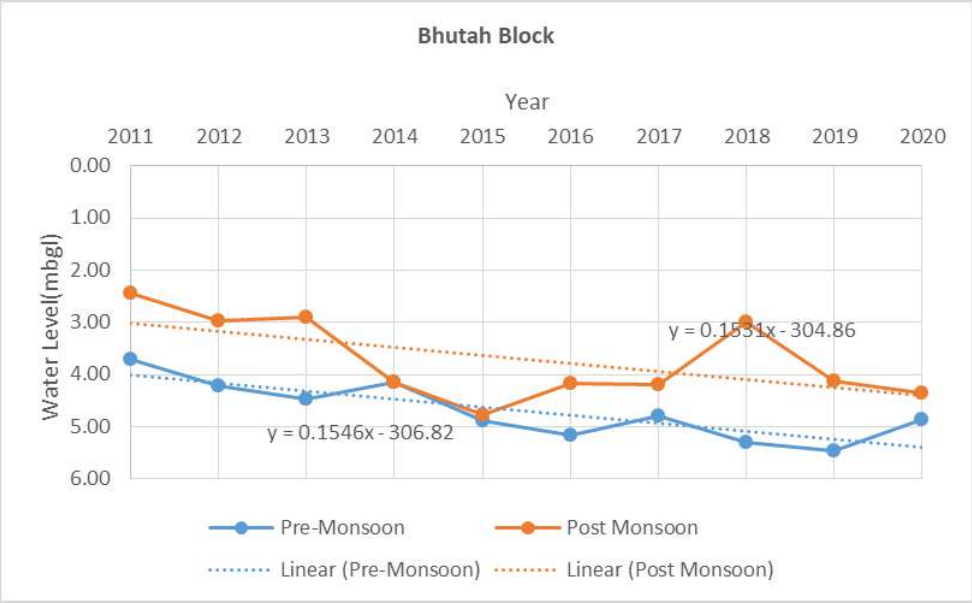
Table7.6b: Agriculture and Irrigation, BHUTAH, Bareilly District, UP

Net Sown Area	27392	**Gross Sown Area**	43236
Net Irrigated Area	24411	**Gross Irrigated Area**	36960
Irrigation Intensity	151.41 %	**Irrigation by GW**	89.82 %
Irrigation by SW	10.18 %		

*Area in Hectare

2. Water Level Behaviour

The average depth to water level has been observed as 4.86 mbgl during Pre-monsoon (2020) and 4.36 mbgl during post-monsoon (2020). For the period of 2011-2020 Pre-monsoon water level trend is 0.154 m/year and post-monsoon water level trend is 0.153m/year.



3. Aquifer Disposition

Three aquifer groups exist in the block:

Aquifer Group I: Ground level to 212 mbgl.

Aquifer Group II: 200mbgl to 405mbgl.

Aquifer Group III: 380 mbgl- 481mbgl

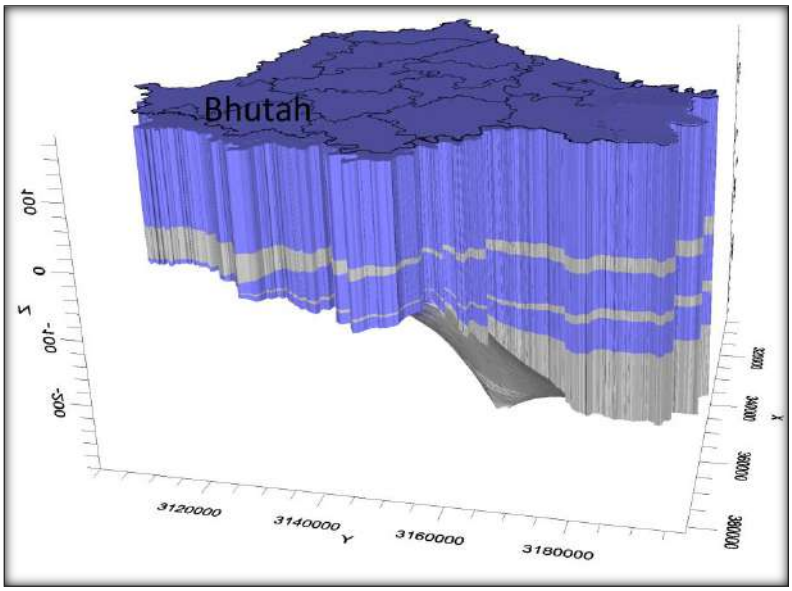


Fig: 7.6a: 3D disposition of Aquifer system

4. Ground water resource, extraction and other issues

Table 22: Ground Water Resource (Static+Dynamic), Extraction as on March, 2020 BHUTAH, Bareilly, UP

A	**FIRST AQUIFER SYSTEM**	
1	**Dynamic Resources (Fresh)**	93.25 MCM
2	**Total GW Extraction**	58.45 MCM
3	**Stage of Ground Water Extraction**	62.68%
4	**Category**	Safe
5	**Static Resources (Fresh)**	6185.10 MCM
7	**Total Resources Dynamic + Static (Fresh)**	6278.25 MCM

Issues: Dependency on Ground Water for Irrigation and declining trend of water level. Presence of Iron (Fe^{3+}) beyond permissible limit has been reported in the blocks.

5. Chemical Quality of ground water and contamination

Table 7.6d: Basic Chemical Quality of Phreatic Aquifer, BHUTAH, Bareilly, UP

Basic Parameter	Permissible Limit	Results
	BIS 10500:2012	
pH	6.5-8.5	8.01
EC (□S/cm) at 25^{0}C	3000	7.97
CO_3 mg/l	-	403
HCO_3 mg/l	-	nil
Cl mg/l	1000	232
F mg/l	1.5	7.1
NO_3 mg/l	45	BDL
SO_4 mg/l	400	BDL
TH as $CaCO_3$ mg/l	600	12
Ca mg/l	200	190
Mg mg/l	100	40
Na mg/l	-	22
K mg/l	-	9
SiO_2 mg/l	-	7.2
PO_4 mg/l	-	41

Table 23: Heavy Metal concentration of Shallow Aquifer, BHUTAH, Bareilly, UP

Heavy Metals		Fe in ppm	Mn in ppm	Cu in ppm	Zn in ppm	As in ppb	Pb in ppb	U in ppb	Cr in ppb
Permissible Limit	**BIS 10500:2012**	1	0.3	1.5	15	10	10	30	50
Results		1.79	0.27	0	0.44	3	1	1	0

6. Ground Water Management:

Table 24: Ground Water Management Strategies and Projected Stage of Extraction

Block	Check Dams (Nos)	Nala Bunds (Nos)	Stream Development (Km)	Ponds (Nos)	On-farm Activities (ha)	Water Use Efficiency (ha)	Recharge from Structure MCM	Saving from Structures MCM	Saving frm On-farm & WUE MCM	Total Recharge MCM	Total Saving MCM	Present Stage of Ground Water Extraction (%)	Projected Stage of Extraction (%) After Interventions
BHUTAH	2	2	2	4	2739	2739	0.15	0.15	3.56	0.15	3.71	62.68	58.61

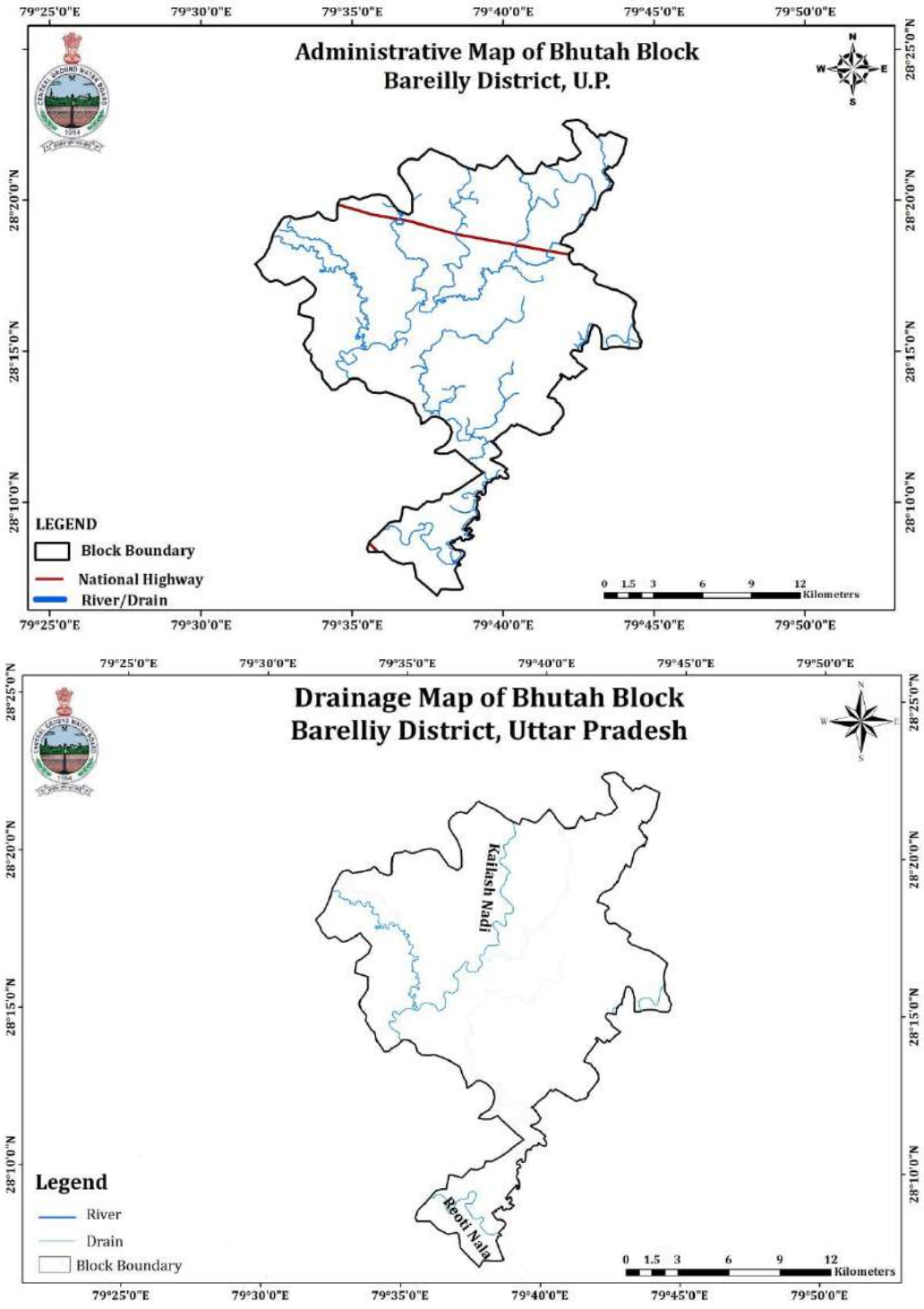


Fig 5: Administrative and Drainage map of BHUTAH, Bareilly District, UP

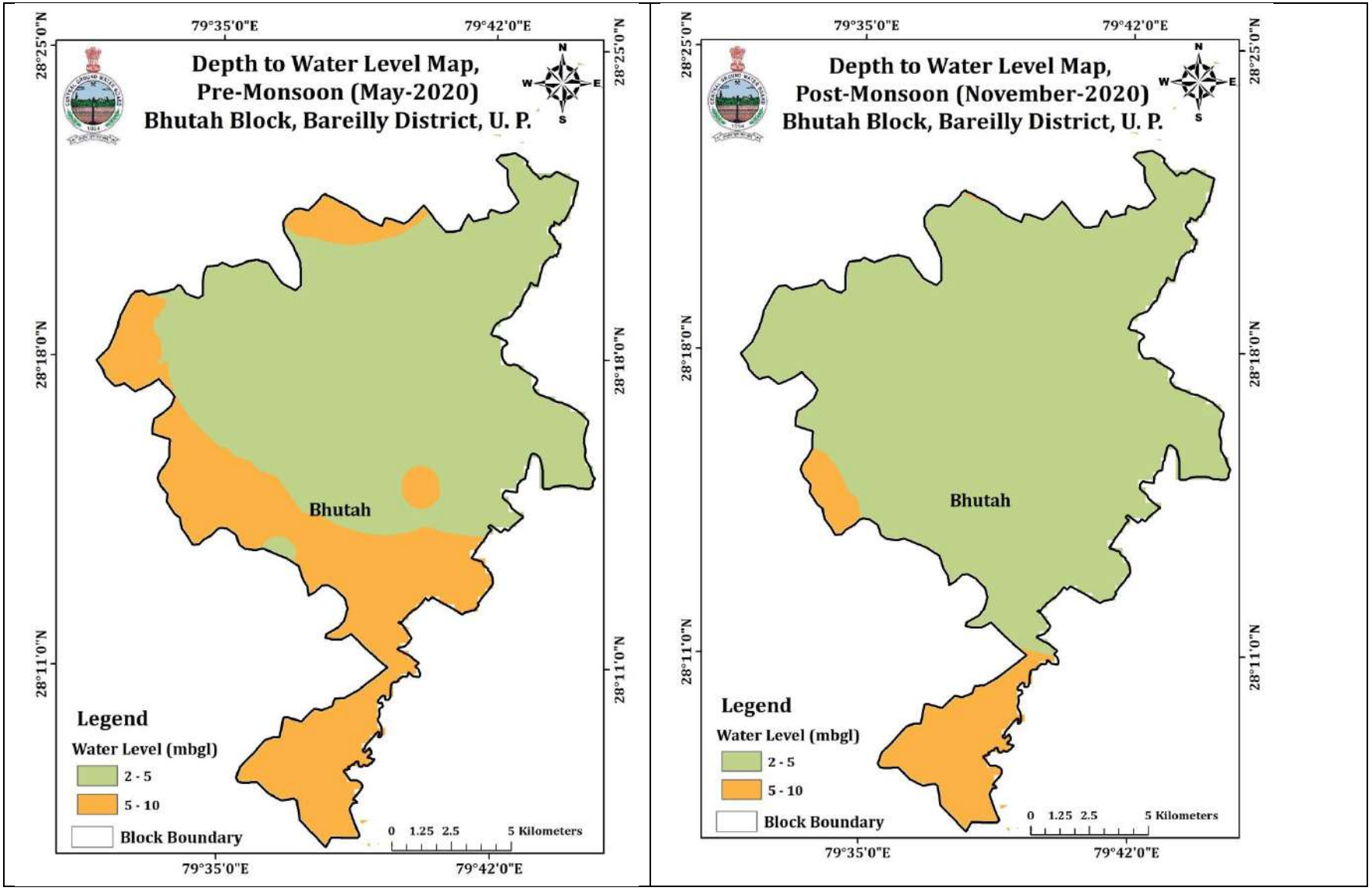


Fig 7.6c: Water Level map of pre-and post-monsoon 2020 of BAHERI Block, Bareilly district, UP

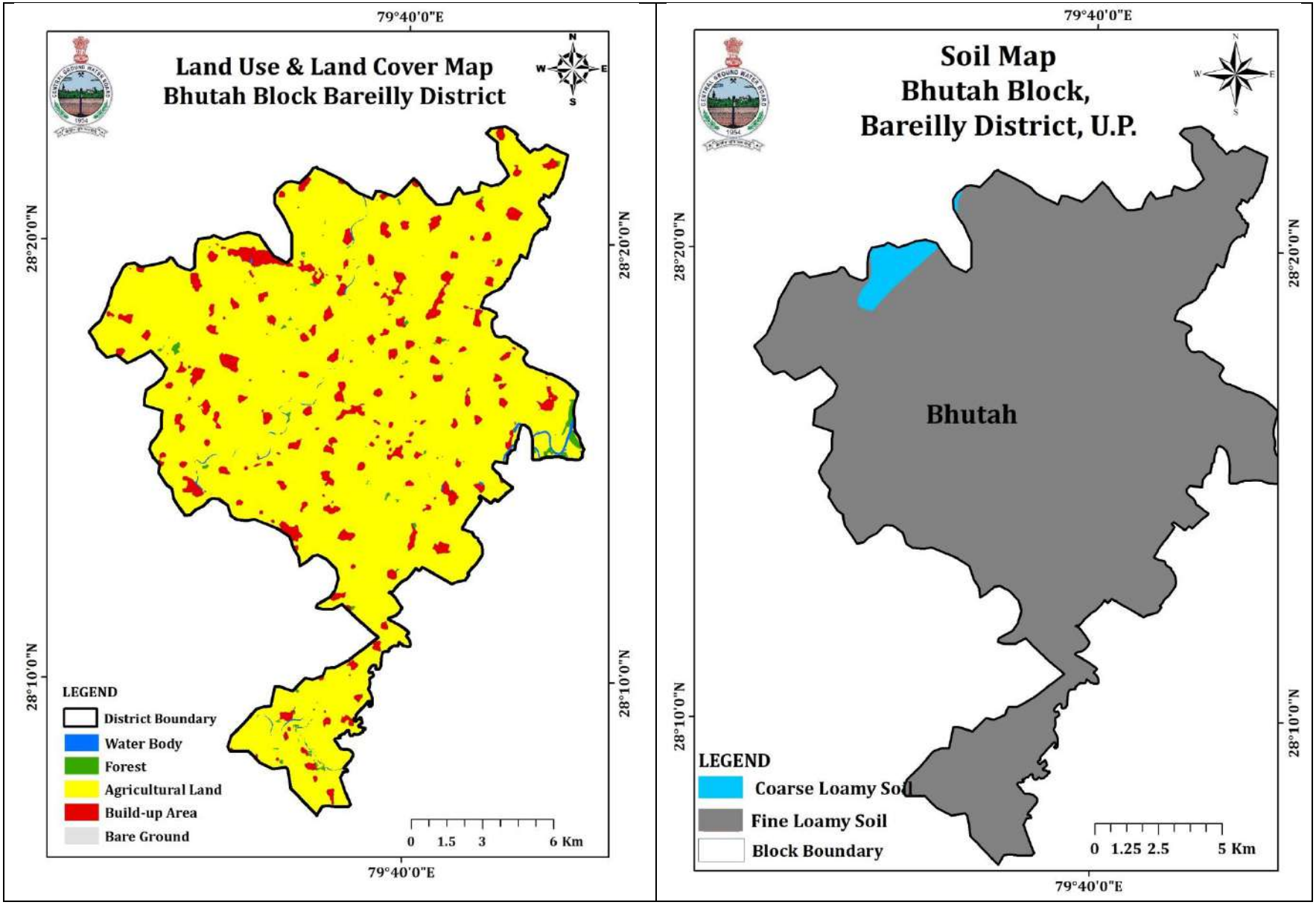


Figure 7.1d: Land use & Land cover and Soil Map of BHUTAH, Bareilly district, UP

7.7 AQUIFER MAPPING AND MANAGEMENT PLAN OF BITHERI CHAINPUR, BAREILLY DISTRICT, U.P.

1. Salient Information

Table 7.7a: Salient Information of BITHERI CHAINPUR, Bareilly District, UP

Area	228.9 Sq. Km					
Population	192003	**Male**	101288	**Female**	90715	
Population Density	839 persons/sq km					
Annual Rainfall (2011-20)	***957*** mm	**Monsoon**	***839.***5mm	**Non-Monsoon**	***117.5*** mm	

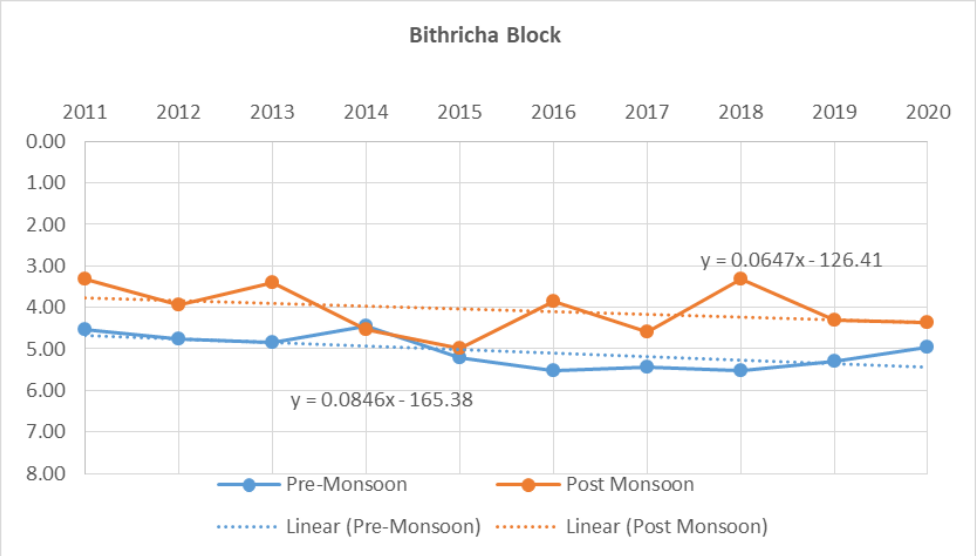
Table7.7b: Agriculture and Irrigation, BITHERI CHAINPUR, Bareilly District, UP

Net Sown Area	19543	**Gross Sown Area**	26773
Net Irrigated Area	20711	**Gross Irrigated Area**	26031
Irrigation Intensity	125.69 %	**Irrigation by GW**	92.62 %
Irrigation by SW	7.38 %		

*Area in Hectare

2. Water Level Behaviour

The average depth to water level has been observed as 4.96 mbgl during Pre-monsoon (2020) and 4.36 mbgl during post-monsoon (2020). For the period of 2011-2020 Pre-monsoon water level trend is 0.084 m/year and post-monsoon water level trend is 0.064m/year.



3. Aquifer Disposition

Three aquifer groups exist in the block:

Aquifer Group I: Ground level to 212 mbgl.

Aquifer Group II: 200mbgl to 305mbgl.

Aquifer Group III: 310 mbgl- 350mbgl.

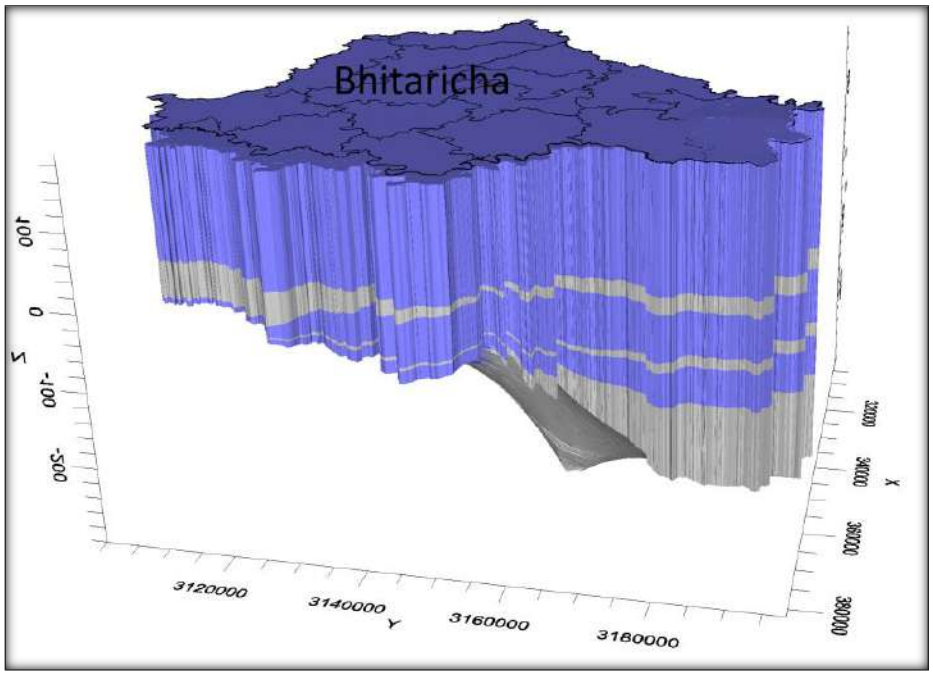


Fig: 7.7a: 3D disposition of Aquifer system

4. Ground water resource, extraction and other issues

Table 25: Ground Water Resource (Static+Dynamic), Extraction as on March, 2020 BITHERI CHAINPUR, Bareilly, UP

A	**FIRST AQUIFER SYSTEM**	
1	**Dynamic Resources (Fresh)**	87.07 MCM
2	**Total GW Extraction**	53.24 MCM
3	**Stage of Ground Water Extraction**	61.14%
4	**Category**	Safe
5	**Static Resources (Fresh)**	3735.64 MCM
7	**Total Resources Dynamic + Static (Fresh)**	3822.71 MCM

5. Chemical Quality of ground water and contamination

Table 7.7d: Basic Chemical Quality of Phreatic Aquifer, BITHERI CHAINPUR Bareilly, UP

Basic Parameter	Permissible Limit	Results
	BIS 10500:2012	
pH	6.5-8.5	8.07
EC (□S/cm) at 25^{0}C	3000	353
CO_3 mg/l	-	nil
HCO_3 mg/l	-	195
Cl mg/l	1000	14
F mg/l	1.5	BDL
NO_3 mg/l	45	BDL
SO_4 mg/l	400	13
TH as $CaCO_3$ mg/l	600	90
Ca mg/l	200	24
Mg mg/l	100	7.2
Na mg/l	-	26
K mg/l	-	31
SiO_2 mg/l	-	49
PO_4 mg/l	-	**Nd**

Table 26: Heavy Metal concentration of Shallow Aquifer, BITHERI CHAINPUR, Bareilly, UP

Heavy Metals		Fe in ppm	Mn in ppm	Cu in ppm	Zn in ppm	As in ppb	Pb in ppb	U in ppb	Cr in ppb
Permissible Limit	**BIS 10500:2012**	1	0.3	1.5	15	10	10	30	50
Results		0.27	0.22	0	0.08	2	1	14	0

6. Ground Water Management:

Table 27: Ground Water Management Strategies and Projected Stage of Extraction

Block	Check Dams (Nos)	Nala Bunds (Nos)	Stream Development (Km)	Ponds (Nos)	On-farm Activities (ha)	Water Use Efficiency (ha)	Recharge from Structure MCM	Saving from Structures MCM	Saving frm On-farm & WUE MCM	Total Recharge MCM	Total Saving MCM	Present Stage of Ground Water Extraction (%)	Projected Stage of Extraction (%) After Interventions
BITHERI CHAINPUR	1	1	1	2	1954	1954	0.09	0.09	2.76	0.09	2.85	61.14	57.81

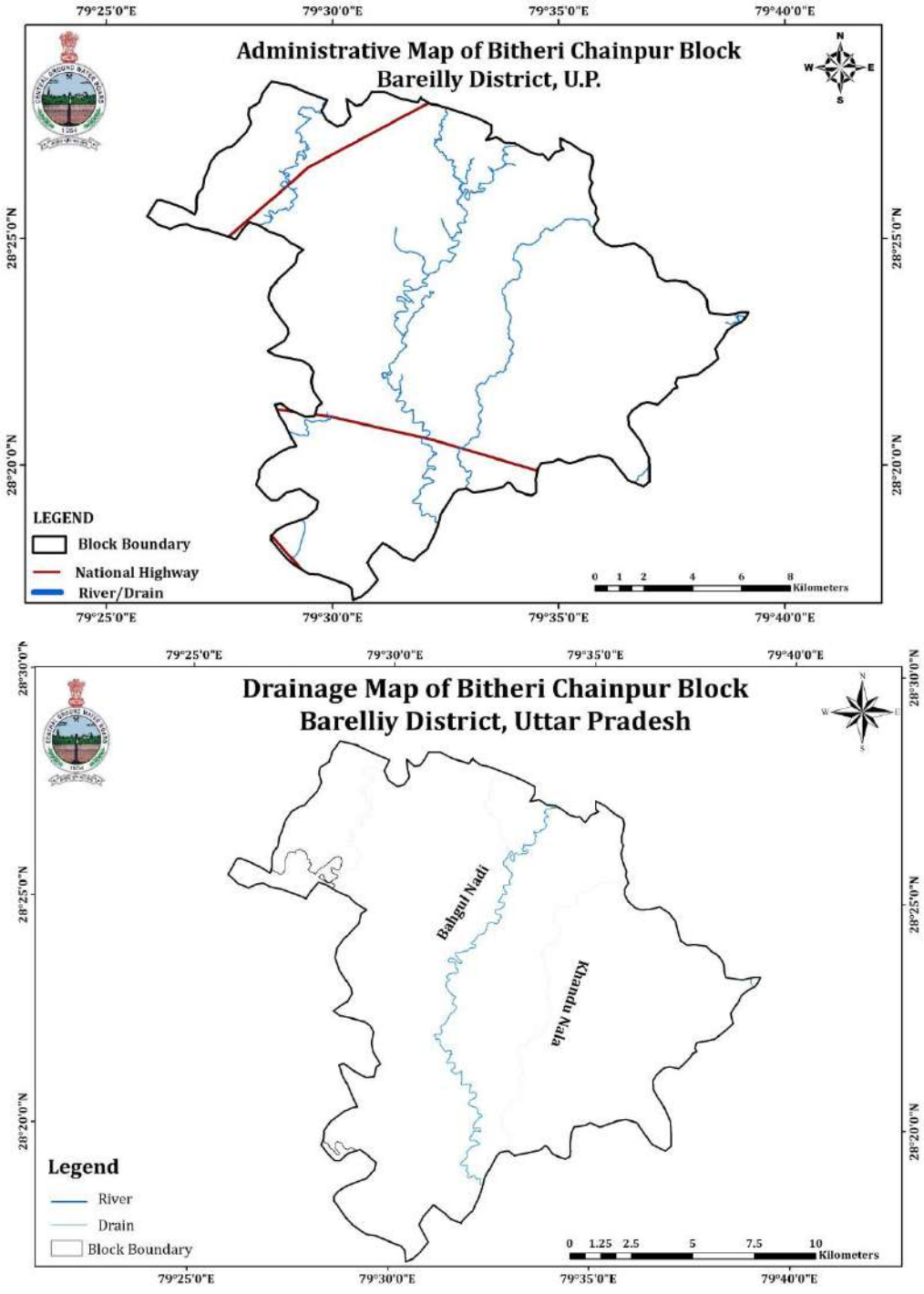


Fig 6: Administrative and Drainage map of BITHERI CHAINPUR, Bareilly District, UP

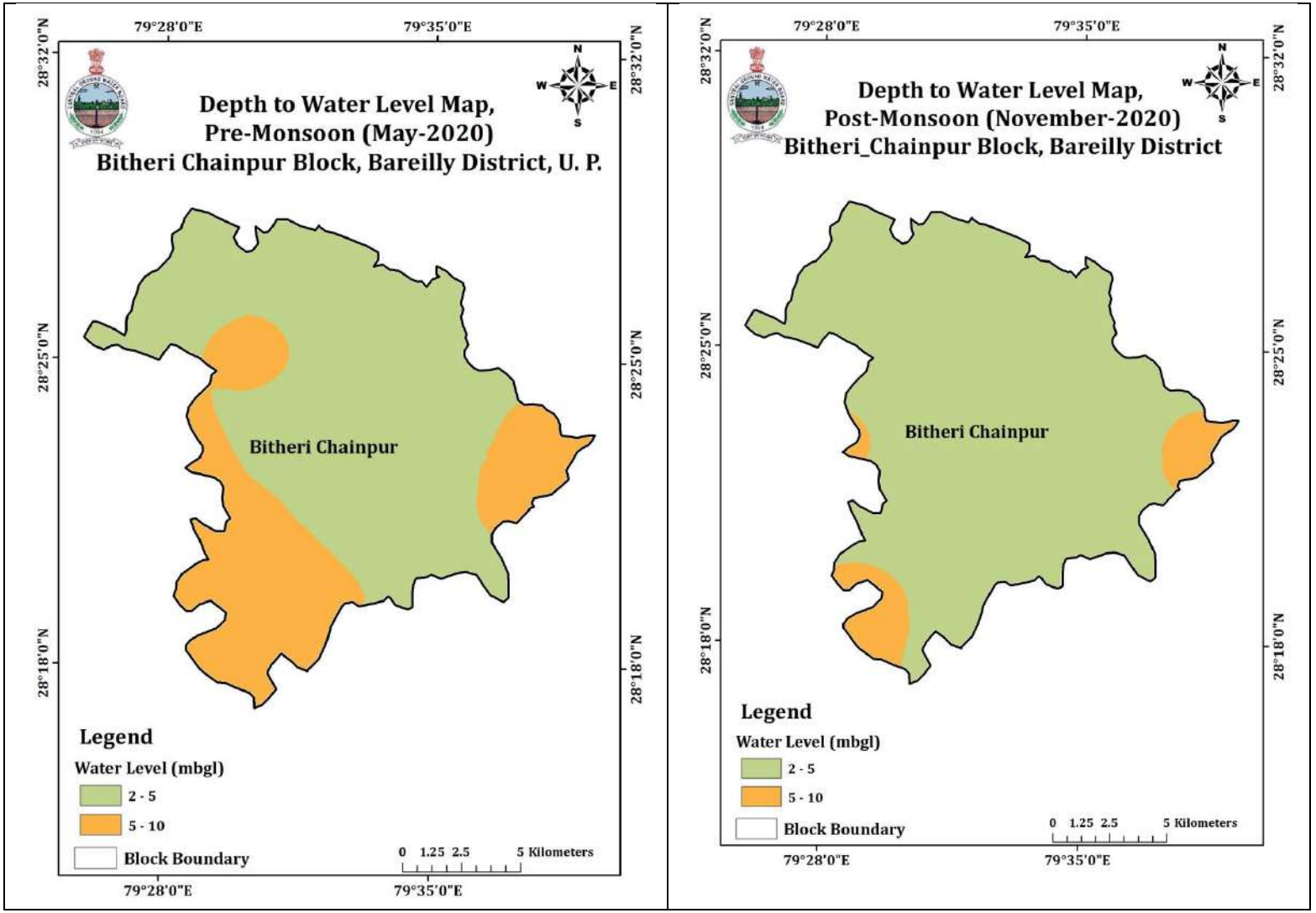


Fig 7.7c: Water Level map of pre-and post-monsoon 2020 of BITHERI CHAINPUR, Bareilly

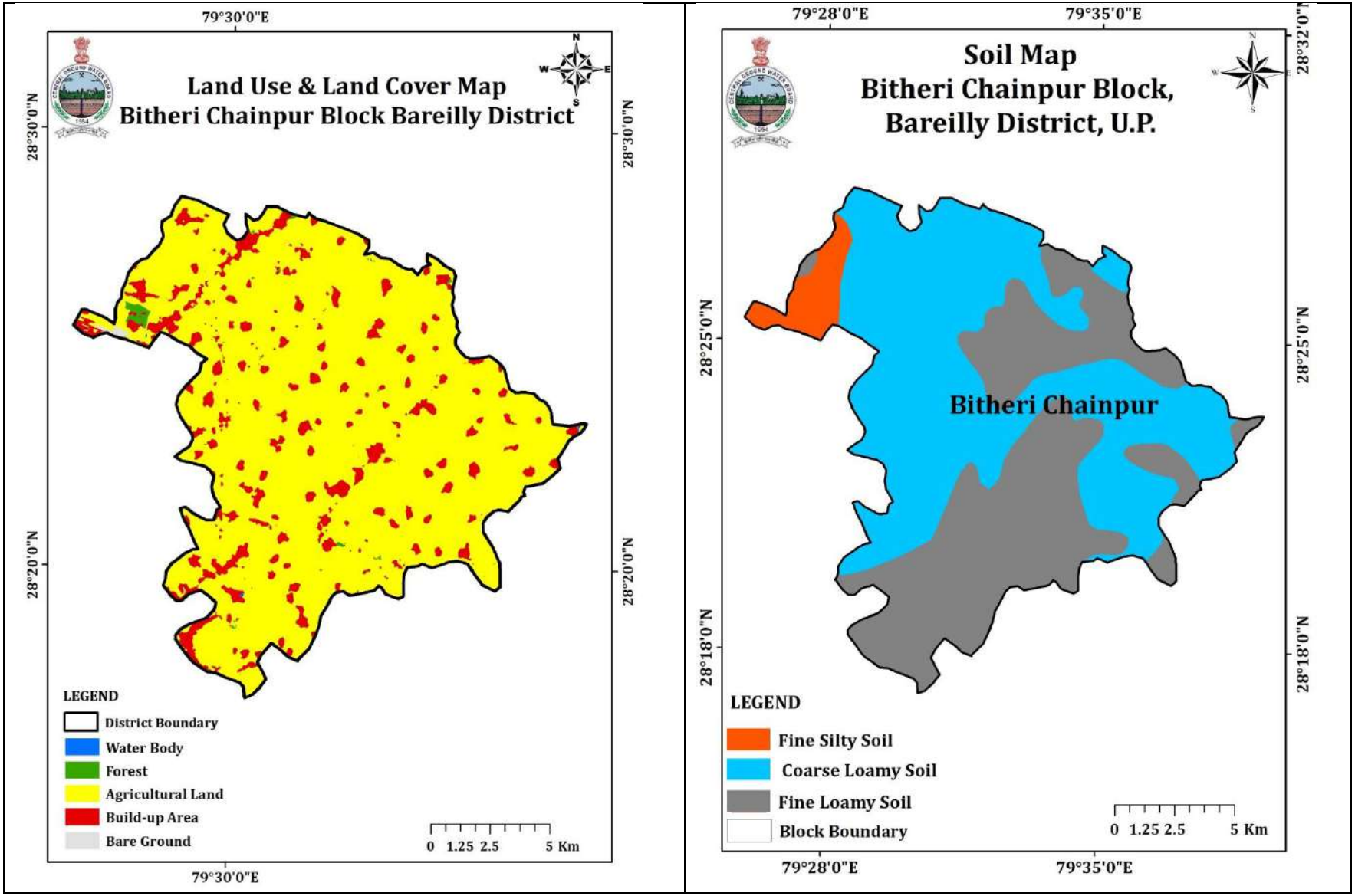


Figure 7.7d: Land use & Land cover and Soil Map of BITHERI CHAINPUR

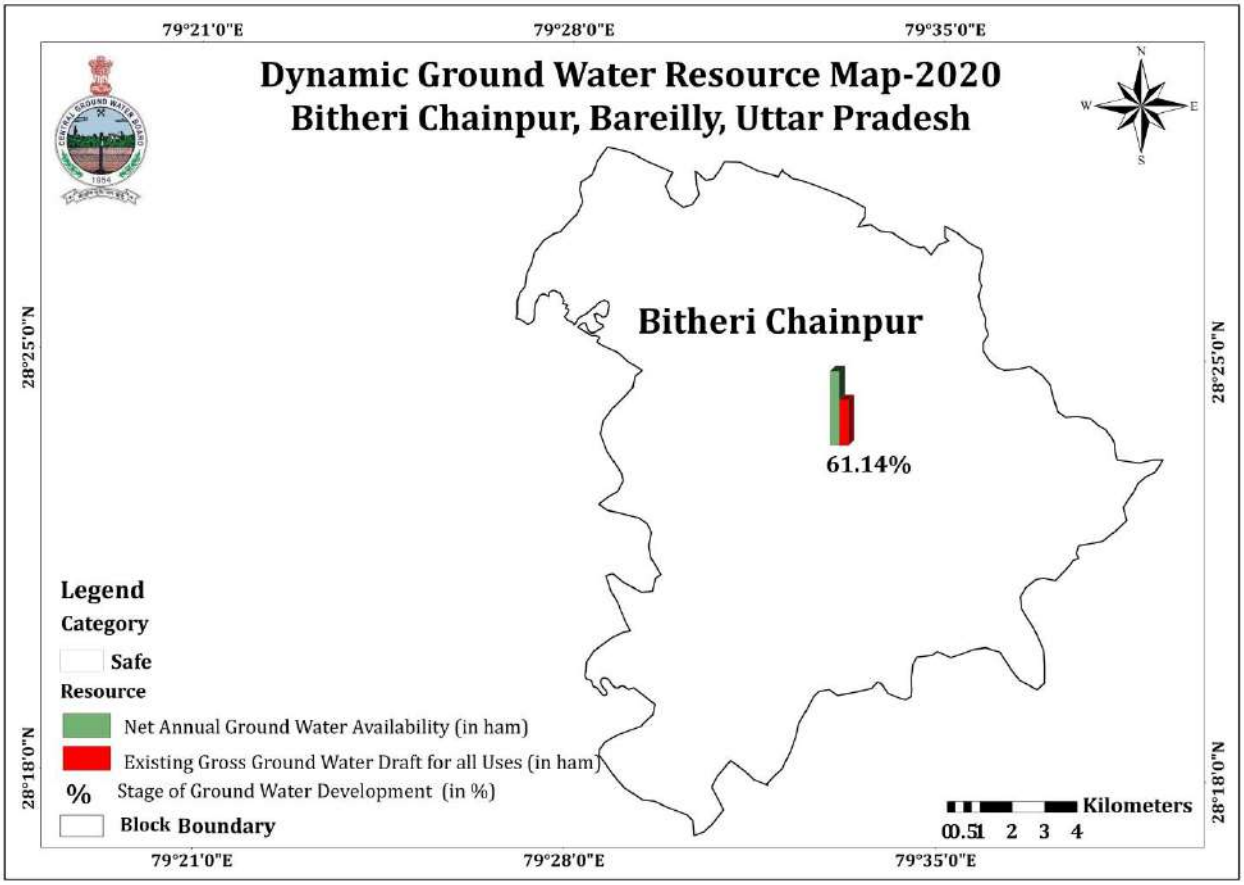


Figure 7.7e : Dynamic GW Resource Map of BITHERI CHAINPUR, Bareilly district, UP

7.8 AQUIFER MAPPING AND MANAGEMENT PLAN OF FARIDPUR, BAREILLY DISTRICT, U.P.

1. Salient Information

Table 7.8a: Salient Information of FARIDPUR, Bareilly District, UP

Area	328.13 Sq. Km					
Population	175652	**Male**	94893	**Female**	80759	
Population Density	535 persons/sq km					
Annual Rainfall (2011-20)	***957*** mm	**Monsoon**	***839.***5mm	**Non-Monsoon**	***117.5*** mm	

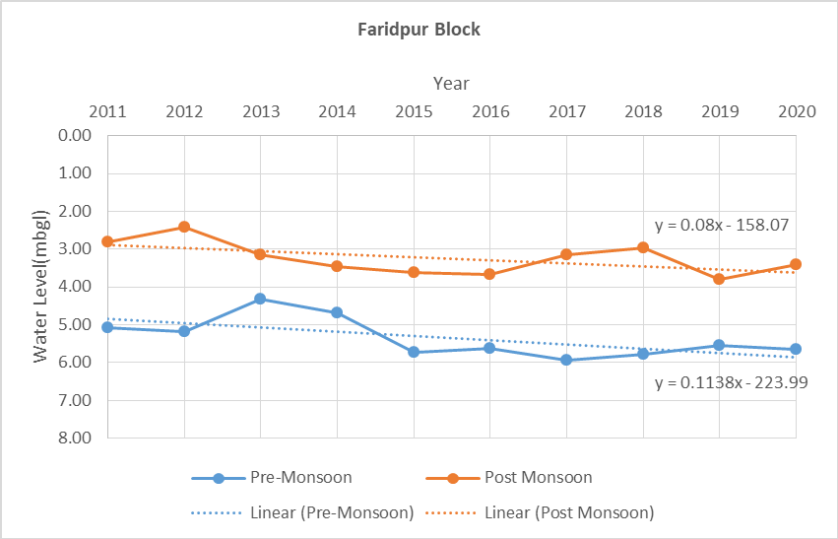
Table7.8b: Agriculture and Irrigation, FARIDPUR, Bareilly District, UP

Net Sown Area	23789	**Gross Sown Area**	41034
Net Irrigated Area	21730	**Gross Irrigated Area**	32449
Irrigation Intensity	149.33 %	**Irrigation by GW**	94.96 %
Irrigation by SW	5.04 %		

*Area in Hectare

2. Water Level Behaviour

The average depth to water level has been observed as 8.6 mbgl during Pre-monsoon (2020) and 8.28 mbgl during post-monsoon (2020). For the period of 2011-2020 Pre-monsoon water level trend is 0.11 m/year and post-monsoon water level trend is 0.08 m/year.



3. Aquifer Disposition

Three aquifer groups exist in the block:

Aquifer Group I: Ground level to 212 mbgl.

Aquifer Group II: 200mbgl to 305mbgl.

Aquifer Group III: 320 mbgl- 350mbgl.

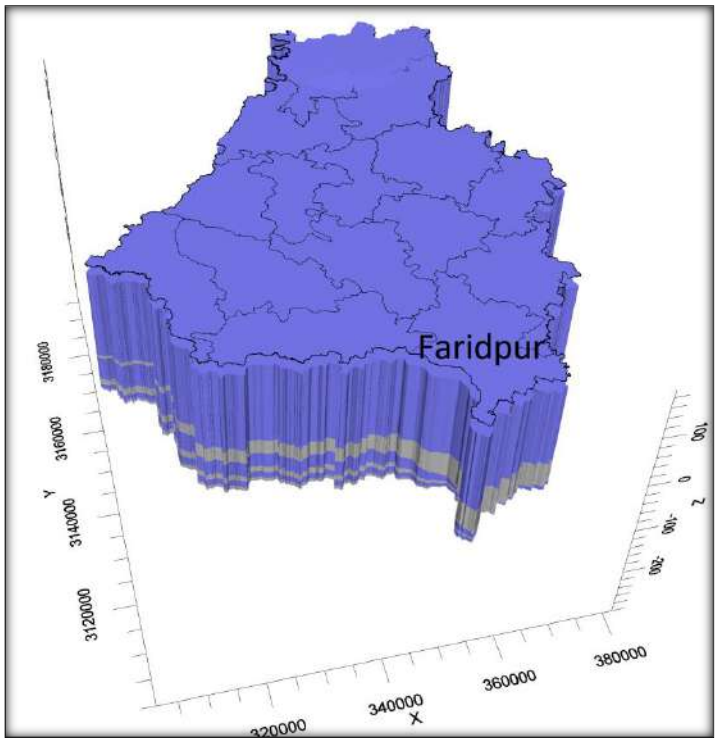


Fig: 7.8a: 3D disposition of Aquifer system

4. Ground water resource, extraction and other issues

Table 28: Ground Water Resource (Static+Dynamic), Extraction as on March, 2020 FARIDPUR, Bareilly, UP

A	**FIRST AQUIFER SYSTEM**	
1	**Dynamic Resources (Fresh)**	93.82 MCM
2	**Total GW Extraction**	57.43 MCM
3	**Stage of Ground Water Extraction**	61.21%
4	**Category**	Safe
5	**Static Resources (Fresh)**	6720.10 MCM
7	**Total Resources Dynamic + Static (Fresh)**	6813.92 MCM

Issues: Dependency on Ground Water for Irrigation and declining trend of water level. Presence of Iron (Fe^{3+}) beyond permissible limit has been reported in the blocks.

5. Chemical Quality of ground water and contamination

Table 7.8d: Basic Chemical Quality of Phreatic Aquifer, FARIDPUR, Bareilly, UP

Basic Parameter	Permissible Limit	Results
	BIS 10500:2012	
pH	6.5-8.5	8.08
EC (□S/cm) at 25^{0}C	3000	512
CO_3 mg/l	-	nil
HCO_3 mg/l	-	244
Cl mg/l	1000	35
F mg/l	1.5	0.25
NO_3 mg/l	45	BDL
SO_4 mg/l	400	29
TH as $CaCO_3$ mg/l	600	230
Ca mg/l	200	48
Mg mg/l	100	26
Na mg/l	-	15
K mg/l	-	10
SiO_2 mg/l	-	55
PO_4 mg/l	-	**Nd**

Table 29: Heavy Metal concentration of Shallow Aquifer, FARIDPUR, Bareilly, UP

Heavy Metals		Fe in ppm	Mn in ppm	Cu in ppm	Zn in ppm	As in ppb	Pb in ppb	U in ppb	Cr in ppb
Permissible Limit	**BIS 10500:2012**	1	0.3	1.5	15	10	10	30	50
Results		2.6	0.17	0	0.16	9	1	1	0

6. Ground Water Management:

Table 30: Ground Water Management Strategies and Projected Stage of Extraction

Block	Check Dams (Nos)	Nala Bunds (Nos)	Stream Development (Km)	Ponds (Nos)	On-farm Activities (ha)	Water Use Efficiency (ha)	Recharge from Structure MCM	Saving from Structures MCM	Saving frm On-farm & WUE MCM	Total Recharge MCM	Total Saving MCM	Present Stage of Ground Water Extraction (%)	Projected Stage of Extraction (%) After Interventions
FARIDPUR	2	2	2	3	2379	2379	0.13	0.13	3.32	0.13	3.45	61.21	57.46

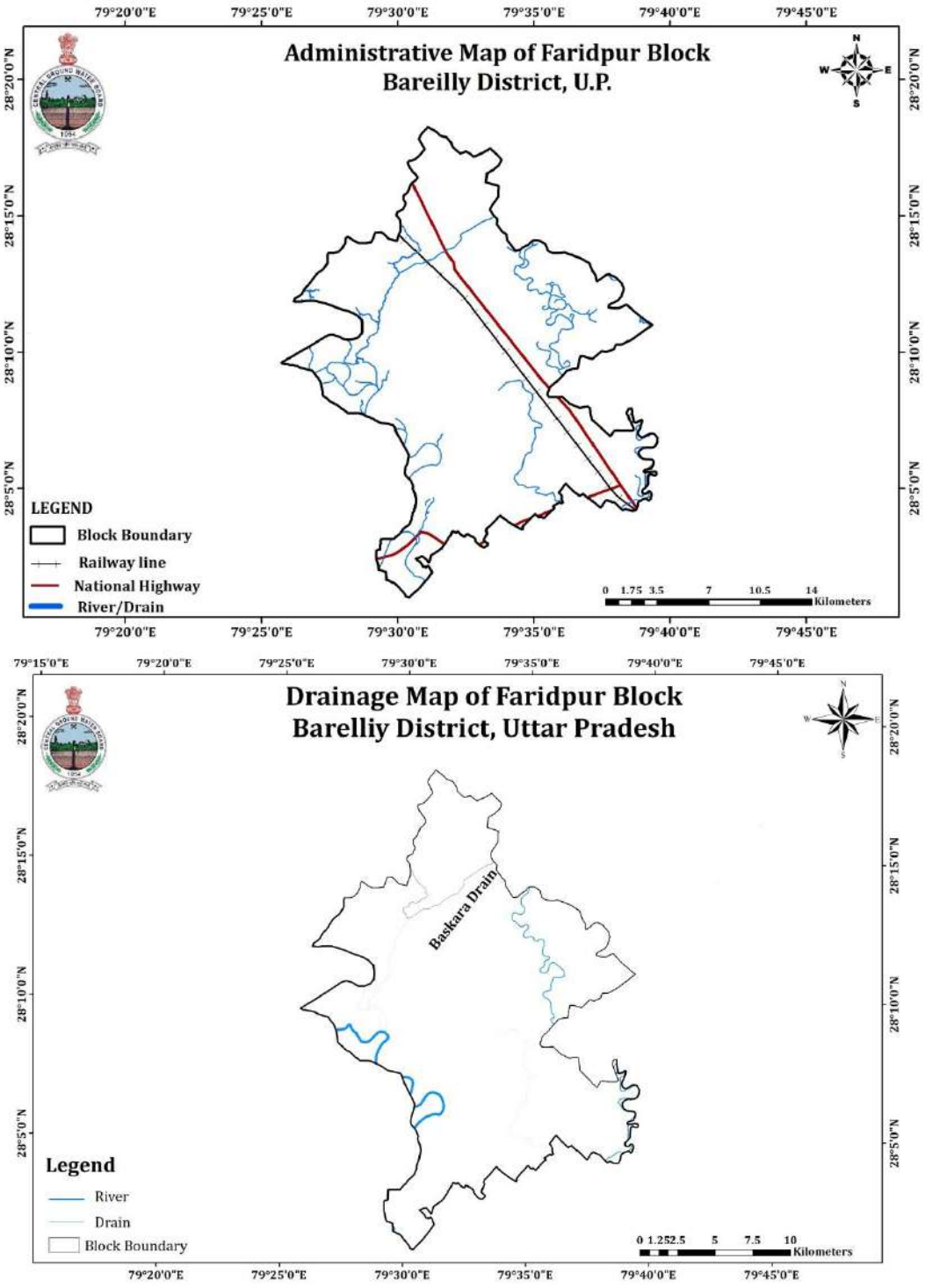


Fig 7: Administrative and Drainage map of FARIDPUR, Bareilly District, UP

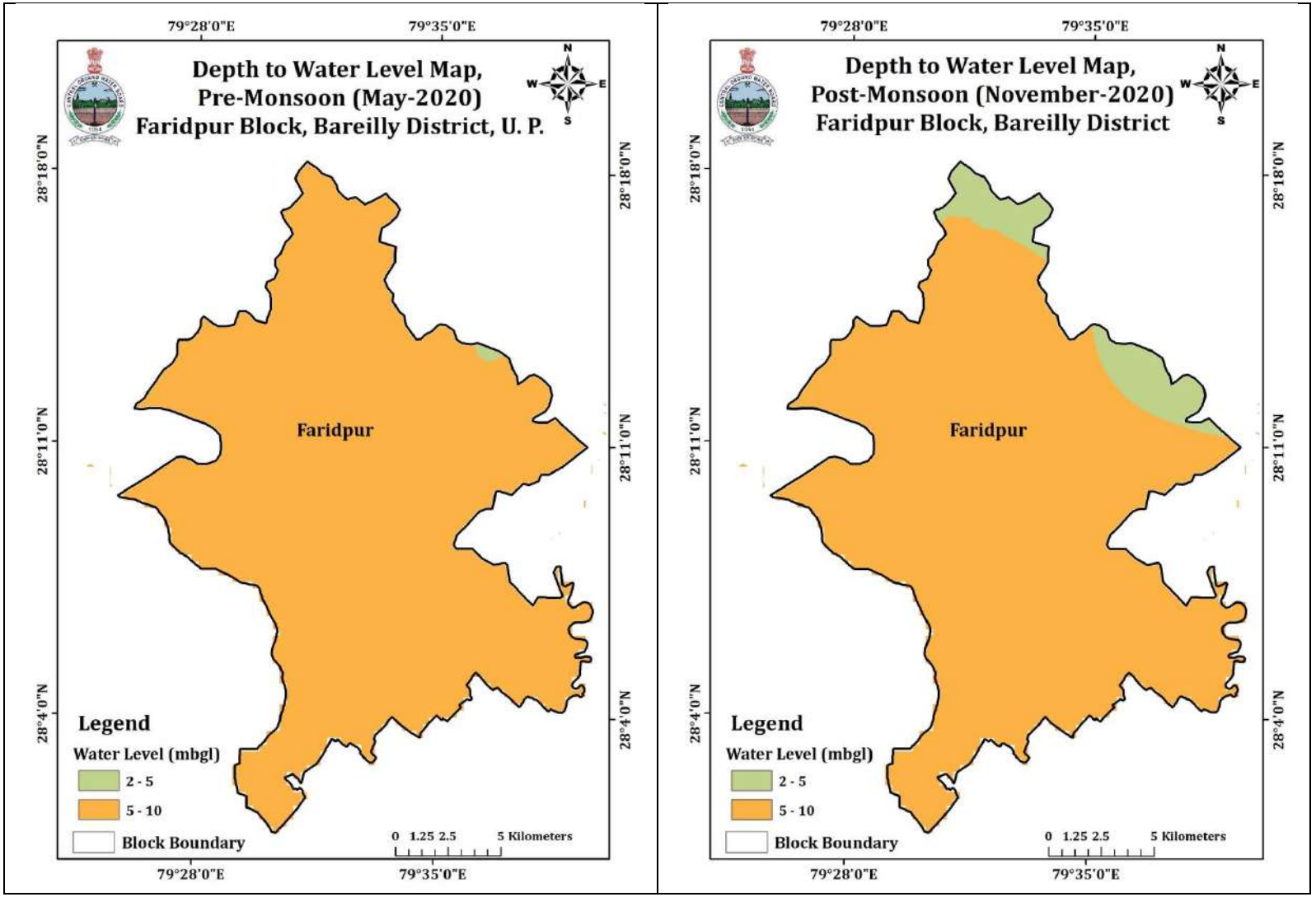


Fig 7.8c: Water Level map of pre-and post-monsoon 2020 of FARIDPUR, Bareilly district, UP

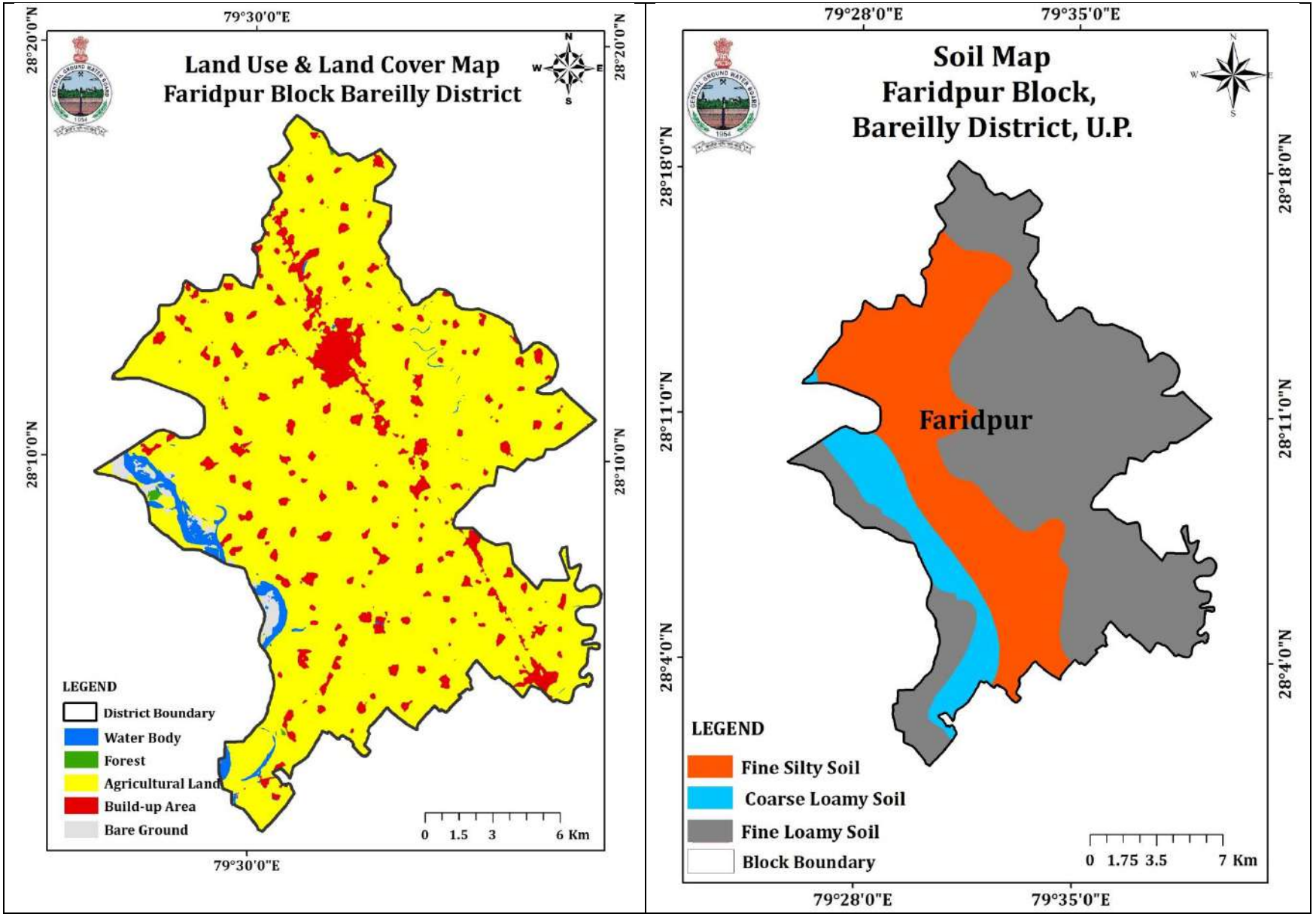


Figure 7.8d: Land use & Land cover and Soil Map of FARIDPUR, Bareilly district, UP

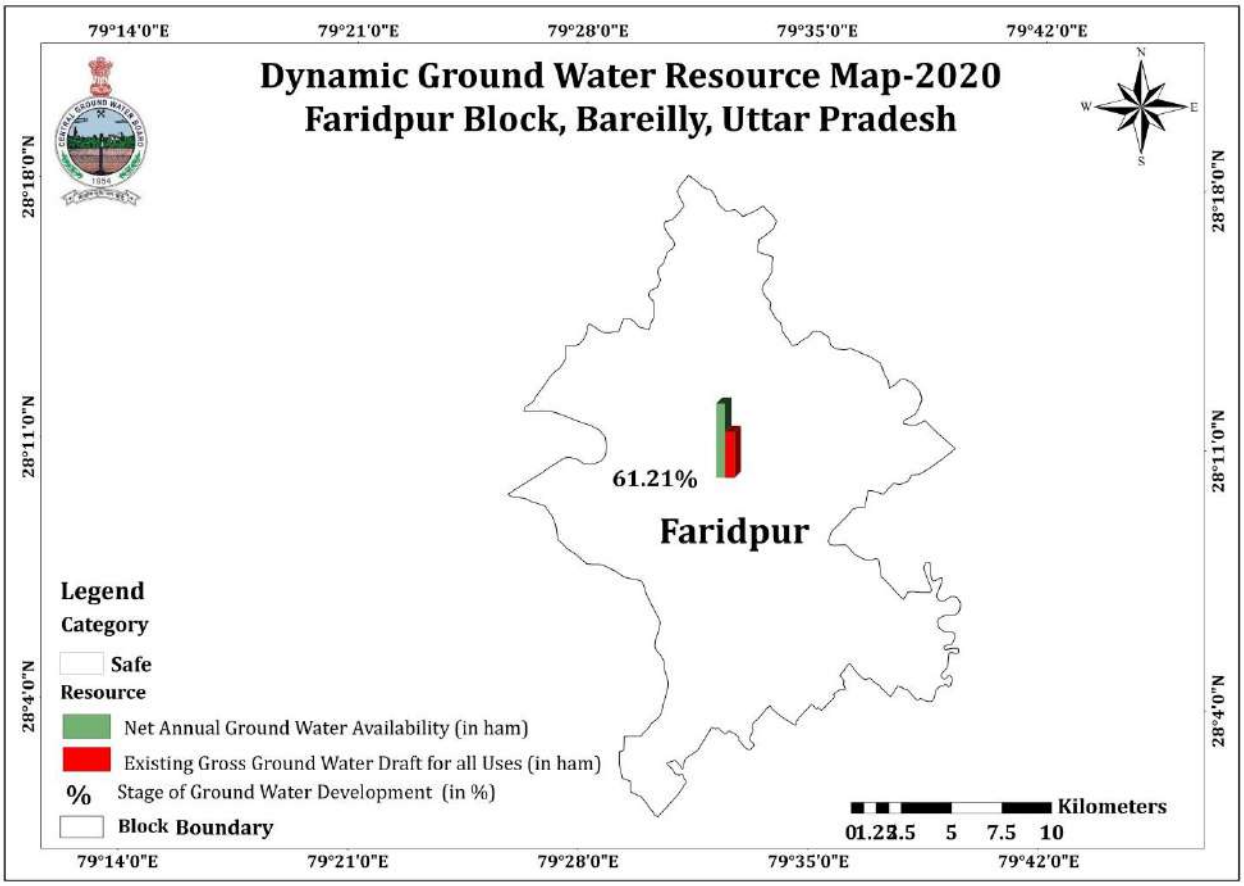


Figure 7.8e : Dynamic GW Resource Map of FARIDPUR, Bareilly district, UP

7.9 AQUIFER MAPPING AND MANAGEMENT PLAN OF FATEHGANJ, BAREILLY DISTRICT, U.P.

1. Salient Information

Table 7.9a: Salient Information of FATEHGANJ, Bareilly District, UP

Area	175.08 Sq. Km					
Population	157576	**Male**	83784	**Female**	73792	
Population Density	900 persons/sq km					
Annual Rainfall (2011-20)	***957*** mm	**Monsoon**	***839.***5mm	**Non-Monsoon**	***117.5*** mm	

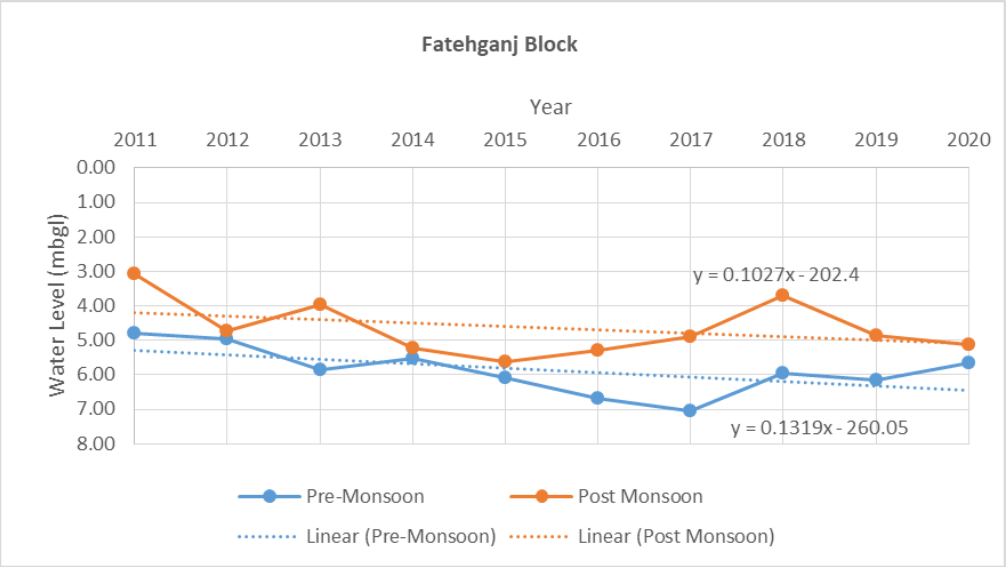
Table7.9b: Agriculture and Irrigation, FATEHGANJ, Bareilly District, UP

Net Sown Area	13763	**Gross Sown Area**	23340
Net Irrigated Area	11470	**Gross Irrigated Area**	23284
Irrigation Intensity	203.00 %	**Irrigation by GW**	91.38 %
Irrigation by SW	8.62 %		

*Area in Hectare

2. Water Level Behaviour

The average depth to water level has been observed as 5.67 mbgl during Pre-monsoon (2020) and 5.14 mbgl during post-monsoon (2020). For the period of 2011-2020 Pre-monsoon water level trend is 0.13 m/year and post-monsoon water level trend is 0.10m/year.



3. Aquifer Disposition

Three aquifer groups exist in the block:

Aquifer Group I: Ground level to 212 mbgl.

Aquifer Group II: 195mbgl to 295mbgl.

Aquifer Group III: 310 mbgl- 370mbgl.

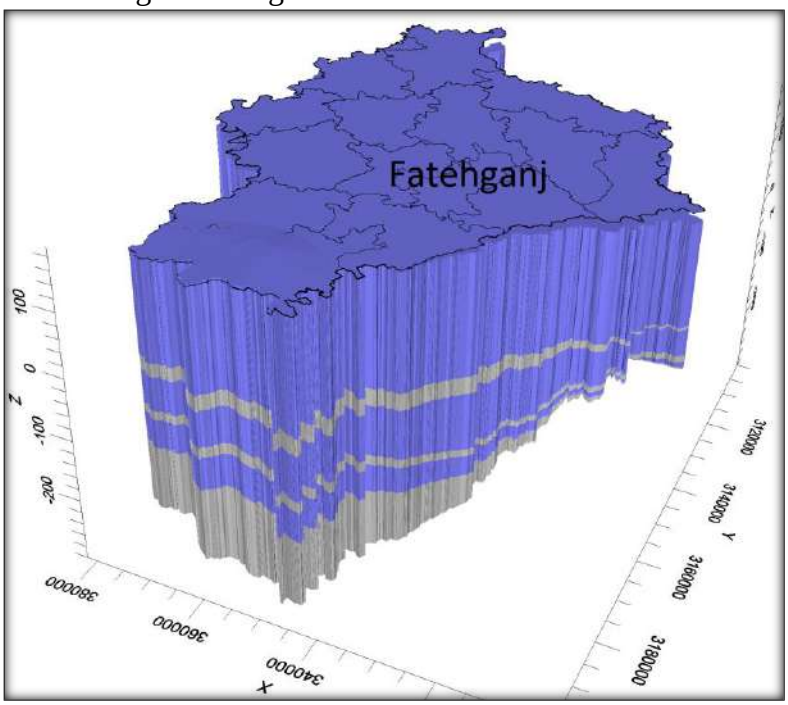


Fig: 7.9a: 3D disposition of Aquifer system

4. Ground water resource, extraction and other issues

Table 31: Ground Water Resource (Static+Dynamic), Extraction as on March, 2020 FATEHGANJ, Bareilly, UP

A	**FIRST AQUIFER SYSTEM**	
1	**Dynamic Resources (Fresh)**	62.96 MCM
2	**Total GW Extraction**	49.67 MCM
3	**Stage of Ground Water Extraction**	78.9%
4	**Category**	Semi critical
5	**Static Resources (Fresh)**	3865.76 MCM
7	**Total Resources Dynamic + Static (Fresh)**	3928.72 MCM

5. Chemical Quality of ground water and contamination

Table 7.9d: Basic Chemical Quality of Phreatic Aquifer, FATEHGANJ, Bareilly, UP

Basic Parameter	Permissible Limit	Results
	BIS 10500:2012	
pH	6.5-8.5	8.17
EC (□S/cm) at 25^0C	3000	477
CO_3 mg/l	-	nil
HCO_3 mg/l	-	256
Cl mg/l	1000	14
F mg/l	1.5	BDL
NO_3 mg/l	45	BDL
SO_4 mg/l	400	8.6
TH as $CaCO_3$ mg/l	600	100
Ca mg/l	200	32
Mg mg/l	100	4.8
Na mg/l	-	57
K mg/l	-	6.3
SiO_2 mg/l	-	48
PO_4 mg/l	-	Nd

Table 32: Heavy Metal concentration of Shallow Aquifer, FATEHGANJ, Bareilly, UP

Heavy Metals		Fe in ppm	Mn in ppm	Cu in ppm	Zn in ppm	As in ppb	Pb in ppb	U in ppb	Cr in ppb
Permissible Limit	BIS 10500:2012	1	0.3	1.5	15	10	10	30	50
Results		0.81	0.09	0	0.04	7	1	0	0

6. Ground Water Management:

Table 33: Ground Water Management Strategies and Projected Stage of Extraction

Block	Check Dams (Nos)	Nala Bunds (Nos)	Stream Development (Km)	Ponds (Nos)	On-farm Activities (ha)	Water Use Efficiency (ha)	Recharge from Structure MCM	Saving from Structures MCM	Saving frm On-farm & WUE MCM	Total Recharge MCM	Total Saving MCM	Present Stage of Ground Water Extraction (%)	Projected Stage of Extraction (%) After Interventions
FATEH GANJ	1	1	1	2	1376	1376	0.07	0.07	3.18	0.07	3.25	78.90	73.65

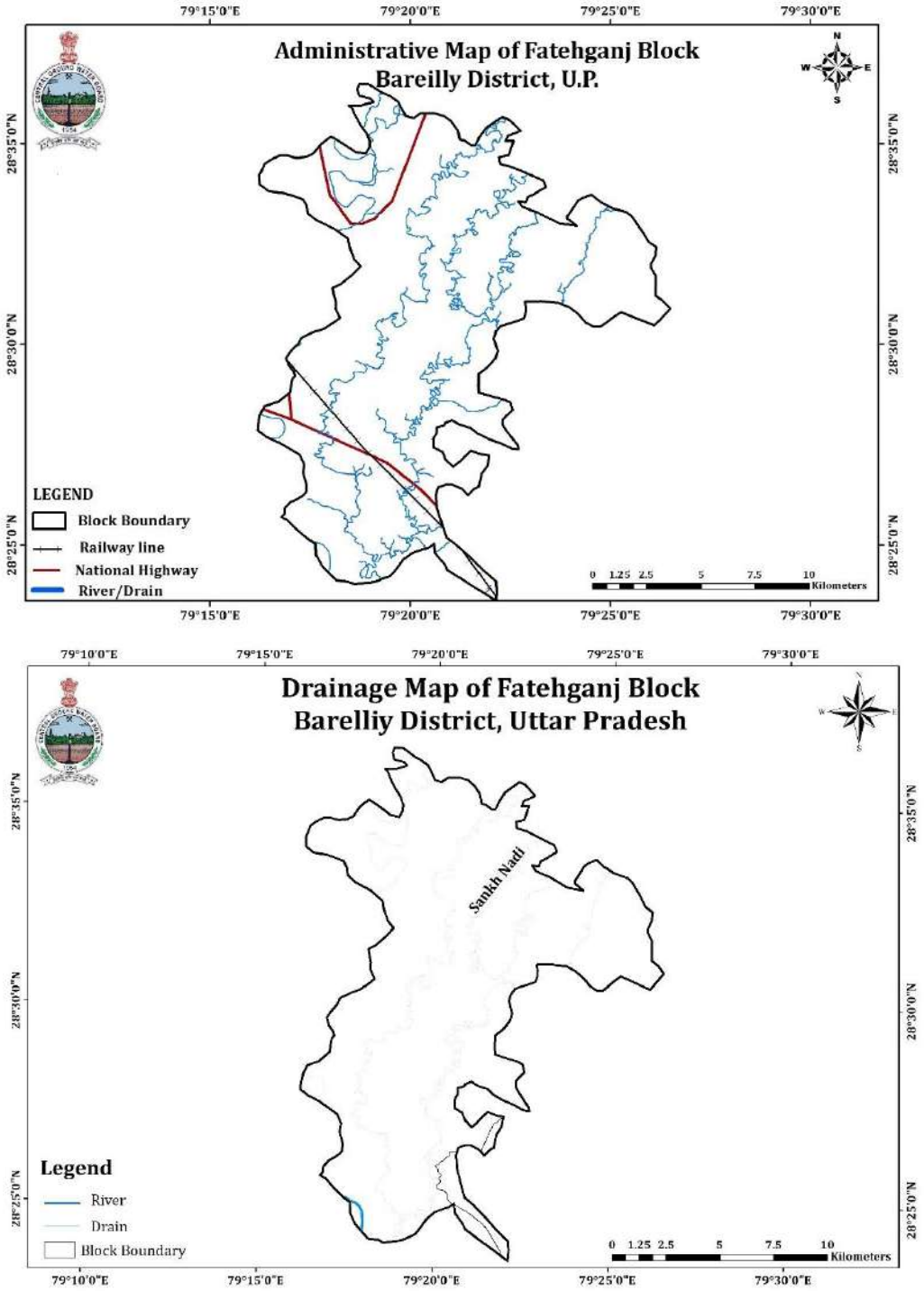


Fig 8: Administrative and Drainage map of FATEHGANJ, Bareilly District, UP

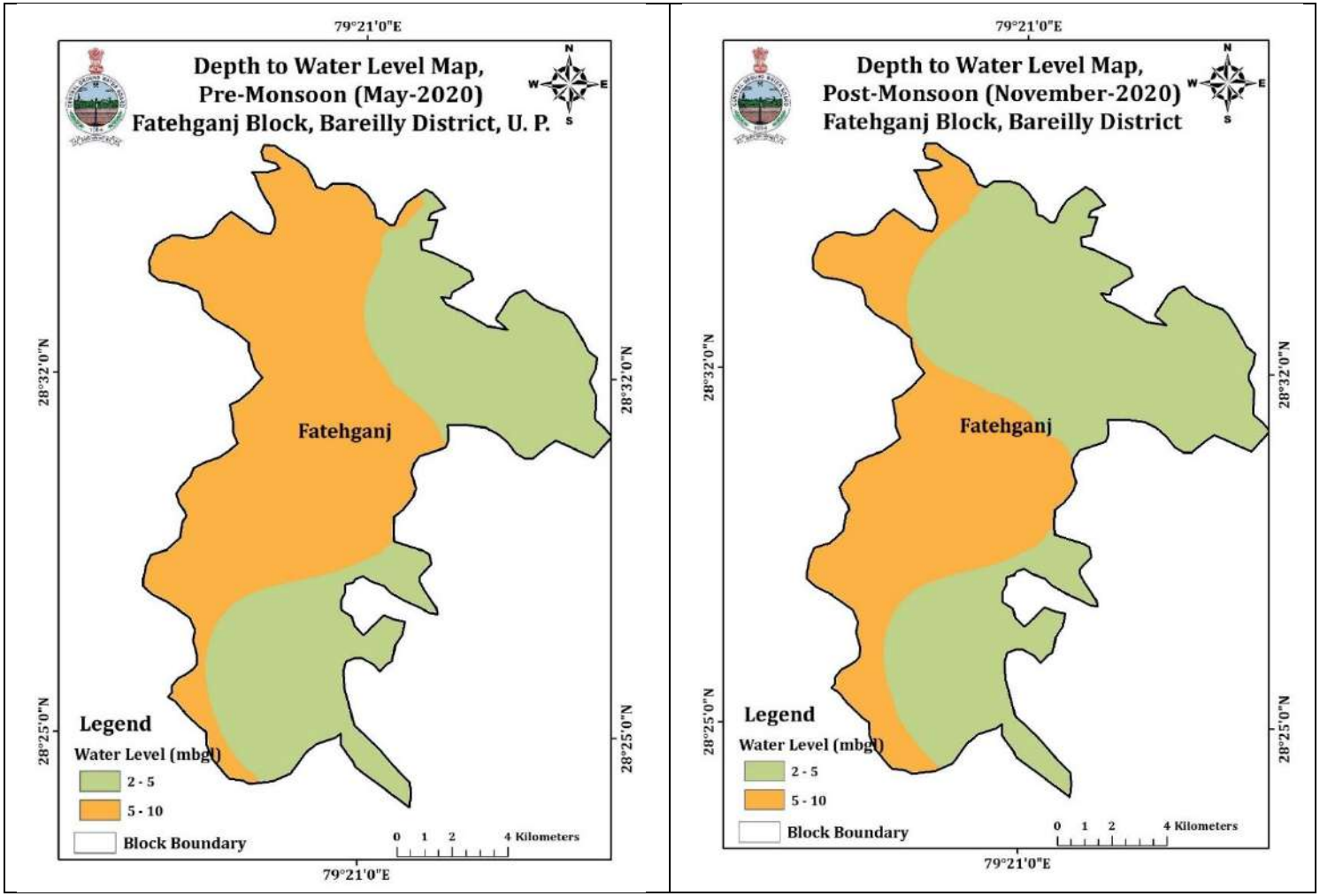


Fig 7.9c: Water Level map of pre-and post-monsoon 2020 of FATEHGANJ, Bareilly district, UP

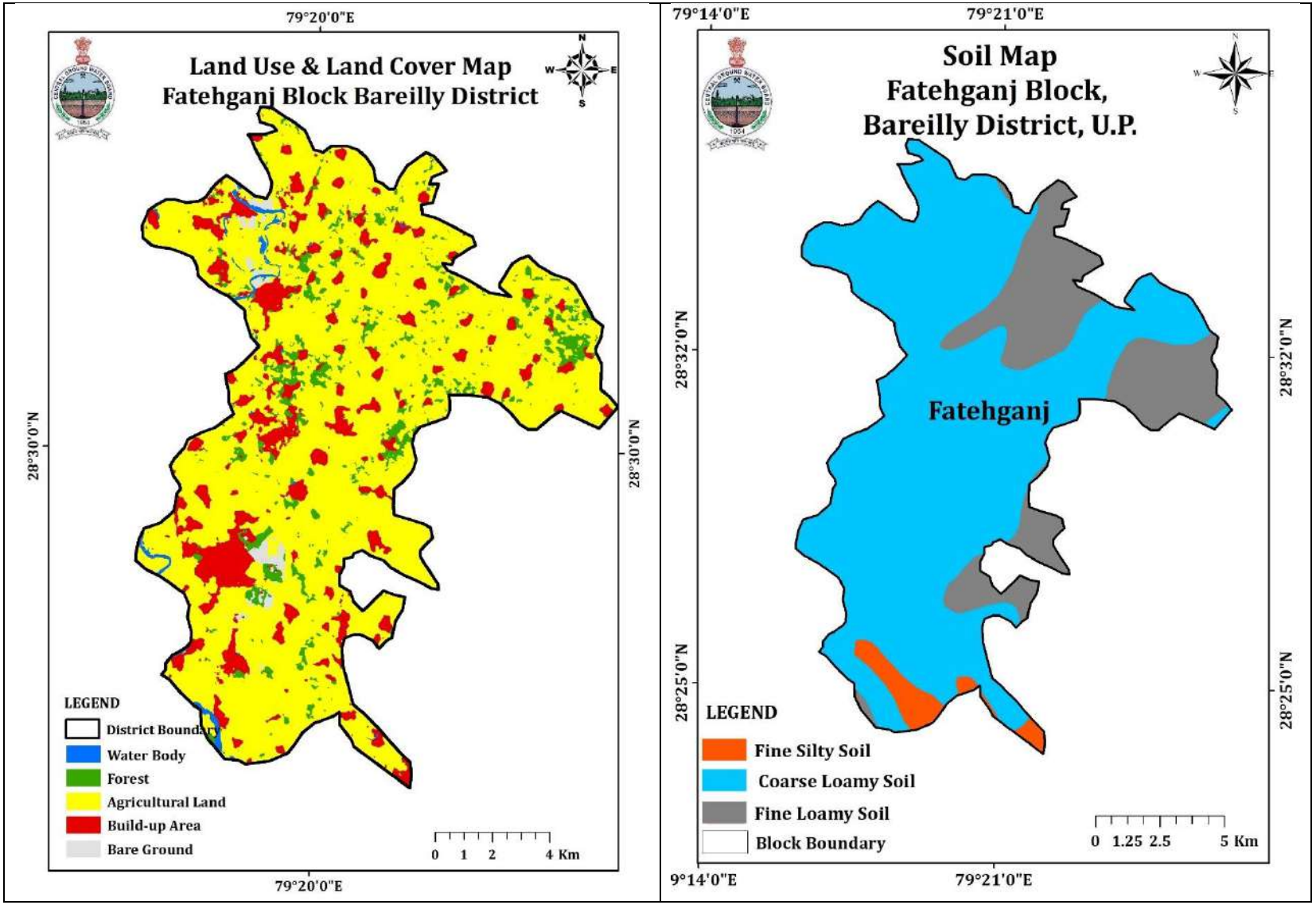


Figure 7.9d: Land use & Land cover and Soil Map of FATEHGANJ, Bareilly district, UP

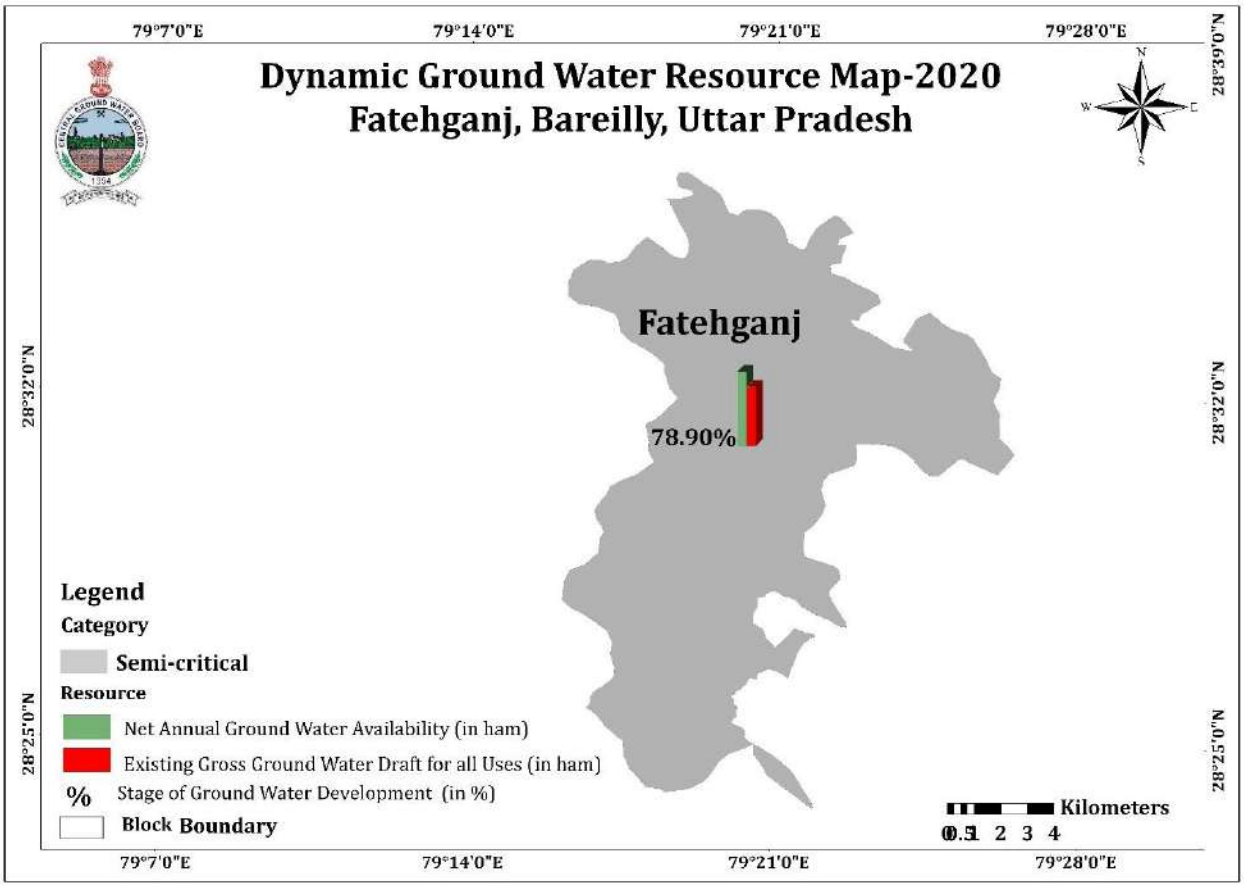


Figure 7.9e : Dynamic GW Resource Map of FATEHGANJ, Bareilly district, UP

7.10 AQUIFER MAPPING AND MANAGEMENT PLAN OF KYARA BLOCK, BAREILLY DISTRICT, U.P.

1. Salient Information

Table 7.10a: Salient Information of KYARA Block, Bareilly District, UP

Area	278.03 Sq. Km					
Population	127393	**Male**	68640	**Female**	58753	
Population Density	458 persons/sq km					
Annual Rainfall (2011-20)	***957*** mm	**Monsoon**	***839.***5mm	**Non-Monsoon**	***117.5*** mm	

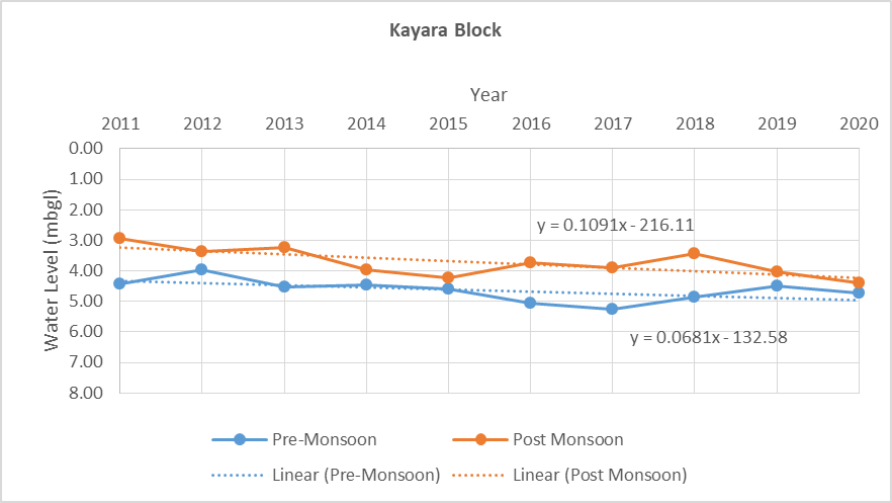
Table7.10b: Agriculture and Irrigation, KYARA Block, Bareilly District, UP

Net Sown Area	10842	**Gross Sown Area**	18856
Net Irrigated Area	10603	**Gross Irrigated Area**	14033
Irrigation Intensity	132.35 %	**Irrigation by GW**	92.85 %
Irrigation by SW	7.15 %		

*Area in Hectare

2. Water Level Behaviour

The average depth to water level has been observed as 4.74 mbgl during Pre-monsoon (2020) and 4.39 mbgl during post-monsoon (2020). For the period of 2011-2020 Pre-monsoon water level trend is 0.07 m/year and post-monsoon water level trend is 0.1 m/year.



3. Aquifer Disposition

Three aquifer groups exist in the block:

Aquifer Group I: Ground level to 212 mbgl.

Aquifer Group II: 200mbgl to 305mbgl.

Aquifer Group III: 320 mbgl- 350mbgl.

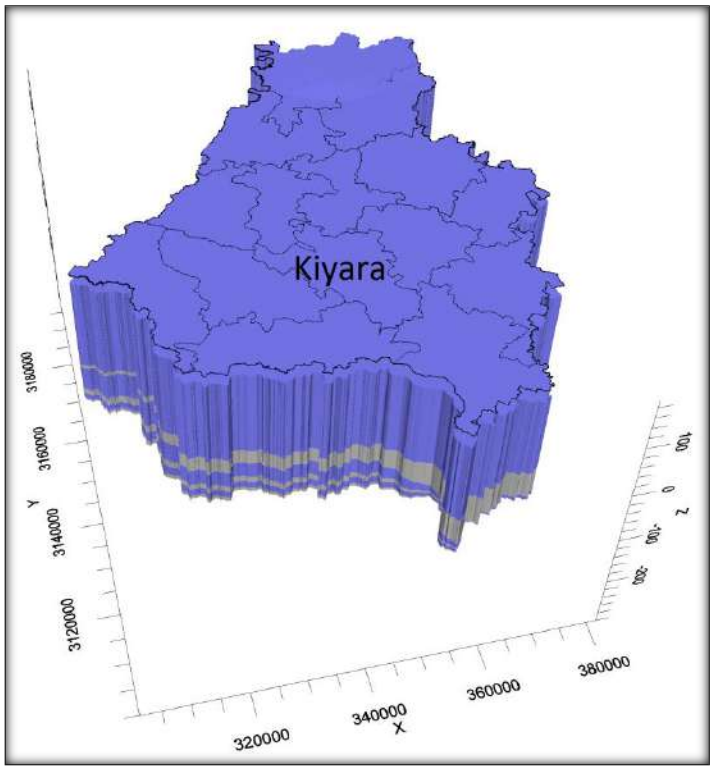


Fig: 7.10a: 3D disposition of Aquifer system

4. Ground water resource, extraction and other issues

Table 34: Ground Water Resource (Static+Dynamic), Extraction as on March, 2020 KYARA Block, Bareilly, UP

A	**FIRST AQUIFER SYSTEM**	
1	**Dynamic Resources (Fresh)**	61.95 MCM
2	**Total GW Extraction**	36.05 MCM
3	**Stage of Ground Water Extraction**	58.2 %
4	**Category**	Semi critical
5	**Static Resources (Fresh)**	5338.17 MCM
7	**Total Resources Dynamic + Static (Fresh)**	5400.12 MCM

Issues: Dependency on Ground Water for Irrigation and declining trend of water level. Presence of Iron (Fe^{3+}) beyond permissible limit has been reported in the blocks.

5. Chemical Quality of ground water and contamination

Table 7.10d: Basic Chemical Quality of Phreatic Aquifer, KYARA Block, Bareilly, UP

Basic Parameter	Permissible Limit	Results
	BIS 10500:2012	
pH	6.5-8.5	7.92
EC (□S/cm) at 25^{0}C	3000	358
CO_3 mg/l	-	nil
HCO_3 mg/l	-	134
Cl mg/l	1000	28
F mg/l	1.5	BDL
NO_3 mg/l	45	BDL
SO_4 mg/l	400	26
TH as $CaCO_3$ mg/l	600	130
Ca mg/l	200	28
Mg mg/l	100	14
Na mg/l	-	14
K mg/l	-	11
SiO_2 mg/l	-	51
PO_4 mg/l	-	**Nd**

Table 35: Heavy Metal concentration of Shallow Aquifer KYARA Block, Bareilly, UP

Heavy Metals		Fe in ppm	Mn in ppm	Cu in ppm	Zn in ppm	As in ppb	Pb in ppb	U in ppb	Cr in ppb
Permissible Limit	**BIS 10500:2012**	1	0.3	1.5	15	10	10	30	50
Results		1.2	0.16	0	0.09	5	1	1	0

6. Ground Water Management:

Table 36: Ground Water Management Strategies and Projected Stage of Extraction

Block	Check Dams (Nos)	Nala Bunds (Nos)	Stream Development (Km)	Ponds (Nos)	On-farm Activities (ha)	Water Use Efficiency (ha)	Recharge from Structure MCM	Saving from Structures MCM	Saving frm On-farm & WUE MCM	Total Recharge MCM	Total Saving MCM	Present Stage of Ground Water Extraction (%)	Projected Stage of Extraction (%) After Interventions
KYARA	1	1	1	3	1084	1084	0.11	0.11	1.97	0.11	2.08	58.20	54.76

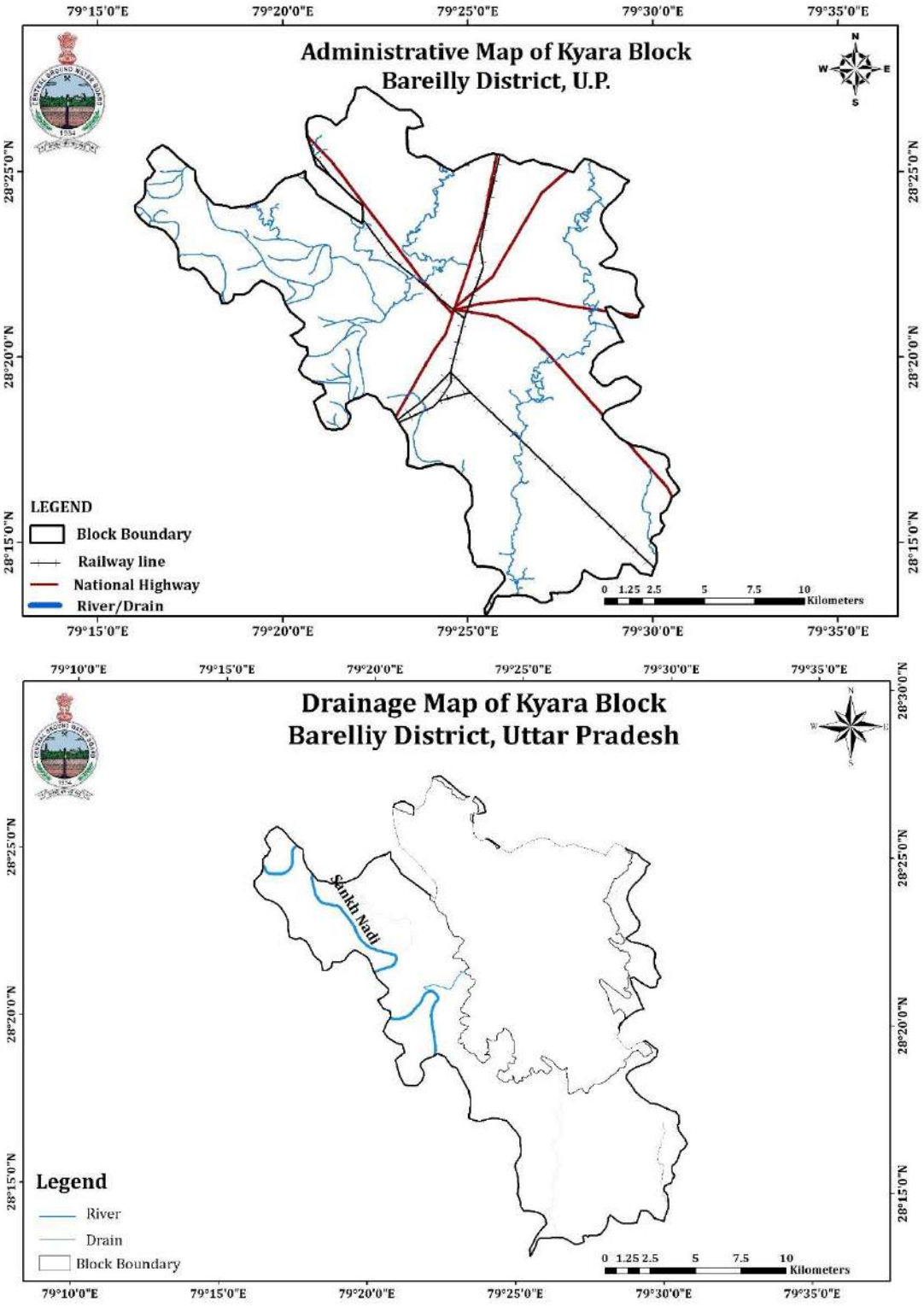


Fig 9: Administrative and Drainage map of KYARA Block, Bareilly District, UP

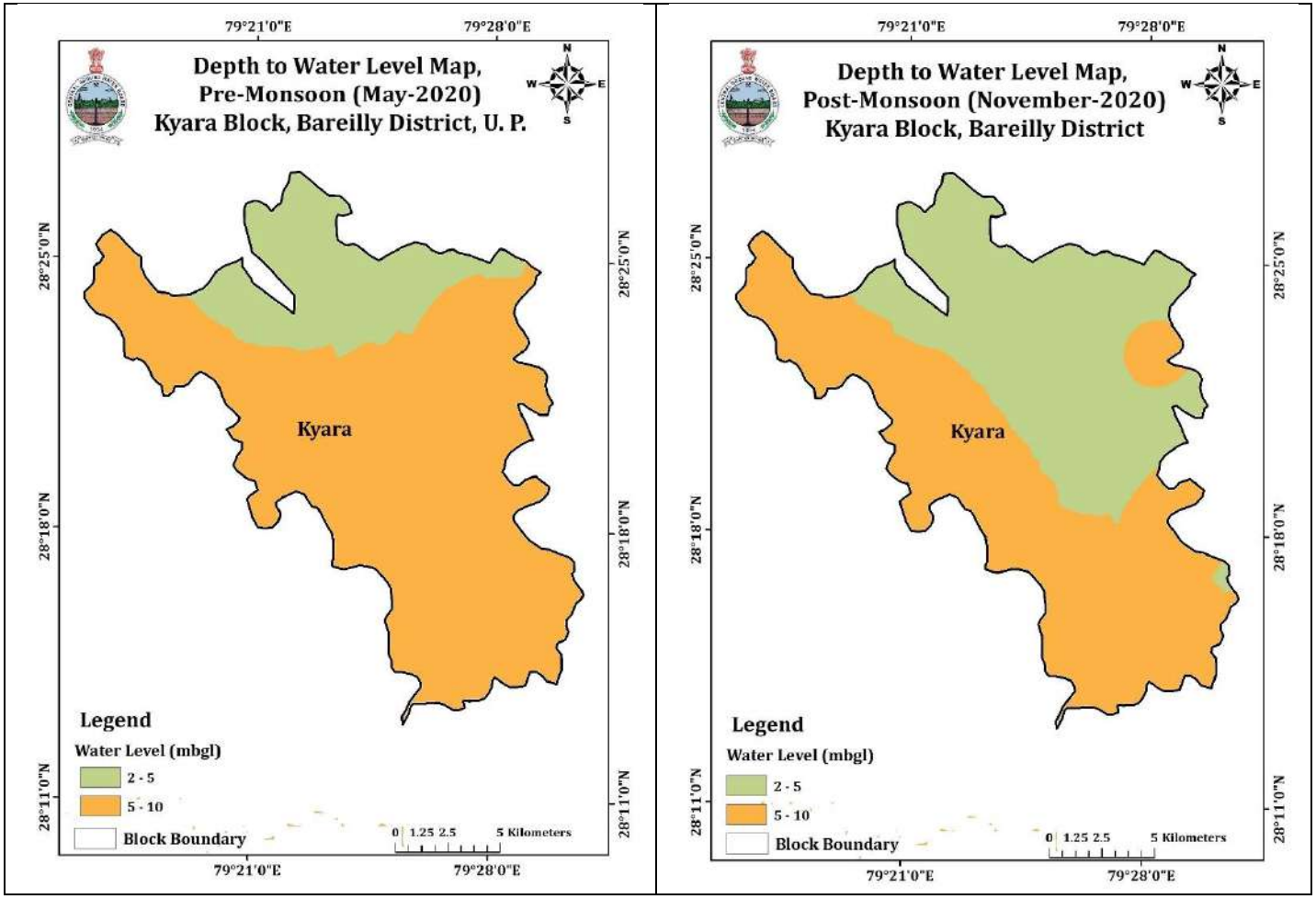


Fig 7.10c: Water Level map of pre-and post-monsoon 2020 of KYARA Block, Bareilly district, UP

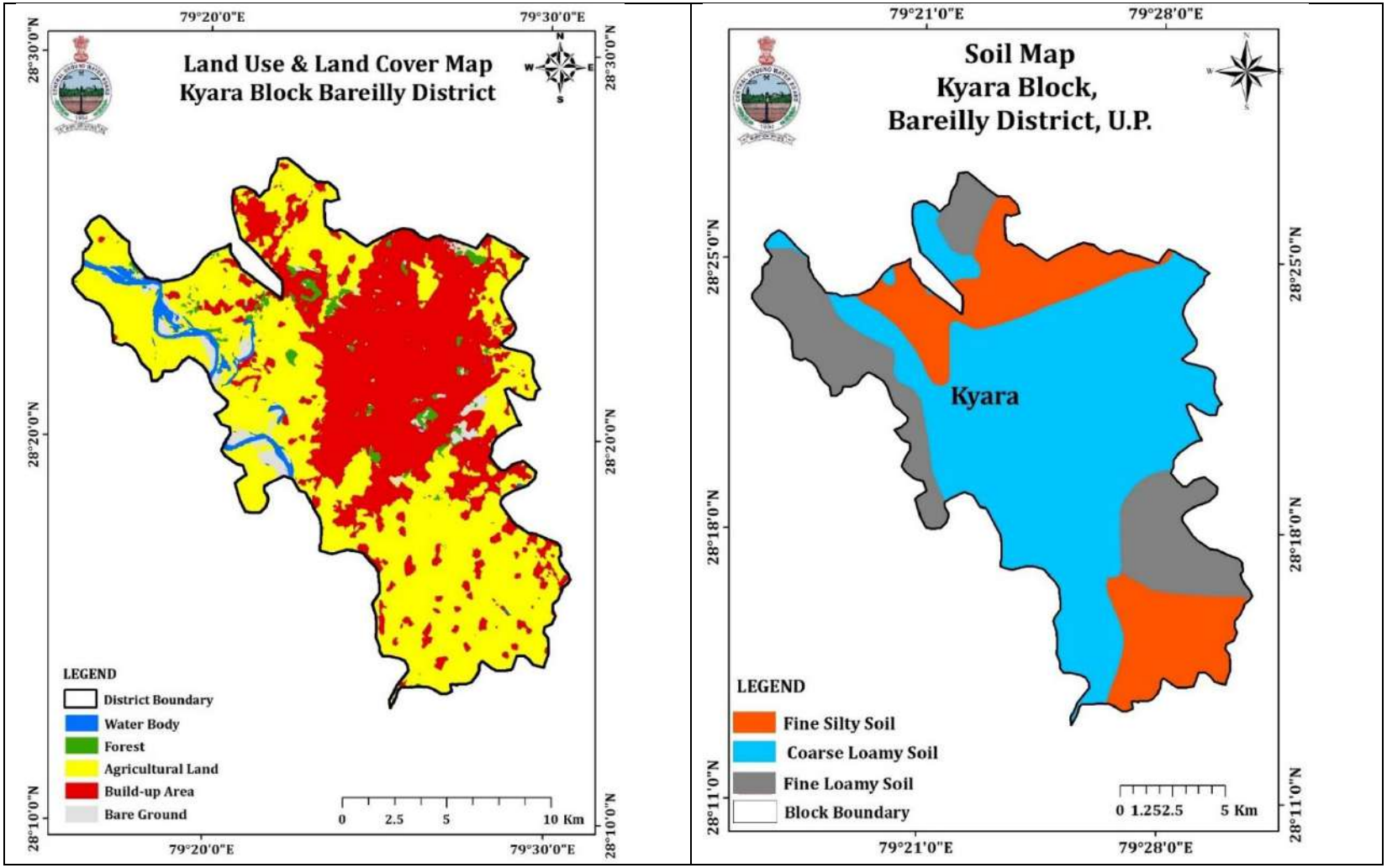


Figure 7.10d: Land use & Land cover and Soil Map of KYARA Block, Bareilly district, UP

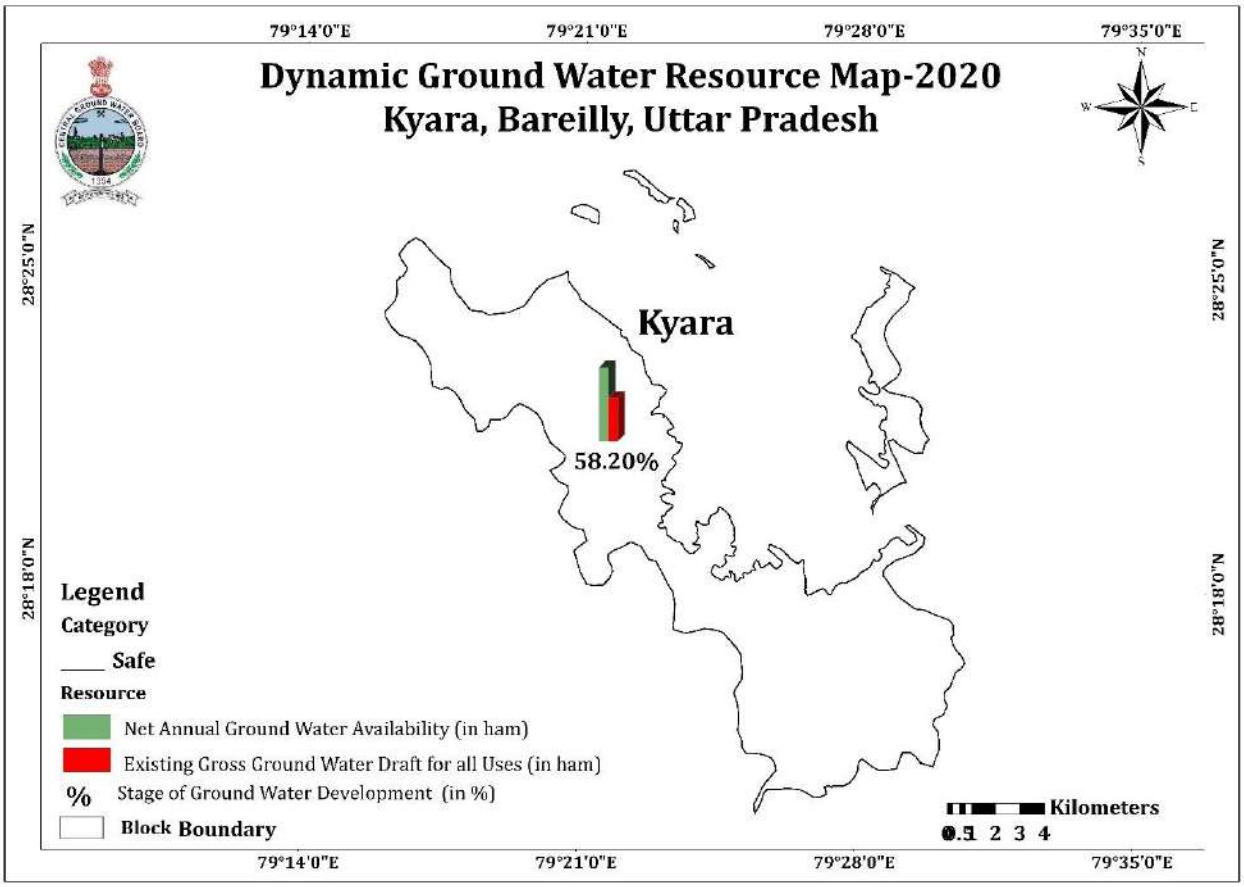


Figure 7.10e : Dynamic GW Resource Map of KYARA Block, Bareilly district, UP

7.11 AQUIFER MAPPING AND MANAGEMENT PLAN OF MAJHGAWA BLOCK, BAREILLY DISTRICT, U.P.

1. Salient Information

Table 7.11a: Salient Information of MAJHGAWA Block, Bareilly District, UP

Area	172.01 Sq. Km					
Population	224467	**Male**	120159	**Female**	104308	
Population Density	1411 persons/sq km					
Annual Rainfall (2011-20)	***957*** mm	**Monsoon**	***839.***5mm	**Non-Monsoon**	***117.5*** mm	

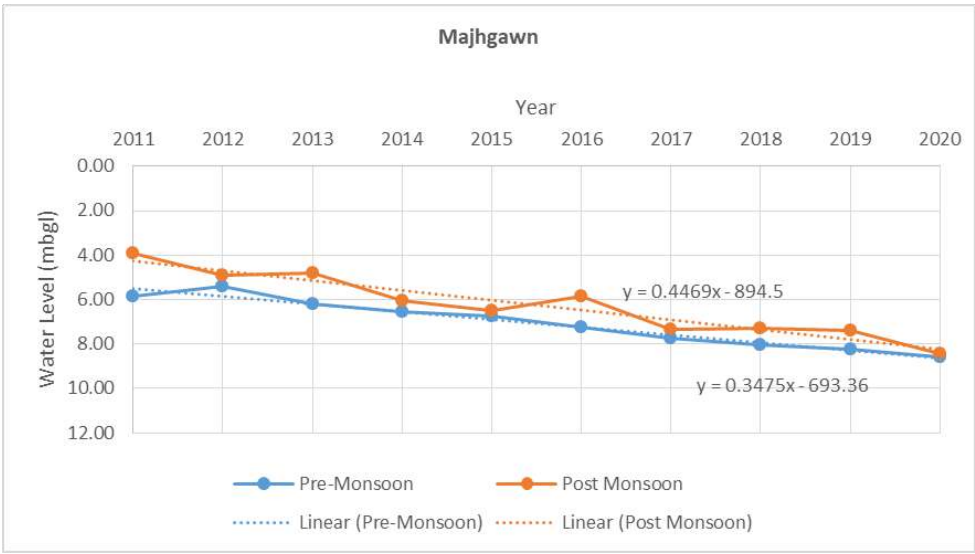
Table7.11b: Agriculture and Irrigation, MAJHGAWA Block, Bareilly District, UP

Net Sown Area	27242	**Gross Sown Area**	41182
Net Irrigated Area	25882	**Gross Irrigated Area**	41143
Irrigation Intensity	158.96 %	**Irrigation by GW**	97.06 %
Irrigation by SW	2.94 %		

*Area in Hectare

2. Water Level Behaviour

The average depth to water level has been observed as 8.56 mbgl during Pre-monsoon (2020) and 8.41 mbgl during post-monsoon (2020). For the period of 2011-2020 Pre-monsoon water level trend is 0.35 m/year and post-monsoon water level trend is 0.45m/year.



3. Aquifer Disposition

Three aquifer groups exist in the block:

Aquifer Group I: Ground level to 212 mbgl.

Aquifer Group II: 200mbgl to 305mbgl.

Aquifer Group III: 320 mbgl- 350mbgl.

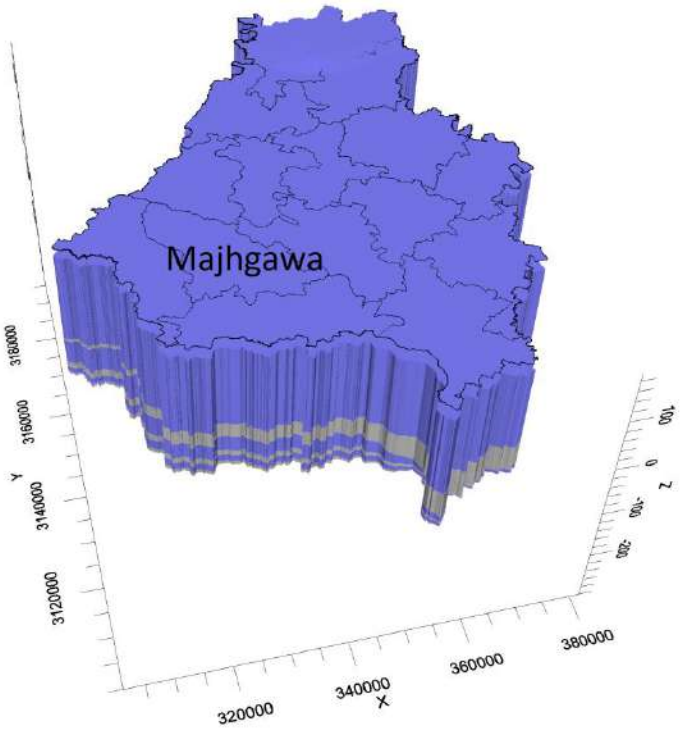


Fig: 7.11a: 3D disposition of Aquifer system

4. Ground water resource, extraction and other issues

Table 37: Ground Water Resource (Static+Dynamic), Extraction as on March, 2020 MAJHGAWA Block, Bareilly, UP

A	**FIRST AQUIFER SYSTEM**	
1	**Dynamic Resources (Fresh)**	50.73 MCM
2	**Total GW Extraction**	35.55 MCM
3	**Stage of Ground Water Extraction**	70.08%
4	**Category**	Semi critical
5	**Static Resources (Fresh)**	3275.07 MCM
7	**Total Resources Dynamic + Static (Fresh)**	3325.8 MCM

5. Chemical Quality of ground water and contamination

Table 7.11d: Basic Chemical Quality of Phreatic Aquifer, MAJHGAWA Block, Bareilly, UP

Basic Parameter	Permissible Limit	Results
	BIS 10500:2012	
pH	6.5-8.5	8.13
EC (□S/cm) at 25^{0}C	3000	630
CO_3 mg/l	-	nil
HCO_3 mg/l	-	207
Cl mg/l	1000	35
F mg/l	1.5	BDL
NO_3 mg/l	45	BDL
SO_4 mg/l	400	48
TH as $CaCO_3$ mg/l	600	100
Ca mg/l	200	28
Mg mg/l	100	7.2
Na mg/l	-	71
K mg/l	-	6.1
SiO_2 mg/l	-	54
PO_4 mg/l	-	**Nd**

Table 38: Heavy Metal concentration of Shallow Aquifer MAJHGAWA Block, Bareilly, UP

Heavy Metals		Fe in ppm	Mn in ppm	Cu in ppm	Zn in ppm	As in ppb	Pb in ppb	U in ppb	Cr in ppb
Permissible Limit	**BIS 10500:2012**	1	0.3	1.5	15	10	10	30	50
Results		0.08	0.21	0	0.26	1	1	2	0

6. Ground Water Management:

Table 39: Ground Water Management Strategies and Projected Stage of Extraction

Block	Check Dams (Nos)	Nala Bunds (Nos)	Stream Development (Km)	Ponds (Nos)	On-farm Activities (ha)	Water Use Efficiency (ha)	Recharge from Structure MCM	Saving from Structures MCM	Saving frm On-farm & WUE MCM	Total Recharge MCM	Total Saving MCM	Present Stage of Ground Water Extraction (%)	Projected Stage of Extraction (%) After Interventions
MAJHGAWA	1	1	1	2	2724	2724	0.07	0.07	1.77	0.07	1.83	70.08	66.38

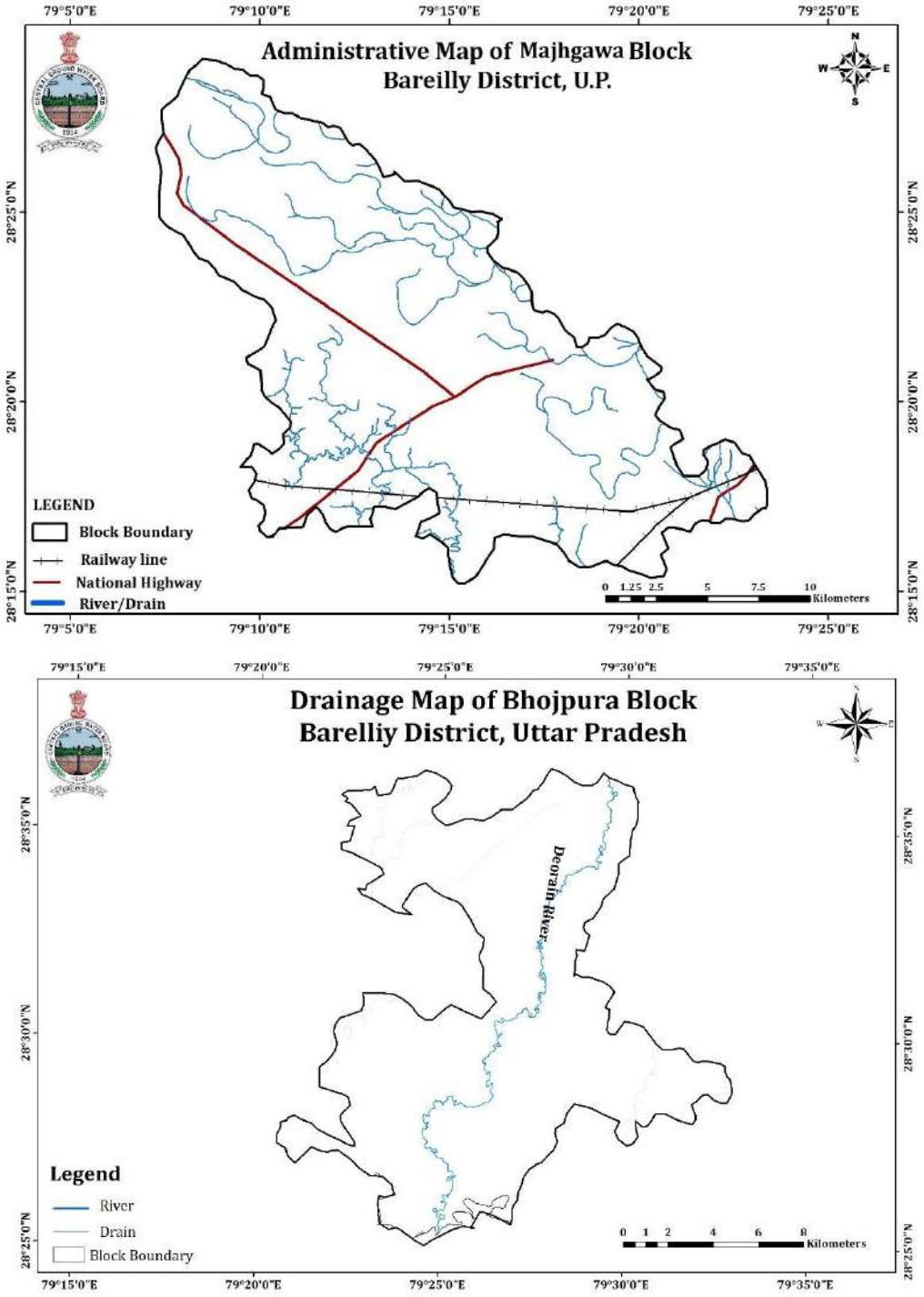


Fig 10: Administrative and Drainage map of MAJHGAWA Block, Bareilly District, UP

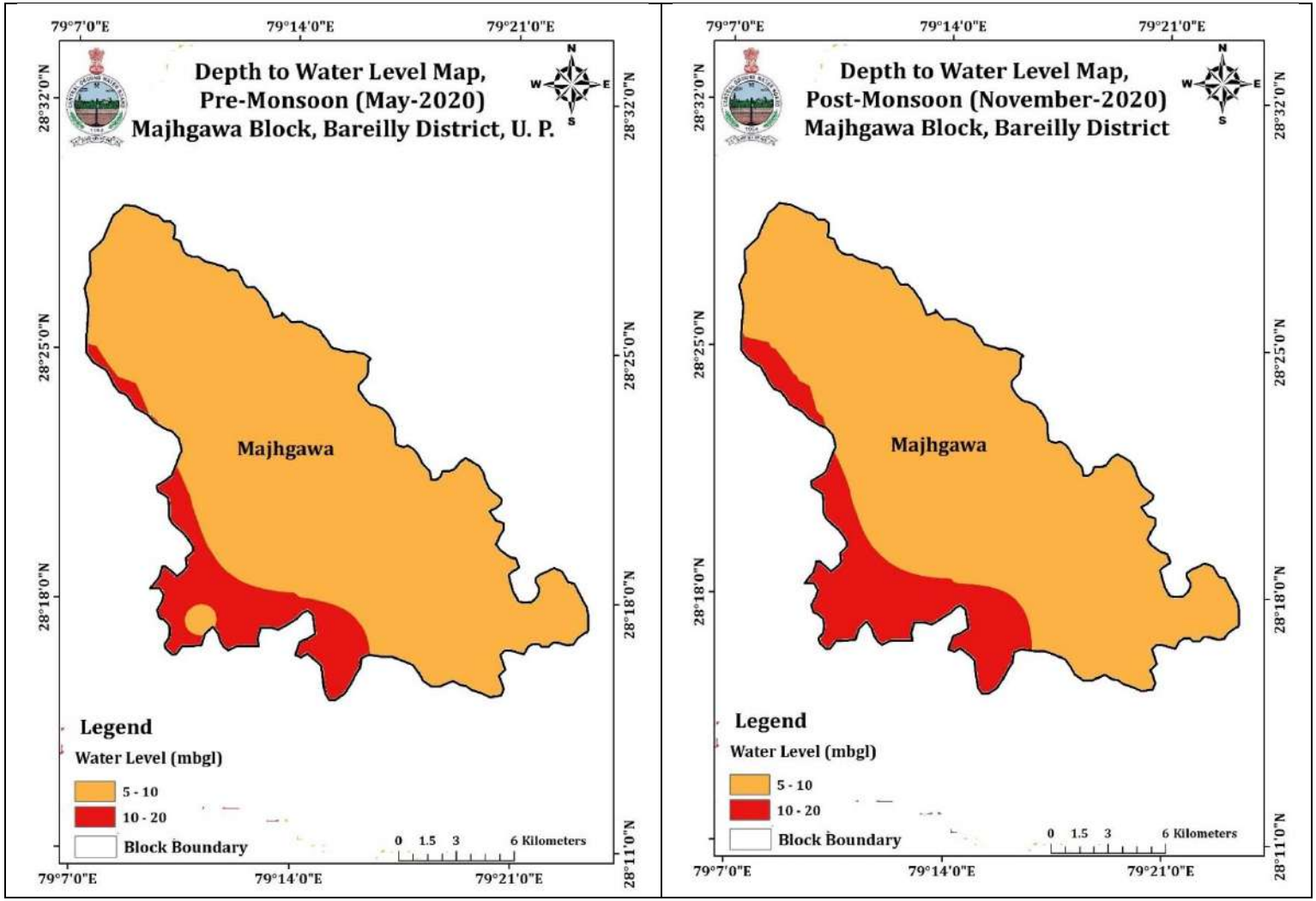


Fig 7.11c: Water Level map of pre-and post-monsoon 2020 of MAJHGAWA Block, Bareilly district, UP

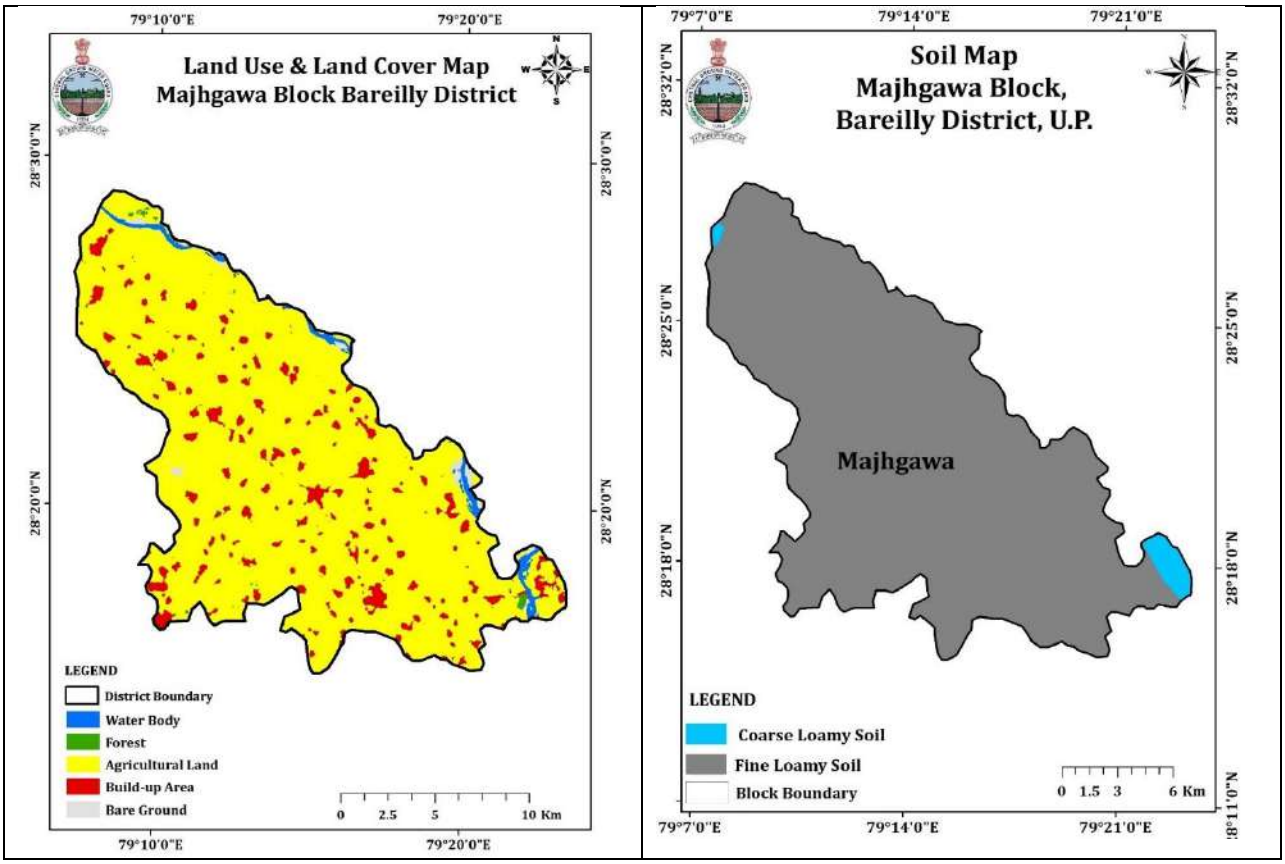


Figure 7.11d: Land use & Land cover and Soil Map of MAJHGAWA Block, Bareilly district, UP

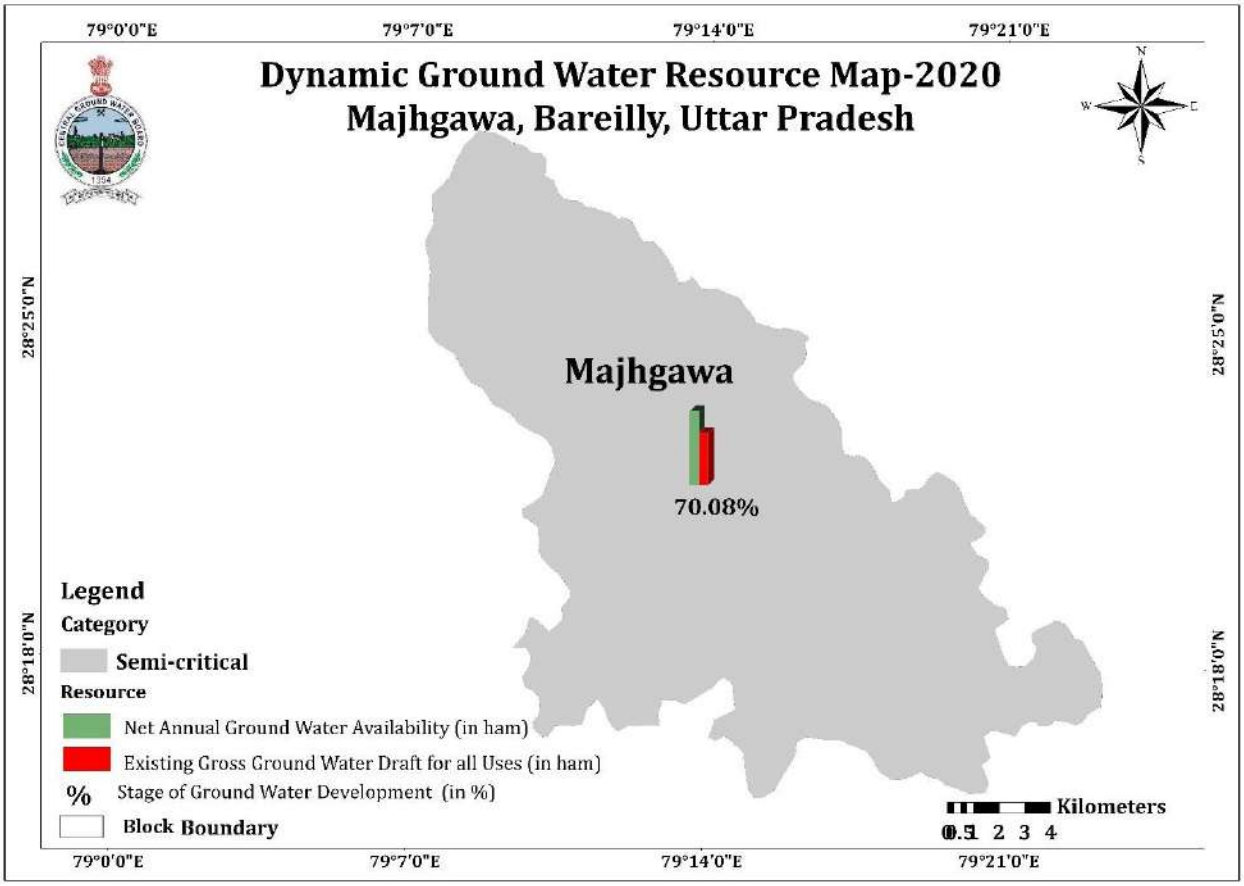


Figure 7.11e : Dynamic GW Resource Map of MAJHGAWA Block, Bareilly district, UP

7.12 AQUIFER MAPPING AND MANAGEMENT PLAN OF MEERGANJ BLOCK, BAREILLY DISTRICT, U.P.

1. Salient Information

Table 7.12a: Salient Information of MEERGANJ Block, Bareilly District, UP

Area	211.67 Sq. Km					
Population	165295	**Male**	87467	**Female**	77828	
Population Density	781 persons/sq km					
Annual Rainfall (2011-20)	***957*** mm	**Monsoon**	***839.***5mm	**Non-Monsoon**	***117.5*** mm	

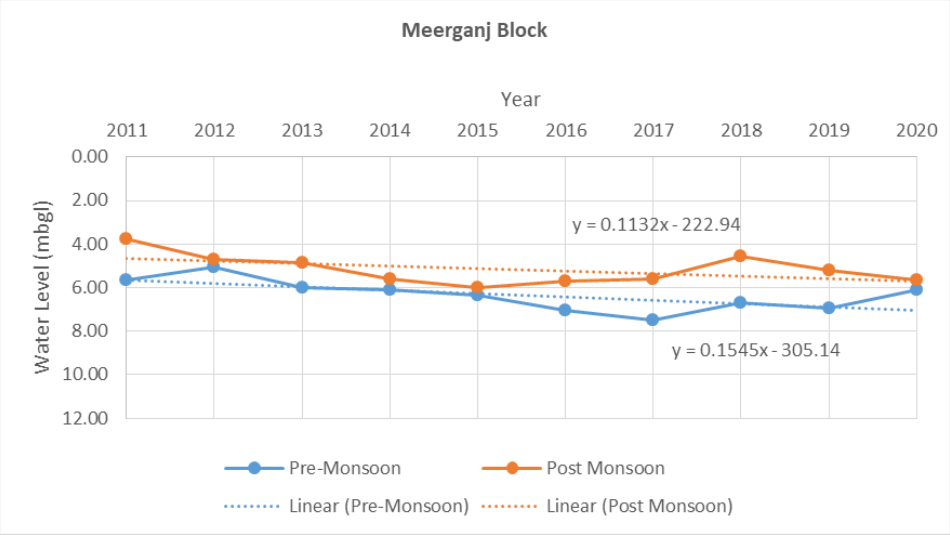
Table7.22b: Agriculture and Irrigation, MEERGANJ Block, Bareilly District, UP

Net Sown Area	18107	**Gross Sown Area**	29643
Net Irrigated Area	15802	**Gross Irrigated Area**	25587
Irrigation Intensity	161.92 %	**Irrigation by GW**	94.26 %
Irrigation by SW	5.74 %		

*Area in Hectare

2. Water Level Behaviour

The average depth to water level has been observed as 6.11 mbgl during Pre-monsoon (2020) and 5.67 mbgl during post-monsoon (2020). For the period of 2011-2020 Pre-monsoon water level trend is 0.15m/year and post-monsoon water level trend is 0.11m/year.



3. Aquifer Disposition

Three aquifer groups exist in the block:

Aquifer Group I: Ground level to 212 mbgl.

Aquifer Group II: 195mbgl to 295mbgl.

Aquifer Group III: 310 mbgl- 370mbgl.

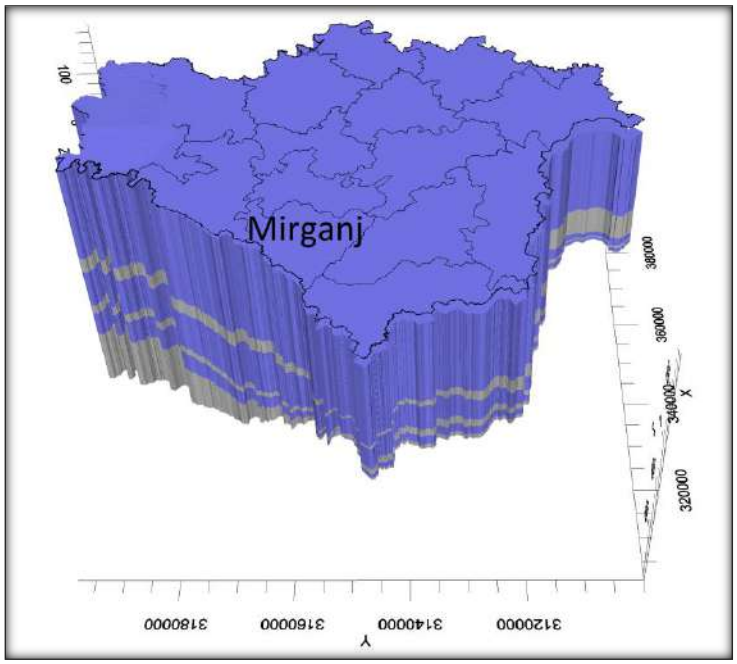


Fig: 7.12a: 3D disposition of Aquifer system

4. Ground water resource, extraction and other issues

Table 40: Ground Water Resource (Static+Dynamic), Extraction as on March, 2020 MEERGANJ Block, Bareilly, UP

A	**FIRST AQUIFER SYSTEM**	
1	**Dynamic Resources (Fresh)**	58.37 MCM
2	**Total GW Extraction**	38.54 MCM
3	**Stage of Ground Water Extraction**	66.03%
4	**Category**	Safe
5	**Static Resources (Fresh)**	4335.00 MCM
7	**Total Resources Dynamic + Static (Fresh)**	4393.37 MCM

Issues: Dependency on Ground Water for Irrigation and declining trend of water level.

Iron (Fe^{3+}) along with Manganese (Mn) is present in the Ground Water in excess quantity beyond permissible limits.

5. Chemical Quality of ground water and contamination

Table 7.12d: Basic Chemical Quality of Phreatic Aquifer, MEERGANJ Block, Bareilly, UP

Basic Parameter	Permissible Limit	Results
	BIS 10500:2012	
pH	6.5-8.5	8.35
EC (□S/cm) at 25^0C	3000	345
CO_3 mg/l	-	30
HCO_3 mg/l	-	110
Cl mg/l	1000	7.1
F mg/l	1.5	BDL
NO_3 mg/l	45	BDL
SO_4 mg/l	400	14
TH as $CaCO_3$ mg/l	600	110
Ca mg/l	200	12
Mg mg/l	100	19
Na mg/l	-	23
K mg/l	-	8.4
SiO_2 mg/l	-	42
PO_4 mg/l	-	Nd

Table 41: Heavy Metal concentration of Shallow Aquifer MEERGANJ Block, Bareilly, UP

Heavy Metals		Fe in ppm	Mn in ppm	Cu in ppm	Zn in ppm	As in ppb	Pb in ppb	U in ppb	Cr in ppb
Permissible Limit	BIS 10500:2012	1	0.3	1.5	15	10	10	30	50
Results		4.16	0.33	0	0.75	7	1	0	0

6. Ground Water Management:

Table 42: Ground Water Management Strategies and Projected Stage of Extraction

Block	Check Dams (Nos)	Nala Bunds (Nos)	Stream Development (Km)	Ponds (Nos)	On-farm Activities (ha)	Water Use Efficiency (ha)	Recharge from Structure MCM	Saving from Structures MCM	Saving frm On-farm & WUE MCM	Total Recharge MCM	Total Saving MCM	Present Stage of Ground Water Extraction (%)	Projected Stage of Extraction (%) After Interventions
MEERGANJ	1	1	1	2	1811	1811	0.08	0.08	2.32	0.08	2.41	66.03	61.82

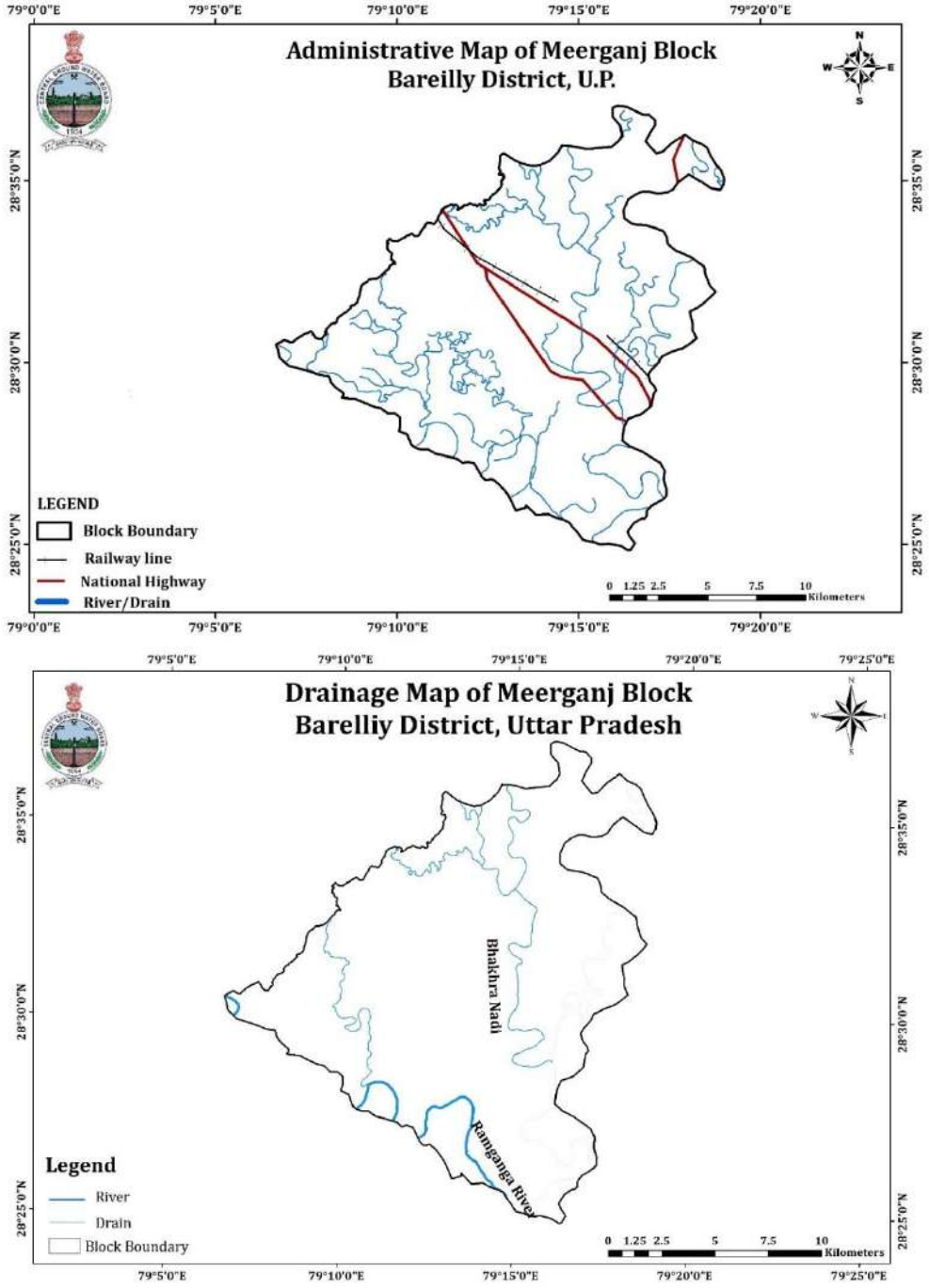


Fig 11: Administrative and Drainage map of MEERGANJ Block, Bareilly District, UP

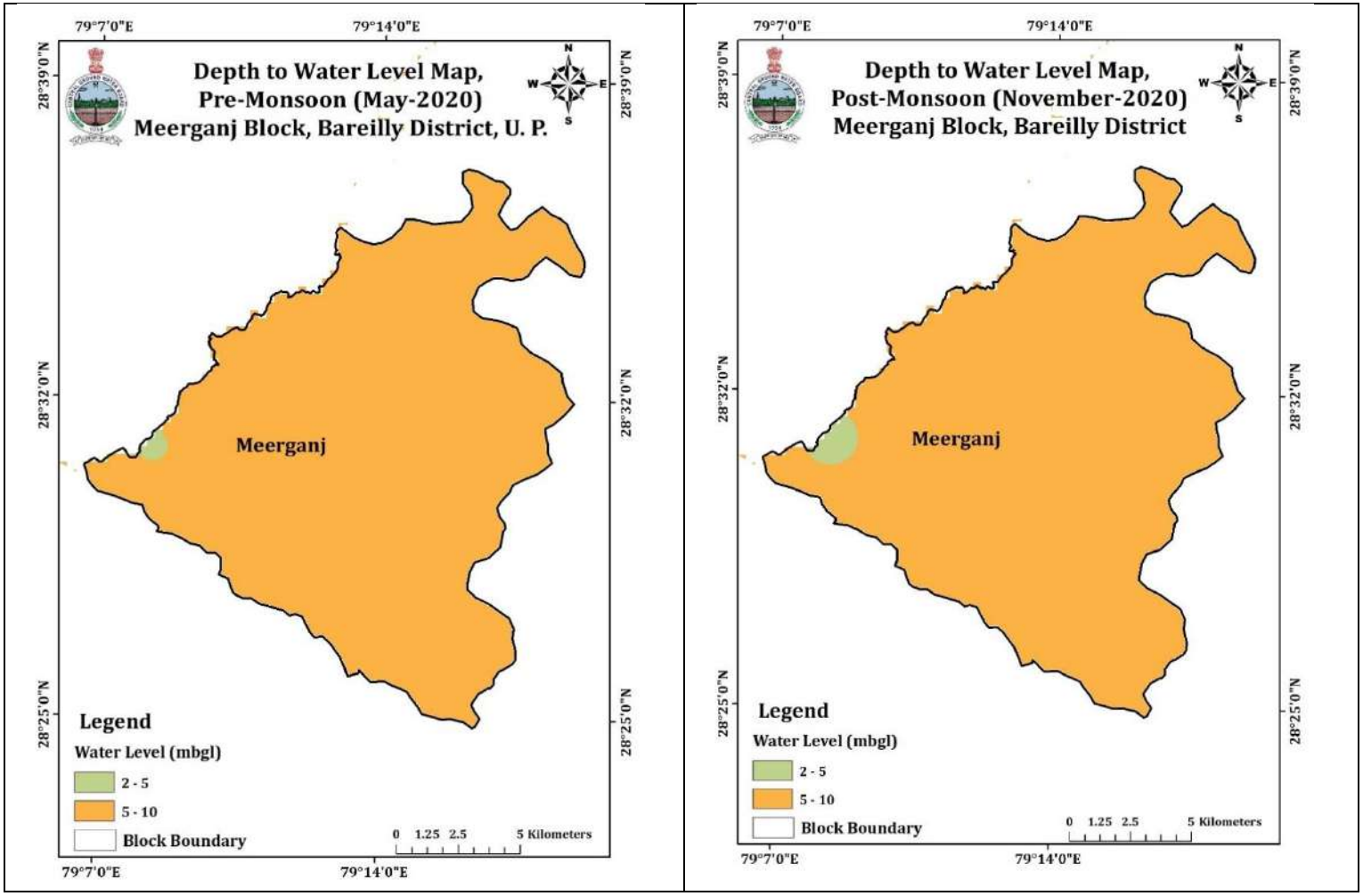


Fig 7.12c: Water Level map of pre-and post-monsoon 2020 of Meerganj Block, Bareilly district, UP

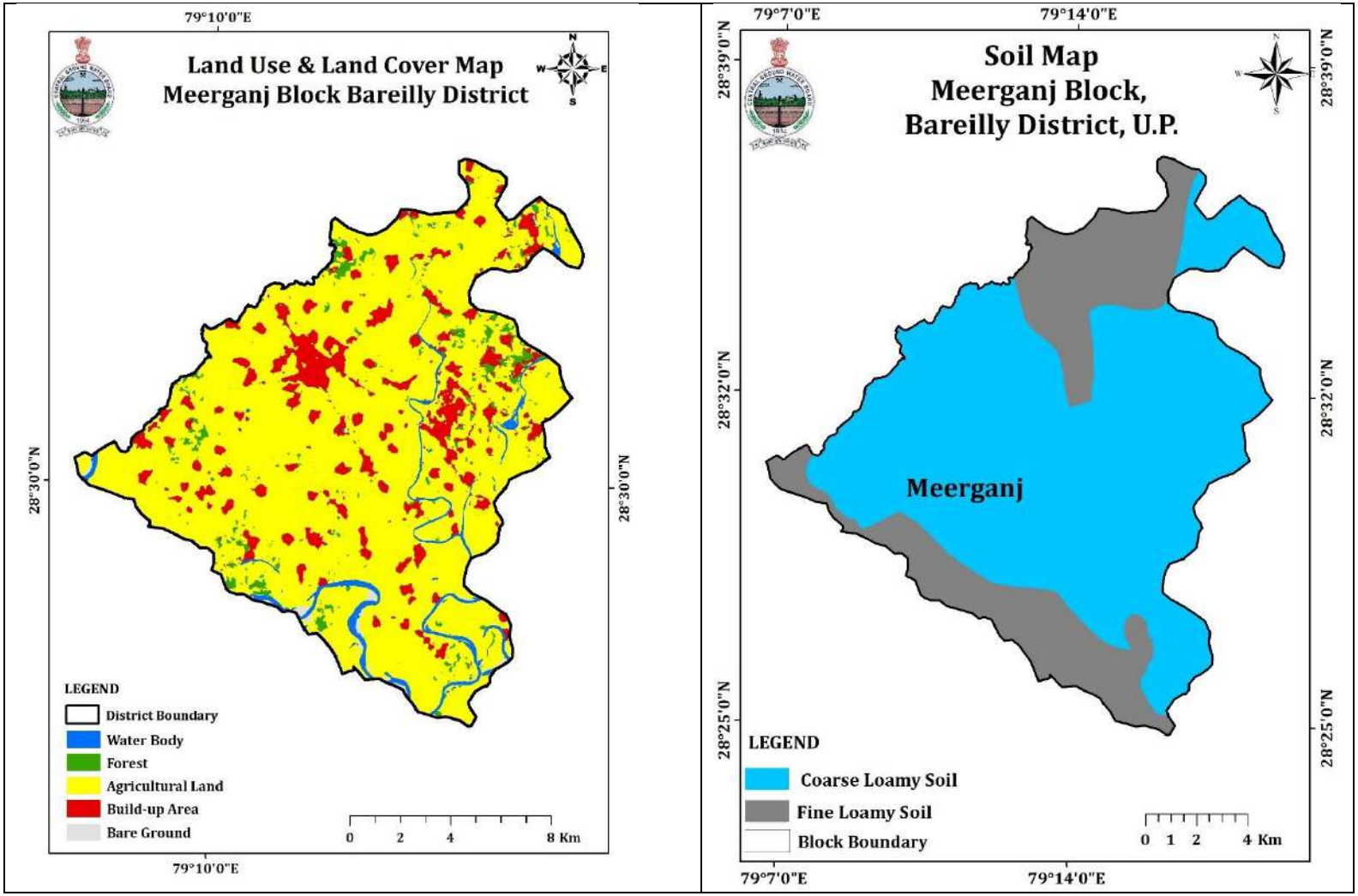


Figure 7.12d: Land use & Land cover and Soil Map of MAJHGAWA Block, Bareilly district, UP

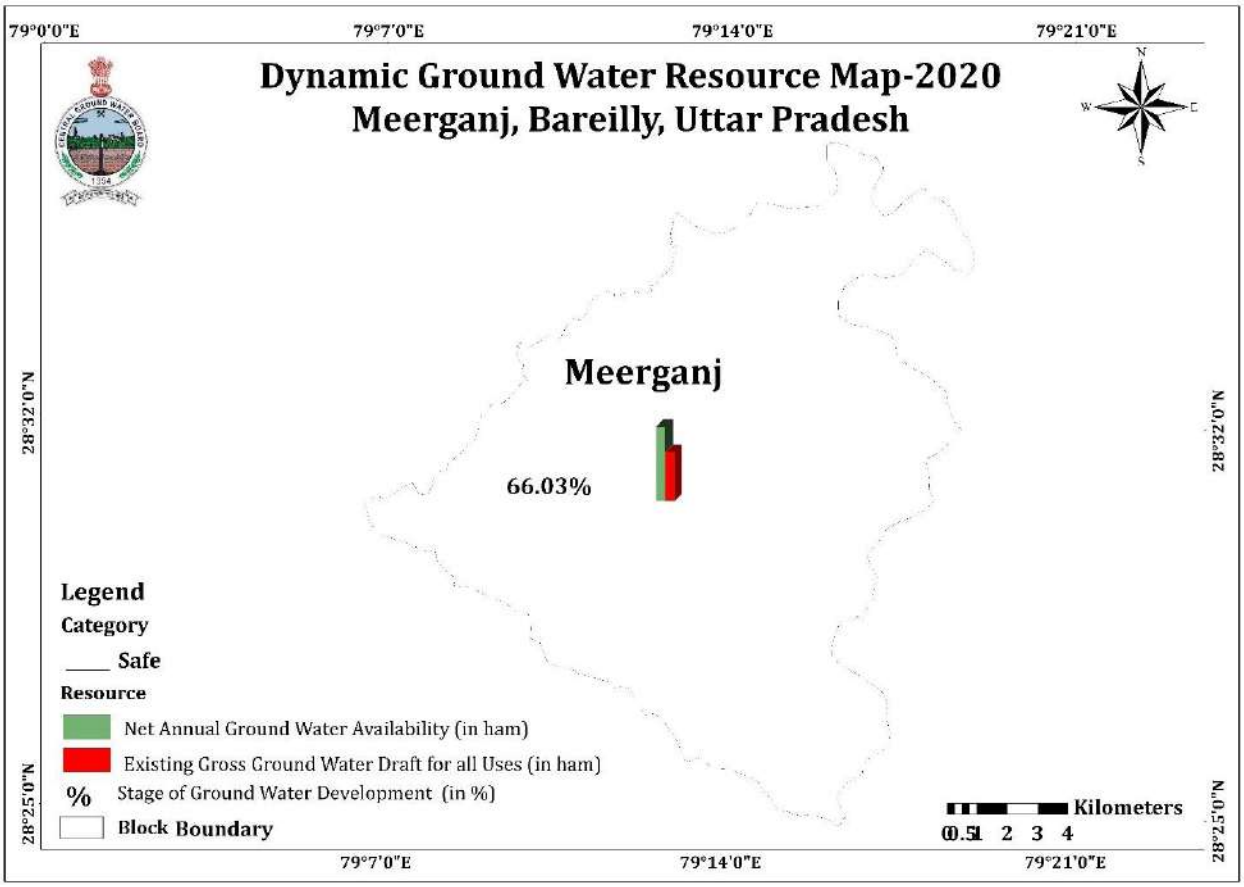


Figure 7.12e : Dynamic GW Resource Map of MEERGANJ Block, Bareilly district, UP

7.13 AQUIFER MAPPING AND MANAGEMENT PLAN OF NAWABGANJ BLOCK, BAREILLY DISTRICT, U.P.

1. Salient Information

Table 7.13a: Salient Information of NAWABGANJ Block, Bareilly District, UP

Area	345.09 Sq. Km					
Population	250055	**Male**	131864	**Female**	118191	
Population Density	739 persons/sq km					
Annual Rainfall (2011-20)	***957*** mm	**Monsoon**	***839.***5mm	**Non-Monsoon**	***117.5*** mm	

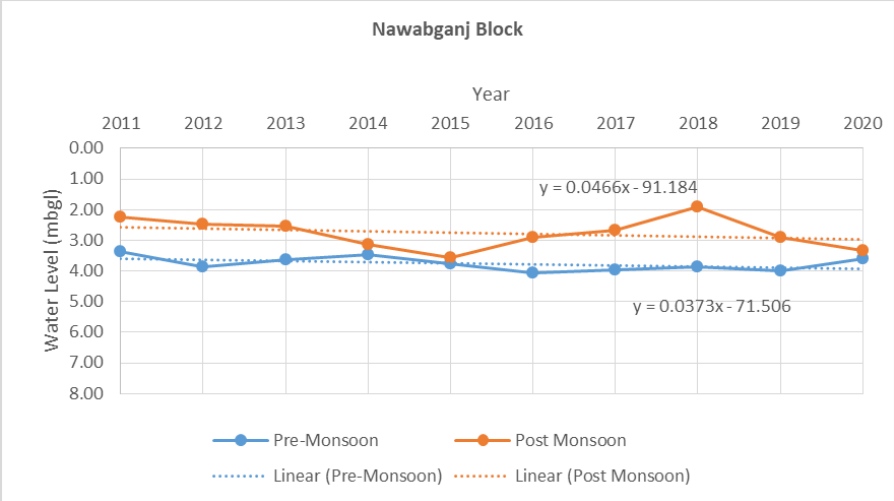
Table7.3b: Agriculture and Irrigation NAWABGANJ Block, Bareilly District, UP

Net Sown Area	27398	**Gross Sown Area**	46291
Net Irrigated Area	26629	**Gross Irrigated Area**	47159
Irrigation Intensity	177.10 %	**Irrigation by GW**	88.26 %
Irrigation by SW	11.74 %		

*Area in Hectare

2. Water Level Behaviour

The average depth to water level has been observed as 3.61 mbgl during Pre-monsoon (2020) and 3.34 mbgl during post-monsoon (2020). For the period of 2011-2020 Pre-monsoon water level trend is 0.04 m/year and post-monsoon water level trend is 0.05m/year.



3. Aquifer Disposition

Three aquifer groups exist in the block:

Aquifer Group I: Ground level to 195 mbgl.

Aquifer Group II: 210mbgl to 330mbgl.

Aquifer Group III: 320 mbgl- 370mbgl.

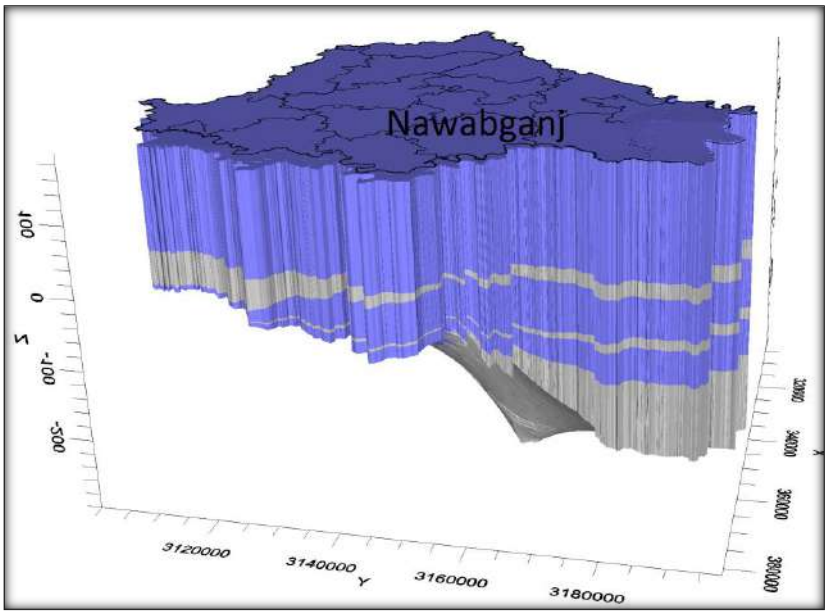


Fig: 7.13a: 3D disposition of Aquifer system

4. Ground water resource, extraction and other issues

Table 43: Ground Water Resource (Static+Dynamic), Extraction as on March, 2020 NAWABGANJ Block, Bareilly, UP

A	**FIRST AQUIFER SYSTEM**	
1	**Dynamic Resources (Fresh)**	101.81MCM
2	**Total GW Extraction**	62.38 MCM
3	**Stage of Ground Water Extraction**	61.27%
4	**Category**	Semi critical
5	**Static Resources (Fresh)**	4693.22 MCM
7	**Total Resources Dynamic + Static (Fresh)**	4795 MCM

5. Chemical Quality of ground water and contamination

Table 7.13d: Basic Chemical Quality of Phreatic Aquifer NAWABGANJ Block, Bareilly, UP

Basic Parameter	Permissible Limit	Results
	BIS 10500:2012	
pH	6.5-8.5	8.38
EC (□S/cm) at 25^{0}C	3000	389
CO_3 mg/l	-	36
HCO_3 mg/l	-	122
Cl mg/l	1000	14
F mg/l	1.5	0.35
NO_3 mg/l	45	BDL
SO_4 mg/l	400	20
TH as $CaCO_3$ mg/l	600	130
Ca mg/l	200	32
Mg mg/l	100	12
Na mg/l	-	27
K mg/l	-	6.9
SiO_2 mg/l	-	49
PO_4 mg/l	-	**Nd**

Table 44: Heavy Metal concentration of Shallow Aquifer NAWABGANJ Block, Bareilly, UP

Heavy Metals		Fe in ppm	Mn in ppm	Cu in ppm	Zn in ppm	As in ppb	Pb in ppb	U in ppb	Cr in ppb
Permissible Limit	**BIS 10500:2012**	1	0.3	1.5	15	10	10	30	50
Results		0.11	0.07	0	0.12	2	1	6	0

6. Ground Water Management:

Table 45: Ground Water Management Strategies and Projected Stage of Extraction

Block	Check Dams (Nos)	Nala Bunds (Nos)	Stream Development (Km)	Ponds (Nos)	On-farm Activities (ha)	Water Use Efficiency (ha)	Recharge from Structure MCM	Saving from Structures MCM	Saving frm On-farm & WUE MCM	Total Recharge MCM	Total Saving MCM	Present Stage of Ground Water Extraction (%)	Projected Stage of Extraction (%) After Interventions
NAWABGANJ	2	2	2	3	2740	2740	0.14	0.14	3.36	0.14	3.50	61.26	57.75

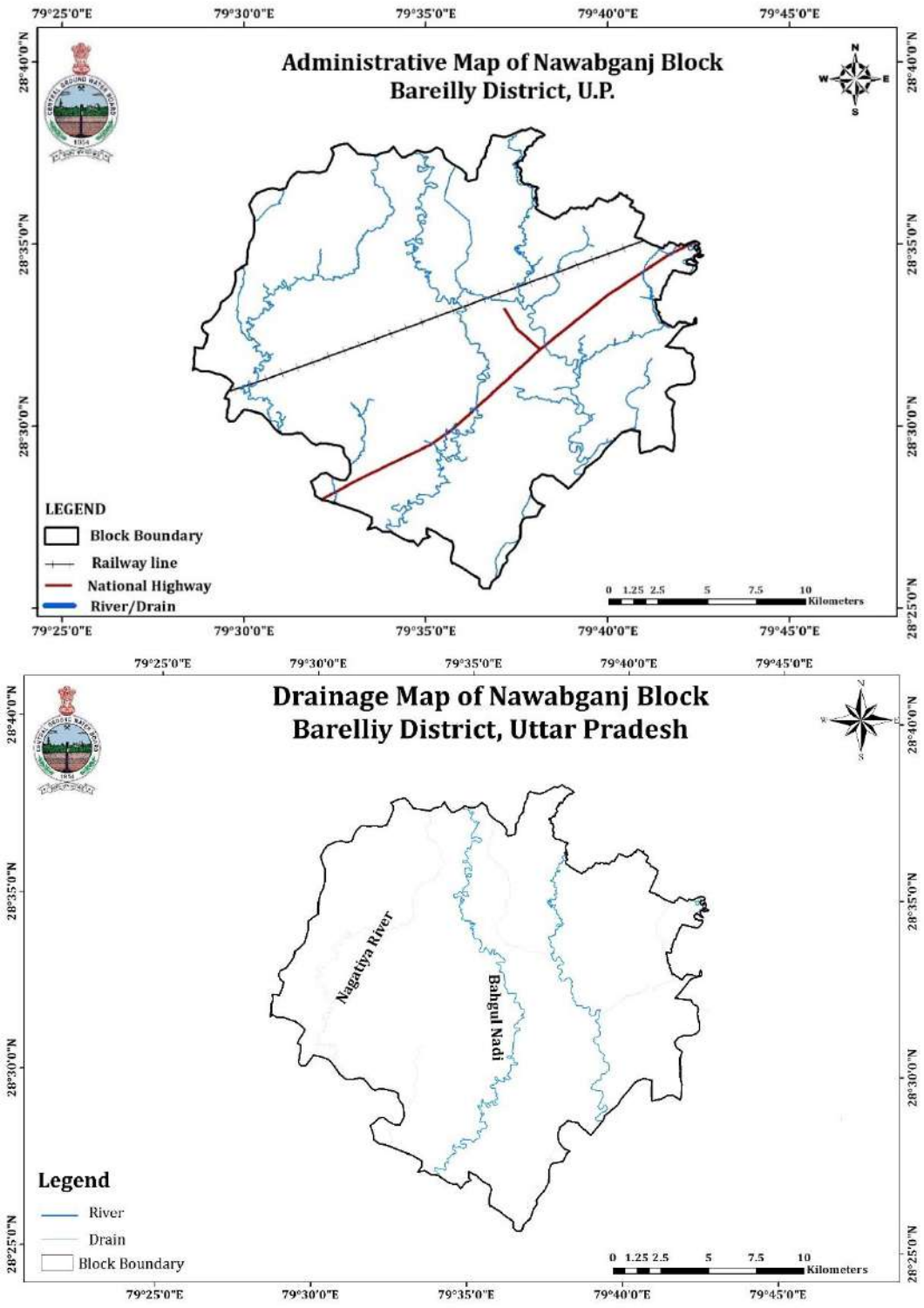


Fig 12: Administrative and Drainage map of NAWABGANJ Block, Bareilly District, UP

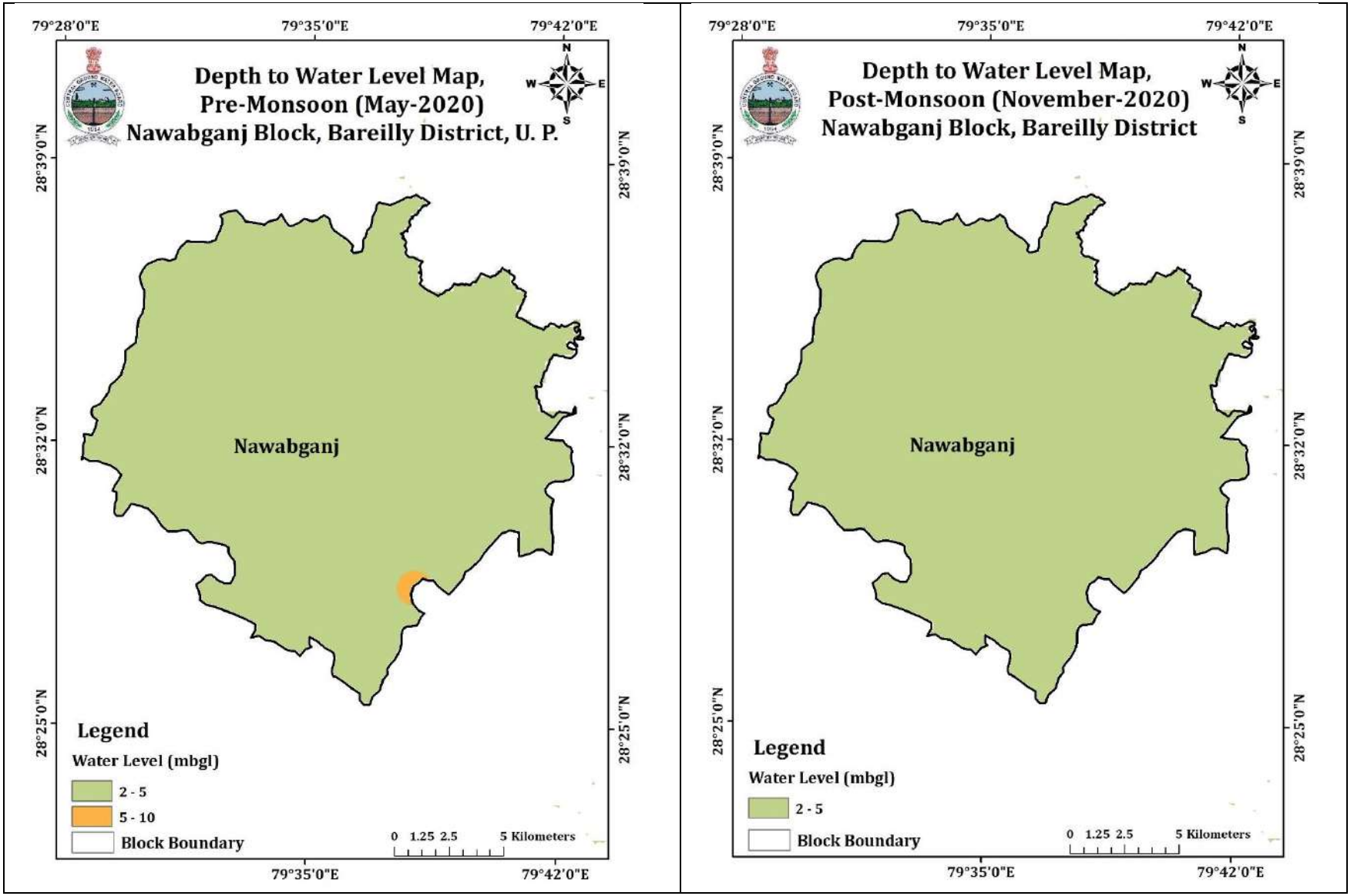


Fig 7.13c: Water Level map of pre-and post-monsoon 2020 of NAWABGANJ Block, Bareilly district, UP

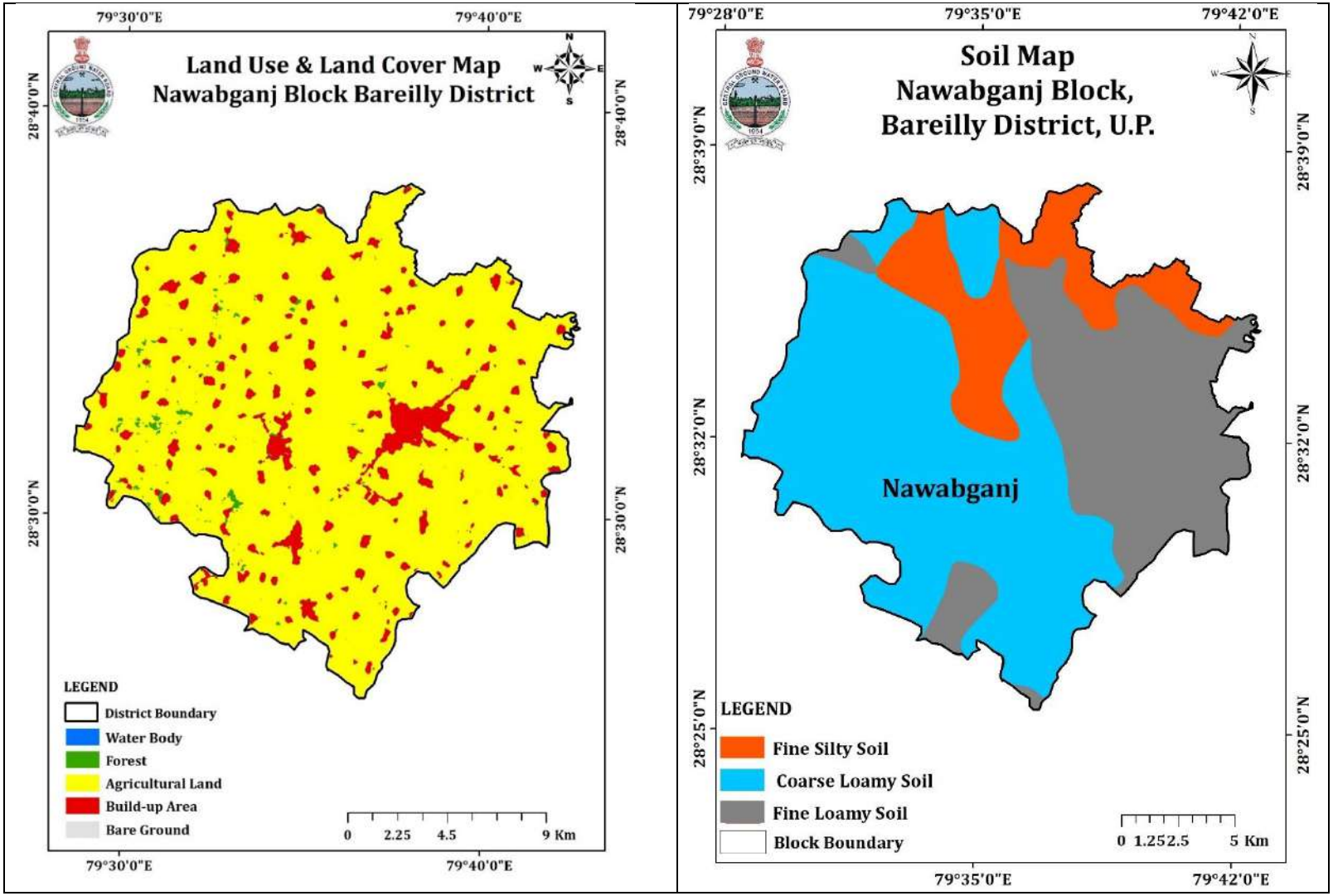


Figure 7.13d: Land use & Land cover and Soil Map of NAWABGANJ Block, Bareilly district, UP

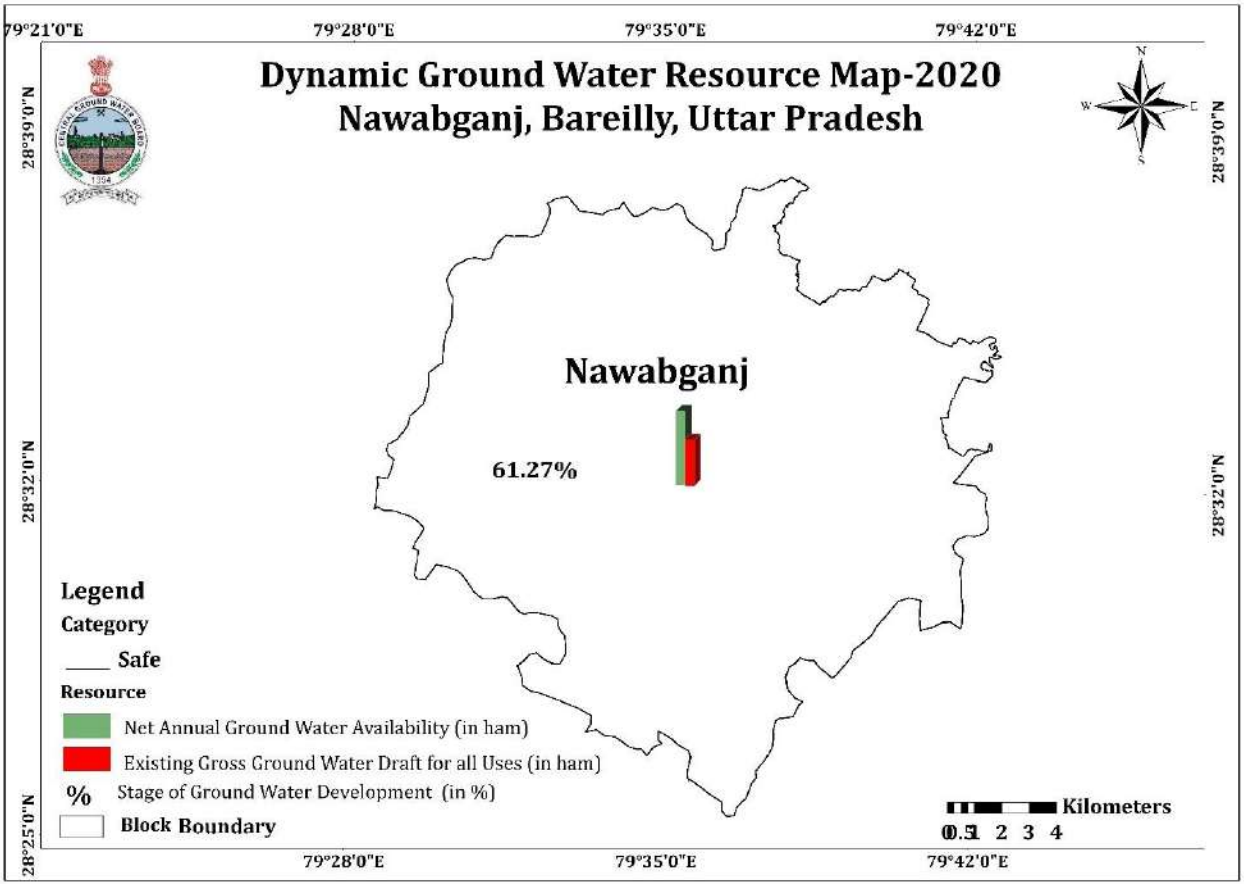


Figure 7.13e : Dynamic GW Resource Map NAWABGANJ Block, Bareilly district, UP

7.14 AQUIFER MAPPING AND MANAGEMENT PLAN OF RAMNAGAR BLOCK, BAREILLY DISTRICT, U.P.

1. Salient Information

Table 7.14a: Salient Information of RAMNAGAR Block, Bareilly District, UP

Area	193.06 Sq. Km					
Population	161170	**Male**	86275	**Female**	74895	
Population Density	835 persons/sq km					
Annual Rainfall (2011-20)	***957*** mm	**Monsoon**	***839.***5mm	**Non-Monsoon**	***117.5*** mm	

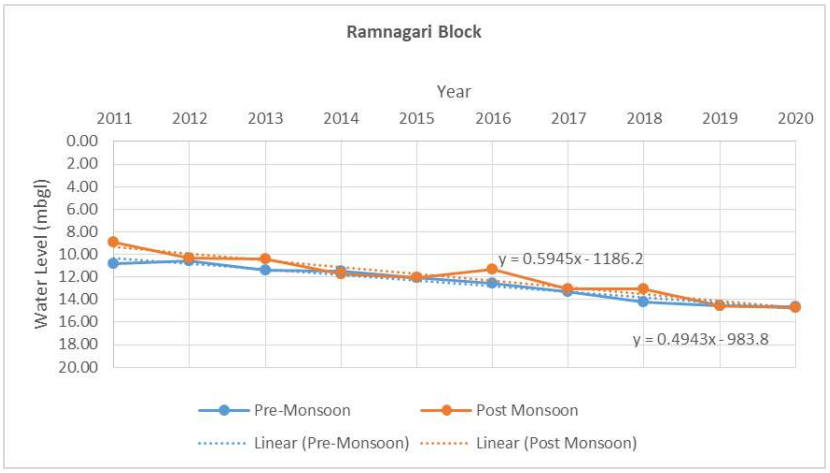
Table7.4b: Agriculture and Irrigation RAMNAGAR Block, Bareilly District, UP

Net Sown Area	18961	**Gross Sown Area**	31154
Net Irrigated Area	18409	**Gross Irrigated Area**	29262
Irrigation Intensity	158.95 %	**Irrigation by GW**	95.08 %
Irrigation by SW	4.92 %		

*Area in Hectare

2. Water Level Behaviour

The average depth to water level has been observed as 14.61 mbgl during Pre-monsoon (2020) and 14.70 mbgl during post-monsoon (2020). For the period of 2011-2020 Pre-monsoon water level trend is 0.49 m/year and post-monsoon water level trend is 0.59m/year.



3. Aquifer Disposition

Three aquifer groups exist in the block:

Aquifer Group I: Ground level to 212 mbgl.

Aquifer Group II: 200mbgl to 305mbgl.

Aquifer Group III: 320 mbgl- 350mbgl.

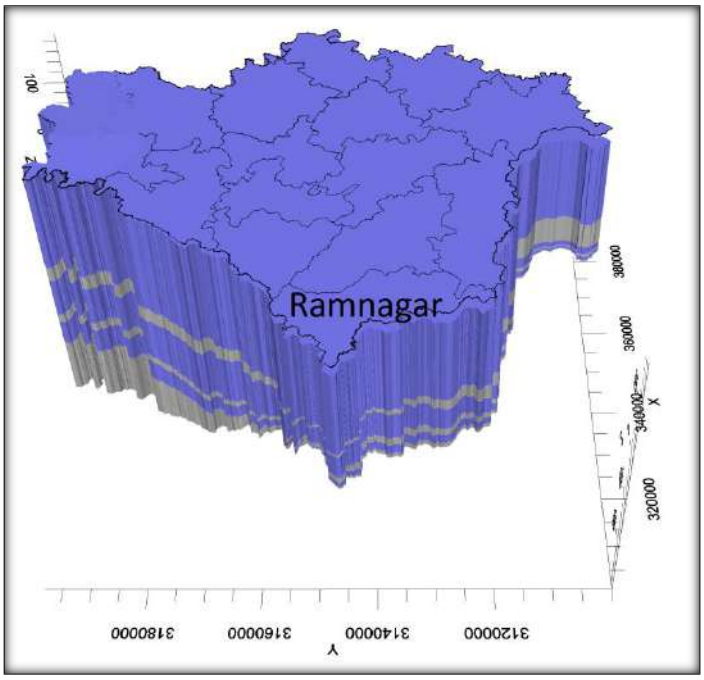


Fig: 7.14a: 3D disposition of Aquifer system

4. Ground water resource, extraction and other issues

Table 46: Ground Water Resource (Static+Dynamic), Extraction as on March, 2020 RAMNAGAR Block, Bareilly, UP

A	**FIRST AQUIFER SYSTEM**	
1	**Dynamic Resources (Fresh)**	59.19 MCM
2	**Total GW Extraction**	50.21 MCM
3	**Stage of Ground Water Extraction**	84.84 %
4	**Category**	Semi critical
5	**Static Resources (Fresh)**	3397.85 MCM
7	**Total Resources Dynamic + Static (Fresh)**	3457 MCM

Issues: Nitrate presence (49 mg/l) of more than permissible limit (40 mg/l) is reported in groundwater sample collected from the Block office premise.

5. Chemical Quality of ground water and contamination

Table 7.14d: Basic Chemical Quality of Phreatic Aquifer RAMNAGAR Block, Bareilly, UP

Basic Parameter	Permissible Limit	Results
	BIS 10500:2012	
pH	6.5-8.5	7.95
EC (□S/cm) at 25^{0}C	3000	320
CO_3 mg/l	-	nil
HCO_3 mg/l	-	98
Cl mg/l	1000	14
F mg/l	1.5	0.27
NO_3 mg/l	45	49
SO_4 mg/l	400	9
TH as $CaCO_3$ mg/l	600	130
Ca mg/l	200	36
Mg mg/l	100	9.6
Na mg/l	-	6
K mg/l	-	5.6
SiO_2 mg/l	-	48
PO_4 mg/l	-	**Nd**

Table 47: Heavy Metal concentration of Shallow Aquifer RAMNAGAR Block, Bareilly, UP

Heavy Metals		Fe in ppm	Mn in ppm	Cu in ppm	Zn in ppm	As in ppb	Pb in ppb	U in ppb	Cr in ppb
Permissible Limit	**BIS 10500:2012**	1	0.3	1.5	15	10	10	30	50
Results		0.13	0.01	0	0.13	3	1	0	0

6. Ground Water Management:

Table 48: Ground Water Management Strategies and Projected Stage of Extraction

Block	Check Dams (Nos)	Nala Bunds (Nos)	Stream Development (Km)	Ponds (Nos)	On-farm Activities (ha)	Water Use Efficiency (ha)	Recharge from Structure MCM	Saving from Structures MCM	Saving frm On-farm & WUE MCM	Total Recharge MCM	Total Saving MCM	Present Stage of Ground Water Extraction (%)	Projected Stage of Extraction (%) After Interventions
RAMNAGAR	1	1	1	2	1896	1896	0.08	0.08	2.80	0.08	2.88	84.84	79.87

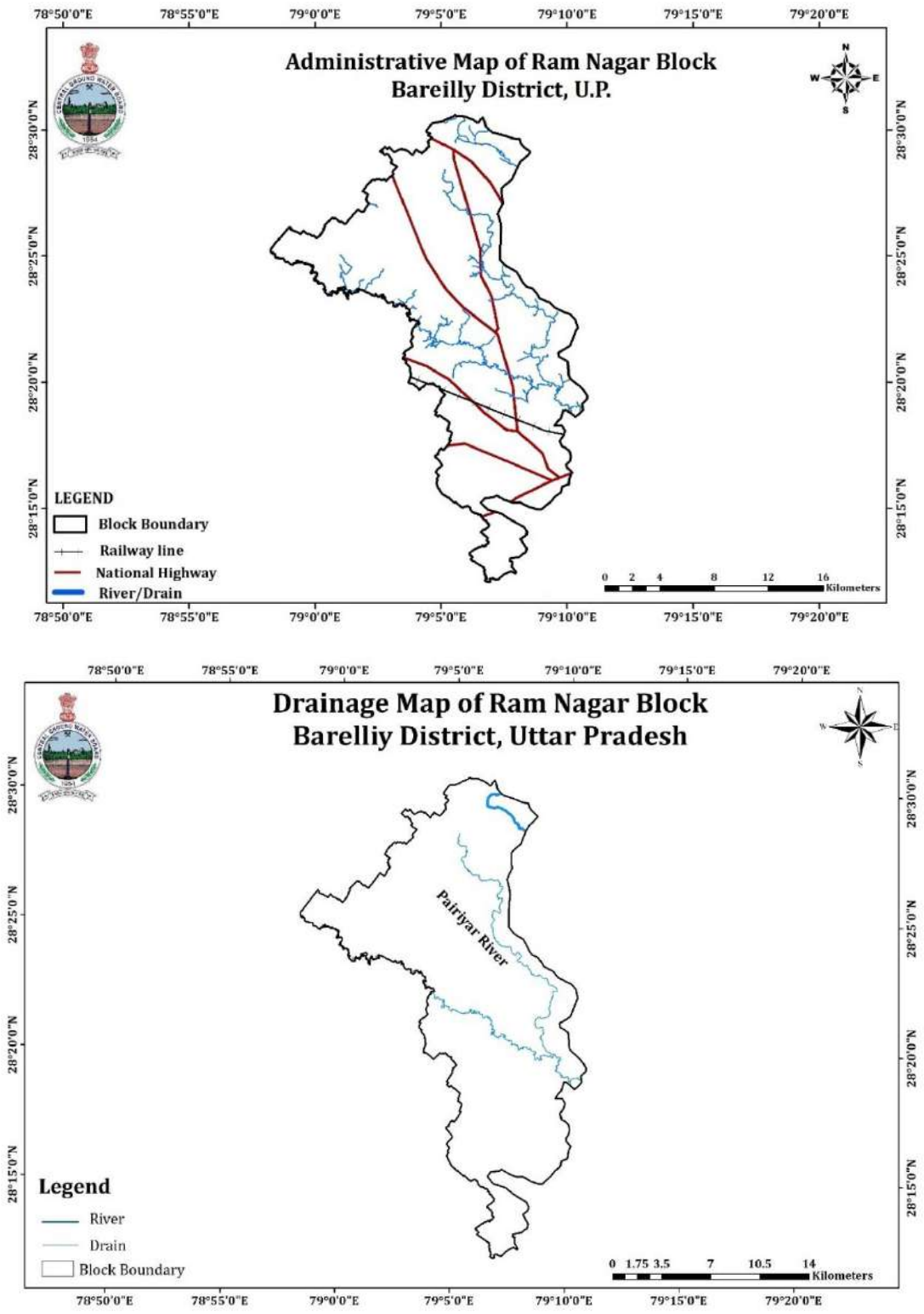


Fig 13: Administrative and Drainage map of RAMNAGAR Block, Bareilly District, UP

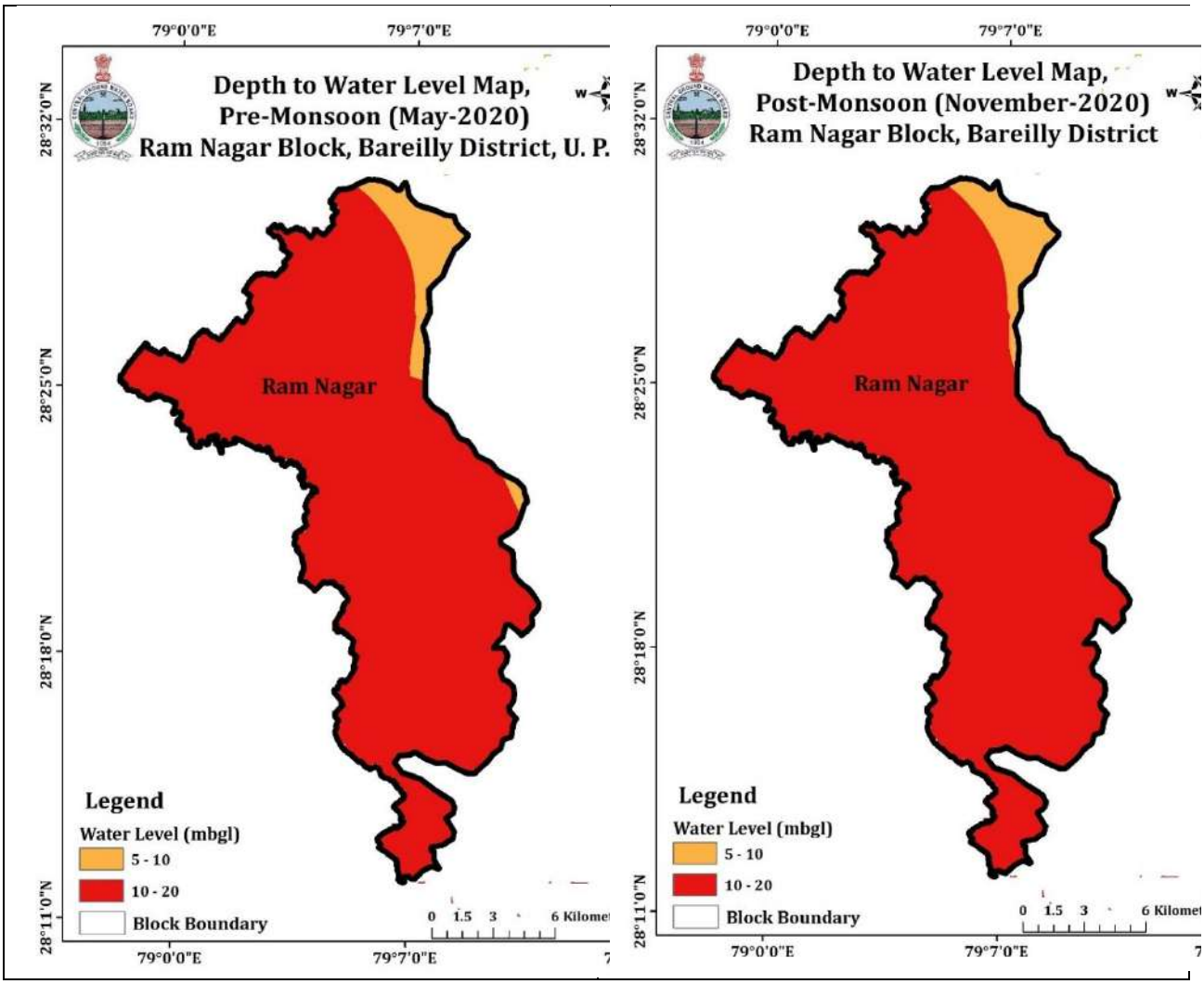


Fig 7.14c: Water Level map of pre-and post-monsoon 2020 of RAMNAGAR Block, Bareilly district, UP

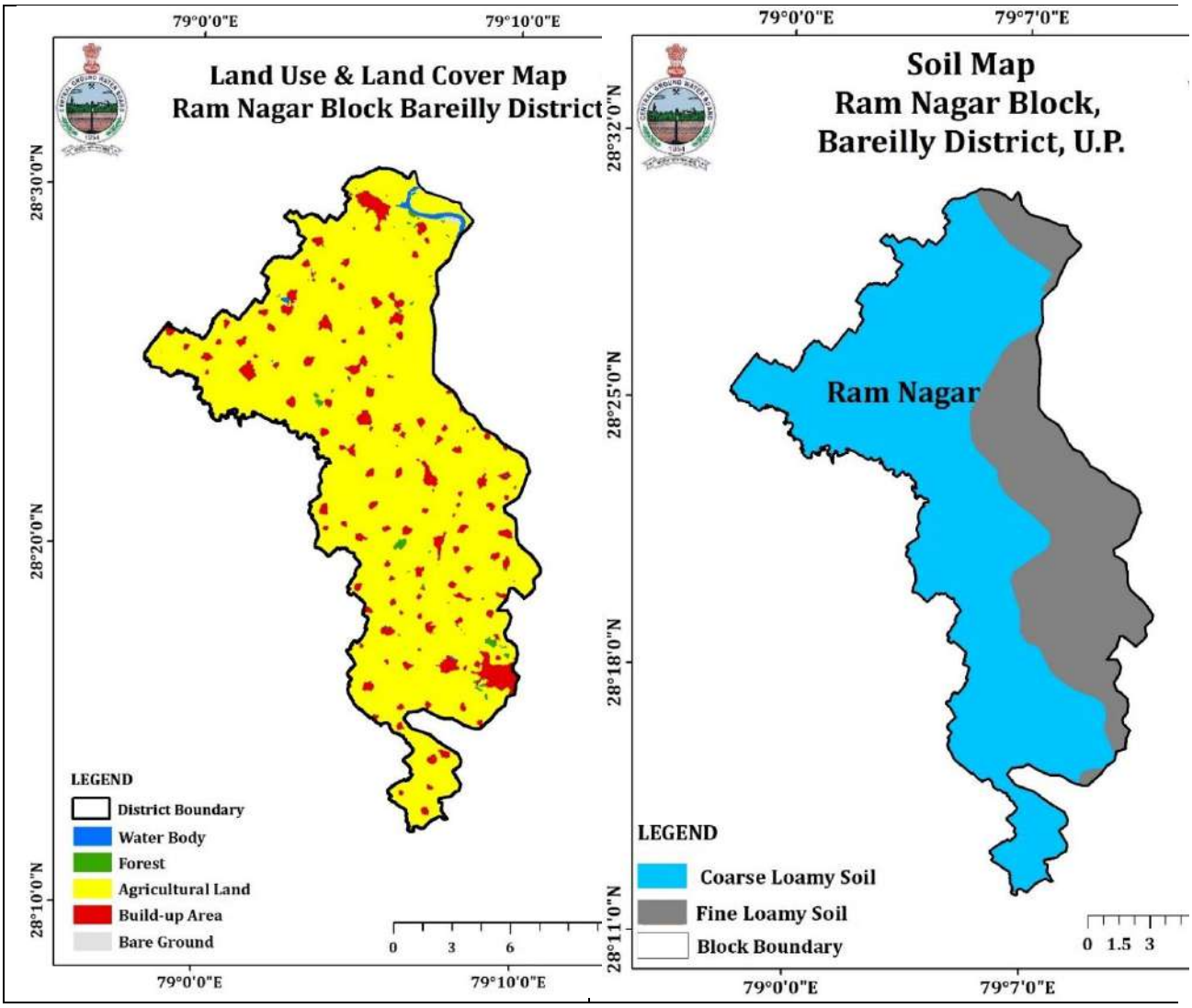


Figure 7.14d: Land use & Land cover and Soil Map of RAMNAGAR Block, Bareilly district, UP

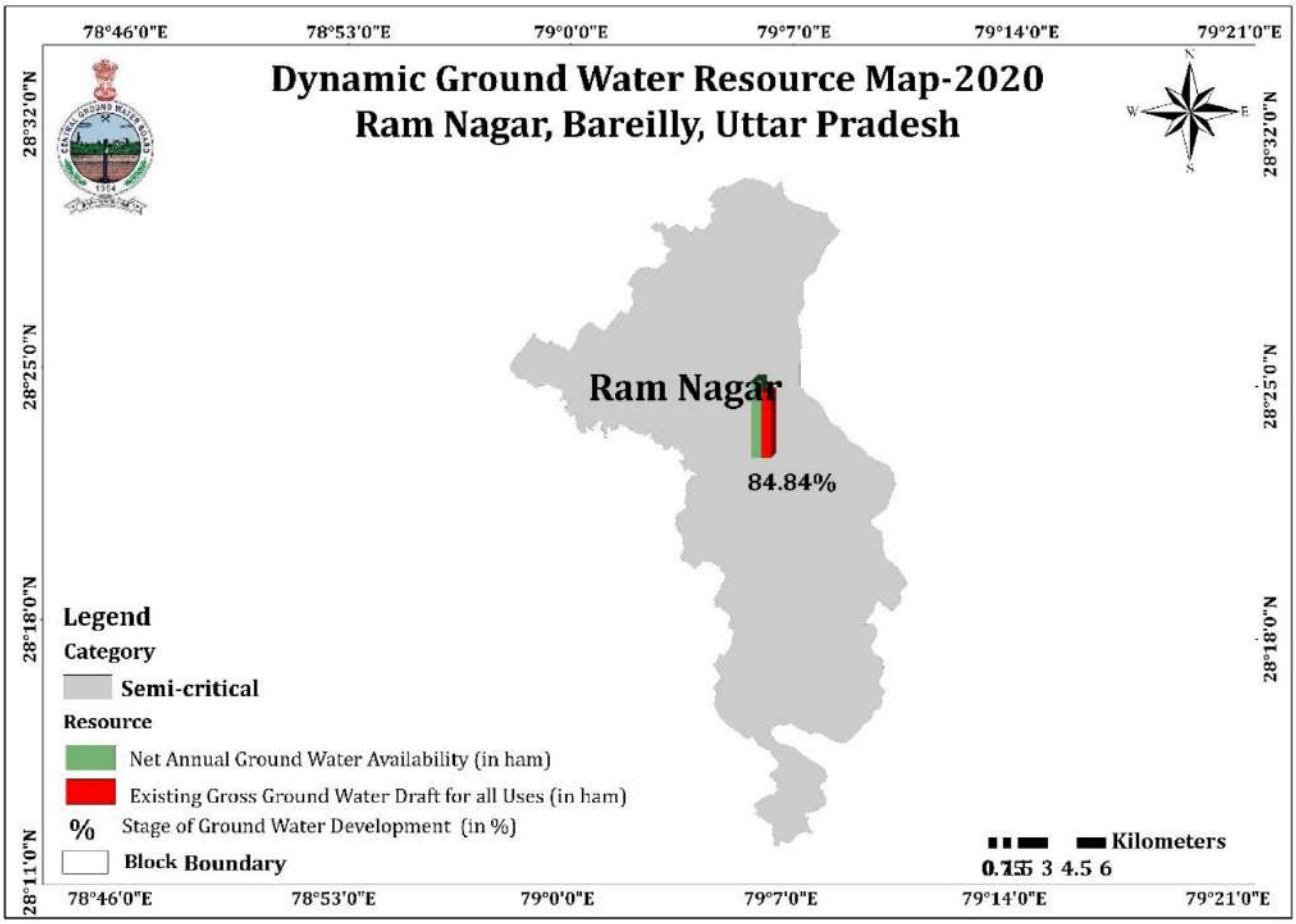


Figure 7.14e : Dynamic GW Resource Map RAMNAGAR Block, Bareilly district, UP

7.15 AQUIFER MAPPING AND MANAGEMENT PLAN OF RICHHA BLOCK, BAREILLY DISTRICT, U.P.

1. Salient Information

Table 7.15a: Salient Information of RICHHA Block, Bareilly District, UP

Area	266.2 Sq. Km					
Population	182167	**Male**	96016	**Female**	86151	
Population Density	684 persons/sq km					
Annual Rainfall (2011-20)	***957*** mm	**Monsoon**	***839.***5mm	**Non-Monsoon**	***117.5*** mm	

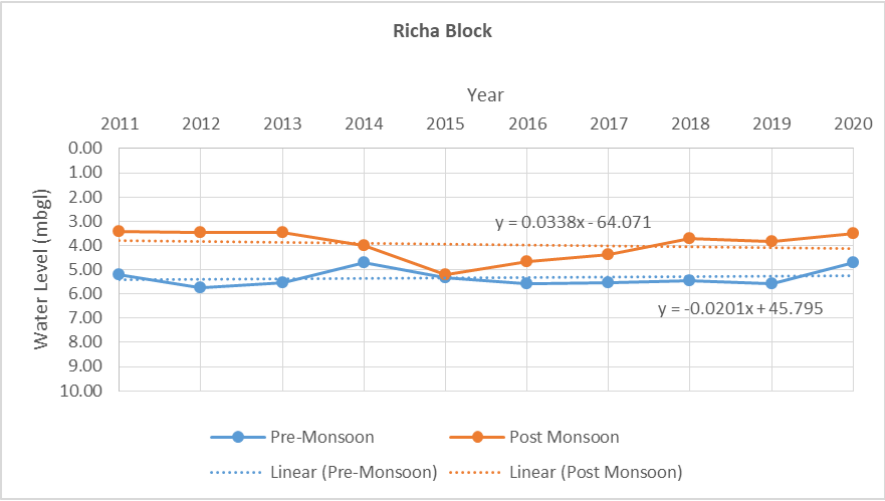
Table7.5b: Agriculture and Irrigation RICHHA Block, Bareilly District, UP

Net Sown Area	20434	**Gross Sown Area**	35485
Net Irrigated Area	20255	**Gross Irrigated Area**	31873
Irrigation Intensity	157.36 %	**Irrigation by GW**	85.71 %
Irrigation by SW	14.29 %		

*Area in Hectare

2. Water Level Behaviour

The average depth to water level has been observed as 4.7 mbgl during Pre-monsoon (2020) and 3.52 mbgl during post-monsoon (2020). For the period of 2011-2020 Pre-monsoon water level trend is 0.02 m/year and post-monsoon water level trend is 0.03m/year.



3. Aquifer Disposition

Three aquifer groups exist in the block:

Aquifer Group I: Ground level to 205 mbgl.

Aquifer Group II: 210mbgl to 305mbgl.

Aquifer Group III: 320 mbgl- 350mbgl.

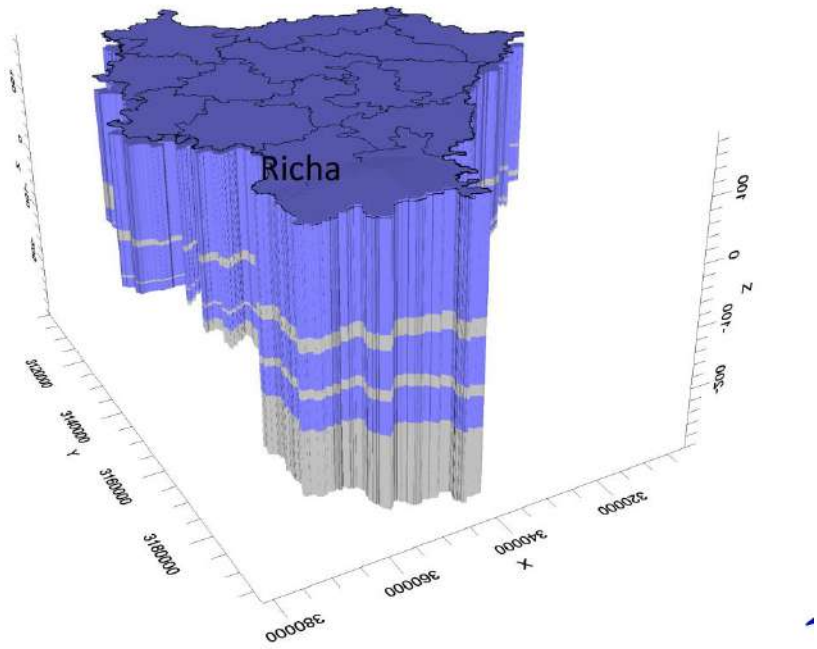


Fig: 7.15a: 3D disposition of Aquifer system

4. Ground water resource, extraction and other issues

Table 49: Ground Water Resource (Static+Dynamic), Extraction as on March, 2020 RICHHA Block, Bareilly, UP

A	**FIRST AQUIFER SYSTEM**	
1	**Dynamic Resources (Fresh)**	111.49 MCM
2	**Total GW Extraction**	72.23 MCM
3	**Stage of Ground Water Extraction**	64.73%
4	**Category**	Safe
5	**Static Resources (Fresh)**	4088.83 MCM
7	**Total Resources Dynamic + Static (Fresh)**	4200.32 MCM

5. Chemical Quality of ground water and contamination

Table 7.15d: Basic Chemical Quality of Phreatic Aquifer RICHHA Block, Bareilly, UP

Basic Parameter	Permissible Limit	Results
	BIS 10500:2012	
pH	6.5-8.5	7.99
EC (□S/cm) at 25^0C	3000	382
CO_3 mg/l	-	nil
HCO_3 mg/l	-	195
Cl mg/l	1000	7.1
F mg/l	1.5	0.39
NO_3 mg/l	45	BDL
SO_4 mg/l	400	24
TH as $CaCO_3$ mg/l	600	120
Ca mg/l	200	28
Mg mg/l	100	12
Na mg/l	-	29
K mg/l	-	6.4
SiO_2 mg/l	-	31
PO_4 mg/l	-	**Nd**

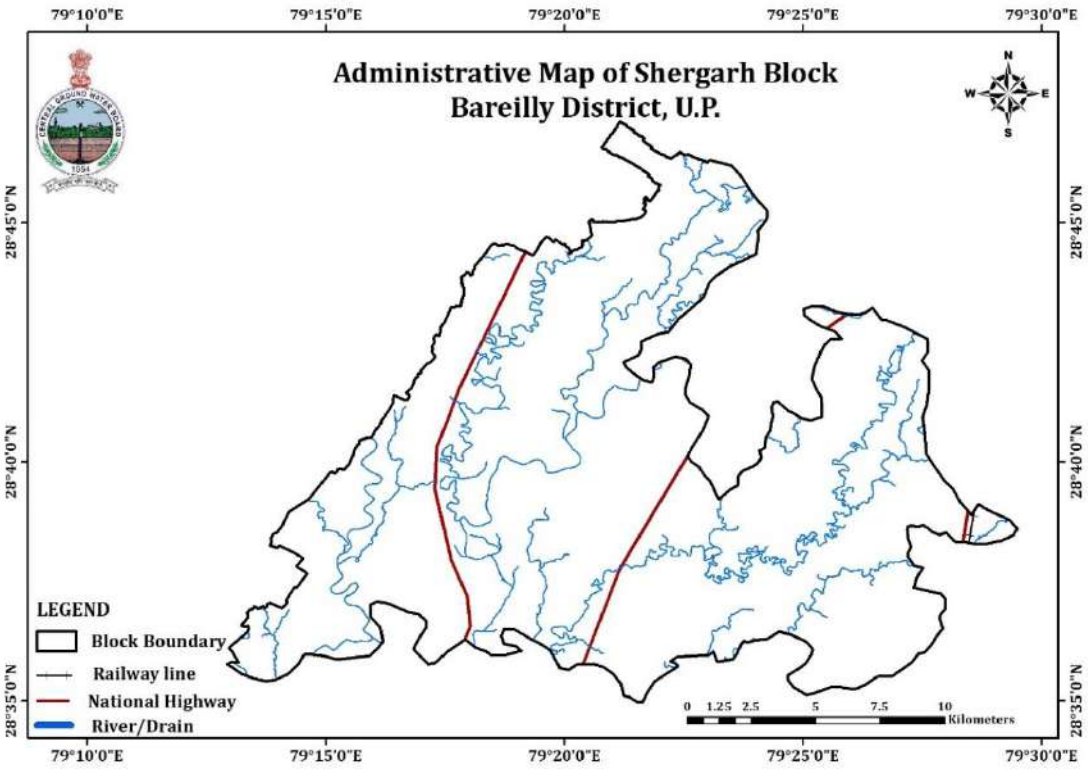
Table 50: Heavy Metal concentration of Shallow Aquifer RICHHA Block, Bareilly, UP

Heavy Metals		Fe in ppm	Mn in ppm	Cu in ppm	Zn in ppm	As in ppb	Pb in ppb	U in ppb	Cr in ppb
Permissible Limit	**BIS 10500:2012**	1	0.3	1.5	15	10	10	30	50
Results		0.86	0.11	0	0.02	1	1	3	0

6. Ground Water Management:

Table 51: Ground Water Management Strategies and Projected Stage of Extraction

Block	Check Dams (Nos)	Nala Bunds (Nos)	Stream Development (Km)	Ponds (Nos)	On-farm Activities (ha)	Water Use Efficiency (ha)	Recharge from Structure MCM	Saving from Structures MCM	Saving frm On-farm & WUE MCM	Total Recharge MCM	Total Saving MCM	Present Stage of Ground Water Extraction (%)	Projected Stage of Extraction (%) After Interventions
RICHHA	1	1	1	3	2043	2043	0.10	0.10	4.03	0.10	4.13	64.73	60.97



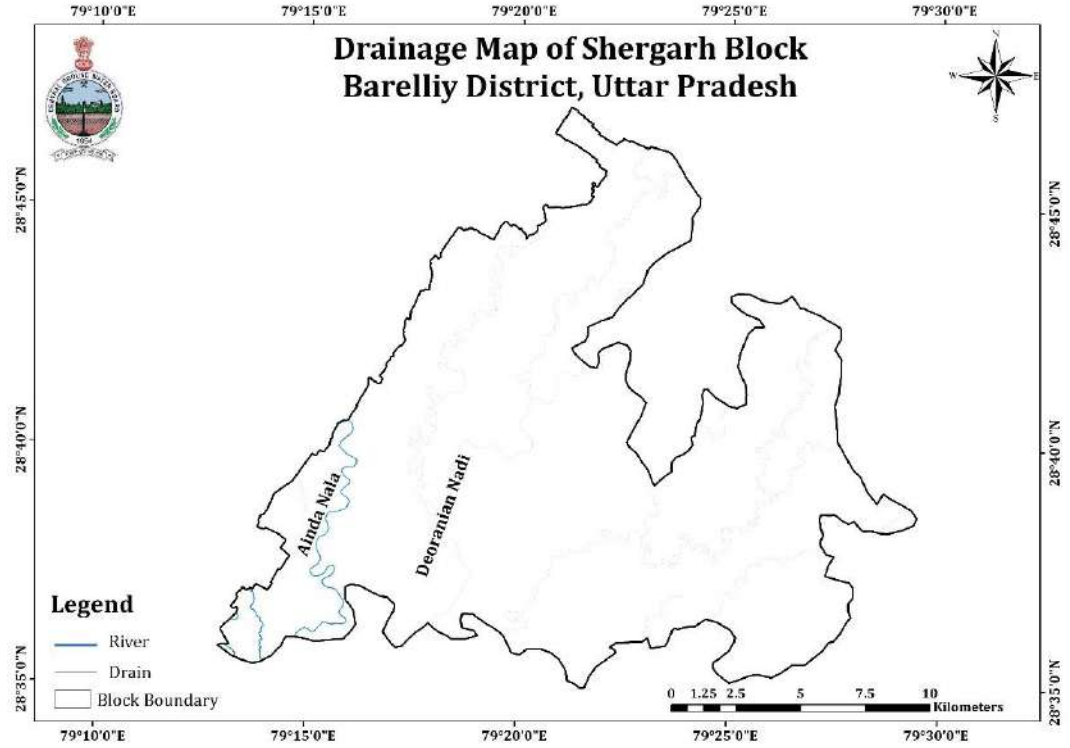


Fig 14: Administrative and Drainage map of RICHHA Block, Bareilly District, UP

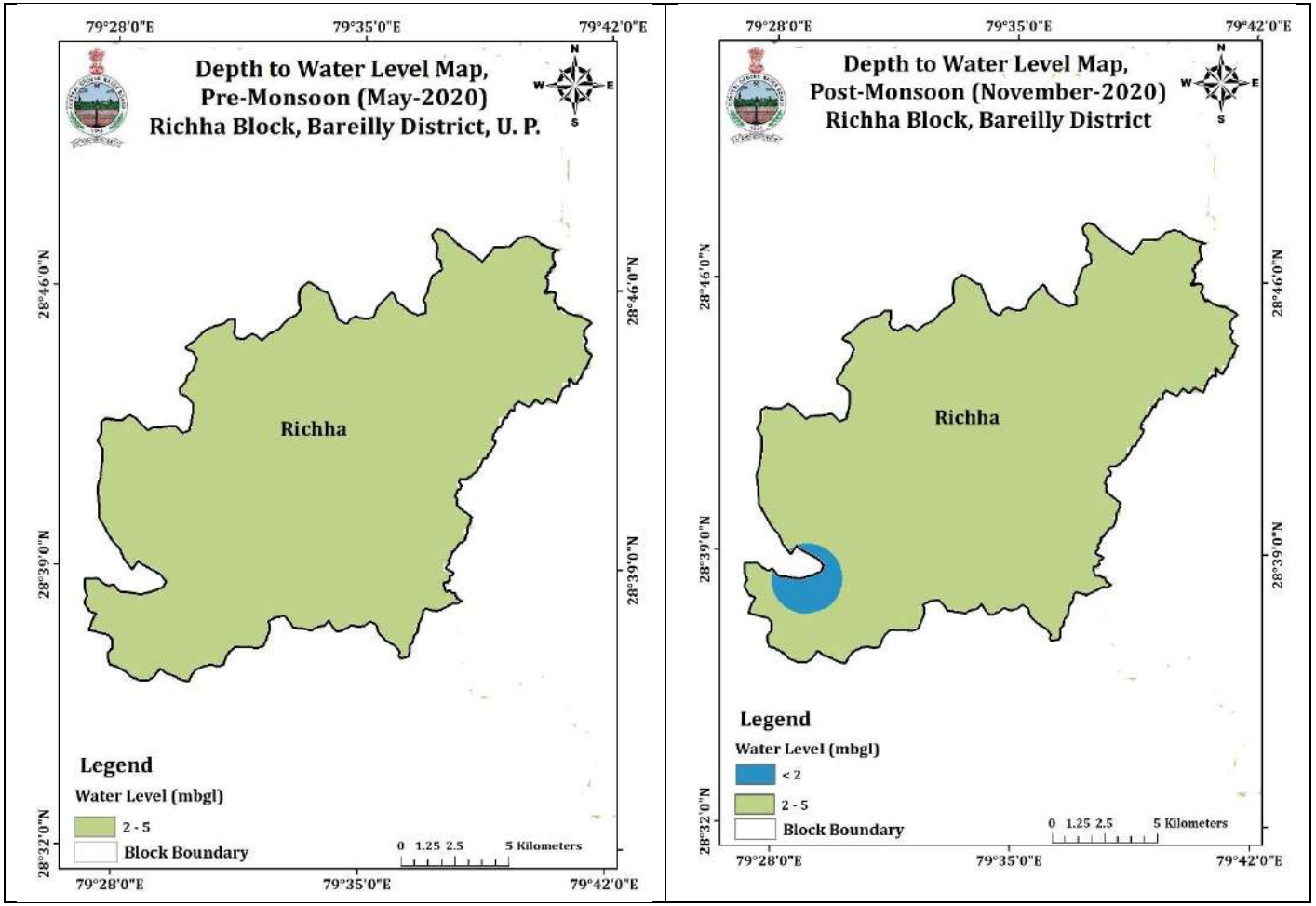


Fig 7.15c: Water Level map of pre-and post-monsoon 2020 of RICHHA Block, Bareilly district, UP

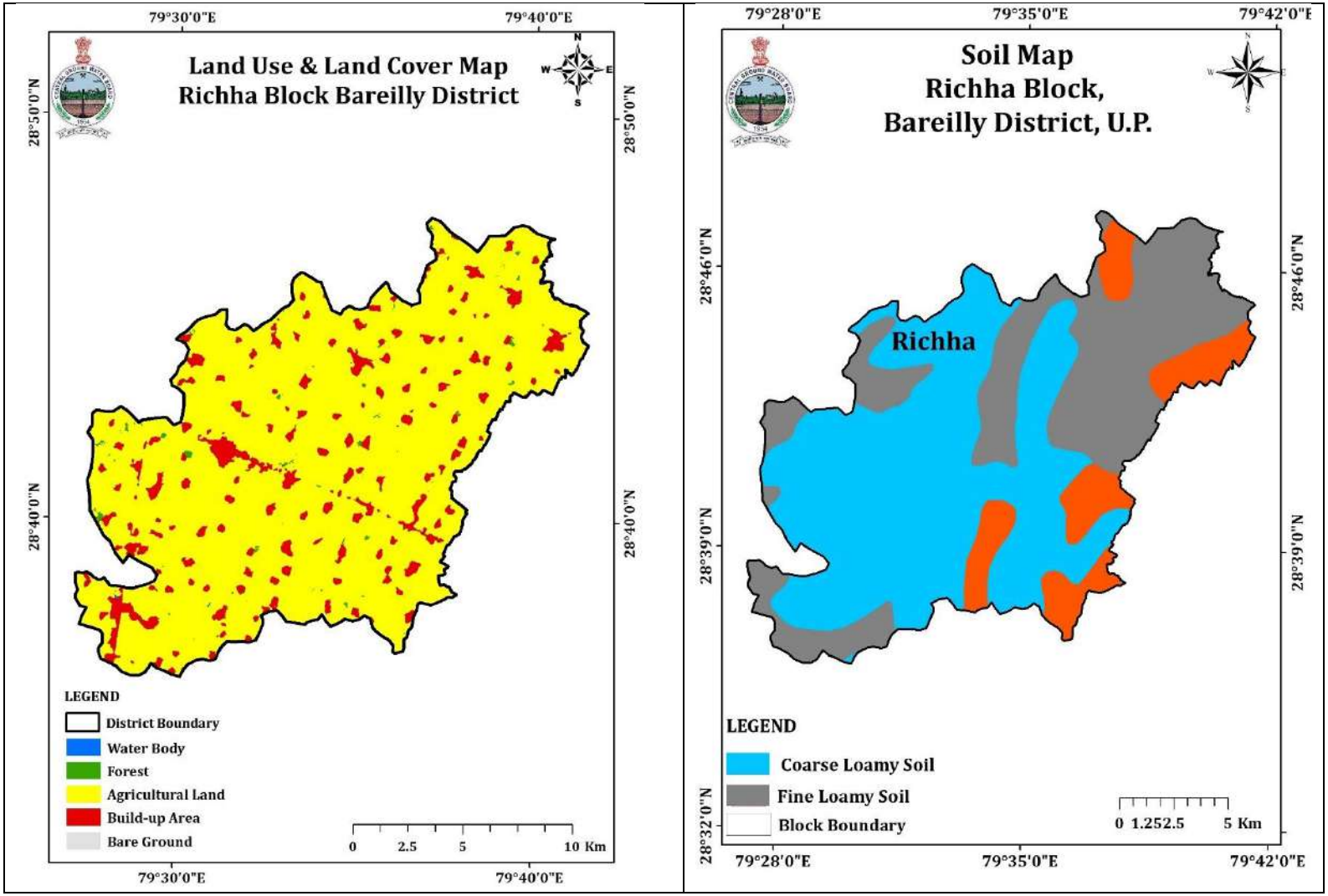


Figure 7.15d: Land use & Land cover and Soil Map of RICHHA Block, Bareilly district, UP

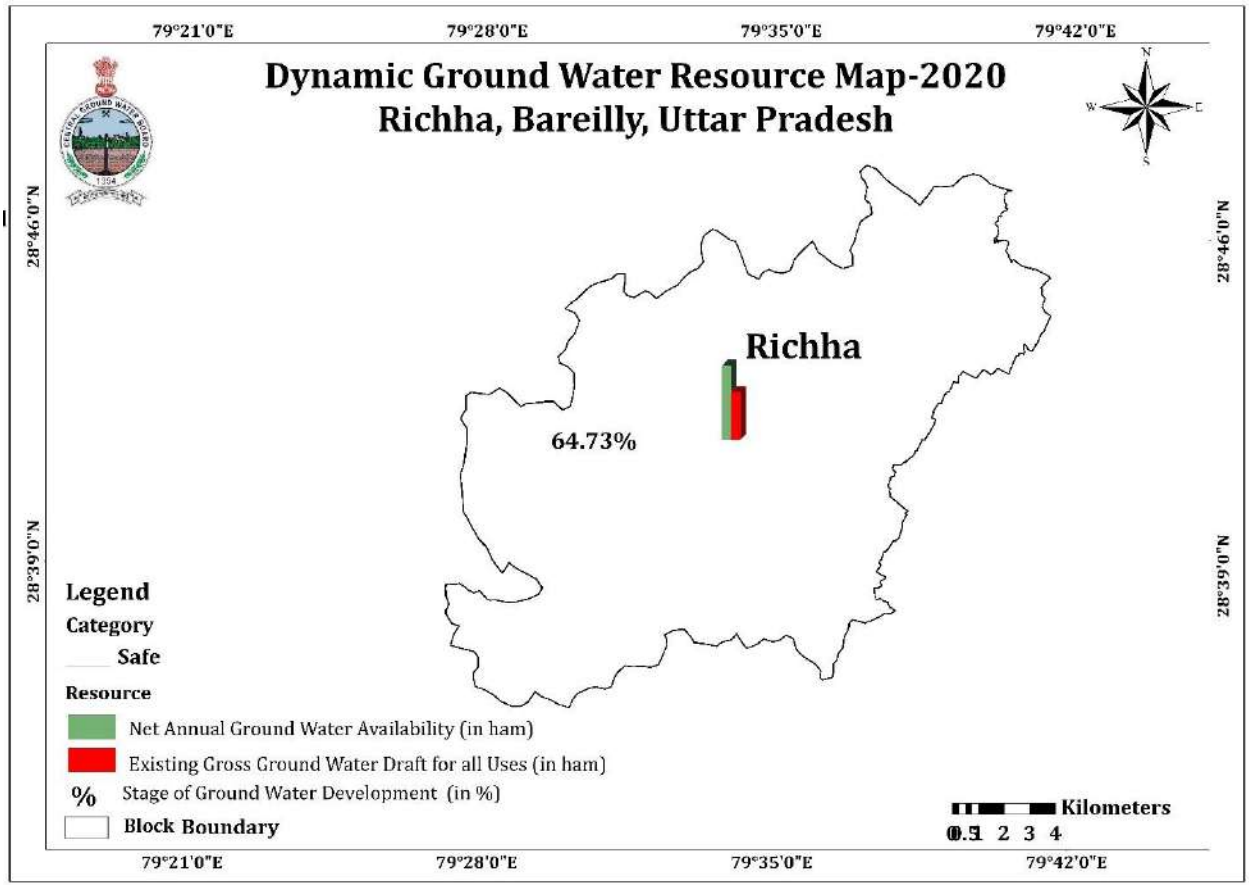


Figure 7.15e : Dynamic GW Resource Map RICHHA Block, Bareilly district, UP

7.16 AQUIFER MAPPING AND MANAGEMENT PLAN OF SHERGARH BLOCK, BAREILLY DISTRICT, U.P.

1. Salient Information

Table 7.16a: Salient Information of SHERGARH Block, Bareilly District, UP

Area	271.36 Sq. Km					
Population	226130	**Male**	119706	**Female**	106424	
Population Density	833 persons/sq km					
Annual Rainfall (2011-20)	***957*** mm	**Monsoon**	***839.***5mm	**Non-Monsoon**	***117.5*** mm	

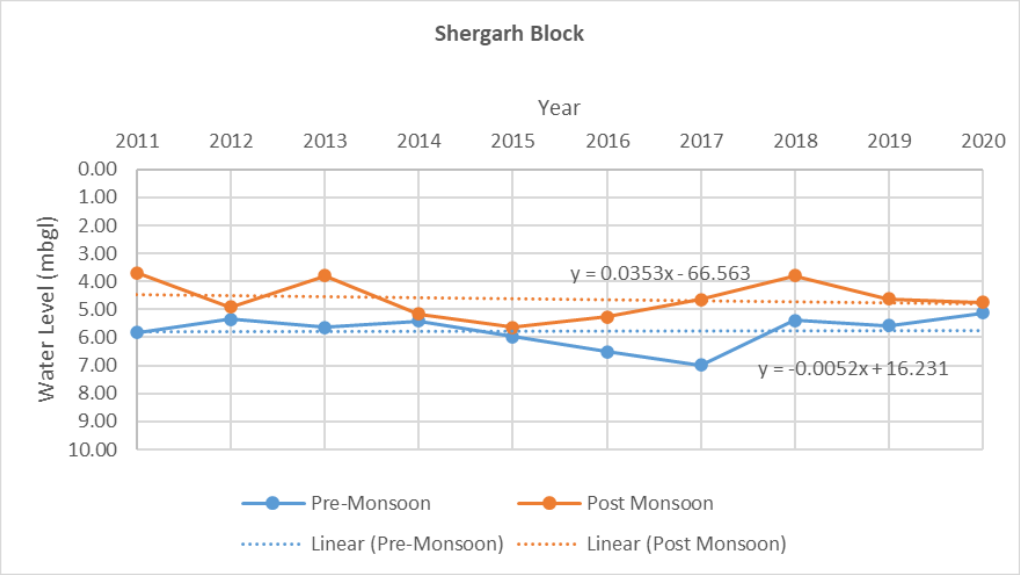
Table7.6b: Agriculture and Irrigation SHERGARH Block, Bareilly District, UP

Net Sown Area	21524	**Gross Sown Area**	36218
Net Irrigated Area	19504	**Gross Irrigated Area**	34029
Irrigation Intensity	174.47 %	**Irrigation by GW**	87.41 %
Irrigation by SW	12.59 %		

*Area in Hectare

2. Water Level Behaviour

The average depth to water level has been observed as 5.12 mbgl during Pre-monsoon (2020) and 4.75 mbgl during post-monsoon (2020). For the period of 2011-2020 Pre-monsoon water level trend is 0.005 m/year and post-monsoon water level trend is 0.035m/year.



3. Aquifer Disposition

Three aquifer groups exist in the block:

Aquifer Group I: Ground level to 212 mbgl.

Aquifer Group II: 195mbgl to 295mbgl.

Aquifer Group III: 310 mbgl- 370mbgl.

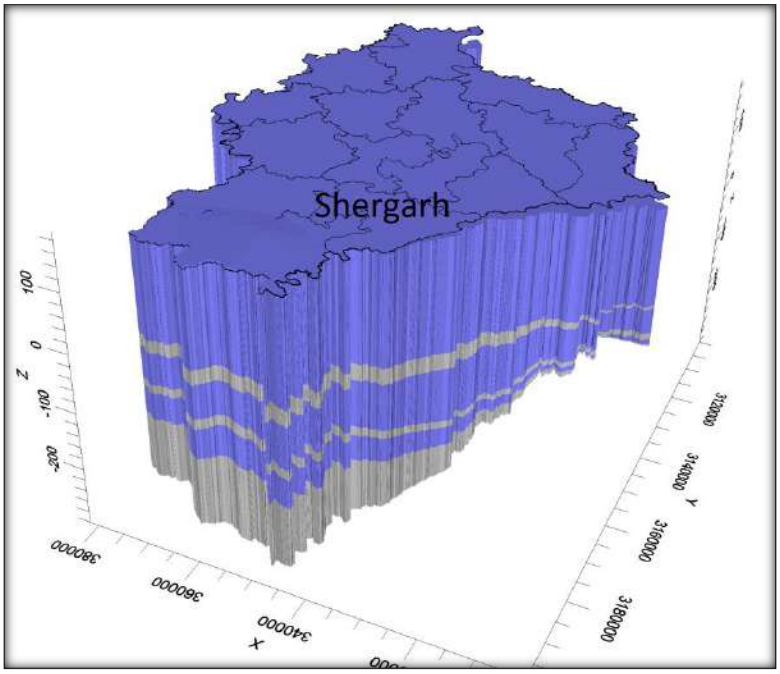


Fig: 7.16a: 3D disposition of Aquifer system

4. Ground water resource, extraction and other issues

Table 52: Ground Water Resource (Static+Dynamic), Extraction as on March, 2020 SHERGARH Block, Bareilly, UP

A	**FIRST AQUIFER SYSTEM**	
1	**Dynamic Resources (Fresh)**	89.72 MCM
2	**Total GW Extraction**	54.44 MCM
3	**Stage of Ground Water Extraction**	60.69%
4	**Category**	Safe
5	**Static Resources (Fresh)**	4558.84 MCM
7	**Total Resources Dynamic + Static (Fresh)**	4648.56 MCM

Issues: Dependency on Ground Water for Irrigation and declining trend of water level. Presence of Iron (Fe^{3+}) beyond permissible limit has been reported in the blocks.

5. Chemical Quality of ground water and contamination

Table 7.16d: Basic Chemical Quality of Phreatic Aquifer SHERGARH Block, Bareilly, UP

Basic Parameter	Permissible Limit	Results
	BIS 10500:2012	
pH	6.5-8.5	7.76
EC (□S/cm) at 25^{0}C	3000	310
CO_3 mg/l	-	nil
HCO_3 mg/l	-	159
Cl mg/l	1000	7.1
F mg/l	1.5	0.33
NO_3 mg/l	45	BDL
SO_4 mg/l	400	22
TH as $CaCO_3$ mg/l	600	130
Ca mg/l	200	32
Mg mg/l	100	12
Na mg/l	-	7
K mg/l	-	12
SiO_2 mg/l	-	49
PO_4 mg/l	-	**nd**

Table 53: Heavy Metal concentration of Shallow Aquifer SHERGARH Block, Bareilly, UP

Heavy Metals		Fe in ppm	Mn in ppm	Cu in ppm	Zn in ppm	As in ppb	Pb in ppb	U in ppb	Cr in ppb
Permissible Limit	**BIS 10500:2012**	1	0.3	1.5	15	10	10	30	50
Results		1.37	0.24	0	0.16	1	1	8	0

6. Ground Water Management:

Table 54: Ground Water Management Strategies and Projected Stage of Extraction

Block	Check Dams (Nos)	Nala Bunds (Nos)	Stream Development (Km)	Ponds (Nos)	On-farm Activities (ha)	Water Use Efficiency (ha)	Recharge from Structure MCM	Saving from Structures MCM	Saving frm On-farm & WUE MCM	Total Recharge MCM	Total Saving MCM	Present Stage of Ground Water Extraction (%)	Projected Stage of Extraction (%) After Interventions
SHERGARH	1	1	1	3	2152	2152	0.11	0.11	3.15	0.11	3.25	60.69	56.99

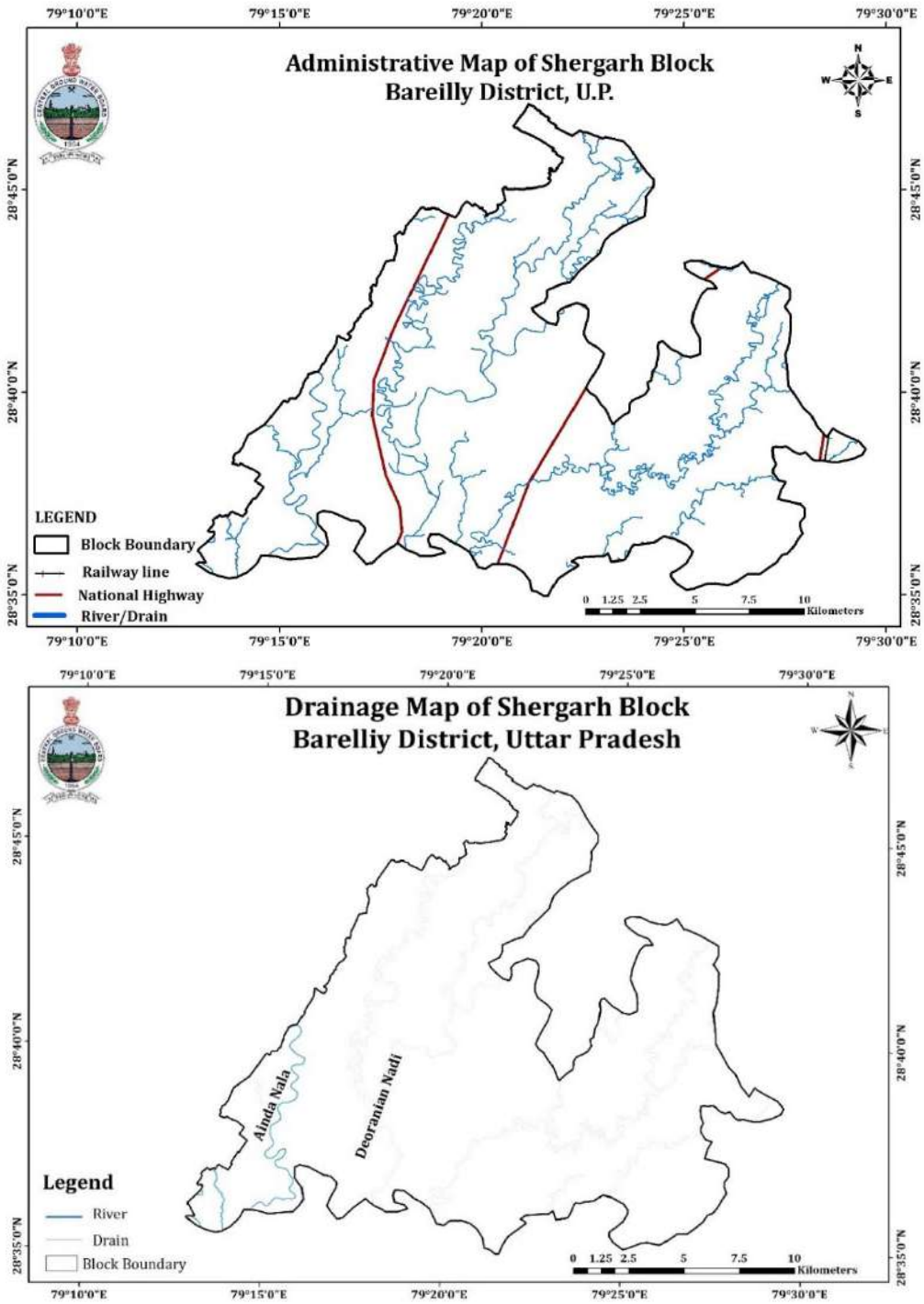


Fig 15: Administrative and Drainage map of SHERGARH Block, Bareilly District, UP

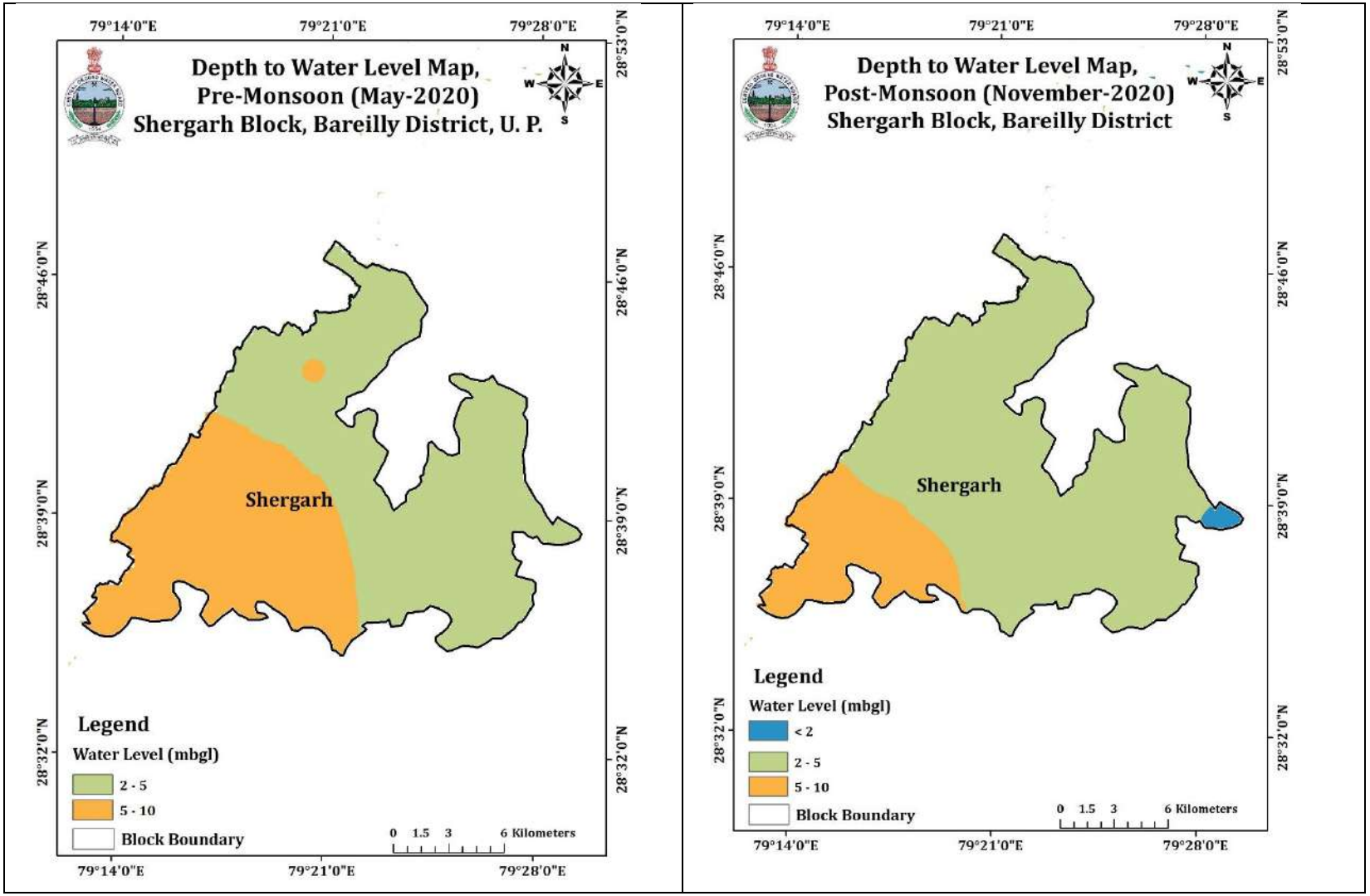


Fig 7.16c: Water Level map of pre-and post-monsoon 2020 of SHERGARH Block, Bareilly district, UP

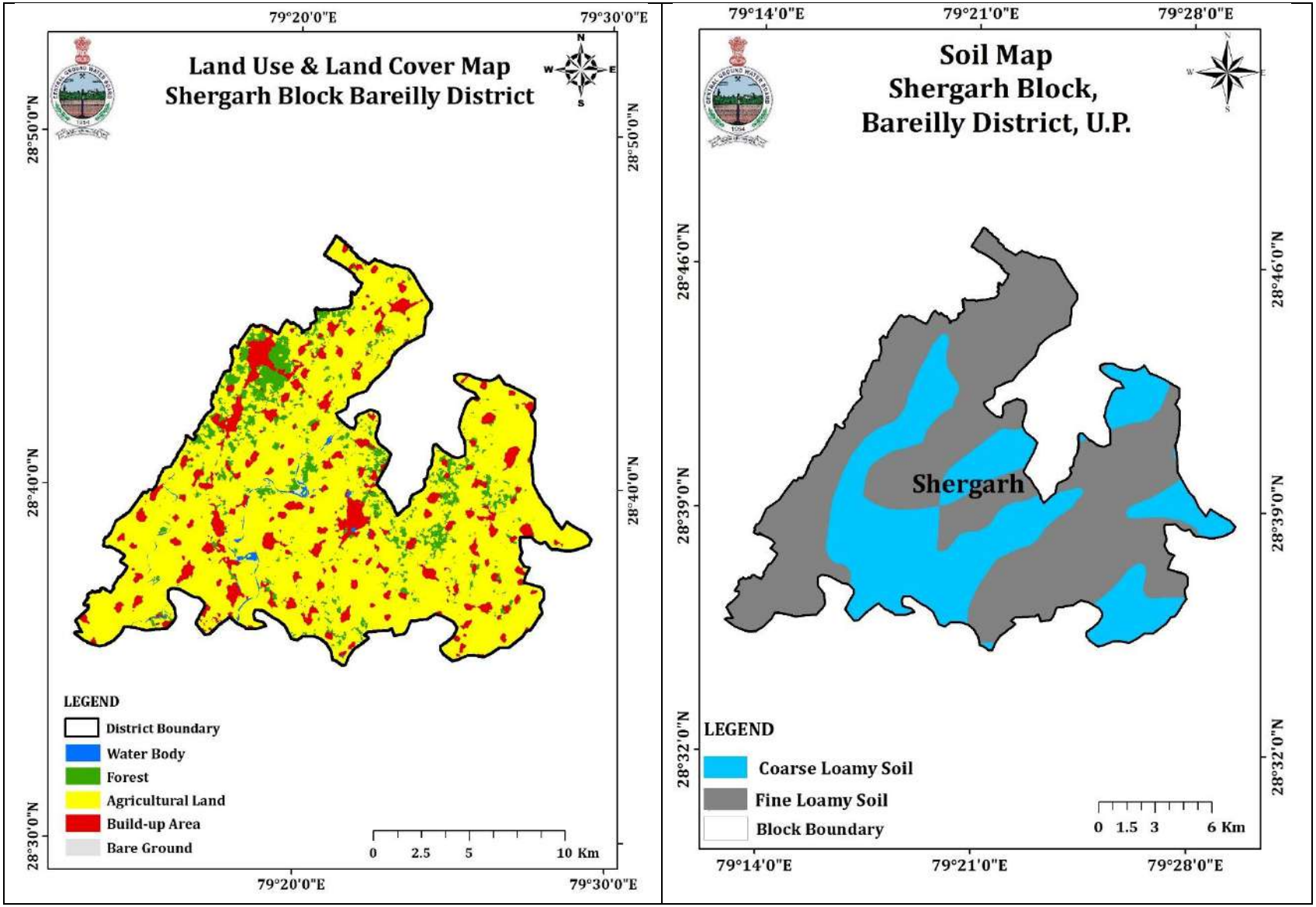


Figure 7.16d: Land use & Land cover and Soil Map of SHERGARH Block, Bareilly district, UP

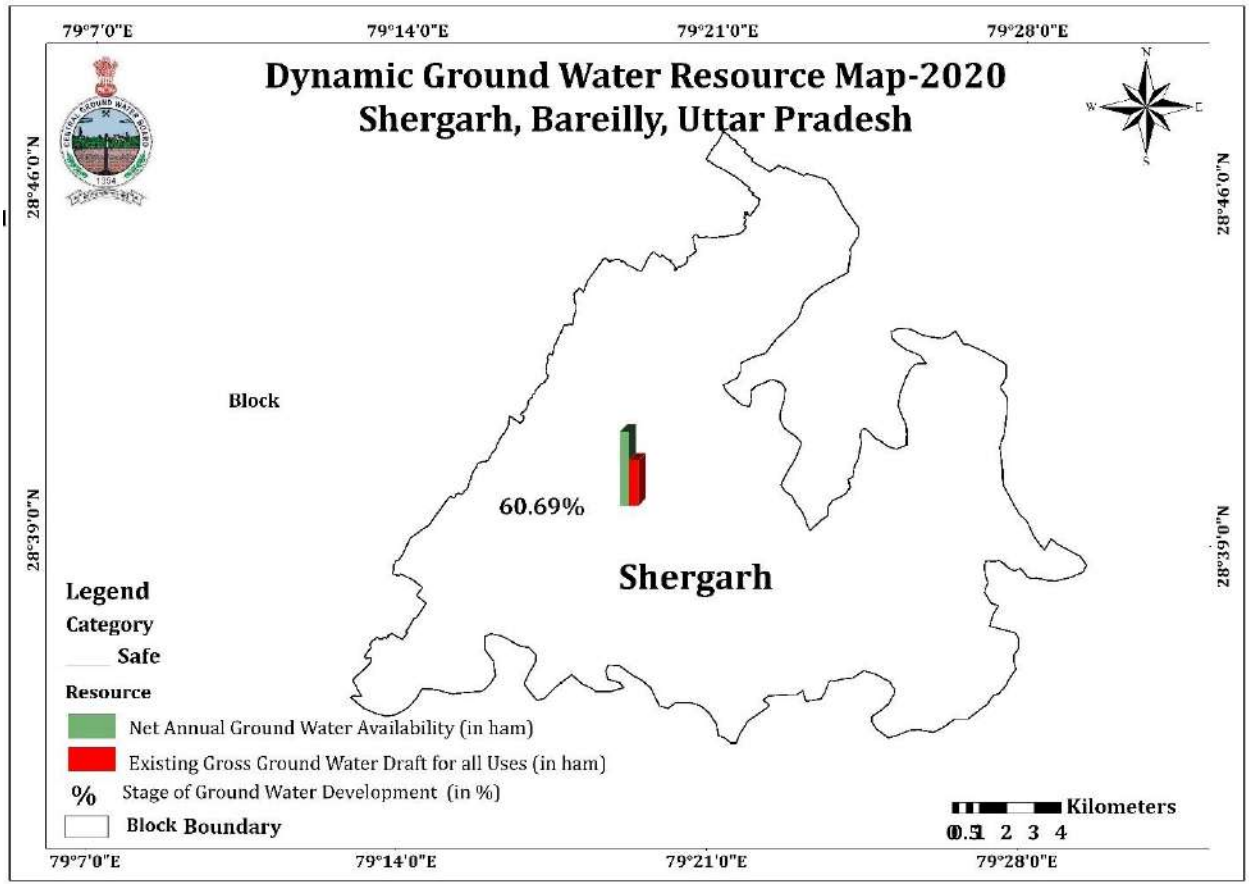


Figure 7.16e : Dynamic GW Resource Map SHERGARH Block, Bareilly district, UP

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