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

MAINPURI DISTRICT
UTTAR PRADESH

उत्तरी क्षेत्र, लखनऊ

Northern Region, Lucknow

ACKNOWLEDGEMENT

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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(VIDYA BHOOSHAN)
Senior Technical Assistant
(Hydrogeology)

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MAINPURI DISTRICT AT A GLANCE

1. GENERAL INFORMATION

i.	**Geographical Area (sq km.)**	: 2758
ii.	**Administrative Divisions**	
	Number of Tehsil/Block	: 06/09
	Number of Panchayat/Villages	: 552/841
iii.	Population (2011 census)	: 1868529
	Rural	: 1580087
	Urban	: 288442
iv.	Average Annual Rainfall (mm)	: 732.33mm

2. GEOMORPHOLOGY

Major Physiographic Units	: Central Ganga alluvial Plain which is sub divided in older and newer alluvial plain(flood Plain)
Major Drainages	Kali , Arind and Isan Rivers

3. LAND USE

a)	Forest area	: 1776 Ha
b)	Net sown area	: 198085 Ha
c)	Gross Sown area	: 327615 Ha

4. MAJOR SOIL TYPES

Sandy loam and Clay, locally classified as Bhur, Matiyar, Dumat and Pilia

5. AREA UNDER PRINCIPAL CROPS (Ham)

Rabi	: 180556
Kharif	**: 133167**
Zaid	**: 13892**

6. IRRIGATION BY DIFFERENT SOURCES (Numbers of structures)

Tubewells / Dugwells	: 556/5
Canals	: 1040 km
Other Sources	: 0
Net Irrigated Area	: 197961 ham
Gross Irrigated Area	: 327654 ha

7. NUMBER OF GROUND WATER MONITORING WELLS OF CGWB (As on 31-3-2020)

No. of Dugwells : 4

No. of Piezometers : 5

8. PREDOMINANT GEOLOGICAL FORMATIONS : Quaternary alluvium consisting of mainly Sands of various grades, silts , clay and kankar.

9. HYDROGEOLOGY AND AQUIFER GROUP : Multiple granular zones (Four) upto154 m depth

10 . MAJOR WATER BEARING FORMATION : Gravel, sand and silt

Pre-monsoon Depth to water level during May' 2020 : 4.85 to 6.85 mbgl

Post-monsoon Depth to water level during Nov' 2020 : 2.6 to 6.33 mbgl

11. GROUND WATER EXPLORATION BY CGWB(As on 31-3-2022)

No of wells drilled (EW,OW,PZ AND SH) : EW-1 (Village-Sonai)

Depth range (m) : 153.92m -302.94m

Discharge (litres per second) : 2.65lps to 47.94 lps

Storativity (S) : NIL

Transmissivity (m^2/day) : NIL

12. GROUND WATER QUALITY

Presence of chemical constituents more than permissible limit: : F(Kishni), Fe (Bewar)

Type of water **:** In general it is fresh except in parts of Kurawali, kishni and bewar blocks where ground water slightly saline in pockets. Other constituents are within permissible limit.

13. DYNAMIC GROUND WATER RESOURCES (Ham)as on 31 March, 2020

Net Ground water availability	: 28499.35
Stage of Ground Water Development	: 69.20%

14. GROUND WATER CONTROL AND REGULATION

Number of Over Exploited Blocks	:	1
Number of Critical Blocks	:	0
Number of Semi Critical Block	:	3
Number of Safe Blocks	:	5

15 . MAJOR GROUND WATER PROBLEMS AND ISSUES: In mainpuri and Barnahal blocks ground water level has gone deep i.e >8mbgl resulting to drying up of some dug wells. Along major canals water logged condition do occur due to excessive seepage from canals

AQUIFER MAPPING AND MANAGEMENT PLAN OF MAINPURI DISTRICT, UTTAR PRADESH
(A.A.P: 2021-2022)

1.0 INTRODUCTION

1.1 General

Mainpuri district, with geographical area of 2758 sq.km , is located in the south western segment of the state of Uttar Pradesh. The District lies between, North Lattitude 26.8833 and 27.5166 and East Longitude 78.75 and 79.433 and forms a part of Agra Division with its District headquarters at Mainpuri . The District is bounded on the north by Etah District , on the East by Farrukhabad, an the south by Etawah and on the west by Firozabad District. It is well connected with Lucknow, Delhi, Agra etc. through road and rail. The Mainpuri contains six tehsil i.e. Mainpuri, Karhal, Bhogaon, kishni, Kurawali and Ghiror . for the convinces of developmental activities, the district is divided in to 9 developmental blocks. The Mainpuri district contains 9 blocks i.e. Ghiror, kurawali, Sultanganj, Mainpuri, Bewar, Jagir, Kishni, Karhal and Barnahal.

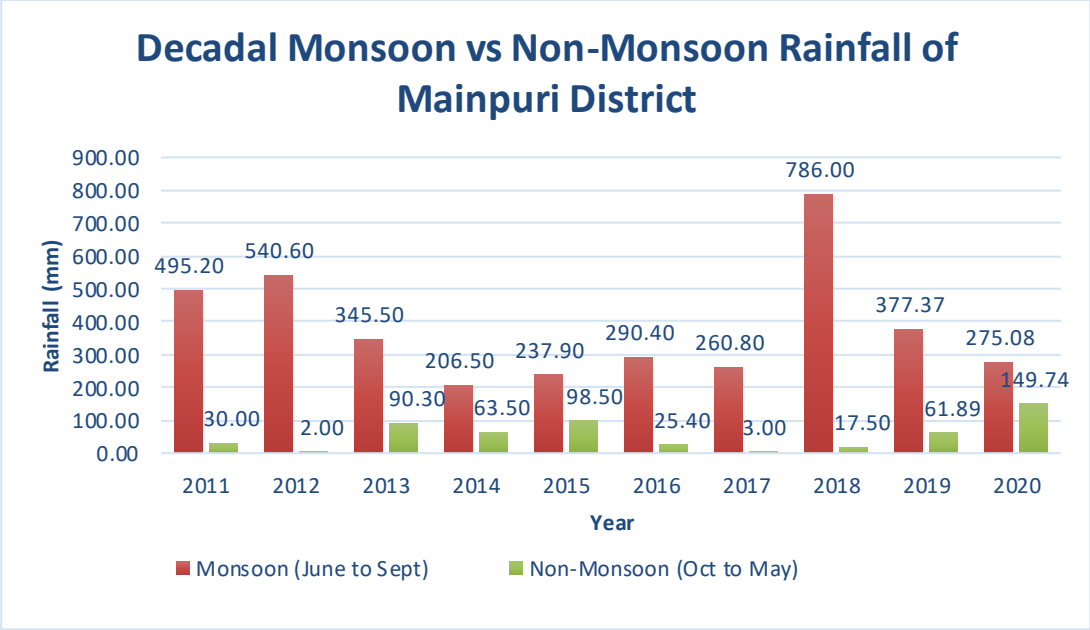
The district has total population of 1868529 as per 2011 census (**source: Census of India web site)** with male population 1580087 and female 288442. and population density of the order of 582 person/ km.

1.2 Rainfall and Climate

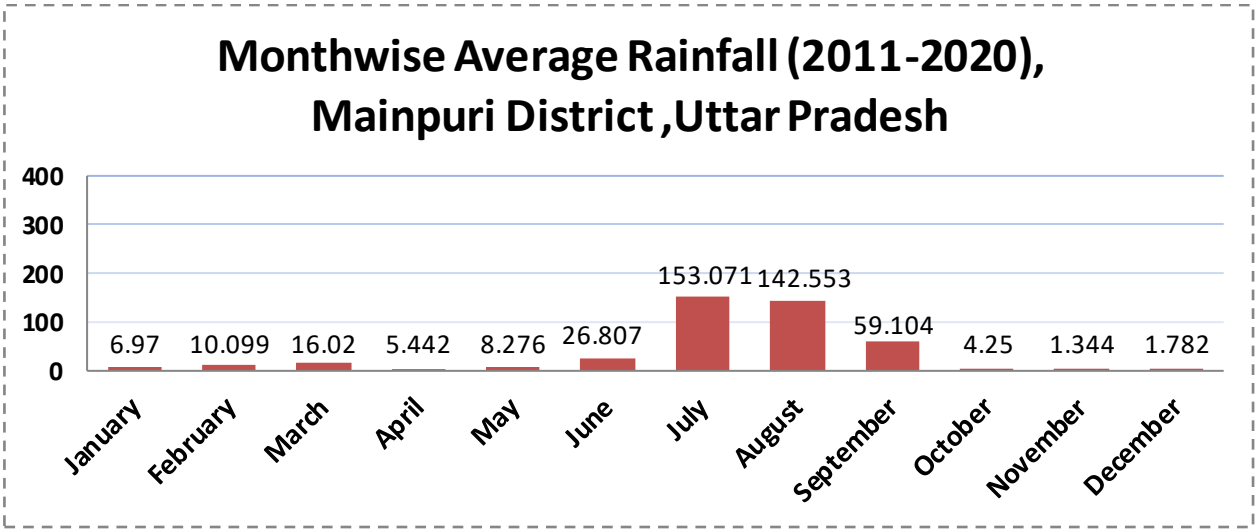
The Average Annual rainfall in Mainpuri district is 496.72 mm (2011-2020 records) of which 87.47 % is contributed from monsoon season (June to September) and remaining 12.53 % rainfall occur during Non-monsoon period. The climate of the district is sub-humid and characterized by hot summer and bracing cold season. After February there is continuous increase in temperature till May which is generally the hottest month. The mean daily maximum temperature in May is 42.2 ^{0}C and the mean daily minimum is 26.2 ^{0}C. Maximum temperature rises up to over 46 ^{0}C with rise of the monsoon in June there is an appreciable drop in the day temperature. The mean monthly maximum temperatures are 32.8 ^{0}C and mean monthly minimum temperature is 16.5 ^{0}C. During the south west monsoon season the relative humidity is high and after the withdrawal of the monsoon humidity decreases. Winds are generally very light. During the period May to September winds often blow between northeast & southeast directions. The mean of wind velocity is 3.5 kmph. The potential evapo-transpiration is 143/.7 mm.

Table 1. Rainfall data of Mainpuri district for the years 2011-2020.

Year	Annual	Monsoon (June to Sept)	Non-Monsoon (Oct to May)
2011	**620.9**	**604.4**	**16.5**
2012	**396.2**	**375.7**	**20.5**
2013	**795.5**	**665.7**	**129.8**
2014	**275.1**	**191.0**	**84.1**
2015	**336.4**	**237.9**	**98.5**
2016	**315.8**	**290.4**	**25.4**
2017	**596.4**	**569.4**	**27.0**
2018	**744.6**	**735.0**	**9.6**
2019	**474.7**	**401.5**	**73.2**
2020	**411.6**	**274.1**	**137.5**
Average	***496.72***	***434.51***	***62.21***



Monsoon vs Non Monsoon Rainfall of last 10 years, Mainpuri, District, UP



Monthwise Average Rainfall (2011-20), Mainpuri, Dsitrict, UP

Study of 10 years monthwise average Rainfall reflects that maximum rainfall occurs in the month July-September in the District.

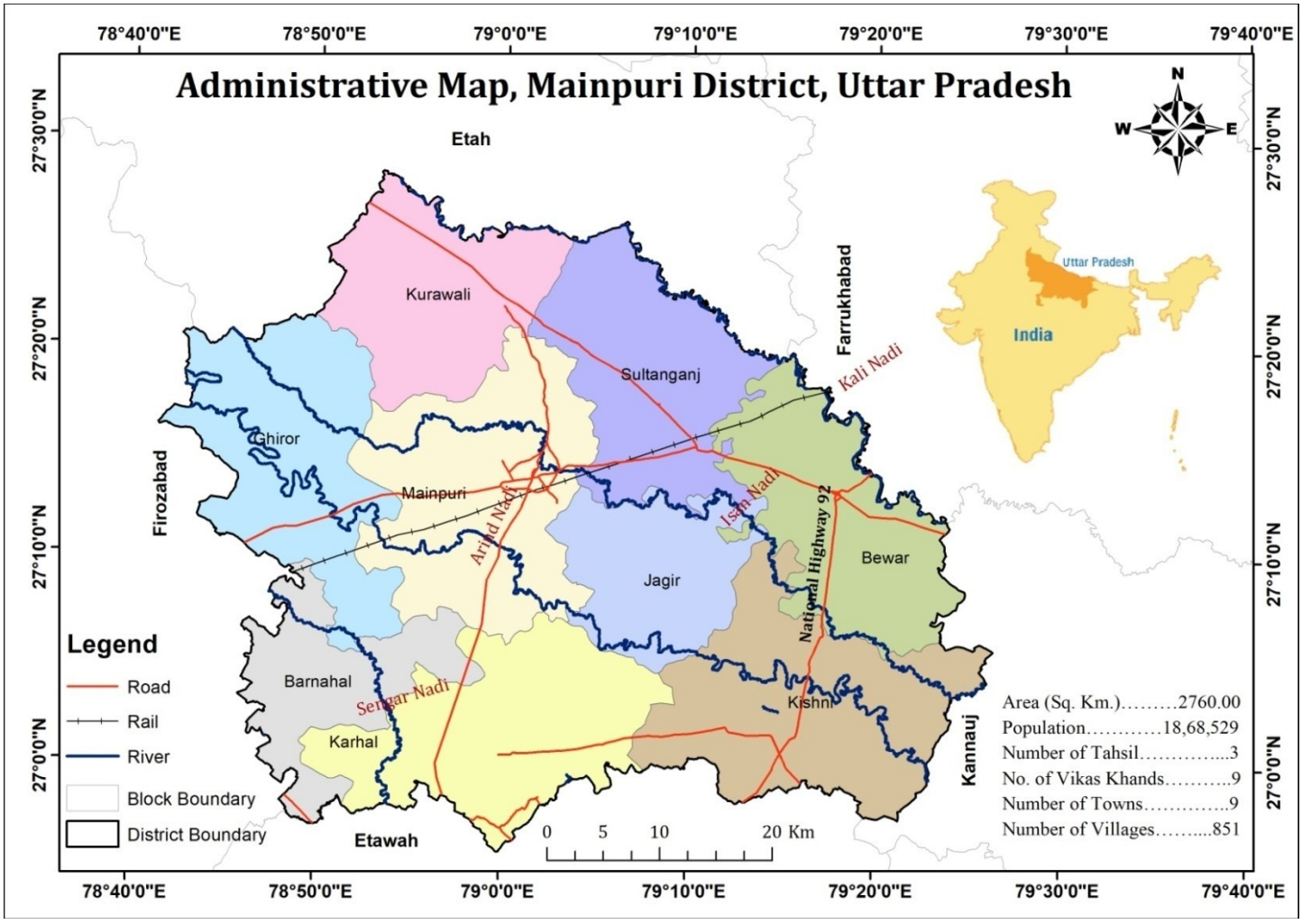


Fig-1: Administrative Map of Mainpuri District, U.P.

1.3 GEOMORPHOLOGY, SOIL, DRAINAGE AND GEOLOGY

1.3.1 Physiography:

The district area , a part of central Ganga alluvial plain(upper Gangetic plain as per the agro climatic zones classification) is an extensively level tract which is intercepted by sand ridges on its western border, the rolling sand hills and undulations of the kali and isan rivers. Kali nadi forms of the bouandry of the plain on the north and north east. The terrain has gentle slope from North West to south east with a gradient of 0.2 m/km.

Physiographically the area can be categorized into two units:

a. **Kali-Isan Tract:** this tract is an inter fluvial zone of Kali and Isan doab with pre dominanetly sandy soil of .in this tract a thin strip of Land forms the bed of kali in the east and north –East of the area, whih rises to barren land with sandy mounds and lows and followed laterally by a level country upto Isan River.
b. **Isan –Sengar Tract:** The Isan and Sengar tract, lying between Isan and Sengar rivers covers about 75% of the total district area. This unit, locally known as " Pachar" is characterized by flat topography with light loamy soil , which is very fertile. A number of impounded water bodies occur in this unit , particularly in the area south –east of Bhogaon and kishni town.

1.3.2 Soils

Soils type found in the area are those generally occur in Ganga alluvial plain. The following are the main soil types:

a.) **Bhur :** youngest soil occur along river beds and contain large portion of sands.

b.) **Matiyar:** occur in low lying areas and contain large portion of sands.

c.) **Dumet:** it is a loamy soil with dark colour, having clay and sand in equal proportion and can be categorized as intermediate type of Bhur and Matiyar .Such soil generally occur in the upland areas.

d.) **Pilia:** A lighter soil than dumet and is an intermediate type of Dumet and Bhur.

The occurance of specific soil at places in the area is appeared to be related with surface runoff intensity in the area.

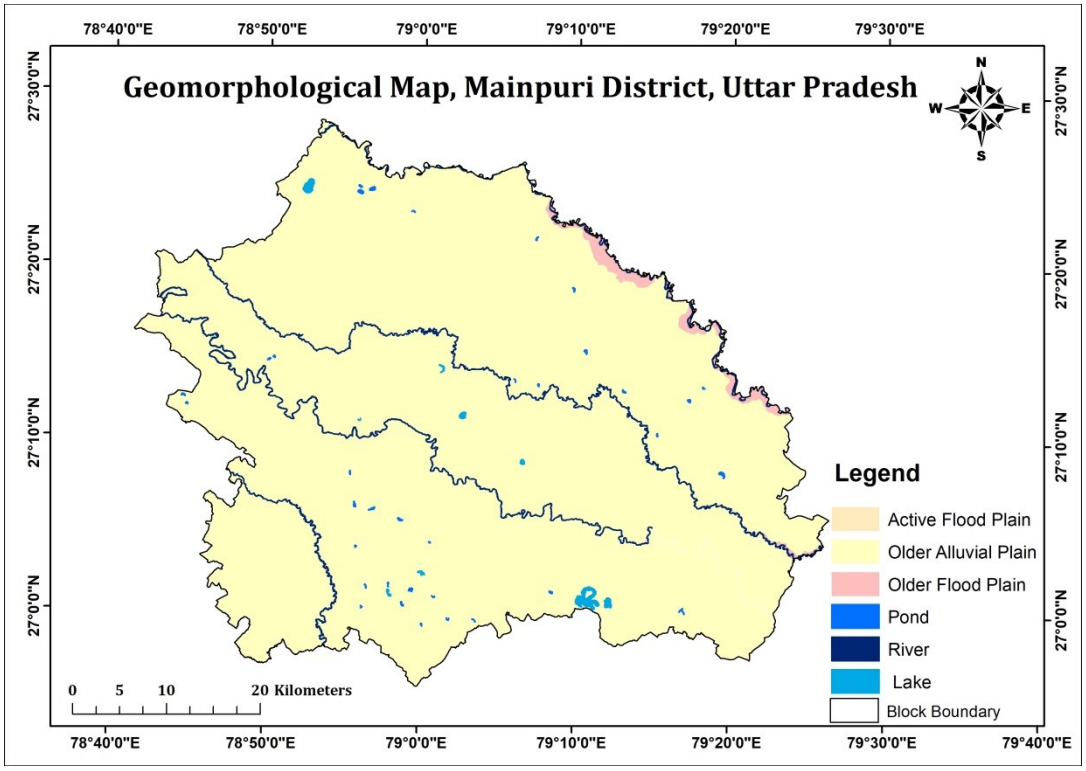


Fig-2: Geomorphological Map of Manipuri District

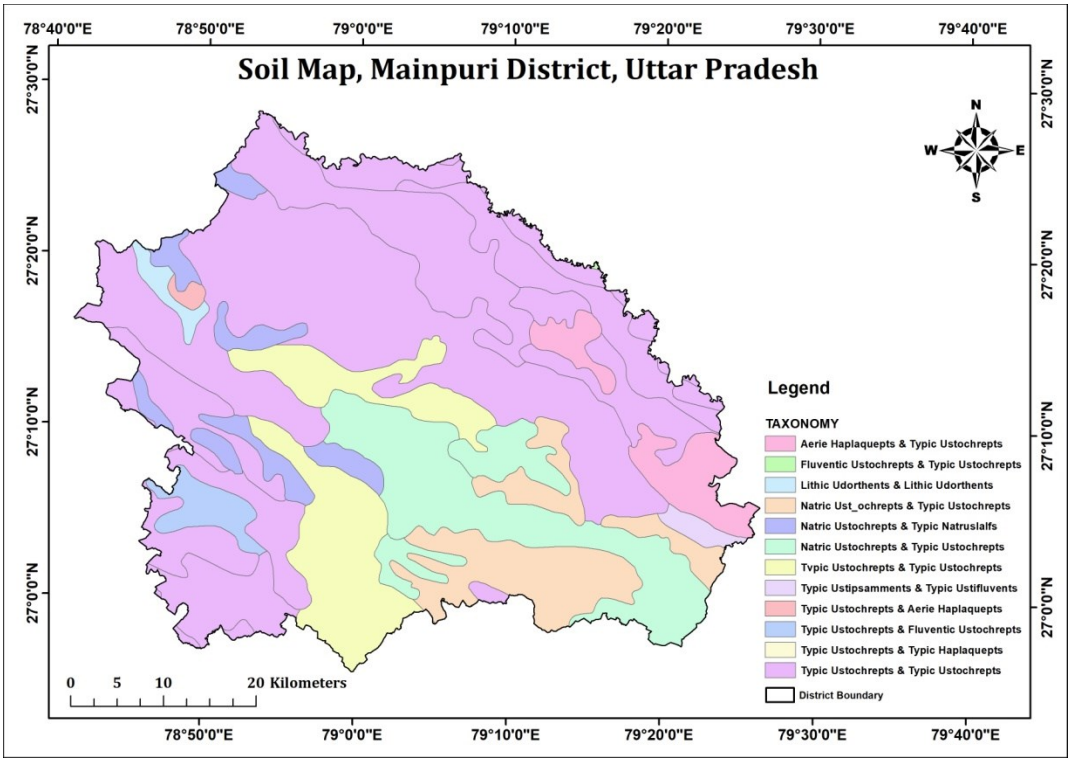


Fig-3: Soil Map of Manipuri District

1.3.3 Drainage

The area is drained by kali, Arind, sengar and isan rivers and their tributaries which flow from NW to SE direction. These streams generally follow a meandering course through narrow flood plains. Both kali and isan rivers are the tributaries of Ganga river, where as arind and sengar rivers are the tributaries of Yamuna river.

Basin and Sub-Basin:

The Mainpuri district falls in Ganga Basin and forms a part of Ganga Yamuna doab , covering the parts of kali, Isan, Arind and senger water sheds.

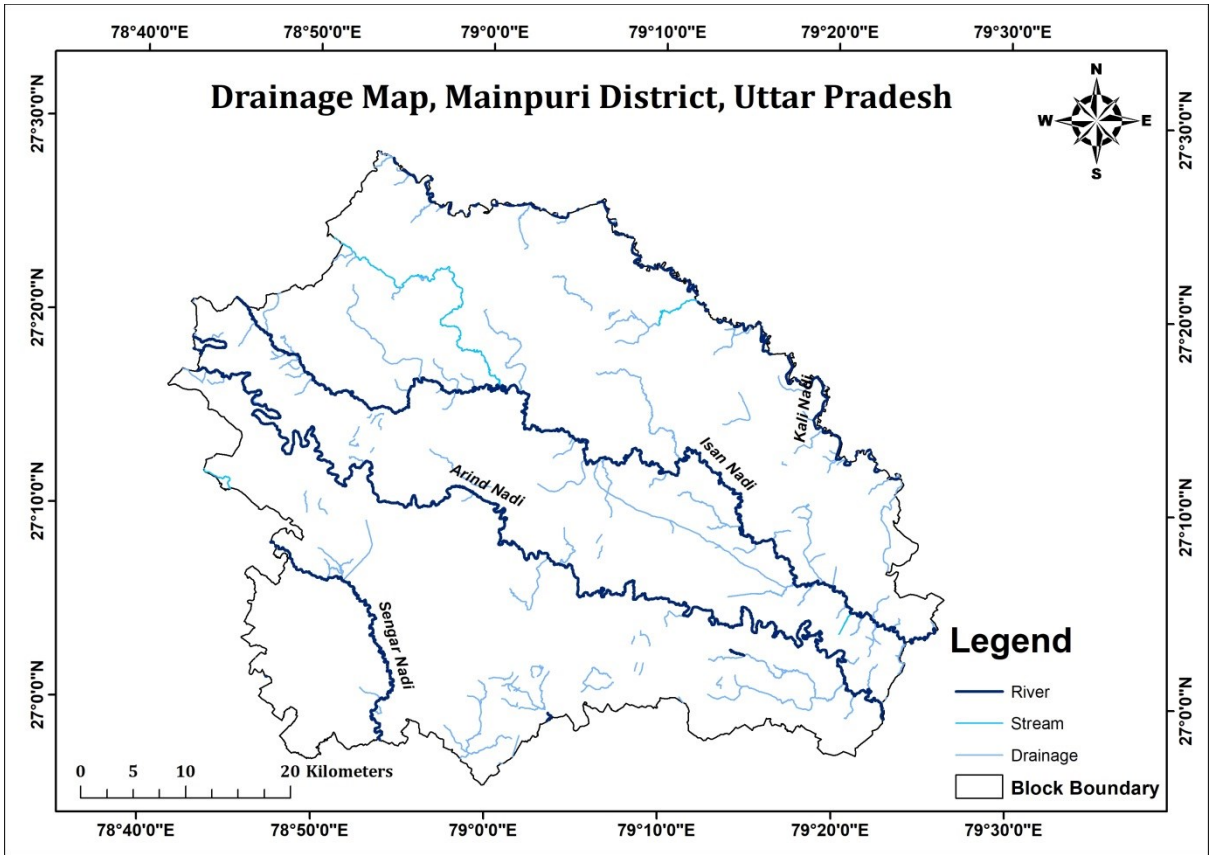


Fig-4: Drainage Map of Mainpuri District

1.3.4 Geology:

The area occupies a part of alluvial plain of Ganga Yamuna doab and is underlain by quaternary sediments constituting clays, silt and sands of different grades. The general litho stratigraphic sequence of the formations present in the area is as under:

Group	Age	Formation	Lithology
Quaternary	Recent to upper Pleistocene	Newer Alluvium	Fine sand, silt, clay
	Upper Pleistocene to lower Pleistocene	Older Alluvium	Clay with kankar and sands of different grades
……Unconformity……			
Purana	Pre Cambrin	Vindhyan	Sandstone, shale and limestone

The older alluvium generally occupies the higher elevations. Sediments are predominantly clayey and argillaceous in nature and relatively compact. Often patches of salt peter are seen associated with older alluviums.

The newar alluvium occur in topographically low regions restricted to course of river are mainly arenaceous. The loose and unconsolidated sediments are reworked fluvial deposit of older alluvium in flood Plaines and back swamp areas along the drainage lines. This has envisaged from the resembling mineral composition of newer alluvium sediments and lower alluvium sediments(Aggrawal 1991.)

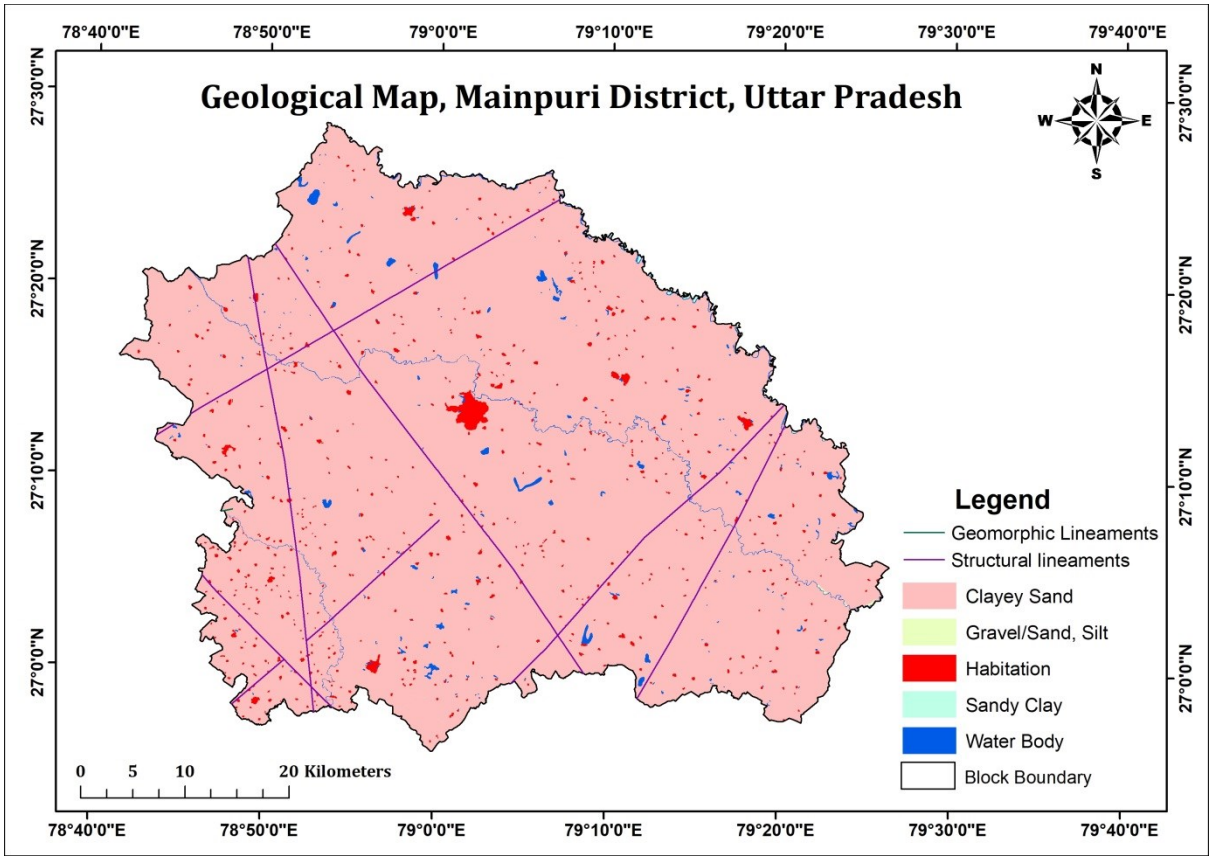


Fig-5: Geological Map of Mainpuri District

1.4 AGRICULTUE AND CROPPING PATTERN

1.4.1 Land Use Pattern:

Agriculture is the Prime occupation of people in the district. Based on the available data for (**Statistical Report 2019-2020,U.P.**) land utilization pattern of the district can be illustrated as below:

Table-2: Details of Land Use pattern (Statistical 2019-2020) (Area in Ha)

Block									Area of garden, trees & shrubs
	Total reoprted area	*Forest*	*Cultivable Waste Land*	*Current fallow*	*Other Fallow*	*Barren Land*	*Land other than agriculture*	*Grasslands*	
1.Ghiror	34987	198	604	1208	1801	2956	5814	217	200
2.Kurawali	26837	138	413	586	560	945	3362	104	65
3.Mainpuri	38553	301	588	2108	2243	3335	6111	202	61
4.Barnahal	21031	334	459	1147	743	2022	3078	85	70
5.Karhal	33106	201	576	1015	988	2232	6046	306	63
6.Sultanganj	30902	140	433	807	564	727	2164	10	106
7.Bewar	29171	112	178	593	352	383	1930	89	112
8.Ailau/jagir	21529	98	191	897	716	756	2942	25	108
9.Kishni	36607	254	358	699	674	1339	3063	175	158
Total Rural	**272723**	**1776**	**3800**	**9060**	**8641**	**14695**	**34510**	**1213**	**943**
Total Urban									
Total District	**272723**	**1776**	**3800**	**9060**	**8641**	**14695**	**34510**	**1213**	**943**

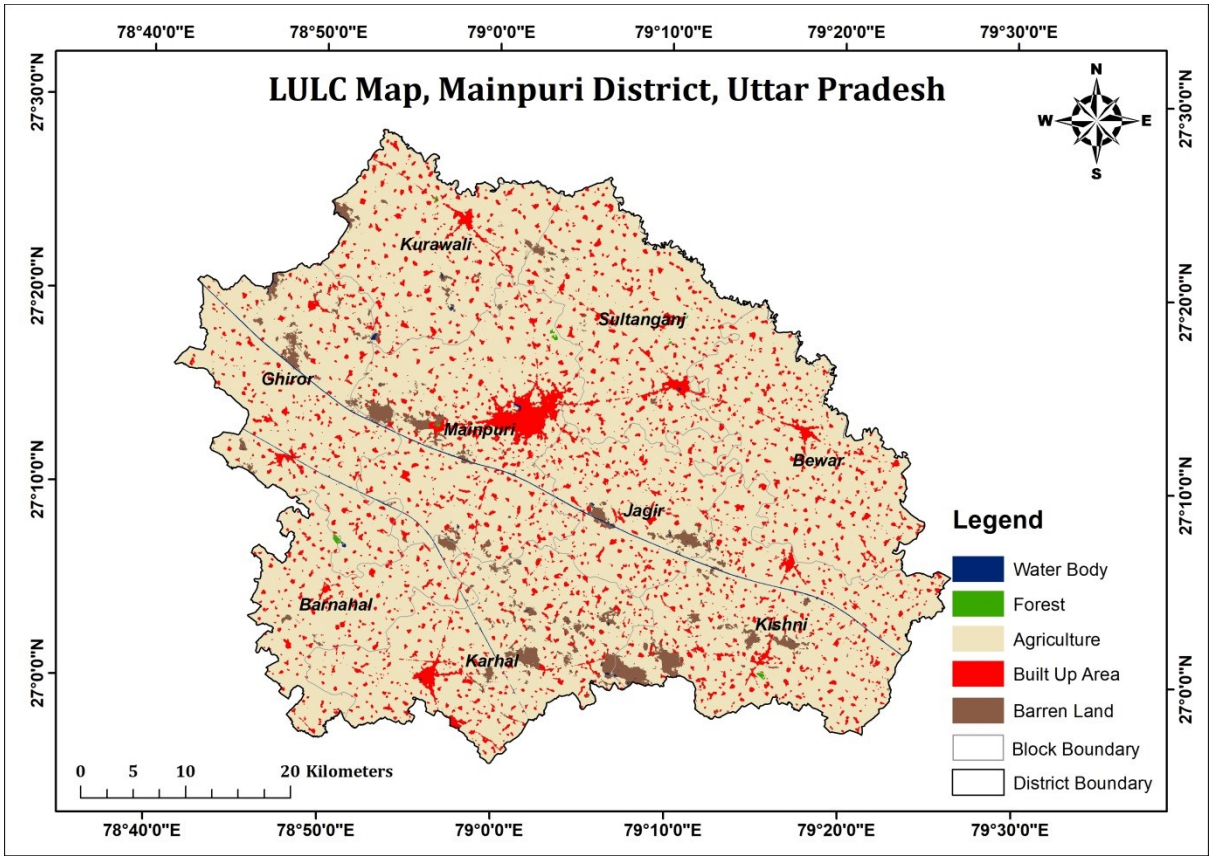


Fig-6: Land Use Map of Mainpuri District

1.4.2 Cropping Pattern:

Cropping pattern of an area is dominantly controlled by the topography , soil characteristics, drainage ,irrigational facilities and climates.in this part of the state double cropping is a common phenomena. two principal harvest of the area Rabi and Kharif, the third zaid is harvested on a very small scale. Other main crops of the district are Barley, Jowar, Bajra, Maize, Pulses, , Gram, Pea, Mustard.

Wheat is the most dominant crop in terms of crop area , Wheat is grown on 163085 ha. Paddy which is sown in Kharif as well as Zaid seasons occupies nearly 79873 ha. Block wise details of the crops along with their area irrigated and non-irrigated is given in the Table 3.

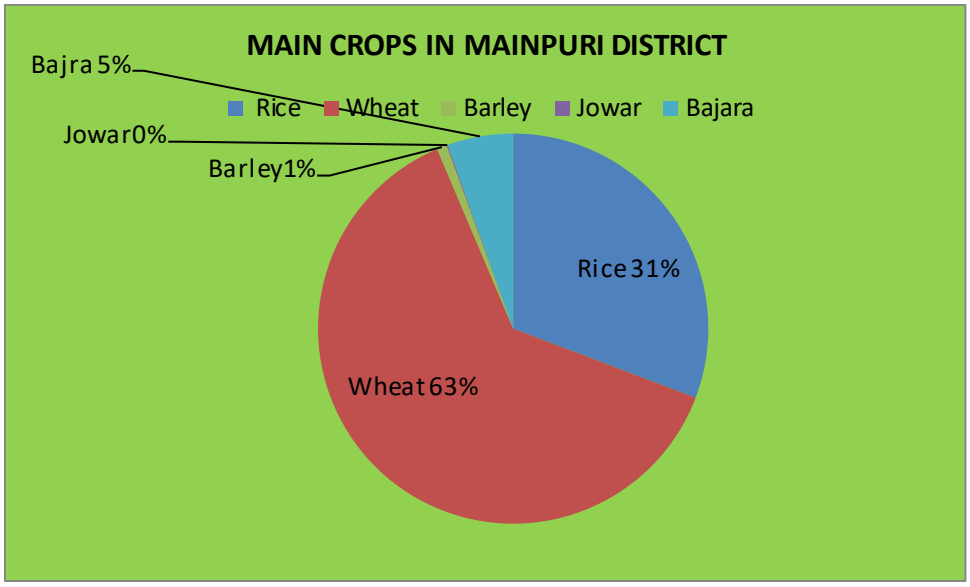


Figure 7 :Percentage distribution of Main crops in Mainpuri District (U.P.)

Table 3. Details of the Cropping Pattern in the Mainpuri district (Area in Ha)

S.No.	Block Name	Blockwise area under main crops in hectare								Blockwise area under main crops in hectare													
		Rice Kharif		Rice Zaid		Total Rice		Wheat		Barley		Jowar		Bajara		Makka Kharif		Makka Rabi		Makka Zaid		Makka Total	
		Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated
1	Ghiror	9072	9072	0	0	9072	9072	19017	19017	209	209	0	0	1802	1802	4017	4017	0	0	68	68	4085	4085
2	Kurawali	5009	5009	9	9	5018	5018	17154	17154	243	243	58	58	1755	1755	4188	4188	0	0	53	53	4241	4241
3	Mainpuri	6853	6853	0	0	6853	6853	19702	19702	305	305	35	35	1816	1741	4666	4666	0	0	96	96	4762	4762
4	Barnahal	5009	5009	9	9	5018	5018	17154	17154	243	243	58	58	1755	1755	4188	4188	0	0	53	53	4241	4241
5	Karhal	15082	15082	6	6	15088	15088	19942	19942	356	356	17	0	2402	143	1491	1254	0	0	36	36	1527	1290
6	Sultanganj	12351	12351	1	1	12352	12352	20235	20235	125	125	7	7	1098	1068	9080	9080	0	0	52	52	9132	9132
7	Bewar	14096	14096	11	11	14107	14107	20063	20063	358	358	15	15	725	725	10769	10769	0	0	153	153	10922	10922
8	Ailau/ jagir	7284	7284	9	9	7293	7293	12664	12664	80	80	12	12	1013	1013	5909	5909	0	0	37	37	5946	5946
9	Kishni	5009	5009	9	9	5018	5018	17154	17154	243	243	58	58	1755	1755	4188	4188	0	0	53	53	4241	4241
	Village Total	79765	79765	54	54	79819	79819	163085	163085	2162	2162	260	243	14121	11757	48496	48259	0	0	601	601	49097	48860
	Urban Total																						
	District Total	79765	79765	54	54	79819	79819	163085	163085	2162	2162	260	243	14121	11757	48496	48259	0	0	601	601	49097	48860

1.5 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.

Mainpuri District has Net Sown area of 1,98,085 ha while the Net Irrigated area is 1,97,961 ha. This results in 94.54% Net Sown Area has the irrigation facility, whereas, 1,29,564 ha area is sown more than once which leads to Gross Sown Area as 3,27,649 ha having cropping intensity of 165.40. Gross irrigated area in the district is 3,27,654 ha with irrigation intensity of 165.51. Block wise Net Sown Area, Gross Sown Area, Irrigated-Net & Gross along with Cropping Intensity and Irrigation intensity is given below in Table-4.

Table 4: Details of Area under Different Crops(Area In Ham)

Block	Net area sown	Area sown more than once	Gross area sown				Sugar cane land	Net irrigated area	Gross irrigated area	Cropping intensity	Irrigation Intensity
			Total	Rabi	Kharif	Zayed					
Ghiror	21989	12792	34781	20139	12597	1993	4	19836	35579	**158.1745418**	**179.3657996**
Kurawali	20664	9201	29865	18899	8813	2189	4	15574	32130	**144.5267131**	**206.3053808**
Mainpuri	23604	11212	34816	21836	10954	2056	5	20052	33947	**147.5004237**	**169.2948334**
Barnahal	13093	5701	18794	11346	6929	588	4	10516	22659	**143.5423509**	**215.4716622**
Karhal	21679	15817	37496	20133	16889	740	4	23890	36024	**172.9600074**	**150.791126**
Sultanganj	25951	21284	47235	24105	21448	1621	4	31152	44107	**182.0161073**	**141.586415**
Bewar	25422	23616	49038	22295	24631	2049	5	29764	47639	**192.8959169**	**160.0557721**
Ailau/jagir	15796	12363	28159	13842	13113	1060	4	17755	35175	**178.2666498**	**198.1132075**
Kishni	29887	17578	47465	27961	17793	1596	5	29422	40394	**158.8148693**	**137.2918224**
Village Total	198085	129564	327649	180556	133167	13892	39	197961	327654	**165.4082843**	**165.5144195**
Urban Total											
District Total	198085	129564	327649	180556	133167	13892	39	197961	327654	**165.4082843**	**165.5144195**

Tubewell is the most important method of irrigation in the district. An area of 1,29,746 ha is irrigated by Tube wells which comprises 65.54% of Net Sown Area. Second most important method or source of irrigation is dugwell. A total of 1,79,12 ha i.e. 9.04% of Net Sown Area is irrigated by this method. Tubewell and Dugwell together contributes to 74.58 % of total irrigation in the district. It shows very high dependency of irrigation on groundwater. Canal, although present, contribute less (25.41%) in irrigation. Details of Block wise sources of irrigation and their contribution is given below in the Table 5.

Table 5:. Details of the Block wise Distribution of Surface and Ground Water for Irrigation (2018-2019)

Blocks	Canal	Tubewell		Dug Well	Pond	Other	Total
		Govt.	*Private*				
1.Ghiror	9792	1700	6919	1425	0	0	19836
2.Kurawali	6629	1931	5274	1730	0	0	15564
3.Mainpuri	8919	1693	7351	2090	0	0	20053
4.Barnahal	783	206	8027	1500	0	0	10516
5.Karhal	16123	331	5436	2000	0	0	23890
6.Sultanganj	1186	116	28144	1704	0	0	31150
7.Bewar	1658	123	25396	2586	0	0	29763
8.Ailau/jagir	1564	162	13905	2129	0	0	17760
9.Kishni	3649	316	22716	2748	0	0	29429
Total Rural	**50303**	**6578**	**123168**	**17912**	**0**	**0**	**197961**
Total Urban							
Total District	**50303**	**6578**	**123168**	**17912**	**0**	**0**	**197961**

Area in Hectare

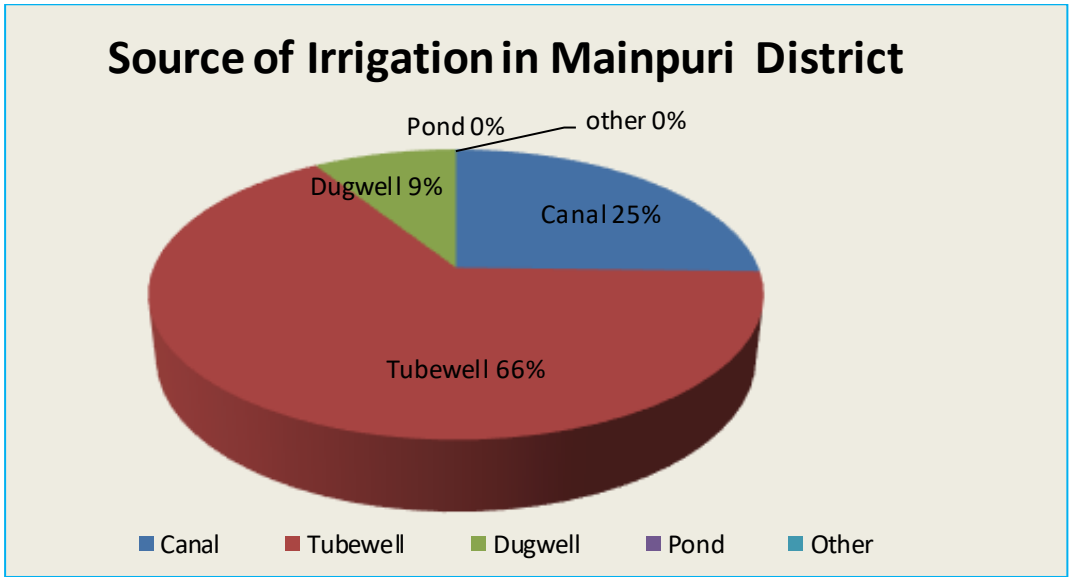


Figure 8.Percentage Distribution showing Methods of Irrigation in Mainpuri

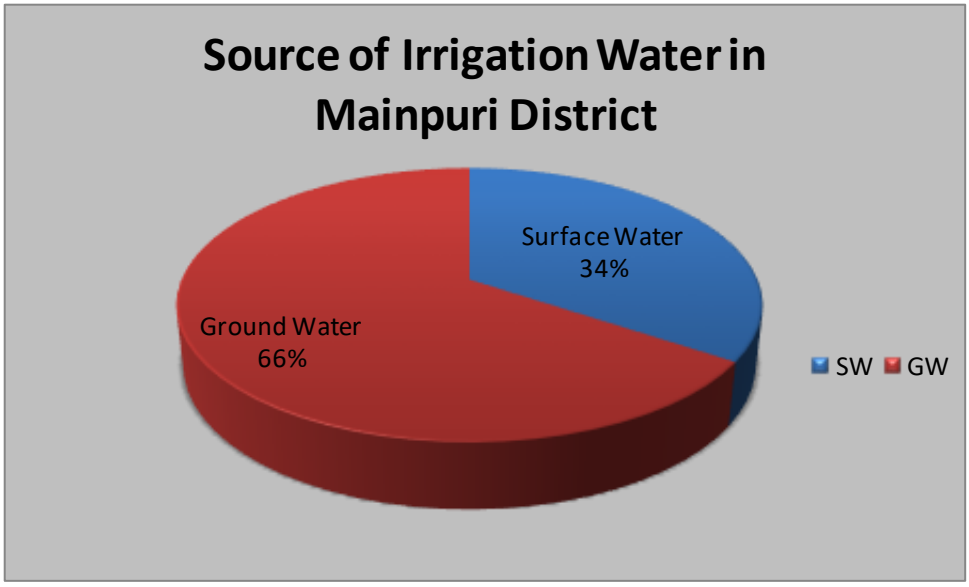


Figure 9. Source of Irrigation Water in Mainpuri District (U.P.)

Table 6. Details of the Distribution of Surface and Ground Water for Irrigation

Block	Length of canals (km)	State tube well (nos.)	Pakka well (nos.)	Shallow tube wells				Medium Tube wells (Nos.)	Deep Tube wells (Nos.)
				Electrical	Diesel	other	Total		
Ghiror	146	84	0	0	489	6423	39	6951	76
Kurawali	79	72	1	0	582	7344	17	7943	145
Mainpuri	83	109	0	0	938	7648	33	8619	121
Barnahal	14	50	2	0	1625	2883	48	4556	197
Karhal	229	48	2	0	587	7064	443	8094	69
Sultanganj	139	67	0	0	1396	8926	207	10529	118
Bewar	128	44	0	0	567	9140	73	9780	56
Ailau/ jagir	74	37	0	0	281	5328	697	6306	100
Kishni	148	45	0	0	1545	3006	53	4604	124
Total Rural	1040	556	5	0	8010	57762	1610	67382	1006
Total District	1040	556	5	0	8010	57762	1610	67382	1006

1.6 AQUIFER MAPPING

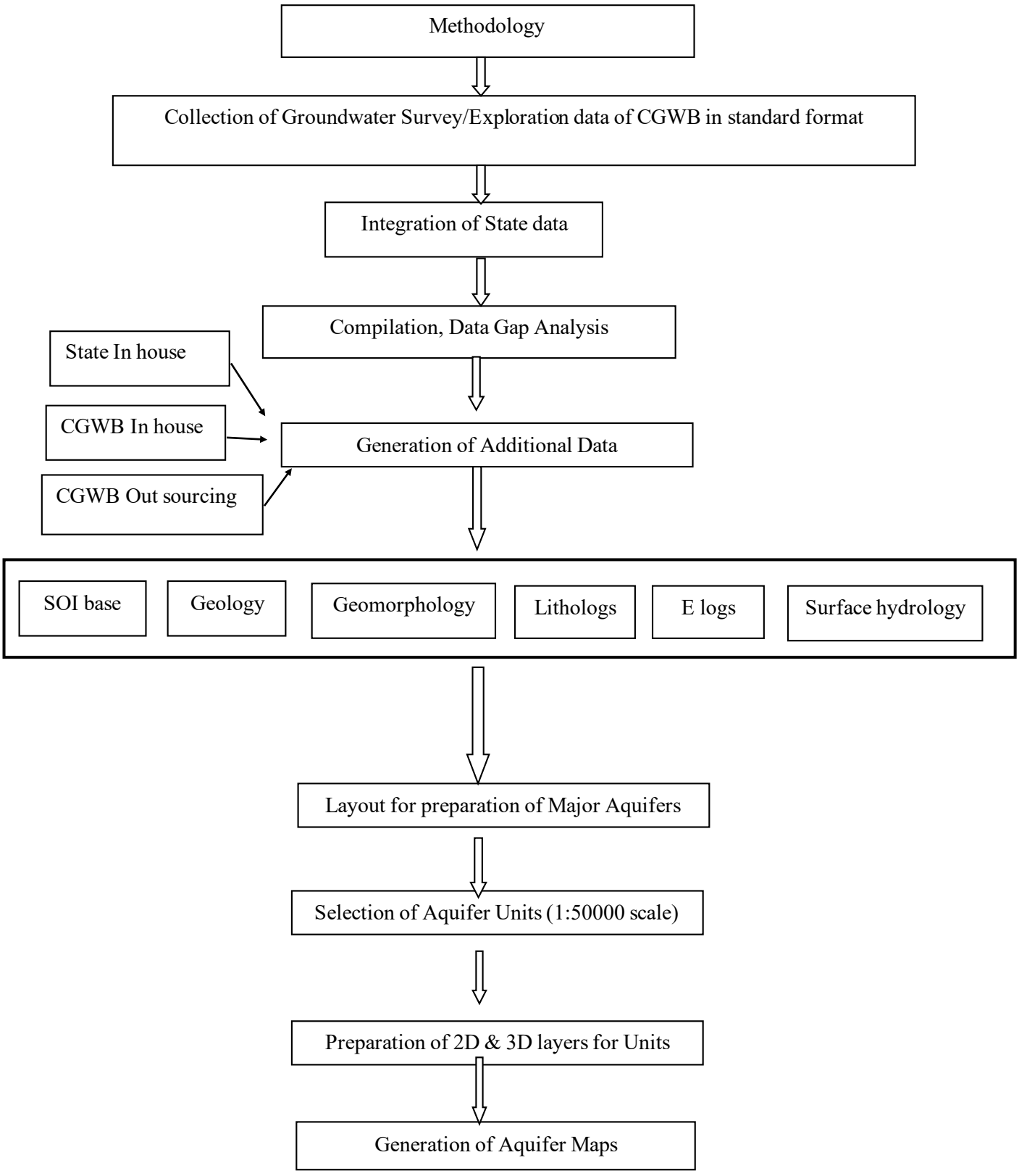
Aquifer mapping is a process wherein a combination of geologic, geophysical, hydrologic and chemical field and laboratory analyses are applied to characterize the quantity, quality and sustainability of ground water in aquifers. There has been a paradigm shift from “groundwater development” to “groundwater 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.

1.6.1 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.

1.6.2 Methodology

Various activities under NAQUIM are as follows



2. DATA COLLECTION AND GENERATION

2.1 HYDROGEOLOGICAL DATA

2.1.1 Geology

The area occupies a part of alluvial plain of Ganga Yamuna doab and is underlain by quaternary sediments constituting clays, silt and sands of different grades. The ground water occurs in a thick zone of saturation in the alluvium both under confined and unconfined conditions. The shallow aquifers, which are unconfined in nature, are being tapped chiefly by open dug well and shallow tube wells. The deeper aquifers, which are underlain by extensive confining clays, occur under confined conditions.

2.1.2 Water Level Behavior: The water level data of all Ground Water Monitoring Wells of 2021 are shown in Table 7:

Table 7.Water Level Data (2017-2021) of GWMW's of Mainpuri, District

Name of GWA Unit (Block)		2017	2018	2019	2020	2021
BARNAHAL	Pre-monsoon	17.01	21.67	21.51	17.17	22.74
	Post-monsoon	21.03	21.33	21.6	21.9	22.19
BEWAR	Pre-monsoon	6.89	6.24	6.83	5.44	7.55
	Post-monsoon	6.55	5.86	6.4	7.24	6.88
GHIROR	Pre-monsoon	7.39	6.24	7.13	4.54	7.86
	Post-monsoon	6.41	6.41	4.44	6.94	7.57
JAGIR	Pre-monsoon	8.76	9.01	5.29	9.29	10.2
	Post-monsoon	7.04	6.42	7.75	9.22	9.32
KARHAL	Pre-monsoon	5.23	4.87	4.62	4.52	5.35
	Post-monsoon	3.51	3.34	2.92	3.69	4.30
KISHNI	Pre-monsoon	6.57	5.7	6.80	6.05	7.54
	Post-monsoon	6.43	3.86	5.59	6.95	7.49
KURAWALI	Pre-monsoon	9.76	8.33	10.12	10.5	11.64
	Post-monsoon	8.71	9.07	10.04	10.7	11.31
MAINPURI	Pre-monsoon	9.8	8.18	9.1	9.47	10.12
	Post-monsoon	9.51	8.01	8.73	9.49	9.99
SULTANGANJ	Pre-monsoon	9.11	7.31	8.6	8.34	10.17
	Post-monsoon	9.32	7.76	8.15	9.27	9.81
District Average	**Pre-monsoon**	**8.94**	**8.61**	**8.88**	**8.36**	**10.35**
	Post-monsoon	**8.72**	**8**	**8.4**	**9.48**	**9.87**

The long-term trend in the water level reflected by water level hydrographs is indicative of change in groundwater storage in phreatic zone with time. Some Ground Water Monitoring Stations indicate a rising trend and this may be due to local hydrological conditions prevailing in the area. Whereas hydrographs of few GWOW show declining trend which may be due to over exploitation of ground water and these areas require careful management of surface water and conjunctive use of surface water and ground water. For the rest of stations, hydrographs neither indicate any substantial rise nor decline thus indicating that the storage (Dynamic) is being maintained at the normal level which is not disturbed by the present level of ground water development. Average district level water level trend of last five years is showing a continuous declining rate.

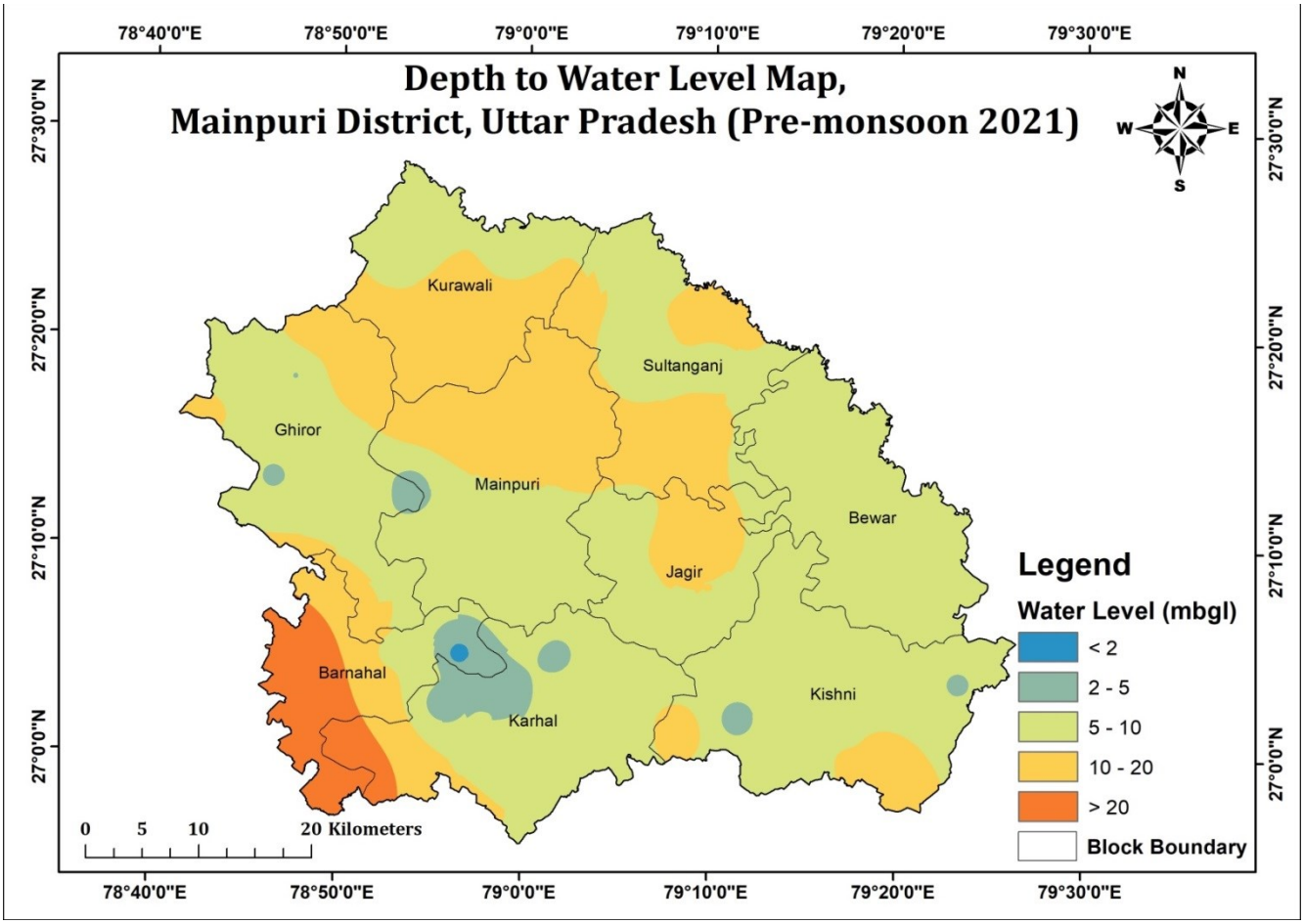


Fig-10: Depth to water level- Pre-monsoon, 2021, Mainpuri District

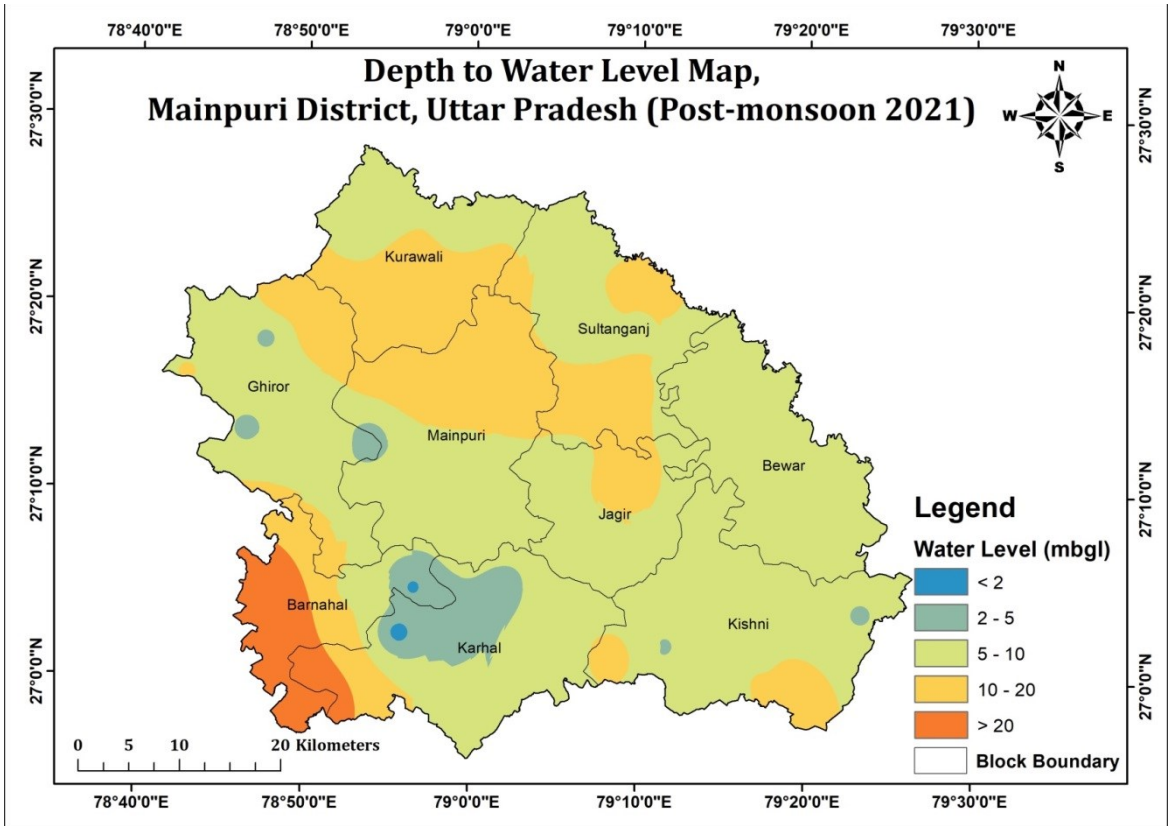


Fig-11: Depth to water level- Post-monsoon, 2021, Mainpuri District

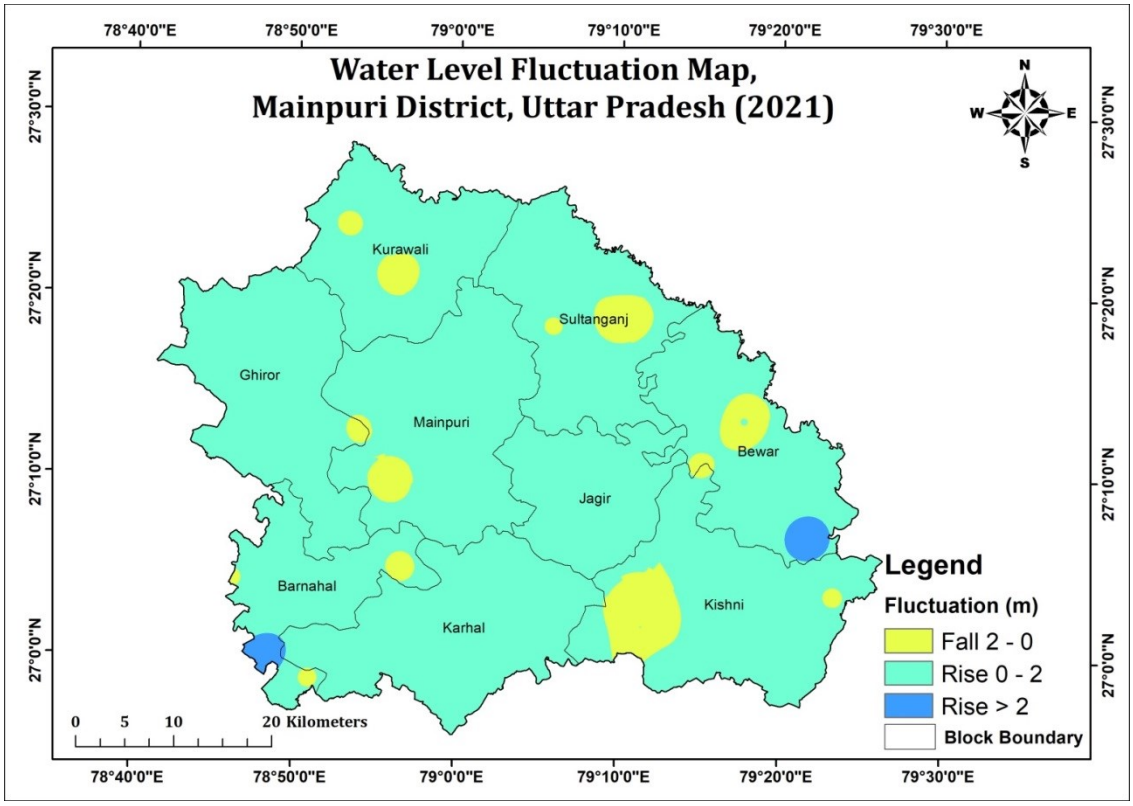
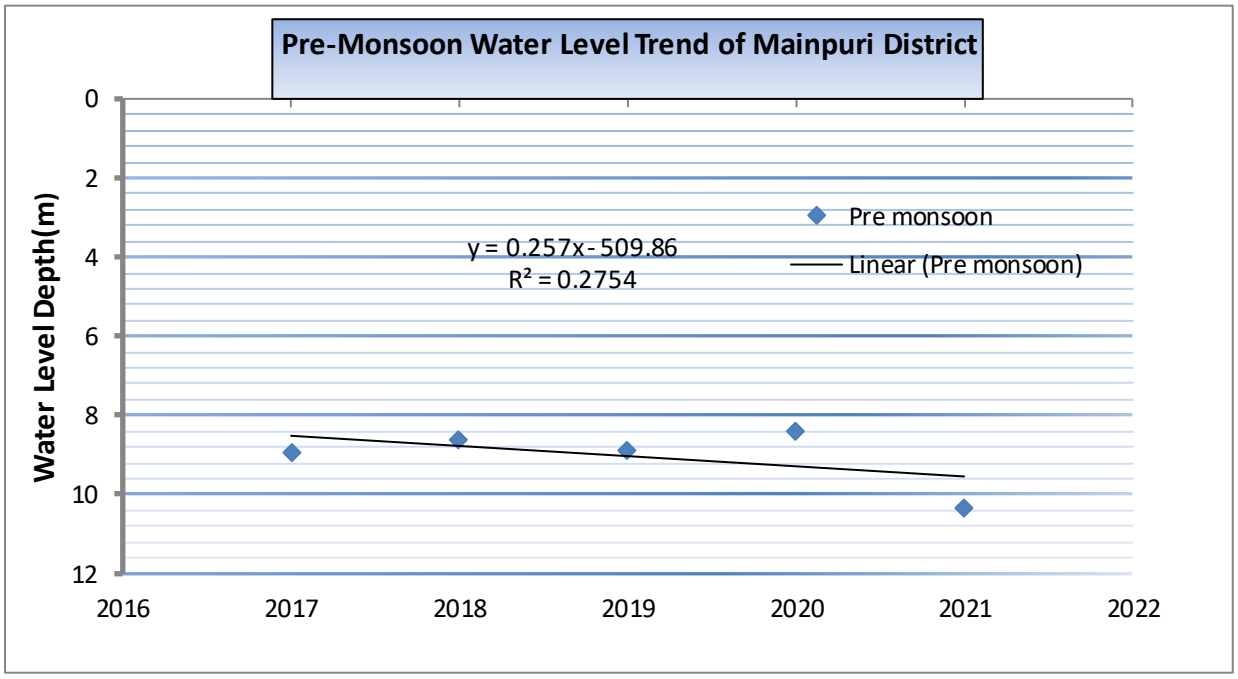
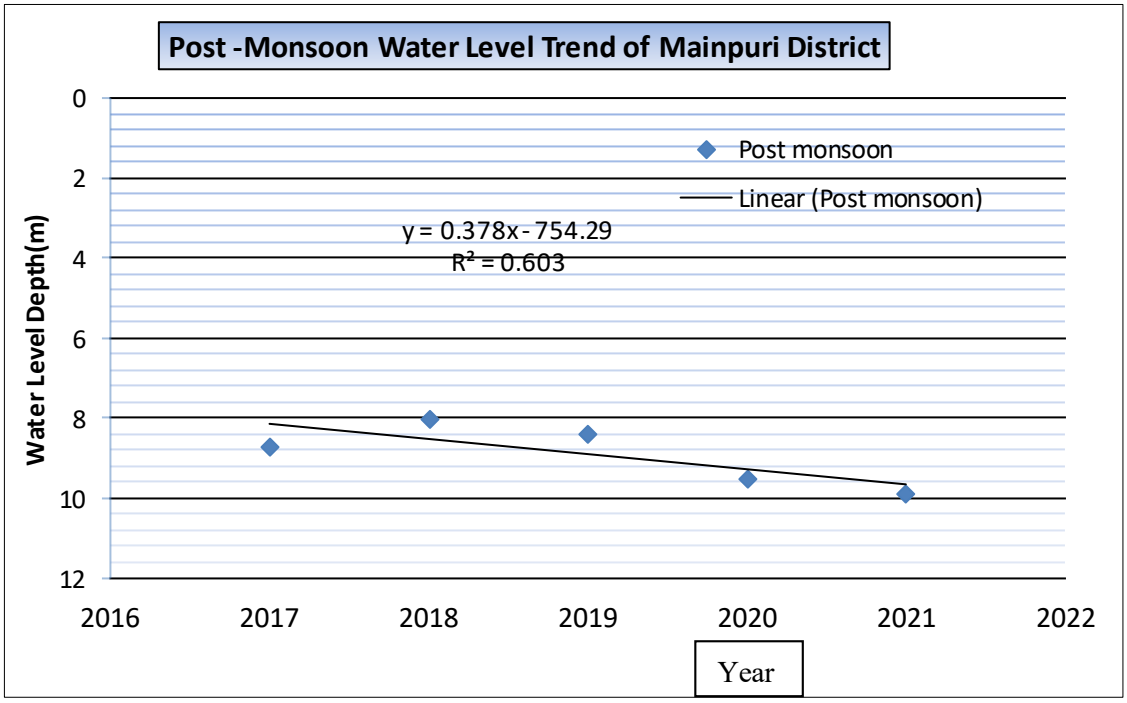


Fig-12: Depth to water level Fluctuation, 2021 Mainpuri District

2.1.3 Hydrographs

As per the Hydrographs, Average water level trend of Mainpuri District for Pre-Monsoon shows fall of 25 cm per year, whereas post-monsoon water level shows the fall of 37 cm per year.





2.2 EXPLORATORY DRILLING- CGWB, STATE AND PRIVATE WELLs

The lithologs of Exploratory Wells of Ground water department and minor irrigation department, Uttar Pradesh have been collected for the preparation of aquifer maps.

Table 8.Data availability of exploration wells in Mainpuri district

S.No	Source of data	Depth Range (m)			
		< 100	100-200	200-300	>300
1	CGWB	0	0	0	0
2	State Well	12	2	0	0
Total		**12**	**2**	**0**	**0**

2.3 GEOPHYSICAL 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 2021 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, 2021 data is shown in Table-8. The constituents, above permissible and acceptable limits of Bureau of Indian Standards (BIS), are highlighted in red.

Table 9.Result of chemical analysis of water samples from GWOW 2021 in Mainpuri district

Block	Lattitude	Longitude	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
					Mg/l												
Barnahal	27.07712	78.84259	7.61	1327	0	336	206	0.47	37	11.4	505	56	88	71	6.1	30	0
Bewar	27.22434	79.28624	7.94	446	0	262	14	0.70	0	7.1	180	36	22	24	3.6	30	0
Ghirore	27.18977	78.79778	7.93	424	0	232	14.2	0.84	0	8	185	44	18	20	4.1	25	0
Jageer	27.16965	79.10707	7.87	453	0	268	7	0.50	0	10	215	40	28	13	3.1	27	0
Karhal	26.99648	78.94045	7.68	910	0	439	64	0.9	36	24	210	32	31	117	5.4	28	0
Kishni	27.03160	79.26555	8.00	1955	0	561	124	2.0	10	425	270	20	53	342	7.1	24	0
Kishni	27.02879	79.26337	7.97	1492	0	561	78	**1.70**	0	117	230	16	46	231	6.9	24	0
Kurawali	27.38832	78.97415	7.71	737	0	366	21	0.75	0	24.6	240	32	38	57	5.2	26	0
Mainpuri	27.23936	79.05139	7.76	433	0	256	14	0.54	0	6.7	190	68	5	20	2.8	29	0
Sultanganj	27.316235	79.1007366	7.82	591	0	353.8	14.2	0.612	0	6.374	250	28	43.2	32.15	5.05	26.06	0

District	Block	Cr(mg/l)	Fe (mg/l)	Mn (mg/l)	Cu (mg/l)	Zn (mg/l)	As (mg/l)	Pb (mg/l)	U (mg/l)
Mainpuri	Barnahal	BDL	-0.028989	0.220784	-0.001067	1.599147	5.59069E-05	-0.000475	0.021660
Mainpuri	Bewar	-0.000160095	**0.350524525**	0.020547771	0.000362918	0.192207479	0.000998	0.001862759	0.01527381
Mainpuri	Ghirore	-0.000375265	-0.035361 77	0.108780961	-0.001157 65	0.012644239	0.000450	-0.000610292	0.011549848
Mainpuri	Jageer	-0.000389542	-0.035565628	0.008584366	0.000210677	0.056668518	0.000637	-0.000615086	0.008347643
Mainpuri	Karhal	0.005262347	0.149983459	0.100748599	0.017283416	0.126496868	0.000528	0.001260093	0.039102388
Mainpuri	Kishni	-0.000389794	-0.035486888	0.077114563	-0.001100404	0.001529 59	0.001326	-0.000589562	0.082657097
Mainpuri	Kishni	-0.000377953	-0.035472 82	0.048417 74	-0.000969 35	0.033804042	2.7403E-05	-0.000616885	0.005807984

Mainpuri	Kurawali	-0.000336718	**1.362668717**	0.036316256	-0.000627748	0.150192828	0.000615	0.000694041	0.030040124
Mainpuri	Mainpuri	-0.000379632	-0.035528186	0.251002697	-0.000990148	0.15740289	0.000551	-0.000626271	0.001888951
Mainpuri	Sultanganj	-2.94009E-06	1.089949806	0.028283096	-0.000234474	1.110945368	0.000516861	0.011274442	0.021578651

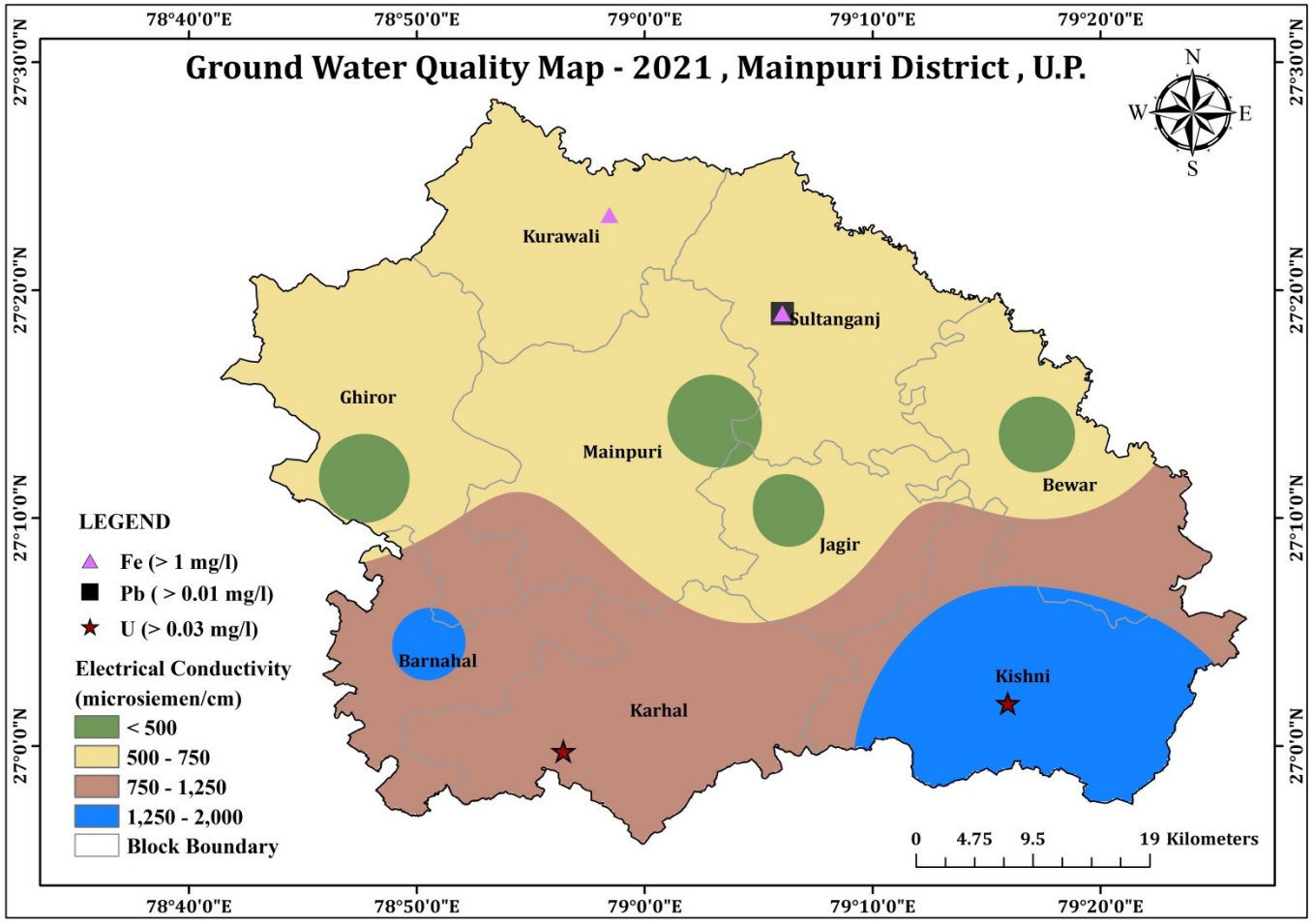


Figure 13. Ground Water Quality Map of Mainpuri District

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. Data Requirement, Data Availability and Data Gap Analysis are summarized in the following table:

Table 10: Data Requirement, Data Availability and Data Gap Analysis for Aquifer Mapping

Sl. No.	Study Aspect	Data Requirement	Data Availability	Data Gap
1.	Geophysics	Geophysical Survey in all blocks	Not Available	in mainpuri district, all blocks are required VES.
2.	Exploration	Exploration are required in all blocks	Not Available	in mainpuri district, all blocks are required Exploration.

3.0 HYDROGEOLOGY

Geologically, the area of the entire district forms a part of the upper Gangetic plain. The alluvial deposits belonging to the quaternary age comprising mainly clay, kankar, sand &gravel over the basement of Pre-Cambrian Vindhyan formation. from the boreholes drilled by state agencies in the area it can be seen that lithologically variations are conspicuous , both laterally and vertically, in the sediments due to facies changes during the process of sedimentation which have resulted in the physical-chemical complexities within its scenario.

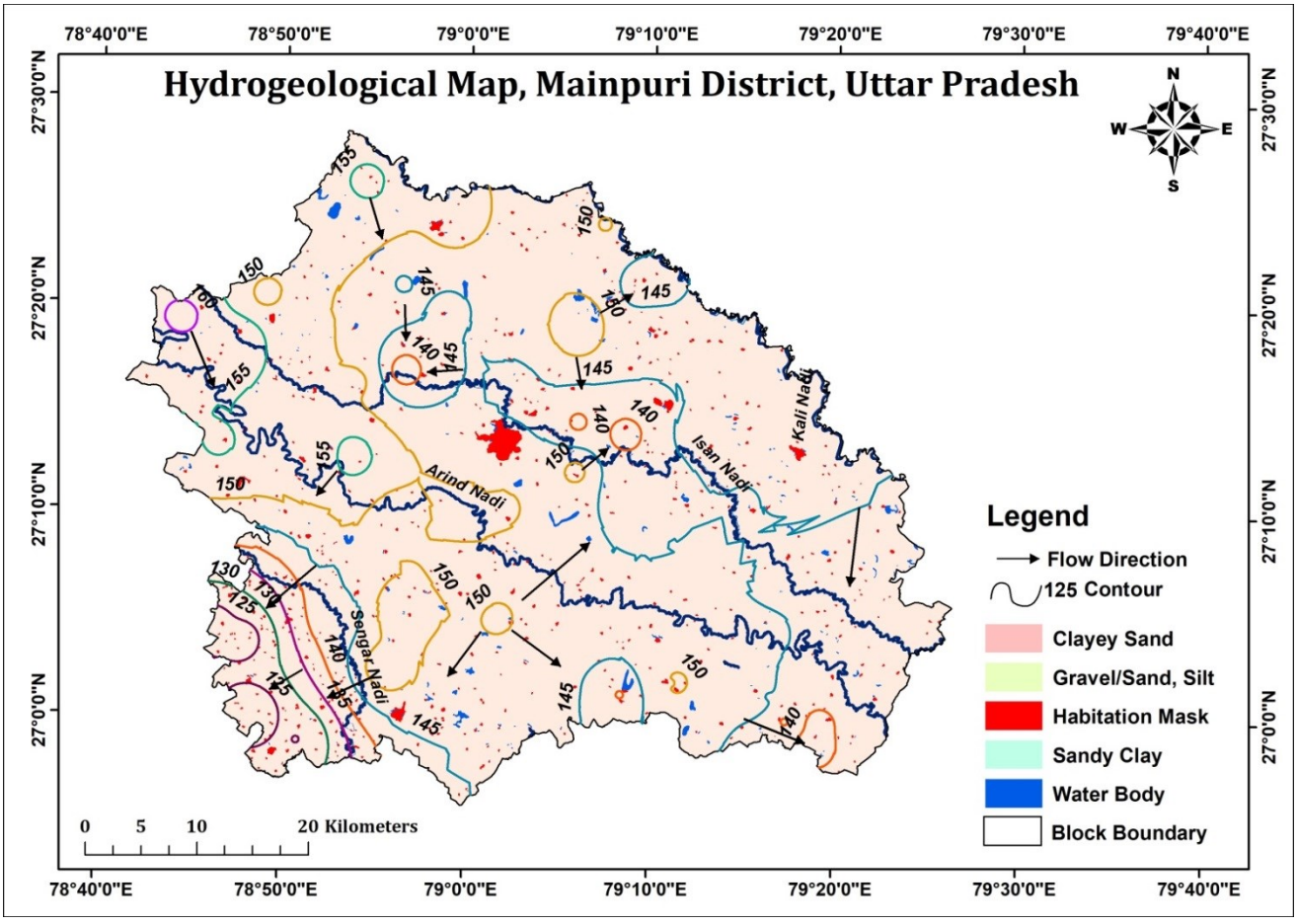


Figure:14 Hydrogeological Map of Mainpuri District

3.1 EXPLORATORY SUMMARY OF MAINPURI DISTRICT

In Mainpuri district, the exploration drillings were carried out by State Department, Uttar Pradesh. 14 exploratory wells were constructed up to maximum depth of 200 mbgl. The aquifer parameters range extracted and is given in below Table-11.

Exploration Details (CGWB)at Mainpuri District

Sl. No	Location	Lattitude/ Longitude	Type of well	Depth drilled(m)	Lithology	SWL (m)	Discharge(lpm)	Drawdown (m)	T(m2 / day)	EC
1.	Sonai	27 21 00/ 78 55 00	EW	153.92	Alluvium	3..74	1523	2.65	587.00	496

Note: No available data (lithology and e log) above well(Sonai).

Table 2: Summary of exploration and hydraulic details (state tubewell)

S. No.	Location/ Latitude/ Longitude/ Toposheet	Type of Well	Drilled depth/Bed rock (mbgl)	Zones tapped (mbgl)	Water Level (mbgl)	Yield (lpm)	Draw Down (m)	Transmissivity (T) m^2/day	Storativity
1	**Sonai**	TW	94.92	30.48-47.41	4.27	2322	5.18	-	-
	27.364484			59.13-75.61					
	78.930213								
2	**Jamthari**	TW	103.66	25.61-33.54	3.96	1719	6.10		
	27.290293			52.13-64.02					
	79.095415			74.70-94.51					
3	**Pusena**	TW	91.46	44.21-83.30	1.61	402.60	10.36		
	27.232829								
	79.065037								
4	**Badshahpur**	TW	121.92	25.08-30.75	5.49	2322	8.23		
	27.247351			89.56-95.45					
	78.755645			103.78-111.10					
5	**Jyoti**	TW	82.31	41.46-53.55	5.67	2445	6.70		
	27.299178			62.30-79.83					

	78.926237								
6	**Ujhaiya**	TW	106.68	25.30-33.83	4.57	1093.8	4.11		
	27.265691			73.47-93.44					
	78.900817								
7	**Akbarpur aunchha**	TW	118.87	47.87-51.22	6.10	-	-	-	
	27.317343			67.53-85.35					
	78.819229			94.51-100.45					
8	**Bigrayi**	TW	170.69	36.58-54.88	6.09	2620.2	7.62		
	27.212374			118.37-137.19					
	78.858567								
10	**Udaipur Naraini**	TW	106.68	38.11-41.16	5.18	-	-		
	27.250876			44.21-53.05					
	79.117935			60.98-64.02					
				85.37-91.46					
11	**Khera Mahan**	TW	116.46	71.26-87.65	10.98	1719	6.10		
	26.998319			96.90-110.65					
	78.795764								
12	**Asrohi**			32..24-40.47	8.00	1290.60	11.55		
	27.006542	TW	108.54	45.21-51.31					
	78.871431			65.55-72.56					
				78.58-81.71					
				93.99-97.96					
13	**Byonti Khurd**	TW	130.94	42.01-53.63	5.09	1621	14.63		
	27.226335			91.04-97.07					
	79.106902			109.02-119.15					
14	**Kharaua**	TW	132.93	48.63-54.57	9.83	1029.60	8.41		
	26.957985			62.68-65.55					
	78.814073			87.73-97.87					
				109.97-128.96					
15	**Birthua**	TW	143.29	91.77-108.84	7.62	2614	-		
	27.038752			110.64-132.32					
	78.795913								

Since no exploratory wells are constructed prior to 2021(CGWB) , and no hydraulic parameters was available for these wells therefore not incorporated in the report

3.2 AQUIFER GEOMETRY AND DISPOSITION

To understand the lithological frame work and aquifer disposition in the sub surface aquifers, the litholog data of wells drilled by GWD,UP and irrigation deptt.UP are used to compile, optimized and modeled into 3D synoptic picture by using the RockWorks16 software. The stratigraphic model has been prepared along with distribution of wells are shown in Fig-11. The major aquifer system of the Mainpuri 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.

Aquifer 3-D models are prepared upto the depth of 450 m bgl. Three Aquifer Groups have been encountered upto the depth of 450mbgl. Out of these 3 Aquifer Groups, 2 are fully penetrated while the 3rd one is only partially penetrated because of the deeper depths. Since, the area belongs to the great northern plains, sediments are quaternary in age, while the sediment type varies in grain size from clay to coarse sand sometimes gravel. These sediments were deposited by the rivers originating from Himalaya. Sand size particles dominate the overall sedimentation, which in turn becomes our major aquifer forming material. Clay, not very thick, layers are intermittent. Regional Clay layers have been identified and marked as the confining layer.

The 1st-group of granular zones is encountered just below the surface clay bed and extends downward upto depth varying from 42.67 to 137.16 metres below ground levels. A number of clay beds varying in thickness from 2 to 8 metres (as per litholog) are encountered within this group at different depths. .

The 2nd group of granular zones is encountred at varaible depths ranging from 142.95 to 235.67 mbgl and extend downward. The granular material comprising of fine to medium sand and medium to coarse sand (sometimes mixed with little clay and Kankar). The local clay lenses ranging in thickness from 6 to 18 metres, are very common within this group also.

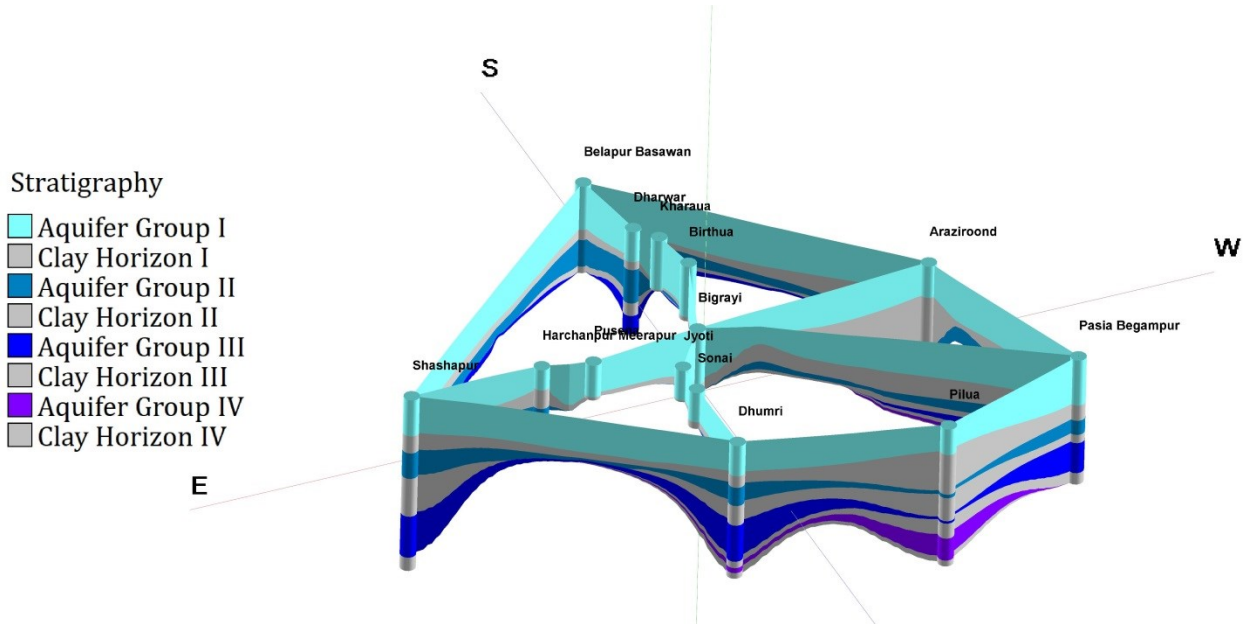
The 3rd group of granular zones which extends downward upto about 415 metres depth bgl. The granular material is consisted of medium to coarse sand, predominantly medium sand.

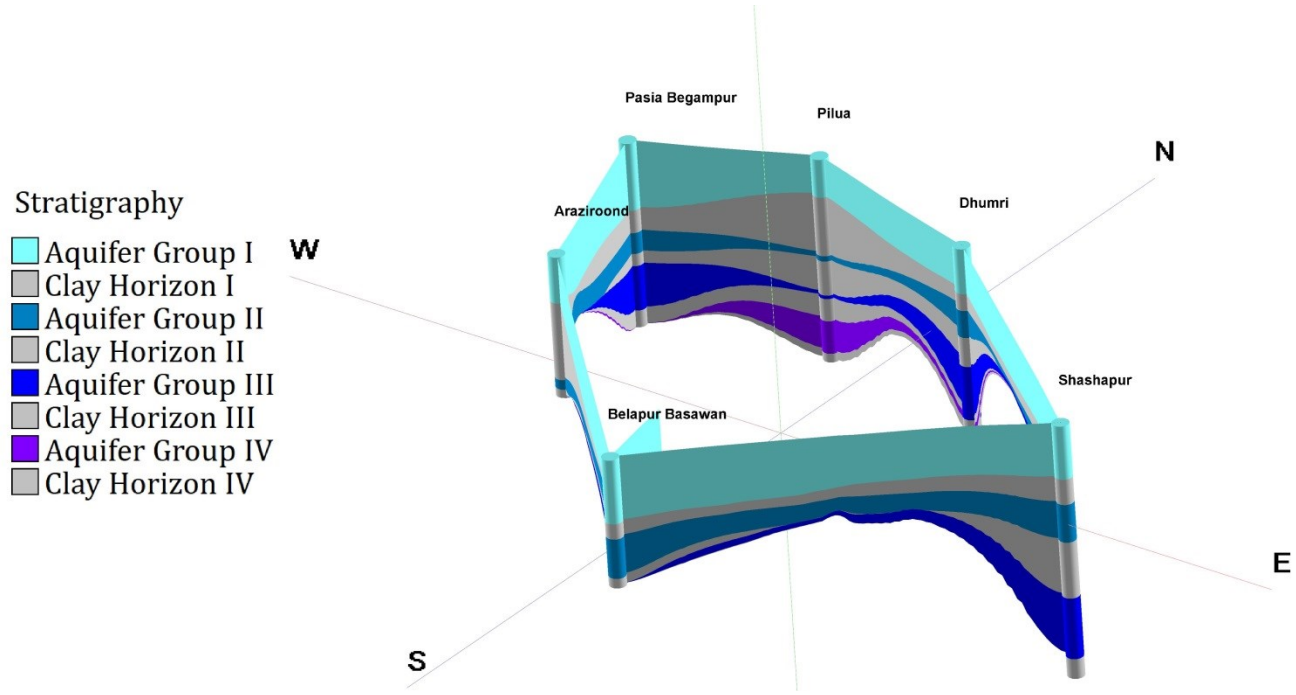
These granular zones having the tremendous capacity of storing water, constitute the

three-tier aquifer system in the area and have been designated, starting from top as I Aquifer group, II Aquifer group and III Aquifer group encountering at depths varying from 0 to 137.16 metre, 142.95- 235.67 metres, 248.30 - 415 metres and below ground level respectively. In present study 3D map prepared up to depth of 450 m bgl. Average thicknes of Aquifer I , II and III are 93.87 m, 183 and 306 m.

Table 3. Aquifers details of Mainpuri ,District

Aquifer system	Depth Range (m bgl)	
	From	To
Aquifer Group -1	0	137.16
Aquifer Group -2	142.95	235.67
Aquifer Group -3	248.3	415


Stratigraphy
Aquifer Group I
Clay Horizon I
Aquifer Group II
Clay Horizon II
Aquifer Group III
Clay Horizon III
Aquifer Group IV
Clay Horizon IV
S
W
E
Belapur Basawan
Dharwar
Kharaua
Birthua
Araziroond
Bigrayi
Pasia Begampur
Harchanpur
Meerapur
Jyoti
Shashapur
Sonai
Pilua
Dhumri


Stratigraphy
Aquifer Group I
Clay Horizon I
Aquifer Group II
Clay Horizon II
Aquifer Group III
Clay Horizon III
Aquifer Group IV
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W
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Pasia Begampur
Pilua
Araziroond
Dhumri
Shashapur
Belapur Basawan

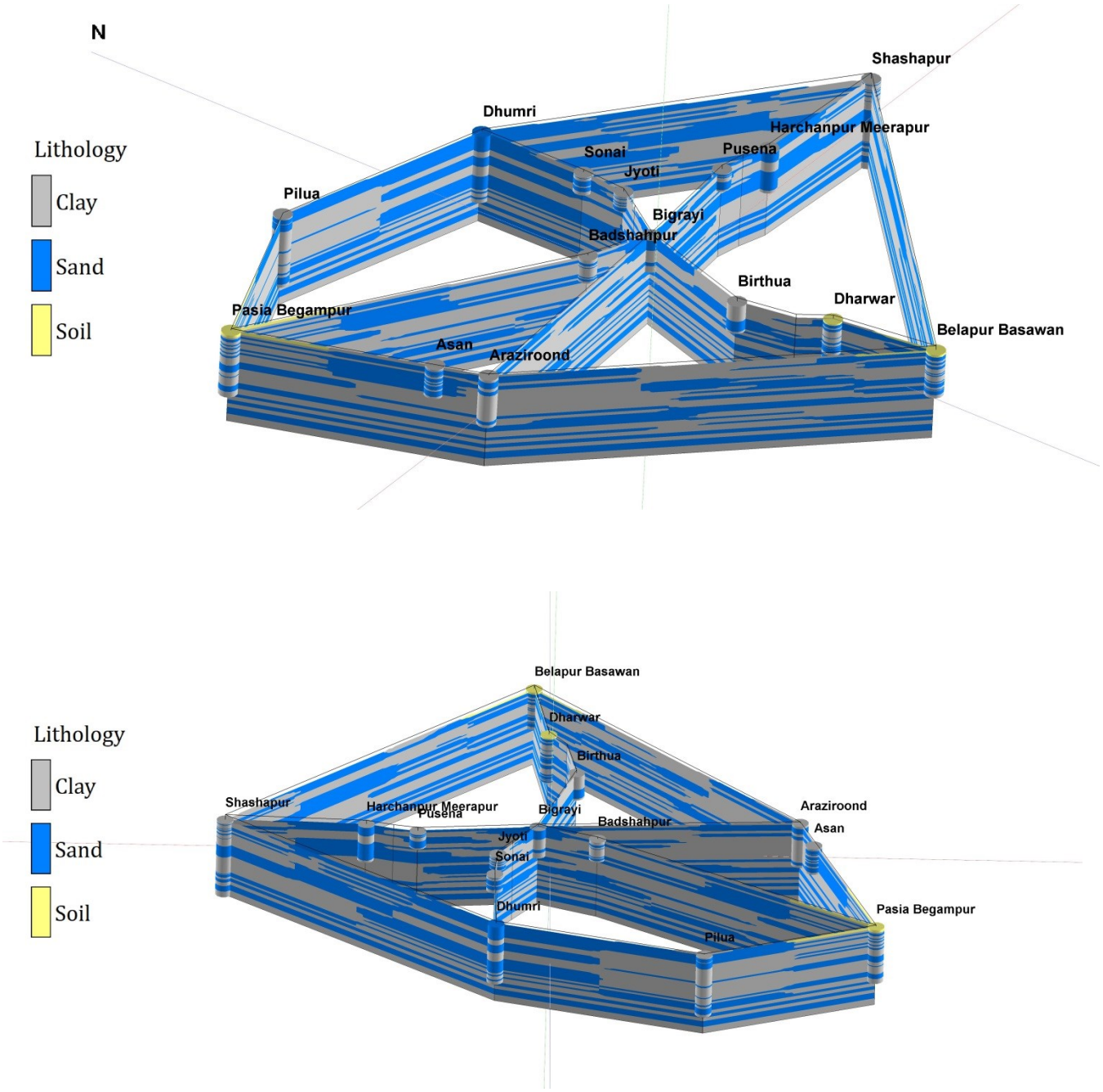


Fig: 15. 3-D Aquifer Map of Mainpuri District

4.0 GROUND WATER 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 214.63 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 214.63 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 Dynamic Resources

(A)- For Unconfined Aquifer-

Mainpuri district, a part of alluvial plain of Ganga Yamuna doab 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, the 5 blocks are under safe category, Barnahal Block is in over-exploited and Kurawali, Mainpuri and Jagir are in semi-critical Category.

Table 4. 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)
BARNAHAL	4612.12	6126	532.99563	6659.00	0	144.38	over_exploited
BEWAR	8738.25	5608.13	285.50154	5893.63	2821.59	67.45	safe
GHIROR	12722.94	5257	575.06115	5832.06	6846.22	45.84	safe
JAGIR	6791.86	4403	618.4341	5021.43	1703.06	73.93	semi_critical
KARHAL	15082.54	8310.8	471.57708	8782.38	6251.29	58.23	safe
KISHNI	10841.59	7059.6	367.69224	7427.29	3375.16	68.51	safe
KURAWALI	8657.48	5084	1001.93814	6085.94	2449.92	70.30	semi_critical
MAINPURI	11435.98	8668.3	443.82759	9112.13	2288.58	79.68	semi_critical
SULTANGANJ	8503.66	5218	473.09694	5691.10	2763.53	66.93	safe
TOTAL	87386.42	55734.83	4770.12441	60504.95	28499.35	69.20	Safe

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 28499.35 ham and allocation of GW for domestic purposes on 2025 as 5240.74 ham.

Table 14: 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	BARNAHAL	574.62	0
2	BEWAR	308.53	2821.59
3	GHIROR	619.72	6846.22
4	JAGIR	685.8	1703.06
5	KARHAL	520.45	6251.29
6	KISHNI	406.82	3375.16
7	KURAWALI	1123.57	2449.92
8	MAINPURI	479.1	2288.58
9	SULTANGANJ	522.13	2763.53
	District Total	5240.74	28499.35

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 Mainpuri District, 5 blocks are under safe category, Barnahal block is in over-exploited and Kurawali, Mainpuri and Jagir are in semi-critical Category.

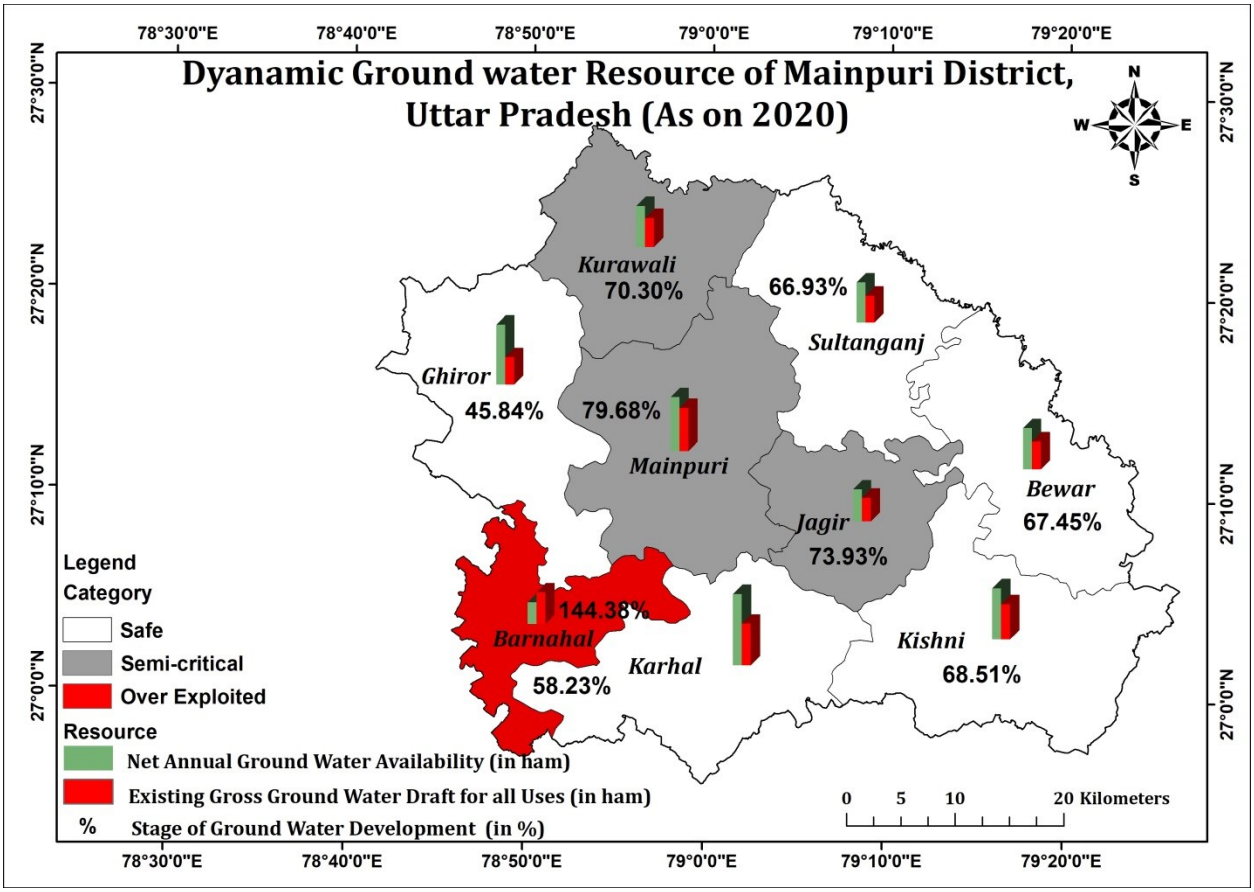


Fig16: Ground Water Availability, Extraction and Categorization Map, Mainpuri district.

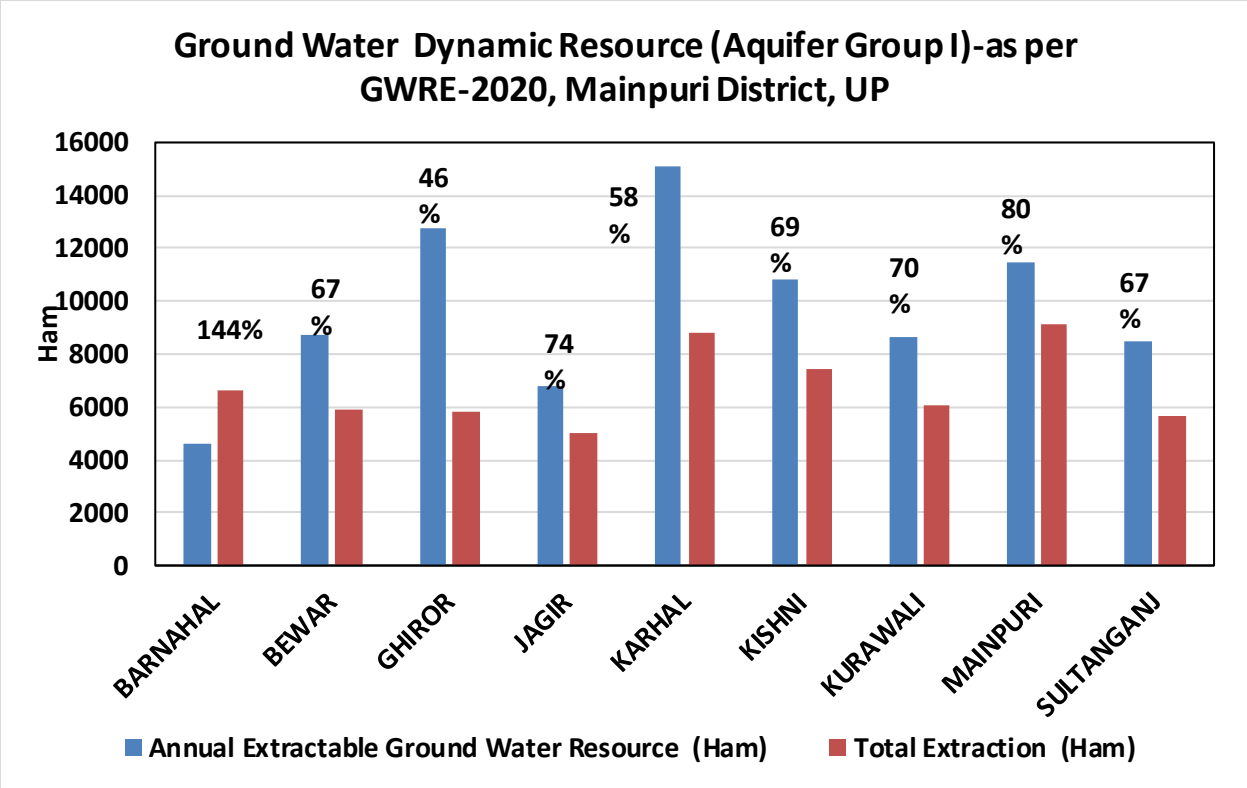


Figure 17: Dynamic Ground Water Resource of Aquifer Group-I, Mainpuri district.

(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.

1. 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 15.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) = 4*8*9*/100
1	2	3	4	5	6	7	8	9	10
1	BARNAHAL	Alluvium	210.35	22.74	132.93	114.59	53.66	16	**1805.98**
2	BEWAR	Alluvium	294.28	7.55	95	88.26	95.00	16	**4473.05**
3	GHIROR	Alluvium	344.91	7.86	111.25	103.23	32	16	**1765.93**
4	JAGIR	Alluvium	211.92	10.20	200.54	193.15	93	16	**3153.36**
5	KARHAL	Alluvium	345.96	5.35	98.1	89.14	31.44	16	**1740.31**
6	KISHNI	Alluvium	365.94	7.54	78	71.24	30	16	**1756.51**
7	KURAWALI	Alluvium	280.79	11.64	76.80	68.61	48.61	16	2183.87
8	MAINPURI	Alluvium	393.98	10.12	102.10	93	41.22	16	2598.37
9	SULTANGANJ	Alluvium	312.59	10.17	112.50	104.58	26.09	16	1304.87
	TOTAL	Alluvium	2760.72	**10.35**	62.95	102.8	50.11	16	2309.13

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.

1. Depletion of Ground Water Resources & Management:

The major source of irrigation in the district is ground water, irrigating 1,47,658 ha contributing about 74.58% of the total irrigation potentials of the district. The contribution of ground water irrigation is minimum in Karhal block which is 32.50%, whereas maximum in Kishni block which is 98.16%. 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.

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 saline / brackish ground water and presence of Fluoride, Iron, and Chloride 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.

Kishni Block- Lead (Pb) is present in the Ground Water in excess quantity beyond permissible limits. (Pb= 0.01 mg/l permissible limits)

Karhal and Kishni Block- Uranium(Ur) is present in the Ground Water in excess quantity beyond permissible limits. (Ur= 0.030mg/l permissible limits)

Kurawali, Sultanganj & Bewar Block- Presence of Iron (Fe^{3+}) beyond permissible limit has been reported from these three blocks. (Fe= 0.30mg/l permissible limits)

Table 16. Quality problem in the Ground Water resources of shallow Phreatic Aquifer

Sl. No.	Chemical Constituent responsible for quality problem	Maximum Permissible limitin the absence of alternate source (mg/lit)	Recorded concentration (mg/lit)	Affected Blocks	Possible adverse effects
1.	Lead(Pb)	0.01	1.08	Kishni	Anemia, weakness, and kidney and brain damage.
2.	Iron (Fe^{3+})	0.30	0.35 to 1.36	Kurawali, Sultanganj and Bewar	May be used with caution after taking suitable treatment measures.
3.	Uranium	0.030	0.039 to 0.082	Karhal and Kishni	uranium can cause chronic kidney disease, deformity of bones and liver

6.0 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 69.76 % in 2017 to 69.20% in 2020. As on 31.03.2020, it shows that block wise level of development of ground water potential in Mainpuri district varies from 45.84% (Ghiror) to 144.00% (Barnahal). 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 all 9 blocks have been classified as 5 safe, 3 semi critical, and 1 over exploitation in terms of exploitation of ground water resources. 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 GWRE-17 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 17.Block wise Unit Draft Calculation, Mainpuri, UP

Sl No	Block	Draft For Irrigation (from Resource)	Net Irrigated Area (From Statistical Diary)	Unit Draft
1	Ghiror	5257	10044	0.52
2	Kurawali	5084	8935	0.57
3	Mainpuri	8668.3	11134	0.78
4	Barnahal	6126	9733	0.63
5	Karhal	8310.8	7767	1.07
6	Sultanganj	5218	29964	0.17
7	Bewar	5608.13	28105	0.20
8	Ailau/ jagir	4403	16196	0.27
9	Kishni	7059.6	25780	0.27
10	**DISTRICT**	**55734.83**	**147658**	**0.38**

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 18: Supply Side Management, Mainpuri District

	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)		
Ghiror	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
Kurawali	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
Mainpuri	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	0.16
Barnahal	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
Karhal	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
Sultanganj	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
Bewar	1	0.04	0.02	0.02	1	0.07	0.03	0.03	1	0.03	0.02	0.02	3	0.09	0.04	0.04	0.23	0.12
Ailau/jagir	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
Kishni	2	0.05	0.03	0.03	2	0.08	0.04	0.04	2	0.04	0.02	0.02	4	0.11	0.05	0.05	0.29	0.14
DISTRICT TOTAL	14	**0.41**	**0.21**	**0.21**	**14**	**0.62**	**0.31**	**0.31**	14	**0.31**	**0.16**	**0.16**	**28**	**0.83**	**0.41**	**0.41**	**2.17**	**1.09**

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.

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.

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.

Table 19. Demand side Management, Mainpuri district

Blocks	On Farm Activities			Water Use Efficiency		Total Saving in 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	
Ghiror	2199	2.20	1.75	2199	1.75	2.33
Kurawali	2066	2.07	2.02	2066	2.02	2.18
Mainpuri	2360	2.36	3.06	2360	3.06	2.52
Barnahal	1309	1.31	2.29	1309	2.29	1.39
Karhal	2168	2.17	2.26	2168	2.26	2.30
Sultanganj	2595	2.60	1.30	2595	1.30	2.72
Bewar	2542	2.54	1.44	2542	1.44	2.66
Ailau/ jagir	1580	1.58	1.18	1580	1.18	1.66
Kishni	2989	2.99	2.15	2989	2.15	3.13
DISTRICT TOTAL	19809	19.81	17.45	19809	0.00	**20.90**

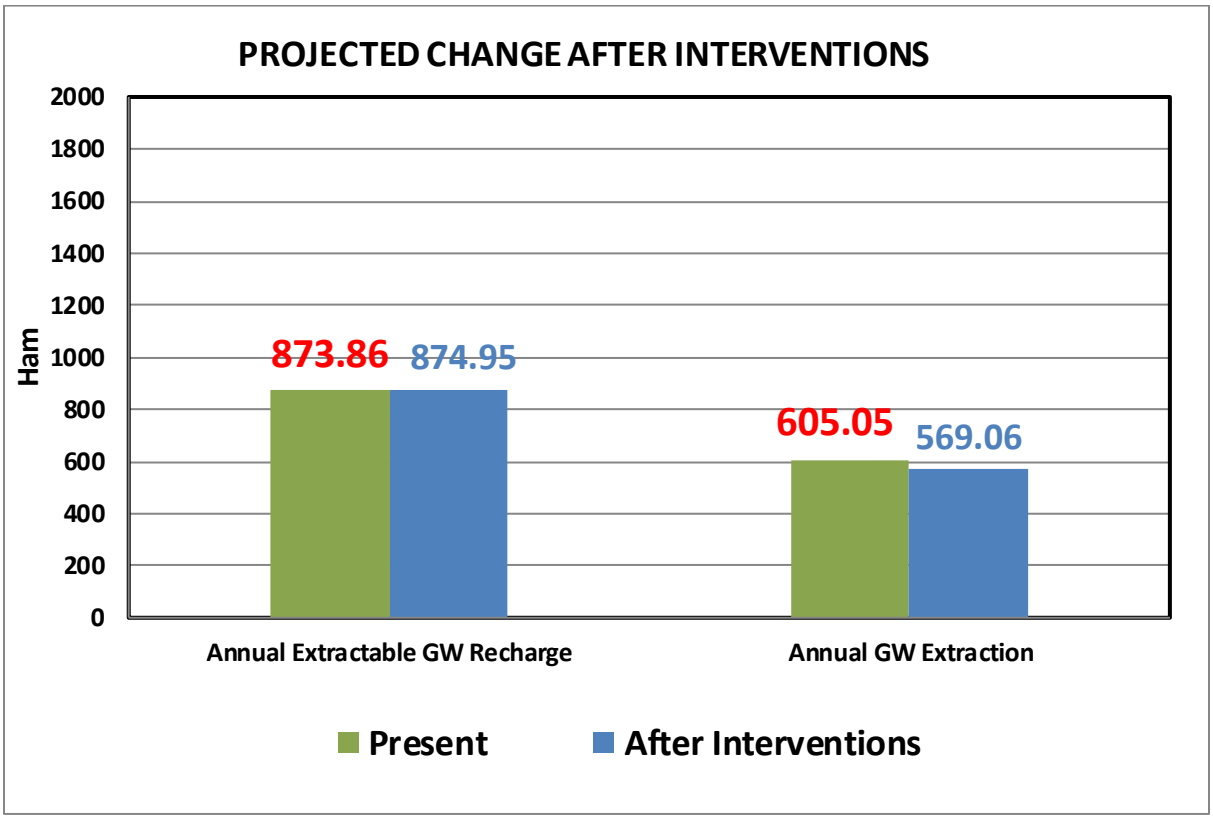
Table 20. Blockwise Summary Report for Ground Water Management, Mainpuri, UP

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
Ghiror	2	2	2	3	2199	2199	0.14	0.14	3.50	0.14	3.63	45.84	42.94
Kurawali	1	1	1	3	2066	2066	0.11	0.11	4.05	0.11	4.16	70.30	65.41
Mainpuri	2	2	2	4	2360	2360	0.16	0.16	6.12	0.16	6.28	79.68	74.09
Barnahal	1	1	1	2	1309	1309	0.08	0.08	4.58	0.08	4.66	144.38	134.04
Karhal	2	2	2	3	2168	2168	0.14	0.14	4.52	0.14	4.66	58.23	55.09
Sultanganj	2	2	2	3	2595	2595	0.12	0.12	2.61	0.12	2.73	66.93	63.62
Bewar	1	1	1	3	2542	2542	0.12	0.12	2.87	0.12	2.99	67.45	63.94
Ailau/jagir	1	1	1	2	1580	1580	0.08	0.08	2.35	0.08	2.43	73.93	70.26
Kishni	2	2	2	4	2989	2989	0.14	0.14	4.30	0.14	4.45	68.51	64.32
Total	**14**	**14**	**14**	**28**	**19809**	**19809**	**1.09**	**1.09**	**34.90**	**1.09**	**35.99**	**69.24**	**65.04**

Table 21.Block wise expected outcomes from Ground Water Management interventions, Mainpuri, 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
Ghiror	344.91	127.23	58.32	45.84	0.14	3.63	127.37	54.69	**42.94**
Kurawali	280.79	86.57	60.86	70.30	0.11	4.16	86.69	56.70	**65.41**
Mainpuri	393.8	114.36	91.12	79.68	0.16	6.28	114.51	84.84	**74.09**
Barnahal	210.35	46.12	66.59	144.38	0.08	4.66	46.20	61.93	**134.04**
Karhal	345.96	150.83	87.82	58.23	0.14	4.66	150.96	83.16	**55.09**
Sultanganj	312.59	85.04	56.91	66.93	0.12	2.73	85.16	54.18	**63.62**
Bewar	294.28	87.38	58.94	67.45	0.12	2.99	87.50	55.95	**63.94**
Ailau/ jagir	211.92	67.92	50.21	73.93	0.08	2.43	68.00	47.78	**70.26**
Kishni	365.94	108.42	74.27	68.51	0.14	4.45	108.56	69.83	**64.32**
DISTRICT TOTAL	**2760.54**	**873.86**	**605.05**	**69.24**	**1.09**	**35.99**	**874.95**	**569.06**	**65.04**

Figure 1. Projected Change of Ground Water Scenario after Management, Mainpuri, UP



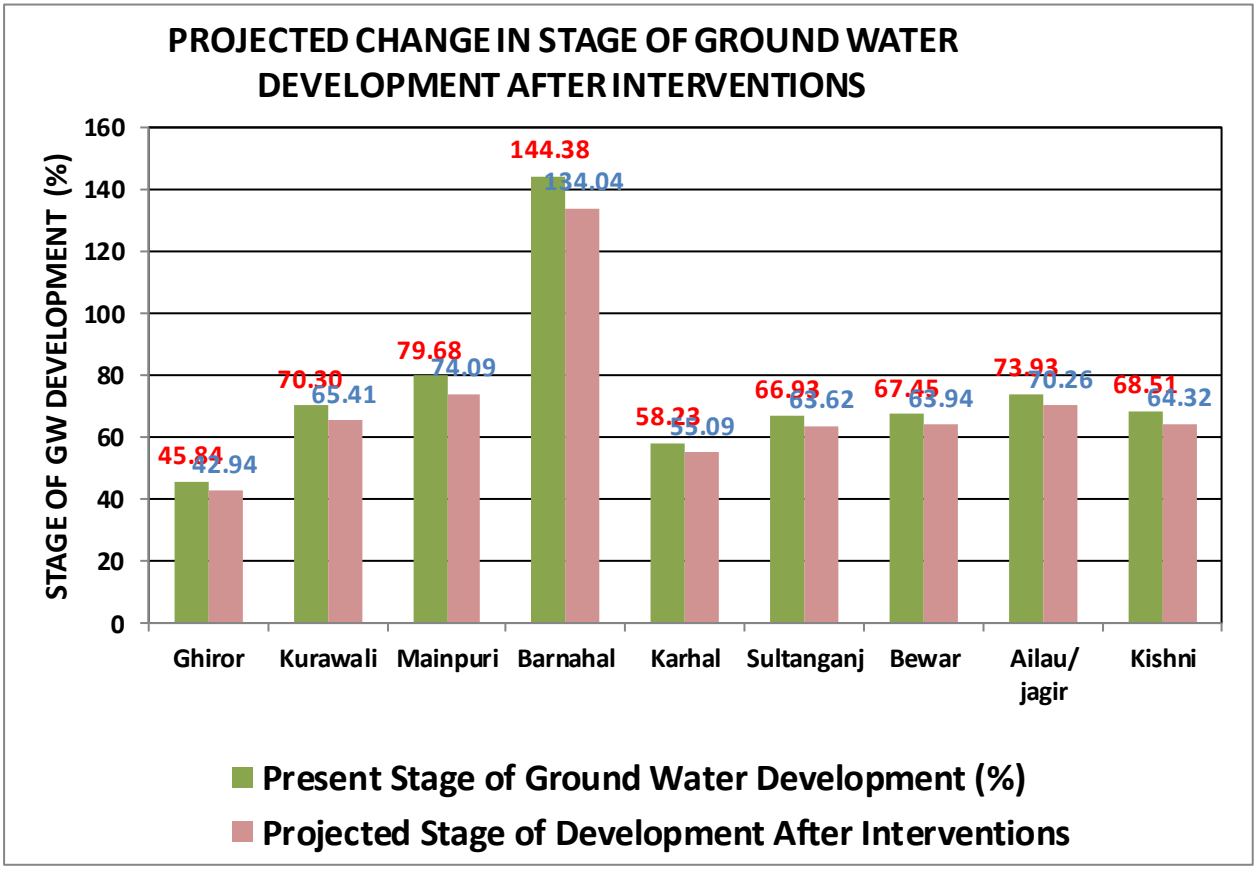


Figure.18. Block wise Projected Change of Ground Water Scenario after Management, Mainpuri, UP

7. BLOCK-WISE AQUIFER MAPS & MANAGEMENT PLANS

7.1 Aquifer Mapping and Management Plan of Ghiror Block, Mainpuri District, U.P.

1. Salient Information

Table 22: Salient Information of Ghiror Block, Mainpuri District, U.P.

Area	344.91 Sq. Km				
Population	171347	**Male**	91765	**Female**	79582
Population Density	496.78 persons/sq km				
Annual Rainfall (2011-20)	496.72 mm	**Monsoon**	434.51 mm	**Non-Monsoon**	62.21 mm

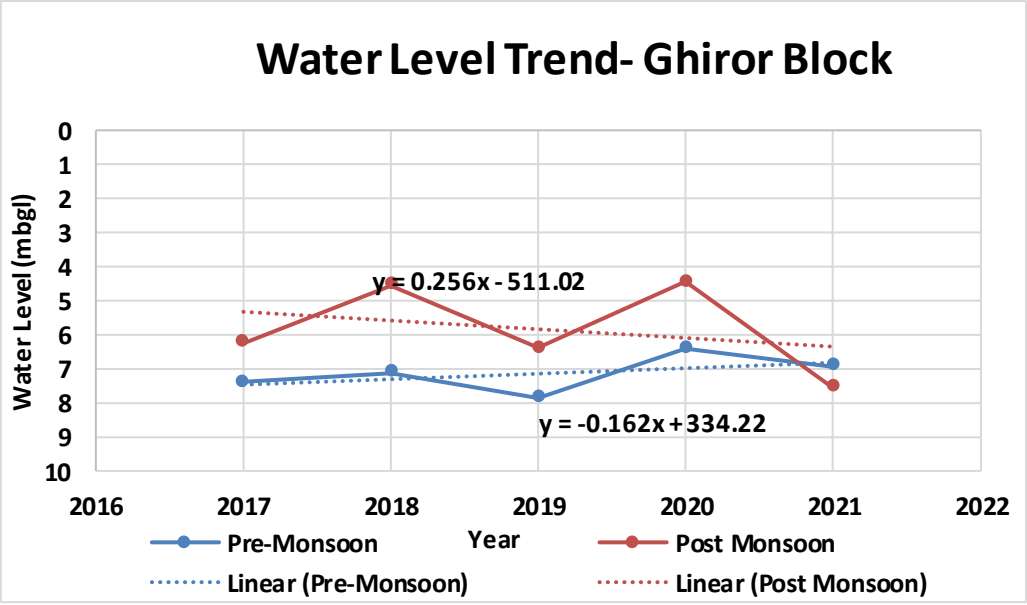
Table 23: Agriculture and Irrigation, Ghiror Block, Mainpuri District, U.P.

Net Sown Area	21989	**Gross Sown Area**	34781
Net Irrigated Area	19836	**Gross Irrigated Area**	35579
Irrigation Intensity	179.36 %	**Irrigation by GW**	50.64%
Irrigation by SW	49.36 %		

*Area in Hectare

3. Water Level Behaviour

There are Eight monitoring wells in the block. for the period of 2017-2021. Pre-monsoon water level trend is - 0.16m/year (Rise) and post-monsoon water level trend is 0.25m/year (Fall).



3. Aquifer Disposition

Three aquifer groups exist in the block:

Aquifer Group I: Ground level to 42.67 mbgl.
Aquifer Group II: 172mbgl to 181.3mbgl.
Aquifer Group III: 242 mbgl- 248.0mbgl.

4. Ground water resource, extraction and other issues

Table 24: Ground Water Resource (Static+Dynamic), Extraction as on March, 2020, Ghiror Block, , UP

A	FIRST AQUIFER SYSTEM	
1	Dynamic Resources (Fresh)	127.22 MCM
2	Total GW Extraction	58.32 MCM
3	Stage of Ground Water Extraction	45.84%
4	Category	Safe
5	Static Resources (Fresh)	1766 MCM
7	Total Resources Dynamic + Static (Fresh)	1893.22MCM

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

5. Chemical Quality of ground water and contamination

Table 25: Basic Chemical Quality of Phreatic Aquifer, Ghiror Block, Mainpuri, UP

Basic Parameter	Permissible Limit	Results
	BIS 10500:2012	
pH	6.5-8.5	7.94
EC (□S/cm) at 25^{0}C	3000	446
CO_3 mg/l	-	NIL
HCO_3 mg/l	-	262
Cl mg/l	1000	14
F mg/l	1.5	0.70
NO_3 mg/l	45	NIL
SO_4 mg/l	400	7.1
TH as $CaCO_3$ mg/l	600	180
Ca mg/l	200	36
Mg mg/l	100	22
Na mg/l	-	24
K mg/l	-	3.6
SiO_2 mg/l	-	30
PO_4 mg/l	-	0

Table 26: Heavy Metal concentration of Shallow Aquifer, Ghiror Block, Mainpuri, 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 (mg/l)		0.035	0.108	0.001	0.012	0.0004	0.0006	0.011	0.0003

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
Ghiror	2	2	2	3	2199	2199	0.14	0.14	3.50	0.14	3.63	45.84	42.94

7 .2 Aquifer Mapping and Management Plan of Kurawali Block, Mainpuri District, U.P.

1. Salient Information

Table 28: Salient Information of Kurawali Block, Mainpuri District, U.P.

Area	280.79 Sq. Km				
Population	150362	**Male**	79567	**Female**	70795
Population Density	535.49 persons/sq km				
Annual Rainfall (2011-20)	496.72 mm	**Monsoon**	434.51 mm	**Non-Monsoon**	62.21 mm

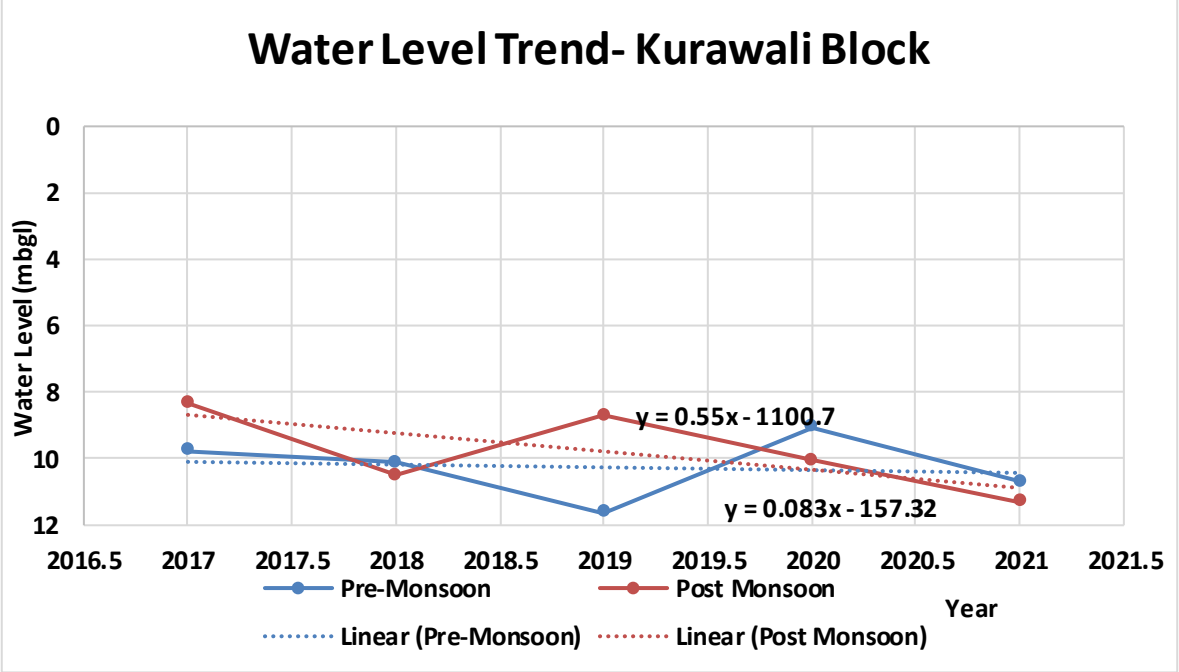
Table 29: Agriculture and Irrigation, Kurawali Block, Mainpuri, UP

Net Sown Area	20664	**Gross Sown Area**	29865
Net Irrigated Area	15574	**Gross Irrigated Area**	32130
Irrigation Intensity	206.30 %	**Irrigation by GW**	57.37%
Irrigation by SW	42.56 %		

*Area in Hectare

1. Water Level Behaviour

There are Five monitoring wells in the block. for the period of 2017-2021. Pre-monsoon water level trend is 0.083m/year (Fall) and post-monsoon water level trend is 0.55m/year (Fall).



2. Aquifer Disposition

Three aquifer groups exist in the block:
Aquifer Group I: Ground level to 76.80 mbgl.
Aquifer Group II: 102 mbgl to 200.54mbgl.
Aquifer Group III: 210 mbgl- 305.0mbgl.

3. Ground water resource, extraction and other issues

Table 30: Ground Water Resource (Static+Dynamic), Extraction as on March, 2020, Kurawali Block, UP

A	FIRST AQUIFER SYSTEM	
1	Dynamic Resources (Fresh)	86.57 MCM
2	Total GW Extraction	60.85 MCM
3	Stage of Ground Water Extraction	70.30%
4	Category	Semi critical
5	Static Resources (Fresh)	2183 MCM
7	Total Resources Dynamic + Static (Fresh)	2270 MCM

Issues: Dependency on Ground Water Irrigation, and declining trend of water level, Iron (Fe) found above permissible limit at some places.

4. Chemical Quality of ground water and contamination

Table 31: Basic Chemical Quality of Phreatic Aquifer, Kurawali Block, Mainpuri, UP

Basic Parameter	Permissible Limit	Results
	BIS 10500:2012	
pH	6.5-8.5	7.71
EC (□S/cm) at 25^{0}C	3000	737
CO_3 mg/l	-	0
HCO_3 mg/l	-	366
Cl mg/l	1000	21
F mg/l	1.5	0.75
NO_3 mg/l	45	0
SO_4 mg/l	400	24.6
TH as $CaCO_3$ mg/l	600	240
Ca mg/l	200	32
Mg mg/l	100	38
Na mg/l	-	57
K mg/l	-	5.2
SiO_2 mg/l	-	26
PO_4 mg/l	-	0

Table 32: Heavy Metal concentration of Shallow Aquifer, Kurawali Block, Mainpuri, UP

Heavy Metals		Cr in ppb	Fe in ppm	Mn in ppm	Cu in ppm	Zn in ppm	As in ppb	Pb in ppb	U in ppb
Permissible Limit	BIS 10500:2012	1	0.3	1.5	15	10	10	30	50
Results (mg/l)		BDL	1.362	0.036	BDL	0.150	0.00061	0.00069	0.030

5. 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
Kurawali	1	1	1	3	2066	2066	0.11	0.11	4.05	0.11	4.16	70.30	65.41

7.3 Aquifer Mapping and Management Plan of Mainpuri Block, Mainpuri District, U.P.

1. Salient Information

Table 34: Salient Information of Mainpuri Block, Mainpuri District, U.P.

Area	393.98 Sq. Km				
Population	219662	**Male**	116934	**Female**	102728
Population Density	557.54 persons/sq km				
Annual Rainfall (2011-20)	496.72 mm	**Monsoon**	434.51 mm	**Non-Monsoon**	62.21 mm

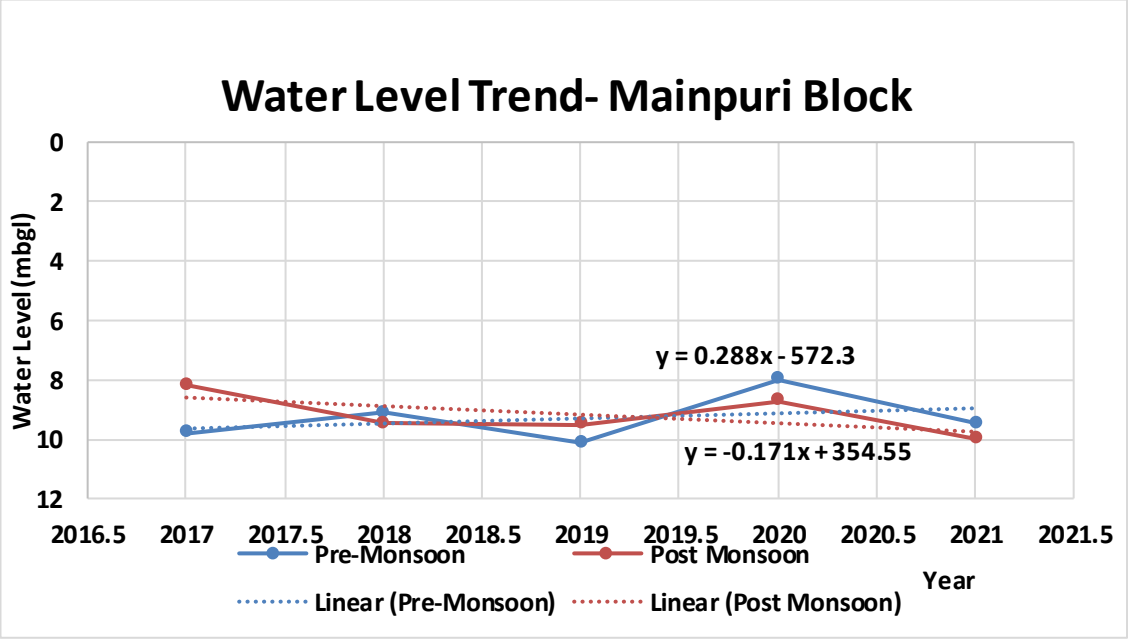
Table 35: Agriculture and Irrigation, Mainpuri Block, Mainpuri District, U.P.

Net Sown Area	23604	**Gross Sown Area**	34816
Net Irrigated Area	20052	**Gross Irrigated Area**	33947
Irrigation Intensity	169.29 %	**Irrigation by GW**	55.53%
Irrigation by SW	44.47 %		

*Area in Hectare

1. Water Level Behaviour

There are Seven monitoring wells in the block. for the period of 2017-2021. Pre-monsoon water level trend is -0.17m/year (Rise) and post-monsoon water level trend is 0.28m/year (Fall).



2. Aquifer Disposition

Three aquifer groups exist in the block:
Aquifer Group I: Ground level to 102.10 mbgl.
Aquifer Group II: 100.28 mbgl to 188mbgl.
Aquifer Group III: 221.27 mbgl- 269.24mbgl.

3. Ground water resource, extraction and other issues

Table 36: Ground Water Resource (Static+Dynamic), Extraction as on March, 2020, Mainpuri Block, Mainpuri District, U.P.

A	FIRST AQUIFER SYSTEM	
1	Dynamic Resources (Fresh)	114.35MCM
2	Total GW Extraction	91.12 MCM
3	Stage of Ground Water Extraction	79.68%
4	Category	Semi critical
5	Static Resources (Fresh)	2598 MCM
7	Total Resources Dynamic + Static (Fresh)	2712.35 MCM

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

4. Chemical Quality of ground water and contamination

Table 37: Basic Chemical Quality of Phreatic Aquifer, Mainpuri Block, Mainpuri District, U.P.

Basic Parameter	Permissible Limit	Results
	BIS 10500:2012	
pH	6.5-8.5	7.76
EC (□S/cm) at 25^{0}C	3000	433
CO_3 mg/l	-	0
HCO_3 mg/l	-	256
Cl mg/l	1000	14
F mg/l	1.5	0.54
NO_3 mg/l	45	0
SO_4 mg/l	400	6.7
TH as $CaCO_3$ mg/l	600	190
Ca mg/l	200	68
Mg mg/l	100	5
Na mg/l	-	20
K mg/l	-	2.8
SiO_2 mg/l	-	29
PO_4 mg/l	-	0

Table 38: Heavy Metal concentration of Shallow Aquifer, Mainpuri Block, Mainpuri District, U.P.

Heavy Metals		Cr in ppb	Fe in ppm	Mn in ppm	Cu in ppm	Zn in ppm	As in ppb	Pb in ppb	U in ppb
Permissible Limit	BIS 10500:2012	1	0.3	1.5	15	10	10	30	50
Results (mg/l)		0.0003	0.035	0.251	0.0009	0.15	0.0005	0.0006	0.0018

5. 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
Mainpuri	2	2	2	4	2360	2360	0.16	0.16	6.12	0.16	6.28	79.68	74.09

7.4 Aquifer Mapping and Management Plan of Barnahal Block, Mainpuri District, U.P.

1. Salient Information

Table 40: Salient Information of Barnahal Block, Mainpuri District, U.P.

Area	210.35 Sq. Km				
Population	145062	**Male**	77382	**Female**	67680
Population Density	689.62 persons/sq km				
Annual Rainfall (2011-20)	496.72 mm	**Monsoon**	434.51 mm	**Non-Monsoon**	62.21 mm

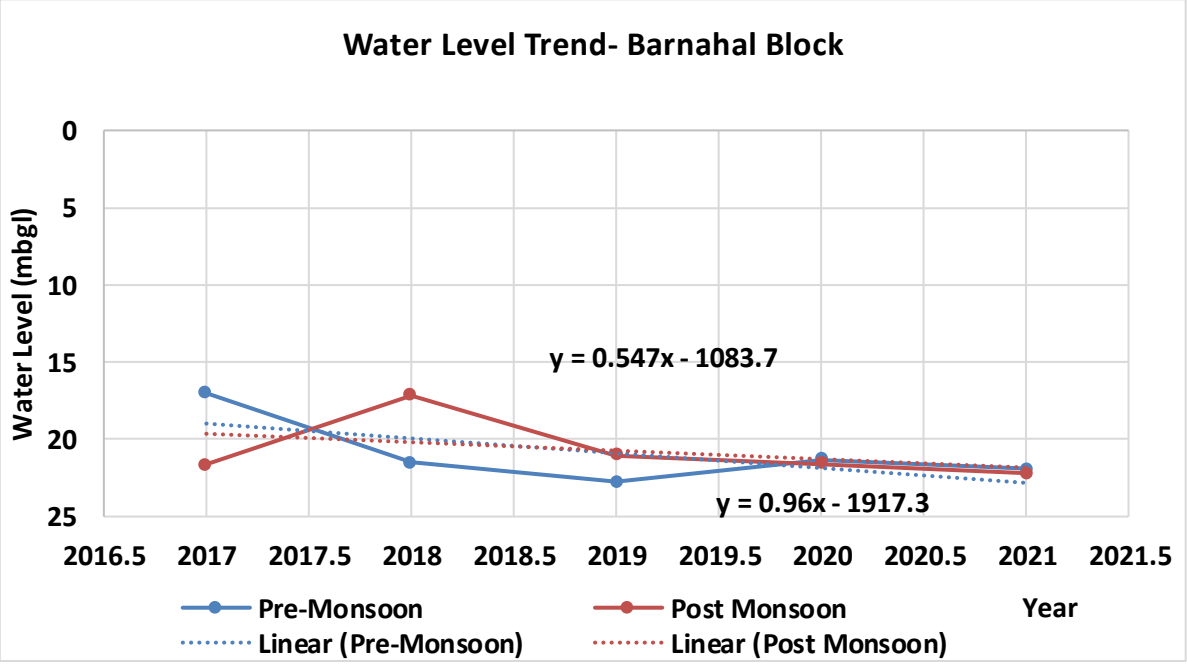
Table 41: Agriculture and Irrigation, Barnahal Block, Mainpuri District, U.P.

Net Sown Area	13039	**Gross Sown Area**	18794
Net Irrigated Area	10516	**Gross Irrigated Area**	22659
Irrigation Intensity	215.47 %	**Irrigation by GW**	92.56%
Irrigation by SW	7.44 %		

*Area in Hectare

1. Water Level Behaviour

There are Six monitoring wells in the block. for the period of 2017-2021. Pre-monsoon water level trend is 0.96m/year (Fall) and post-monsoon water level trend is 0.54m/year (Fall).



2. Aquifer Disposition

Two aquifer groups exist in the block:
Aquifer Group I: Ground level to 132.93 mbgl.
Aquifer Group II: 218.19 mbgl to 235.67mbgl.

3. Ground water resource, extraction and other issues

Table 42: Ground Water Resource (Static+Dynamic), Extraction as on March, 2020, Barnahal Block, Mainpuri District, U.P.

A	FIRST AQUIFER SYSTEM	
1	Dynamic Resources (Fresh)	46.12MCM
2	Total GW Extraction	66.59 MCM
3	Stage of Ground Water Extraction	144.38%
4	Category	Over Exploited
5	Static Resources (Fresh)	1805.98 MCM
7	Total Resources Dynamic + Static (Fresh)	1852.10MCM

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

4. Chemical Quality of ground water and contamination

Table 43 : Basic Chemical Quality of Phreatic Aquifer, Barnahal Block, Mainpuri District, U.P.

Basic Parameter	Permissible Limit	Results(mg/l)
	BIS 10500:2012	
pH	6.5-8.5	7.61
EC (□S/cm) at 25^{0}C	3000	1327
CO_3 mg/l	-	0
HCO_3 mg/l	-	336
Cl mg/l	1000	206
F mg/l	1.5	0.47
NO_3 mg/l	45	37
SO_4 mg/l	400	11.4
TH as $CaCO_3$ mg/l	600	505
Ca mg/l	200	56
Mg mg/l	100	88
Na mg/l	-	71
K mg/l	-	6.1
SiO_2 mg/l	-	30
PO_4 mg/l	-	0

Table 44: Heavy Metal concentration of Shallow Aquifer, Barnahal Block, Mainpuri District, U.P.

Heavy Metals		Cr in ppb	Fe in ppm	Mn in ppm	Cu in ppm	Zn in ppm	As in ppb	Pb in ppb	U in ppb
Permissible Limit	BIS 10500:2012	1	0.3	1.5	15	10	10	30	50
Results (mg/l)		BDL	0.028	0.22	0.0010	1.599	BDL	0.00047	0.021

5. 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
Barnahal	1	1	1	2	1309	1309	0.08	0.08	4.58	0.08	4.66	144.38	134.04

7.5 Aquifer Mapping and Management Plan of Karhal Block, Mainpuri District, U.P.

1. Salient Information

Table 46: Salient Information of Karhal Block, Mainpuri District, U.P.

Area	345.96Sq. Km				
Population	158955	**Male**	85098	**Female**	73857
Population Density	459.60 persons/sq km				
Annual Rainfall (2011-20)	496.72 mm	**Monsoon**	434.51 mm	**Non-Monsoon**	62.21 mm

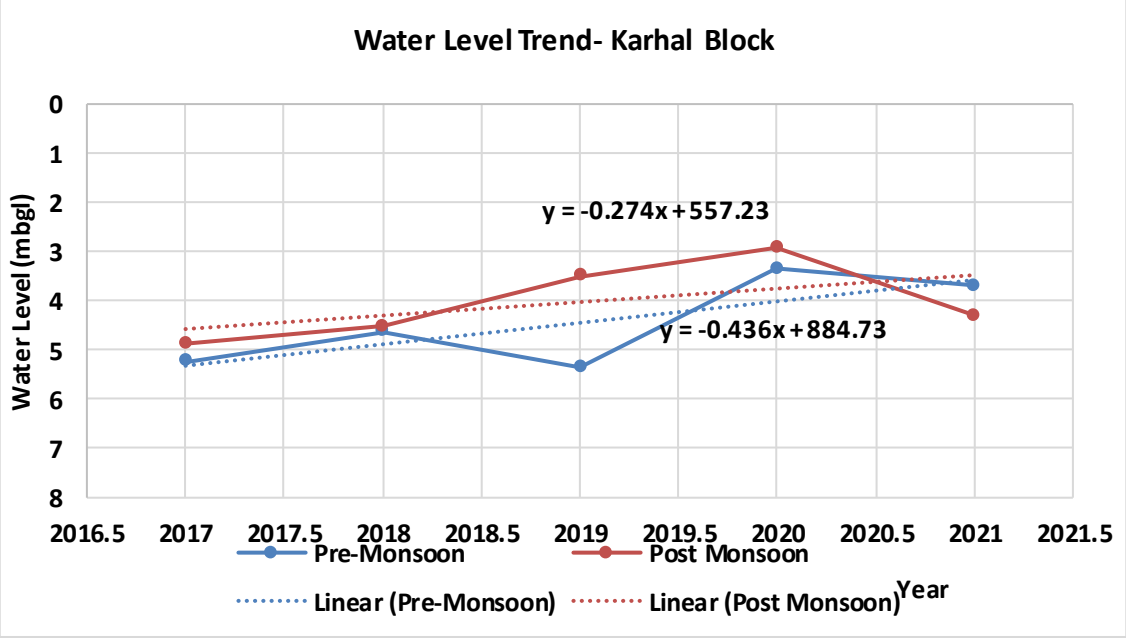
Table 47: Agriculture and Irrigation, Karhal Block, Mainpuri District, U.P.

Net Sown Area	21679	**Gross Sown Area**	37496
Net Irrigated Area	23890	**Gross Irrigated Area**	36024
Irrigation Intensity	150.79 %	**Irrigation by GW**	32.51%
Irrigation by SW	67.49 %		

*Area in Hectare

1. Water Level Behaviour

There are Five monitoring wells in the block. for the period of 2017-2021. Pre-monsoon water level trend is -0.43m/year (Rise) and post-monsoon water level trend is -0.27m/year (Rise).



2. Aquifer Disposition

Three aquifer groups exist in the block:
Aquifer Group I: Ground level to 98.10 mbgl.
Aquifer Group II: 141 mbgl to 211mbgl.
Aquifer Group III: 221.27 mbgl to 269.24mbgl

3. Ground water resource, extraction and other issues

Table 48: Ground Water Resource (Static+Dynamic), Extraction as on March, 2020, Karhal Block, Mainpuri District, U.P.

A	**FIRST AQUIFER SYSTEM**	
1	**Dynamic Resources (Fresh)**	150.82MCM
2	**Total GW Extraction**	87.82MCM
3	**Stage of Ground Water Extraction**	58.23%
4	**Category**	Safe
5	**Static Resources (Fresh)**	1740.31 MCM
7	**Total Resources Dynamic + Static (Fresh)**	1891.30MCM

4. Chemical Quality of ground water and contamination

Table 49: Basic Chemical Quality of Phreatic Aquifer, Karhal Block, Mainpuri District, U.P.

Basic Parameter	Permissible Limit	Results(mg/l)
	BIS 10500:2012	
pH	6.5-8.5	7.68
EC (□S/cm) at 25^{0}C	3000	910
CO_3 mg/l	-	0
HCO_3 mg/l	-	439
Cl mg/l	1000	64
F mg/l	1.5	0.9
NO_3 mg/l	45	36
SO_4 mg/l	400	24
TH as $CaCO_3$ mg/l	600	21
Ca mg/l	200	3
Mg mg/l	100	31
Na mg/l	-	117
K mg/l	-	5.4
SiO_2 mg/l	-	28
PO_4 mg/l	-	0

Table 50: Heavy Metal concentration of Shallow Aquifer, Karhal Block, Mainpuri District, U.P.

Heavy Metals		Cr in ppb	Fe in ppm	Mn in ppm	Cu in ppm	Zn in ppm	As in ppb	Pb in ppb	U in ppb
Permissible Limit	BIS 10500:2012	1	0.3	1.5	15	10	10	30	50
Results (mg/l)		0.0052	0.149	0.1007	0.017	0.126	0.0005	0.00126	0.039

5. 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
Karhal	2	2	2	3	2168	2168	0.14	0.14	4.52	0.14	4.66	58.23	55.09

7.6 Aquifer Mapping and Management Plan of Sultanganj Block, Mainpuri District, U.P.

1. Salient Information

Table 52: Salient Information of Sultanganj Block, Mainpuri District, U.P.

Area	312.59Sq. Km				
Population	158955	Male	212406	Female	112842
Population Density	508.55 persons/sq km				
Annual Rainfall (2011-20)	496.72 mm	Monsoon	434.51 mm	Non-Monsoon	62.21 mm

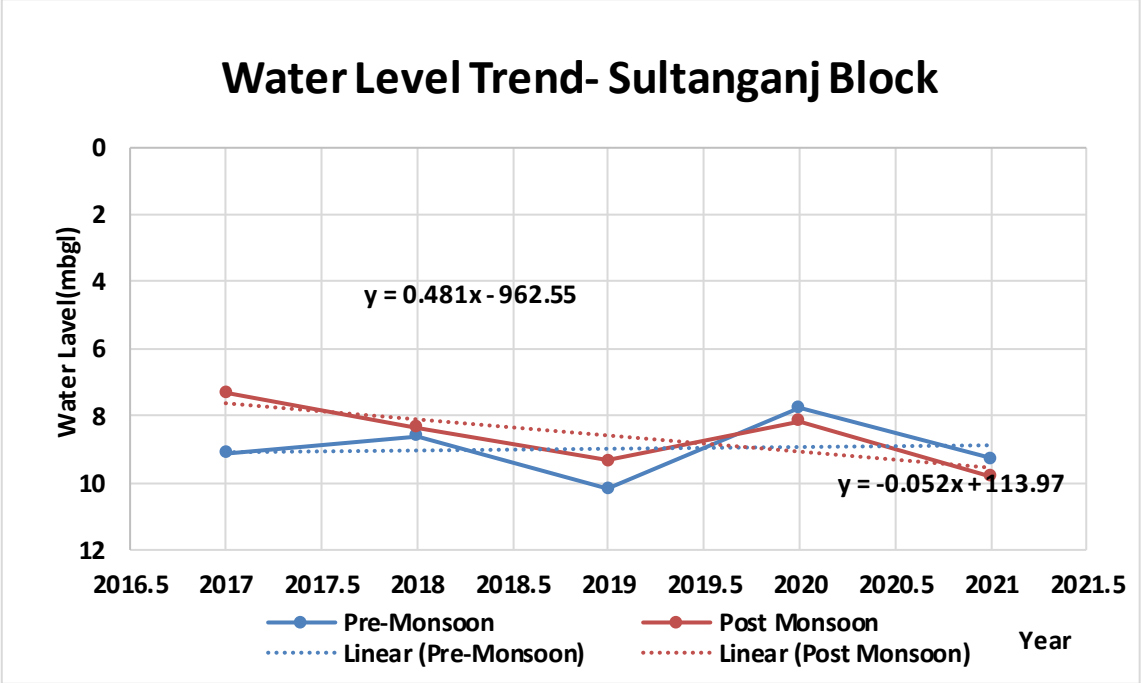
Table 53: Agriculture and Irrigation, Sultanganj Block, Mainpuri District, U.P.

Net Sown Area	22951	Gross Sown Area	47235
Net Irrigated Area	31152	Gross Irrigated Area	44107
Irrigation Intensity	141.58 %	Irrigation by GW	96.21%
Irrigation by SW	3.80 %		

*Area in Hectare

1. Water Level Behaviour

There are Ten monitoring wells in the block. for the period of 2017-2021. Pre-monsoon water level trend is -0.52m/year (Rise) and post-monsoon water level trend is 0.48m/year (Fall).



2. Aquifer Disposition

Two aquifer groups exist in the block:

Aquifer Group I: Ground level to 89.00 mbgl.
Aquifer Group II: 140 mbgl to 207mbgl.

3. Ground water resource, extraction and other issues

Table 54: Ground Water Resource (Static+Dynamic), Extraction as on March, 2020, Sultanganj Block, Mainpuri District, U.P.

A	FIRST AQUIFER SYSTEM	
1	Dynamic Resources (Fresh)	85.03MCM
2	Total GW Extraction	56.91MCM
3	Stage of Ground Water Extraction	66.93%
4	Category	Safe
5	Static Resources (Fresh)	1304.87 MCM
7	Total Resources Dynamic + Static (Fresh)	1389.90MCM

Issues: Dependency on Ground Water Irrigation, Intensive Ground Water Development and declining trend of water level, Iron (Fe) found above permissible limit at some places.

4. Chemical Quality of ground water and contamination

Table 55: Basic Chemical Quality of Phreatic Aquifer, Sultanganj Block, Mainpuri District, U.P.

Basic Parameter	Permissible Limit	Results(mg/l)
	BIS 10500:2012	
pH	6.5-8.5	7.82
EC (□S/cm) at 25⁰C	3000	591
CO_3 mg/l	-	0
HCO_3 mg/l	-	3538
Cl mg/l	1000	142
F mg/l	1.5	0.612
NO_3 mg/l	45	0
SO_4 mg/l	400	6.374
TH as $CaCO_3$ mg/l	600	250
Ca mg/l	200	28
Mg mg/l	100	432
Na mg/l	-	32.15
K mg/l	-	5.05
SiO_2 mg/l	-	26.06
PO_4 mg/l	-	0

Table 56: Heavy Metal concentration of Shallow Aquifer, Sultanganj Block, Mainpuri District, U.P.

Heavy Metals		Cr in ppb	Fe in ppm	Mn in ppm	Cu in ppm	Zn in ppm	As in ppb	Pb in ppb	U in ppb
Permissible Limit	BIS 10500:2012	1	0.3	1.5	15	10	10	30	50
Results (mg/l)		BDL	1.089	0.028	BDL	1.110	0.00051	0.011	0.021

5. Ground Water Management:

Table 57: 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
Sultanganj	2	2	2	3	2595	2595	0.12	0.12	2.61	0.12	2.73	66.93	63.62

7.7 Aquifer Mapping and Management Plan of Bewar Block, Mainpuri District, U.P.

1. Salient Information

Table 58: Salient Information of Bewar Block, Mainpuri District, U.P.

Area	294.28Sq. Km				
Population	211333	**Male**	112527	**Female**	98806
Population Density	730.54 persons/sq km				
Annual Rainfall (2011-20)	496.72 mm	**Monsoon**	434.51 mm	**Non-Monsoon**	62.21 mm

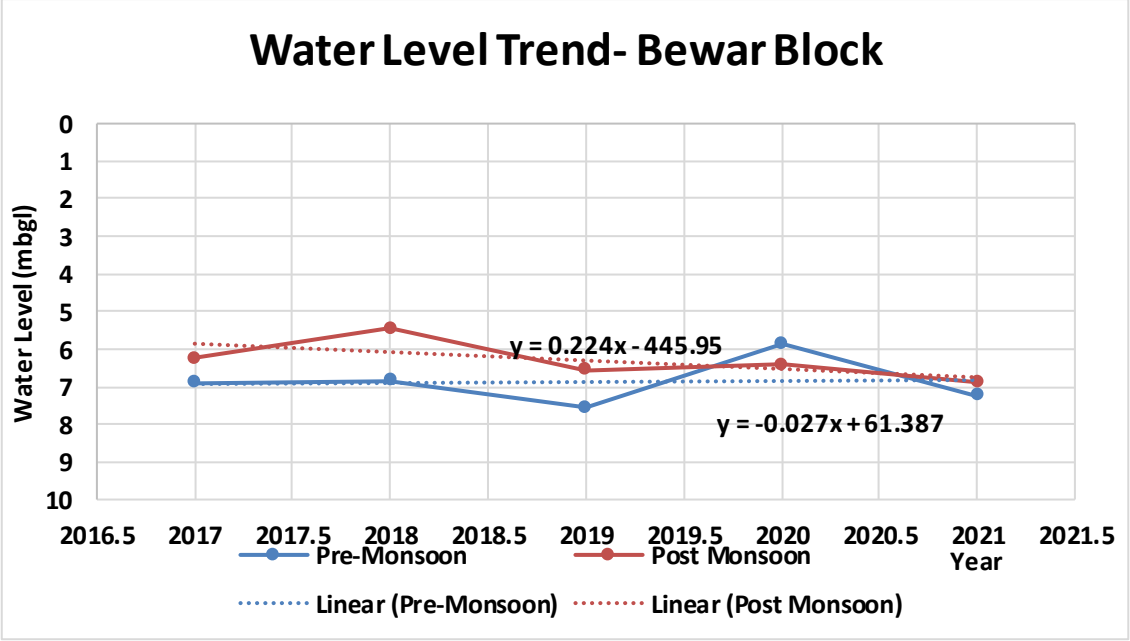
Table 59: Agriculture and Irrigation, Bewar Block, Mainpuri District, U.P.

Net Sown Area	25422	**Gross Sown Area**	49038
Net Irrigated Area	29764	**Gross Irrigated Area**	47639
Irrigation Intensity	161.05 %	**Irrigation by GW**	94.43%
Irrigation by SW	5.57%		

*Area in Hectare

1. Water Level Behaviour

There are Five monitoring wells in the block. for the period of 2017-2021. Pre-monsoon water level trend is -0.027m/year (Rise) and post-monsoon water level trend is 0.22m/year (Fall).



2. Aquifer Disposition

Three aquifer groups exist in the block:

Aquifer Group I: Ground level to 95.00 mbgl.
Aquifer Group II: 140 mbgl to 207mbgl.
Aquifer Group III: 307 mbgl to 415mbgl.

3. Ground water resource, extraction and other issues

Table 60: Ground Water Resource (Static+Dynamic), Extraction as on March, 2020, Bewar Block, Mainpuri District, U.P.

A	FIRST AQUIFER SYSTEM	
1	Dynamic Resources (Fresh)	87.38MCM
2	Total GW Extraction	58.93MCM
3	Stage of Ground Water Extraction	67.45%
4	Category	Safe
5	Static Resources (Fresh)	4473.05 MCM
7	Total Resources Dynamic + Static (Fresh)	4560.43MCM

Issues: Dependency on Ground Water Irrigation, Intensive Ground Water Development and declining trend of water level, Iron (Fe) found above permissible limit at some places.

4. Chemical Quality of ground water and contamination

Table 61: Basic Chemical Quality of Phreatic Aquifer, Bewar Block, Mainpuri District, U.P.

Basic Parameter	Permissible Limit	Results(mg/l)
	BIS 10500:2012	
pH	6.5-8.5	7.94
EC (□S/cm) at 25^{0}C	3000	446
CO_3 mg/l	-	0
HCO_3 mg/l	-	262
Cl mg/l	1000	14
F mg/l	1.5	0.70
NO_3 mg/l	45	0
SO_4 mg/l	400	7.1
TH as $CaCO_3$ mg/l	600	180
Ca mg/l	200	36
Mg mg/l	100	22
Na mg/l	-	24
K mg/l	-	3.6
SiO_2 mg/l	-	30
PO_4 mg/l	-	0

Table 62: Heavy Metal concentration of Shallow Aquifer, Bewar Block, Mainpuri District, U.P.

Heavy Metals		Cr in ppb	Fe in ppm	Mn in ppm	Cu in ppm	Zn in ppm	As in ppb	Pb in ppb	U in ppb
Permissible Limit	BIS 10500:2012	1	0.3	1.5	15	10	10	30	50
Results (mg/l)		-0.000160095	0.350524525	0.020547771	0.000362918	0.192207479	0.000998	0.001862759	0.015273781

5. Ground Water Management:

Table 63: 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
Bewar	1	1	1	3	2542	2542	0.12	0.12	2.87	0.12	2.99	67.45	63.94

7.8 Aquifer Mapping and Management Plan of Jagir Block, Mainpuri District, U.P.

1. Salient Information

Table 64: Salient Information of Jagir Block, Mainpuri District, U.P.

Area	211.92Sq. Km				
Population	102435	**Male**	55481	**Female**	46954
Population Density	483.36 persons/sq km				
Annual Rainfall (2011-20)	496.72 mm	**Monsoon**	434.51 mm	**Non-Monsoon**	62.21 mm

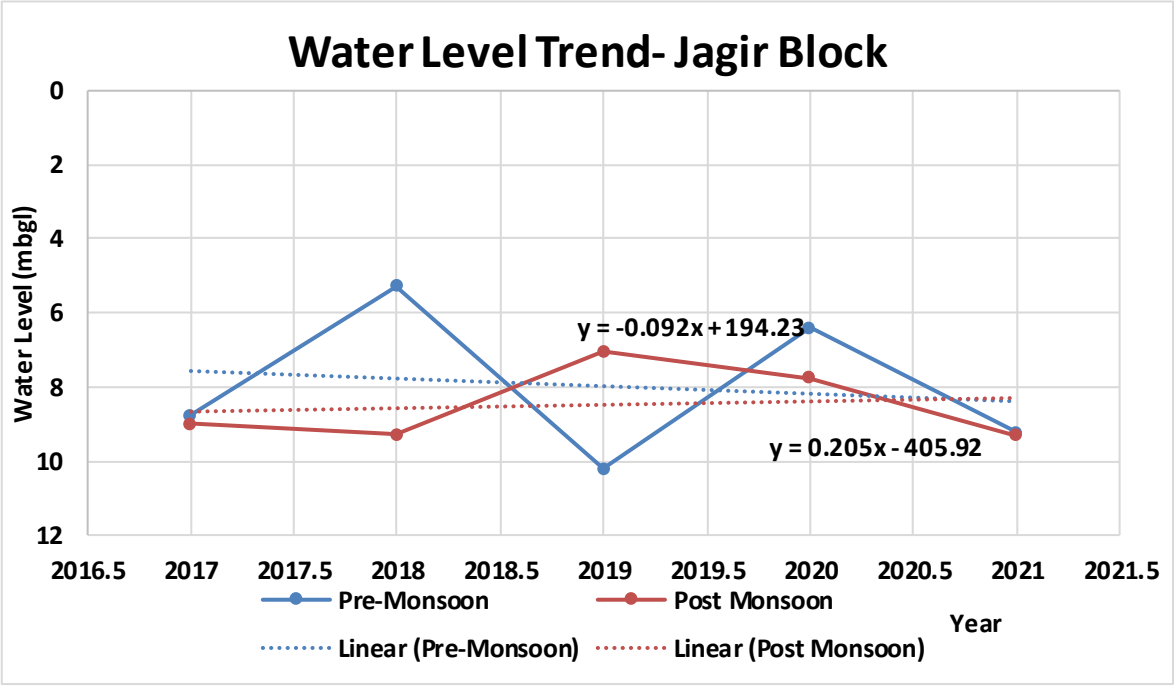
Table 65: Agriculture and Irrigation, Jagir Block, Mainpuri District, U.P.

Net Sown Area	15796	**Gross Sown Area**	28159
Net Irrigated Area	17755	**Gross Irrigated Area**	35175
Irrigation Intensity	161.05 %	**Irrigation by GW**	91.20%
Irrigation by SW	8.80%		

*Area in Hectare

1. Water Level Behaviour

There are two monitoring wells in the block. for the period of 2017-2021. Pre-monsoon water level trend is 0.20m/year (Fall) and post-monsoon water level trend is -0.09m/year (Rise).



2. Aquifer Disposition

Two aquifer groups exist in the block:

Aquifer Group I: Ground level to 52.98 mbgl.
Aquifer Group II: 102.16 mbgl to 200.54mbgl.

3. Ground water resource, extraction and other issues

Table 66: Ground Water Resource (Static+Dynamic), Extraction as on March, 2020, Jagir Block, Mainpuri District, U.P.

A	FIRST AQUIFER SYSTEM	
1	Dynamic Resources (Fresh)	67.91MCM
2	Total GW Extraction	50.21MCM
3	Stage of Ground Water Extraction	73.93%
4	Category	Semi critical
5	Static Resources (Fresh)	3153.36 MCM
7	Total Resources Dynamic + Static (Fresh)	3221.27MCM

Issues: Dependency on Ground Water Irrigation, Intensive Ground Water Development and declining trend of water level.

4. Chemical Quality of ground water and contamination

Table 67: Basic Chemical Quality of Phreatic Aquifer, Jagir Block, Mainpuri District, U.P.

Basic Parameter	Permissible Limit	Results(mg/l)
	BIS 10500:2012	
pH	6.5-8.5	7.87
EC (□S/cm) at 25⁰C	3000	453
CO_3 mg/l	-	0
HCO_3 mg/l	-	268
Cl mg/l	1000	7
F mg/l	1.5	0.50
NO_3 mg/l	45	0
SO_4 mg/l	400	10
TH as $CaCO_3$ mg/l	600	215
Ca mg/l	200	40
Mg mg/l	100	28
Na mg/l	-	13
K mg/l	-	3.1
SiO_2 mg/l	-	27
PO_4 mg/l	-	0

Table 68: Heavy Metal concentration of Shallow Aquifer, Jagir Block, Mainpuri District, U.P.

Heavy Metals		Cr in ppb	Fe in ppm	Mn in ppm	Cu in ppm	Zn in ppm	As in ppb	Pb in ppb	U in ppb
Permissible Limit	BIS 10500:2012	1	0.3	1.5	15	10	10	30	50
Results (mg/l)		BDL	BDL	0.0085	0.00021	0.056	0.0006	BDL	0.0083

5. Ground Water Management:

Table 69: 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
Jagir	1	1	1	2	1580	1580	0.08	0.08	2.35	0.08	2.43	73.93	70.26

7.9 Aquifer Mapping and Management Plan of Kishni Block, Mainpuri District, U.P.

1. Salient Information

Table 70: Salient Information of Kishni Block, Mainpuri District, U.P.

Area	365.94Sq. Km				
Population	172184	**Male**	96163	**Female**	79021
Population Density	470.52 persons/sq km				
Annual Rainfall (2011-20)	496.72 mm	**Monsoon**	434.51 mm	**Non-Monsoon**	62.21 mm

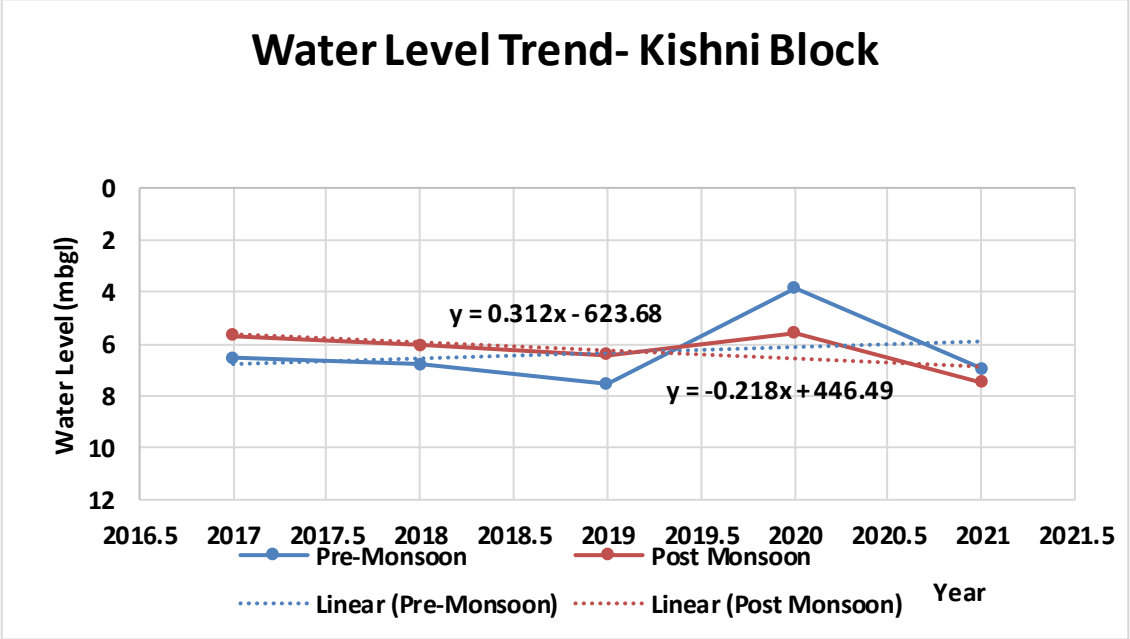
Table 71: Agriculture and Irrigation, Kishni Block, Mainpuri District, U.P.

Net Sown Area	29887	**Gross Sown Area**	47465
Net Irrigated Area	197961	**Gross Irrigated Area**	327654
Irrigation Intensity	161.05 %	**Irrigation by GW**	98.16%
Irrigation by SW	1.84%		

*Area in Hectare

1. Water Level Behaviour

There are Nine monitoring wells in the block. for the period of 2017-2021. Pre-monsoon water level trend is -0.21m/year (Rise) and post-monsoon water level trend is 0.31m/year (Fall).



2. Aquifer Disposition

Two aquifer groups exist in the block:

Aquifer Group I: Ground level to 80 mbgl.
Aquifer Group II: 120 mbgl to 220mbgl.

3. Ground water resource, extraction and other issues

Table 72: Ground Water Resource (Static+Dynamic), Extraction as on March, 2020, , Kishni Block, Mainpuri District, U.P.

A	**FIRST AQUIFER SYSTEM**	
1	**Dynamic Resources (Fresh)**	108.41MCM
2	**Total GW Extraction**	74.27MCM
3	**Stage of Ground Water Extraction**	68.51%
4	**Category**	Safe
5	**Static Resources (Fresh)**	1756.51 MCM
7	**Total Resources Dynamic + Static (Fresh)**	1864.92MCM

Issues: Dependency on Ground Water Irrigation, Intensive Ground Water Development and declining trend of water level.

4. Chemical Quality of ground water and contamination

Table 73: Basic Chemical Quality of Phreatic Aquifer, , Kishni Block, Mainpuri District, U.P.

Basic Parameter	Permissible Limit	Results(mg/l)
	BIS 10500:2012	
pH	6.5-8.5	7.97
EC (□S/cm) at 25^{0}C	3000	1492
CO_3 mg/l	-	0
HCO_3 mg/l	-	561
Cl mg/l	1000	78
F mg/l	1.5	1.70
NO_3 mg/l	45	0
SO_4 mg/l	400	117
TH as $CaCO_3$ mg/l	600	230
Ca mg/l	200	16
Mg mg/l	100	46
Na mg/l	-	231
K mg/l	-	6.9
SiO_2 mg/l	-	24
PO_4 mg/l	-	0

Table 74: Heavy Metal concentration of Shallow Aquifer, , Kishni Block, Mainpuri District, U.P.

Heavy Metals		Cr in ppb	Fe in ppm	Mn in ppm	Cu in ppm	Zn in ppm	As in ppb	Pb in ppb	U in ppb
Permissible Limit	BIS 10500:2012	1	0.3	1.5	15	10	10	30	50
Results (mg/l)		0.00037	0.035	0.048	0.0009	0.0338	BDL	0.0006	0.0058

5. Ground Water Management:

Table 75: 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
Kishni	2	2	2	4	2989	2989	0.14	0.14	4.30	0.14	4.45	68.51	64.32