केंद्रीय 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

BANDA DISTRICT, UTTAR PRADESH

उत्तरी क्षेत्र, लखनऊ
Northern Region, Lucknow

BANDA DISTRICT AT A GLANCE

1.	**GENERAL INFORMATION**		
i.	Geographical Area(sq. km.)	:	4496
ii.	Administrative Divisions Number of Block:08 Number of Gram Panchayats/Villages		
iii.	Population(2011census)	:	1799000
iv.	Average Annual Rainfall(mm)	:	902
v.	Average monthly rainfall(mm)	:	451
vi.	No of rainy days	:	48-60
vii.	Cumulative PET	:	50.1-210.3
viii.	Elevation	:	71 to 424amsl
2.	**GEOMORPHOLOGY** Major Physiographic Units	:	Lower Yamuna Plain Alluvial Plain, Marginal Alluvial, Southern High Lands
	Major Drainages	:	Yamuna, Ken and Baghain
3.	**LAND USE (Sq.Km.)**		
a)	Forest area	:	51.90
b)	Net area sown	:	3547.74
c)	Net Irrigated area	:	1644.31
4.	**MAJORSOILTYPES**	:	Silty clay, Black cotton soil and Silty loam.
5.	**AREA UNDER PRINCIPAL CROPS Sq.Km.**	:	4241.81 (Wheat, Paddy, Oilseed, Pulses)
6.	**IRRIGATION BY DIFFERENT SOURCES (Numbers of structures)**		
	Govt Tube wells	:	633
	Medium tube wells	:	473
	Deep tube wells	:	1297
	Canals	:	1193km
	Other Sources	:	
	NetI rrigated Area	:	1644.31SqKm
	Gross Irrigated Area	:	2199.31SqKm
7.	**NUMBER OF GROUND WATER MONITORING WELLS OF CGWB (As on 31-3-2018)**		
	No. of Dug wells	:	18
	PREDOMINANTGEOLOGICALFORMATIONS	a)	Bundelkhand Granite
		b)	Vindhayan Sandstone and Limestone and
		c)	Alluvium
8.	**HYDROGEOLOGY ANDAQUIFERGROUP**	:	Quaternary alluvium Yamuna river systems. 1. Marginal Alluvium 2. Fractured Basement

Major water bearing formation	: Sand
Pre-monsoon Depth to water level duringMay'2018	: 0.15 to 28.90 mbgl
Post-monsoon Depth to water level duringNov'2018	: 0.15 to 29.10mbgl
Pre-monsoon fall	: 14-31cm/yr.
Post-monsoon fall	: 9- 46cm/yr.

9. GROUND WATER EXPLORATION BY CGWB (As on31-3-2018)

No of wells drilled (EW, OW, PZ, SH, Total)	: EW-36,
Depth range (m)	: 43-200
Discharge (liters per second)	: 0.33-60
Storativity (S)	: $1.95x10^{-4}$
Transmissivity (m^2/day)	: 9 -2800m^2/day

10. GROUND WATERQUALITY

Presence of chemical constituents more than permissible:

Iron	: 1.250 – 1.870mg/l
Type of water	: Good

11. DYNAMIC GROUND WATER RESOURCES (Ham)

as on 31 March, 2013

Annual Extractable Ground Water Resources	: 59608.51
Current annual ground water extraction	: 40153.75
Provision for Domestic and Industrial Requirement	: 6187.92 Supply
Stage of Ground Water Extraction	: 67.36%

12. GROUND WATER CONTROL ANDREGULATION

Number of Semi Critical Blocks	: 4 Number of Safe Blocks
Number of blocks notified	: 4

13. MAJOR GROUNDWATER PROBLEMS AND ISSUES : Over-Exploitation of Ground Water and Declining trend in Ground water levels

1.0 INTRODUCTION

The district Banda is named after the Headquarters town Banda. It is said to have derived its name from "Bamdeo" a sage in Hindu mythology and contemporary of Lord Rama. Banda district is one of the important and water scarcity district in Bundelkhand region of U.P. Present ground water is not enough to meet the requirement either due to non- feasibility of construction of tube wells or quality problems encountered in patches.

Surface water of rivers is being used for domestic as well as irrigation purpose in the district on a significant scale. To study the district from ground water point of view an attempt has been made through hydro-geological reappraisal survey.

Administrative Detail

Location, Extent and Accessibility:

The district is located in southwestern part of U.P. and bounded by State of Madhya Pradesh in south, district Chitrkoot Dham in east, Hamirpur in west and Fatehpur in northeast. The district lies between latitude $25^0$00" and $25^0$59'00" and longitude $80^0$06'00" and $81^0$00'00". District Banda is accessible by both train and road. National Highway (NH-76) leads to Banda and onward from Allahabad, the road is mettalled and good for transport. Other roads of the district are also good except few like Baberu-Kamasin-Rajapur roads.

Administrative Divisions and Demographic Particulars:

There are four tehsils and eight (8 no.) development blocks in the district. The district Headquarters is in Banda town.

Name of tehsil	**Name of blocks**
Banda	Jaspura, Tindwari, Badokhar Khurd
Attarra	Bisanda, Mahua
Naraini	Naraini
Baberu	Baberu, Kamasin
Total-4	Total-8

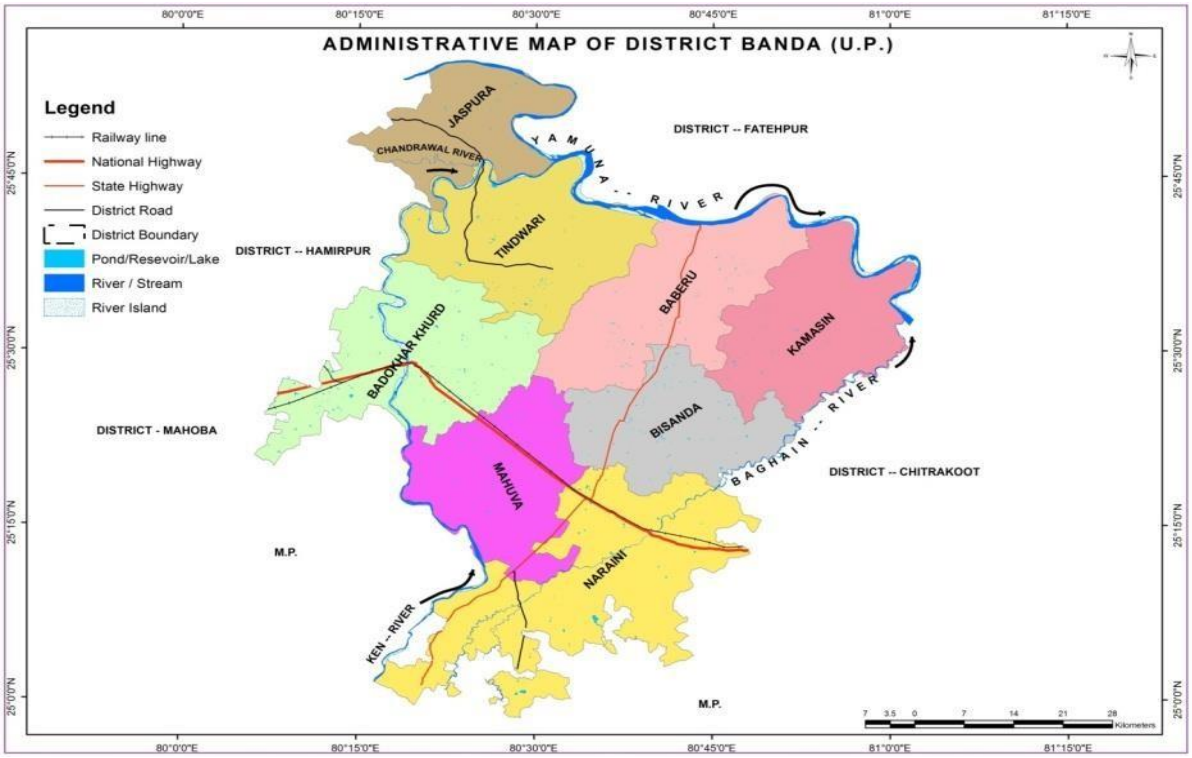


Figure 1: Administrative Division of Banda District, U.P.

Basin and Sub-Basin:
The district occupies part of the Ganga basin and Yamuna sub basin.

Drainage and Morph metric Features:
The district is characterized by good network of drainage system. River Yamuna, Kenand Baghain are the perennial and major drainage in the district. Ken and Baghain rivers are part of Yamuna river system. There are other stream observed in the district like Banganga, Karauli, Garhara, Turi and Madron Nadi as shown in fig-2. Drainage density is moderate in central and northern part of the district while it is high is southern part. Most of the streams are of second to third order. Very few streams are either of first or fourth order in the entire district. River Yamuna bifurcates the district Banda from Fatehpur in north. River Yamuna flows from west to east in the entire district. River Ken meets to river Yamuna at Chilla, River Baghain also bifurcates Banda from Chitrakoot in southeast. Meandering is most significant character of streams observed in the district. It reflects that the river Yamuna and Ken both are in mature to old stage. Energy condition is moderate to poor therefore these streams are unable to carry huge sediment loads and they leave the sediment at frequent interval during their course.

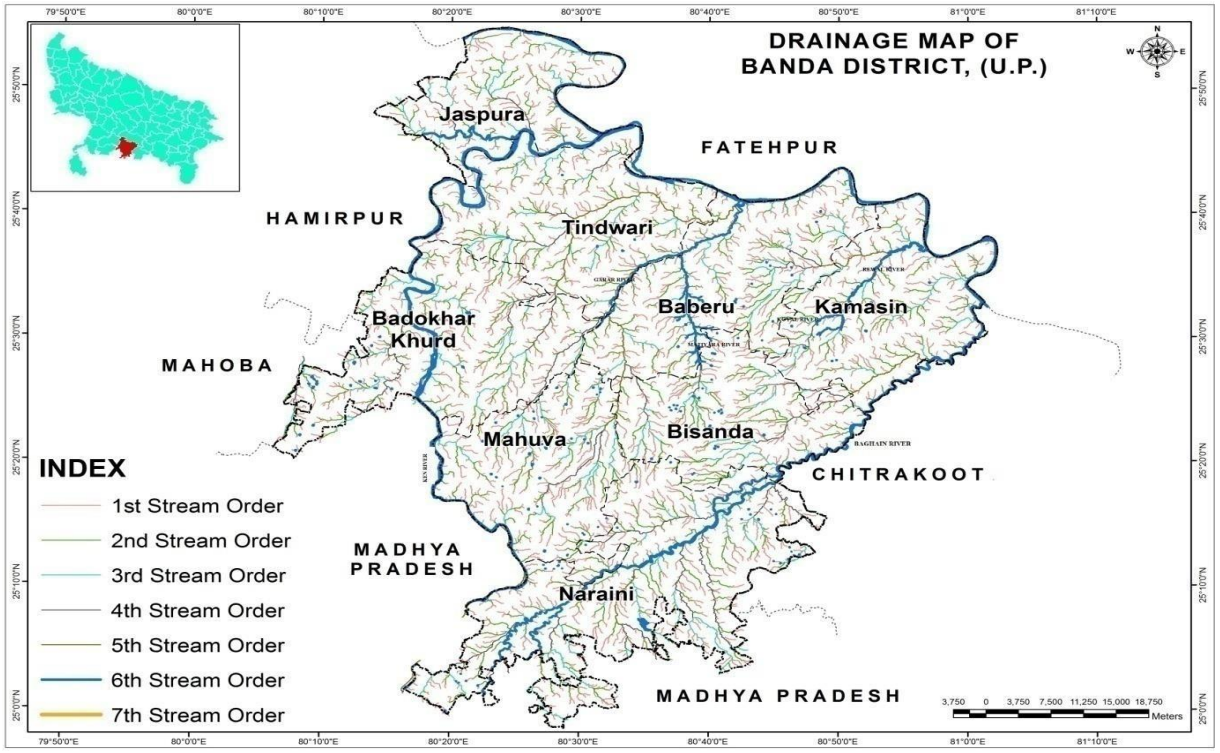


Figure 2: Drainage Map of Banda District, U.P.

Ken River:

The river Ken is in semi-circular to crescent shaped with old meandering loops all along it course. It borders the western fringe of the area. It is major and viable source for drinking as well as irrigation during lean period. It flows from south to north in the district.

Baghain River:

River Baghain flows obliquely across the area from south-west to north-east. It cuts the area into well marked two Banda and Chitrakoot districts. It is perennial in nature but its discharge is very poor during summer season. The meandering is common character of river Baghain.

Ranj River:

It originates from hills of Kartal and meets river Baghain at Basrahi (Chauki) on Narraini- Nagod road. Zig-Zag course of Ranj River is observed in the district.

KarailiNadi/Banganga Nadi:

It flows in southern part of Badaura. It confluences with the Baghain river near the village Kentan Ka Purwa.

Cropping Pattern and Irrigation Practices:

Yamuna flowing north of the district is the principal river attracting all the drainage of the district. The economy of the district is predominantly based on agriculture. There are three distinct crop seasons, namely Kharif, Rabi and Zaid. The Kharif season starts with Southwest Monsoon under which the cultivation of tropical crops such as rice, cotton, jute, jowar, bajra and tur are cultivated. The Rabi season starts with the onset of winter in October-November and ends in March-April. Zaid is a short duration summer cropping season beginning after harvesting of Rabi crops. The main crop seasons are Rabi and Kharif the third crop Zaid does not have considerable impact on economy. The surface water and ground is for providing irrigation facility in the district. As shown in table No1 the main *rabi* crops are wheat, Barley, Gram and oil seeds while paddy Jowar, Bazra, Groundnut and pulses are the main *kharif* crops.

Table-1: Details of the Cropping Pattern (Area in Ha) 2017-18

Block	Rice (Kharif)		Rice (Jayad)		Total Rice		Wheat		Pulses		Oilseed	
	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated
1. Jaspura	4	0	0	0	4	4	6545	6242	17035	237	1856	25
2. Tindwari	480	473	0	0	480	473	20559	19612	24317	690	8793	25
3.Badokhurd khurd	3583	3531	0	0	3583	3531	22419	21386	27607	709	7352	23
4. Baberu	2534	2487	0	0	2534	2487	20932	19968	27267	984	5745	10
5. Kamasin	2797	2757	0	0	2797	2757	14210	13556	23631	420	4295	10
6. Bisanda	13238	13041	0	0	13238	13041	25872	24680	13391	360	3783	8
7. Mahua	21658	21371	0	0	21658	21371	31087	29655	10315	189	1701	4
8. Naraini	11659	11480	0	0	11659	11480	23781	22685	21604	224	4940	12
TOTAL District	55953	55144	0	0	55953	55144	165405	157784	165167	3813	38465	117

Table 2: Decadal comparison of cropping pattern in the District

Years	Area	Rice	Wheat	Barley	Jowar	Millet	Total Pulse	Total Oilseed
2008-09	Ha	61775	151459	979	24171	3133	163104	7155
2017-18	Ha	55953	165405	822	24677	3197	165167	38465

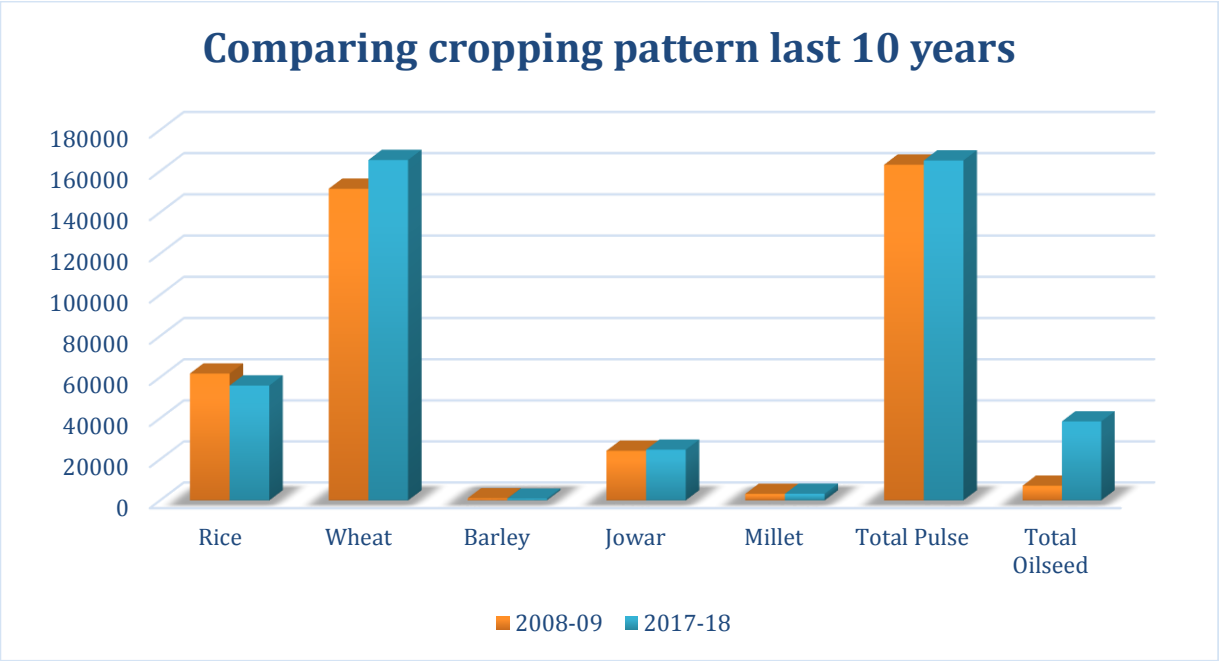


Figure 3: Decadal Crop Production

A perusal of Table 2, and depicted in Bar form in Figure 2, Shows that the cropping pattern is almost same in the decade except that there has been a considerable rise of 437% in oil seed sowing the majority of oil seed is dominated by aggressive sesame sowing.

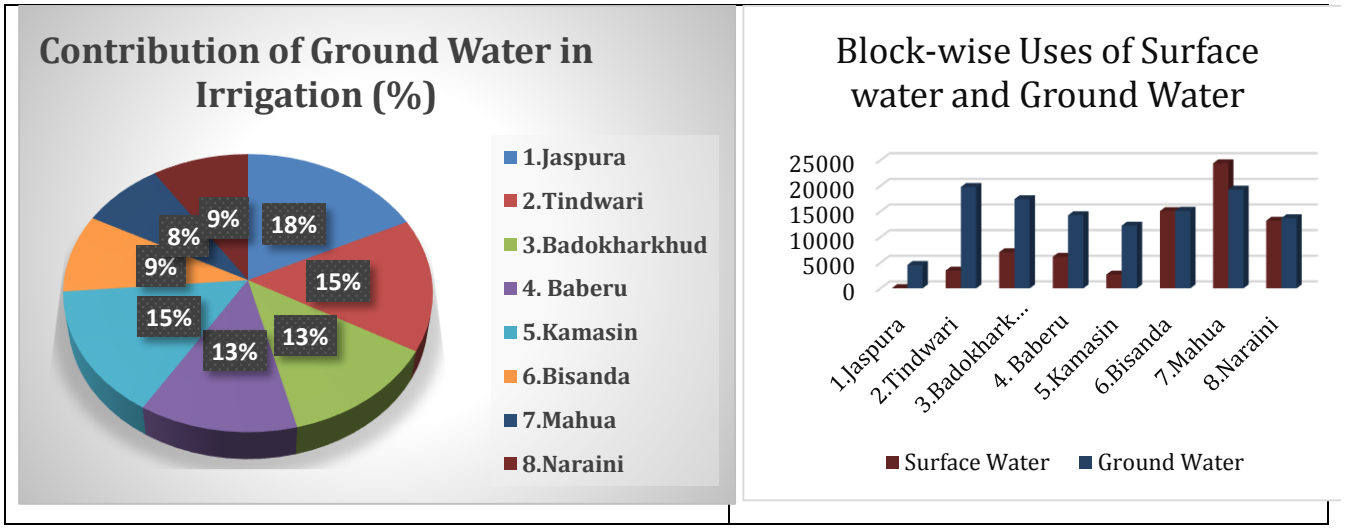


Figure 4: Ground Water Distribution in Irrigation

Figure 3, shows the contribution of Ground water in irrigation to Net Sown area and Total irrigated area in the district. It is very clear that Ground water is being harnessed more than the surface water due to its availability in shallow depths and can be exploited through affordable shallow tube wells run by diesel pumps. However the blocks doing so have been categorized as semi critical in 2017 and need to come out of this stage by adhering to Promote ground water recharge and augmentation measures through supply and demand side recharge measures.

Table-3: Details of Irrigated area in (Ha) by different sources in the district and Groundwater contribution (2017-18)

Block	Canal	Tube well		Well	Pond	Other	Total	Contribution of G. Water in%
		State	Private					
1.Jaspura	0	2377	2123	58	43	14	4615	98
2.Tindwari	3229	5743	14020	7	154	73	23226	85
3.Badokharkhud	6700	4299	12735	351	259	85	24429	71
4. Baberu	5755	4507	8398	1345	272	131	20408	70
5.Kamasin	2519	1923	9745	547	121	44	14899	82
6.Bisanda	14876	1090	12162	1868	121	58	30175	50
7.Mahua	24299	1024	14728	3490	62	33	43636	44
8.Naraini	12716	121	9511	4052	338	139	26877	51
Total District	**70094**	**21084**	**83422**	**11718**	**1370**	**577**	**188265**	**62**

A perusal of Table No2 shows that the maximum canal irrigation is in the Mahua block followed by Bisanda whereas it is absent in Jaspura block. About 62% of the irrigation is being done by groundwater in the district. The maximum groundwater irrigation (98%) is in Jaspura Block whereas it is minimum in Mahua block (44%).

The Net area sown in the district is about 345479Ha with largest area in B.Khurd block and smallest in Jaspura block. Cropping intensity is the fraction of the arable area that is harvested. The cropping intensity may exceed 100% where more than one crop is harvested each year. A perusal of Table No 4 shows that the cropping intensity in all the blocks is more than 100% with largest in Mahua block and least in Jaspura block.

Table No 4: Agricultural statistics Banda, 2016-17

Block	Sown area			Irrigated Area		Cropping Intensity	Irrigation Intensity
	Net Area Sown	Area sown more than once	Total	Net Irrigated	Gross Irrigated		
Baberu	44964	10630	55594	20088	26166	124	130.25687
Badokhurdhurd	48366	10880	59246	23609	30393	122	128.7348
Bisanda	35369	22102	57471	29276	38565	162	131.72906
Jaspura	25351	1865	27216	4213	5488	107	130.26347
Kamasin	38783	8372	47155	13908	18117	122	130.26316
Mahua	37186	31332	68518	42288	55084	184	130.25918
Naraini	46081	22221	68302	27215	35451	148	130.26272
Tindwari	43262	9294	52556	21444	27717	121	129.25294

The low irrigation intensity pattern seen in table No4 indicates that the development of irrigation facility through surface and groundwater is still insufficient due to either unfavorable geographical area, infertile soil coverage, or absence of sufficient rain water harvesting structures.

The economy of Banda district is based mainly on agriculture. The soils here are mostlyfertileandinspiteofmanyprojectsofirrigationsasseeninthepast,theuncertainty of irrigation and its dependence on rains has made this tract adopt mostly the traditional farming, despite the Govt's push for hybrid seeds and commercial agriculture and several droughts and floods which affect the seeds most, the farmers have been able to save some of their traditional seeds.

The main crops grown presently are as follows: Kharif, Paddy, Jowar, Bajra, Til, Moong, Urad, Arhar and Sanai are the main crops taken these days. Paddy is normally taken as mono crop while others are mixed sown. 100 years ago cotton was taken as a mixed crop along with other crops in Kharif. Presently Government is pushing Soyabean replacing all other Kharif crops. In Rabi: Wheat, barley along with gram, linseed, mustard, Masoor and

Peas are the major crops. There is a tendency for mixed cropping and regional variation in choices of the crops depending upon the geographical situation and the availability of irrigation. Zaid the third crops are usually taken in the river beds; that includes Kakri. Tarbooj (water melon), Kharbooja and some vegetable.

Table 5: Details of Abstraction structures of Surface and Ground Water for Irrigation

BLOCK	Canal Length in Km	Govt. Tube well	Dug well	Ground Pump set	Shallow pump set				Midium tube well	Deep Tube well
					Electric run	Diesel Run	Others	Total		
1. Jaspura	8	130	351	10	89	679	10	778	11	55
2. Tindwari	116	15	0	116	179	1008	15	1202	63	476
3. B.khurd	288	104	99	194	175	1766	15	1956	148	359
4. Baberu	229	111	63	70	45	1694	10	1749	104	182
5. Kamasin	65	56	607	85	47	1438	10	1495	55	88
6. Bisanda	179	35	361	50	73	1630	10	1713	49	27
7. Mahua	166	36	623	276	147	1744	10	1901	30	81
8. Naraini	142	2	2822	333	166	2206	4	2376	13	29
Rural	1193	633	4926	1134	921	12165	84	13170	473	1297
Urban	0	0	0	0	0	0	0	0	0	0
TOTAL	1193	633	4926	1134	921	12165	84	13170	473	1297

As shown in table 5, surface water Irrigation facility in the district is mainly by canals. The longest length of canal is in B.Khurd block whereas the shortest length is in Jaspura block.

Groundwaterirrigationfacilityisdonethroughmediumanddeeptubewellswhichagain are highest in B.Khurd block and lowest in Naraini block.

Table 6: Numbers of Water Sources for the irrigation

Year	Canal (m)	Govt. Tube wells	Permanent wells	Ground Pump set	Electricity Run pump set	Diesel Run pump set	Other	Deep tube wells
2008-09	1193	460	3034	1066	884	11933	84	1045
2017-18	1193	633	4926	1134	921	12165	84	1297

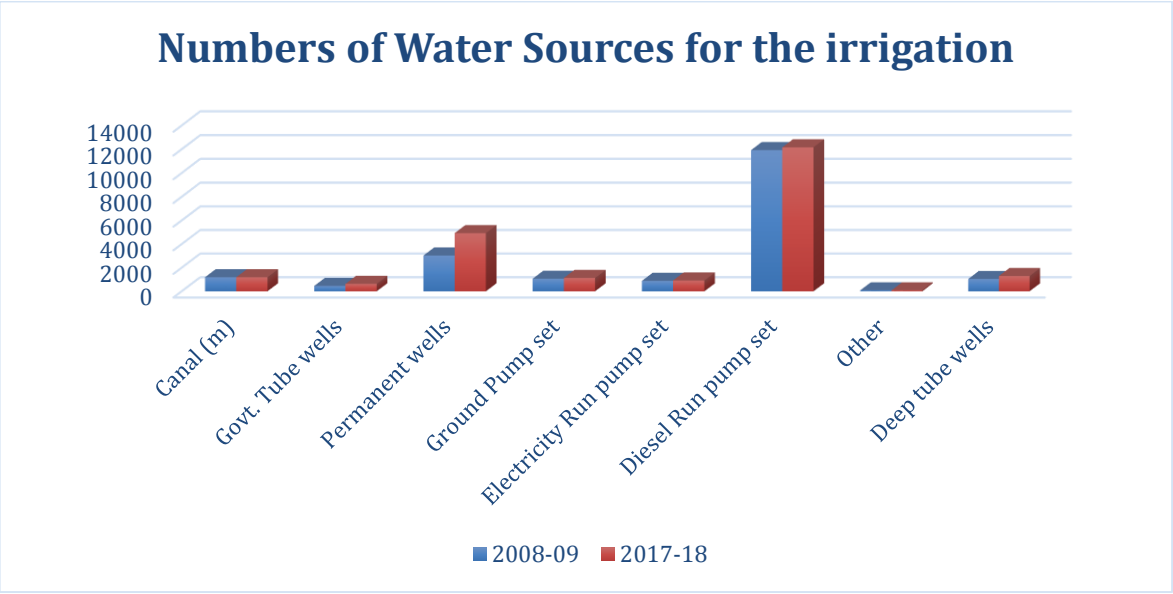


Figure 5: Numbers of Water Sources for the irrigation

A perusal of decadal data of abstraction structures shown in Table No 6 and Fig No5 in the district shows that shallow tube wells run by Diesel pump sets are the favorite as they are not dependent on electricity supply however 62% of increase is seen in the number of permanent wells and 24% increase is seen in deep tube wells. There is no change in the canal length.

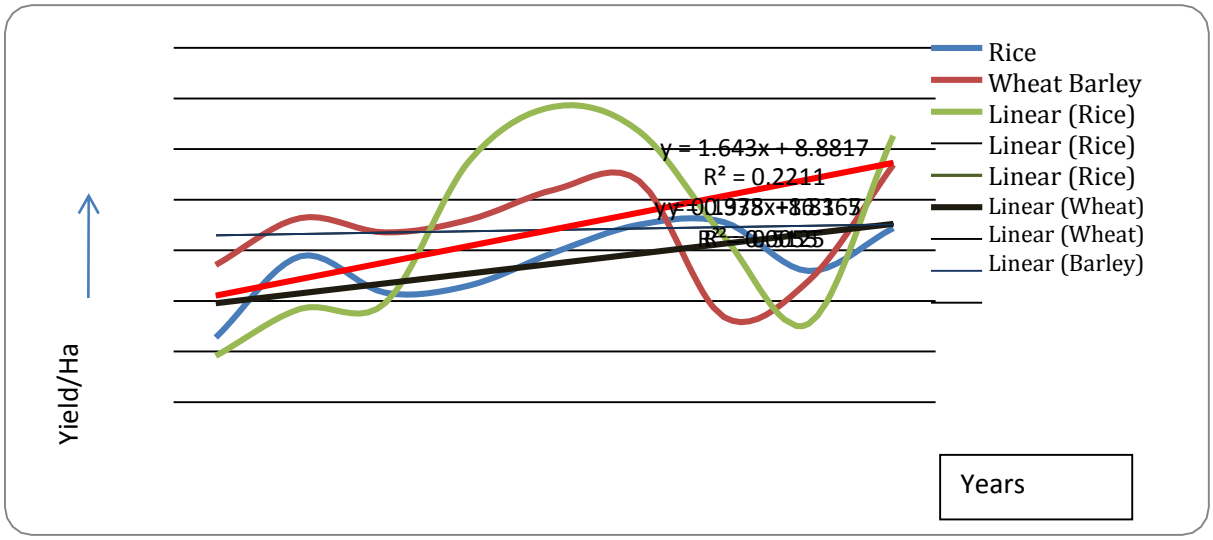


Figure 6: Crop Production Trend

A perusal of the figure 6 indicate that the yield per hectare of Barley and Wheat is highest followed steadily by paddy. The trend line shows that the district is not only producing wheat, but is adapting to two seasons cropping of rabi and kharif crops. It also emphasizes that farmers are going for more water intensive crops due to increase in irrigation facility in some blocks viz Mahua and Bisanda.

2.0 RAINFALL & CLIMATE

Climate Condition

May is the hottest month with mercury shooting upto 47.0 °C. With the advance of monsoon by mid-June, temperature starts decreasing. January is usually the coldest month with temperature going upto 5.8 °C.

Rainfall & Humidity

The average annual rainfall is 902.00 mm. The climate is typical subtropical characterized by long and intense summers. About 80% of the annual rainfall is received from south- west monsoon.

The relative humidity is highest in August about 85% and lowest in April. There is a meteorological observatory at Jhansi, which may be taken as representative of meteorological condition. The mean wind velocity is 4.5Km.p.h. The potential evapotranspiration varies from 50 to 205mm.

Bundelkhand is known as a drought prone region. It is comprised of 7 districts of Uttar Pradesh and 6 districts of Madhya Pradesh. Monsoon rains are crucial. However for past several years, the region has faced deficit rains leading to water scarcity particularly for agriculture related activities. Let us the situation of Monsoon rain in Bundelkhand this year.

The rainfall analysis for the period 2010-2017 shows that only in two years (2013 and 2016) the annual rainfall has exceeded the normal rainfall in the district.

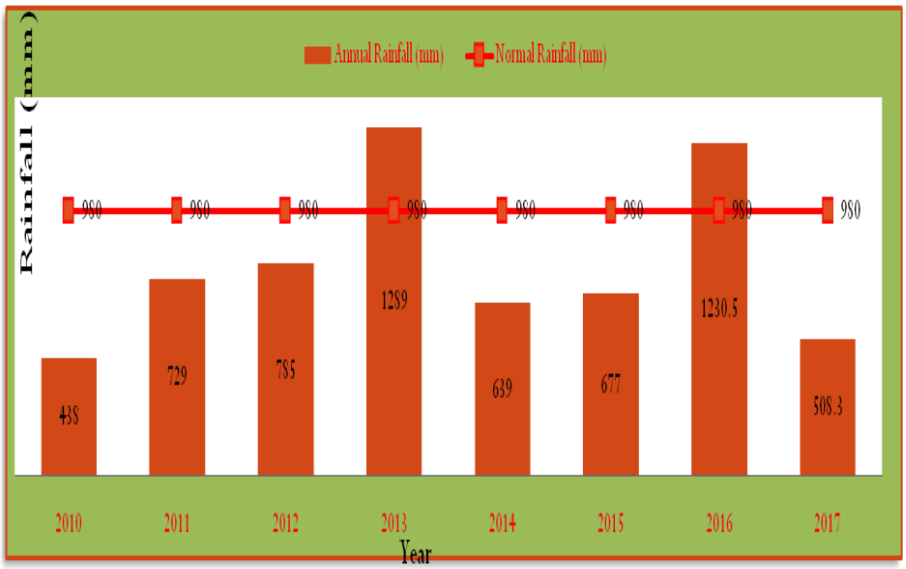


Figure 7: Average Rainfall of Banda District, U.P.

Analysis of district-wise seasonal & annual rainfall statistics of districts by IMD in 2016 the monthly rainfall in (mm) is as under (Figure3).

Table 7: District wise monthly rainfall (mm) for 2016(IMD)

	June-July 2018			**Aug-18**			**Sep-18**		
District	Actual	Normal	% Dep	Actual	Normal	% Dep	Actual	Normal	% Dep
Banda	347.6	353.1	-2	273.8	316.4	-14	151.3	170.9	-11

District	**Winter**	**Pre-monsoon**	**Monsoon**	**Post-monsoon**	**Annual**
BANDA	19.0	36.5	1164	11.0	1230.5

% Departures of District-wise seasonal and annual rainfall – 2016

District	Winter	Pre-monsoon	Monsoon	Post-monsoon	Annual
Banda	-35%	59%	39%	-78%	30%

District	**JAN**	**FEB**	**MARCH**	**APRIL**	**MAY**	**JUNE**	**JULY**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**
Banda	11.1	7.9	6.3	0.0	30.2	71.4	583.5	452.2	56.9	11.0	0.0	0.0

Bundelkhand is part of Lower Yamuna Basin, for which IMD provides rainfall figures in its river basin wise rainfall maps. This basin received 785.4 mm rainfall in 2018 monsoon, 9% below normal rainfall of 863 mm for this sub-basin.

Cumulative District Wise Rainfall Distribution in 2018 (Source IMD) says that in Banda district the rainfall departure is -8%

3.0 GEOLOGY, GEOMORPHOLOGY AND SOIL

General Geology, Succession Details:

Geologically the district is characterized by Bundelkhand granite/gneiss, Vindhyan formation and younger alluvium near the bank of river Ken and Yamuna.

The geological succession of different lithological formations is given below:-

Group	Formation	Lithology	Age	Thickness (m)
Quaternary	Alluvium	Clay, silt and sand	Sub-Recent to Recent	130.50
----------Unconformity----------				
Upper Vindhyan	Kaimur	Sand stone and quartzite	Pre-Cambrian	152.50
----------Unconformity----------				
Lower Vindhyan	Semari	Tirohan breccia, Tirohan Limestone, Upper gluconitic sandstone, Lower gluconitic sand stone and conglomerate	Pre-Cambrian	15.00 76.00 18.00 1.00
----------Unconformity----------				
Bundelkhand Group	-	Granite, schist, quartzite dyke of basic igneous rock	Archean	-

On the basis of above mentioned geological succession three major geological formations have been noticed in the district. All three units are found in the entire district at different depth and of different thickness.

Bundelkhand Granite:

The Bundelkhand granite, which forms the basement complex in the area, is oldest in age. The granite is often traversed by pegmatite veins and well-marked quartz reefs of different width and length.

Quartz reefs form a characteristic feature of landscape at Gorepur and Girwan villages near Naraini town. It also occurs north of Kalinger fort in southwest-northeast direction. Granite is also intruded by basic dykes striking west northwest-east south-east direction and forms hillocks at Raksi, Chmitaini and Pangara near Naraini town.

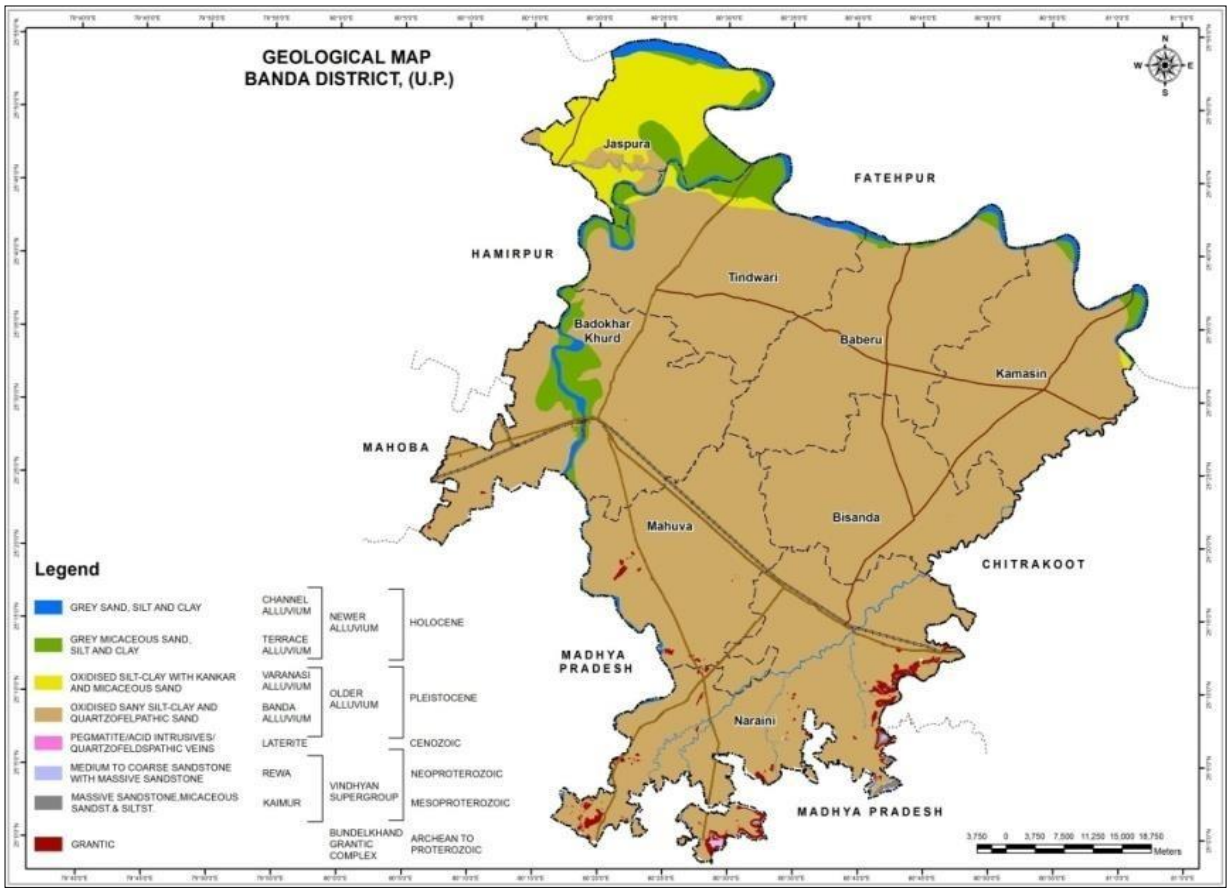


Figure 8: Geological map of Banda district

Vindhayan:

The southern hilly tract of the area is characterised by Vindhyan formation (Plate-5.1). These include rocks of Semari series of lower Vindhyan and upper Kaimur. Quartzite and sandstone are important litho units which form structural hills and plateau.

Alluvium:

The sediments deposited over either Bundelkhand granite or Vindhyan Sand stone/Quartzite is found as alluvium. The thickness of this alluvium is highest in northern of the district and minimum in southern part of the district. Alluvium comprises gravel, sand and clay with sub-ordinate presence of kankar. Main alluvial deposits are found between Baghain and Ken rivers.

Sub-Surface Geology:

The Sub-Surface geology of the district has been inferred on the basis of borehole data (lithological character). The thickness of alluvium varies from place to place. But on the regional scale the thickness of alluvium is more in north and central part while it

diminishes in south and western part of the district.

Thickness of clay is higher in western part than eastern part of the district while it is contrary for kankar. Kankar has less thickness in western part and increases in eastern part of the district.

Clay, kankar and sand are observed in descending order in underground behavior. Thickness of sand is higher in west and east than central part of district.

Basement has been encountered at different depth (54.27 m to 94.51 m). Bundelkhand granite and Vindhayan are common basement which are encountered in the entire district.

Granites occurring in the area are highly jointed and weathered. It is overlain by Quaternary Alluvium which is in the northern part of the district.

Sandstone of Vindhayan is red to greyish in color medium to fine grained, compact and highly jointed. The joints area widely open at surface and have tendency to close down with depth.

Structures:

Since the district is rocky, rugged topography and a number of structures are observed.

(i)Naraini Depression

(ii)Baghela-Bari Depression

(i) Naraini Depression:

The depression lies between Ken and Baghain rivers south of Naraini town and extends for about 22 Km upto Kartal Village. The depth of bedrock varies from 20 to 105 m.

(ii) Baghela-Bari Depression:

The depression is bounded by Banganga and Karelli rivers. Doab is about 15 Km. long North-south and 2-7 Km wide. It has 2 Km. Width at Fatehganj in south and Tamar in north but attains 7 Km. width near Baghela-Bari. Depth of bed rock increases 30 m. at Kalayanpur towards Baghela-Bari where it reaches up to 66m.

There are other structural features observed in the district as:

Erosional Hills:

Erosional hills are developed in hard rock area of granite/ Vindhyans. River/streams have eroded soft part and left hardest part as remnants. These type of hills are observed mean Naraini, Kalinger, Kartal and Badauraarea.

Inselbergs:

Isolated granitic hills emerging beneath the alluvial cover at Banda and Naraini forms as Inselbergs. The general trend of Inselbergs is ENE-WSN and they exhibit steep slopes.

Linear Ridges:

Linear ridges are formed from hills emerging beneath the alluvial cover at Banda and Naraini. Granites show differential weathering and are well jointed in nature.

Piedmont Zone:

Isolated occurrence of piedmont zones has been identified around the Inselbergs at various places in the district. Under piedmont zone, plateau, paleo-channel meander scars and faults are quite visible. Two major faults (lineaments) trend in northeast and south-west direction and third which is less common trends in ENE-WSN direction.

The district is characterized by alluvial, hard rock as well as marginal alluvium. The district can be broadly classified into three physiographic units. i.e. (i) The alluvial Plain, (ii) Marginal Alluvial, and (iii) High Land Area.

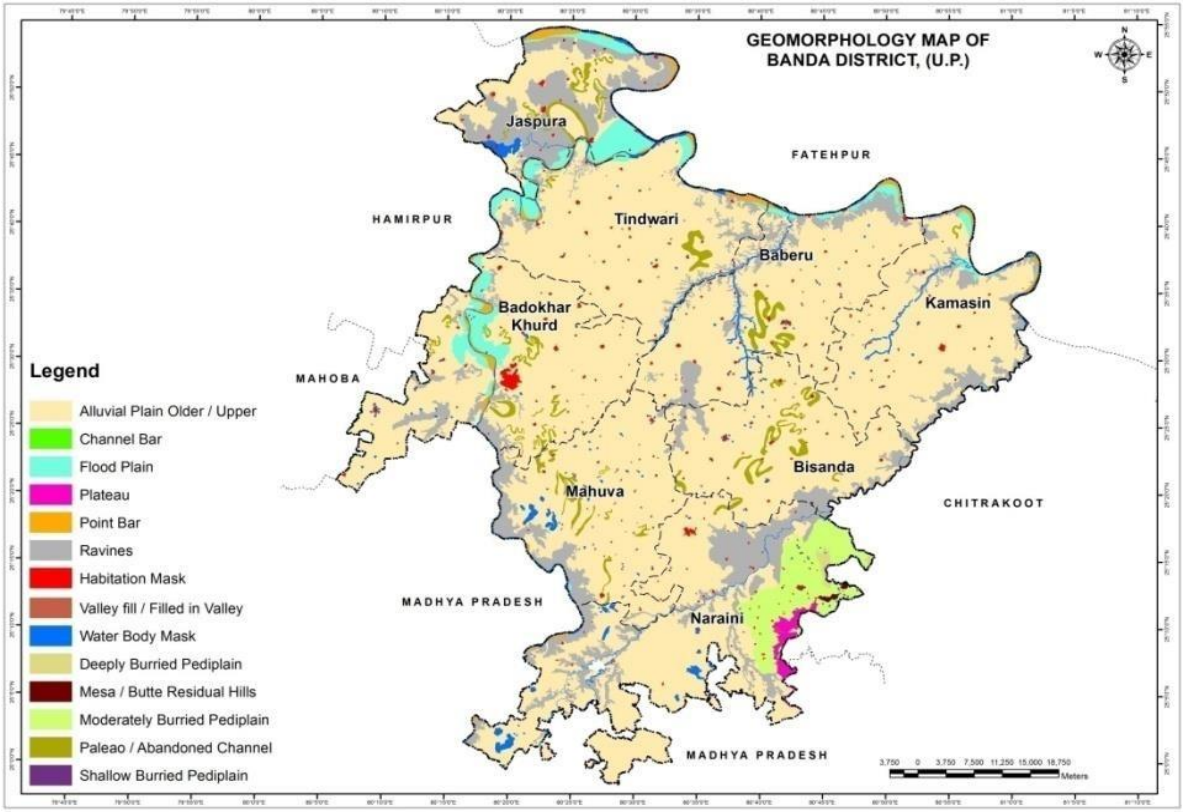


Figure 9: Geomorphological Map of Banda District

Soil Characteristics:

District is characterized by loose sediments as well as black cotton soil. Loose sediments constitute clay, silt and sand.

Black cotton soil is quite prominent in central part of the Banda district.

On the basis of local name of soils and its coverage in different blocks, these are four types of soils as below:-

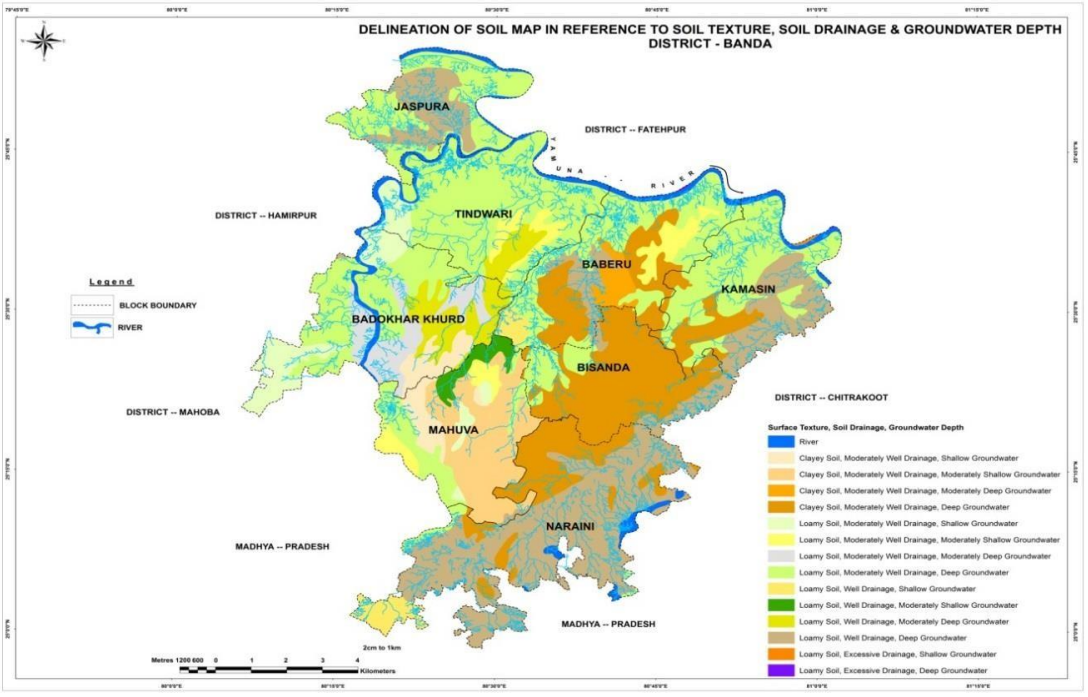


Figure 10: Soil Map of Banda District

(a) Rakar:

It is characterised by silt, clay and subordinate amount of sand. It is spread over Badokhar Khurd, Tindwari and Jaspura block.

(b) Mar:

It is also characterised by silt, clay and sub-ordinate amount of sand. It has coarse texture than Rakar. It is spread over Badokhar Khurd, Tindwari and Bansi blocks. It is fertile and absorb more water.

(c) Kabar:

It is characterized by black cotton soil and is fertile. Rabi crops are more grown and yielded from this type of soil. Baberu and Kamasin blocks have this type of soil.

(d) Padua:

It is characterized by silty loam type of soil which is less fertile and water retention capacity is poor. This type of soil is found in mainly Mahua, Bansi and Bisanda blocks.

After above all types of soil, it is important to note that soil is deciding factor for cropping pattern in the district.

4.0 GROUNDWATER

Water Bearing Formations:

Since the district is characterized by alluvium, marginal alluvium and hard rock terrain, the ground water occurs in porous formation like sand, gravel and fractures/joints (secondary porosity).

Alluvium:

Exploratory drilling as well as strata chart of shallow tube wells of Jal Nigam reveal that there is two distinct zone of ground water formations.

Upper horizon consists of clay, kankar and lenticular bodies of silt and fine to medium sand. The thickness of this horizon varies between 20 to 50 mbgl. Lower horizon consists of sand and gravel with minor presence of clay and silt. Its thickness varies between 40-80.00m.

Hard Rock Formation:

It is commonly observed that the ground water is being extracted from alluvium at major scale. But hard rock (Bundelkhand granite) has also good potential and yield economical discharge.

Granite has been encountered at different depth at different places as basement. Since, the exposure of granite is in limited area it does not have much significance for ground water development.

Aquifer Geometry:

On the basis of exploratory as well as state tube well data it may be inferred that there is a distinct zone of shallow and deeper aquifer. Panel diagram (Plate-6.2) reveals that the shallow aquifer constitutes clay and kankar with sub-ordinate sand. Thickness of this zone is less in western part of district than central and eastern part. Fine grained sand with kankar contribute medium to poor discharge.

It is interesting to note that in extreme south (south of Naraini) only the shallow aquifer is present and below this the basement is encountered. Therefore only single tier aquifer system prevail in southern most part of the district.

Deeper aquifer is characterized by medium to coarse grained sand and have regional extension in north and central part of the district. Thickness of deeper aquifer varies between 50.00 to 80.00 m. Deeper aquifer is absent in southern (south to Naraini and Badaura) part of the district.

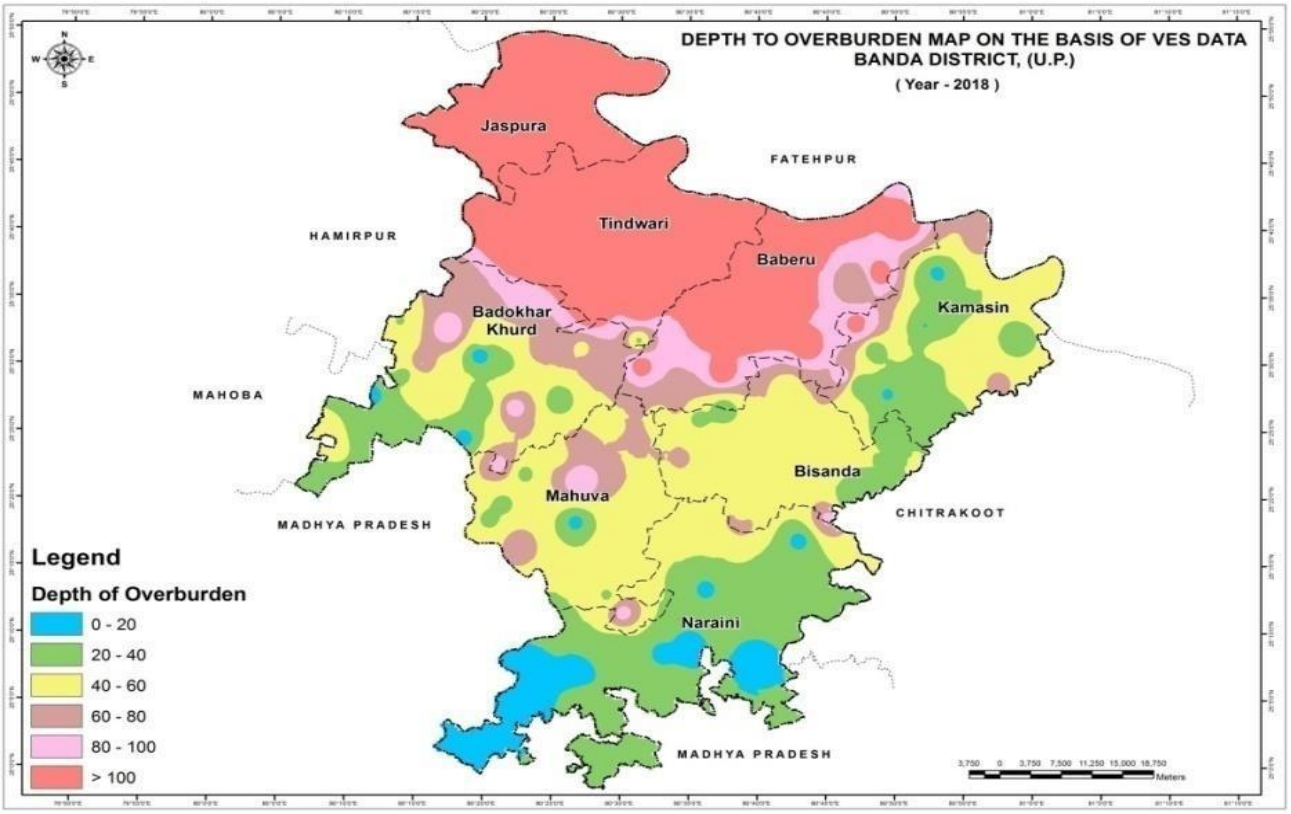


Figure 11: Depth to overburden map-Banda District

Depth to overburden of first aquifer system in Figure 7; shows that thickness of the aquifer increases towards Northern part of the district towards Yamuna river and decreases in southern part of the district towards the exposed Vindhyan super group.

Occurrence, Movement and Distribution of Ground Water in each Unit:

Occurrence of ground water is mainly controlled by drainage, topography and lithological behavior of water bearing formation.

Ground water occurs under confined conditions at shallower depth and under confined condition at deeper depth in alluvium. It occurs in fractures and joints in hard rock. Major potential is present in deeper aquifer which is being exploited in the district. Ground water moves towards major drainage like rive Yamuna and Ken. Ground water movement is slower in northern part than southern part of the district. Since the thickness of clay is more in southern and central part of the district, the groundwater movement is not fast as in southern part. The magnitude of ground water flow is 1.3 m/Km and 3.5 m/Km (towards river) Plate-6.3.

Ground water is distributed unevenly in each block. In five blocks among eight which are situated in northern part of the district have more groundwater potential than southern part of the district.

Comparison of the Present Ground Water Regime with Reference to Earlier Studies over the Years:

The data of ground water regime in district Banda is available for the year 2003 which may be compared with present study (2018). Data pertaining to the phreatic aquifer is only available which can be compared with respect to its water level, seasonal fluctuation and ground water flow.

During 2003, the majority of Key wells record the depth to water (Pre-Monsoon) from 2.20 to 23.20mbgl while it becomes shallower in year 2018. Water level ranges from 1.99 to 12.95 mbgl in year 2018.

Post-Monsoon water level varied from 1.45 to 21.320 mbgl during year 2003 while this magnitude becomes shallower during year 2018. Depth to water level varies between from 1.15 to 13.8 mbgl during post-monsoon inyear-2018.

It is observed that the depth to water level becomes shallower in canal command area which were less developed in year 2003 in comparison to year 2018. However the depth to water level towards major streams becomes steeper than 2003. Seasonal water level fluctuation during year 2003 was from 2-5 m and most of the values were in the range of 2-4 m. and maximum limit was 9-10 m in eastern most part near bank of river Yamuna in district Banda. In year 2018, most of the values range from 0-5m .It is observed that in central and northern portion of district Banda, the water level fluctuation has minimized over the years.

Aquifer Characteristics:

Geophysical Survey (resistivity) reveals that the aquifer consisting of sand and silt with sub-ordinate amount of clay extend from river Ken to Baghain in western part from Kalinger to Sakatpur in southern part of district Banda.

In extreme south, the thick weathered granite layer and Vindhyan sandstones form the aquifers. Thickness of the alluvium varies from 45.00 to 200.00 mbgl in the district. Maximum thickness of alluvium which forms the aquifer has been observed in Banda Town after geophysical survey.

Yield of the well varies between 50 to 1800 lpm in hard rock area. More discharge is observed in Vindhyan sandstone than granite. The yield is quite high in alluvium area of northern and central part of district Banda. It varies between 1500 lpm to 3811 in 60.00 to

130.00 mt. deep bore well.

In hard rock the aquifer is mainly secondary porosity/permeability developed in granite and sandstone due to fractures and joints. Sand of various grades in alluvium form the aquifer which is unconfined to confined conditions.

Urban Hydrogeology:

There are eight numbers of towns including Banda in the district viz. Banda, Attarra, Tindwari, Naraini, Bisanda, Oran, Baberu and Mataundh. The population of Banda town is 1799000 (2011). In earlier days the source for drinking purpose in the town was only dugwells. Due to rapid urbanization and population growth the source became surface water (River Ken) since the success rate of tube wells is very poor.

There are fourteen (14 no) functional tube wells having 3500 lpm discharge in Banda town. In spite of 14 no. of tube wells the water of river Ken after filtration is being supplied to the town to meet the deficit in water supply.

There are 423 number of hand pumps installed for drinking purpose in the BandaTown whereas this number is in two digits in rest of the towns in the district.

The potentiality of the hard rock in Banda town has not yet been tested and confirmed. There is a single hydrograph station located in town which is being monitored regularly. Long term trend depicts that annual fall in water level of 0.18 m has been recorded over past 10 years. Average seasonal fluctuation is only 1.64 m over last ten years.

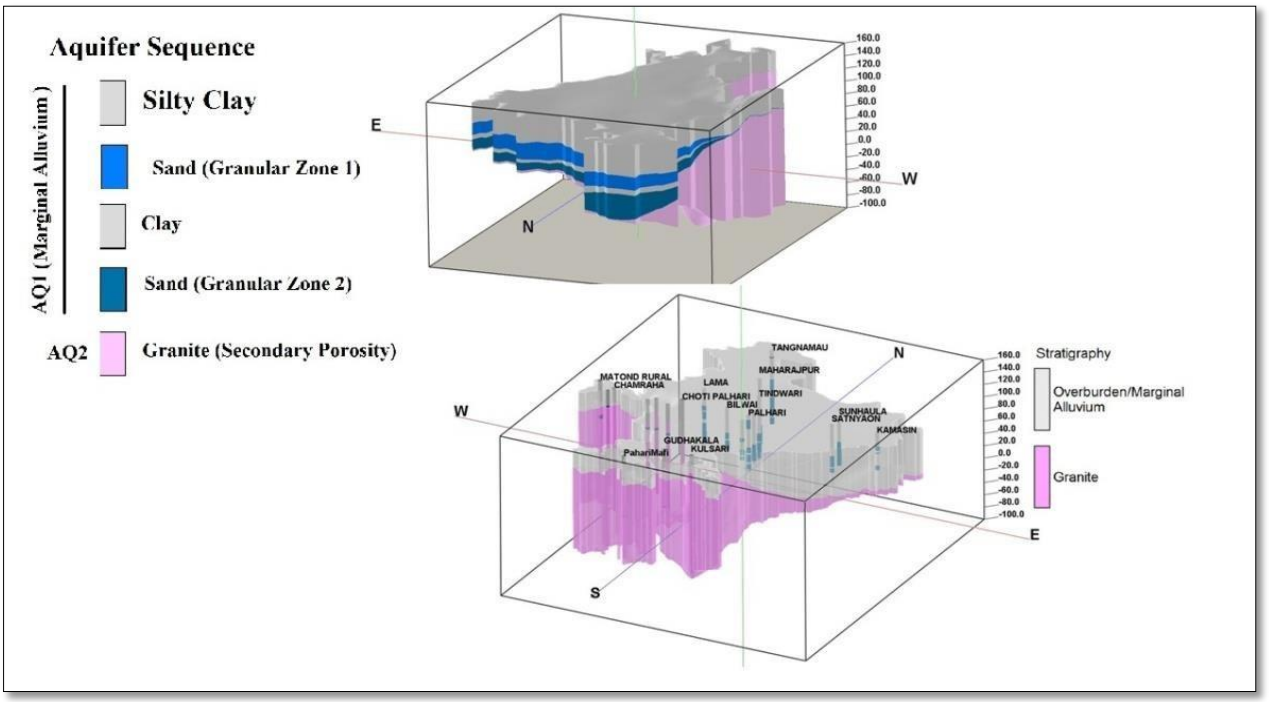


Figure 12: 3D- Aquifer Disposition in Banda District

The Figure-8, 9 and 10 gives an overview of 3-dimensional disposition of aquifer disposition in Banda district down to 200m depth. It depicts that in northern part of the district the first aquifer is predominantly sandy in nature whereas sand content considerably decreases toward southern part of the district due to dominance of Vindhayan sandstone.

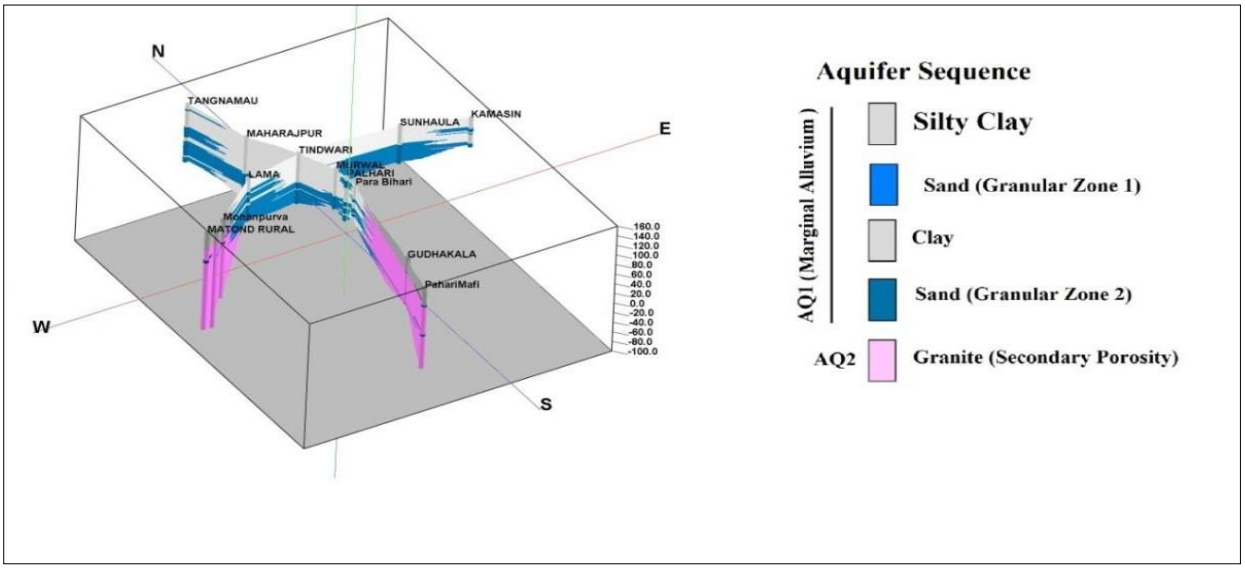


Figure 13: Fence diagram Depicting Sub-surface Part of Ist and 2nd Aquifer

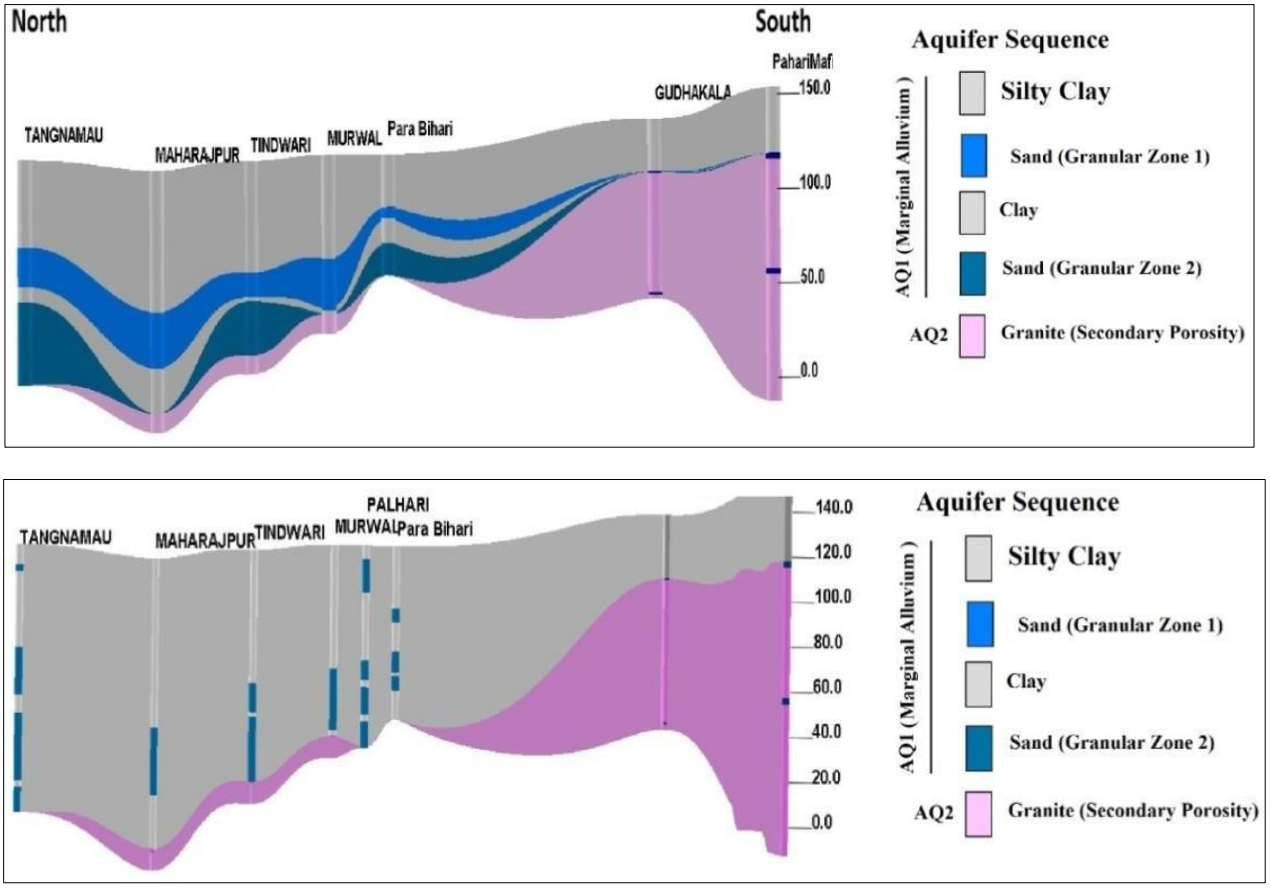


Figure 14: Section Lines for Lithological Section from drilling data

Fence diagram in Figure 9, depicts the regionalized aquifer disposition down to 200 m depth in the district that shows first (marginal aquifer group) is basically encountered up to a maximum of 150 meter and second aquifer (fractured basement group) has been encountered upto a maximum of 200 m depth.

Fence diagram in Figure 9, depicts that the thickness of this zone is less in western part of district than central and eastern part.

It is interesting to note that in extreme south (south of Naraini) only the shallow aquifer is present and below this the basement is encountered. Therefore only single tier aquifer system prevails in southern most part of the district.

Deeper aquifer is characterized by medium to coarse grained sand and has regional extension in north and central part of the district. Thickness of deeper aquifer varies between 50.00 to 150 m. Deeper aquifer is absent in southern (south to Naraini and Badaura) part of the district.

Ground Water Condition:

Confined to unconfined aquifer is observed in north and central Banda district while unconfined aquifer is dominant in extreme southern portion of the district.

Phreatic aquifers mainly exist in the southern part of the district. Depth of the wells representing phreatic aquifer varies from 5.87 to 25.00 mbgl. Depth is less in canal command and in the area of central inland of the district while is more and more towards river either Yamuna or Ken.

Depth to water during pre-monsoon ranges between 2.2 to 22.20 mbgl. It shows that there is a significant variation in water level of phreatic aquifer also.

Diameter of dug wells which represent phreatic aquifer ranges between 1.00 to 5.00 m. Water level data of all the NHS falling in the district for 10years were analyzed for its seasonal and long term seasonal fluctuations. It is observed that season fluctuation (2018-2019) ranges between 1.8 to 12.95 m in pre monsoon and 1.15 to 13.8 m in post monsoon, in dug wells spreading over entire district. Long-term water level fluctuation (2009-2019) shows rise in7 stations from 0.3068 m/year and a fall of 0.1595 m/year in 4 stations. During the post monsoon period there is a rise of 0.3049 m/year in 4 blocks and fall of 0.1700m/year in 11 locations. The higher fluctuation corroborates the fact that the base flow of ground water is higher in the area where long term/seasonal fluctuation is more pronounced. It is also observed that in hilly and rocky area the fluctuation is higher than plain. Fluctuation is more where less order of streams is found. The depth to water level map of pre- monsoon 2018 is presented in Figure-11.

Table-8: Water Level of CGWB GWMS (in mbgl)

Monitoring Station	Jan 18	May, 2018	Aug, 2018	Nov, 2018
Baberu new	5.07			3.1
Baberu			0.95	
Banda	8.43	10.08	7.51	13.8
Bargaini			7.46	9
Jamnipurva	5.48		5.4	
Mataund	5.23	7.19		
Bisanda	4.03	7.18	2.6	2.75
Chilla			14.14	
Dadoghat			22.43	
Attara	4.54	6.78	3.5	3.6
Girwan	2.42		0.1	1.15
Khurrand	1.53	1.99	0.7	1.15
Naraini new	3	6.49	0.59	1.3
Pangra	2.03		0.49	1.16
Badausa		7.29	2.87	3.1
Badehan	10.8	12.95	7.8	6.3
Mukera	6.96	9.19	4.62	3.55
Rolikalyanpur	13.16		12.7	9.85
Tindwari			3.1	

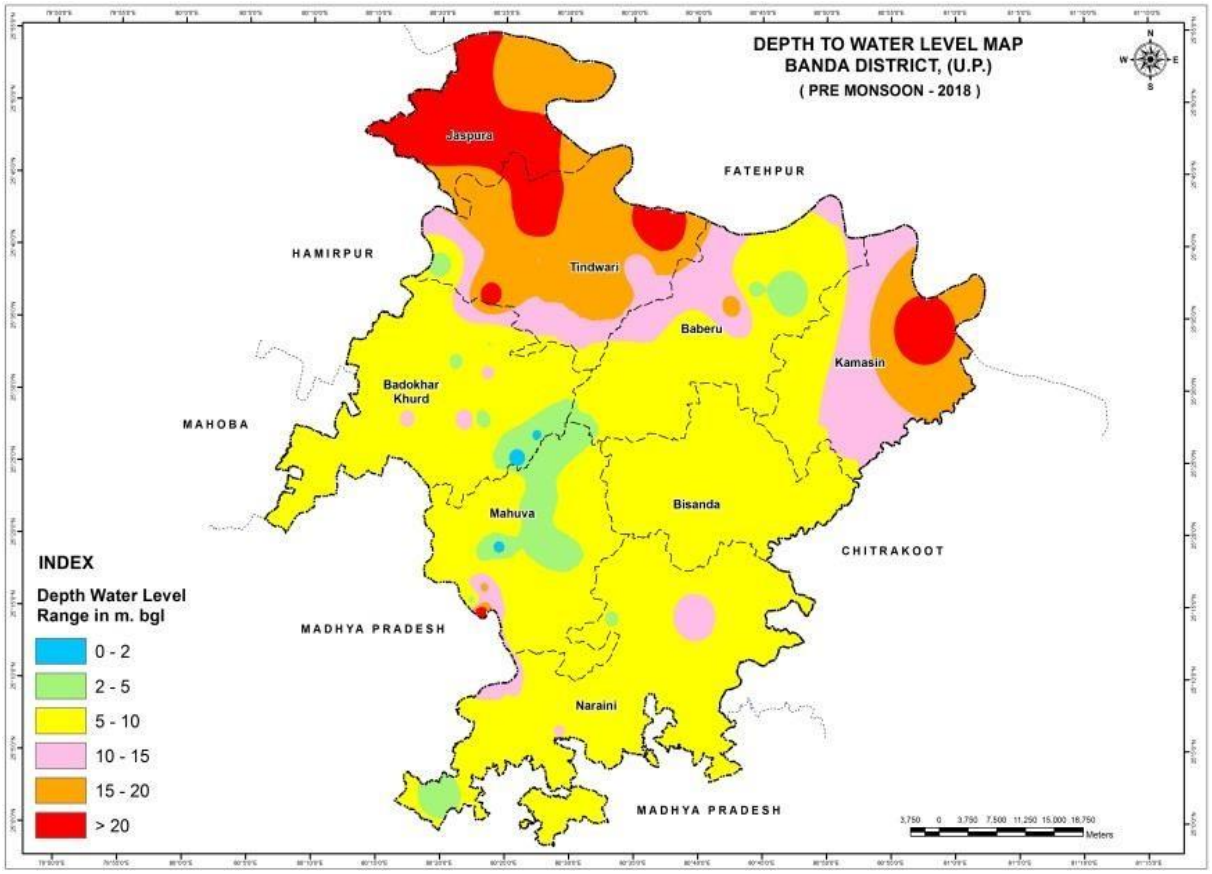


Figure 15: Depth to water level- Pre-monsoon, 2018 Banda District

Figure 11, shows that deeper water is observed in the northern as well as northeastern part of the district whereas relatively shallower water levels are present in the central and southern part of the district.

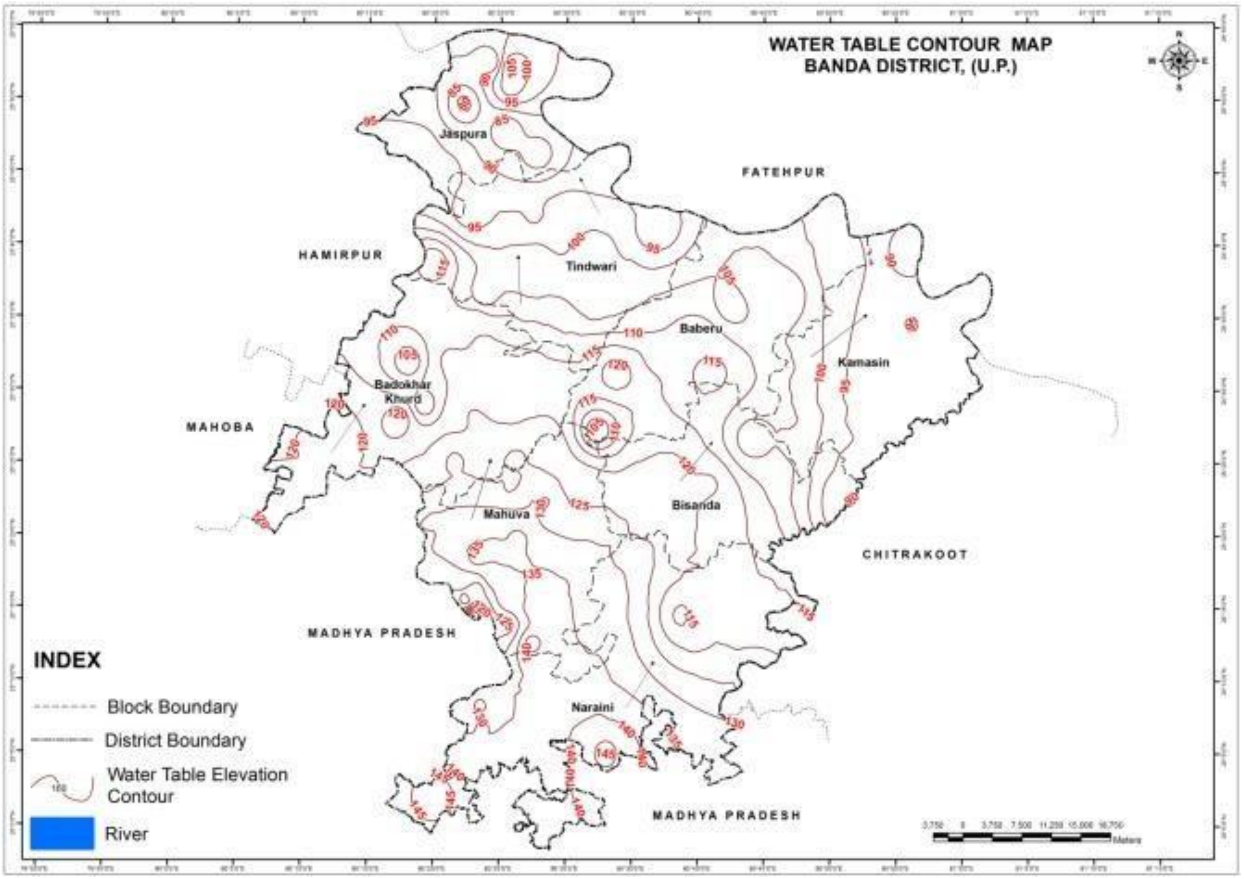


Figure 16: Water Table Elevation-Banda District

Figure 12, shows that groundwater flow direction is broadly North-Northeast in the district towards Yamuna River. It shows that major river system in the district is perennial in nature

Long Term Water Level Trend:

The long term water level trend for the period 2009-2018 indicates both rise and fall in water level. The pre-monsoon rise is seen in 7 number of observation station ranging from 0.04 to 0.72 m/year and fall has been observed in 4 number of observation station ranging from 0.06 to 0.31 m/yr. The post monsoon rise is seen in 4 number of observation station ranging from 0.02 to 0.90 m/year and fall has been observed in 11number of observation station ranging from 0.001 to 0.56 m/yr.

Table 9: Long Term Water Level Trend (2009 – 2018) (CGWB GWM Wells) Trend of Water Level - All

From Year 2009-2018										
S. No.	Location	Pre-Monsoon			Post-Monsoon			Annual		
		Data Points	Rise (m/year)	Fall (m/y)	Data Point s	Rise (m/yea)	Fall (m/yea)	Data Points	Rise (m/yea)	Fall (m/yea)
1	Baberu NEW	0			2			4		
2	Naraini New	2			3			11		
3	Mukera	2			3			11		
4	Jamnipurwa	8	0.0402		9		0.3202	35		0.0536
5	Baberu1	7	0.5337		7	0.2006		28	0.2363	
6	Paprenda	2			1			4		
7	Kamasin	2			1			5		
8	Badausa	9	0.725		10	0.7941		36	0.7958	
9	Dadoghat	1			0			6		
10	Mataundh	9		0.3105	7		0.5614	31		0.3706
11	Atarra	10		0.1477	10		0.1364	43		0.1203
12	Tindwari	3			3			15		
13	Girwan	6	0.1376		10		0.0963	35	0.0124	
14	Bisanda	5			7		0.0931	24		0.3113
15	Aliha	5			4			20		
16	Badehan	10		0.1155	8	0.1981		36	0.0854	
17	Pailani	6	0.3359		6		0.0054	21		
18	Chilla	4			6		0.0201	23		
19	Bhitaridera	1			3			8		
20	Sukulkuan	3			4			15		
21	Banda	10		0.0643	10		0.2592	38		0.1022
22	Khhurand	10	0.1603		10	0.0268		37	0.0795	
23	Kazi ka tola	1			0			1		
24	Rolikalyanpur	5			9		0.1942	32		0.0586
25	Pangara	6	0.2149		9		0.001	33	0.1264	
26	Bargaini	5			8		0.183	30	0.2277	
27	Naraini	2			4			13		

Aquifer Parameters:
Two aquifer groups exist.

Aquifer Group I (Marginal Alluvium):
Transmissivity 500-3000 m2/day
Storativity: 8.5 X 10^{-5}
Exploration depth up to 150 m.

Aquifer Group II (Fractured Basement):
Transmissivity 20-50 m2/day
Storativity: 5.88 X 10^{-4}
Exploration depth: 200m

Aquifer Group I (Marginal Alluvium): 800 - 3000 lpm Aquifer Group II (Fractured basement): 30 – <600 lpm

Ground Water Resource:

Ground water resources have been computed jointly by Central Ground Water Board and Ground Water Department, Govt. of U.P. as on 31st March 2017. The salient features of the computations are as following. The geographical area of the district is 4408 Sq km and the ground water recharge worthy area is 4404 Sq Km. The total annual ground water recharge is 63332 Ham and the annual discharge is 3723 Ham thus the annual extractable ground water recharge is 59608Ham. The current annual groundwater extraction for all uses is 40154 Ham. The net ground water availability for future use stands at 17304 Ham. The stage of ground water extraction for the district stands at 67.36%. Four blocks in the district namely Kamasin, B.Khurd, Mahua and Bisanda fall in SAFE category. The blocks falling in SEMICRITICAL category are Tindwari, Jaspura, Naraini and Baberu the reason attributed for, is largely due to increase in Ground Water extraction for irrigation and domestic uses, which have increased due to the increase in number of abstraction structures particularly shallow tube wells and population in these blocks.

Table 10: The average unit draft (Ham) of irrigation structures during monsoon and non-monsoon period for the district is:

Structure	Monsoon	Non monsoon
Private tube well deep	2.22 Ham	6.57 Ham
Private Shallow well	0.33 Ham	0.88 Ham
Open wells	0.20 Ham	0.60 Ham
Shallow tube wells	3.14 Ham	8.58 Ham

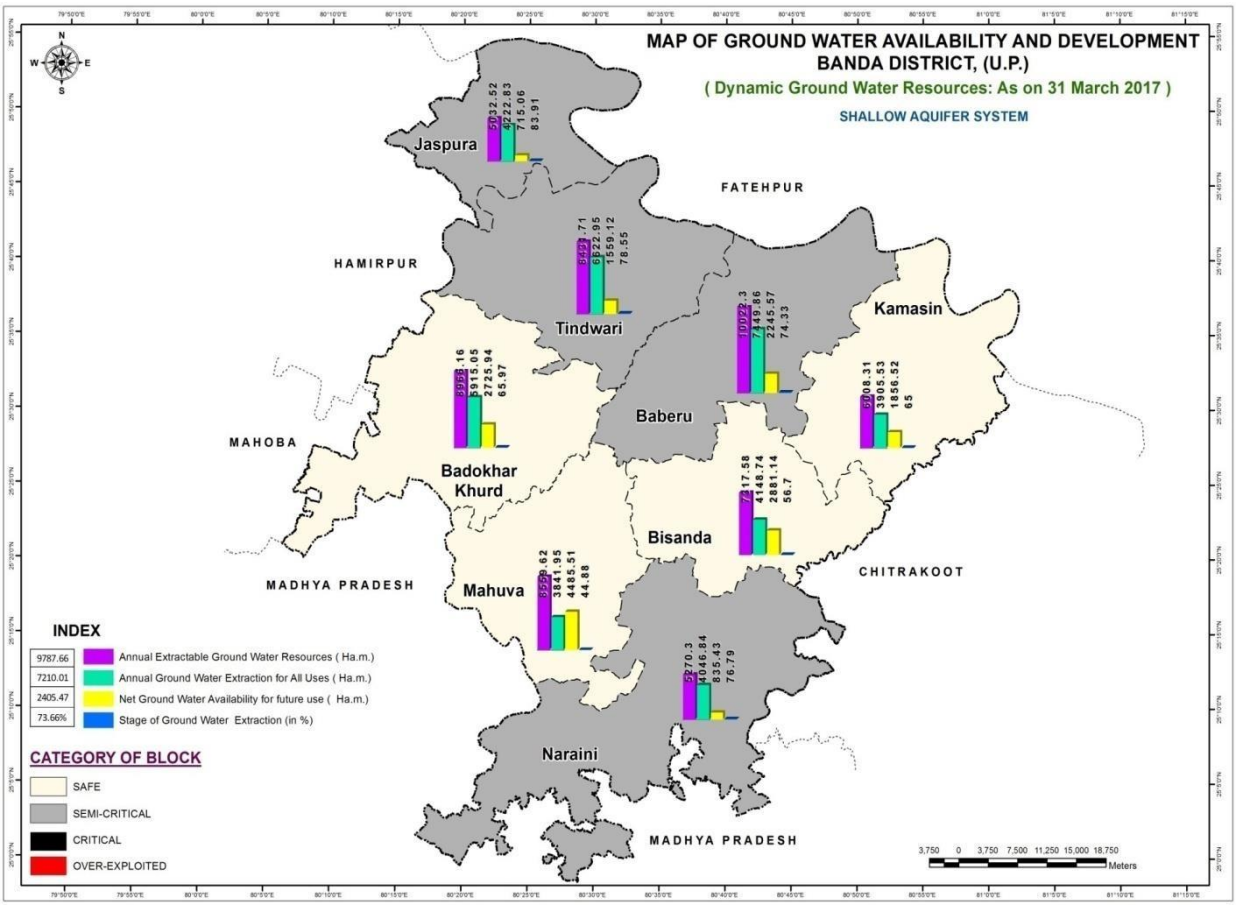


Figure 17: Ground Water Resources, As on 31.03.2017 of Banda District U.P.

Table-11: Details of Recharge and Natural Discharge (ham) of Banda district 2017

S. No.	Assessment Unit	Annual Extractable Ground Water Recharge (Ham)	Current Annual Ground Water Extraction(Ham)			Annual GW Allocation for for Domestic Use as on 2025	Net Ground Water Availability for future use	Stage of Ground Water Extraction (%)
			Irrigation Use	Domestic& Industry Use	Total Extraction			
1	Baberu	10022.30	6878.40	571.46	7449.86	898.33	2245.57	74.33
2	Badokhar Khurd	8966.16	5356.82	558.23	5915.05	883.40	2725.94	65.97
3	Bisanda	7317.58	3638.40	510.34	4148.74	798.04	2881.14	56.70
4	Jaspura	5032.52	3969.80	253.03	4222.83	347.67	715.06	83.91
5	Kamisin	6008.31	3471.20	434.33	3905.53	680.60	1856.52	65.00
6	Mahuva	8559.62	3322.00	519.95	3841.95	752.11	4485.51	44.88
7	Naraini	5270.30	3329.27	717.57	4046.84	1105.60	835.43	76.79
8	Tindwari	8431.71	6150.40	472.55	6622.95	722.18	1559.12	78.55
9	Total	59608.51	36116.28	4037.47	40153.75	6187.92	17304.30	67.36

Table-12: Static Resource in Aquifer- I (Marginal Alluvium) in Banda District

S. No	Assessment Unit Name	Ground Water Recharge(Ham)				Total Annual Ground Water (Ham) Recharge	Total Natural Discharges (Ham)	Annual Extractable Ground Water Recharge (Ham)
		Monsoon Season		Non-monsoon season				
		Recharge from Rainfall	Recharge from Other Sources	Recharge from Rainfall	Recharge from Other Sources			
1	BABERU	8457.47	1012.68	80.11	1585.64	11135.89	1113.59	10022.30
2	BADOKHAR KHURD	7123.70	878.47	74.04	1361.85	9438.06	471.90	8966.16
3	BISANDA	5481.94	896.38	64.42	1259.98	7702.72	385.14	7317.58
4	JASPURA	4424.68	378.00	43.14	451.57	5297.39	264.87	5032.52
5	KAMISIN	5320.55	389.70	68.65	545.64	6324.54	316.23	6008.31
6	MAHUVA	6219.82	1103.05	68.81	1618.45	9010.13	450.51	8559.62
7	NARAINI	4409.95	436.01	47.24	654.48	5547.68	277.38	5270.30
8	TINDWARI	7250.41	626.23	73.39	925.45	8875.48	443.77	8431.71
District	**TOTAL**	**48688.53**	**5720.51**	**519.79**	**8403.06**	**63331.90**	**3723.39**	**59608.51**

Table -13 (a): Block-wise Dynamic Resource in Banda District U. P.

BLOCKWISE STATIC GROUND WATER RESOURCE OF UN-CONFINED AQUIFER OF BANDA district UTTAR PRADESH									
S. No.	Block	Area in sq.km.	Predominant Pre Monsoon DTWL considered for calculation in mbgl	Average Bottom depth in mbgl considered for depth to overburden map.	Average Thickness of Un-confined Aquifer below WL in m(5-4)	Thickness of the granular zone/productive zone below pre-monsoon water level in (m)	Specific Yield % as taken for estimating Dynamic Resource 2017	Resource (area* granular zone thickness * Sp Yield*0.60) MCM	Fresh & potable ground water in MCM
1	Baberu	590.41	7.93	80	72.07	55	0.1	1948.35	1948.35
2	B.Khurd	671.62	6.45	50	43.55	42	0.073	1235.51	1235.51
3	Bisanda	474.76	9.54	50	40.46	25	0.1	712.14	712.14
4	Jaspura	317.96	18.93	120	101.07	24	0.1	457.862	457.862
5	Kamasin	505.97	12.86	40	27.14	31	0.1	941.1	941.1
6	Mahua	507.74	6.82	50	43.18	17	0.073	378.06	378.06
7	Naraini	798.63	8.66	30	21.34	15	0.015	107.81	107.81
8	Tindwari	540.91	17.02	100	82.98	20	0.1	649.09	649.09
Total District		4408						6429.92	6429.92

Table -13 (b): Block-wise Dynamic Resource (2017) in Banda District U. P.

Block	Annual Extractable GW Resource	Total Annual GW Extraction	Stage of GW Extraction in %	Category	Declining Trend	
					Pre	Post
BABERU	10022.30	7449.86	74.33	Semi-Critical	55.0	-
BAROKHAR	8966.16	5915.05	65.97	Safe	-	-
BISANDA	7317.58	4148.74	56.70	Safe	-	-
JASPURA	5032.52	4222.83	83.91	Semi-Critical	-	24.0
KAMASIN	6008.31	3905.53	65.00	Safe	-	-
MAHUA	8559.62	3841.95	44.88	Safe	-	-
NARAINI	5270.30	4046.84	76.79	Semi-Critical	38.0	71.0
TINDWARI	8431.71	6622.95	78.55	Semi-Critical	-	44.0
TOTAL DISTRICT	59608.51	40153.75	67.36			

Table-14: In storage Resource in weathered and fractured Basement Banda District

Block	Dynamic Resource (MCM)	In storage Resource in weathered/Alluvium (MCM)	In storage Resource in fractured hard rock up to 200 meters (MCM)	Total in storage Resource of the district (MCM)
Baberu	100.22	1948	5.9	1953.9
B.Khurd	89.66	1235	6.71	1241.71
Bisanda	73.18	712	4.74	716.74
Jaspura	50.33	458	3.17	461.17
Kamasin	60.08	941	5.05	946.05
Mahua	85.60	378	5.07	383.07
Naraini	52.70	108	7.98	115.98
Tindwari	84.32	649	5.4	654.40
TOTAL	**596.09**	**6429**	**44.02**	**6473.02**

4.1 GROUND WATER QUALITY

Groundwater in phreatic aquifer in general, is colorless, odorless and slightly alkaline in nature. A total of 171 samples were collected from the district at a density of one sample representing 27 Sq Km and it is observed that in general the groundwater is suitable for drinking agricultural & industrial purposes in respect of all the constituents' viz. EC, CO3, HCO3, Cl, F, No3, SO4, TH, Ca, and Mg & Na. The specific electrical conductance of groundwater in phreatic aquifer ranges from 315-12940 micro Siemens/cm at 25^0C. Fluoride ranges from 0.10-5.0 mg/l, which in general is within desirable limit except 9 locations were the values are beyond permissible limit and needs for an immediate sensitization. Nitrate ranges from Nd-1040 mg/l and is found in excess of permissible limit (>45mg/l) in 23 out of 171 samples which is likely due to return irrigation flow from agricultural fields and often improper waste disposal. The TDS ranges from 189 to 1578 which in general is within permissible limit except 2 locations.

Among heavy metals, Iron concentration ranges from 0.134-17.2 mg/l. Out of 56 samples collected from the district 28 samples spread over all the blocks show iron value between 0.13-

1.0 mg/l & other 28 show iron value >1.0 mg/l .The permissible limit of Iron as per BIS-2012 is 0.30 mg/l. The presence of Iron above 1.0 mg/l may lead to deposits in pipes and in the presence of aluminum may lead to dirty water problems. It is more of aesthetic value than toxicity and may be showing in water due to old rusted pipes in the hand pumps. Manganese concentration ranges from Nd-1.43 mg/l and in two out of 56 samples it shows value more than the permissible limit (>0.3 mg/l). Almost all the samples show Zn and copper concentration within the permissible limits.

Table 15: The block-wise range of some important constituents is shown below:

Block	EC Range	pH	TDS Range	F Range	NO3 Range
B.Khurd	473-12940*	7.26-8.93	273-3444*	0.18-2.91*	3.4-1040*
Mahua	422-1998	8.0-9.02	297-1198	0.25-1.54	1.8-536
Naraini	368-2250*	7.23-8.76	220-1350	0.2-5.0*	0.2-205*
Bisanda	576-1926	7.7-8.39	345-1155	0.21-1.48	2.45-444*
Kamasin	539-1632	7.7-8.29	363-1014	0.26-0.93	1.3-32.0
Baberu	407-1634	7.7-8.41	244-980	0.10-2.10*	2.5-67
Jaspura	428-2630	7.73-8.92	256-1578	0.25-1.54	1.1-25
Tindwari	556-1835	7.58-8.15	333-1101	0.19-0.70	1.2-245*

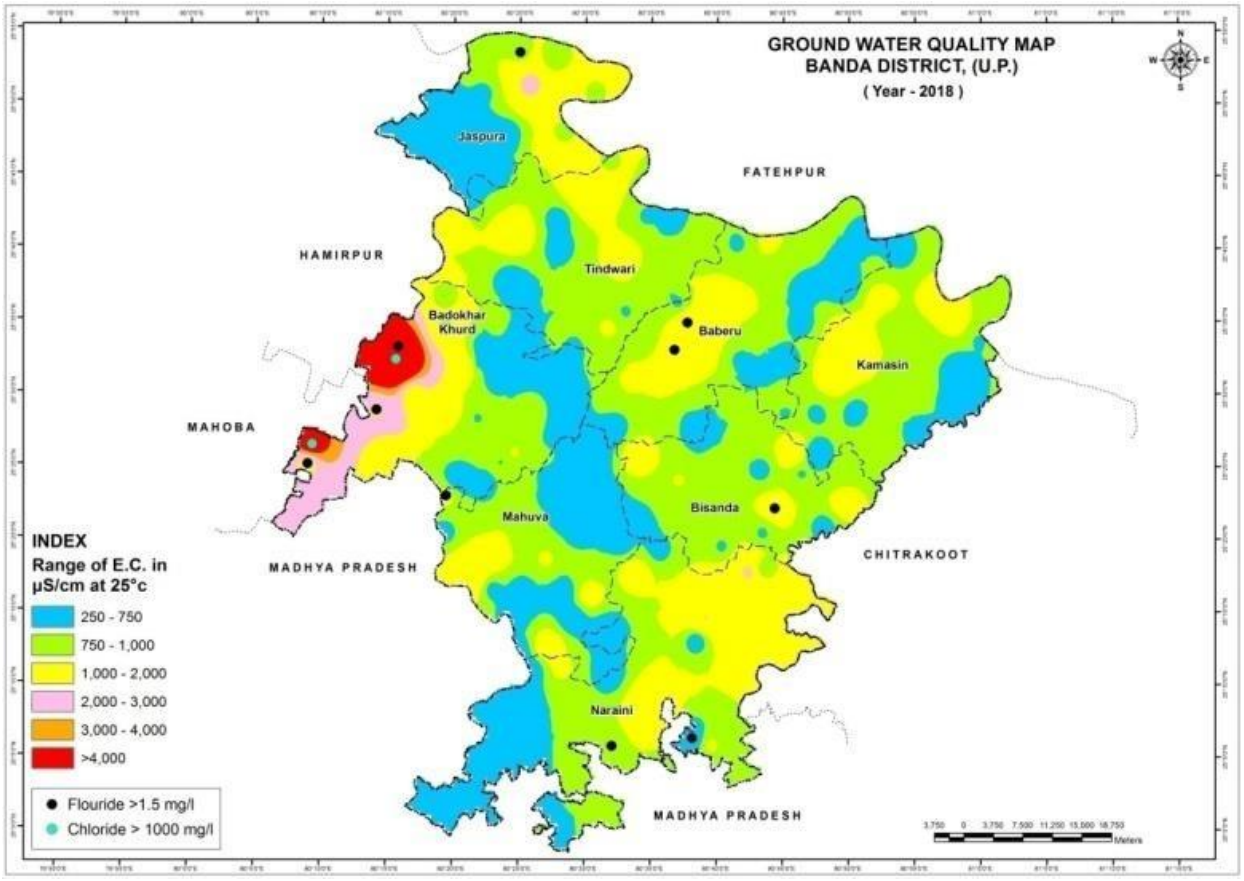


Figure 18: Water Quality map of Phreatic Aquifer Banda District U.P.

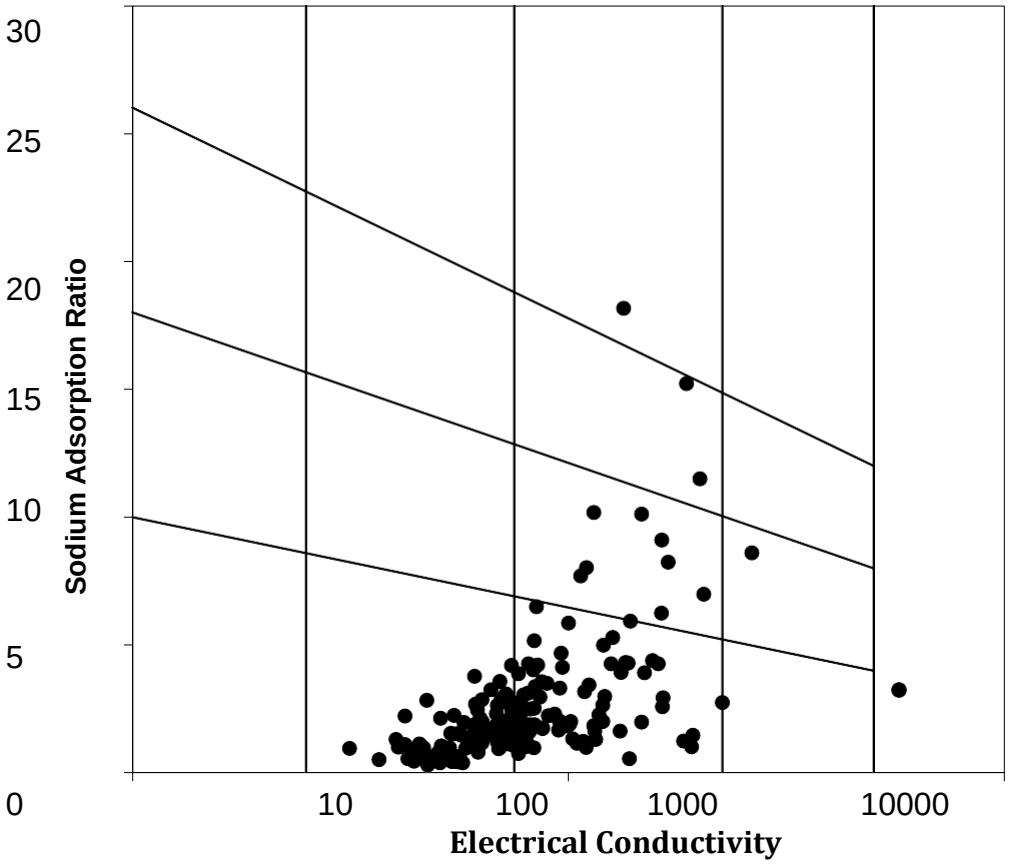


Figure 19: SAR and Salinity Class of Phreatic Samples in Banda District

In general, water chemistry is guided by complex weathering process, ion exchange and influence of agriculture and sewage impact. Comparison of groundwater viability for irrigation suitability through the Wilcox plot show that majority of sample fall in *S1C2 and S1C3 class with low SAR values and medium to high salinity values. Very few samples are falling inS3C3 and S3C4 class. (*S1, S2, S3 and S4 are Low, Medium, High and Very High Sodium Hazards respectively. C1, C2, C3 and C4 are Low, Medium, High and Very High Salinity Hazards respectively.)

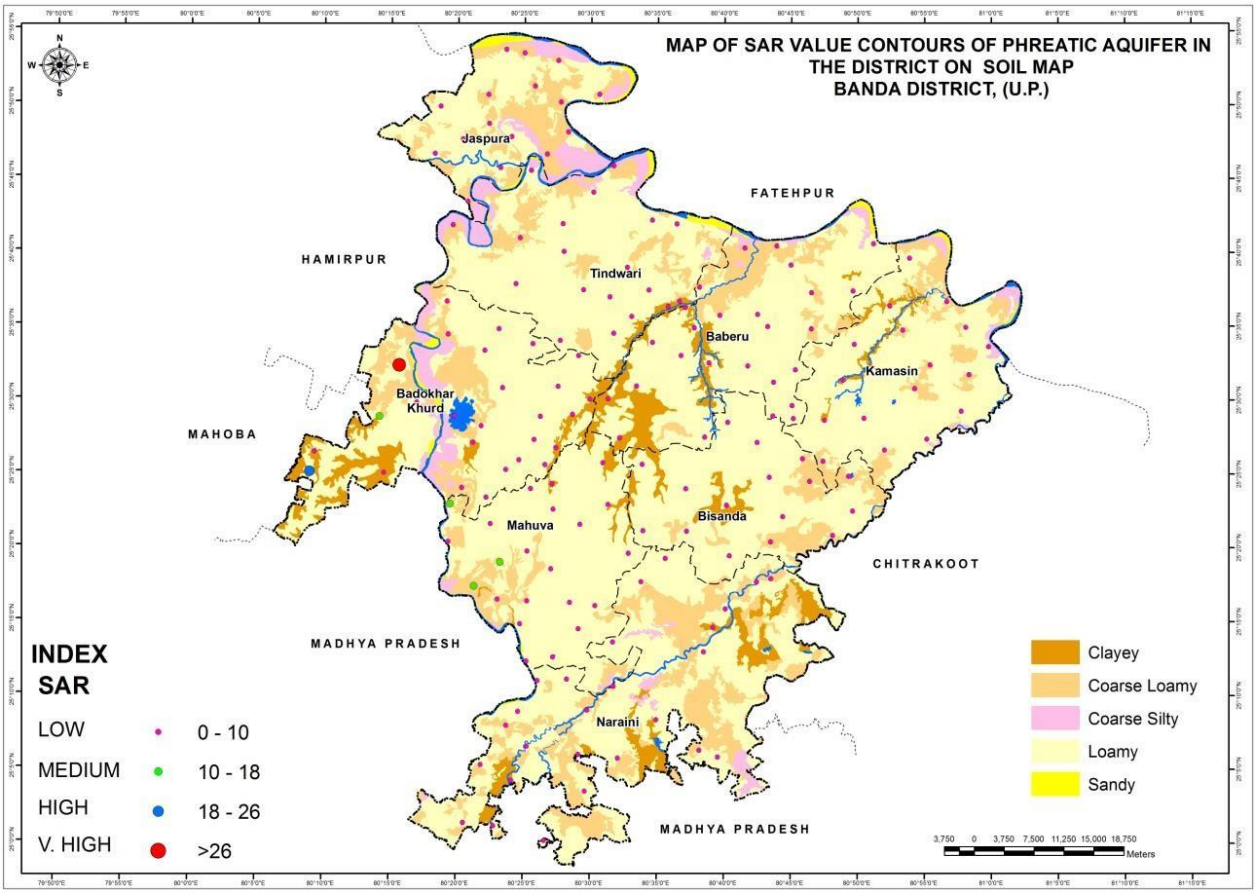


Figure 20: Suitability of water for irrigation use (Adopted from U.S. Salinity Laboratory Staff (1954)).

Table 16: Electrical Conductivity and SAR value (> 10) Map of Banda District

Block	Location	Point source(IM-II)	Electrical Conductivity	SAR Value
B. Khurd	GoyraMungli	25°28'49"/80°14'12"	1863	15.15136
B Khurd	Jakhaura	25°25'05"/80°09'00"	1336	18.07757
B. Khurd	Achharaund	25°32'18"/80°15'40"	12940	27.39608
Mahuwa	Madhopur	25°22'55"/80°19'30"	1143	10.13685
Mahuwa	Girwan	25°18'59"/80°23'15"	1470	10.06987
Mahuwa	Syodha	25°17'21"/80°21'19"	1998	11.45423

In table 16 the point sources in different blocks have been identified with SAR values >10 and higher EC values as well.

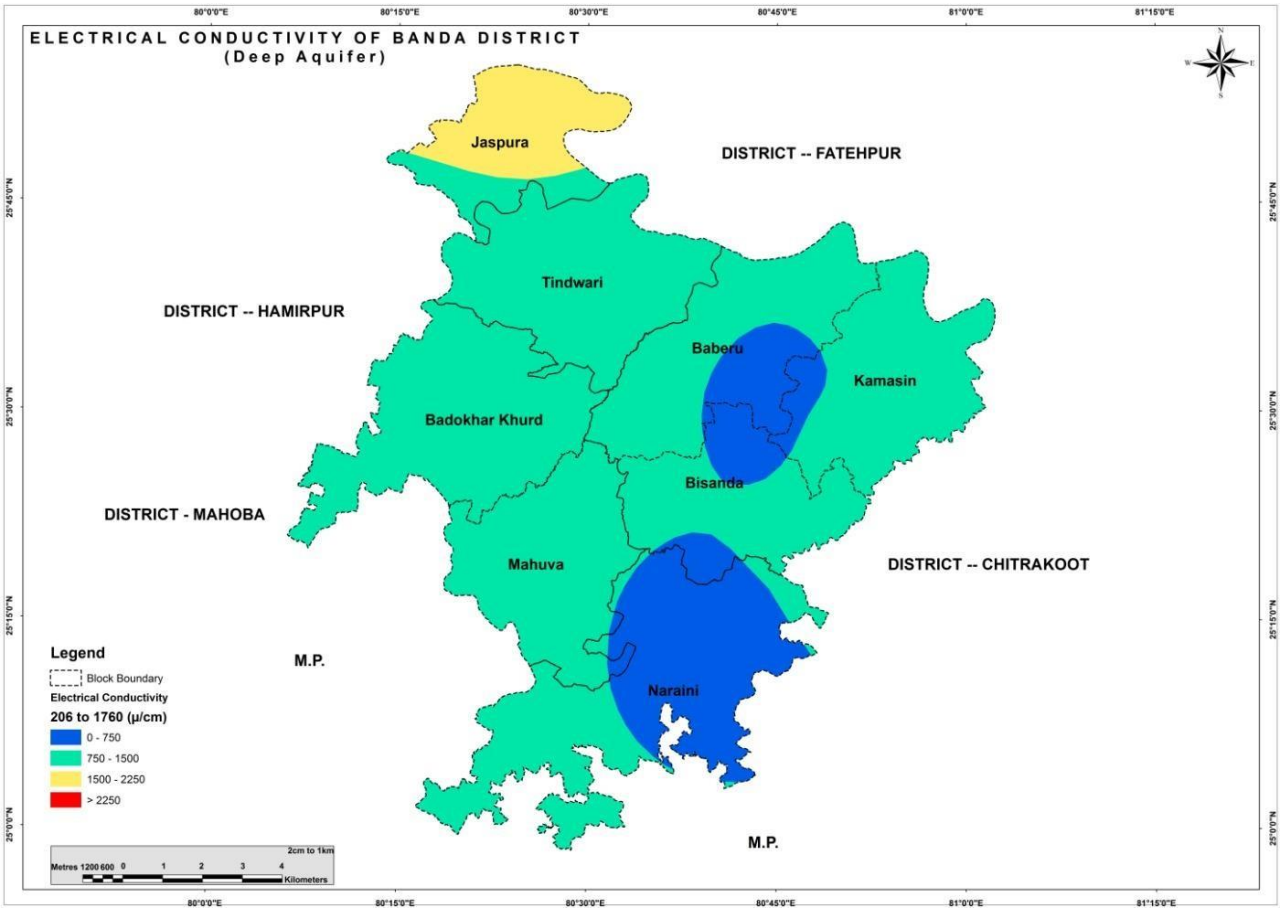


Figure 21: Chemical Quality Map of Deeper Aquifers

The deeper aquifers have been encountered through in-house and outsourcing exploration programs of CGWB and it has been found that in general the EC ranges from750-1500 and at some places it was beyond 2000.

4.2 STATUS OF GROUND WATER DEVELOPMENT

Presently ground water is being developed through 13170 private tube wells & bore wells in addition to 4926 dug wells. The total groundwater draft is 40153.75 ham, which is being used in present for domestic, irrigation & industrial purposes against the groundwater availability of 59608.51 ham. Out of 8 blocks, four blocks falls under semi critical category which are Jaspura, Tindwari, Baberu and Naraini and rest four (4) blocks are under Safe category and presented in Fig-13. The percentage wise development is given in Table Ground water

Development is basically people programme undertaken through individual and collective efforts from finance obtained as loans from institutional sources or invested by the farmers from their own sources. Ground water development has several advantages over surface water and has become a vital factor in promoting innovating agriculture practices through high yielding varieties of crops. Ground water is widely distributed and provides an assured and dependable source of irrigation input. Net ground water availability for future use is 17304.30 ham. The overall development stage of the district is 67.36%.

5.0 GROUND WATER RELATED ISSUES AND PROBLEMS

The development of groundwater in the district, in general, is high as 4 (four) blocks (Naraini, Baberu, Jaspura and Tindwari) out of 8 blocks in the district have been categorized as semi critical although overall stage of ground water development in the district is about 67.36%, yet the trend analysis of historical ground water level data indicates a long term fall in most of the wells in these blocks. Based on the factors mentioned, it is inferred that the northern blocks in general could be considered vulnerable to various environmental impacts of water level depletion such as declining groundwater levels, drying up of shallow wells, and decrease in yield of bore wells and increased expenditure and power consumption for drawing water from progressively greater depths.

6.0 GROUND WATER MANAGEMENT STRATEGY

To arrest the further decline in groundwater levels and depletion of ground water resources, there is urgent need to implement both Supply side and Demand side measures which includes artificial recharge and water conservation, On-farm activities and adoption of water use efficiency measures.

GW Management options	
Supply side Interventions	**Demand side Interventions**
Ridge to valley approach in the watershed Efforts to minimize base flow. Catchment treatment to promote soil conservation through large scale plantation. Construction of Nala plug, Gabbion structures, Nala bunds & check dams. Desilting of historical ponds to make them functional by community participation. Diverting surplus runoff in dry open wells, deepening at the same time. Infrastructure development oriented rain water harvesting pond (Road, Railway and Canal) Bundelkhand cries out for CSR	Formation of village level committee of Panidars assuring gender participation for water budgeting of the village. Water use efficiency through piped and pressurized irrigation (Rain gun & Sprinkler) in at least 100 sq.km area and monitoring of the same by village Panidar team. Promoting HDPE pipe distribution to avoid transmission losses Awareness of farmers/stakeholders related to understanding of aquifer dispositions & characteristics and proper selection of sites through training and awareness programmes. Motivating Farmers with 10 Hectares land holding or more, to go for 1Hectare

Rain Gauge stations at every 100 Skim for recording each event. Scope of supply side management is limited due to topography, land availability and also less available surplus water. Scope of supply side interventions is limited due to topography, land availability and also less availability of surplus water.	Farm Pond (replicating successful Apna talab yojna) Motivating farmers for "Medhbandhi" and Laser leveling of all farms at village level. (replicating successful measures taken at Jalgram Jhakni) Most effective option to reduce ground water withdrawal by 35-40% especially for Sugarcane areas by adopting new irrigation practices and new varieties.

Supply side Management:

It is proposed to adopt supply side management options in the blocks. There is considerable scope for implementation of Roof Top Rain Water Harvesting in the urban areas of the district. Check dams, Nala bunds renovation and creating new ponds are ideal structures for rainwater harvesting in rural areas. Water conservation structures such as check dams, farm, ponds, Nala bunds etc, result in groundwater recharge to the tune of about 51% of the storage capacity considering 3 annual fillings. It is proposed to construct 75 Check dams of 15,000 cubic meter. Capacity and 70 Nala bunds of 15000 cubic meter capacity, to revive and renovate70 ponds.

It is also proposed to adopt On Farm practices such as laser leveling, bench terracing, construction of farm ponds, a forestation, diversification of crops etc. On farm activities are proposed in an area of 30551 hectare. It is expected that above measures will lead to additional recharge of 59.07(includes saving in draft) MCM of ground water. Block-wise details are given in Table16.

Demand side Management:

Agriculture is the major consumer of ground water. In the district, about 70% irrigation is dependent on groundwater. Even in the canal command areas, enough groundwater is being used to irrigate the fields. In the major parts of area, flow irrigation is being used. There is urgent need to promote piped and pressurized irrigation practices which can save 25 to 70% of water use in the agriculture. It is proposed to initiate these measures initially in approximately 10% area of each of block. It is also proposed to adopt new water saving agricultural practices in about 10600 Ha with an estimated saving of 9.31 MCM of water with this measure. Such practices have the potential of saving 35-40% irrigation water there by drastically reducing the draft for irrigation leading the change of category of block from Semi

Critical to safe.

The measures adopted for supply side and demand side management in Banda district will substantially bring down stage of groundwater development. Block wise details are given in table16.

Trash Mulching

Trash i.e. dry leaves available after harvesting of the crop is a valuable source of organic matter & water saving. In general farmers burn trash or utilize it for other purposes such as thatching, fuel litter etc. If, it is recycled in the cane field itself it contributes not only in saving precious irrigation water but also adds organic matter as well as other plant nutrients in soil. So it is important to recycle trash by mulching infield.

Advantages

Irrigation water is saved up to 40% as it conserves the soil moisture & reduces evaporation from soil surface. Increased availability of nutrients especially Nitrogen and Phosphorus to the plants.

Mulch also adds large quantity of organic matter thus improves soil health of the soil.

Micro Irrigation (Sprinkler/ Drip Irrigation)

Micro irrigation is the frequent application of small quantities of water on, above or through water directly at the root zone of the plant in a uniform and effective way.

Advantages

Water Use Efficiency can be improved from 50-60 % to 90-95%. The consumption of fertilizers can be reduced by 30%. Weed infestation is reduced considerably. Can be used on undulating topography & on soils having low infiltration rates.

Table-17: Summary of Interventions.

Interventions Recommended	
Check Dam / Nala Bund of 15000 cum Capacity	145 Nos.
Ponds of 100mx100mx3m dimensions	75 Nos.
On-farm Activities	30551ha
Water Use Efficiency (WUE) Measures	10600 ha
Piezometers for Impact monitoring	51 Nos.
Expected Benefits	

Expected Annual Recharge	3272 ham
Provision for supplemental irrigation	220 ham
Expected conservation of GW through efficiency enhancement	3786 ham
Total Recharge/ Saving	7278 ham

Table-18: Block-wise Projected Status of Groundwater Resource & Utilization in Banda District after AR Interventions

BLOCK	Net annual Extractable GW availability (ham)	Existing gross GW draft for all uses (ham)	Stage	Total recharge through intervention on (ham)	Total GW saving through interventions (ham)	Projected net Extractable GW availability (ham)	Projected gross GW draft (ham)	Projected stage of GW development t post intervention %
BABERU	10022	7449	74.33	472	809	10494	6640	63.27
JASPURA	5032	4222	83.91	280	746	5312	3476	65.43
TINDWARI	8431	6622	78.55	690	751	9121	5871	64.32
NARAINI	5270	4046	76.79	536	415	5806	3631	62.53
B.KHURD	8966	5915	65.97	504	574	9470	5341	56.4
KAMASIN	6008	3905	65	402	385	6410	3520	55
MAHUA	8559	3841	44.88	204	147	8763	3694	42.15
BISANDA	7317	4148	56.7	188	179	7505	3969	52.88
TOTAL	**59608.51**	**40153.75**	**67.36**	**3276**	**4006**	**62881**	**36142**	**58**

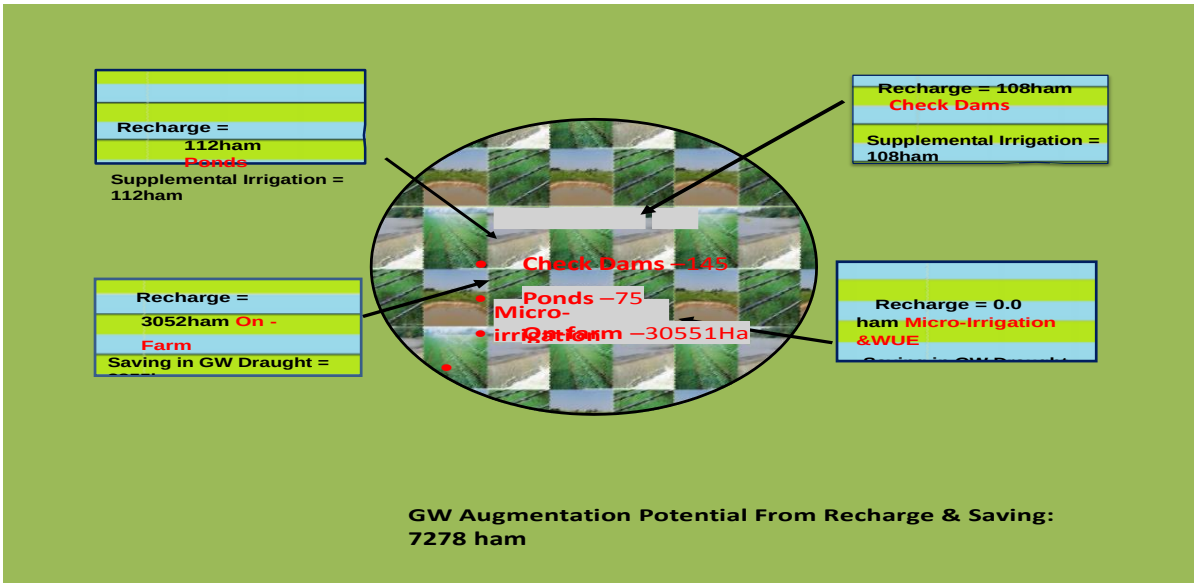


Figure 22: Post-intervention, Ground Water Augmentation Recourse Potential

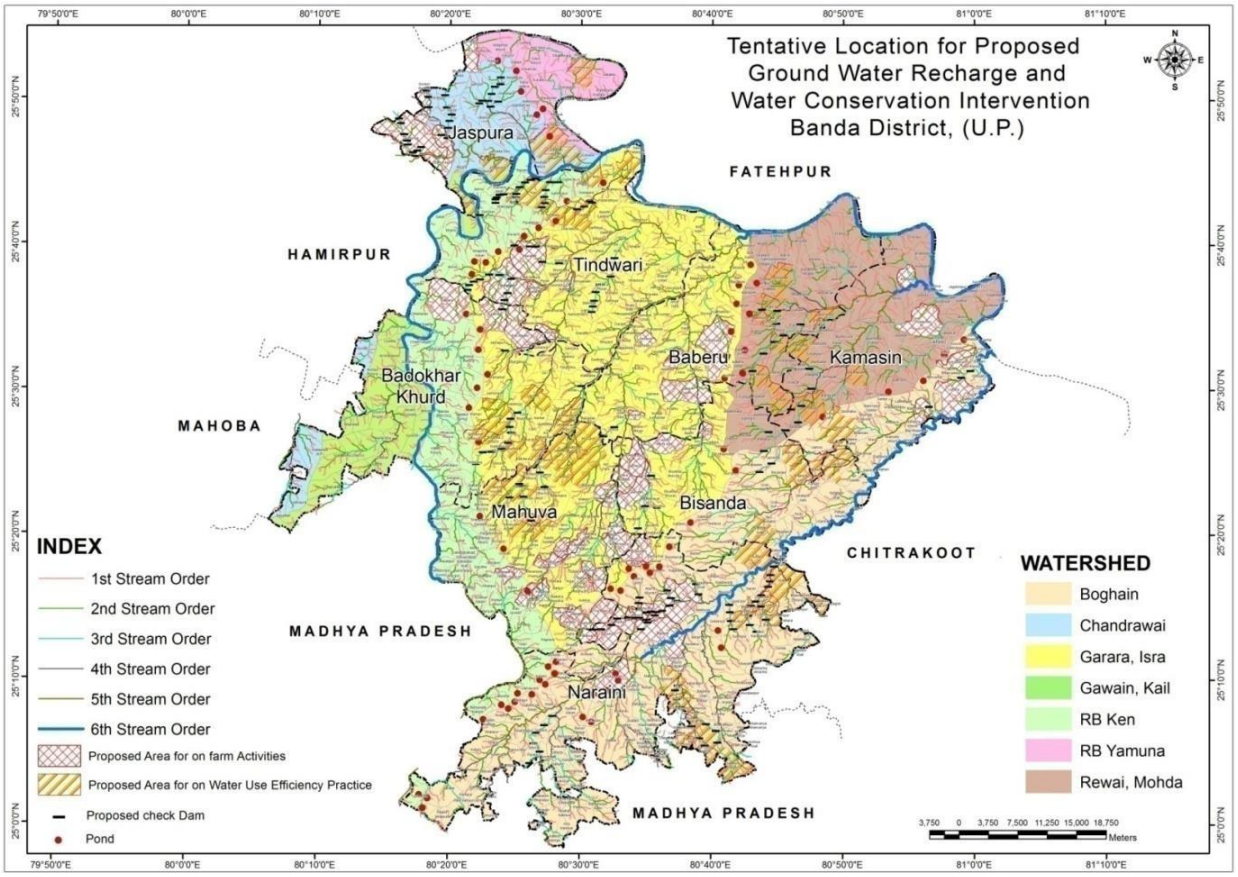


Figure 23: Tentative Ground Water Recharge and Conservation Structures

7.0 BLOCKWISE GROUND WATER MANAGEMENT PLAN OF BANDA DISTRICT

1. General Information: Badokhar Khurd

State Name	Uttar Pradesh
District name	BANDA
Block Name	BAROKHARKHURD
BLOCK STATUS AS PER GWRE2017.	BAROKHARKHURD: SAFE
Location	Bundelkhand region of Uttar Pradesh
Geographical area	671.62 sq km
Basin/Sub-basin	Yamuna/Ken
Principal Aquifer System	Banda Alluvium (marginal)
Major Aquifer System	Banda alluvium overlying Bundelkhand granite
Normal Annual Rainfall	902 mm

Aquifer Disposition

Three figures are required Showing aquifer disposition (Fig. 20 – Fig.21)

Aquifer Disposition	Two aquifer groups exist. • Aquifer Group I (Marginal Alluvium/weathered residuum): : Exploration depth:20 to 90mbgl Aquifer Group II: Fractured Bundelkhand granite Exploration depth: 20 to 200mbgl.
Groundwater Monitoring Status	Ground Water Monitoring Wells: 03(NHS) as on January2020.
Ground Water Quality	Aquifer Group-I (Marginal Alluvium): Suitable for domestic, drinking, irrigation and Industrial purpose. Aquifer Group– II: Ground Water is fresh and potable in general with sporadic saline pockets.
Aquifer Potential	Aquifer Group I (Marginal Alluvium): 1000 -2000 lpm Aquifer Group II :30 to 500 LPM
Groundwater Resource	Annual Extractable Ground Water:89.66 MCM Annual Ground Water extraction for all uses:59.15 MCM Stage of GW Extraction:65.97% Total in-storage resource up to 200m for the block is:1241.71 MCM
Existing and Future Water Demand	Present demand for All Usage: 59.15MCM • Net Ground water availability for future use:27.26 MCM

Aquifer Management Plan

<table>
<tr><td>Groundwater Management issues</td><td colspan="2">• Increase in Ground water extraction structures for irrigation and domestic use.
• Lack of awareness in stakeholders leading to very low demand side management efforts.
• Leading to decline in water levels in some parts.
• Locating feasible sites for successful wells.
• Lack of village level data on water requirement for irrigation and domestic work.</td></tr>
<tr><td>Artificial Recharge & Conservation Possibilities</td><td colspan="2">Construction of Recharge Structures. Adoption of water use efficiency practices and conservation structures(ponds)</td></tr>
<tr><td>Groundwater Management Plan</td><td colspan="2">SUPPLY SIDE MANAGEMENT: Promoting watershed approach towards soil &Water conservation to reduce surface runoff and increase recharge to ground water. Promoting on farm activities. (With emphasis on construction of farm Ponds and Peripheral bunding).Infrastructure development oriented rain water harvesting ponds (Road, Railway and Canal) should also be encouraged.
Intensive Public interaction Programme and data collection at village level for stake holder mapping on land and water use to be carried out.
DEMAND SIDE MANAGEMENT: Adoption of techniques to enhance water Use Efficiency viz sprinkler, drip irrigation and better choice of crops(more crop per drop)
Community led initiative in water resource management.</td></tr>
<tr><td>Status of GW Exploration</td><td colspan="2">Exploratory Wells:08
Observation Wells:03
Piezometer :nil
Shallow well: 1</td></tr>
<tr><td>Aquifer Characteristics</td><td colspan="2">Aquifer Group I (Marginal Alluvium):
Transmissivity 1000-3000 m2/day
Storativity :2.33 X 10-4
Aquifer Group II: Transmissivity NA
Storativity :NA</td></tr>
<tr><td colspan="2" rowspan="2">• Net GW Augmentation Potential (Recharge + Supplemental Irrigation or Saving) :=10.78MCM =1078Ham</td><td>• 15% Proposed to be Allocated for Drinking Water:162Ham
• Population to be benefited considering 70 lpcd = 63405</td></tr>
<tr><td>• 85% Proposed to be Allocated for Irrigation:916Ham
• Area to be brought under irrigation considering 0.40m as Delta factor:2290Ha</td></tr>
</table>

Ground water Related Issues and Management Options

Supply side management

- Issue High runoff and erratic rainfall
- Suggested Interventions
  - Surface water storage structures viz. dams/ponds/ percolation tanks, gully plugs, nala bunds, gabion structures
- Issue : High base flow
- Suggested Interventions : Studies at micro-watershed level and construction of Subsurface dykes
- Issues : Siltation of surface water bodies
- Suggested Interventions :Desiltation of streams/ nalas,Restoration/ revival/ reconstruction of existing Ponds/ tanks/ reservoirs, Catchment treatment through large scale plantation.
  - Large scale Forestation measures

Demand Side Management

- Issues: Inefficient irrigational practices
- Suggested Interventions :
  - Promotion of drip and sprinkler/ piped water irrigation practices to reduce water losses.
  - Farm ponds, on farm activities such as land leveling, peripheral bunds/ trench etc.
  - Catchment treatment and other rainwater harvesting structures.

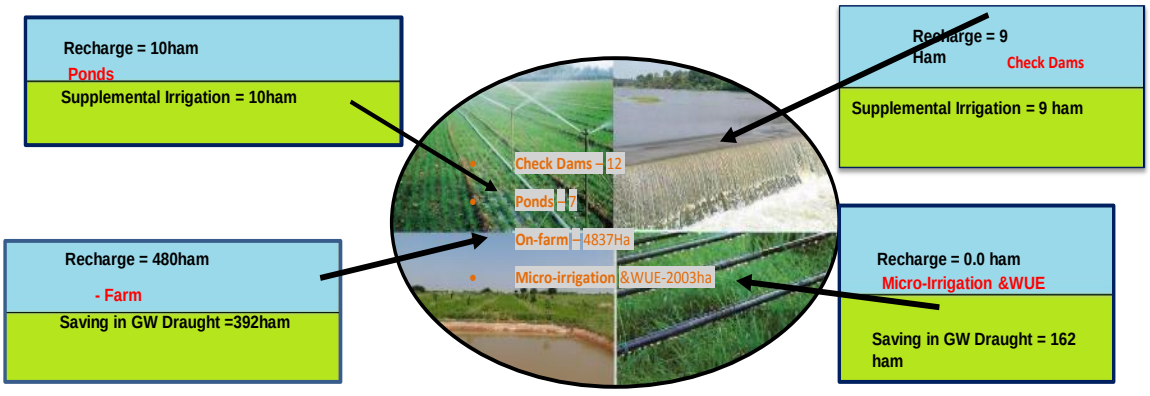
GROUND WATER MANAGEMENT PLAN, BADOKHARKHURD BLOCK, BANDA DISTRICT

BLOCKWISE INTERVENTION STRUCTURES

BLOCK	NO OF CD/NB	NO OF POND/PT	ON FARM AREA(HA)	WUE AREA (HA)
B. KHURD	12	7	4837	2003
TOTAL	12	7	4837	2003

water management strategy

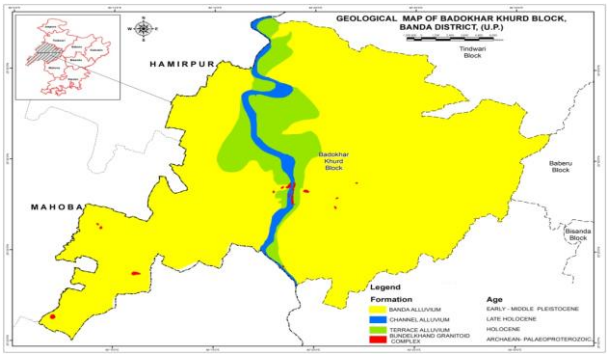
Block	Net annual Extractable GW availability (ham)	Existing gross GW draft for all uses (ham)	Stage of GW development %	Total recharge through intervention (ham)	Total GW saving through interventions (ham)	Projected net Extractable GW availability (ham)	Projected gross GW draft (ham)	Projected stage of GW development post intervention %
B. KHURD	8966	5915	65.97	504	574	9470	5341	56.4
TOTAL	8966	5915	65.97	504	574	9470	5341	56.4



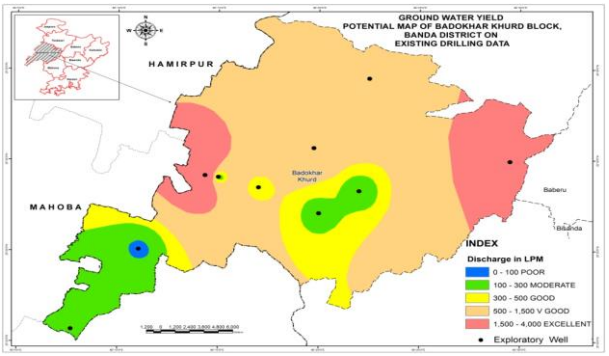
GW Augmentation Potential From Recharge & Saving: 1072 ham

Ground Water Yield Potential

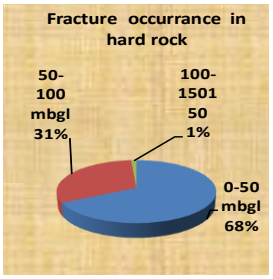
Geology Map



Yield Potential Map

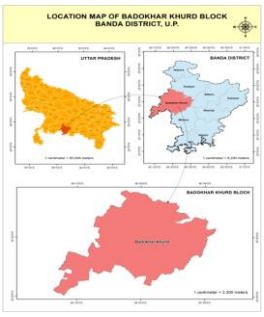


Unit	Topography	Geology	Aquifer Charecteristics				Quality	Remarks
			Aq.Nature	Aq. Type	Exploration Depth (m)	Hydrogeological parameters		
Marginal Alluvium plain	Northerly sloping alluvial plains with hillocks at places and ravines.	Sand, Silt, Clay and Sand of Quarternary age	Unconfined to semi confined	Single	20-90	T(1000-3000) Q(1000-2000lpm)	Good to poor(nitrate and Floride occurance at places	Predominance of finer sediments
Southern highlands	Gentley sloping plateau	Precambrian Vindhyan Sandstone and Limestone and Bundelkhand massif of	Semiconfined	Fractured	20-200	T(5-50) S:2.33X10^{-4} Q(<30-500 lpm)	Good	Success rate is low due to hetrogenetie s

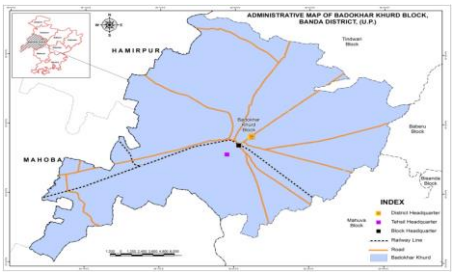


Maps of B.KHURD BLOCK District BANDA as on 2018

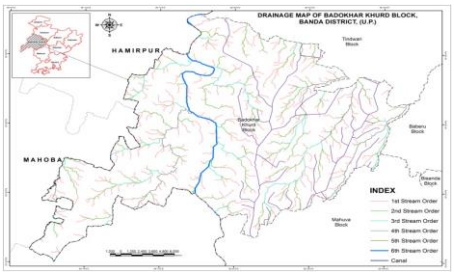
Location Map



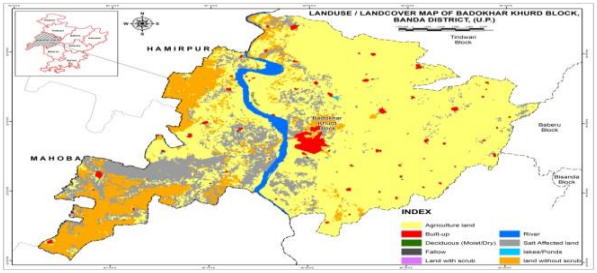
Index Map



Drainage Map



Land Use Map



About

Area: 657.40 SqKm
Population : (Census2011): 199300
Population Density: 303/SqKm
Number of Villages : 77
Net sown area:48366 ha
Gross sown area:59246 ha
Normal Rainfall (mm) : 902
Normal Monsoon Rainfall (mm): 800
G.Water irrigated area:81%

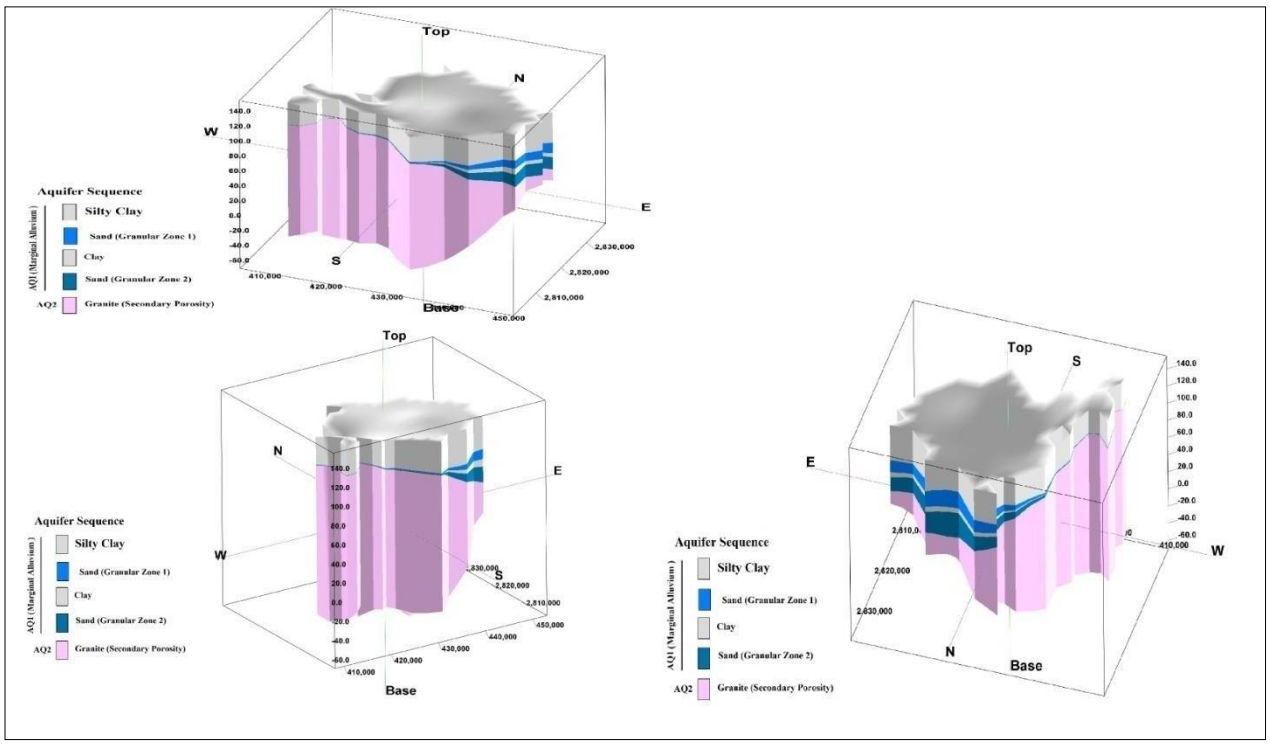
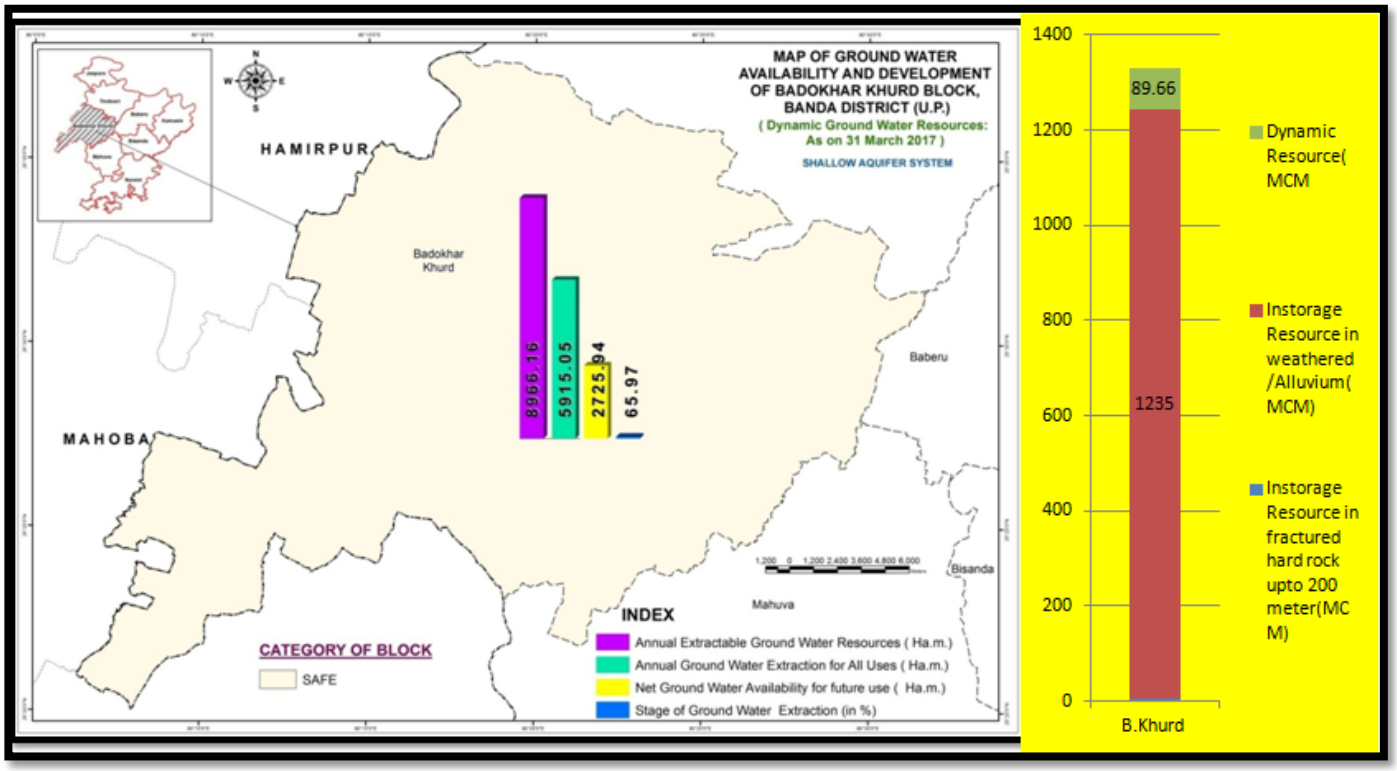


Figure 24: 3D Presentation of Aquifer Disposition in Block B.Khurd Based On Existing Exploratory Data



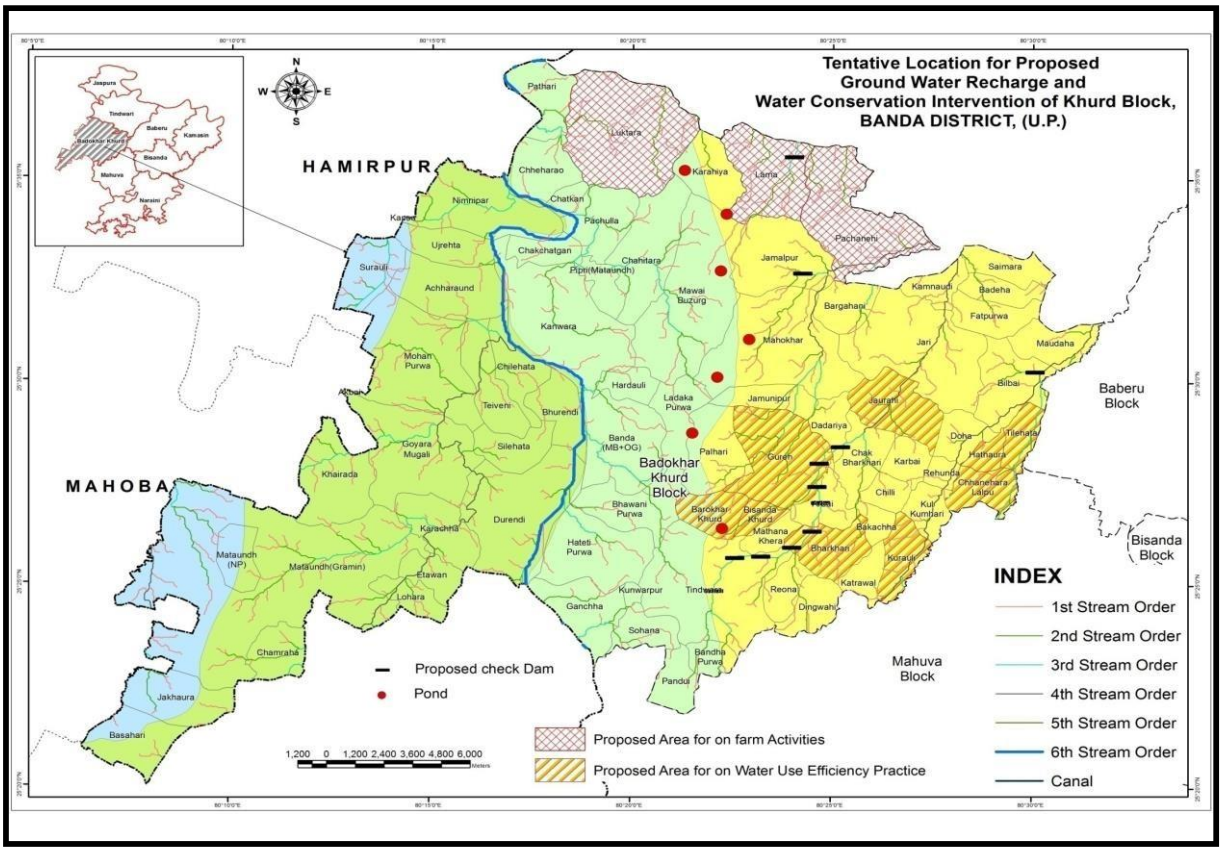


Figure 25: Tentative Locations of Demand and Supply-Side Management Interventions

2. General Information: Jaspura

State Name	Uttar Pradesh
District name	BANDA
Block Name	JASPURA
BLOCK STATUS AS PER GWRE2017.	JASPURA: SEMICRITICAL
Location	Bundelkhand region of Uttar Pradesh
Geographical area	317.96 sq. km
Basin/Sub-basin	Yamuna
Principal Aquifer System	Alluvium (marginal)
Major Aquifer System	Varanasi Alluvium overlying Bundelkhand granite
Normal Annual Rainfall	902 mm

Aquifer Disposition

Aquifer Disposition	Two aquifer groups exist. • Aquifer Group I (Marginal Alluvium): Transmissivity 1000-3000 m2/day Storativity: ND : Exploration depth up to 150 m. Aquifer Group II: Fractured basement, not explored
Groundwater Monitoring Status	Ground Water Monitoring Wells: NIL (NHS) as on January2020.
Ground Water Quality	Aquifer Group-I (Marginal Alluvium): Suitable for domestic, drinking, irrigation and Industrial purpose. Aquifer Group– II: Not explored.
Aquifer Potential	Aquifer Group I (Marginal Alluvium): 1000 -3000 lpm Aquifer Group II :Not explored
Groundwater Resource	Annual Extractable Ground Water:50.32 MCM Annual Ground Water extraction for all uses:42.23 MCM Stage of GW Extraction:83.91% Total in-storage resource up to 200m for the block is: 461.17MCM
Existing and Future Water Demand	Present demand for All Usage: 42.23MCM • Net Ground water availability for future use:7.15 MCM

Aquifer Management Plan

Four figures are required Showing aquifer disposition (Fig. 22 – Fig.23)

Groundwater Management issues	• Increase in Ground water extraction structures for irrigation and domestic use. • Lack of awareness in stakeholders leading to very low demand side management efforts. • Leading to decline in water levels in some parts. • Locating feasible sites for successful wells. • Lack of village level data on water requirement for irrigation and domestic work.
Artificial Recharge & Conservation Possibilities	Construction of Recharge Structures. Adoption of water use efficiency practices and conservation structures(ponds)
Groundwater Management Plan	SUPPLY SIDE MANAGEMENT: Extensive afforestation to be carried for soil &Water conservation to reduce surface runoff and increase recharge to ground water. Promoting on farm activities. (With emphasis on construction of farm Ponds and Peripheral bunding). Infrastructure development rain water harvesting ponds should also be encouraged at suitable locations where ever there is road, railway and canal construction. Intensive Public interaction Programme and data collection at village level for stake holder mapping on land and water use to be carried out. DEMAND SIDE MANAGEMENT: Adoption of techniques to enhance water Use Efficiency viz sprinkler, drip irrigation and better choice of crops(more crop per drop) Community led initiative in water resource management.
Status of GW Exploration	Exploratory Wells :01 Observation Wells :nil Piezometer :nil
Aquifer Characteristics	Aquifer Group I (Marginal Alluvium):Explored depth( )Transmissivity 1000-3000 m2/day Storativity :8.5 X 10-5 Aquifer Group II: Not explored.
• Net GW Augmentation Potential (Recharge + Supplemental Irrigation or Saving) :=10.26MCM =1026Ham	• 15% Proposed to be Allocated for Drinking Water: 154Ham • Population to be benefited considering 70 lpcd = 63405
	• 85% Proposed to be Allocated for Irrigation:872Ham Area to be brought under irrigation considering 0.40m as Delta factor:2180Ha

Ground water Related Issues and Management Options

Supply side management

- Issue High runoff and erraticrainfall
- SuggestedInterventions
  - Surface water storage structures viz. dams/ponds/ percolation tanks, gully plugs,nala bunds, gabion structures
- Issue : High baseflow
- Suggested Interventions : Studies at micro-watershed level and construction of Subsurfacedykes
- Issues : Siltation of surface waterbodies
- Suggested Interventions :Desiltation of streams/ nalas,Restoration/ revival/ reconstruction of existing Ponds/ tanks/ reservoirs, Catchment treatment through large scaleplantation.
  - Large scale Forestationmeasures

Demand Side Management

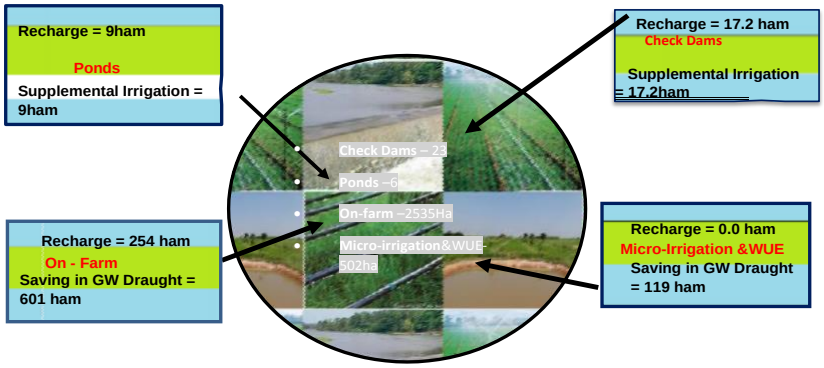
- Issues: Inefficientirrigational practices
- Suggested Interventions:
  - Promotionofdripand sprinkler/ piped water irrigation practices to reduce waterlosses.
  - Farm ponds, on farm activities such as land leveling, peripheral bunds/ trenchetc.
  - Catchment treatment and other rainwater harvestingstructures.

GROUND WATER MANAGEMENT PLAN, JASPURA BLOCK WITH INTERVENTION STRUCTURES

BLOCK	NO OF CD/NB	NO OF POND/PT	ON FARM AREA (HA)	WUE AREA (HA)
JASPURA	23	6	2535	502
TOTAL	23	6	2535	502

Projected stage of ground water development after implementation of suggested Ground water management strategy

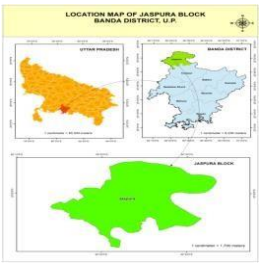
Block	Net annual Extractable GW availability (ham)	Existing gross GW draft for all uses(ham)	Stage of GW development %	Total recharge through intervention (ham)	Total GW saving through interventions (ham)	Projected net Extractable GW availability (ham)	Projected gross GW draft (ham)	Projected stage of GW development post intervention %
JASPURA	5032	4222	83.91	280	746	5312	3476	65.43
TOTAL	5032	4222	83.91	280	746	5312	3476	65.43



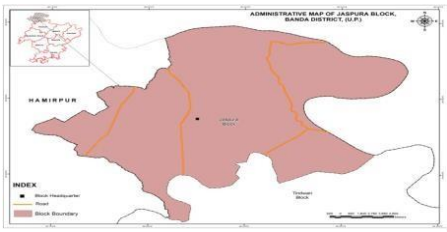
Augmentation Potential from Recharge & Saving: 1026.4ham

Maps of Jaspura Block, Banda District

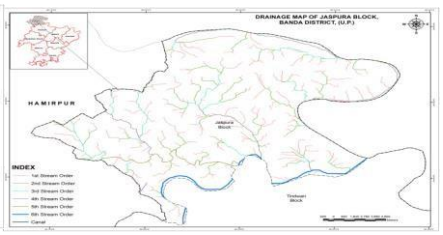
LocationMap

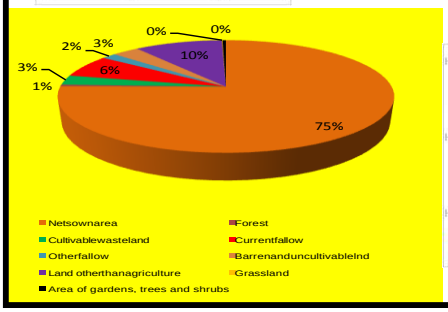


Index MapJaspuraBlock

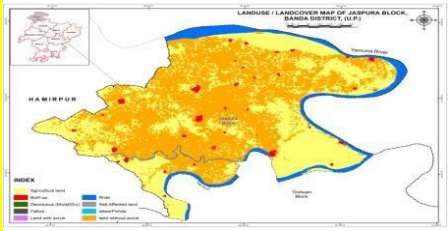


DrainageMap





LAND USE



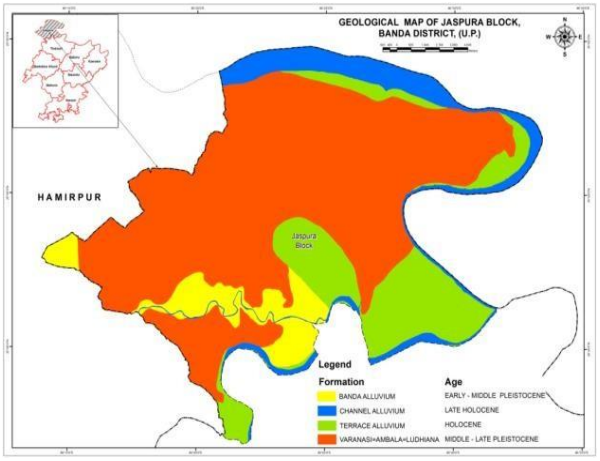
Land use in percentage to total reported area

About

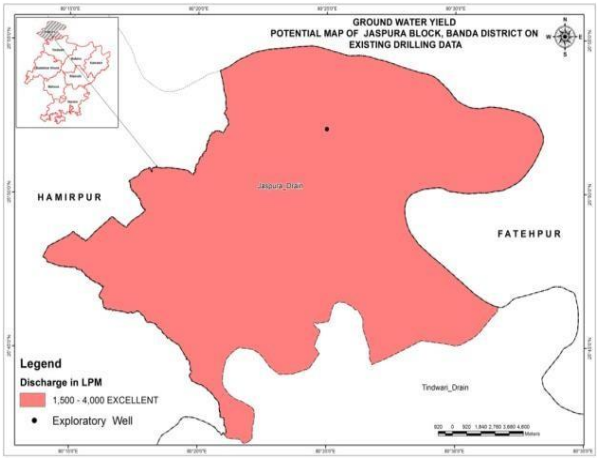
Area: 337.55 SqKm
Population : Census2011): 105180
Population Density: 293/SqKm
Number of Villages : 45
Net sown area: 25351 ha
Gross sown area: 27216 ha
Normal Rainfall (mm) : 902
Normal Monsoon Rainfall (mm): 800
Ground Water irrigated area :99%

Ground Water Yield Potential

Geology Map



Yield Potential Map



Unit	Topography	Geology	Aquifer Charecteristics				Quality	Remarks
			Aq.Nature	Aq. Type	Exploration Depth (m)	Hydrogeological parameters		
Marginal Alluvium plain	Northerly slopingalluvial plains with hillocks at placesand ravines.	Sand, Silt, Clay and Sand ofQuarternary age	Unconfinedto semiconfined	Single	0-150	T(1000-3000) Q(1000-3000lpm) Storativity:8.5x10-5	Good (slightly higher EC at some places)	Predominance of finer sediments and saline water.
Southern highlands	Gently sloping plateau	Precambrian Vindhayan Sandstone and Limestone and Bundelkhand massif of Archean age	Semi confined	Unexplored	unexplored	No data	No data	

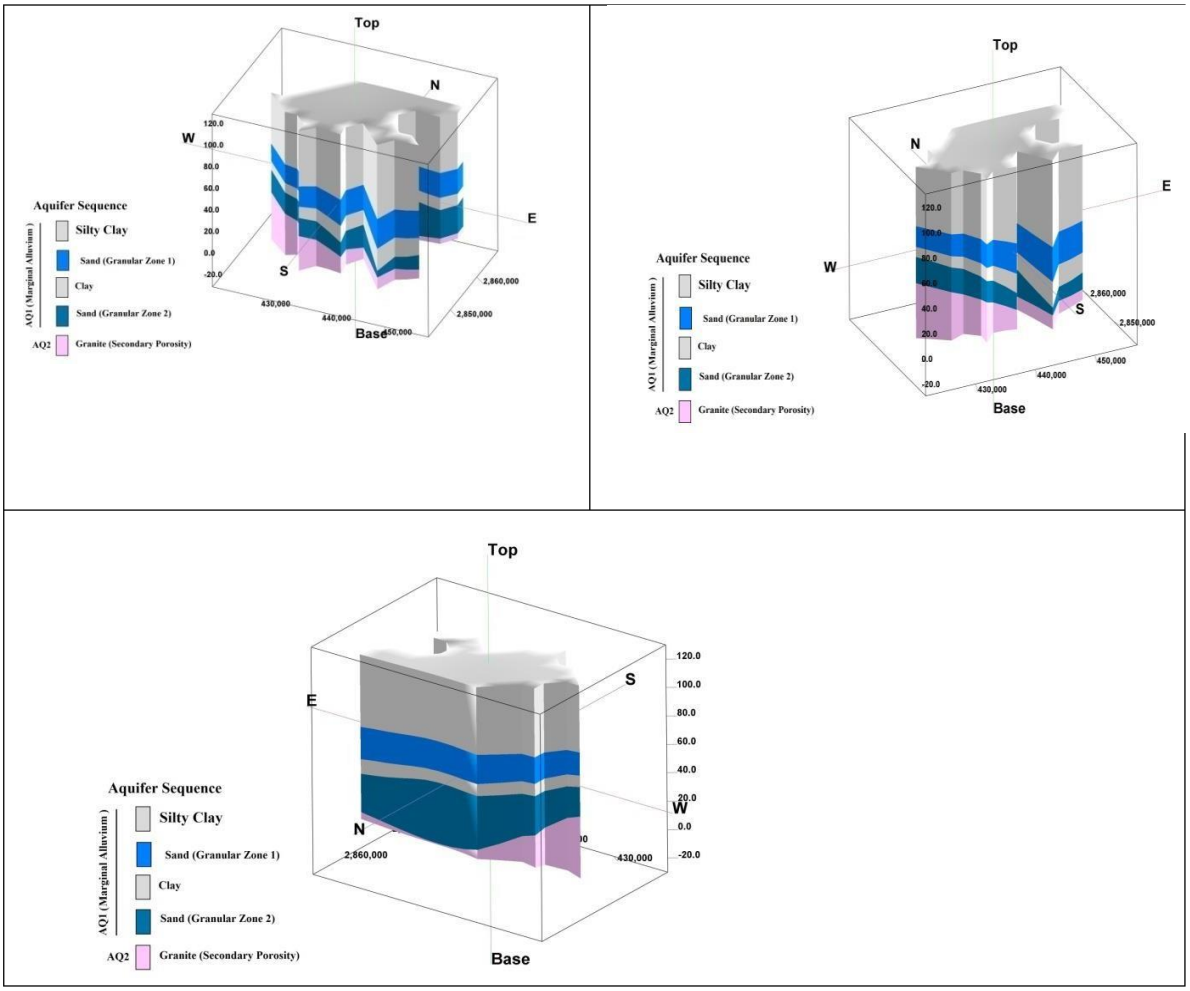
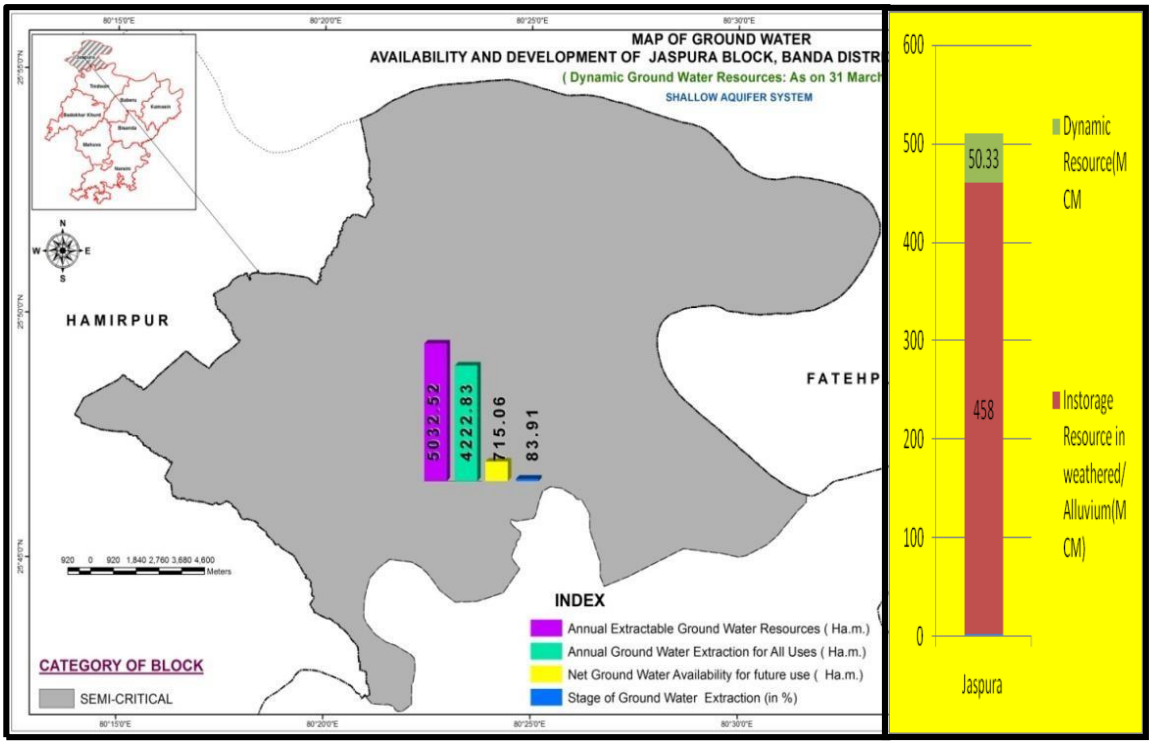


Figure 26: 3D Presentation of Aquifer Disposition In, Jaspura Block, Based On Existing Exploratory Data



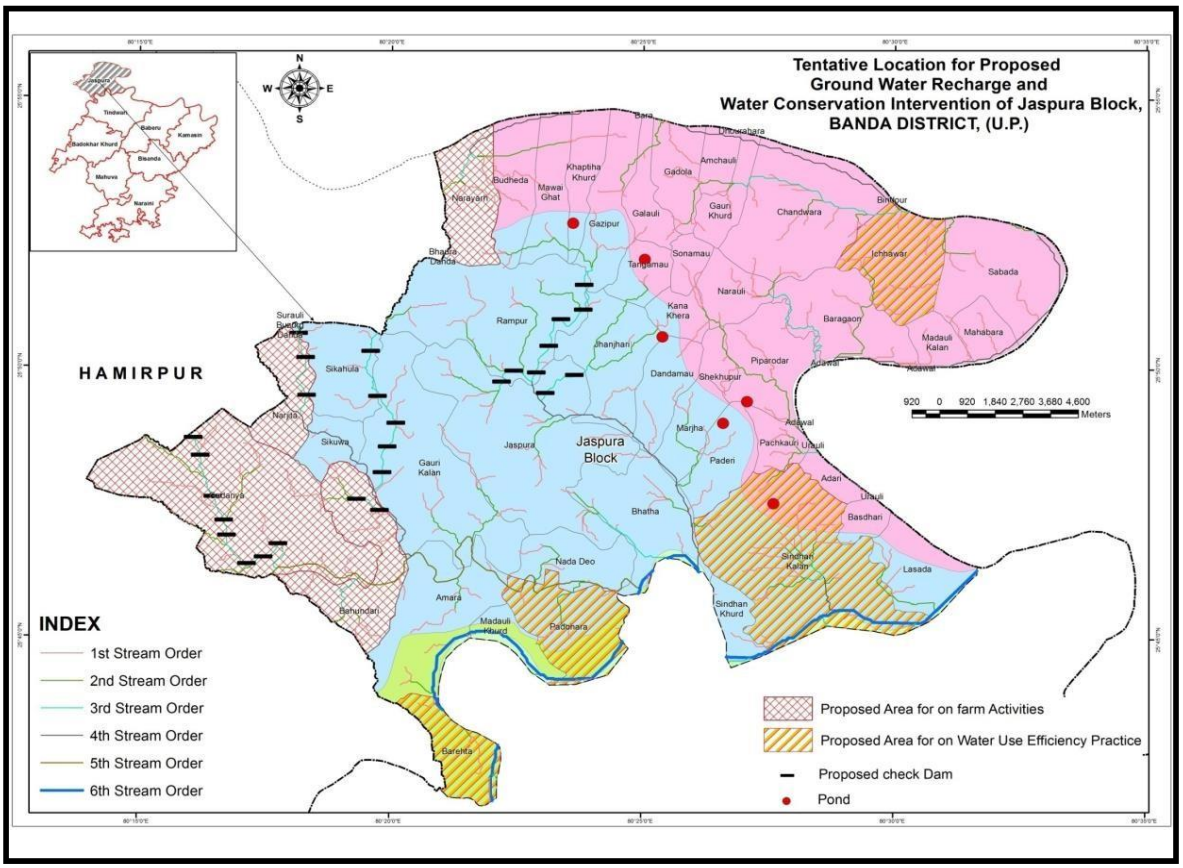


Figure 27: Tentative Locations of Demand and Supply-Side Management Interventions

3. General Information: Mahua

State Name	Uttar Pradesh
District name	BANDA
Block Name	MAHUA
BLOCK STATUS AS PER GWRE2017.	MAHUA: SAFE
Location	Bundelkhand region of Uttar Pradesh
Geographical area	507.74 sq km
Basin/Sub-basin	Yamuna
Principal Aquifer System	Alluvium (marginal)
Major Aquifer System	Banda Alluvium overlying bundelkhand granite
Normal Annual Rainfall	902 mm

Aquifer Disposition
Three figures are required Showing aquifer disposition (Fig. 24 – Fig.25)

Aquifer Disposition	Two aquifer groups exist. • Aquifer Group I (Marginal Alluvium): 15-70mbgl Exploration depth: up to 70m. Specific Yield: up 500lpm. Aquifer Group II: (Fractured Basement underlying marginal alluvium): Exploration depth: 15-200 mbgl.
Groundwater Monitoring Status	Ground Water Monitoring Wells: 01(NHS) as on January2020.
Ground Water Quality	Aquifer Group-I (Marginal Alluvium): Suitable for domestic, drinking, irrigation and Industrial purpose. Aquifer Group– II: Ground Water is fresh and potable.
Aquifer Potential	Aquifer Group I (Marginal Alluvium):No data(cased) Aquifer Group II: ND
Groundwater Resource	Annual Extractable Ground Water:85.59 MCM Annual Ground Water extraction for all uses:38.42 MCM Stage of GW Extraction:44.88% Total in-storage resource up to 200m for the block is:383.07 MCM
Existing and Future Water Demand	Present demand for All Usage: 38.42MCM • Net Ground water availability for future use:44.86 MCM

Aquifer Management Plan

<table>
<tr><td>Groundwater Management issues</td><td colspan="2">• Increase in Ground water extraction structures for irrigation and domestic use.
• Lack of awareness in stakeholders leading to very low demand side management efforts.
• Leading to decline in water levels in some parts.
• Locating feasible sites for successful wells.
• Lack of village level data on water requirement for irrigation and domestic work.</td></tr>
<tr><td>Artificial Recharge & Conservation Possibilities</td><td colspan="2">Construction of Recharge Structures. Adoption of water use efficiency practices and conservation structures(ponds)</td></tr>
<tr><td>Groundwater Management Plan</td><td colspan="2">SUPPLY SIDE MANAGEMENT: Promoting watershed approach towards soil &Water conservation to reduce surface runoff and increase recharge to ground water. Promoting on farm activities. (With emphasis on construction of farm Ponds and Peripheral bunding).Infrastructure development oriented rain water harvesting ponds (Road, Railway and Canal) should also be encouraged.
Intensive Public interaction Programme and data collection at village level for stake holder mapping on land and water use to be carried out.
DEMAND SIDE MANAGEMENT: Adoption of techniques to enhance water Use Efficiency viz sprinkler, drip irrigation and better choice of crops(more crop per drop)
Community led initiative in water resource management.</td></tr>
<tr><td>Status of GW Exploration</td><td colspan="2">Exploratory Wells :01
Observation Wells :nil
Piezometer :nil</td></tr>
<tr><td>Aquifer Characteristics</td><td colspan="2">Aquifer Group I (Marginal Alluvium): No data
Aquifer Group II: Transmissivity: ND
Storativity: ND</td></tr>
<tr><td colspan="2" rowspan="2">• Net GW Augmentation Potential (Recharge + Supplemental Irrigation or Saving) :=3.51MCM =352Ham</td><td>• 15% Proposed to be Allocated for Drinking Water:53Ham
• Population to be benefited considering 70 lpcd = 20743</td></tr>
<tr><td>• 85% Proposed to be Allocated for Irrigation: 298Ham
Area to be brought under irrigation considering 0.40m as Delta factor:745 Ha</td></tr>
</table>

Ground water Related Issues and Management Options

Supply side management

- Issue High runoff and erratic rainfall
- Suggested Interventions
  - Surface water storage structures viz. dams/ponds/ percolation tanks, gully plugs, nala Bunds, gabion structures
- Issue : High baseflow
- Suggested Interventions : Studies at micro-watershed level and construction of Sub-surface dykes
- Issues : Siltation of surface waterbodies
- Suggested Interventions: De-siltation of streams/ nalas, Restoration/ revival/ reconstruction of existing Ponds/tanks/ reservoirs, Catchment treatment through large scale plantation.
  - Large scale Forestation measures

Demand Side Management

- Issues: Inefficientirrigational Practices
- Suggested Interventions:
  - Promotion of drip and sprinkler/ piped water irrigation practices to reduce water losses.
  - Farm ponds, on farm activities such as land leveling, peripheral bunds/ trenched.
  - Catchment treatment and other rainwater harvesting structures.

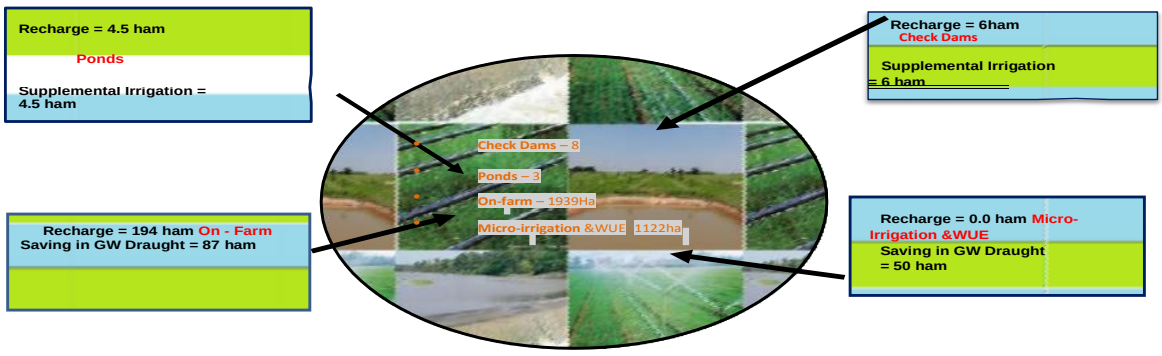
GROUND WATER MANAGEMENT PLAN, MAHUA BLOCK, BANDA DISTRICT
BLOCKWISE INTERVENTION STRUCTURES

Projected stage of groundwater development after implementation of suggested ground water management strategy

BLOCK	NO OF CD/NB	NO OF POND/PT	ON FARM AREA(HA)	WUE AREA (HA)
MAHUA	8	3	1939	1122
TOTAL	8	3	1939	1122

GW Augmentation Potential From Recharge & Saving: 352 ham

Block	Net annual Extractable GW availability (ham)	Existing gross GW draft for all uses (ham)	Stage of GW Development %	Total recharge through intervention (ham)	Total GW saving through interventions (ham)	Projected net Extractable GW availability(ham)	Projected gross GW draft (ham)	Projected stage of GW development post intervention %
MAHUA	8559	3841	44.88	204	147	8763	3694	42.15
TOTAL	8559	3841	44.88	204	147	8763	3694	42.15



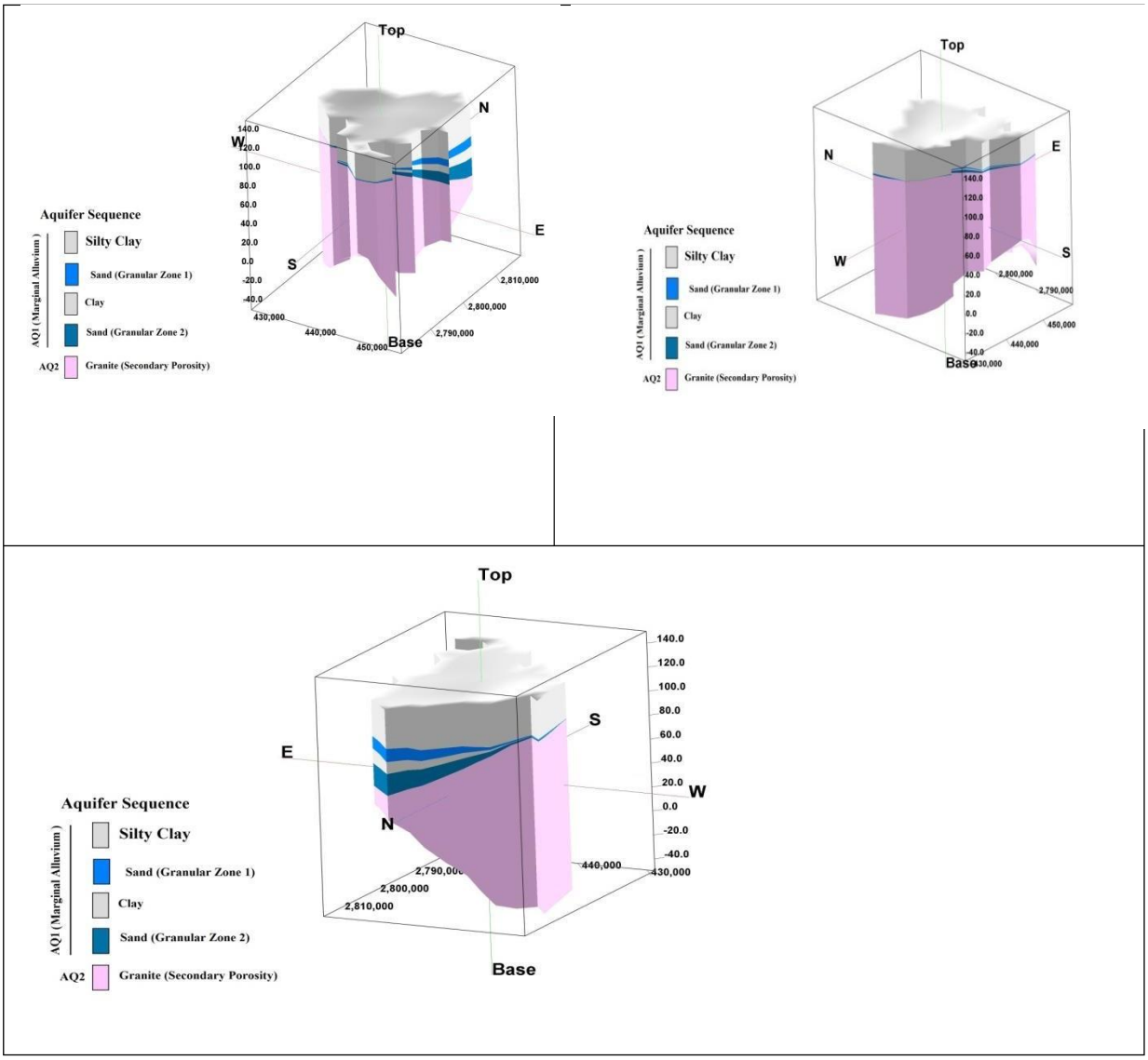
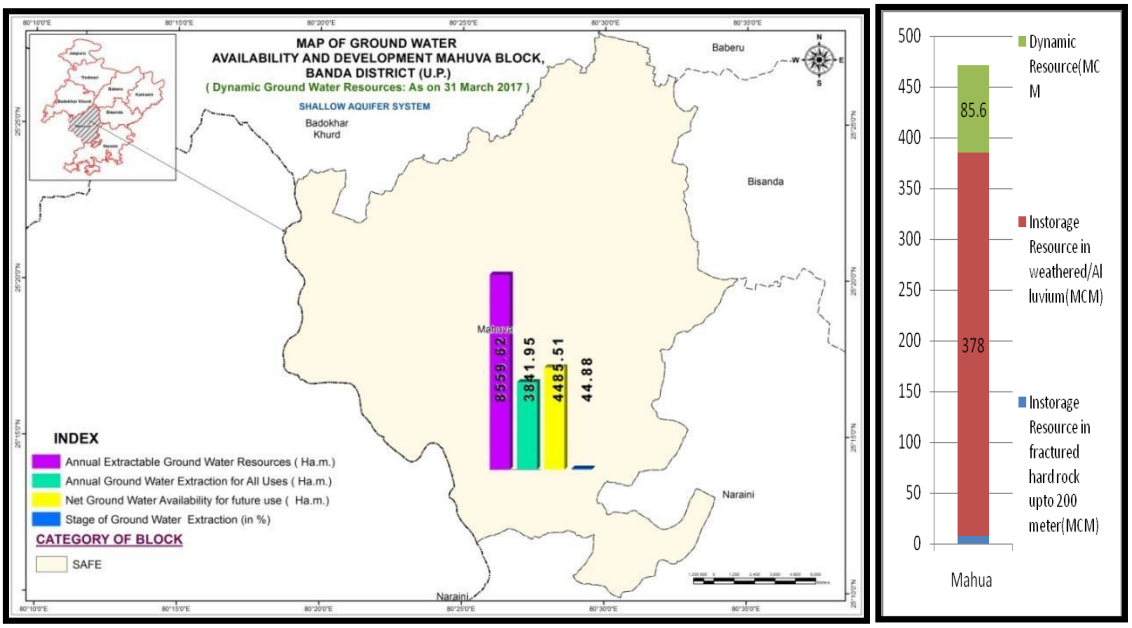


Figure 28: 3D Presentation of Aquifer Disposition In, Mahua Block, Based On Existing Exploratory Data



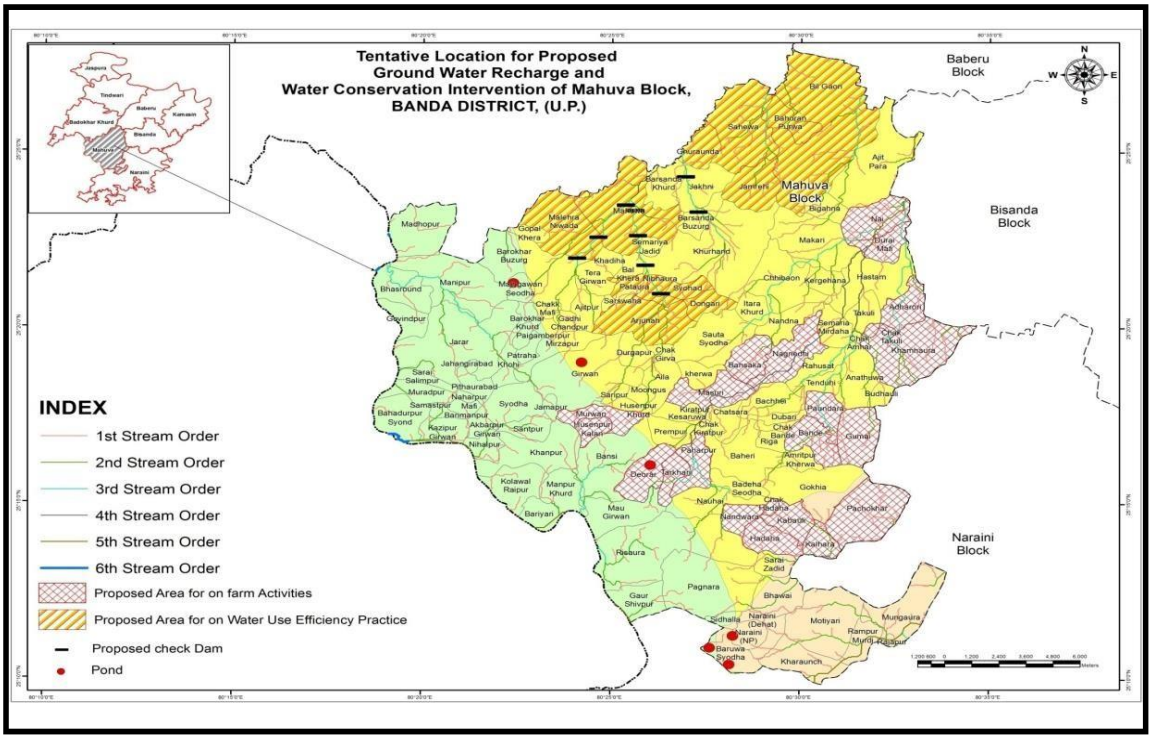


Figure 29: Tentative Locations of Demand and Supply-Side Management Interventions

4. General Information: Naraini Block

State Name	Uttar Pradesh
District name	BANDA
Block Name	NARAINI
BLOCK STATUS AS PER GWRE2017.	NARAINI: SEMICRITICAL
Location	Bundelkhand region of Uttar Pradesh
Geographical area	798.63 sq. km
Basin/Sub-basin	Yamuna/Ken
Principal Aquifer System	Banda alluvium overlying Bundelkhand Granite
Major Aquifer System	Fractured Bundelkhand granite
Normal Annual Rainfall	902 mm

Aquifer Disposition
Three figures are required Showing aquifer disposition (Fig. 26 – Fig.27)

Aquifer Disposition	Two aquifer groups exist. • Aquifer Group I (Marginal Alluvium/Weathered residum): Depth range:5 mbgl to 30 mbgl cased Specific Yield:0.015 Aquifer II: (Fractured Bundelkhand granite) Exploration depth 5 mbgl to 200 mbgl. uncased Transmissivity 20-50 m2/day
Groundwater Monitoring Status	Ground Water Monitoring Wells: 06(NHS) as on January2020.
Ground Water Quality	Aquifer Group-I (Marginal Alluvium/Weathered residuum): Suitable for domestic, drinking, irrigation and Industrial purpose. Aquifer Group– II: Ground Water is fresh and potable.
Aquifer Potential	Aquifer Group I (Marginal Alluvium): No information as this is cased. Aquifer Group II:(Fractured basement):20 <500 lpm
Groundwater Resource	Annual Extractable Ground Water:52.70 MCM Annual Ground Water extraction for all uses:40.47 MCM Stage of GW Extraction:76.79% Total in-storage resource up to 200m for the block is:115.98MCM
Existing and Future Water Demand	Present demand for All Usage: 40.47MCM • Net Ground water availability for future use:8.35MCM

Aquifer Management Plan

<table>
<tr><td>Groundwater Management issues</td><td colspan="2">• Increase in Ground water extraction structures for irrigation and domestic use.
• Lack of awareness in stakeholders leading to very low demand side management efforts.
• Leading to decline in water levels in some parts.
• Locating feasible sites for successful wells.
• Lack of village level data on water requirement for irrigation and domestic work.</td></tr>
<tr><td>Artificial Recharge & Conservation Possibilities</td><td colspan="2">Construction of Recharge Structures. Adoption of water use efficiency practices and conservation structures(ponds)</td></tr>
<tr><td>Groundwater Management Plan</td><td colspan="2">SUPPLY SIDE MANAGEMENT: Promoting watershed approach towards soil &Water conservation to reduce surface runoff and increase recharge to ground water. Promoting on farm activities. (With emphasis on construction of farm Ponds and Peripheral bunding).Infrastructure development oriented rain water harvesting ponds (Road, Railway and Canal) should also be encouraged. Extensive afforestation to be carried.
Intensive Public interaction Programme and data collection at village level for stake holder mapping on land and water use to be carried out.
DEMAND SIDE MANAGEMENT: Adoption of techniques to enhance water Use Efficiency viz sprinkler, drip irrigation and better choice of crops(more crop per drop)
Community led initiative in water resource management.</td></tr>
<tr><td>Status of GW Exploration</td><td colspan="2">Exploratory Wells :04
Observation Wells :02
Piezometer :nil</td></tr>
<tr><td>Aquifer Characteristics</td><td colspan="2">Aquifer Group I: (Marginal Alluvium): 5 to 30 mbgl (cased)
Specific Yield:0.015
Aquifer II: (Fractured Bundelkhand granite)
Exploration depth 5 mbgl to 200 mbgl.
uncased Discharge: 30 to <700 LPM.
Transmissivity 20-50 m2/day</td></tr>
<tr><td rowspan="2">• Net GW Augmentation Potential (Recharge + Supplemental Irrigation or Saving) :=9.51MCM =951Ham</td><td>• 15% Proposed to be Allocated for Drinking Water:143Ham
• Population to be benefited considering 70lpcd =55968</td></tr>
<tr><td>• 85% Proposed to be Allocated for Irrigation: 808Ham.Area to be brought under irrigation considering 0.40m as Deltafactor:2021Ha</td></tr>
</table>

Ground water Related Issues and Management Options

Supply side management

- Issue High runoff and erratic rainfall
- Suggested Interventions
  - Surface water storage structures viz. dams/ponds/ percolation tanks, gully plugs, nala Bunds, gabion structures
- Issue : High baseflow
- Suggested Interventions : Studies at micro-watershed level and construction of Sub surface dykes
- Issues : Siltation of surface water bodies
- Suggested Interventions: DE siltation of streams/ nalas, Restoration/ revival/ reconstruction of existing Ponds/ tanks/ reservoirs, Catchment treatment through large scale plantation.
  - Large scale Forestation measures

Demand Side Management

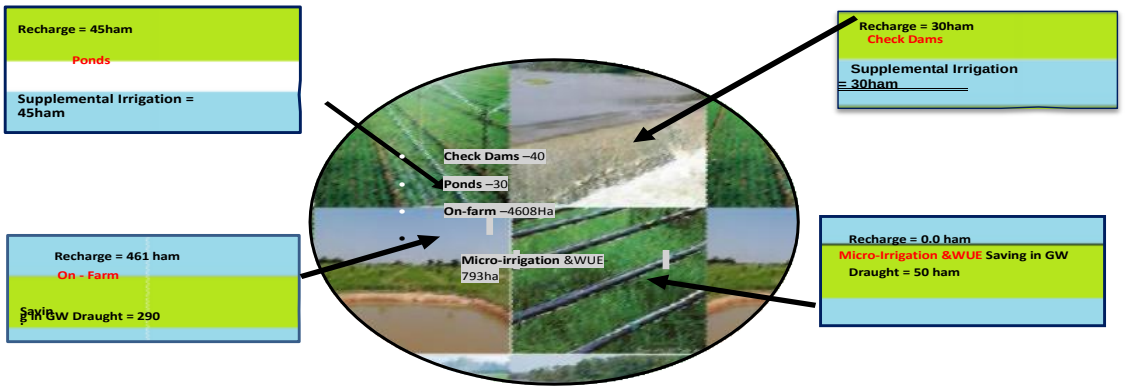
- Issues: Inefficientirrigational Practices
- Suggested Interventions:
  - Promotion of drip and sprinkler/piped water irrigation practices to reduce water losses.
  - Farm ponds, on farm activities such as land leveling, peripheral bunds/ trench etc.
  - Catchment treatment and other rainwater

GROUND WATER MANAGEMENT PLAN, Naraini BLOCK, BANDA DISTRICT
BLOCKWISE INTERVENTION STRUCTURES

BLOCK	NO OF CD/NB	NO OF POND/PT	ON FARM AREA(HA)	WUE AREA (HA)
NARAINI	40	30	4608	793
TOTAL	40	30	4608	793

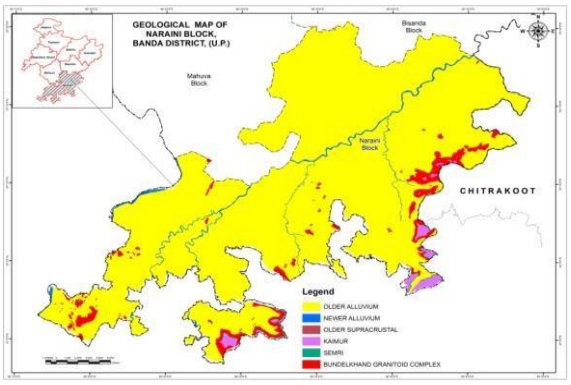
Projected stage of groundwater development after implementation of suggested ground water management strategy

BLOCK	Net annual Extractable GW availability (ham)	Existing gross GW draft for all uses (ham)	Stage of GW development %	Total recharge through intervention (ham)	Total GW saving through interventions (ham)	Projected net Extractable GW availability (ham)	Projected gross GW draft (ham)	Projected stage of GW development post intervention %
NARAINI	5270	4046	76.79	536	415	5806	3631	62.53
TOTAL	5270	4046	76.79	536	415	5806	3631	62.53

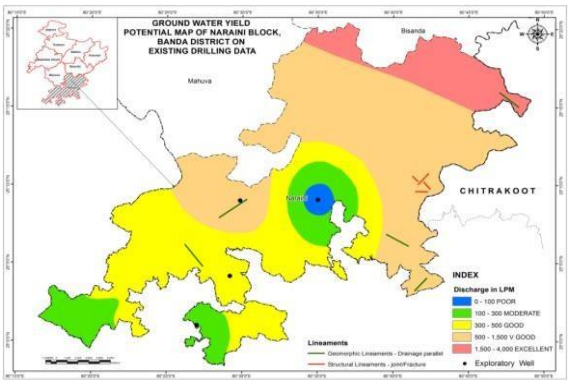


Ground Water Yield Potential

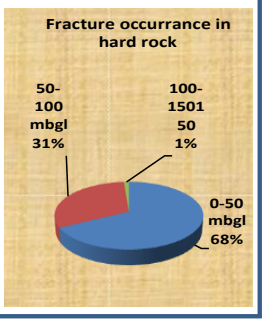
GeologyMap



Yield PotentialMap

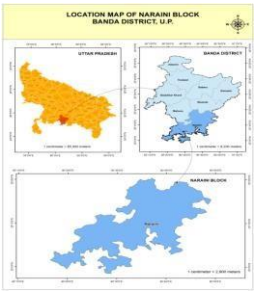


Aquifer Charecteristics								
Unit	Topography	Geology	Aq.Nature	Aq. Type	Exploration Depth(m)	Hydrogeological parameters	Quality	Remarks
Marginal Alluvium plain	Northerly sloping alluvial plains with hillocks at place sand ravines.	Sand, Silt, Clay and Sand of Quarternaryage	Unconfined	Single			Good to Poor (Nitrate occurance at some places)	Predominanceof finer sediments and salinewater.
Southern highlands	Gentley sloping plateau	Precambrian Vindhyan Sandstone, Limestone and Bundelkhand massif of Archean age	Semiconfined	Fractured	5-200	T(20-50) Q(<30-600 lpm)	Good	Success rateis low due to hetrogenety of aquifer. Highyielding wells are connected to positive boundries

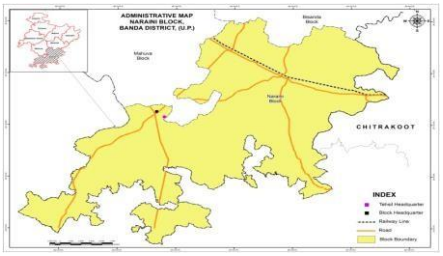


Maps of Naraini block, Banda district

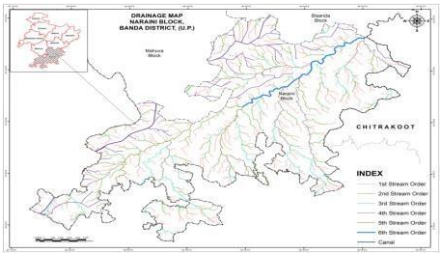
Location Map



Index Map Naraini Block



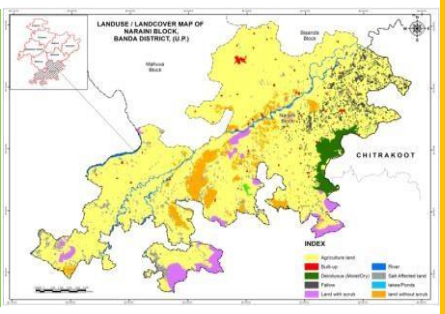
Drainage Map

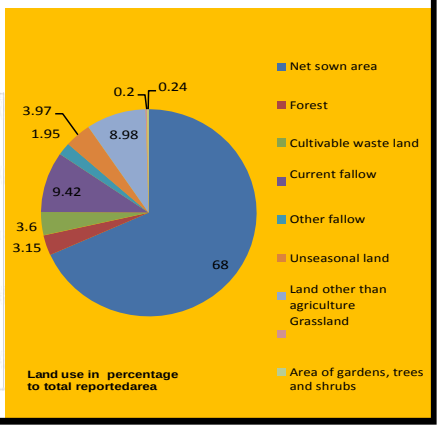


About

Area: 673.14 Sq.Km.
Population: Census2011): 257933
Population Density: 311 Sq.Km.
Number of Villages: 134
Net sown area: 46081 ha
gross sown area: 68302
ha Normal Rainfall (mm):
902
Normal Monsoon Rainfall (mm):
800 Ground Water irrigated area

Land use





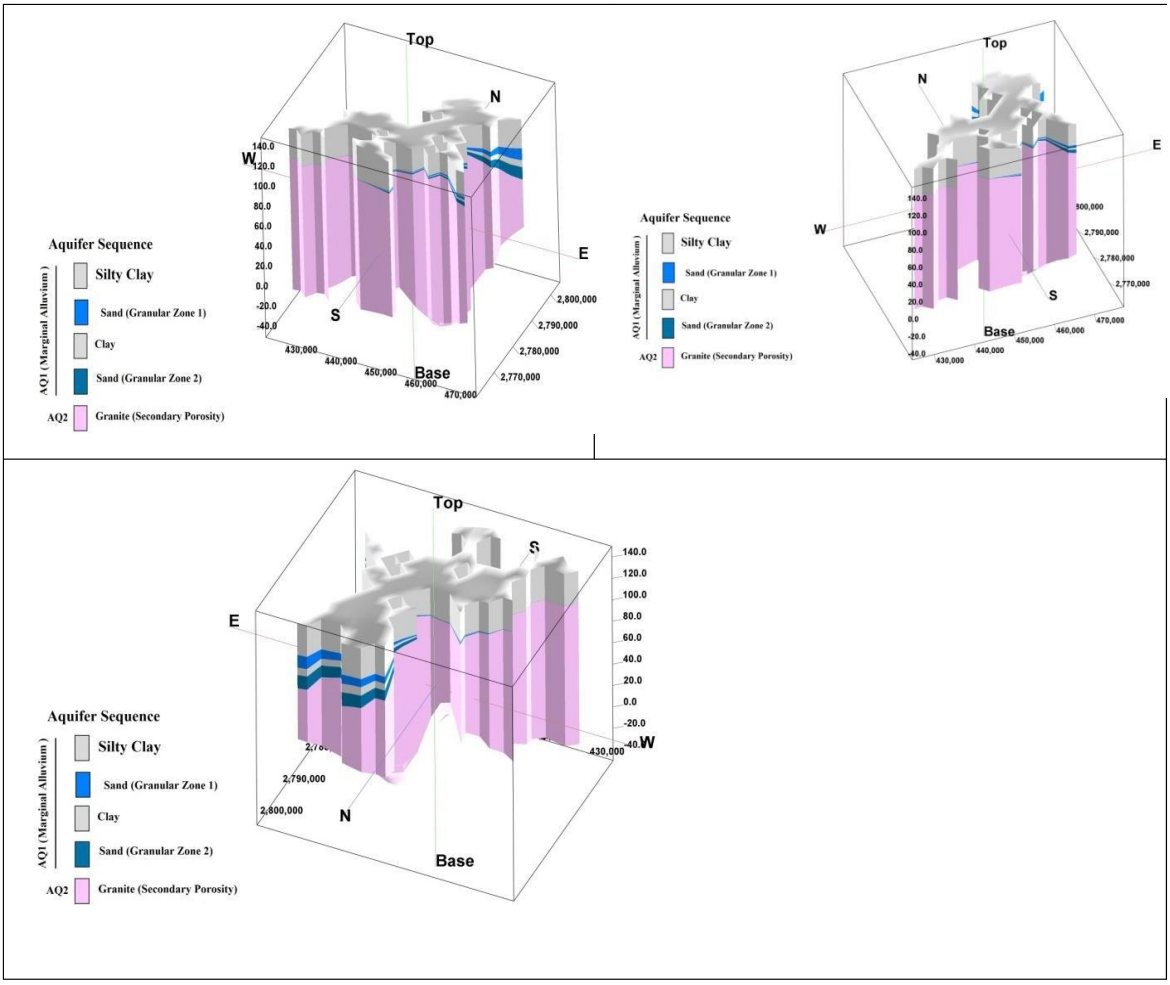
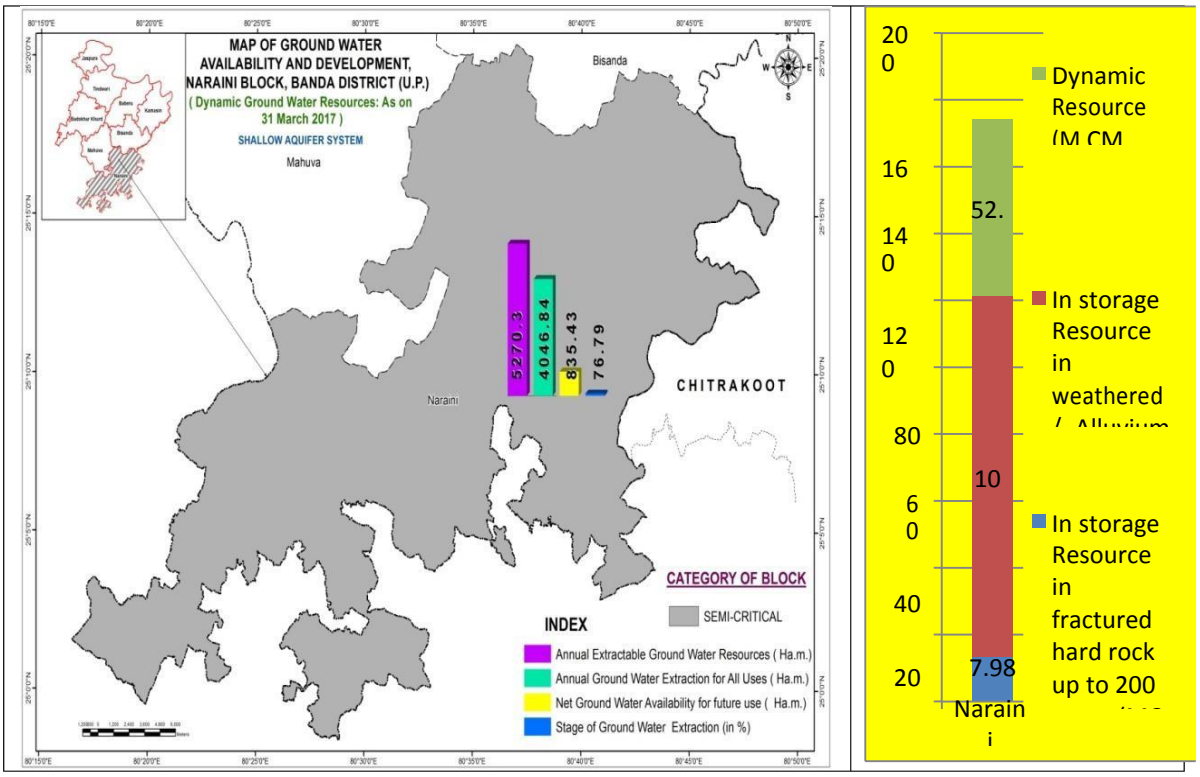


Figure 30: 3D Presentation of Aquifer Disposition In, Naraini Block, Based on Existing Exploratory Data



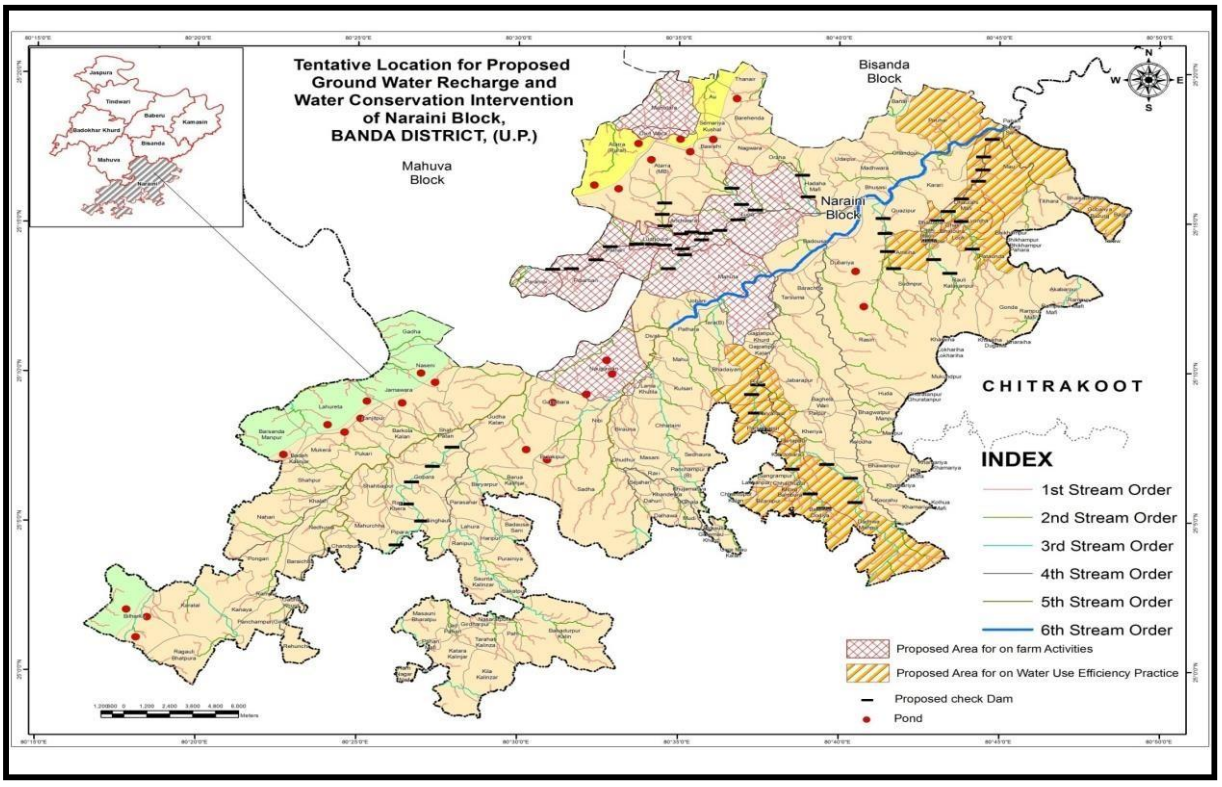


Figure 31: Tentative Locations of Demand and Supply-Side Management Interventions

5. General Information: Tindwari

State Name	Uttar Pradesh
District name	BANDA
Block Name	TINDWARI
BLOCK STATUS AS PER GWRE2017.	TINDWARI: SEMICRITICAL
Location	Bundelkhand region of Uttar Pradesh
Geographical area	540.91 sq km
Basin/Sub-basin	Yamuna
Principal Aquifer System	Alluvium (marginal)
Major Aquifer System	Banda Alluvium overlying Bundelkhand granite
Normal Annual Rainfall	902 mm

Aquifer Disposition

Three figures are required Showing aquifer disposition (Fig. 28 – Fig.29)

Aquifer Disposition	Two aquifer groups exist. • Aquifer Group I (Marginal Alluvium): Specific Capacity: up to 700lpm/m. Storativity: ND : Exploration depth range (60m to 130 mbgl) basement encountered Aquifer Group II: Fractured basement not explored
Groundwater Monitoring Status	Ground Water Monitoring Wells :01(NHS)
Ground Water Quality	Aquifer Group-I (Marginal Alluvium): Suitable for domestic, drinking, irrigation and Industrial purpose. Aquifer Group– II: Not explored
Aquifer Potential	Aquifer Group I (Marginal Alluvium): 1000 -3000 lpm Aquifer Group II (Fractured basement):Not explored
Groundwater Resource	Annual Extractable Ground Water:84.32 MCM Annual Ground Water extraction for all uses:66.23 MCM Stage of GW Extraction:78.55% Total in-storage resource up to 200m for the block is:654.40 MCM
Existing and Future Water Demand	Present demand for All Usage: 66.23 MCM • Net Ground water availability for future use:15.59MCM

Aquifer Management Plan

Groundwater Management issues	• Increase in Ground water extraction structures for irrigation and domestic use. • Lack of awareness in stakeholders leading to very low demand side management efforts. • Leading to decline in water levels in some parts. • Locating feasible sites for successful wells. • Lack of village level data on water requirement for irrigation and domestic work.
Artificial Recharge & Conservation Possibilities	Construction of Recharge Structures. Adoption of water use efficiency practices and conservation structures(ponds)
Groundwater Management Plan	SUPPLY SIDE MANAGEMENT: Extensive afforestation to be carried for soil &Water conservation to reduce surface runoff and increase recharge to ground water. Promoting on farm activities. (With emphasis on construction of farm Ponds and Peripheral bunding). Infrastructure development rain water harvesting ponds should also be encouraged at suitable locations where ever there is road, railway and canal construction. Intensive Public interaction Programme and data collection at village level for stake holder mapping on land and water use to be carried out. DEMAND SIDE MANAGEMENT: Adoption of techniques to enhance water Use Efficiency viz sprinkler, drip irrigation and better choice of crops(more crop per drop) Community led initiative in water resource management.
Status of GW Exploration	Exploratory Wells : 02 Observation Wells :Nil Piezometer :nil
Aquifer Characteristics	Aquifer Group I (Marginal Alluvium):Explored depth( ) Transmissivity 1000-3000 m2/day Storativity :8.5 X 10-5 Aquifer Group II: Not explored.
• **Net GW Augmentation Potential (Recharge + Supplemental Irrigation or Saving) :=14.41MCM =1441Ham**	• 15% Proposed to be Allocated for Drinking Water:202Ham • Population to be benefited considering 70 lpcd =79061
	• 85% Proposed to be Allocated for Irrigation: 1239HamArea to be brought under irrigation considering 0.40m as Delta factor:3098Ha

Ground water Related Issues and Management Options

Supply side management

- Issue High runoff and erraticrainfall
- SuggestedInterventions
  - Surfacewaterstoragestructures viz. dams/ponds/ percolation tanks, gully plugs,nala bunds, gabion structures
- Issue : High baseflow
- Suggested Interventions : Studies at micro-watershedlevelandconstruction of Subsurfacedykes
- Issues : Siltation of surface waterbodies
- Suggested Interventions :Desiltation of streams/ nalas,Restoration/ revival/ reconstructionofexistingPonds/tanks/ reservoirs, Catchment treatment through large scaleplantation.
  - Large scale Forestationmeasures

Demand Side Management

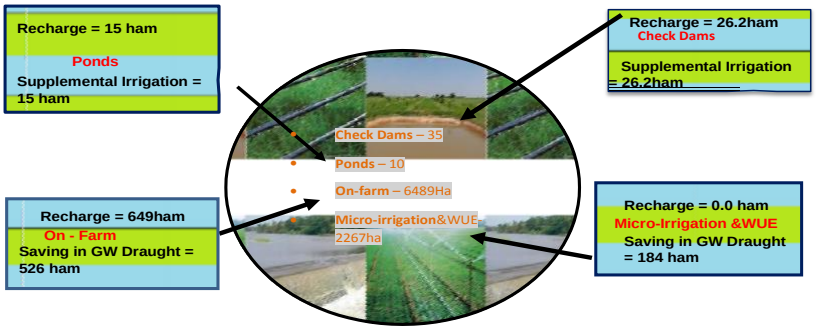
- Issues: Inefficientirrigational practices
- Suggested Interventions:
  - Promotion of drip and sprinkler/ piped water irrigation practices to reduce waterlosses.
  - Farm ponds, on farm activities such as land leveling, peripheral bunds/ trenchetc.
  - Catchment treatment and other rainwater harvestingstructures.

GROUND WATER MANAGEMENT PLAN, Naraini BLOCK, BANDA DISTRICT
BLOCKWISE INTERVENTION STRUCTURES

BLOCK	NO OF CD/NB	NO OF POND/PT	ON FARM AREA (HA)	WUE AREA (HA)
TINDWARI	35	10	6489	2267
TOTAL	35	10	6489	2267

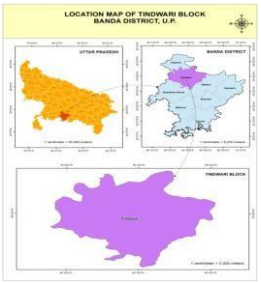
Projected stage of groundwater development after implementation of suggested Ground water management strategy

BLOCK	Net annual Extractable GW availability (ham)	Existing gross GW draft for all uses (ham)	Stage of GW development%	Total recharge through intervention (ham)	Total GW saving through interventions (ham)	Projected net Extractable GW availability (ham)	Projected gross GW draft (ham)	Projected stage of GW development post intervention %
TINDWARI	8431	6622	78.55	690	751	9121	5871	64.32
TOTAL	8431	6622	78.55	690	751	9121	5871	64.32

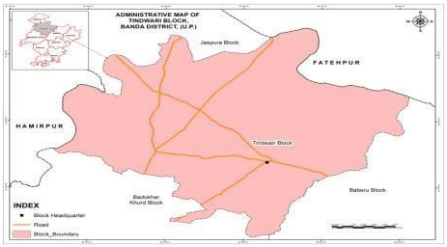


Maps of Tindwari Block, District Banda as on 2018

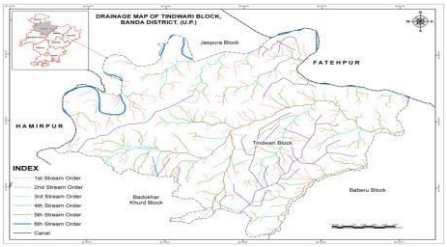
LocationMap



Index MapTindwariBlock



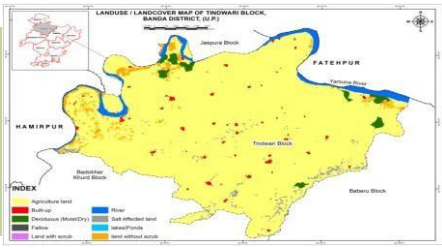
DrainageMap

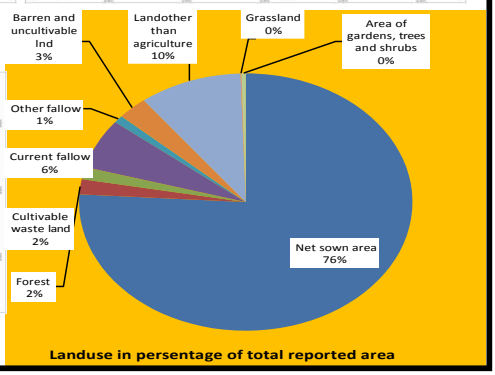


About

Area: 569.80 SqKm
Population: Census2011):178627
Population Density: 301 SqKm
Number of Villages : 89
Net sown area: 43262 ha
Gross sown area: 52556 ha
Normal Rainfall (mm) : 902
Normal Monsoon Rainfall(mm): 800
G.Water irrigated area:91%

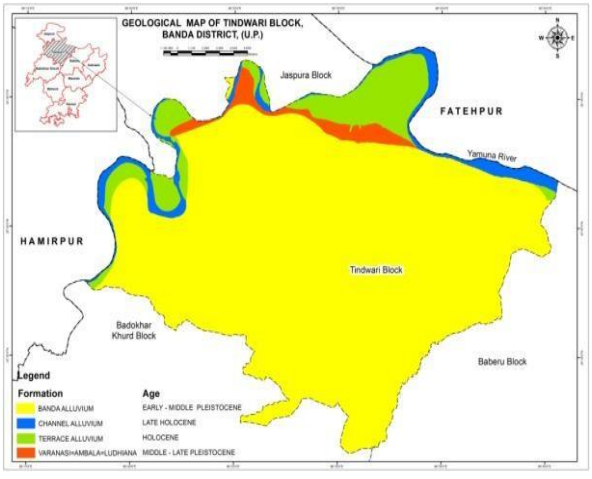
Land Use



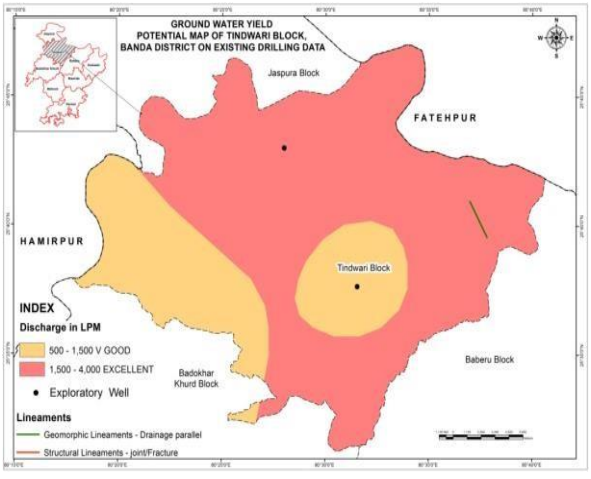


Ground Water Yield Potential

Geology Map



Yield Potential Map



Unit	Topography	Geology	Aquifer Characteristics				Quality	Remarks
			Aq. Nature	Aq. Type	Exploration Depth (m)	Hydrogeological parameters		
Marginal Alluvium plain	Northerly sloping alluvial plains with hillocks at places and ravines.	Sand, Silt, Clay and Sand of Quarternary age	Unconfined to semi confined	Single	60-120	Sp. Capacity: upto 700lmp/m Q(1000-3000lpm)	Good to Poor(Nitrate occurance atsome places)	Predominance of finer sediments and saline water.
Southern highlands	Gentley sloping plateau	Precambrian Vindhyan Sandstone and Limestone and Bundelkhand massif of Archean age	Unconfined	Fractured	unexplored	No data	No data	

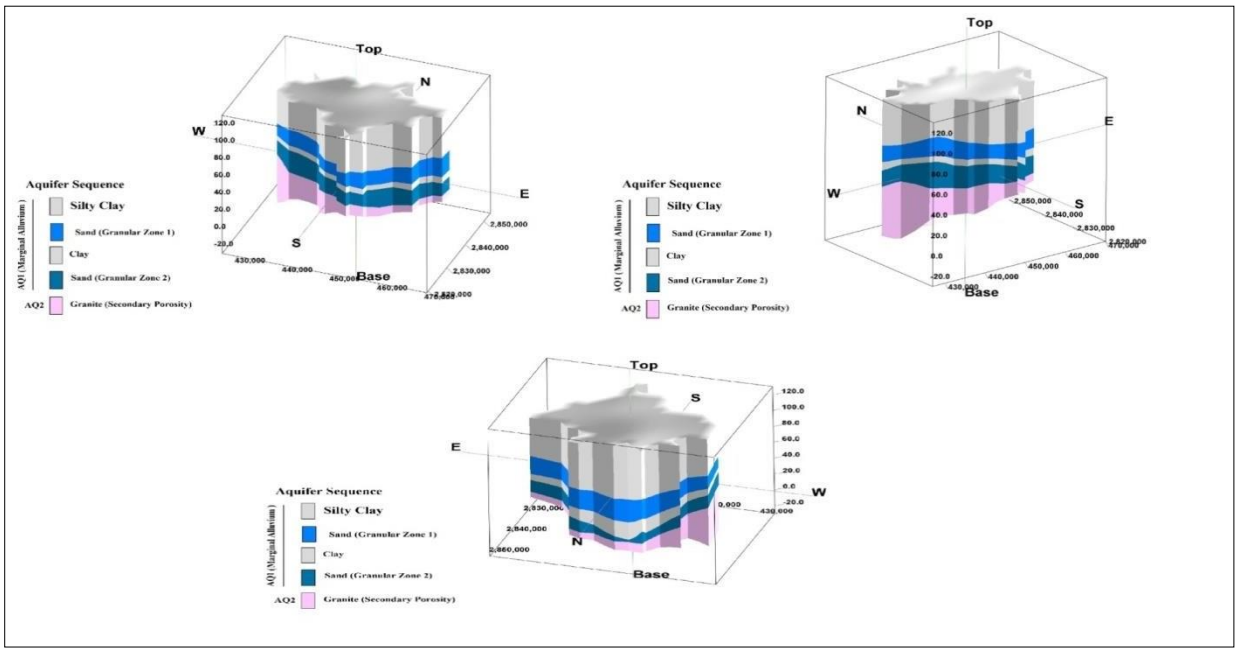
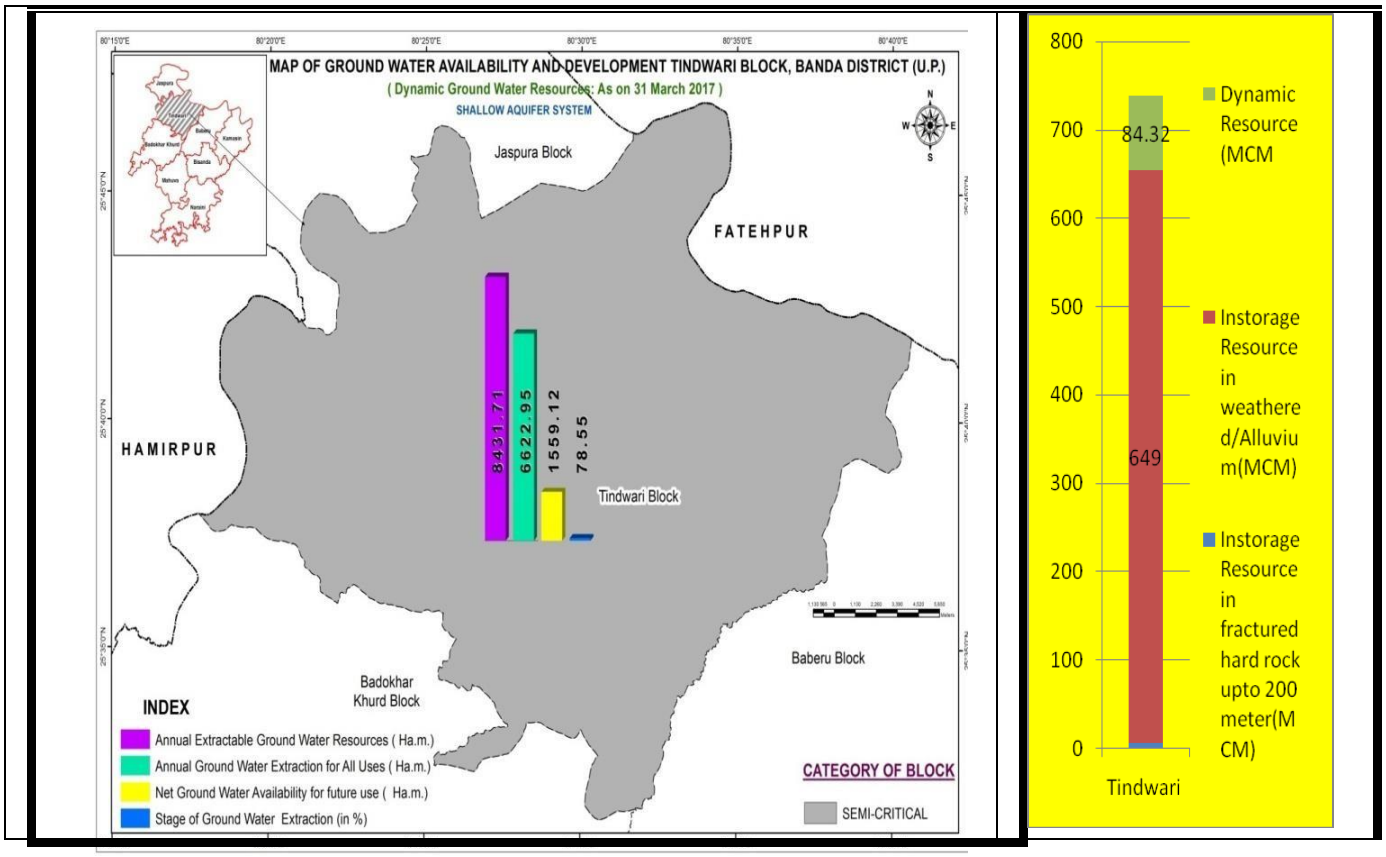


Figure 32: 3D Presentation of Aquifer Disposition In, Tindwari Block, Based On Existing Exploratory Data



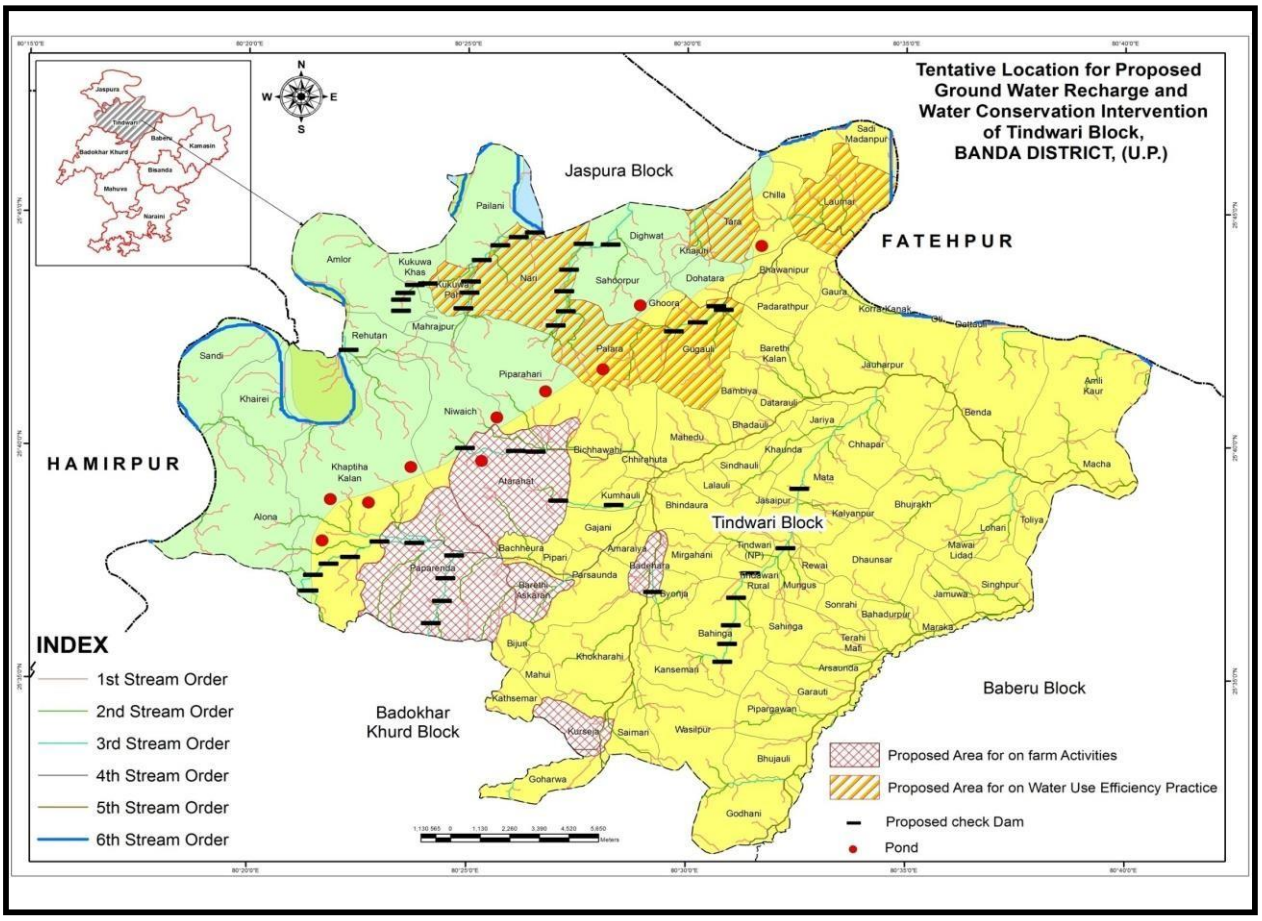


Figure 33: Tentative Locations of Demand and Supply-Side Management Interventions

6. General Information: Bisanda

State Name	Uttar Pradesh
District name	BANDA
Block Name	**BISANDA**
BLOCK STATUS AS PER GWRE2017.	**BISANDA** : SAFE
Location	Bundelkhand region of Uttar Pradesh
Geographical area	474.76 sq. km
Basin/Sub-basin	Yamuna
Principal Aquifer System	Alluvium (marginal)
Major Aquifer System	Banda Alluvium overlying Bundelkhand granite
Normal Annual Rainfall	902 mm

Aquifer Disposition

Aquifer Disposition	Two aquifer groups exist. • Aquifer Group I (Marginal Alluvium): Transmissivity ND Storativity: ND : Exploration depth range: Not Explored Aquifer Group II: Not Explored
Groundwater Monitoring Status	Ground Water Monitoring Wells : 01 (NHS)
Ground Water Quality	Aquifer Group-I (Marginal Alluvium): Suitable for domestic, drinking, irrigation and Industrial purpose. Aquifer Group– II: Not Detected
Aquifer Potential	Aquifer Group I (Marginal Alluvium): Not Detected Aquifer Group II (Fractured basement):Not Detected
Groundwater Resource	Annual Extractable Ground Water:84.32 MCM Annual Ground Water extraction for all uses:66.23 MCM Stage of GW Extraction:78.55% Total in-storage resource up to 200m for the block is:716.74 MCM
Existing and Future Water Demand	Present demand for All Usage: 66.23 MCM • Net Ground water availability for future use:15.59MCM

Aquifer Management Plan

Groundwater Management issues	Increase in Ground water extraction structures for irrigation and domestic use. Lack of awareness in stakeholders leading to very low demand side management efforts. Leading to decline in water levels in some parts. Locating feasible sites for successful wells. Lack of village level data on water requirement for irrigation and domestic work.	
Artificial Recharge & Conservation Possibilities	Construction of Recharge Structures. Adoption of water use efficiency practices and conservation structures(ponds)	
Groundwater Management Plan	SUPPLY SIDE MANAGEMENT: Extensive afforestation to be carried for soil &Water conservation to reduce surface runoff and increase recharge to ground water. Promoting on farm activities. (With emphasis on construction of farm Ponds and Peripheral bunding). Infrastructure development rain water harvesting ponds should also be encouraged at suitable locations where ever there is road, railway and canal construction. Intensive Public interaction Programme and data collection at village level for stake holder mapping on land and water use to be carried out. DEMAND SIDE MANAGEMENT: Adoption of techniques to enhance water Use Efficiency viz sprinkler, drip irrigation and better choice of crops(more crop per drop) Community led initiative in water resource management.	
Status of GW Exploration	Exploratory Wells :Nill Observation Wells : Nill Piezometer :Nill	
Aquifer Characteristics	Aquifer Group I (Marginal Alluvium):Explored depth( ) Transmissivity Not Detected Storativity: Not Detected Aquifer Group II: Not Detected.	
Net GW Augmentation Potential (Recharge + Supplemental Irrigation or Saving) : =3.67MCM =367Ham		15% Proposed to be Allocated for Drinking Water: 55**Ham** Population to be benefited considering 70 lpcd = 21526
		85% Proposed to be Allocated for Irrigation: 312**Ham.** Area to be brought under irrigation considering 0.40m as Delta factor: 780**Ha**

Ground water Related Issues and Management Options

Supply side management

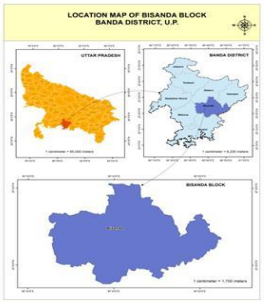
- Issue High runoff and erratic rainfall
- Suggested Interventions
  - Surface water storage structures viz. dams/ponds/ percolation tanks, gully plugs, nala, bunds, gabion structures
- Issue : High baseflow
- Suggested Interventions : Studies at micro-water shed level and construction of Subsurface dykes
- Issues : Siltation of surface water bodies
- Suggested Interventions: Desiltation of streams/ nalas, Restoration/ revival/ reconstruction of existing Ponds/tanks/ reservoirs, Catchment treatment through large scale plantation.
  - Large scale Forestation measures

Demand Side Management

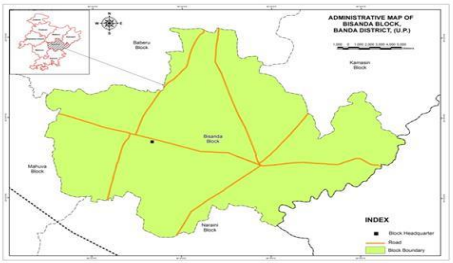
- Issues: Inefficientirrigational Practices
- Suggested Interventions:
  - Promotion of drip and sprinkler/piped water irrigation practices to reduce water losses.
  - Farm ponds, on farm activities such as land leveling, peripheral bunds/ trench etc.
  - Catchment treatment and other rainwater

Maps of Bisanda Block, Banda District

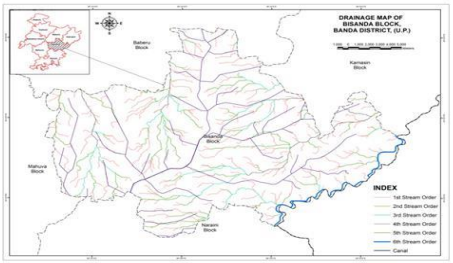
Location Map

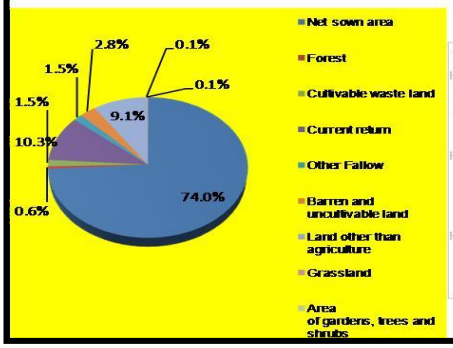


Index Map Bisanda Block

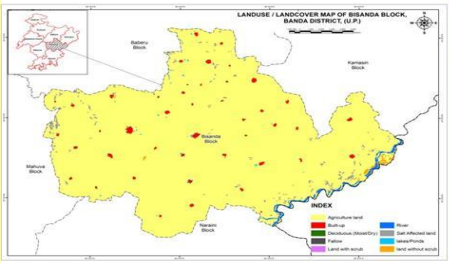


Drainage Map





LAND USE



Land use in percentage to total reported area

About

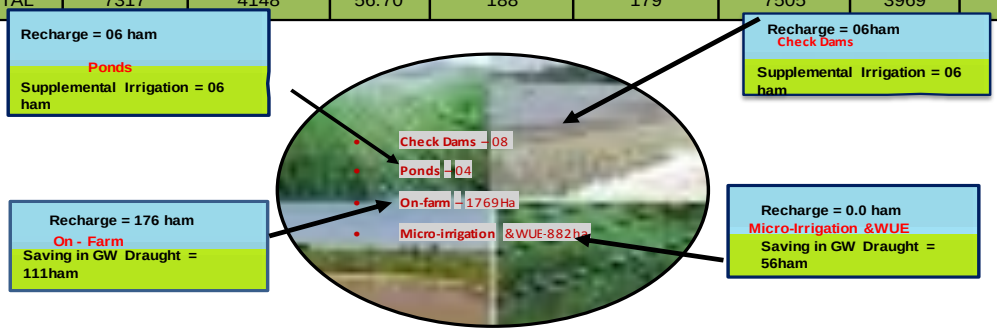
Area: 477.8 SqKm
Population : Census2011): 184494
Population Density: 394.56 SqKm
Number of Villages : 57
Net sown area: 35369
Gross sown area: 57471
Normal Rainfall (mm) : 902
Normal Monsoon Rainfall (mm): 800
Ground Water irrigated area of :

GROUND WATER MANAGEMENT PLAN, BISANDA BLOCK WITH INTERVENTION STRUCTURES

BLOCK	NO OF CD/NB	NO OF POND/PT	ON FARM AREA (HA)	WUE AREA (HA)
BISANDA	8	4	1769	882
TOTAL	8	4	1769	882

Projected stage of ground water development after implementation of suggested ground

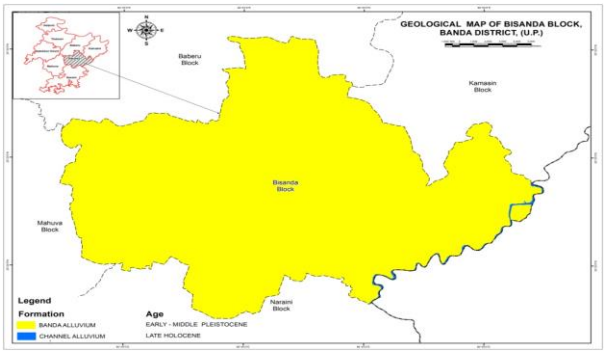
Block	Net annual Extractable GW availability (ham)	Existing gross GW draft for all uses(ham)	Stage of GW developm ent %	Total recharge through intervention (ham)	Total GW saving through interventions (ham)	Projected net Extractable GW availability (ham)	Projected gross GW draft (ham)	Projected stage of GW development post intervention %
BISANDA	7317	4148	56.70	188	179	7505	3969	52.88
TOTAL	7317	4148	56.70	188	179	7505	3969	52.88



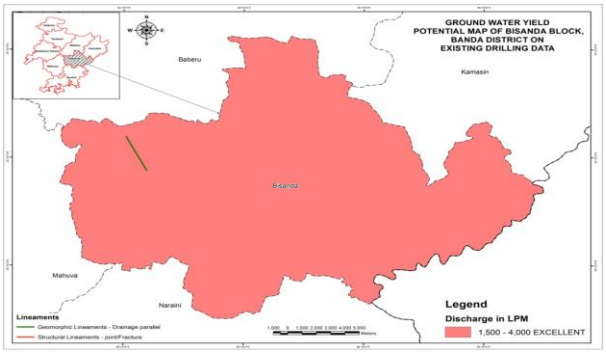
GW Augmentation Potential From Recharge & Saving: 367 ham

Ground Water Yield Potential

Geology Map



Yield Potential Map



Unit	Topography	Geology	Aquifer Charecteristics				Quality	Remarks
			Aq.Nature	Aq. Type	Exploration Depth (m)	Hydrogeological parameters		
Marginal Alluvium plain	Northerly sloping alluvial plains with hillocks at places and ravines.	Sand, Silt, Clay and Sand of Quarternary age	Unconfined to semi confined	Single	Not Detected	Not Detected	Good (slightly higher EC at some places)	Predominance of finer sediments and saline water.
Southern highlands	Gentley sloping plateau	Precambrian Vindhyan Sandstone and Limestone and Bundelkhand massif of Archean age	Semiconfined	Unexplored	unexplored	No data	No data	

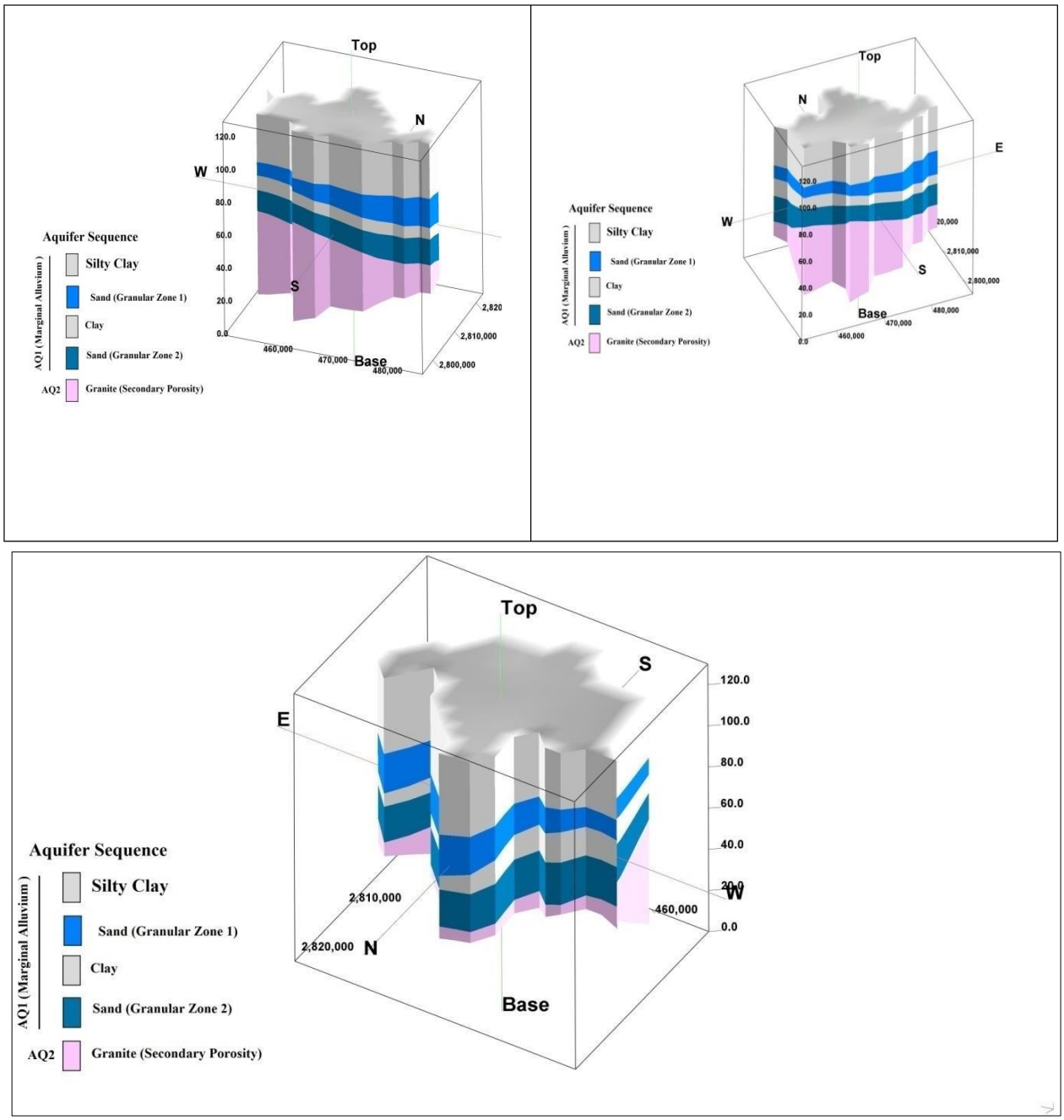
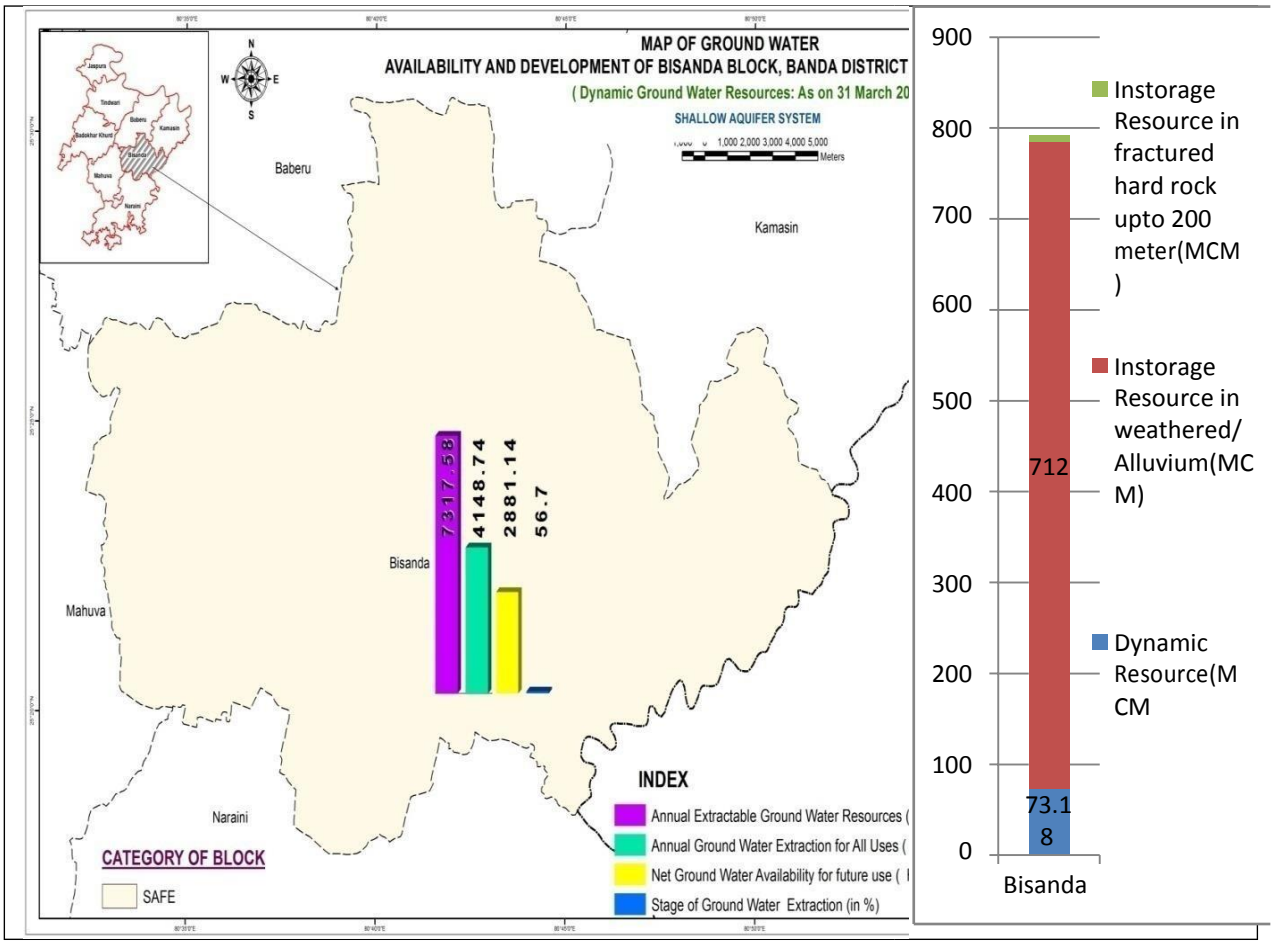


Figure 34: 3D Presentation of Aquifer Disposition in Block Bisanda Based On Existing Exploratory Data



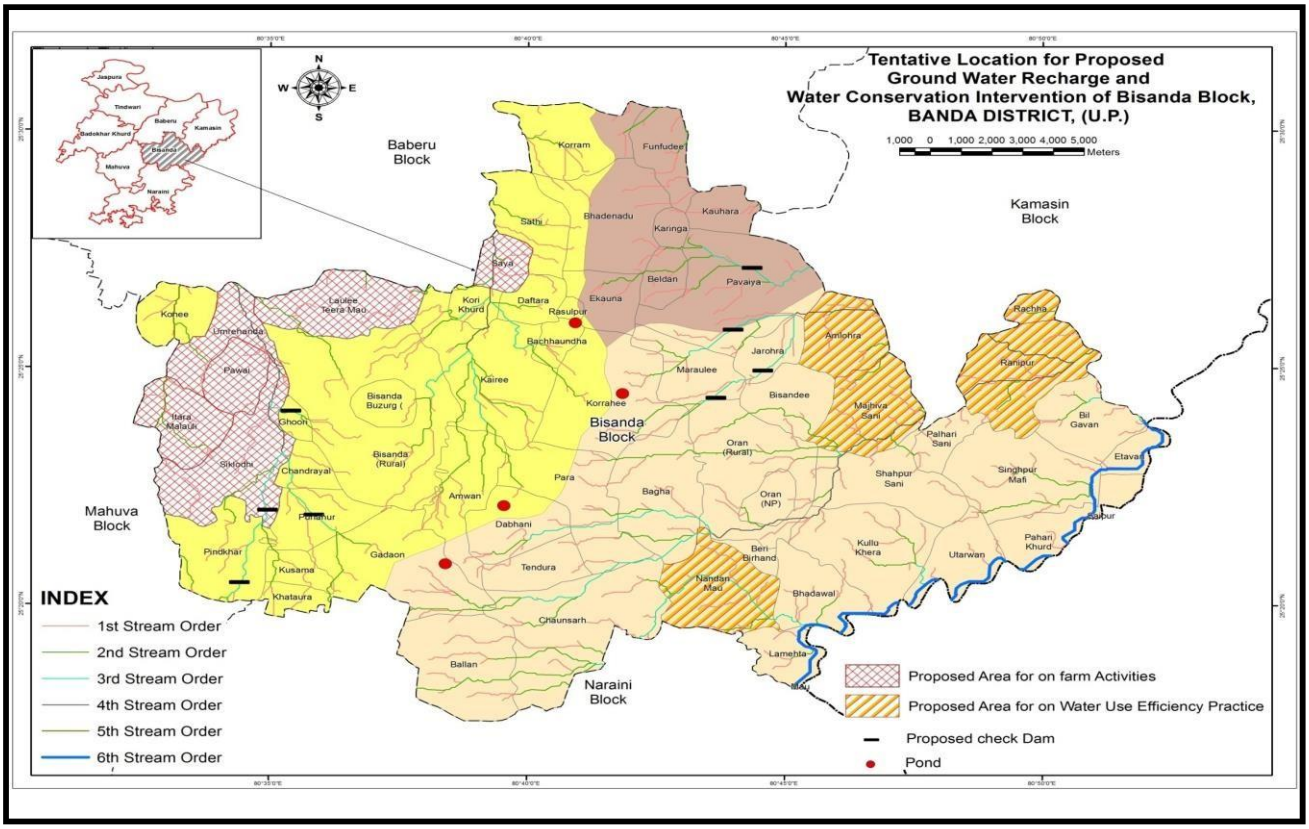


Figure 35: Tentative Locations of Demand and Supply-Side Management Interventions

7. General Information: Kamasin

State Name	Uttar Pradesh
District name	BANDA
Block Name	KAMASIN
BLOCK STATUS AS PER GWRE2017.	KAMASIN: SAFE
Location	Bundelkhand region of Uttar Pradesh
Geographical area	505.97 sq km
Basin/Sub-basin	Yamuna
Principal Aquifer System	Alluvium (marginal)
Major Aquifer System	Banda Alluvium overlying Bundelkhand granite
Normal Annual Rainfall	902 mm

Aquifer Disposition

Aquifer Disposition	Two aquifer groups exist. • Aquifer Group I (Marginal Alluvium): Transmissivity: 315 -1500 m2/day Storativity: Not Detected : Exploration depth range (60m to 90mbgl) basement encountered Aquifer Group II: Fractured basement not explored
Groundwater Monitoring Status	Ground Water Monitoring Wells :01 (NHS)
Ground Water Quality	Aquifer Group-I (Marginal Alluvium): Suitable for domestic, drinking, irrigation and Industrial purpose. Aquifer Group– II: Not explored
Aquifer Potential	Aquifer Group I (Marginal Alluvium): up to 1500lpm Aquifer Group II (Fractured basement):Not explored
Groundwater Resource	Annual Extractable Ground Water:60.08 MCM Annual Ground Water extraction for all uses:39.06 MCM Stage of GW Extraction:65% Total in-storage resource up to 200m for the block is:946.05 MCM
Existing and Future Water Demand	Present demand for All Usage: 66.23 MCM • Net Ground water availability for future use:15.59MCM

Aquifer Management Plan

Groundwater Management issues	Increase in Ground water extraction structures for irrigation and domestic use. Lack of awareness in stakeholders leading to very low demand side management efforts. Leading to decline in water levels in some parts. Locating feasible sites for successful wells. Lack of village level data on water requirement for irrigation and domestic work.	
Artificial Recharge & Conservation Possibilities	Construction of Recharge Structures. Adoption of water use efficiency practices and conservation structures(ponds)	
Groundwater Management Plan	SUPPLY SIDE MANAGEMENT: Extensive afforestation to be carried for soil &Water conservation to reduce surface runoff and increase recharge to ground water. Promoting on farm activities. (With emphasis on construction of farm Ponds and Peripheral bunding). Infrastructure development rain water harvesting ponds should also be encouraged at suitable locations where ever there is road, railway and canal construction. Intensive Public interaction Programme and data collection at village level for stake holder mapping on land and water use to be carried out. DEMAND SIDE MANAGEMENT: Adoption of techniques to enhance water Use Efficiency viz sprinkler, drip irrigation and better choice of crops(more crop per drop) Community led initiative in water resource management.	
Status of GW Exploration	Exploratory Wells :05 Observation Wells :01 Piezometer :nil	
Aquifer Characteristics	Aquifer Group I (Marginal Alluvium):Explored depth( ) Transmissivity 41-3257 m2/day Storativity :8.5 X 10-5 Aquifer Group II: Not explored.	
Net GW Augmentation Potential (Recharge + Supplemental Irrigation or Saving) : =7.87 MCM =787Ham		15% Proposed to be Allocated for Drinking Water: 118H**am** Population to be benefited considering 70 lpcd = 46184.
		85% Proposed to be Allocated for Irrigation: 6609**Ham**Area to be brought under irrigation considering 0.40m as Delta factor: **16522Ham**

Ground water Related Issues and Management Options

Supply side management

- Issue High runoff and erraticrainfall
- SuggestedInterventions
  - Surface water storage structures viz. dams/ponds/ percolation tanks, gully plugs, nala bunds, gabion structures
- Issue : High baseflow
- Suggested Interventions : Studies at micro-watershed level and construction of Subsurfacedykes
- Issues : Siltation of surface waterbodies
- Suggested Interventions :Desiltation of streams/ nalas,Restoration/ revival/ reconstruction of existing Ponds/ tanks/ reservoirs, Catchment treatment through large scaleplantation.
  - Large scale Forestationmeasures

Demand Side Management

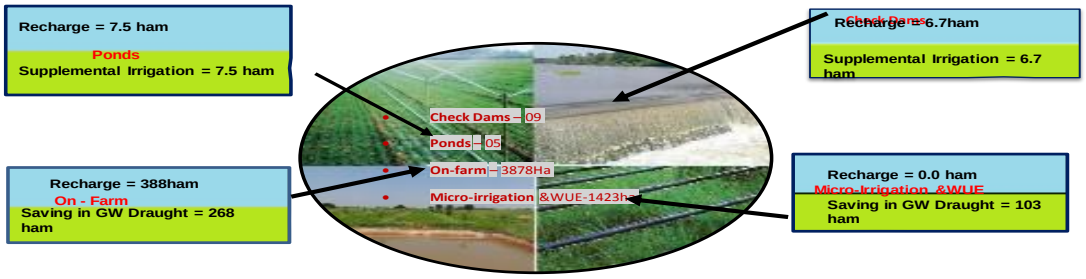
- Issues: Inefficientirrigational practices
- Suggested Interventions:
  - Promotionofdripand sprinkler/ pipedwater irrigation practices to reduce waterlosses.
  - Farm ponds, on farm activities such asland leveling, peripheral bunds/ trenchetc.
  - Catchment treatmentand other rainwater harvestingstructures.

GROUND WATER MANAGEMENT PLAN, KAMASIN BLOCK WITH INTERVENTION STRUCTURES

BLOCK	NO OF CD/NB	NO OF POND/PT	ON FARM AREA (HA)	WUE AREA (HA)
KAMASIN	9	5	3878	1423
TOTAL	9	5	3878	1423

Projected stage of ground water development after implementation of suggested ground water management strategy

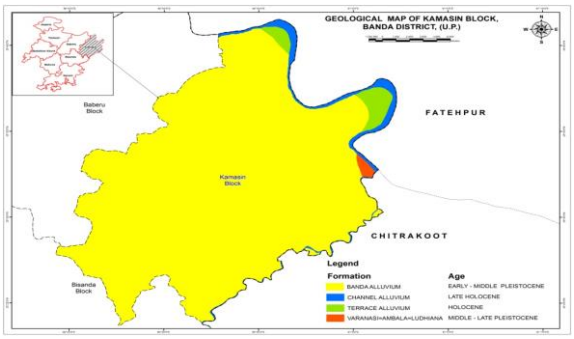
Block	Net annual Extractable GW availability (ham)	Existing gross GW draft for all uses(ham)	Stage of GW development %	Total recharge through intervention (ham)	Total GW saving through interventions (ham)	Projected net Extractable GW availability (ham)	Projected gross GW draft (ham)	Projected stage of GW development post intervention %
KAMASIN	6008	3905	65	402	385	6410	3520	55.00
TOTAL	6008	3905	65	402	385	6410	3520	55.00



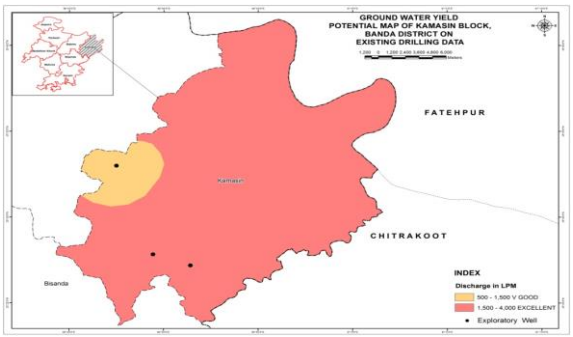
GW Augmentation Potential From Recharge & Saving:787 ham

Ground Water Yield Potential

Geology Map



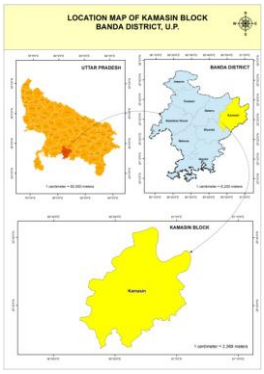
Yield Potential Map



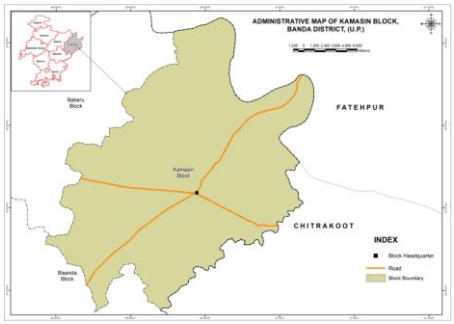
Unit	Topography	Geology	Aquifer Charecteristics				Quality	Remarks
			Aq.Nature	Aq. Type	Exploration Depth (m)	Hydrogeological parameters		
Marginal Alluvium plain	Northerly sloping alluvial plains with hillocks at places and ravines.	Sand, Silt, Clay and Sand of Quarternary age	Unconfined to semi confined	Single	60-90	T(315 - 1500 m2/day)	Good (slightly higher EC at some places)	Predominance of finer sediments and saline water.
Southern highlands	Gentley sloping plateau	Precambrian Vindhyan Sandstone and Limestone and Bundelkhand massif of Archean age	Semiconfined	Unexplored	unexplored	No data	No data	

Maps of Kamasin Block, Banda District

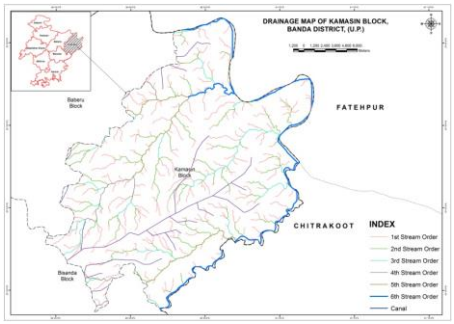
Location Map



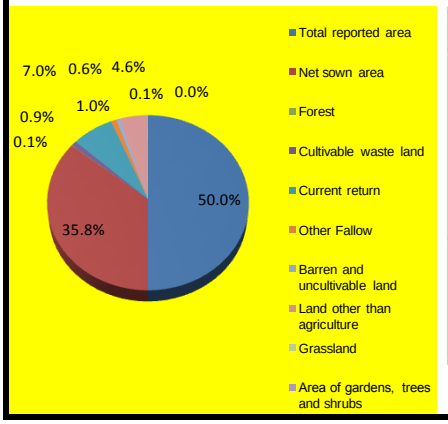
Index Map Kamasin Block

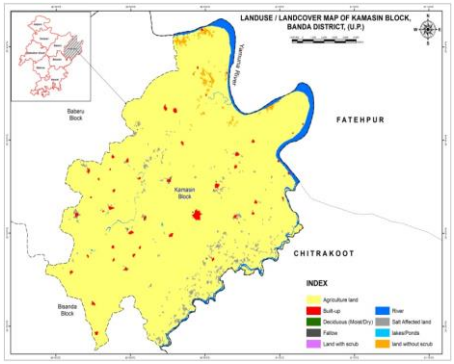


Drainage Map



LAND USE





Land use in percentage to total reported area

About

Area: 541.55 SqKm

Population : Census2011): 172913

Population Density: 331.88 SqKm

Number of Villages : 76

Net sown area: 38783

Gross sown area: 47155

Normal Rainfall (mm) : 902

Normal Monsoon Rainfall (mm): 800

Ground Water irrigated area of :

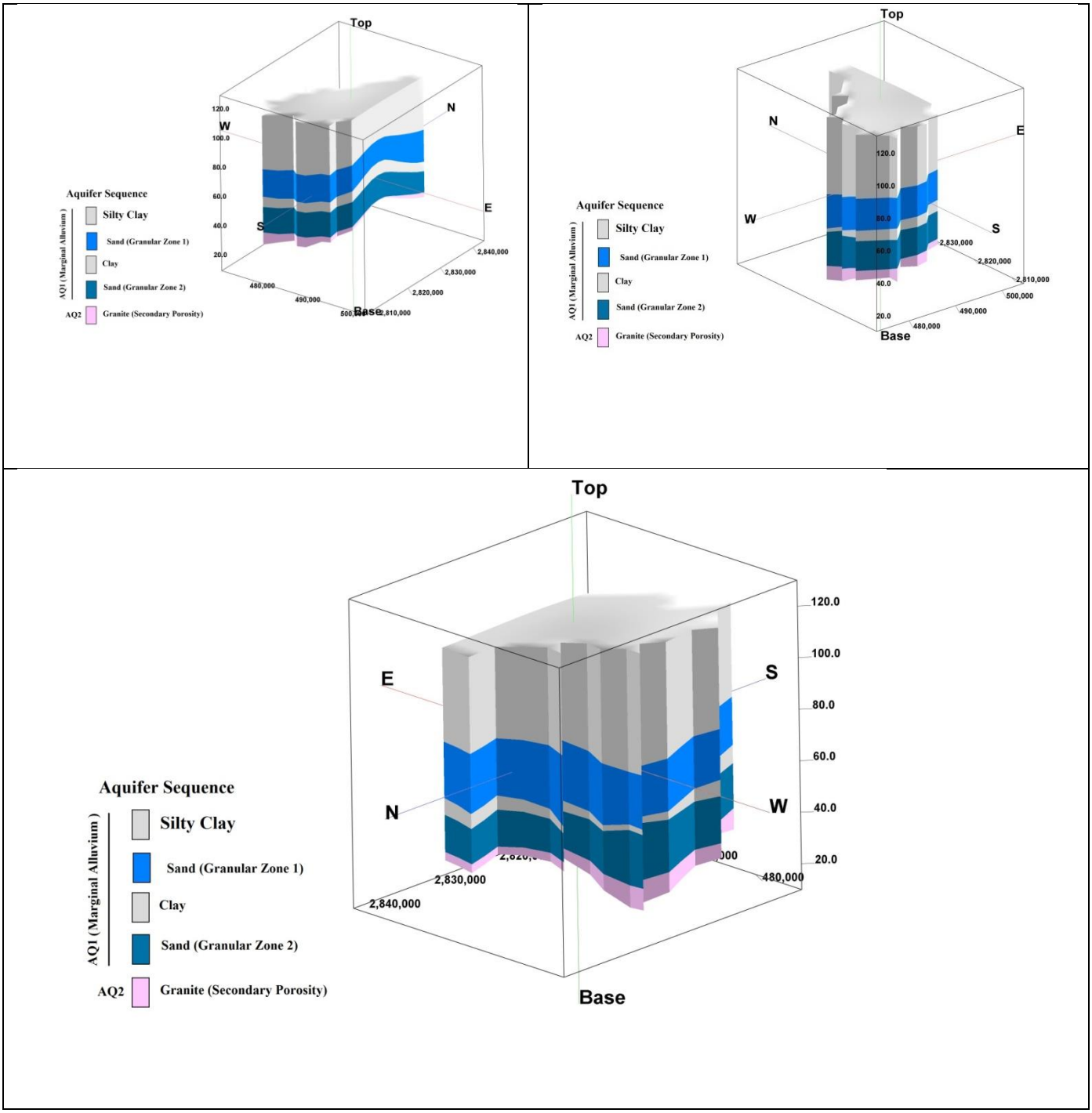
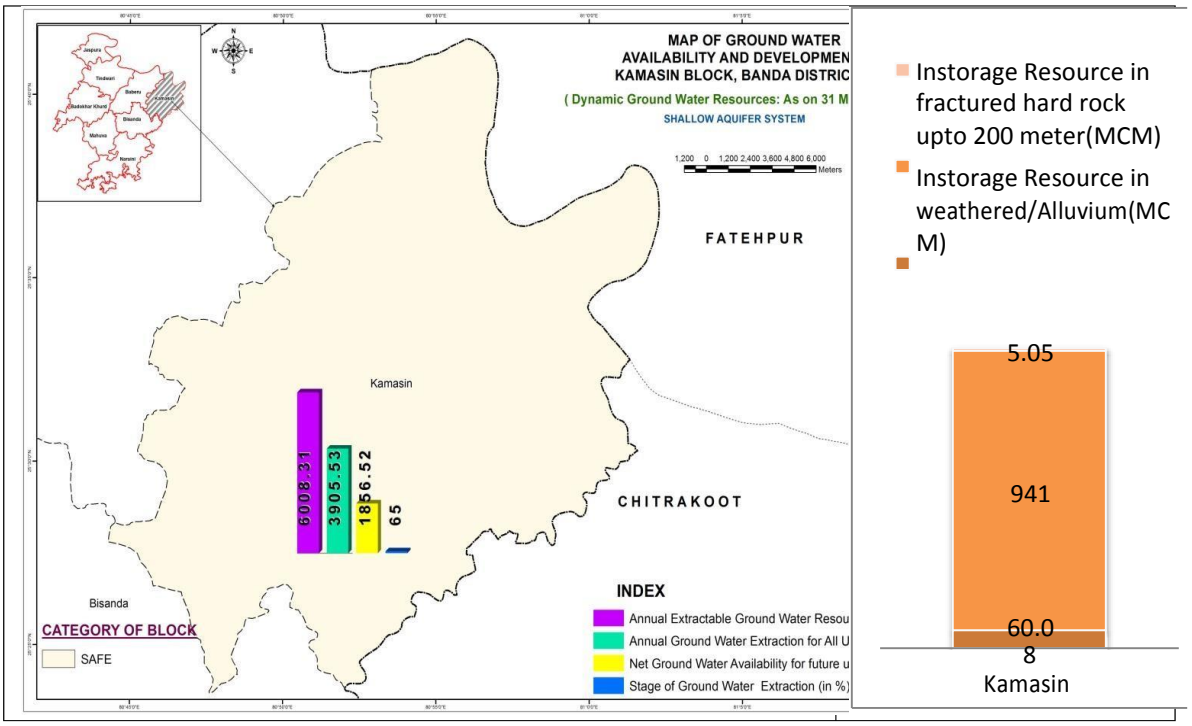


Figure 36: 3D Presentation of Aquifer Disposition In, Kamasin Block, Based On Existing Exploratory Data



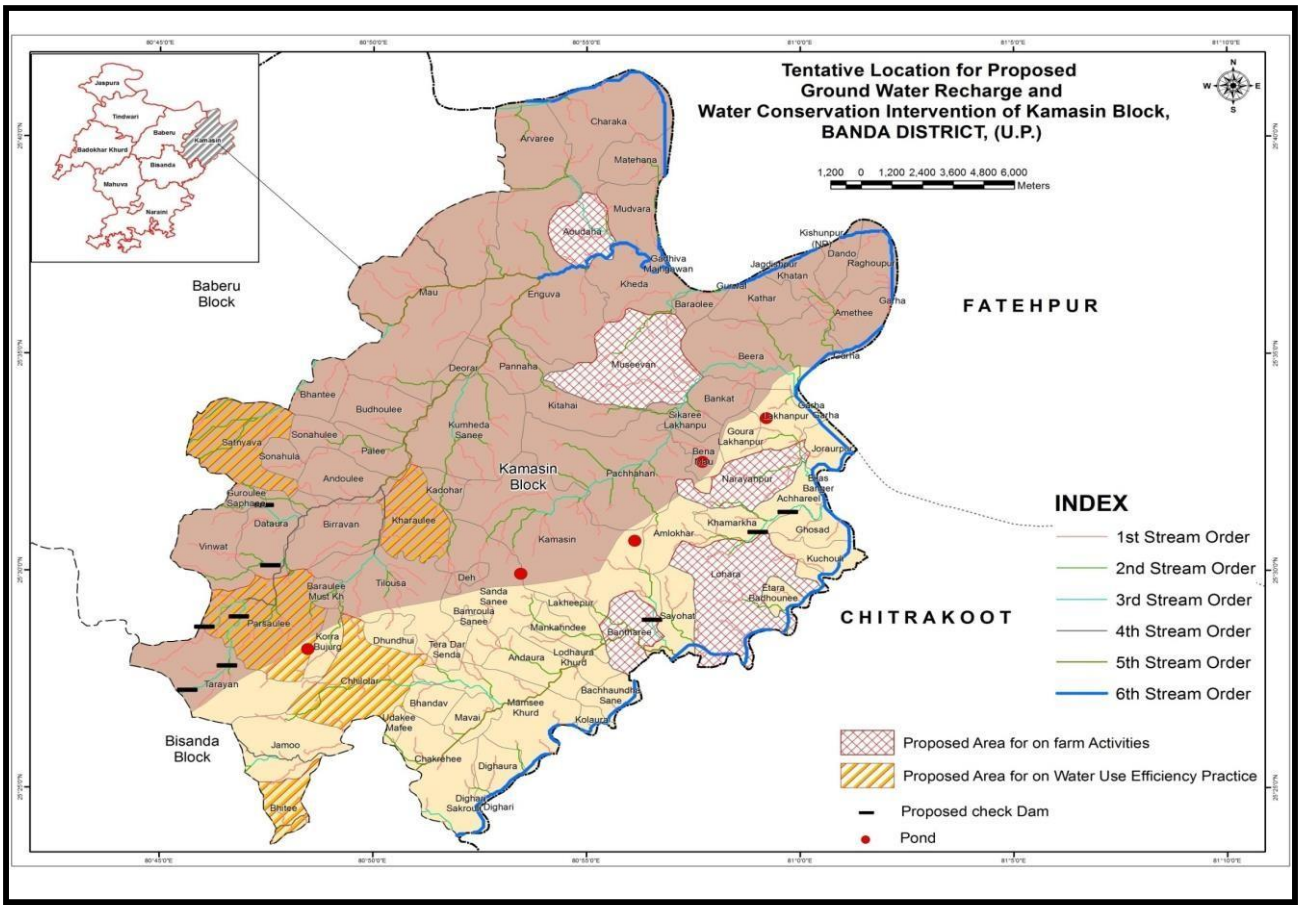


Figure 37: Tentative Locations of Demand and Supply-Side Management Interventions

8. General Information: Baberu

State Name	Uttar Pradesh
District name	BANDA
Block Name	BABERU
BLOCK STATUS AS PER GWRE2017.	BABERU: SEMICRITICAL
Location	Bundelkhand region of Uttar Pradesh
Geographical area	590.41sq km
Basin/Sub-basin	Yamuna
Principal Aquifer System	Alluvium (marginal)
Major Aquifer System	Banda Alluvium overlying Bundelkhand granite/Vindhayan
Normal Annual Rainfall	902 mm

Aquifer Disposition
Three figures are required Showing aquifer disposition (Fig. 34 – Fig.35)

Aquifer Disposition	Two aquifer groups exist. • Aquifer Group I (Marginal Alluvium): Transmissivity 1000-3000 m2/day Storativity: 1.9 X 10-4 : Exploration depth range (up to 90 mbgl) basement encountered Aquifer Group II:Fractured basement not explored
Groundwater Monitoring Status	Ground Water Monitoring Wells :….(NHS)
Ground Water Quality	Aquifer Group-I (Marginal Alluvium): Suitable for domestic, drinking, irrigation and Industrial purpose. Aquifer Group– II: Not explored
Aquifer Potential	Aquifer Group I (Marginal Alluvium): 1000 -3000 lpm Aquifer Group II (Fractured basement):Not explored
Groundwater Resource	Annual Extractable Ground Water:84.32 MCM Annual Ground Water extraction for all uses:66.23 MCM Stage of GW Extraction:78.55% Total in-storage resource up to 200m for the block is:1953.9 MCM
Existing and Future Water Demand	Present demand for All Usage: 66.23 MCM • Net Ground water availability for future use:15.59MCM

Aquifer Management Plan

Groundwater Management issues	Increase in Ground water extraction structures for irrigation and domestic use. Lack of awareness in stakeholders leading to very low demand side management efforts. Leading to decline in water levels in some parts. Locating feasible sites for successful wells. Lack of village level data on water requirement for irrigation and domestic work.	
Artificial Recharge & Conservation Possibilities	Construction of Recharge Structures. Adoption of water use efficiency practices and conservation structures(ponds)	
Groundwater Management Plan	SUPPLY SIDE MANAGEMENT: Extensive afforestation to be carried for soil &Water conservation to reduce surface runoff and increase recharge to ground water. Promoting on farm activities. (With emphasis on construction of farm Ponds and Peripheral bunding). Infrastructure development rain water harvesting ponds should also be encouraged at suitable locations where ever there is road, railway and canal construction. Intensive Public interaction Programme and data collection at village level for stake holder mapping on land and water use to be carried out. DEMAND SIDE MANAGEMENT: Adoption of techniques to enhance water Use Efficiency viz sprinkler, drip irrigation and better choice of crops(more crop per drop) Community led initiative in water resource management.	
Status of GW Exploration	Exploratory Wells :05 Observation Wells :01 Piezometer :nil	
Aquifer Characteristics	Aquifer Group I (Marginal Alluvium):Explored depth( ) Transmissivity 1000-3000 m2/day Storativity :1.9 X 10-4 Aquifer Group II: Not explored.	
Net GW Augmentation Potential (Recharge + Supplemental Irrigation or Saving) : =12.81MCM = 1281Ham		15% Proposed to be Allocated for Drinking Water: 192**Ham** Population to be benefited considering 70 lpcd = 75147.
		85% Proposed to be Allocated for Irrigation: **1089Ham** Area to be brought under irrigation considering 0.40m as Delta factor:2722 **Ha**

Ground water Related Issues and Management Options

Supply side management

- Issue High runoff and erratic rainfall
- Suggested Interventions
  - Surface water storage structures viz. dams/ponds/ percolation tanks, gully plugs, nala bunds, gabion structures
- Issue : High base flow
- Suggested Interventions : Studies at micro-watershed level and construction of Subsurface dykes
- Issues : Siltation of surface water bodies
- Suggested Interventions :Desiltation of streams/ nalas,Restoration/ revival/ reconstruction of existing Ponds/ tanks/ reservoirs, Catchment treatment through large scale plantation.
  - Large scale Forestation measures

Demand Side Management

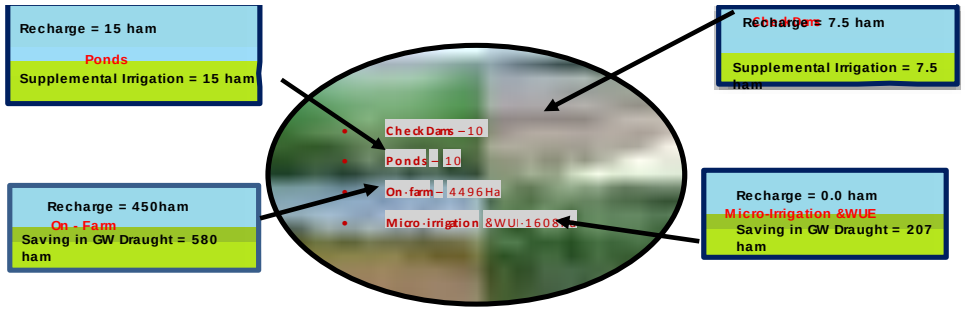
- Issues: Inefficient irrigational practices
- Suggested Interventions :
  - Promotion of drip and sprinkler/ piped water irrigation practices to reduce water losses.
  - Farm ponds, on farm activities such as land leveling, peripheral bunds/ trench etc.
  - Catchment treatment and other rainwater harvesting structures.

GROUND WATER MANAGEMENT PLAN, BABERU BLOCK WITH INTERVENTION STRUCTURES

BLOCK	NO OF CD/NB	NO OF POND/PT	ON FARM AREA (HA)	WUE AREA (HA)
BABERU	10	10	4496	1608
TOTAL	10	10	4496	1608

Projected stage of ground water development after implementation of suggested ground water management strategy

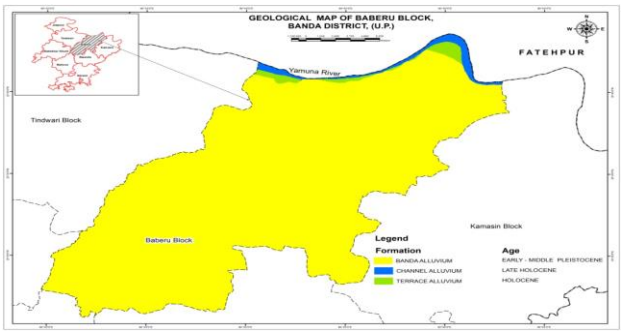
Block	Net annual Extractable GW availability (ham)	Existing gross GW draft for all uses(ham)	Stage of GW develop ment %	Total recharge through intervention (ham)	Total GW saving through interventions (ham)	Projected net Extractable GW availability (ham)	Projected gross GW draft (ham)	Projected stage of GW development post intervention %
BABERU	10022	7449	74.33	472	809	104.4	6640	63.27
TOTAL	10022	7449	74.33	472	809	104.4	6640	63.27



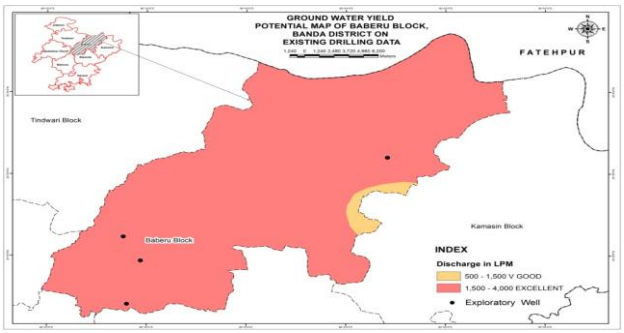
GW Augmentation Potential From Recharge & Saving:1281 ham

Ground Water Yield Potential

Geology Map



Yield Potential Map



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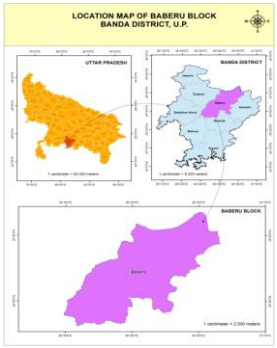
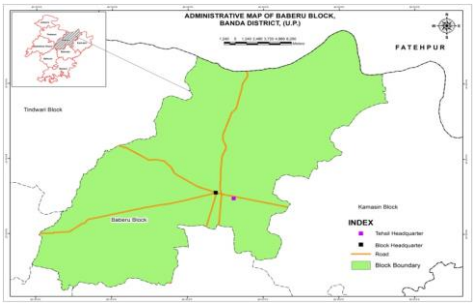
			Aq.Nature	Aq. Type	Exploration Depth (m)	Hydrogeological parameters		
Marginal Alluvium plain	Northerly sloping alluvial plains with hillocks at places and ravines.	Sand, Silt, Clay and Sand of Quarternary age	Unconfined to semi confined	Single	Up to 90	-T(1000-3000) Q(1000-3000lpm) Storativity:1.9x10^{-4}	Good (slightly higher EC at some places)	Predominance of finer sediments and saline water.
Southern highlands	Gentley sloping plateau	Precambrian Vindhyan Sandstone and Limestone and Bundelkhand massif of Archean age	Semiconfined	Unexplored	unexplored	No data	No data	

Maps of Baberu Block, Banda District

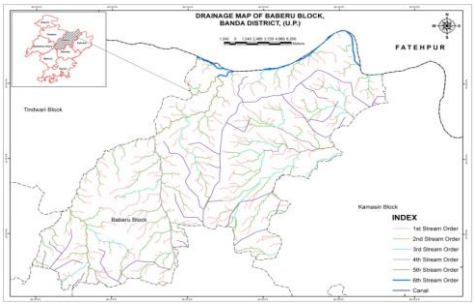
Location Map

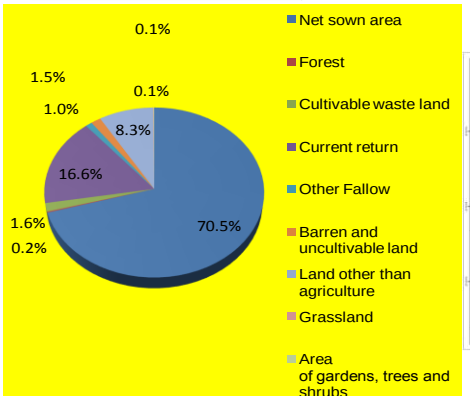


Index Map Baberu Block

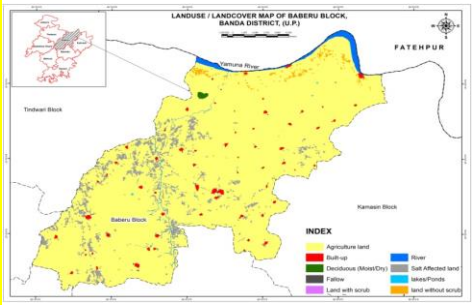


Drainage Map





LAND USE



Land use in percentage to total reported area

About

Area: 637.39 SqKm
Population : Census2011): 212598
Population Density: 362.62 SqKm
Number of Villages : 84
Net sown area: 44964
Gross sown area: 55594
Normal Rainfall (mm) : 902
Normal Monsoon Rainfall (mm): 800
Ground Water irrigated area of :

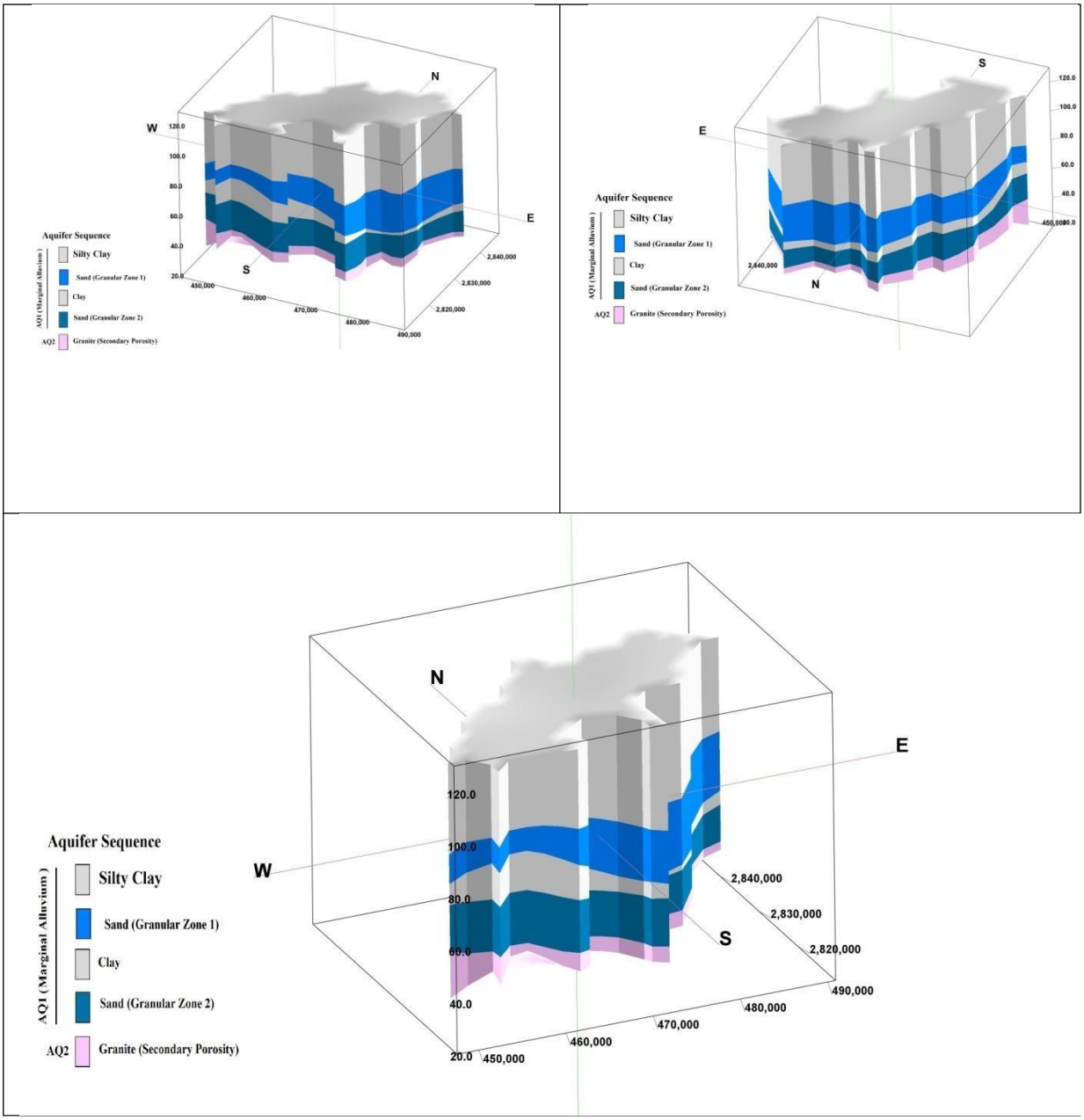
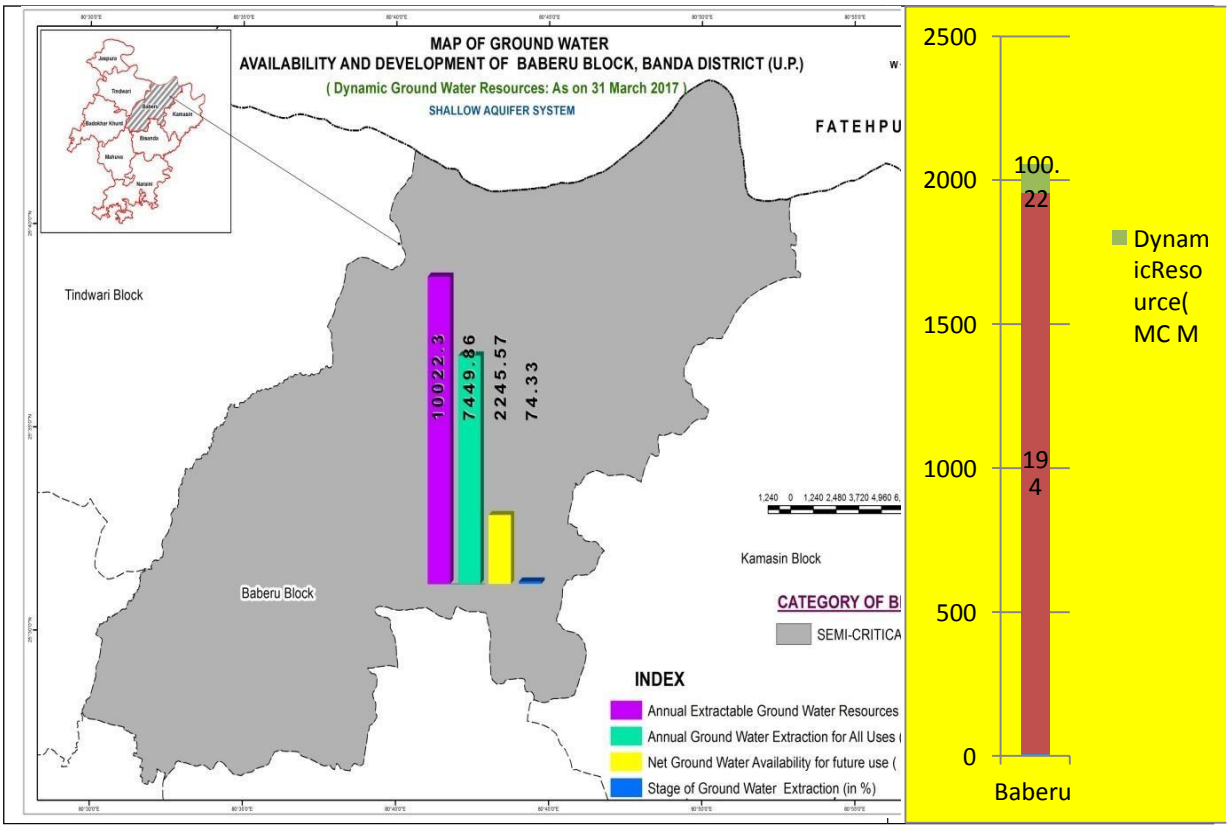


Figure 38: 3D Presentation of Aquifer Disposition In, Baberu Block, Based On Existing Exploratory Data



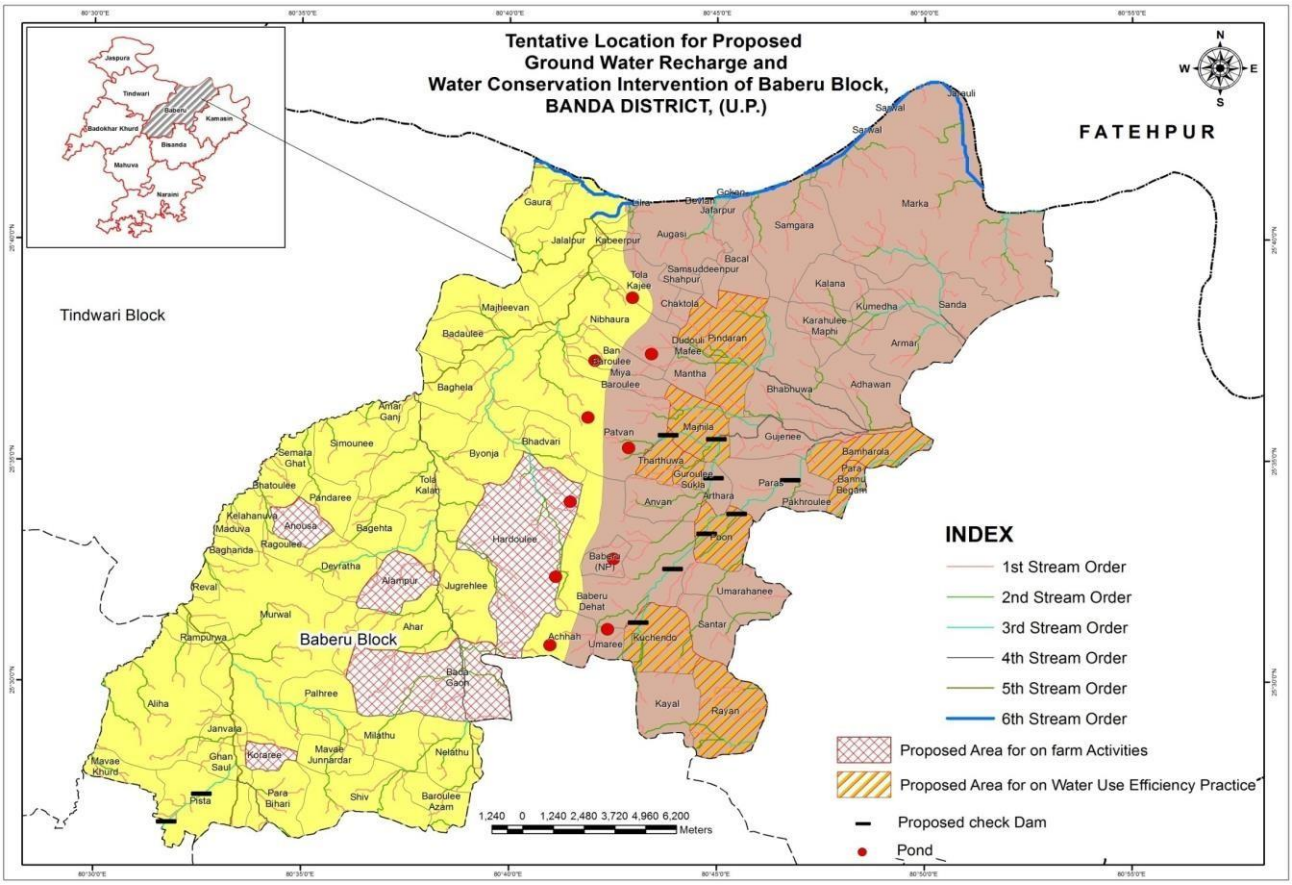


Figure 39: Tentative Locations of Demand and Supply-Side Management Interventions

CONCLUSION

- Banda district, covering an area of 4496 sq. km lies in the bundelkhand region of Uttar Pradesh. For administrative purposes, the districthasbeensub-dividedinto4-tehsilsand 8-developmental blocks.
- The district is located in southwestern part of U.P. and bounded by State of Madhya Pradesh in south, district Chitrakoot Dham in east, Hamirpur in west and Fatehpur in northeast.
- The district lies between latitude $25^0$00" and $25^0$59'00" and longitude $80^0$06'00" and $81^0$00'00".
- The drainage pattern of the district is strictly governed by the two major rivers Yamuna and Ken, which forms western boundary of the district.
- District is characterized by loose sediments as well as black cotton soil. Loose sediments constitute clay, silt and sand. Black cotton soil is quite prominent in central part of the Bandadistrict.Onthebasisoflocalnameofsoilsanditscoverageindifferentblocks,these are four types of soils as below:-
  Rakar (b) Mar (c) Kabar (d) Padua
- The main rabi crops are wheat and oil seeds while paddy and pulses are the main kharif crops.
- Net Area Sown in the district is 345479 ha, Net irrigated area is 188265 and Gross irrigatedareais267567ha.Groundwater irrigation accounts for about 62% in the area.
- The maximum canal irrigation is in the Mahua block 24299Ha
- The normal annual rainfall in the district is 902 mm. About 80% of rainfall takes places from June to September.
- The district is characterized by alluvial, hard rock as well as marginal alluvial geomorphic features. District is bounded between river Yamuna, Vindhyan hills and river Betwa. River Baghain which flows from southwest to northeast direction divided the plain area into two halves.
- Physiographic ally, Banda district can be divided into three physiographic units:
- The Alluvial Plain (ii) Marginal Alluvial and (iii) High Land (Hard Rock) Area.
- Geologically the district is characterized by Bundelkhand granite, Vindhyan sandstone and alluvium.
- Bundelkhand granite which is observed and found in most part of the district is oldest and

Younger alluvium along the river/streams youngest in age.

- On the basis of borehole data, it is found that thickness of alluvium varies between 40mbgl to 130 mbgl. Thickness of alluvium diminishes towards south from north in the district.
- Bundelkhand granite and Vindhayan are common basement which are encountered in the district. Granite is mostly weathered and fractured at shallow depth. Isolated occurrence of piedmont zones has been identified around the Inselbergs at various places.
- Water level data of all the NHS falling in the district for 10 years were analyzed for its seasonal and long term seasonal fluctuations. It is observed that season fluctuation (2018- 2019) ranges between 1.8 to 12.95 m in pre-monsoon and 1.15 to 13.8 m in post-monsoon, in dug wells spreading over entire district. Long-term water level fluctuation (2009-2019) shows rise in 7 stations from 0.3068m/year and a fall of 0.1595 m/yea in 4 stations. During the post monsoon period there is a rise of 0.3049m/year in 4 blocks and fall of 0.1700m/year in 11 locations. The higher fluctuation corroborates the fact that the base flow of ground water is higher in the area where long term/seasonal fluctuation is more pronounced.
- From the water table elevation contour map (Plate-…) the ground water flow is towards river Yamuna in north and northeastern part of the district. In western part of the district the ground water flow is towards river Ken. Magnitude of ground water flow is less in southern and eastern part than northern and eastern part of the district.
- Broadly Aquifer Group I (Marginal Alluvium) extends down to around 150m, Aquifer Group II (Hard rock) extends down to around200m.
- Two aquifer groups exist. •Aquifer Group I (Marginal Alluvium):Transmissivity 500-3000 m2/day Storativity: 8.5 X 10^{-5}: Exploration depth up to 150 m. • Aquifer Group II (Fractured Basement): Transmissivity 20-50 m2/day Storativity: 5.88 X 10^{-4}Exploration depth: 200mAquifer Group I (Marginal Alluvium): 800 -3000 lpm Aquifer Group II (Fractured basement):30 – <600lpm
- Sand percentage in the first aquifer system is on the higher side towards Yamuna River in the northern part of the district ranging whereas sand percentage decreases progressively towards southern part of the district ranging.
- Based on the existing lithologs of exploratory wells the depth to overburden map of the district shows that there is a gradual increase in thickness from south to north. It is

interesting to note that in extreme south (south of Naraini) only the shallow aquifer is present and below this the basement is encountered. Therefore only single tier aquifer system prevails in southern most part of the district.

- Deeper aquifer is characterized by medium to coarse grained sand and has regional extension in north and central part of the district. Thickness of deeper aquifer varies between 50.00 to 80.00 m. Deeper aquifer is absent in southern (south to Naraini and Badausa) part of the district.
- The total groundwater draft is 40153.75 ham, which is being used in present for domestic, irrigation & industrial purposes against the ground water availability of 59608.51 ham. Out of 8 blocks, four blocks falls under semi critical category which are Jaspura, Tindwari, Baberu and Naraini and rest four (4) blocks are under Safe. The overall stage of ground water development is67.36%.
- Ground water in phreatic aquifer in general, is colorless, odorless and slightly alkaline in nature. A total of 171 samples were collected from the district at a density of one sample representing 27 Sq Km and it is observed that in general the ground water is suitable for drinking agricultural & industrial purposes in respect of all the constituents' viz. EC, CO3, HCO3, Cl, F, No3, SO4, TH, Ca, Mg & Na, except at few locations.
- Panchayat led groundwater management and behavioral change with primary focus on demand side management, improving cropping pattern and efficient use of groundwater.

RECOMMENDATIONS

Preparation of water security plans and implementations of management interventions.

- To arrest the further decline in ground water levels and depletion of ground water resources, there is urgent need to implement both Supply-side and Demand-side measures which includes artificial recharge and water conservation, On-farm activities and adoption of water use efficiency measures.
- It is proposed to adopt a robust demand side management options in the Semi Critical blocks. There is considerable scope for implementation of Roof Top Rain Water Harvesting in the urban areas of the district. Check dams, cement plugs, renovation of ponds are ideal structures for rain water harvesting in rural areas. Water conservation structures such as check dams, farm ponds, anal bunds etc. result in ground water recharge to the tune of about 50% of the storage capacity considering 3 annual fillings.
- It is also proposed to adopt On Farm practices such as laser leveling, bench terracing, construction of farm ponds, afforestation, diversification of crops etc. On farm activities are proposed in an area of 30551hectare.
- It is proposed to construct 145 Check dams of 10,000 cubic m. capacity to revive and renovate 75ponds.
- In demand side management there is urgent need to promote piped and pressurized irrigation practices which can save 25 to 70% of water use in the agriculture. It is proposed to initiate these measures initially in 10% area of overexploited & critical blocks. The measures adopted for supply side and demand side management in Banda district will substantially bring down stage of ground water development.
- Although there is good scope of groundwater development in 4-'Safe' blocks the area calls for adoption of efficient water saving Irrigation practices and encouragement of demand side management to reduce the draft.
- Less water consuming varieties of paddy and wheat should be promoted in the district.
- Agriculture department should promote to conserve the soil moisture by reducing ET losses through cultivation of 'Green Manure'.
- Alternate cropping system having lower requirement of water should be encouraged in accordance to the irrigation water availability.
- Furrow irrigation with raised bed planting in wide row crops should be practiced.
- Irrigation in checks in close row crops should be practiced.

- Multiuse of water through integrated farming system.
- Conjunctive use of surface and groundwater should been courage in the canal command of the district.
- Besides the above, there is urgent need for participatory ground water management in the area which will further help in bringing more awareness among the common farmers which will reduce the ground water withdrawal and bring down the stage of ground water development.
- 17 All efforts should be taken to ensure treatment of waste disposal both solid and liquid from industries and urban areas to prevent pollution of ground water and surface water.

ACKNOWLEDGEMENTS

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REFERENCES

- Todd. D.K, 1980 Ground Water Hydrogeology, second edition, John Wiley & sons, Newwork Pandey H.K., 2005
- Report of Ground Water Management Studied of Banda district, U.P. CGWB 2007
- Manual on artificial recharge of ground water
- BIS 2012 Indian standards Specification for Drinking Water, B.S.10500 Statistical Handbook U.P

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