केंद्रीय भूमि जल बोर्ड

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विभाग, जल शक्ति मंत्रालय

भारत सरकार

Central Ground Water Board

Department of Water Resources, River Development and Ganga Rejuvenation,
Ministry of Jal Shakti
Government of India

AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES

KHAIRAGARH BLOCK, RAJNANDGAON DISTRICT, CHHATTISGARH

उत्तर मध्य छत्तीसगढ़ क्षेत्र, रायपुर

North Central Chhattisgarh Region, Raipur

AQUIFER MAPS AND GROUND WATER MANAGEMENT PLAN, KHAIRAGARH BLOCK, RAJNANDGAON DISTRICT, CHHATTISGARH

C O N T R I B U T O R S'

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ACKNOWLEDGEMENT

The author is grateful to Shri G. C. Pati, Chairman, Central Ground Water Board for giving opportunity for preparation of the National Aquifer Mapping & Management report of Rajnandgaon block, Rajnandgaon district, Chhattisgarh. I express my sincere gratitude to Shri G. L. Meena, Member (WQ & WTT) & Sh. S. Marwaha, Member (Scientific), CGWB for giving valuable guidance, encouragement and suggestions during the preparation of this report. The author is thankful to Dr. S. K. Samanta, Head of the Office, Central Ground Water Board, NCCR, Raipur extending valuable guidance and constant encouragement during the preparation of this report. The author is also thankful to Sh. A. K. Biswal, Sc. D; Sh. A. K. Patre, Sc.D; Sh. J. R. Verma, Sc.D; Sh. Uddeshya Kumar, Sc-B & Sh. R. K. Dewangan, Sc-B and other officers and officials of all the sections of the office for the help rendered & for providing the needful data during the preparation of this report on "AQUIFER MAPPING & MANAGEMENT PLAN IN KHAIRAGARH BLOCK, RAJNANDGAON DISTRICT, CHHATTISGARH".

Contents

List of Figures

List of Tables

BLOCK-WISE AQUIFER MAPS AND MANAGEMENT PLANS
KHAIRAGARH BLOCK, RAJNANDGAON DISTRICT

1. SALIENT INFORMATION

1.1 About the area:

Name of the Block	Khairagarh
Area	805 Sq. km.
District	Rajnandgaon
State	Chhattisgarh

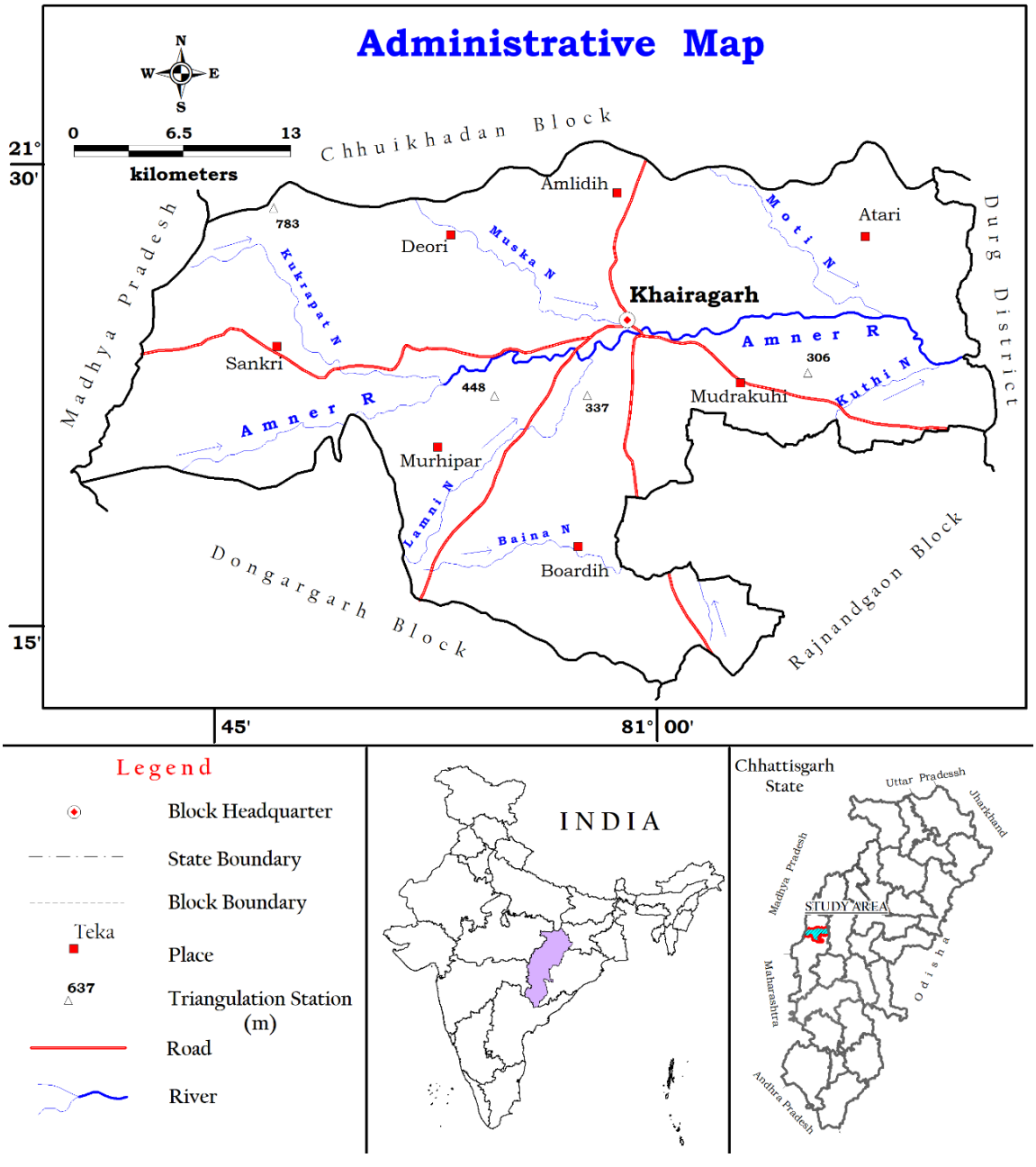


Figure 1 Administrative Map

1.2 Population:

The total population of Khairagarh block as per 2011 Census is 192222 The population break up i.e. male, female, rural & urban is given below;

Table 1 Population Break-up

Block	Total population	Male	Female	Rural population	Urban population
Khairagarh	192222	97059	95163	169658	22564

Source: CG Census, 2011

1.3 Population Growth rate:

The decadal growth rate of this block is 22.96 as per 2011 census.

1.4 Rainfall:

The study area receives rainfall mainly from south-west monsoon. It sets in third/fourth week of June and continues till mid-August/September with heaviest showers in the months of July and August. The months of July and August are the heaviest rainfall months and nearly 95% of the annual rainfall is received during June to September months. Average annual rainfall in the study area is (Average of the last five years i.e. 2012-13 to 2016-17) 797.26mm

Table 2 Rainfall data in Khairagarh block (in mm)

Year	2012-13	2013-14	2014-15	2015-16	2016-17
Monsoon rainfall	942.4	1080.8	582.1	690	691

Source: Statistical Hand Book Rajnandgaon District, 2016-17

1.5 Agriculture and Irrigation:

Agriculture is practiced in the area during Kharif and Rabi season every year. During the Kharif, cultivation is done through rainfall while during the Rabi season, it is done through ground water as well as partly through surface water like ponds and other sources. The groundwater abstraction structures are generally Dugwells, Borewells /tubewells. The principal crops in the block are Paddy, Wheat and Gram. In some areas, double cropping is also practiced. The agricultural pattern, cropping pattern and area irrigated data of Khairagarh block is given in Table No. 3 (A, B, C, and D).

Drainage Map

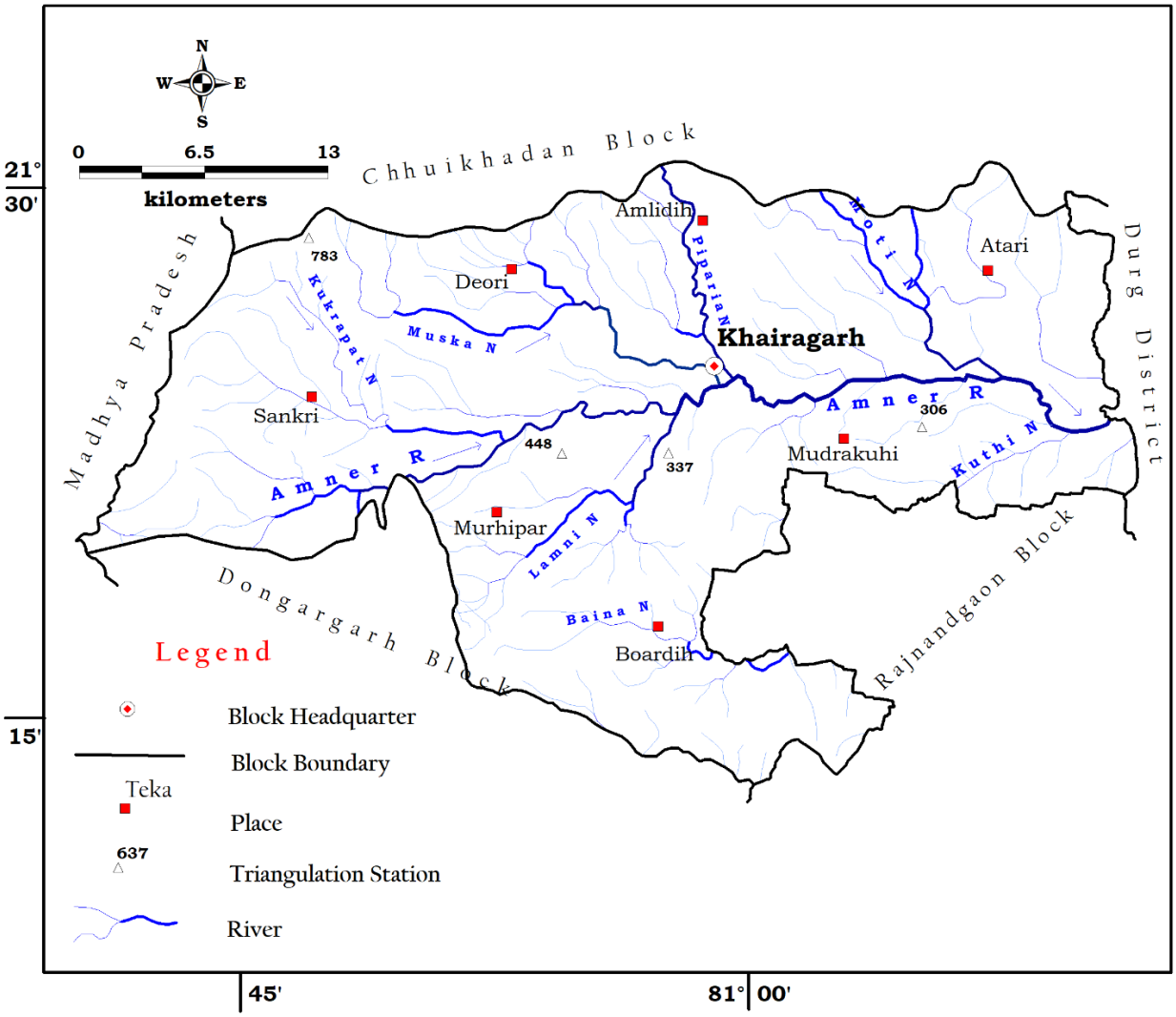


Figure 2 Drainage Map

Table 3(A) Land use pattern (in ha)

Block	Total geographical area	Revenue forest area	Area not available for cultivation	Non-agricultural & Fallow land	Agricultural Fallow land	Net sown area	Double cropped area	Gross cropped area
Khairagarh	81095	956	8737	4707	6546	57967	30835	88802

Table 3(B) Cropping pattern (in ha)

Block	Kharif	Rabi	Cereal				Tilhan	Fruits Vegetable	Mirch Masala	Sugar-cane
			Wheat	Rice	Jowar & Maize	Others				
Khairagarh	56441	32361	4432	37240	36	0	6749	1801	20	0

Table 3(C) Area irrigated by various sources (in ha)

No. of canal s (private and Govt.)	Irrigated area	No.of bore wells/ Tube wells	Irrigated area	No. Of dug wells	Irrigated area	No. of Talabs	Irrigated area	Irrigated area by other sources	Net Irrigated area	Gross irrigated area	% of irrigated area wrt. Net sown area
40	8416	4419	16950	572	43	31	165	32	25606	25606	44.17

Table 3(D) Contribution of Groundwater in Irrigation Pattern (ha)

Block	Area irrigated through Borewell/ Tubewell	Area irrigated through Dugwell	Area irrigated through Groundwater	Net area irrigated through all sources	GW contribution in Irrigation (%)
Khairagarh	16950	43	16993	25606	66.36

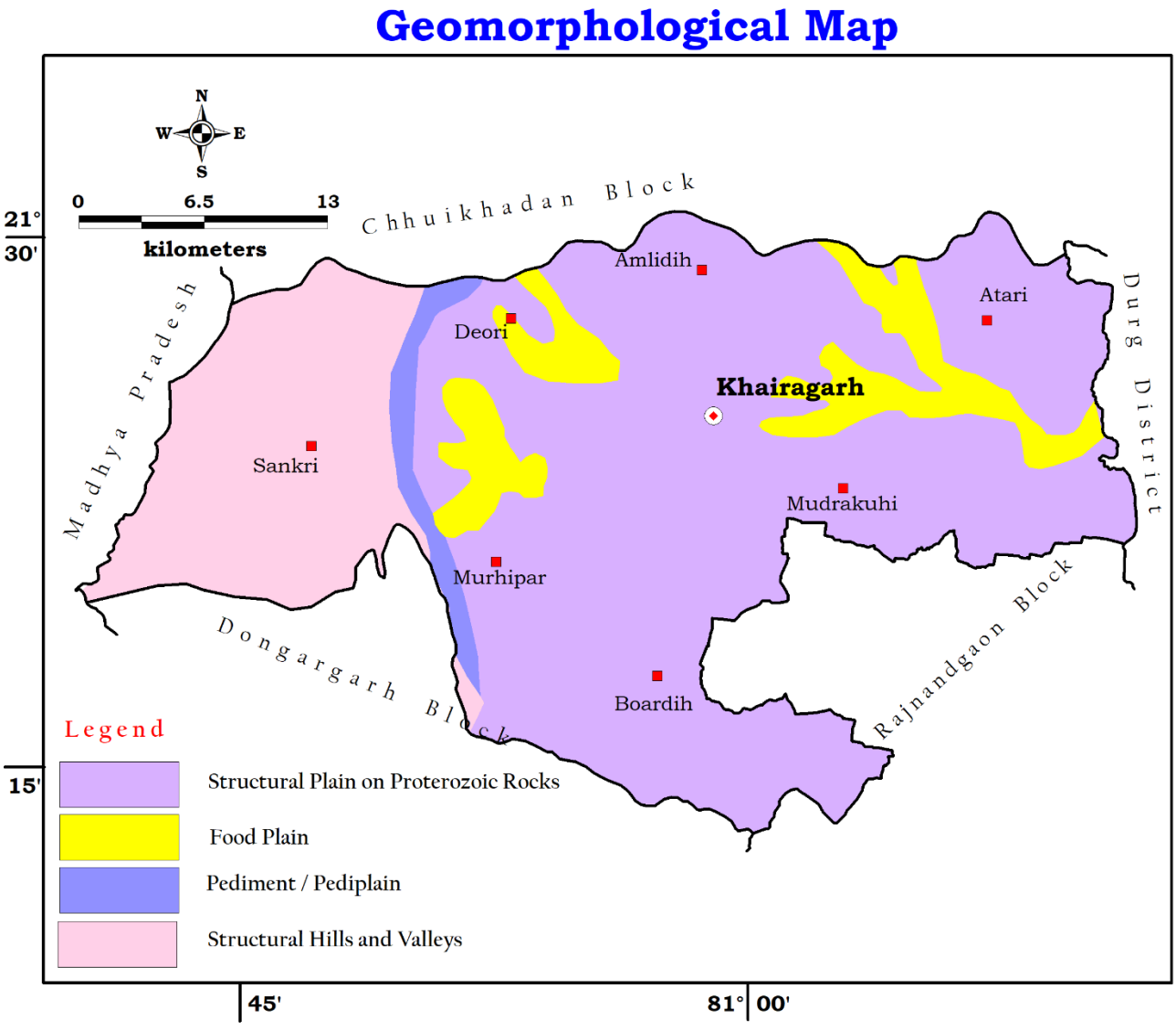


Figure 3 Geomorphological Map

1.6 Groundwater Resource Availability:

Based on the resource assessment made, the resource availability in Khairagarh block is given in the Table No. 4.

Table 4 Ground Water Resources of Khairagarh block in Ham

Name of Block	Ground Water Recharge (Ham)				Total Annual Ground Water (Ham) Recharge (5=1+2+3+4)	Total Natural Discharges (Ham)	Annual Extractable Ground Water Recharge (Ham) (7=5-6)
	Monsoon Season		Non-monsoon season				
	Recharge from Rainfall	Recharge from Other Sources	Recharge from Rainfall	Recharge from Other Sources			
	1	2	3	4	5	6	7
Khairagarh	5338.61	1319.40	637.94	2122.78	9418.73	941.87	8476.86

1.7 Water Level Behavior:

1.7.1 Pre- monsoon water level (May 2018):

In the pre-monsoon period, it has been observed that in Khairagarh block, water level in Phreatic aquifer vary between 2.6 to 14.37 m bgl with average water level of 7.9m bgl shown in Table No. 5(A). In deeper semi-confined aquifer, water level varies between 10.1 to 24.25 m bgl with average water level of 18.18 m bgl shown in Table No. 5(B).

Table 5(A) Aquifer wise Depth to Water Level (Pre-monsoon)

Block Name	Phreatic Aquifer		
	Min	Max	Avg
Dongargarh	2.6	14.37	7.9

Table 5(B) Aquifer wise Depth to Water Level (Pre-monsoon)

Block Name	Semi-confined Aquifer		
	Min	Max	Avg
Dongargarh	10.1	24.25	18.18

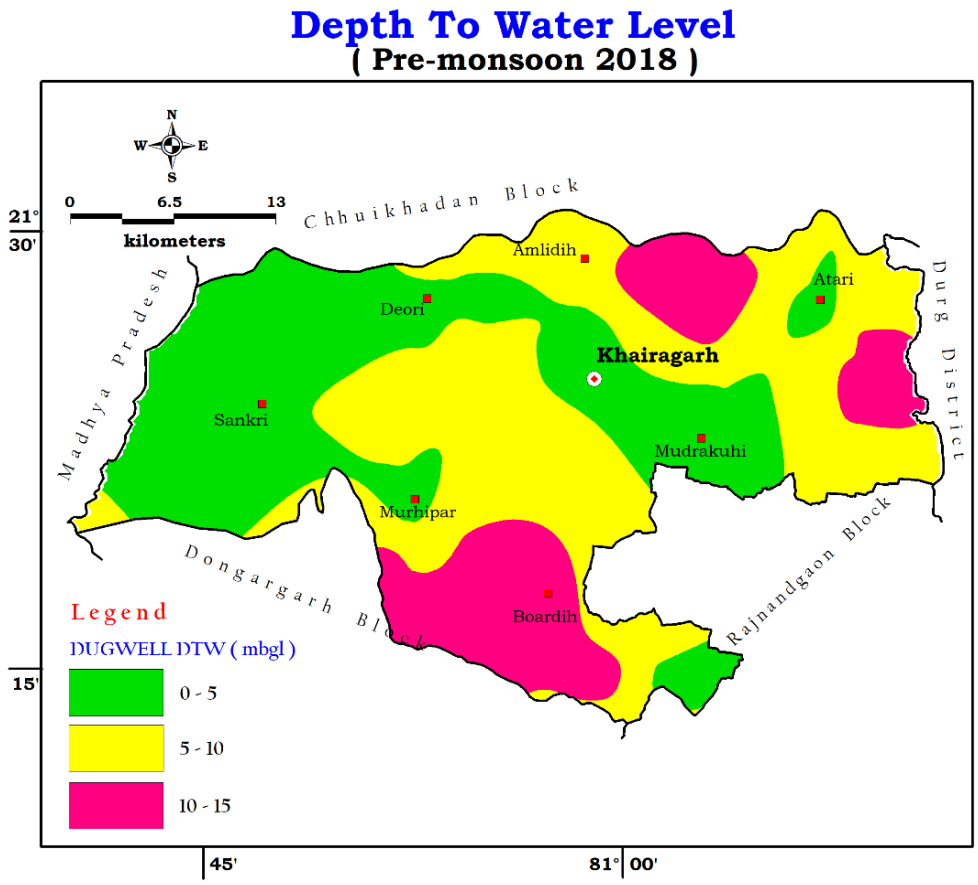


Figure 4 Pre monsoon Depth to water level of Phreatic Aquifer

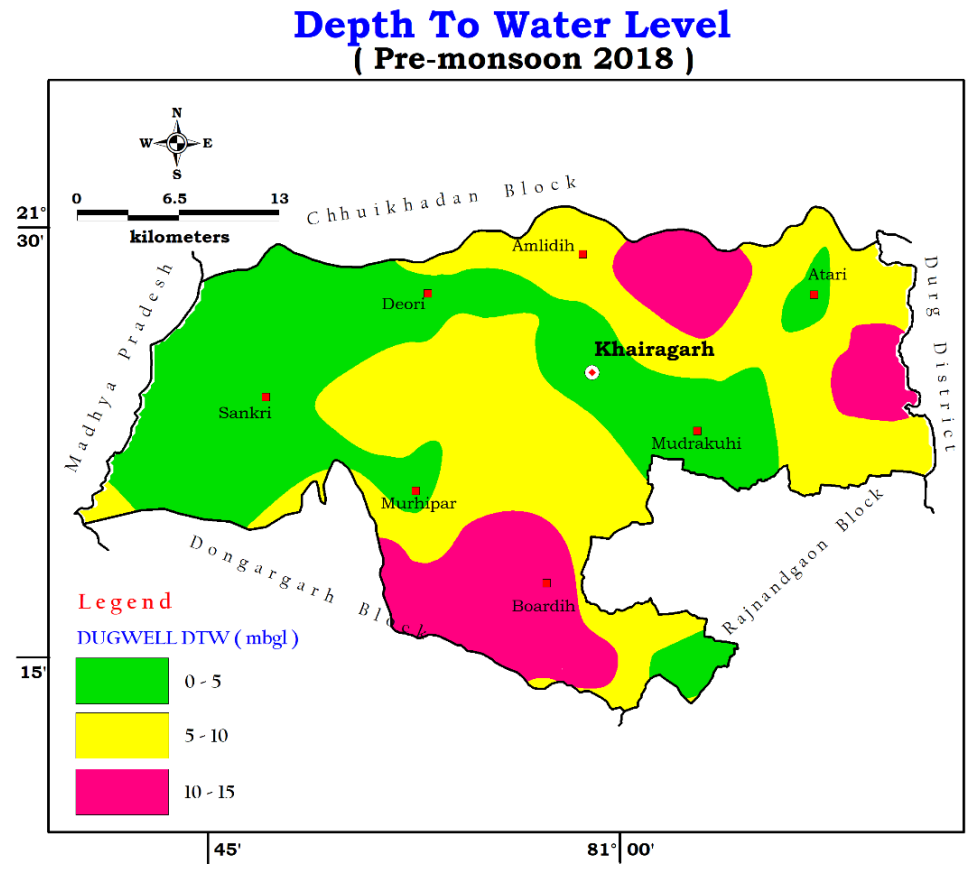


Figure 5 Pre monsoon Depth to water level of Semiconfined Aquifer

1.7.2 Post- monsoon water level (Nov 2018):

In the post-monsoon period, it has been observed that in Khairagarh block, water level in Phreatic aquifer vary between 0.4 to 13.7 m bgl with average water level of 5.62 m bgl shown in Table No. 5(C). In deeper semi-confined aquifer, water level varies between 6.41 to 19.19 m bgl with average water level of 13.13 m bgl shown in Table No. 5(D).

Table 5(C) Aquifer wise Depth to Water Level (Post-monsoon)

Block Name	Phreatic Aquifer		
	Min	Max	Avg
Dongargarh	0.4	13.7	5.62

Table 5(D) Aquifer wise Depth to Water Level (Post-monsoon)

Block Name	Semi-confined Aquifer		
	Min	Max	Avg
Dongargarh	6.41	19.19	13.13

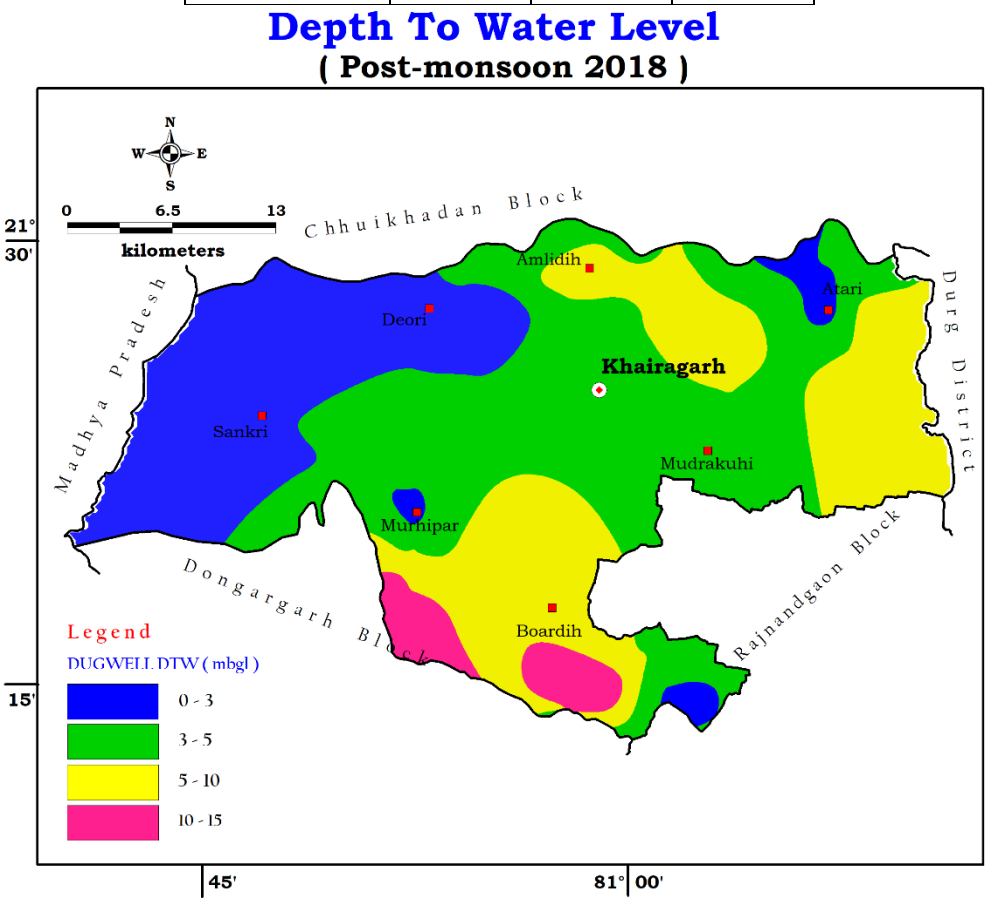


Figure 6 Post monsoon Depth to water level of Phreatic Aquifer

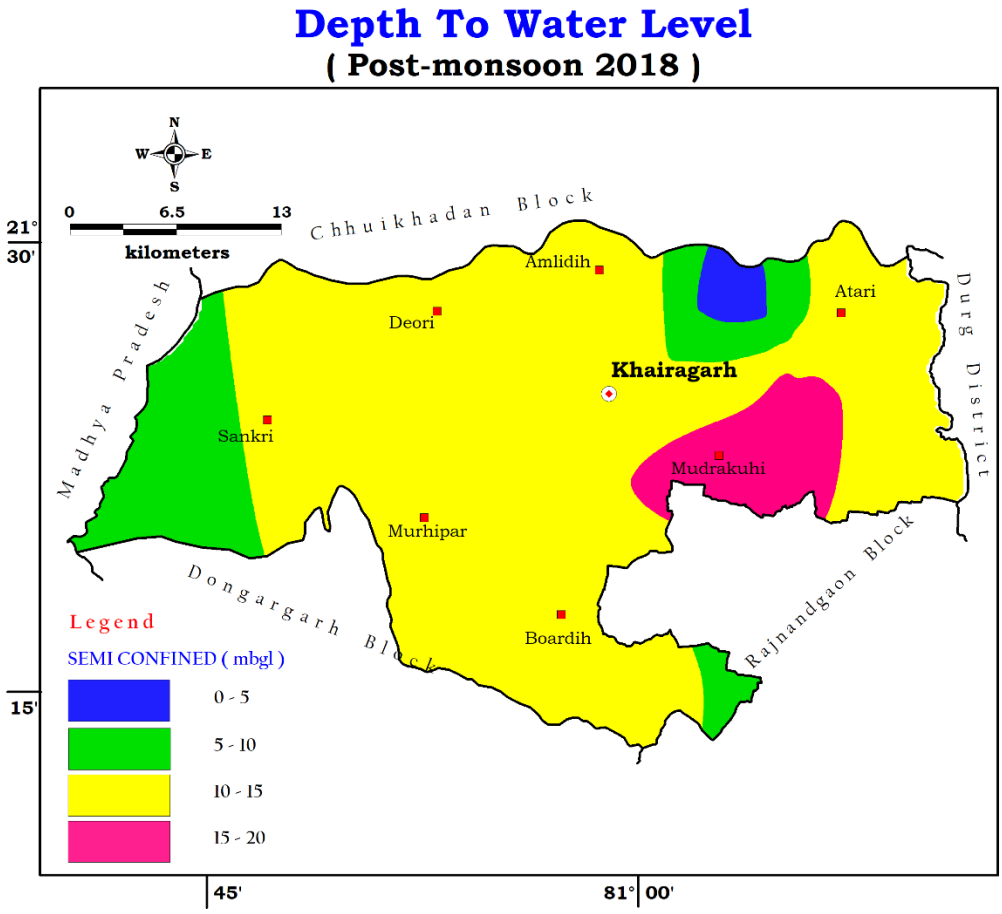


Figure 7 Post monsoon Depth to water level of Semiconfined Aquifer

1.7.3 Seasonal water level fluctuation:

The water level fluctuation data indicates that in Khairagarh block, water level fluctuation in phreatic aquifer varies from 0.2 to 6.6m with an average fluctuation of 2.25m show in Table No. 5(E). Water level fluctuation in semi-confined aquifer varies from 2.23 to 11.2 m with an average fluctuation of 5.05 m shown in Table No. 5(F).

Table 5(E) Aquifer wise Depth to Water Level Fluctuation (Phreatic aquifer)

Block Name	Phreatic Aquifer		
	Min	Max	Avg
Dongargarh	0.2	6.6	2.25

Table 5(F) Aquifer wise Depth to Water Level Fluctuation (Semi-confined aquifer)

Block Name	Semi-confined Aquifer		
	Min	Max	Avg
Dongargarh	2.23	11.2	5.05

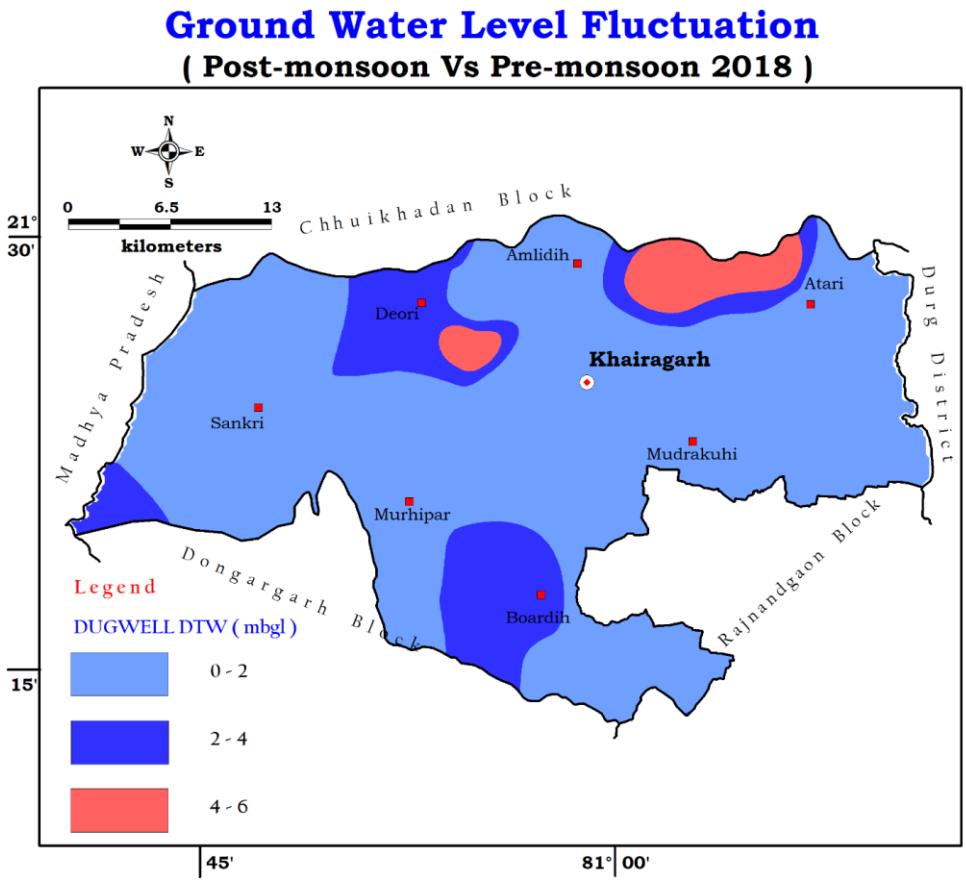


Figure 8 Ground water level fluctuation of Phreatic Aquifer

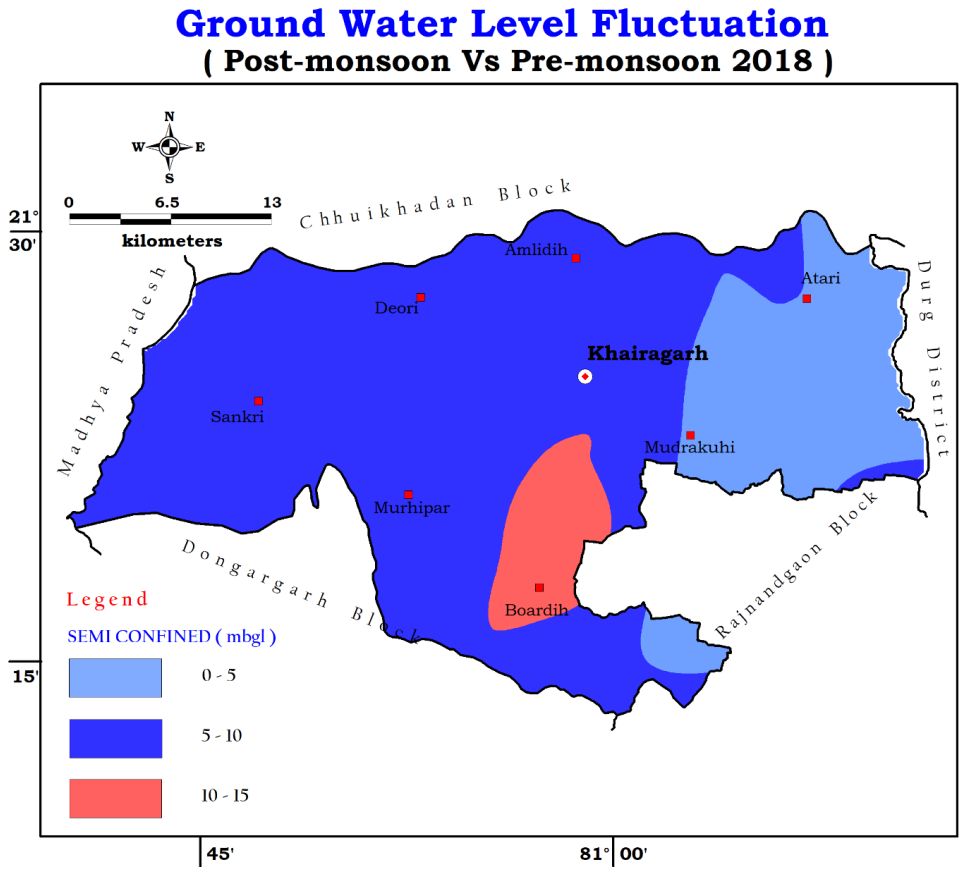
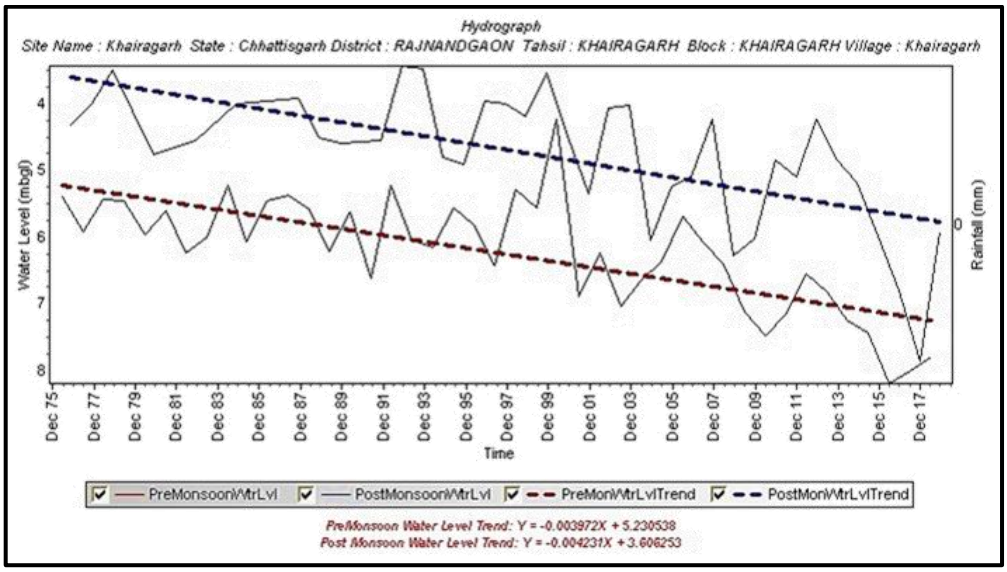


Figure 9 Ground water level fluctuation of Semiconfined Aquifer

1.7.4 The long-term water level trend:



Considering the last 40 years from 1975 to 2017 there was fall in both pre-monsoon and post-monsoon water level trend which implies the extraction of ground water was increased.

2. AQUIFER DISPOSITION:

2.1 Number of Aquifers:

There are two major aquifers present in this block. As the aquifers are Consolidated in nature, so further those aquifers are divided in to two sub aquifers in Z-direction. One is Aquifer-I, which represents the Phreatic Aquifer or Weathered zone and another one is Aquifer-II, which represents Fractured Aquifer or Semi-confined aquifer as the fractures are connected to the weathered zone.

Table 6 Details of Aquifer in Khairagarh Block

Geological Formation	Aquifer	Area Covered (Sq. k. m.)
Chandi Limestone	Chandi Limestone *Aquifer-I (Phreatic Aquifer)* *Aquifer-II (Fractured aquifer*)	438
Khairagarh Group	Basic volcanics *Aquifer-I (Phreatic Aquifer)* *Aquifer-II (Fractured aquifer*)	338

1. Chandi-formation occupying the central- eastern part of the district covers about 790 sq.km of the area in parts of Khairagarh and Chhuikhadan blocks. It comprises a thick sequence of Stromatolitic limestone, dolomite & shale has a gradational contact with the underlying Gunderdehi shale. In middle horizon of this formation, stromatilitic limestone and flaggy limestone are associated with green calcareous shale.
2. The Khairagarh volcano-sedimentary sequence is exposed along the Kotri–Dongargarh Belt towards the north-eastern part of the Bastar Craton. This sequence is exposed south of the Central Indian Shear (CIS) and east of the Sakoli Group rocks. The Khairagarh group rocks are basic in nature and unconformably overlies the rock of Dongargarh granite.

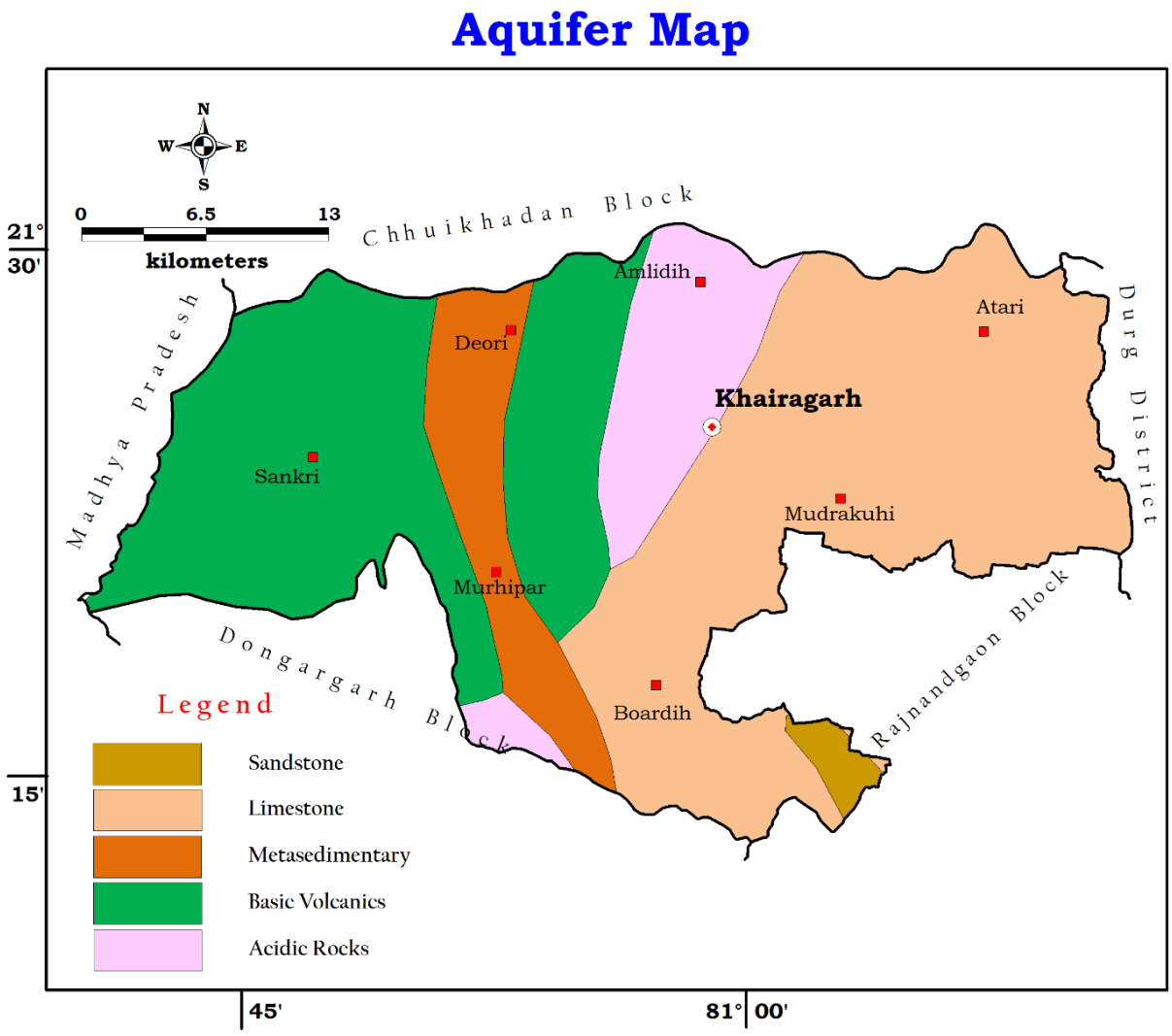


Figure 10 Aquifer Map of Khairagarh Block

2.2 3-d aquifer disposition and basic characteristics of each aquifer:

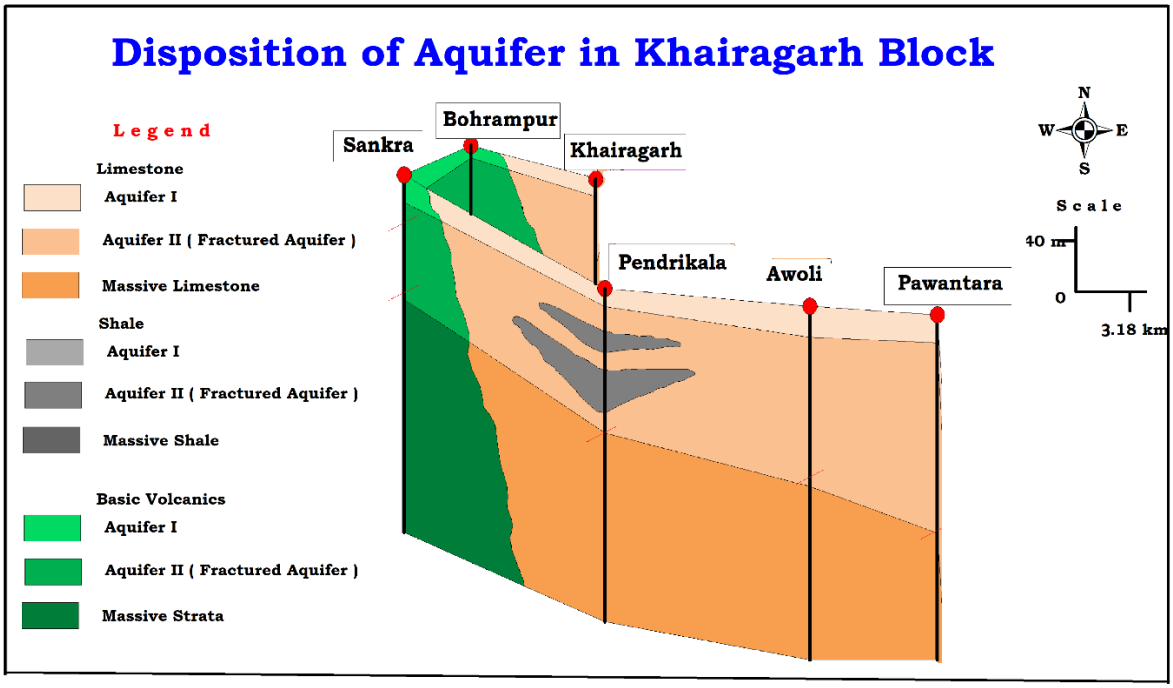


Figure 11 Fence diagram of Khairagarh Block

Table 7 Aquifer Characteristics of Khairagarh Block

Places		Khairagarh	Sankra	Pendrikala	Pawantara
Major Formation		Limestone and Basic volcanics	Basic volcanics	Limestone and Shale	Limestone
Thickness (in m)	Aquifer-I	9.7	17.7	14.2	35
No of potential zone	Aquifer-II	3 (45.5-48.6, 57.7-60.8, 85.2-88.2)	2 (24.20-27.20, 66.9-69.9)	1 (79.1-82.2)	2 (39.40-42.50, 121.80-124.8)
Yield (lps)		6.18	2.49	0.078	0.731
Transmissivity (m2/day)		12.36	14.591	30.59	18.23
Drawdown (m)		21.24	13.32	20	23.98

3. GROUND WATER RESOURCE, EXTRACTION, CONTAMINATION AND OTHER ISSUES:

Aquifer wise resource availability is given in the following table where the total resource available in Khairagarh block is 3467.61 ham. The extraction details and the future scenario (2025) along with the categorization is depicted in the table

Table 8 Ground Water Resources of Khairagarh block in Ham

Net Annual Ground Water Availability (Ham)	23646.5
Existing Gross Ground Water Draft for All uses (Ham)	5557.18
Provision for domestic requirement supply to 2025(Ham)	653.47
Stage of Ground Water Development %	65.56
Category	Safe

Name of Block	Annual Extractable Ground Water Recharge (Ham) (7=5-6)	Current Annual Ground Water Extraction (Ham)				Annual GW Allocation for Domestic Use as on 2025	Net Ground Water Availability for future use (13=7-8-9-12)
		Irrigation Use	Industrial Use	Domestic Use	Total Extraction (11=8+9+10)		
Khairagarh	**7**	**8**	**9**	**10**	**11**	**12**	**13**
	9409.46	5267.50	0.12	524.38	5792.00	674.23	3467.61

4. GROUND WATER RESOURCE ENHANCEMENT:

4.1 Aquifer wise space available for recharge and proposed interventions:

Table 9 Aquifer wise space availability

Block	Area Identified for Artificial Recharge* Sq.Km	Average Depth to Postmonsoon water level (mbgl)-3			Sy	Sub surface storage potential (mcm)	Surface Water Requirement (mcm)
		3 to 5	5 to 10	10 to 15			
Khairagarh	710.18	1	4.5	9.5	0.015	29.7	39.5

5. ISSUES:

i. The aquifer itself is a low yielding one due to which during summer, dugwells in almost all villages are dry except a few locations. Several handpumps also stop yielding water.
ii. It has been observed during fieldwork in pre-monsoon period, there is colossal wastage of groundwater through public water supply system.
iii. Uneven distribution of yield potential in consolidated Khairagarh Group.
iv. Good potential zone confined in structurally low laying areas whereas in higher elevation, it is poorly yielding
v. There is further scope of groundwater development.

6. MANAGEMENT PLAN:

6.1 Supply side interventions:

i. Sanctuary wells may be constructed for drinking needs as a step towards crisis management.
ii. It has been observed during fieldwork in pre-monsoon period, there is colossal wastage of groundwater through public water supply system. In this state, the Government has undertaken "Nal Jal Yojana" to provide water to villages. Under this scheme, the government has dug borewells of about 150-200feet depth, lowered a pump in the well to draw out water and constructed a small tank to hold water. Unfortunately, people do not switch off the pump once the tank is full. Also, the pipes are not fitted with taps to control the flow of water. So, Information, education and Communication (IEC) activities to be organized to sensitize people on the issues of depleting groundwater resource. Massive awareness campaigns are essential to aware people about the importance community participation in saving water.
iii. Desiltation of existing Tanks and Talabs to be carried out for efficient storage of rainwater. Also Rain water harvesting structures may be constructed in villages to reduce stress on groundwater.
iv. it has been observed that the demand of ground water is increasing for irrigation, industrial and domestic uses. At location near urban areas water level is declining, so we have to go for artificial recharge on a long-term sustainability basis. Artificial Recharge structures may be constructed at suitable locations especially in the areas where the water level remains more than 3m in the post-monsoon

period in this block to arrest the huge non-committed run-off and augment the ground water storage in the area. The different types of artificial structures feasible in the block are described in table

v. Recharge should be practice in dried up bore well and Dug well.

vi. Govt. may set up network of grids to purchase electricity generated from solar panels. This will encourage the farmers not to waste electricity by extracting groundwater unnecessarily and also provide alternative income.

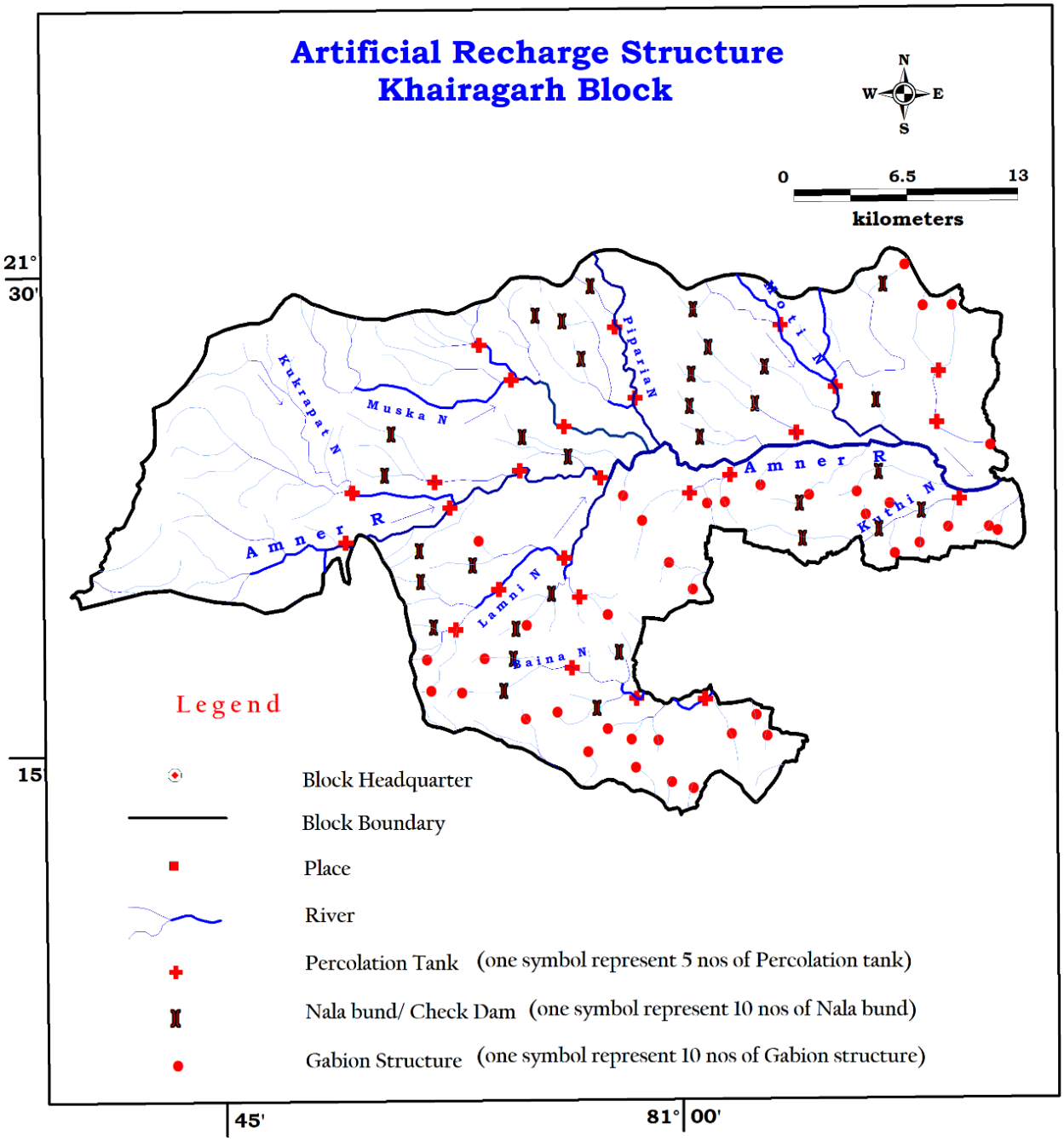


Figure 12 Management plan of Khairagarh Block

Table 10 Types of Artificial Recharge structures feasible

Name of Block	Area Feasible for recharge (sq.km)	Sub surface storage potential (mcm)	Types of Structures Feasible and their Numbers		
			P	NB & CD	G
Khairagarh	710.18	39.5	135	329	395
	Recharge Capacity		27	9.87	1.975
	Estimated cost (Appx. 305 million rupees)		270	32.9	3.95

6.2 Demand side interventions:

i. Change in Irrigation practices- Water can be Saved using micro irrigation methods such as sprinklers, drip irrigation etc.
ii. Change in cropping pattern- Water can be Saved by change crops from paddy to Maize.
iii. Control on wasting water through Public water Supply- Unfortunately, people do not switch off the pump once the tank is full. Also, the pipes are not fitted with taps to control the flow of water.
iv. Sapling should be planted in Barren land

7. CONCLUSION:

An area of 805 sq.km of Khairagarh block of Rajnandgaon district has been considered for Aquifer Mapping and Management Plans. The total ground water resource is 23646.5 Ham with stage of ground water development 65.56% and categorized as “Safe”. 66.36 % of the irrigated area is uses groundwater for irrigation. The major aquifer groups are Khairagarh group (Basic volcanics) and Chandi Formation (Limestone). In terms of Demand side management, by change in cropping and irrigation pattern (micro irrigation methods) water can be saved respectively. In terms of Supply side management, Percolation Tank (135), Nala bund or Check dam (329) and Gabion structures (395) can be constructed to recharge 39.5 MCM water to underground. and constructing of tubewell at suitable locations, drinking water needs may be fulfilled.