केंद्रीय भूमि जल बोर्ड

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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

RAJNANDGAON DISTRICT, CHHATTISGARH

उत्तर मध्य छत्तीसगढ़ क्षेत्र, रायपुर

North Central Chhattisgarh Region, Raipur

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

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1. INTRODUCTION

1.1 Objective

The groundwater is the most valuable resource for the country. However, due to rapid and uneven development, this resource has come under stress in several parts of the country. Central Ground Water Board (CGWB) is, therefore, involved in hydrogeological investigations for Re-appraisal of ground water regime. CGWB has also carried out ground water exploration in different phases with prime objective of demarcating and identifying the potential aquifers in different terrains for evaluating the aquifer parameters and also for developing them in future. The reports and maps generated from the studies are mostly based on administrative units such as districts and blocks and depict the subsurface disposition of aquifer on regional scale. However, due to paradigm shift in focus from development to management of ground water in last one decade, the need for more reliable and comprehensive aquifer maps on larger scale has been felt for equitable and sustainable management of the ground water resources at local scale.

1.2 Scope of study

The demand for ground water for various types of use is increasing day by day; consequently, indiscriminate development of ground water has taken place and the ground water resource has come under stress in several parts of the country. On the other hand, there are also areas where adequate development of ground water resources has not taken place. These facts underscore the need for micro- level study of the aquifer systems of the country. The water resource managers and planners to develop and implement effective long term as well as short term aquifer management strategies, a host of scientific questions must be answered. These questions can be best answered through a comprehensive process that integrates the available scientific data. Aquifer mapping study thus is a multidisciplinary scientific process wherein a combination of geological, hydrogeological, geophysical, hydrological and quality data is integrated to characterize the quantity, quality and movement of ground water in aquifers. It primarily depends on the existing data that are assembled, analyzed and interpreted from available sources. The data gap analysis carried out helped to generate data from data newly collected through activities such as exploratory drilling, groundwater level monitoring on a regular basis for a considerable period and groundwater quality analysis. These existing as well as generated data were analyzed in ordered to prepare regional hydrogeological, thematic, water quality maps, cross-sections, 2 –D and 3-D aquifer disposition maps. The aquifer

maps are the maps depicting aquifer disposition, giving lateral and vertical extension. The maps will also provide information on the quantity and quality. It explains the components of the Aquifer Classification System, outlines the assumptions underlying the map information presented and summarizes the content of an aquifer classification map. The goal is to help the map users understand the strengths and limitations of the information contained on the aquifer classification maps so that they can apply that information appropriately to their particular water and land management needs. The system and maps are designed to be used together and in conjunction with other available information as a screening tool for setting groundwater management priorities. These provide a way of comparing aquifers within a consistent hydrogeological context and prioritizing future actions at various planning levels. The maps may provide some background information for site-specific projects. However, the maps are not to be used for making site-specific decisions. The classification of an aquifer reflects the aquifer as a whole and at a specific time. Groundwater conditions, such as the degree of vulnerability and water quality, may vary locally and over time respectively. This variability in the data sometimes requires subjective decision-making and generalizing of information for an entire aquifer.

1.3 Approach and Methodology

The activities under the aquifer project can be summarized as follows:

i) Data Compilation & Data Gap Analysis: One of the important aspects of the aquifer mapping Programme was the synthesis of the large volume of data already collected during specific studies carried out by the Central Ground Water Board and various other government organizations with a new set of data generated that broadly describe an aquifer system. The data were compiled, analyzed, synthesized and interpreted from available sources. These sources were predominantly non-computerized data that were converted into computer-based GIS data sets. On the basis of these available data, Data Gaps were identified.

ii) Data Generation: It was evident from the data gap that additional data should be generated to fill the data gaps in order to achieve the objective of the aquifer mapping Programme. This was done by multiple activities like exploratory drilling, hydro chemical analysis, use of geophysical techniques as well as detail hydrogeological surveys.

ii) Aquifer map Preparation: On the basis of integration of data generated through various hydrogeological and geophysical studies, aquifers have been delineated and characterized in terms of quality and potential. Various maps have been prepared bringing out the Characterization of Aquifers. These maps may be termed as Aquifer Maps depicting

spatial (lateral and vertical) variation of the aquifers existing within the study area, quality, water level and vulnerability (quality and quantity).

iv) Aquifer Management Plan: Based on the integration of these generated, compiled, analysed and interpreted data, the management plan has been prepared for sustainable development of the aquifer existing in the area.

1.4 Area Details

Under the aquifer mapping Programme, an area comprising of 5 no of development blocks namely Rajnandgaon, Khairagarh, Chuikadan, Dongargaon, and Dongargarh of Rajnandgaon district was taken up covering an area of 4197 sq. km. Rajnandgaon district is situated in the westtern part of the Chhattisgarh state. It falls in the Survey of India's Degree Sheet No. 64 C, D, G and H between the Latitude 20°70'- 22°29'N and Longitude 80°23' to 81°29'. It is surrounded by Kawardha district in north, Durg district in the east, Bastar district is in the south and Garchiroli, Bhandara (Maharashtra) and Balaghat (Madhya Prasesh) districts in the west. The District headquarter Rajnandgaon is on the Mumbay - Howrah line of southeastern railways. The National Highway no. 6 (Great Eastern Road) also passes through the town of Rajnandgaon. The nearest airport to the District is at Mana (Raipur), about 80 kms away. All-important places within the district are well connected by a network of the state highways and all-weather roads.

1.4.1 Administrative Division

District includes 09 blocks and It is further divided in 1 Nagar Palik Nigam, 2 Nagar Palika, 5 Nagar Panchayat, 9 Janpad Panchayat, 692 Gram Panchayat among which the study area confined with 05 blocks and 502 Panchayats. The name of the 9 blocks are given below.

1. Rajnandgaon Block
2. Dongagaon Block
3. Dongargarh Block
4. Khairagarh Block
5. Chuikhadan Block
6. Chhuriya Block
7. Ambagarh Chowki Block
8. Mohla Block
9. Manpur Block

The administrative map for the study area is given in Figure 1.

Administrative Map

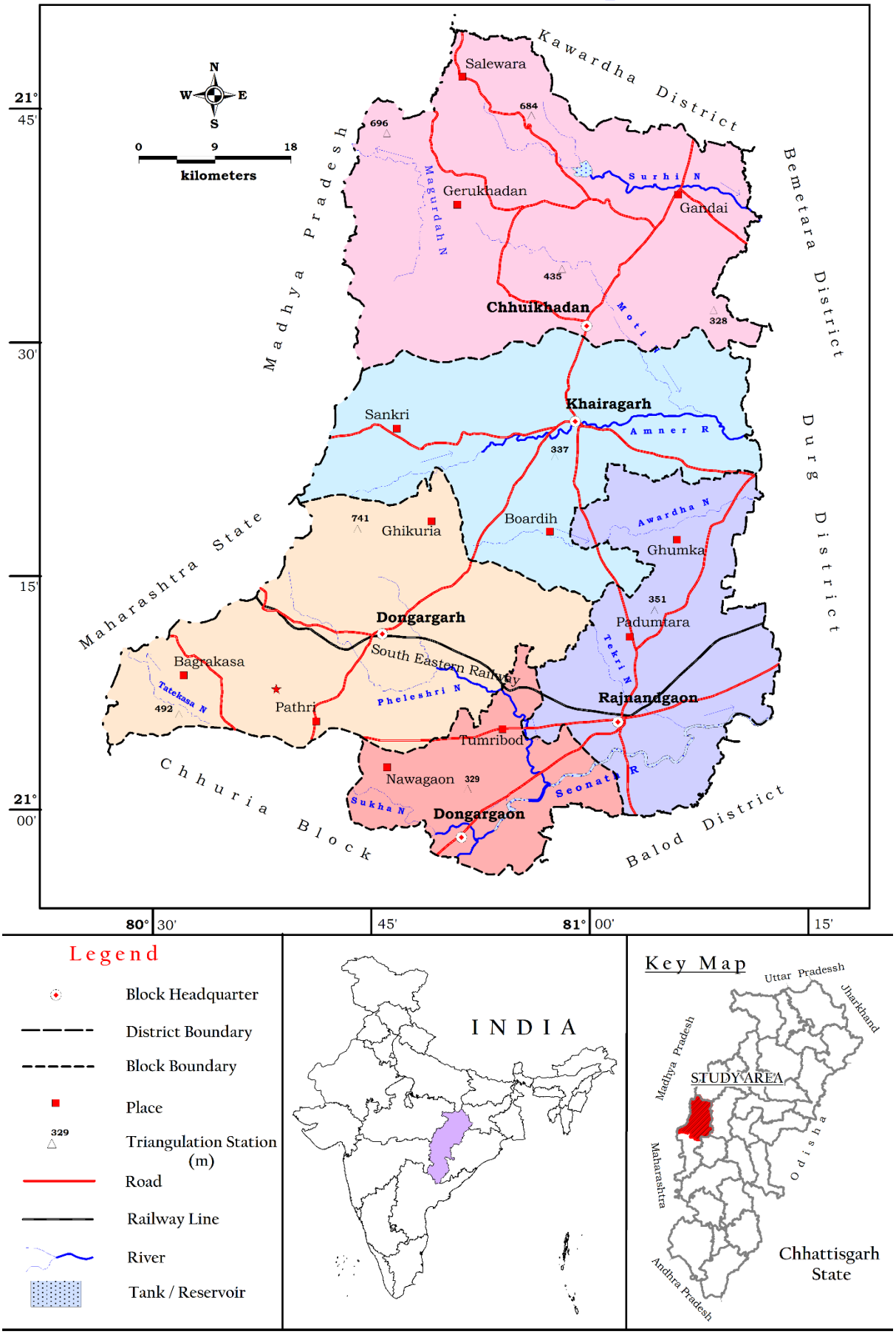


Figure 1 Administrative Map of Rajnandgaon District

1.5 Data Availability, Data Adequacy and Data gap Analysis

Table 1 Data Integration

District	Block	Existing				Data generation			
		EW	CHEM	VES	WL	EW	CHEM	VES	WL
Rajnandgaon	**Rajnandgaon**	8	18	15	21	5	15	14	24
	Dongargaon	13	4	8	6	3	8	-	17
	Dongargarh	12	13	12	13	6	10	12	20
	Khairagarh	5	10	16	12	6	15	12	29
	Chuikhadan	8	5	17	7	2	10	12	15
Total		**46**	**50**	**68**	**59**	**22**	**58**	**50**	**105**

1.6 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 and nearly 95% of the annual rainfall is received during this period. The average annual rainfall for the study area is around 1037 mm (Average of the last five years i.e. 2012 to 2017) which is presented below in Figure 2. *Source: IMD. Raipur*

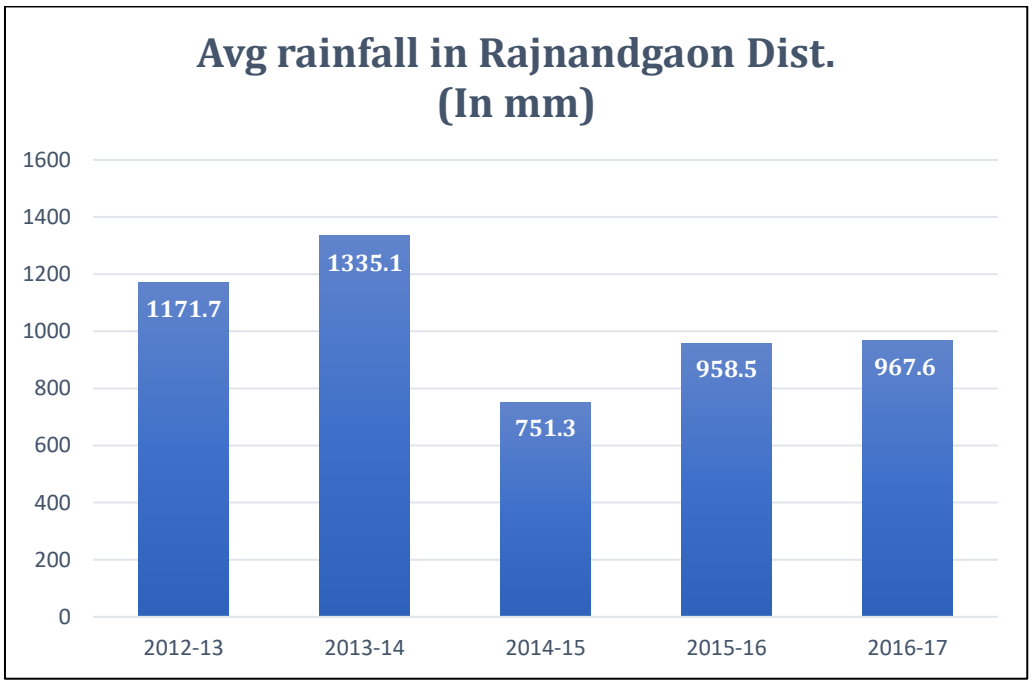


Figure 2 Avg. Rainfall in Rajnandgaon District

1.7 Physiography/Geomorphology

Geomorphologically the study area displays;

- Structural Plains and valleys
- Pediment/Pediplain
- Structural plain on Proterozoic rock
- Flood Plain
- Denudational plateau on magmatic and metamorphic rock

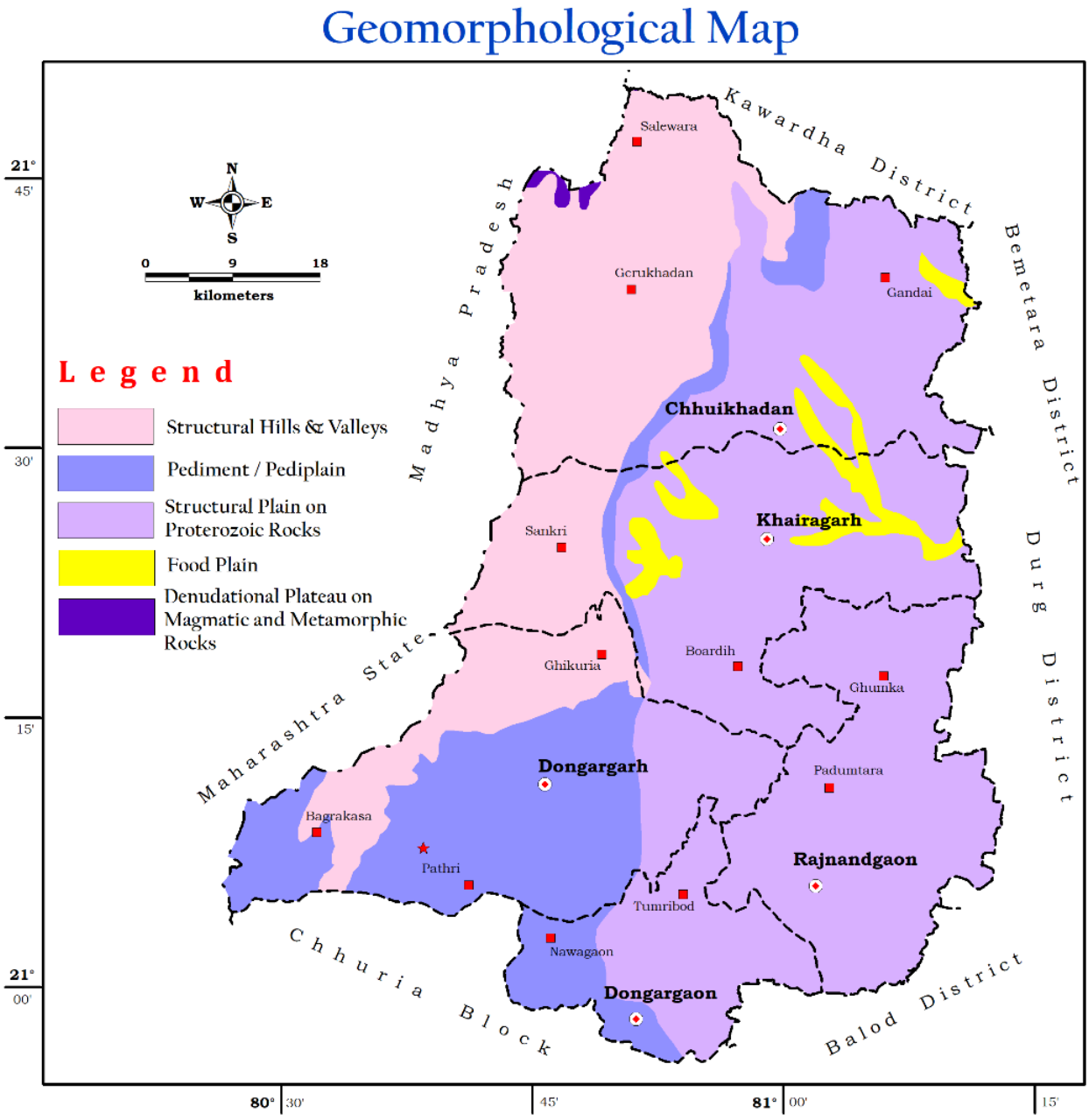


Figure 3 Geomorphology Map of the Study area

All these Geomorphologic structures comes under the physiographic unit belonging to Chhattisgarh basin area. The Central Chhattisgarh Plain is represented by Structural Plain

on Proterozoic rocks which cover major area in the eastern & central part of the district. This unit is developed over rocks of Purana sedimentary basin of Chhattisgarh. This unit has extensive cris-crossed fractures and joints. They are having gently sloping erosional surfaces and thin to moderate cover of soil.

Along with the above-mentioned geomorphic unit, Pediment/Pediplain is also developed in the district especially in Southern part of the study area. The eastern part is covered by structural hills and valleys. Figure 3 shows the Geomorphology in the study area.

1.8 Land use

There is 98955 ha revenue forest and protected forest, other forest in the district. Area not available for cultivation is 69413 ha. Details are presented in Table no.2. Figure 4 shows the Landuse pattern in the study area.

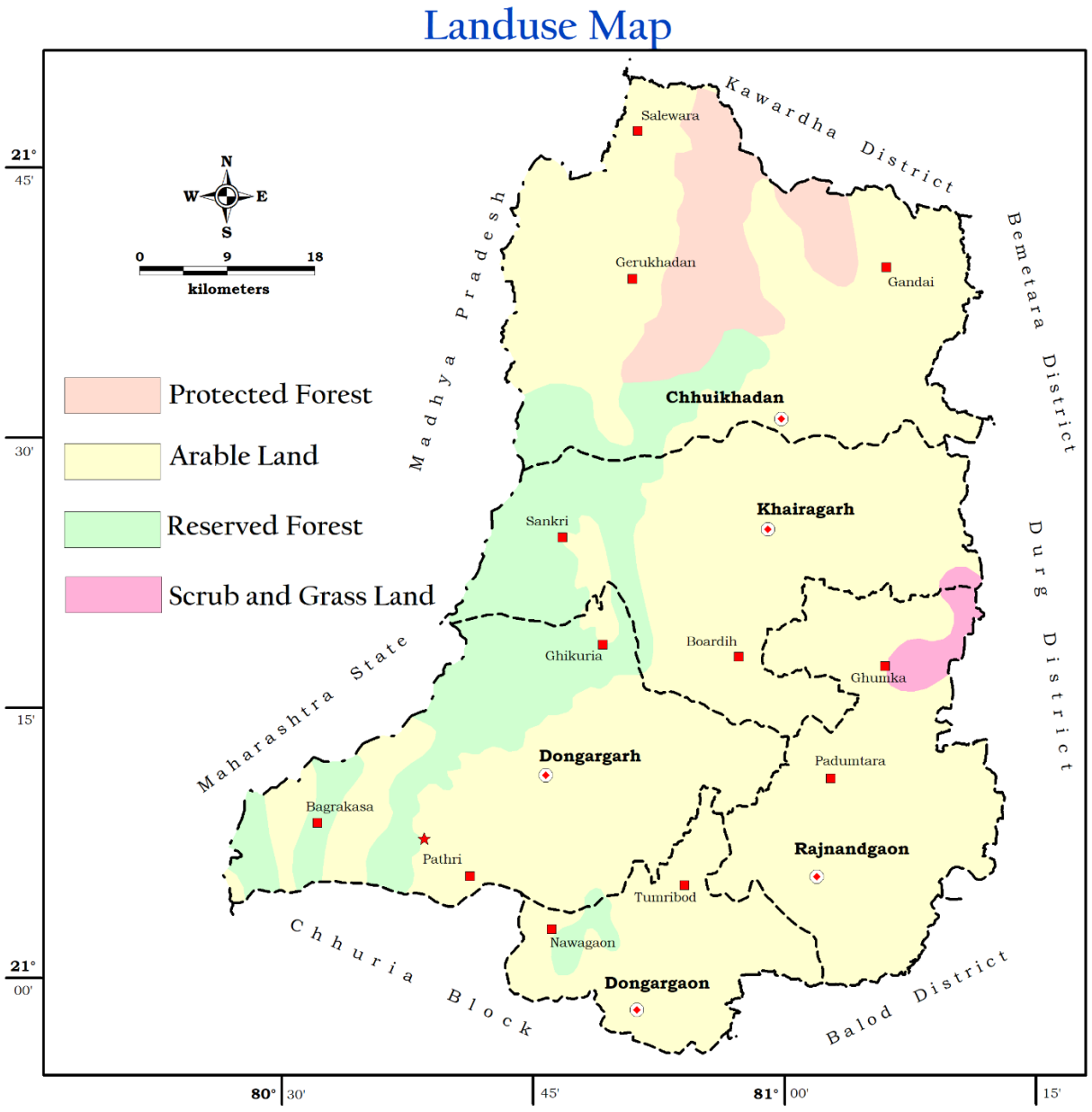


Figure 4 Landuse map of the study area

Table 2 Land use pattern (in ha)

District	Total Geographical Area (In ha)	Revenue forest area (In ha)	Area not available for cultivation (In ha)	Non-agricultural & Fallow land (In ha)	Agricultural Fallow land (In ha)	Net sown area (In ha)	Double cropped area (In ha)	Gross cropped area (In ha)
Rajnandgaon	642507	98955	69413	54737	41285	357568	136162	493730

1.9 Soil

The soils in the district are having wide variations. In all two types of soils are abundant in the study area and are mostly insitu in nature. They are red sandy Alfisols and the medium black Vertisols. Figure 5 represents the different kind of soil that present in the study area.

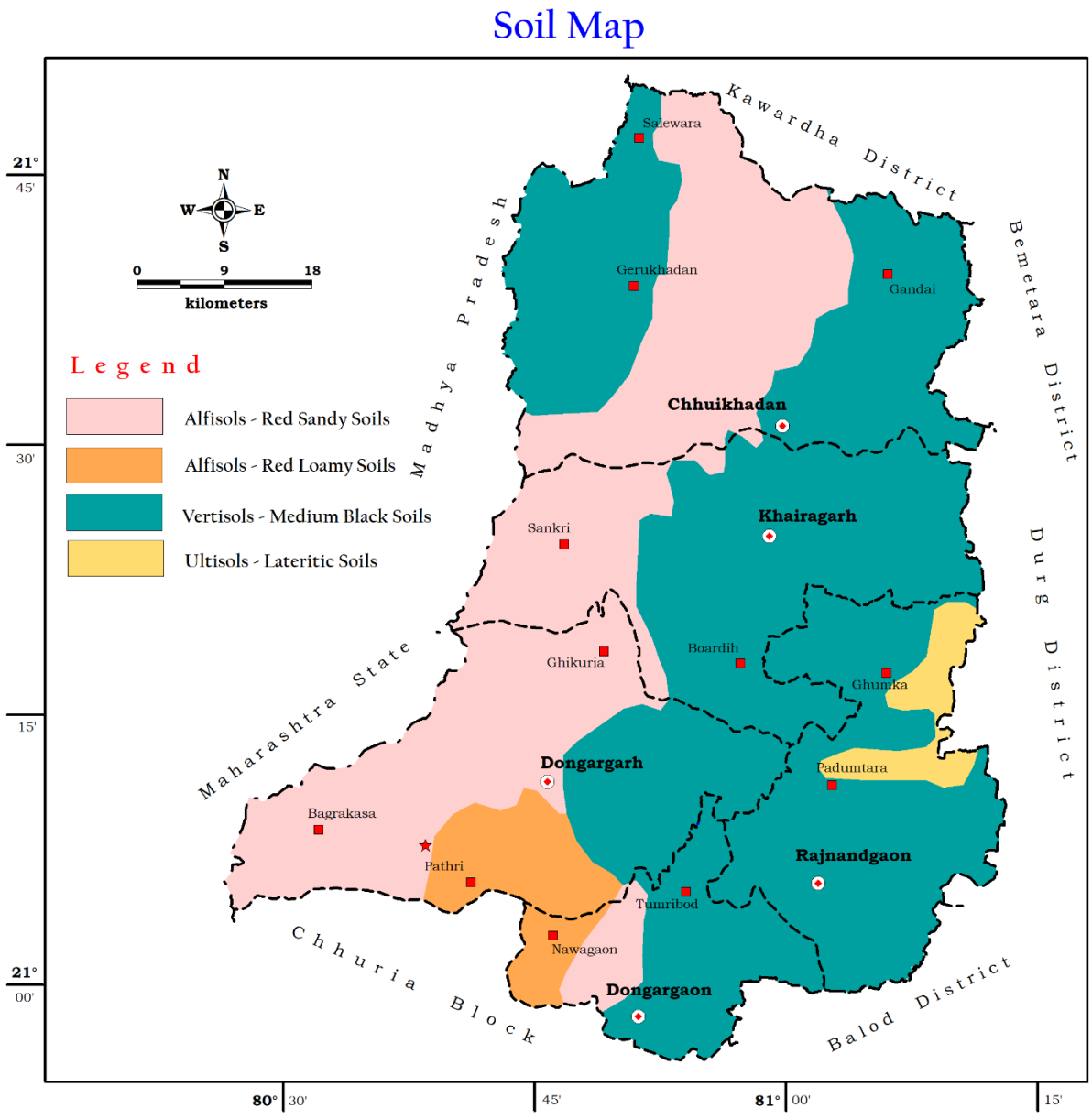


Figure 5 Soil map of the study area

1.10 Hydrology and Drainage

The general slope of the district is towards east. All the rivers of the distric flow in eastern direction. Seonath is the most important river. The important tributaries of the river are Amner, Jonk, Ghumriya, Pairi Zura and Hanf. Nearly 71.8 percent area of the district falls under Mahanadi river basin. The river Seonath which is a tributary of Mahanadi, originates near village Kotgul, Garh-Chiroli district (Maharashtra) on the border of Chowki block and is the principal river of this district and is a fifth order river. The drainage density is very high on the western part of the area and is low on the eastern part. The high drainage density indicates higher run off and less infiltration. (Figure 6)

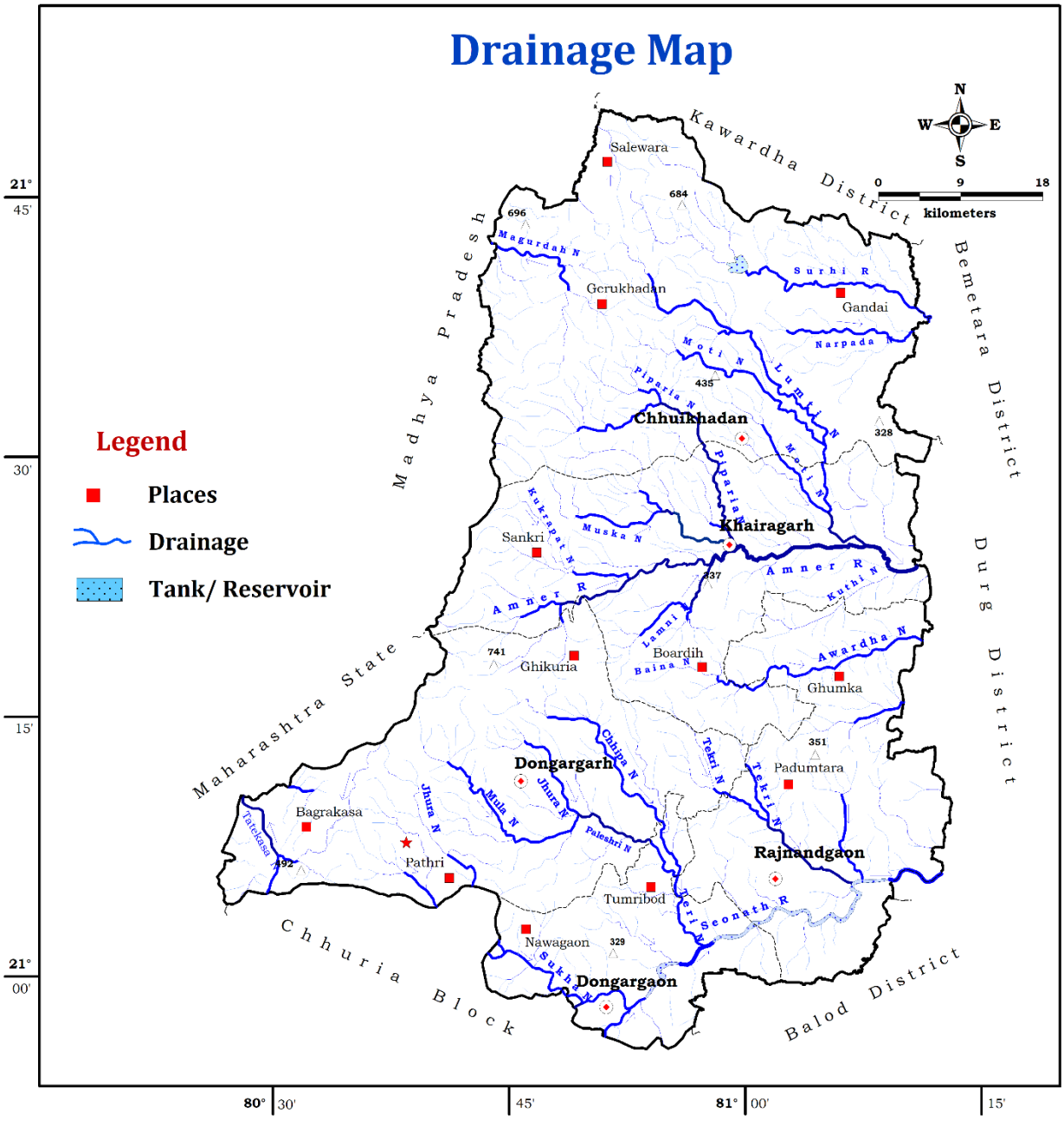


Figure 6 Drainage map of the study area

1.11 Geology

Rajnandgaon district is mainly underlain by hard rock belonging to Precambrian age, part from these alluvium and laterite of Quaternary age occur in very isolated pocket with and limited extension. Hard rock mainly includes granites and its variants, metasediments, rhyolite etc. and also sandstone, shale, limestone / dolomite sequence belonging to Proterozoic Purana rocks of Chhattisgarh super group. The country rocks are intruded by basic and acid intrusive like dolerite dykes and sills and quartz and pegmatite veins. Major part of the district is occupied by granitic rocks belonging to Dongargarh group followed by Purana rocks of Chhattisgarh Supergroup. The laterite occurs as capping over the country rock in pockets particularly in elevated area in limited thickness. The recent alluvium with limited thickness and extension occur along the major river and stream channels.(Figure 7)

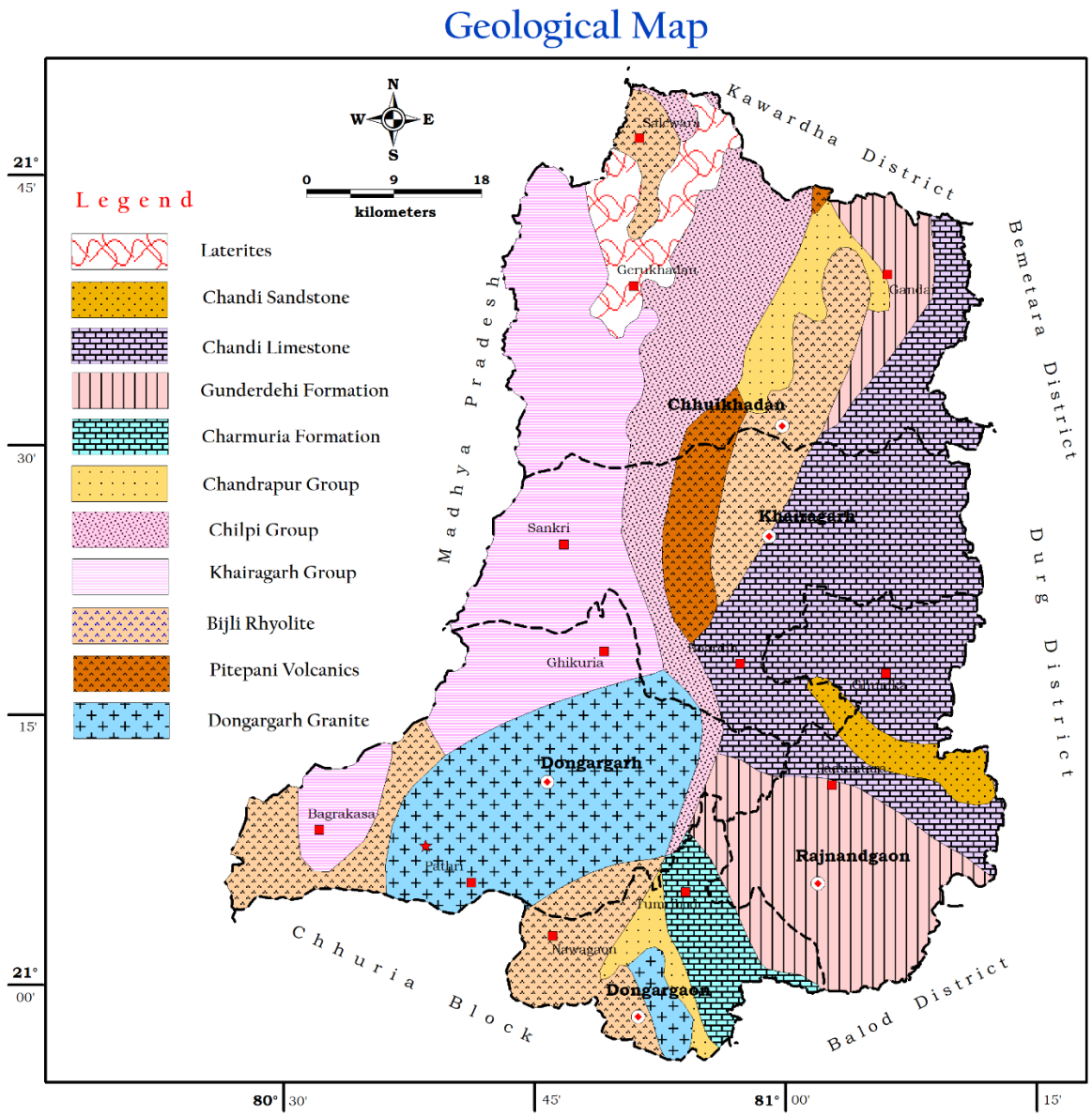


Figure 7 Geological map of the study area

1.12 Agriculture, Irrigation, Cropping Pattern

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 canals and other sources. The groundwater abstraction structures are generally Dugwells, Borewells /tubewells. The principal crops are paddy, wheat, vegetables and pulses. In some areas, double cropping is also practiced. The agricultural pattern, cropping pattern and area irrigated data of Rajnandgaon district is given in Table No. 3 (A, B, C).

Table 3(A) Cropping pattern (in ha)

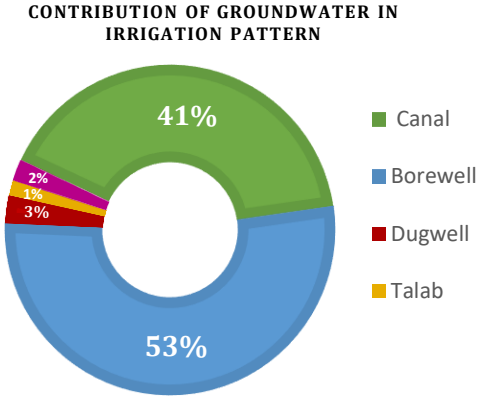
Block	Kharif	Rabi	Cereal				Pulses	Tilhan	Fruits Vegetables	Reshe	Mirch Masala	Sugarcane
			Wheat	Rice	Jowar & Maize	Others						
Rajnandgaon	215728	155627	11789	174603	592	16	86058	19645	14002	7	267	60

Table No. 3(B) 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
123	38285	13366	49710	4295	2544	91	1369	1954	93862	93862	42

Table No. 3(C) Contribution of Groundwater in Irrigation Pattern (in ha)

District	Area Irrigated through Borewells/Tube wells	Area Irrigated through Dug wells	Area Irrigated through Groundwater	Net Area Irrigated through all sources	% Groundwater contribution in Irrigation
Rajnandgaon	49710	2544	52254	93862	55.67



Area Irrigated by groundwater is 52254 ha i.e. 58% (53%-Borewell, 5%-Dugwell) of the total Irrigated area.

2. DATA GENERATION, DATA INTERPRETATION AND DATA INTEGRATION

2.1 Hydrogeological Data

both in phreatic and fractured condition in general two aquifers exist in the area although both are hydraulically connected. The first shallow unconfined/ phreatic aquifer between 0-20 mbgl and the second semi confined to confined aquifer below 20 mbgl. It has been found that within the second aquifer, there are 2-3 set of aquifers which are not well connected. The different sets of aquifers are of different thickness as well as of varying horizontal extent. In the study area, key wells were established during the pre-monsoon period and have been subsequently monitored in the post-monsoon period. The key wells are distributed throughout the study area (Figure 8) covering all the geological formations, the details of which are presented in the Table No

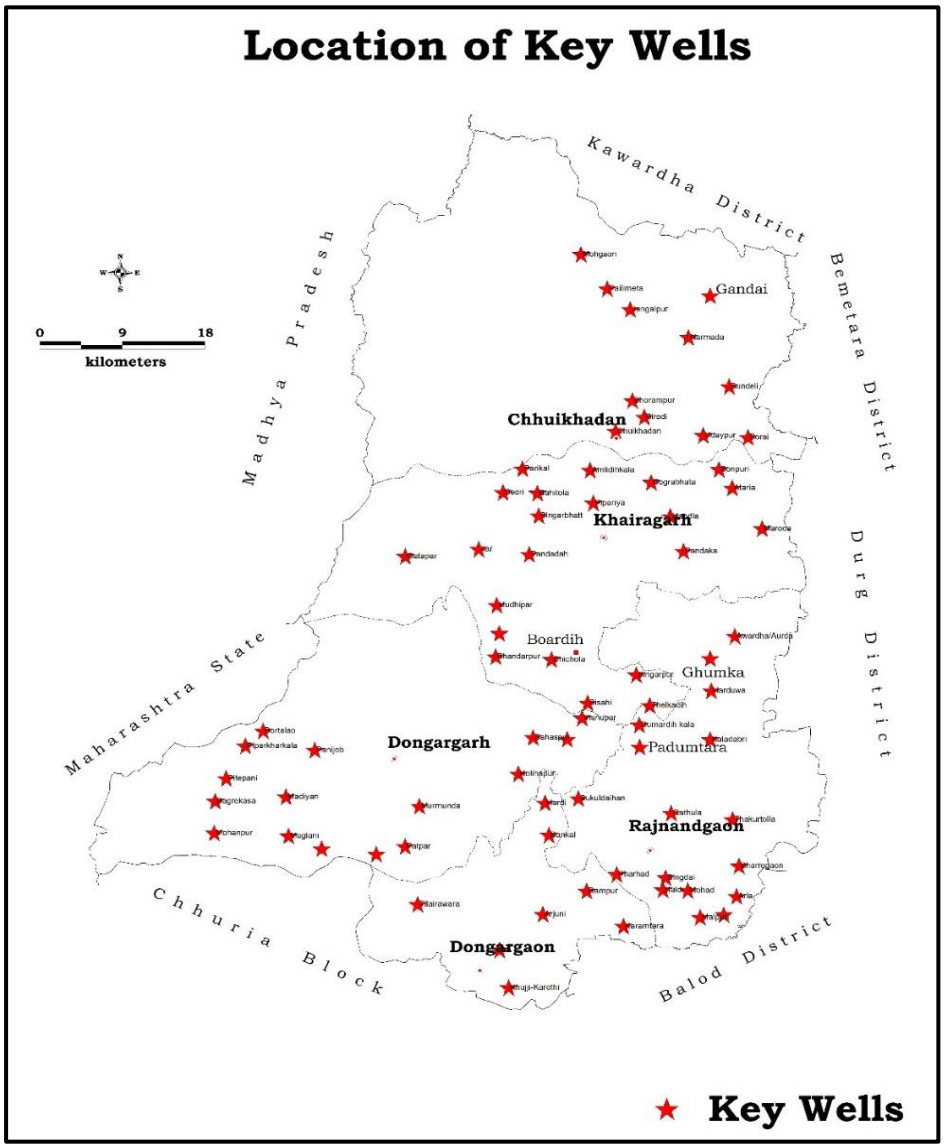


Figure 8 Key Wells of the study area

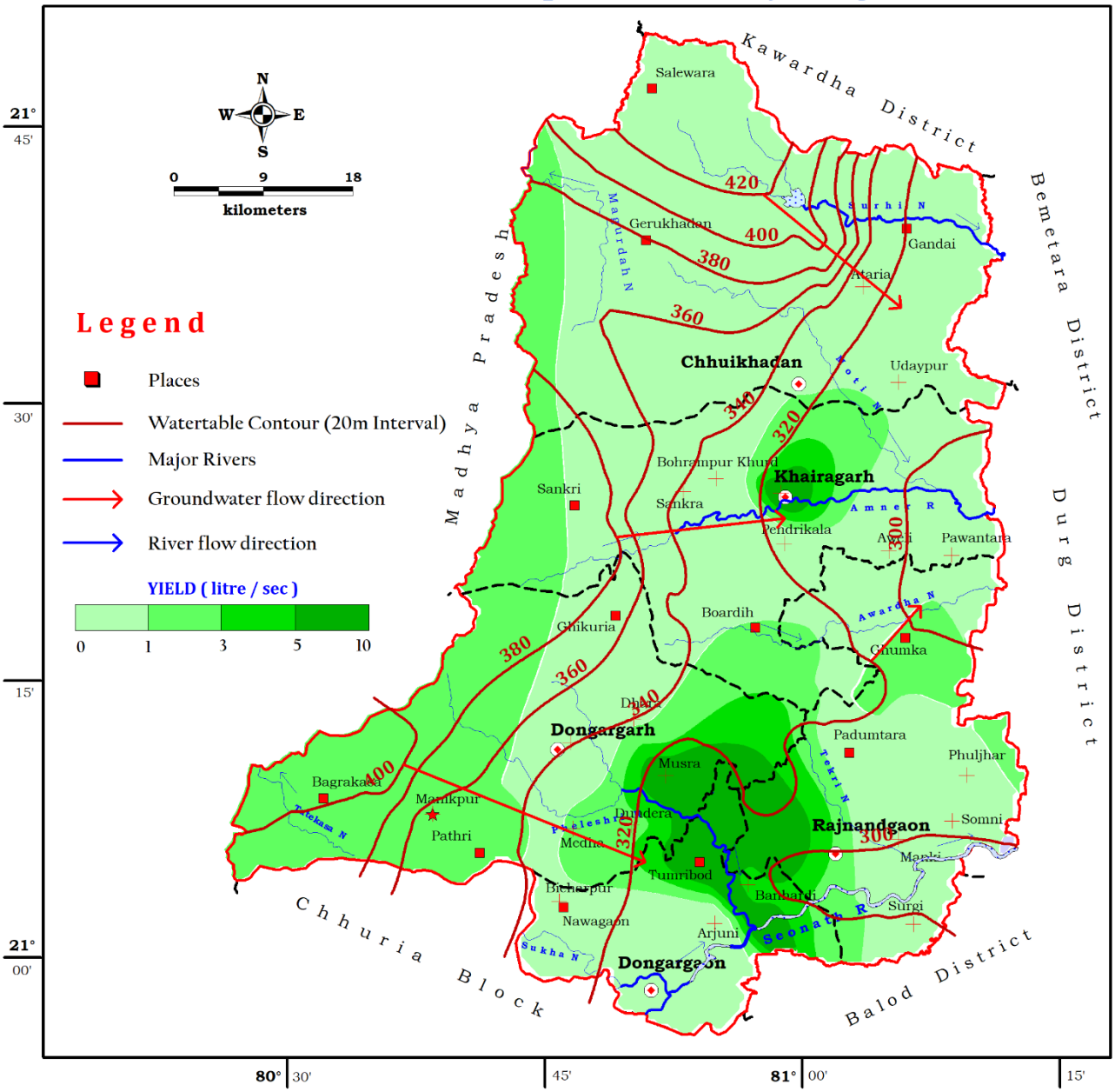


Figure 9 Water table contour map

2.1.1 Water level behavior

Based on the depth to water level periodical monitoring data of the key wells established in the study area, pre-monsoon and post-monsoon depth to water level maps as well as seasonal fluctuation maps have been prepared.

i. Pre- monsoon water level (May 2018):

In the pre-monsoon period, it has been observed that in the study area water level in Phreatic aquifer vary between 1.52 to 14.37 m bgl with average water level of 7.22m bgl shown in Table No. 4(A). In deeper semi-confined aquifer, water level varies between 7.63 to 29.66 m bgl with average water level of 16.97 m bgl shown in Table No. 4(B).

Table 4(A)- Aquifer wise Depth to Water Level (Pre-monsoon)

District Name	Phreatic Aquifer		
	Min	Max	Avg
Rajnandgaon	1.52	14.37	7.22

Table No. 4(B)- Aquifer wise Depth to Water Level (Pre-monsoon)

District Name	Semi-confined Aquifer		
	Min	Max	Avg
Rajnandgaon	7.63	29.66	16.97

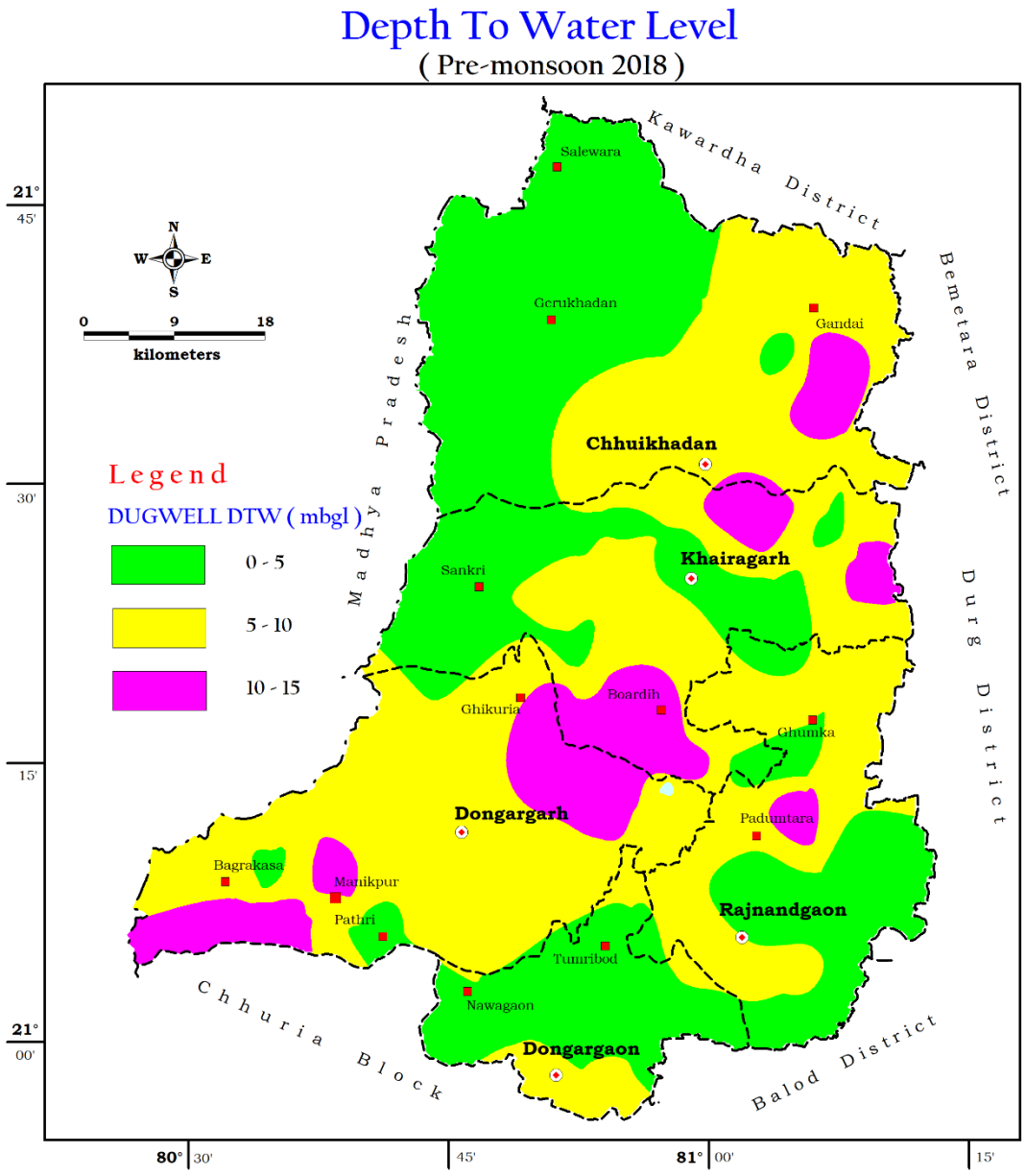


Figure 10 Pre monsoon Water Level Maps of Phreatic Aquifer

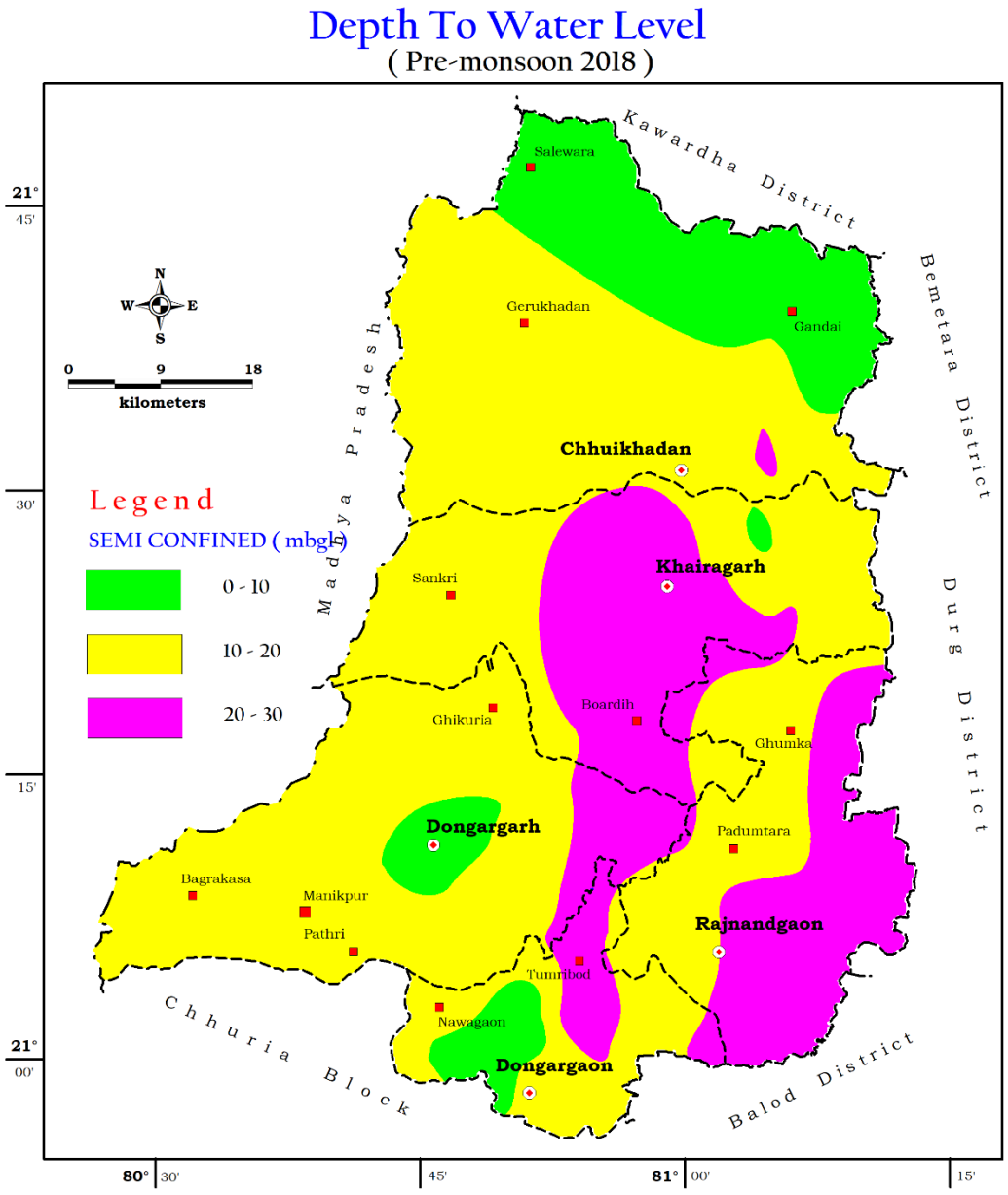


Figure 11 Pre monsoon Water Level Maps of Semi-Confined Aquifer

ii. Post- monsoon water level (Nov 2018):

In the post-monsoon period, it has been observed that in the study area, water level in Phreatic aquifer vary between 0.8 to 10.6 m bgl with average water level of 4.94 m bgl shown in Table No. 4(C). In deeper semi-confined aquifer, water level varies between 4.86 to 22.04 m bgl with average water level of 11.04 m bgl shown in Table No. 4(D).

Table No. 4(C)- Aquifer wise Depth to Water Level (Post-monsoon)

District Name	Phreatic Aquifer		
	Min	Max	Avg
Rajnandgaon	0.8	10.6	4.94

Table No. 4(D)- Aquifer wise Depth to Water Level (Post-monsoon)

District Name	Semi-confined Aquifer		
	Min	Max	Avg
Rajnandgaon	4.86	22.04	11.04

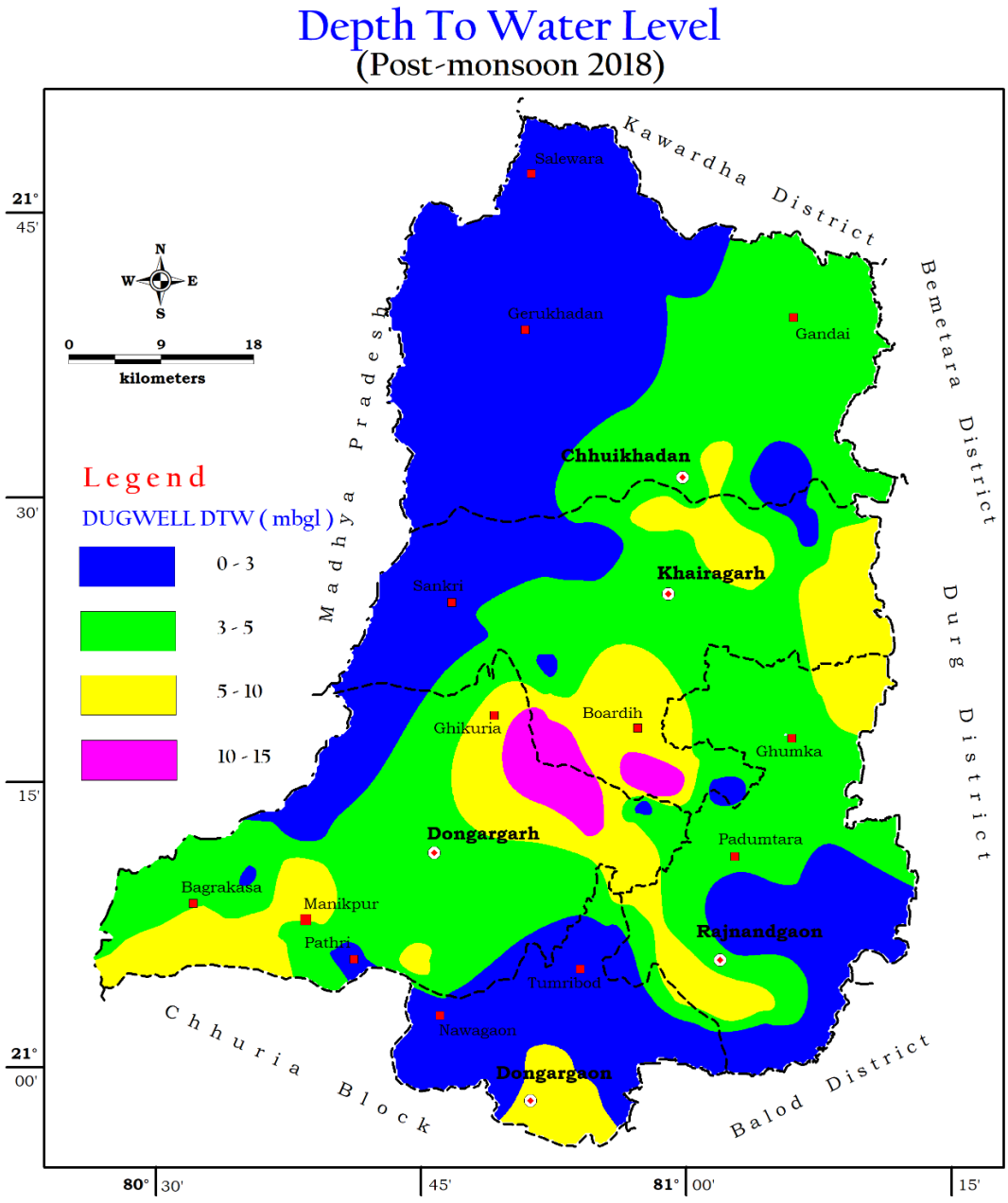


Figure 12 Post monsoon Water Level Map of Phreatic Aquifer

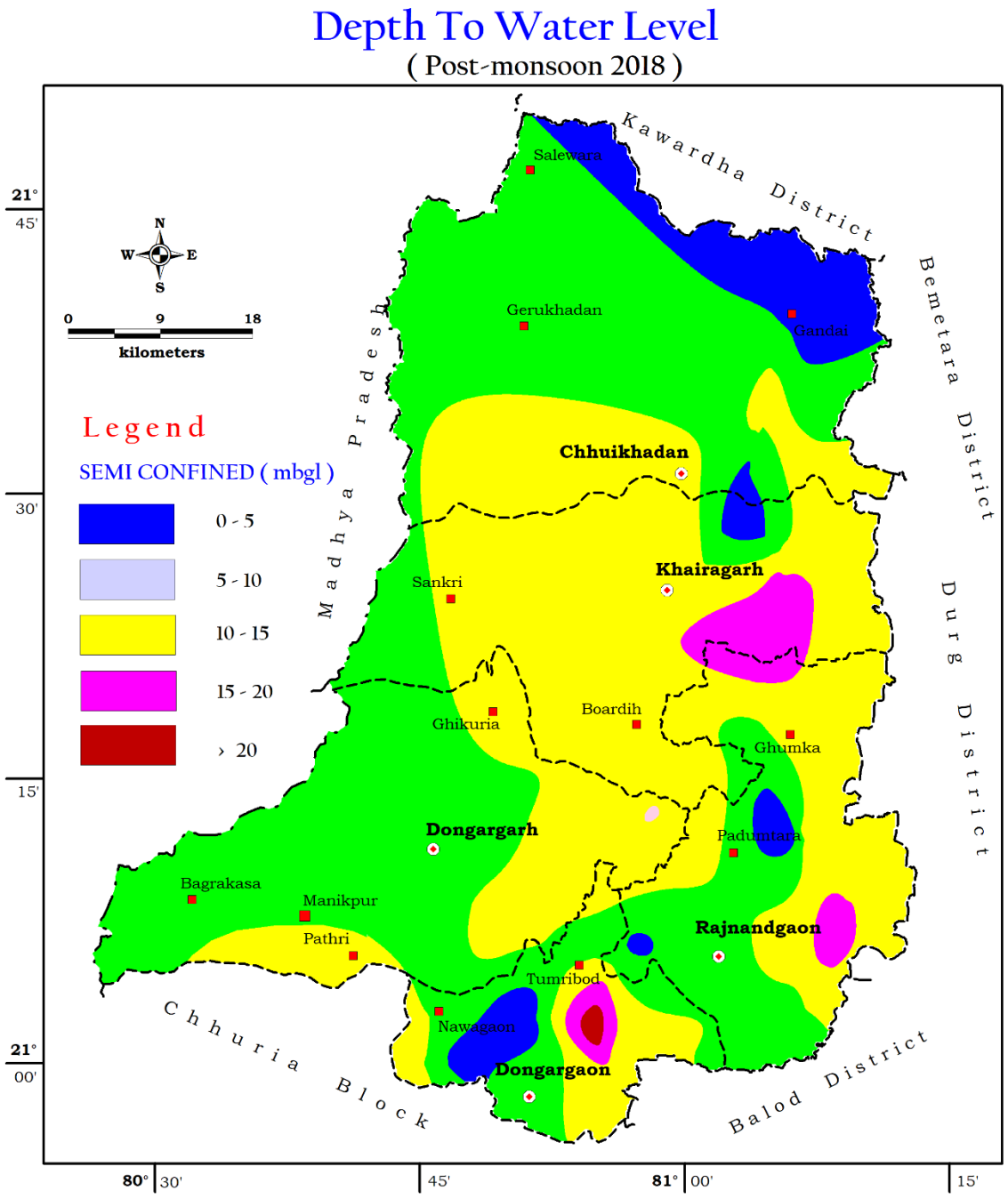


Figure 13 Post monsoon Water Level Maps of Semi-Confined Aquifer

iii. Seasonal water level fluctuation:

The water level fluctuation data indicates that in the study area, water level fluctuation in phreatic aquifer varies from 0.2 to 6.6m with an average fluctuation of 2.25m show in Table No. 4(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. 4(F).

Table No. 4(E)- Aquifer wise Depth to Water Level Fluctuation (Phreatic aquifer)

District Name	Phreatic Aquifer		
	Min	Max	Avg
Rajnandgaon	0.2	8.7	2.27

Table No. 4(F)- Aquifer wise Depth to Water Level Fluctuation (Semi-confined aquifer)

District Name	Semi-confined Aquifer		
	Min	Max	Avg
Rajnandgaon	0.25	11.99	5.93

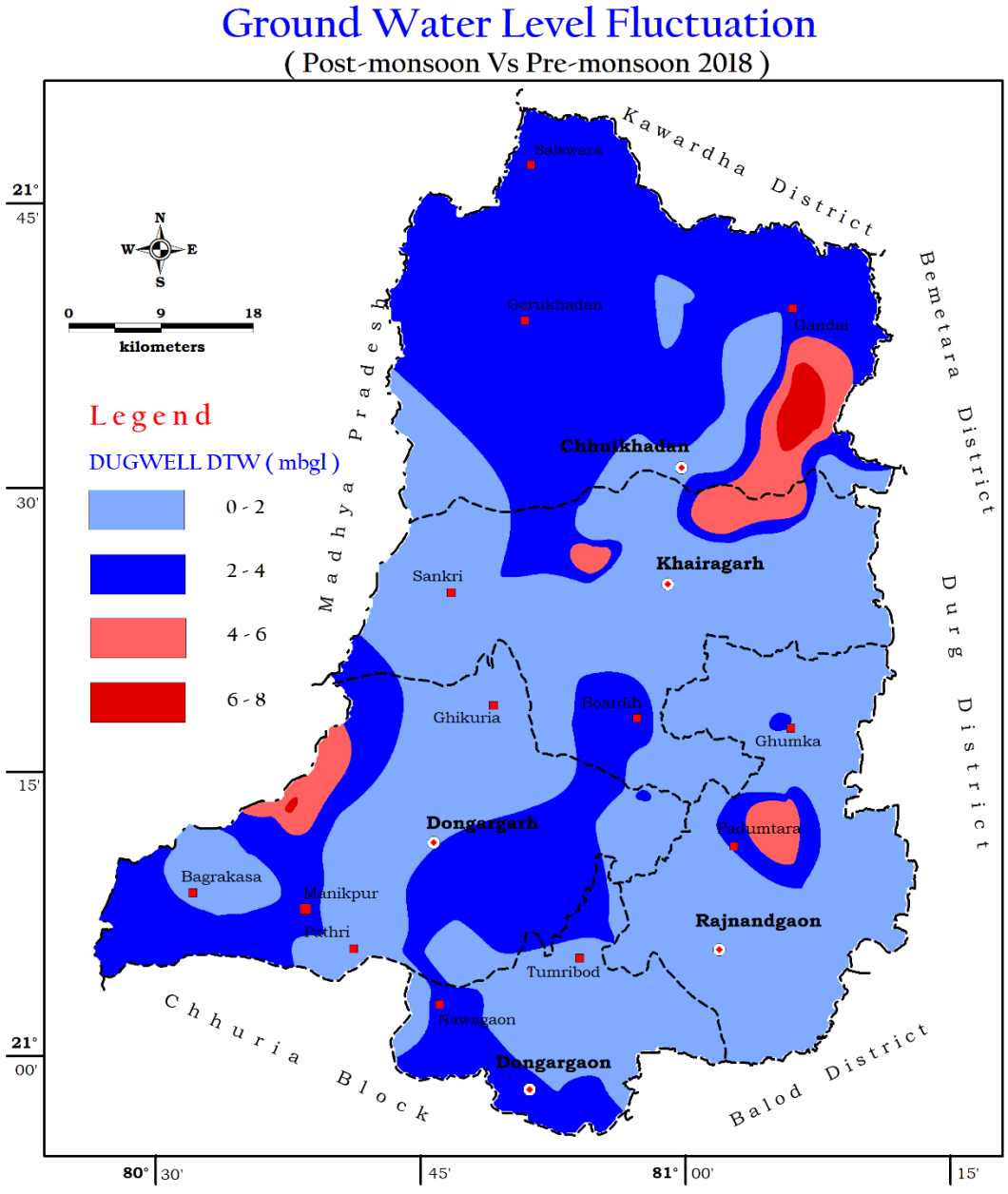


Figure 14 Water level fluctuation of Phreatic aquifer 2018

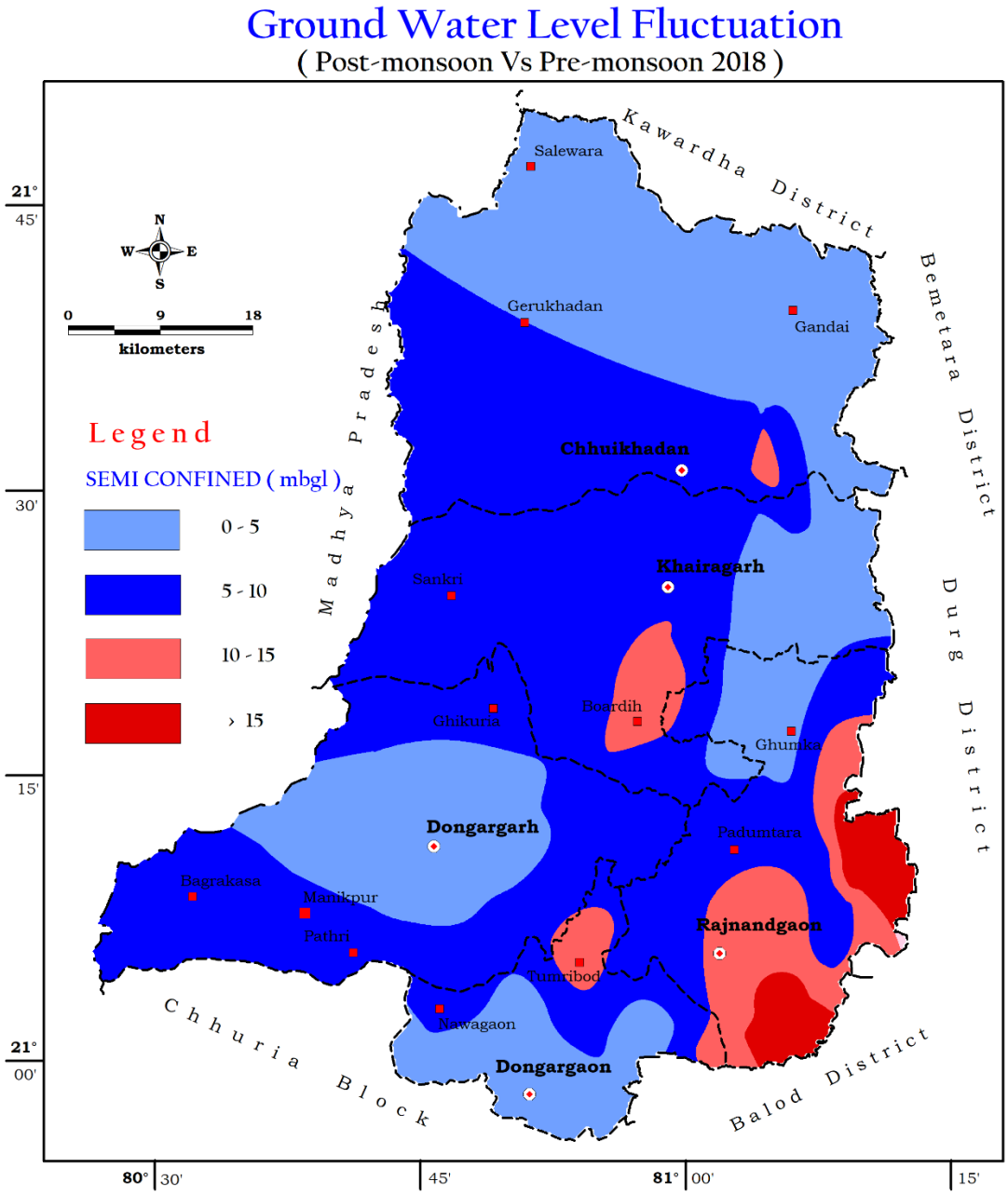


Figure 15 Water level fluctuation of Semiconfined aquifer 2018

3. AQUIFER DEPOSITION AND GROUND WATER RESOURCES

3.1 Aquifer Geometry and Characterization

Based on the exploratory drilling data generated for the blocks, the existing aquifer systems in the area may be divided into two namely phreatic and deeper fractured aquifer. The major aquifers present in the study area are (1) Chandi Limestone (2) Gunderdehi shale (3) Charmuria limestone (4) Chandrapur sandstone with shale iterbeded (5) Chilpi metasedimentary (6) Dongargarh granite and granitic gneiss. Details are represented in Table no. 5.

(1) Chandi Formation

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. The limestone is pink to light grey in color. fine grained with extensive development of stromotalitic structure and is thickly bedded. Minor shale partings are present. Stromalities are grey to brown in colour with intercolumnar space filled with argillaceous carbonate material. In middle horizon of this formation, stromatilitic limestone and flaggy limestone are associated with green calcareous shale. The green shale is friable and splintery, calcareous and at places itself contains columnar stromatalitic structure inclined to bedding plane. Upper horizon is predominantly pink to purple, medium to coarse grained dolomitic limestone with characteristic development of stromatalities. The rock has a mottled appearance due to dolomite crystals. It is generally massive in look and is associated with purple to grey shale intercalations. Towards upper part, the rock gradually changes and devoid of stromatalitic structure. The rock is also gypsiferous containing gypsum in cavities

(2) Gunderdehi formation

Gunderdehi Formation, which occupies the central and southern part of the Rajnandgaon and, some part of Dongargarh block acts as an aquiclude. Only weathered mantle to a depth of 30m is Productive for water.

(3) Charmuria formation

Charmuria Formation occurring in parts of Dongargaon, Dongargarh, Khairagarh and Chhuhikhadaon blocks is the most prolific aquifer. In Rajnandgaon district the Ranidhar Member comprising of cherty limestone and dolomite is mainly calcareous in nature and is deposited above sandstone of Chandrapur Formation. It is the most prolific aquifer. Due to heterogeneity of the contact and cherty limestone, the development of solution cavities along the bedding plane is very common and these cavernous zones are filled with clay material and intraformational conglomerate.

(4) Chandrapur formation

Chandrapur Group in the district consists of Orthoquartzitic to subarkosic sandstone and black shale. These sandstones are dominantly orthoquartzite in composition and are highly silicified. Primary sedimentary structures like Ripple marks and cross bedding are

common. Mega scale cross bedding in these sandstones is seen. The black shale is occurring low lying area and only can be seen subsurface. These are horizontally bedded and thinly laminated. Fresh rocks are hard and compact. The Chandrapur formation comprises sandstone & shales.

(5) Chilpi formation

The occurrence of ground water in this formation is mainly in the weathered zone and in the fracture zones.

(6) Dongargarh granite and Bijli rhyolite

In the case of weathered granite, the depth and intensity of weathering control the occurrence and movement of groundwater but at deeper levels in hard granite rocks controlling factor are occurrence of fractures and joints below the weathered zone and lineaments. It is observed that occurrence of shallow fractures are more common in case of granite, It is also observed that wells located in the topographic low areas are generally having better yield.

Table 5 Aquifer Parameters

Major Geological Formation	Major Rock type	Transmissivity (m^2/day)	Discharge (lps)
Chandi Formation	Limestone	8.5-396	0 to 3
Gunderdehi formation	Shale	0.4-0.92	0 to 3
Charmuria formation	Limestone	37.14-132.15	1 to 5
Chandrapur formation	Sandstone and Shale	15.1-922.9	1 to 3
Chilpi formation	Metasedimentary	63.28-266.34	1 to 3
Dongargarh granite and Bijli rhyolite	Crystalline acidic rock (Granite and Rhyolite)	-	3 to 10

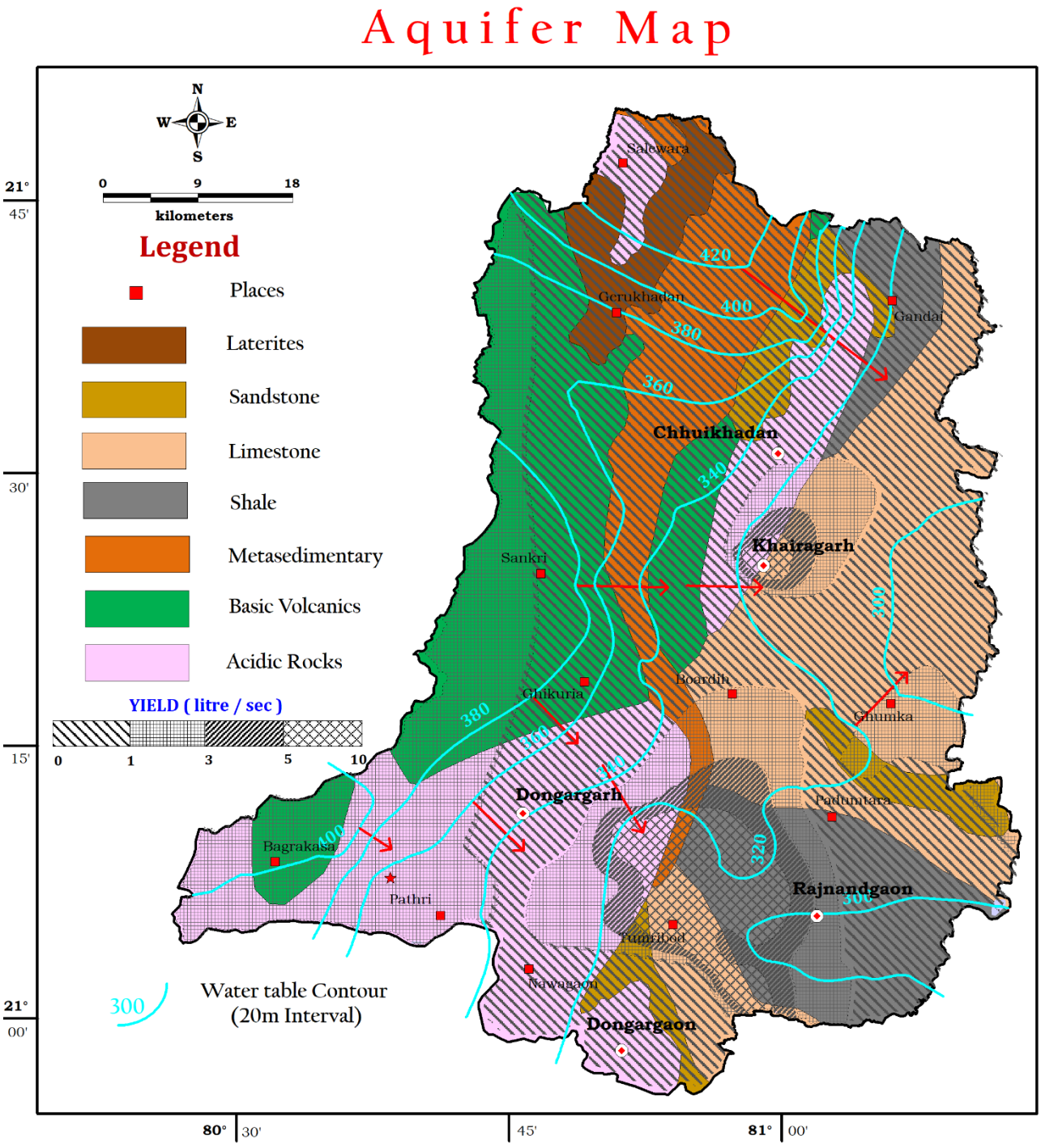


Figure 16 Aquifer Map of Study Area (Parts of Rajnandgaon District

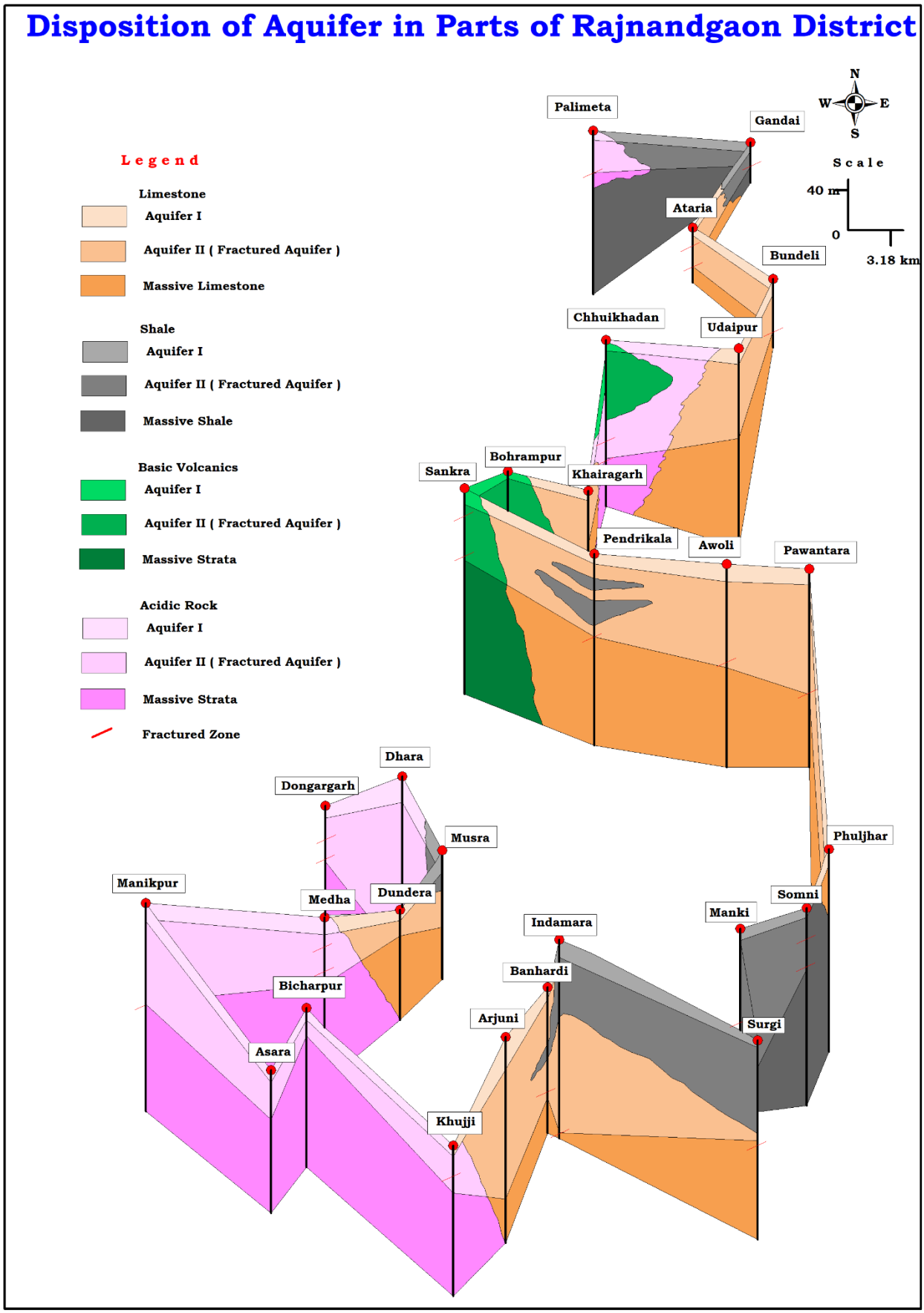


Figure 17 3d Disposition of Aquifer in Study area

3.2 Groundwater Resources Availability and Extraction

Based on the resource assessment made, the resource availability in Block wise in Rajnandgaon district upto 200m depth is given in Table no 6

Table 6 Groundwater Resource up to 200m bgl (MCM)

District	Block	Aquifer I Dynamic Resources (MCM)	Insitu Resources (MCM)		Total Resources (MCM)
			Aquifer I	Aquifer II	
Rajnandgaon	Chhuikhadan	76.2	19.54	4.60	100.34
	Dongargaon	62.2	26.91	4.87	93.98
	Dongargarh	94.1	21.43	4.46	119.99
	Khairagarh	84.8	45.80	16.91	147.51
	Rajnandgaon	96.2	20.71	4.53	121.44

3.3 Existing and Future Water Demand (2025)

Table 7 Ground Water Resources of the Study area in Ham

Block	Total Annual Ground Water (Ham) Recharge	Total Natural Discharges (Ham)	Annual Extractable Ground Water (Ham) (3=1-2)	Current Annual Ground Water Extraction (Ham)				Annual GW Allocation for Domestic Use as on 2025	Net Ground Water Availability for future use (9=3-4-5-8)	Stage of ground water development in % (7/3 *100)
				Irrigation Use	Industrial Use	Domestic Use	Total Extraction (7=4+5+6)			
	1	2	3	4	5	6	7	8	9	
Rajnandgaon	10687.74	1068.78	9618.96	6888	92.45	1265.51	8245.96	1235.22	1403.29	85.73
Dongargaon	6913.45	691.35	6222.1	4727.98	5.99	339.73	5073.7	447.48	1040.65	81.54
Dongargarh	10042.86	633.4	9409.46	5267.5	0.12	524.38	5792	674.23	3467.61	61.56
Khairagarh	9418.73	941.87	8476.86	5068.86	0	488.32	5557.18	653.47	2754.53	65.56
Chhuikhadan	8462	846.2	7615.8	4709.86	0	455.67	5165.53	615.31	2290.63	67.83
TOTAL	**45524.78**	**4181.6**	**41343.18**	**26662.2**	**98.56**	**3073.61**	**29834.37**	**3625.71**	**10956.71**	**72.16**

The existing demand for irrigation in the area is 29530.10 Ham while the same for domestic and industrial field is 4241.31 Ham. To meet the future demand for ground water, a total quantity of 32212.95 ham of ground water is available for future use.

4. GROUND WATER RELATED ISSUES

- During summer, Dugwells in villages are dry except in few locations Several hand pumps also stop yielding water. Drying Dugwells and depletion of ground water level during premonsoon in Rajnandgaon and Dongargaon blocks is due to excessive ground water withdrawal.
- In Rajnandgaon block Ground Water Draft for Irrigation is 6888 ham which is 95% of Gross draft i.e. 8345.96 and in Dongargaon block Ground Water Draft for Irrigation is 4727.98 ham which is 93% of Gross draft i.e. 5073.7
- The aquifer itself is a low yielding one in Dongargaon block (i.e. Charmuria formation) and upper part of Rajnandgaon block (Chandi formation as it has a gradational contact with the underlying Gunderdehi shale).
- Uneven distribution of yield potential in consolidated Dongargarh granite.
- Good potential zone confined in structurally low laying areas whereas in higher elevation, it is poorly yielding.

5. GROUND WATER MANAGEMENT PLAN

i. Supply Side management

- ***Construction of AR Structures*** in Dongargarh, Dongargaon, Rjnandgaon, Khairagarh Block It is observed that post monsoon water level in shallow aquifer zone is deeper at many places. So, these places need artificial recharge structures in a long-term basis to arrest the noncommitted run-off to augment the ground water storage in the area. In order to strike a balance between the ground water draft and the available resource, suitable artificial structures at appropriate locations be constructed through successive phases.
- ***Ground Water Development*** in Low ground water developed blocks like Khairagarh and Chuikhadan, additional Ground water potential can be created by construction of ground water abstraction structure.
- ***Training through IEC*** 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 teach people about the importance community participation in saving water.

- ***De-siltation of existing Tanks and Ponds*** to be carried out for efficient storage of rainwater. Also Rain water harvesting structures may be constructed in villages to reduce stress on groundwater in,
- ***Recharge in dried up bore wells and Dug wells.***

ii. Demand Side Management

- ***Change in Irrigation practices*** Water can be Saved using micro irrigation methods such as sprinklers and drip irrigation etc.
- ***Change in cropping pattern*** Water can be Saved by change crops from paddy to Maize.
- ***Control on wasting water through Public water Supply*** There is colossal wastage of groundwater through public water supply system. In this state, the Government has undertaken "Gaon Ganga 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.
- ***Sapling should be planted in Barren land***

Figure 18 Proposed Artificial Recharge structure in the study area