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

JANJGIR CHANPADISTRICT, CHHATTISGARH

उत्तर मध्य छत्तीसगढ़ क्षेत्र, रायपुर
North Central Chhattisgarh Region, Raipur

2021-22

भारत सरकार

Government of India

जल शक्ति मंत्रालय, जल संसाधन, नदी विकास एवं गंगा संरक्षण बिभाग

Ministry of Jal Shakti, Department of Water Resources, River Development & Ganga Rejuvenation

केन्द्रीय भूमि जल बोर्ड

Central Ground Water Board

जांजगीर चंपा जिला, छत्तीसगढ़ के जलभृत नक्शे एवं भूजल प्रबंधन योजना

Aquifer Maps and Ground Water Management Plan of Janjgir Champa District, Chhattisgarh

केन्द्रीय भूमि जल बोर्ड

उत्तर मध्य छत्तीसगढ़ क्षेत्र

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रायपुर

FOREWORD

Groundwater resources are being developed over years in order to meet domestic, irrigation and industrial requirements. The spatial distribution of availability of ground water resources however, is uneven and is being indiscriminately exploited by various users thereby creating relentless pressure. On the other hand, rapid urbanization, industrialization and land use changes has resulted decline of water levels in many parts of the country.

There is an urgent need for scientific approach for proper management of the available ground water resources for sustainability of this precious natural resource for present and future generation.

Central Ground Water Board has been in the forefront of activities for occurrence, development, and management of this resource through various scientific studies and techniques. Over the last four decades CGWB, NCCR, Raipur has gathered a huge amount of data regarding ground water resources of Chhattisgarh. Based on this experience aquifer mapping of Janjgir Champa district was prepared with the vast amount of data generated and available with North Central Chhattisgarh Region. The report embodies all the features of ground water and related aspects of the study area including physiography, meteorological conditions, hydrology, drainage, geomorphology, geology, hydrogeology, ground water resources, hydrochemistry, geophysics, ground water problems etc.

The report titled "A REPORT ON AQUIFER MAPS AND GROUNDWATER MANAGEMENT PLAN OF JANJGIR CHAMPA DISTRICT, CHHATTISGARH" is prepared by Sh Suvam Prakash Dash, AHG under supervision of Smt. Prachi Gupta SCIENTIST-B .I appreciate the concerted efforts put by the author to make it possible to bring the report in its present shape. I hope this report will no doubt be useful and worthy for the benefit of anjgir Champa district and would be a useful document for academicians, administrators, planners and all the stakeholders in ground water.

Though utmost care has been taken to minimize the errors, some errors may have inadvertently crept in. It is expected that these mistakes will be taken in the proper spirit.

Dr. P. K. Naik
(REGIONAL DIRECTOR)

Executive summary

Aquifer mapping 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. 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. Volumetric assessment of ground water and strategies for future development and management are the primary objectives of aquifer mapping.

Under the aquifer mapping Programme, all the development blocks of Janjgir Champa District namely Akaltara, Baloda, Bamhindih, Dabhara, Jaijaipur, Malkharoda, Nawagarh, Pamgarh, and Sakti were taken up covering an area of 3717.5 sq. km. The Janjgir-Champa district is bounded by East longitudes of 82°17' to 83°19' and by North Latitudes of 21°40' to 22°15'30" and is surrounded by Raigarh and Raipur district in South, Janjgir Champa district in west, Korba and Raigarh district in North and East respectively (Plate-I). The district falls under Survey of India toposheet no. 64J/8, 64J/12, 64J/16, 64K/5, 64K/6, 64K/9, 64K/10, 64K/13, 64K/14, 640/1, 64O/2, 64O/5 and 64N/4. The district head quarters Janjgir and Champa – the twin towns are well connected with roads as well as rail. National highway No. 200 passes through both the towns. Janjgir is 180 km from Raipur, 75 km from Janjgir Champa and 94 km from Raigarh. Both Janjgir and Champa are connected with Howrah and Mumbai by SECR Mumbai- Nagpur - Howrah main line. There is a good network of State Highways in the district.

The total population of the study area as per 2011 Census is 1,619,707out of which rural population is 1,394,646& the urban population is only 225,061.

The study area experiences sub-tropical climate. The average annual rainfall for the study area is around 1163 mm (Average of the last five years i.e. 2012 to 2018).

Geomorphologically the district is having matured type of land forms and can be broadly divided into four prominent geomorphic units. These are 1. Residual Hills (Igneous & Metamorphics) formed by Archaean Crystalline and Metamorphics, 2. Structural Hills (Vindhyans of Chhattisgarh) formed by Proterozoic sandstones, 3. Dissected Pediplain (Vindhyans of Chhattisgarh) made by Proterozoic shale-limestone-dolomite area and 4. Alluvial

Plain formed by Mahanadi Alluvium with an elevation ranging from 210 and 350 m amsl (metres above mean sea level).

The net sown area is 257232 hectares, while double-cropped area is 16116 hectares. Rice is sown in nearly 261169 hecters of the net sown area.

The net irrigated area in the study area is 221673 hectares where ground water contribution is 12181 Ha only. Percentage of Area Irrigated by ground water with respect to net irrigated area is 5.49%.

Based on the exploratory drilling data generated for the blocks, the existing aquifer systems in the area may be divided into phreatic and fractured aquifer. The major aquifers present in the study area are 1. Shale (Raigarh, Gunderdehi and Bamindih), 2. Limestone (Pandaria, Charmuria and Chandi) 3. Sandstone (Raigarh and Chadrapur) and Bastar gneiss. Discharge varies from negligible to 26 lps. Higher yields are obtained where thick weathered zones are associated cavernous limestone.

As per 2020 ground water resource calculation stage of ground water development in the study area is only 55.72%. So, there is scope of utilizing more ground water for future irrigation purpose and other purposes. Additional number of Ground water abstraction structure may be developed for the effective utilization of ground water resources.

The existing demand for irrigation in the area is 19315.2 Ham while the same for domestic use is 4441.568Ham and for industrial field is 111.2328Ham. To meet the future demand for ground water, a total quantity of 18907.64Ham of ground water is available for future use.

The major ground water issues identified during the survey in the study area are as follows: (i) Drying of Dugwells and handpumps during summer. (ii) Inherent hydrogeological character of aquifer. (iii) Drilling difficulties in limestone terrain (iv) Fluoride concentration. (v) Nitrate contamination and (vi) Sodium enrichment.

In study area because of complex hydrogeological conditions ground availability is scattered. In area where ground water availability is limited, surface water may be conserved and utilized. High value of Fluoride and Nitrate has been reported from some locations. In granitic aquifer system at many places ground water is contaminated with Fluoride because of geogenic reasons. The problem of fluoride contamination in drinking water may be tackled by setting up

of small defluorination units in affected villages or alternate source may be identified. Little high concentration of nitrate reported in few places which mainly due to anthropogenic activity like waste disposal. So the waste disposal should be checked and to be done in proper manner without affecting water souces.Similarly excessive irrigationshould be checked in places where Na enrichment reported.Regular ground water quality monitoring is also required.

So far as Management strategies are concerned for ground water availability, for effective utilization of Ground water existing draft for irrigation may be coupled with micro irrigation system. Change in irrigation pattern, optimum use of available resource, use of ground water potential created after artificial recharge can lead to groundwater savings and increase in gross cropped area of the district.

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The author is grateful to Shri Sunil Kumar, Chairman, Central Ground Water Board for giving opportunity for preparation of Aquifer Map and Management Plan of, Balod district of Chhattisgarh state. I express my sincere gratitude to Shri Sateesh Kumar Member (East), CGWB for giving valuable guidance, encouragement and suggestions during the preparation of this report. The author is thankful to Dr. P. K Naik, Regional Director, Central Ground Water Board, NCCR, Raipur for extending valuable guidance and constant encouragement during the preparation of this report. I am extremely grateful to Sh. A.K. Biswal, Scientist-E for his continuous guidance and support. I would like to acknowledge the help rendered by Smt Prachi Gupta, Sc-B while preparing district map, aquifer map, 3-d disposition of aquifers and preparation of this report. The author is also thankful to Sh Uddeshya kumar, Sc-B for rendering help and valuable inputs while preparing the report. The author is also thankful to Sh. Sidhant Kumar Sahu, Sc-B for the guidance and suggestions. The author is also thankful to Sh Rakesh Dewangan, Sc-B for the chemical analysis and valuable inputs on quality issues. The author is also thankful to Dr. A. K. Sinha, Sc-B for the geophysical studies. The author is also thankful to Sh Sarboday Barik, AHG; Sh Sudeepta Sunder Parida, AHG; Ms. Sweta Mahanty, AHG for their technical support and valueable guidance. The efforts made by Sh. T.S. Chouhan, Draftsman, for digitization of maps are thankfully acknowledged. The author is also thankful to the state agencies for providing the various needful data. The author is thankful to Technical Section, Data Centre, Chemical Section, Report Processing Section and Library of CGWB, NCCR, Raipur for providing the various needful data.

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AQUIFER MAPS AND GROUND WATER MANAGEMENT PLAN, JANJGIR CHAMPA DISTRICT, CHHATTISGARH

(09 BLOCKS- Akaltara, Baloda, Bamhindih, Dabhara, Jaijaipur, Malkharoda, Nawagarh, Pamgarh Block & Sakti Block)

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ABBREVIATIONS

a msl	above mean sea level
BDR	Basic Data Report
BW	Borewell
CGWB	Central Ground Water Board
Dia	Diameter
DTW	Depth to Waterlevel
DW	Dugwell
EC	Electrical Conductivity
EW	Exploratory Wells
GS	Gabion structures
GW/ gw	Ground Water
ham	Hectare meter
HP	Handpump (Shallow)
lpcd	litres per capita per day
lpm	litres per minute
lps	liters per second
m	meter
m bgl	meter below ground level
m2/day	Square meter/ day
m3/day	cubic meter/day
MCM/mcm	Million Cubic Meter
NCCR	North Central Chhattisgarh Region
NHNS/ NHS	National Hydrograph Network Stations
OW	Observation Well
PZ	Piezometre
STP	Sewage Treatment Plan
T	Transmissivity
TW	Tubewell

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 the re-appraisal of groundwater 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 9 no. of blocks of Janjgir Champa district was taken up covering an area of 3852.75 sq.kms. Janjgir-Champa district is situated between 21° 06' to 22° 04' North latitudes and between 8203' to 8302' East longitudes in Chhattisgarh state. Height of the district from sea level is 294.4 mts. topographically, the district is bounded by Raigarh district in the East, Janjgir Champa distict in the West, Korba and Janjgir Champa district in the North and Raipur & Raigarh district in the South. Total geographical area of the district is 3852.75 sq.kms as reported by the Surveyor General of India. The district Janjgir-Champa is situated in the upper-center part of the State. The district falls under Survey of India toposheet no. 64J/8, 64J/12, 64J/16, 64K/5, 64K/6, 64K/9, 64K/10, 64K/13, 64K/14, 640/1, 640/2, 640/5 and 64N/4. All-important places within the district are well connected by a network of the state highways and all-other roads.

1.4.1 Administrative Division

For the convenience of administration, the district is divided into eight tehsils, nine Community Development blocks and 528 no. of gram panchayats. The district has eight townships out of which five are Nagar Panchayats (Akaltara, Baloda, Kharod, Seorinarayan and Baradwar) 3 are Municipalty (Janjgir-Naila, Champa, Sakti).

The name of the 9 blocks are given below.

1. Akaltara Block
2. Baloda Block
3. Bamhindih Block
4. Dabhara Block
5. Jaijaipur Block
6. Malkharoda Block
7. Nawagarh Block
8. Pamgarh Block
9. Sakti Block

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

1.5 Data Availability, Data Adequacy and Data gap Analysis

Table 1 Data Integration

Districts	Blocks	Existing			Data Generation		
		EW	**Chem**	**WL**	**EW**	**Chem**	**WL**
Janjgir Champa	Akaltara	06	06	05	01	06	12
	Baloda	07	02	03	0	02	06
	Bamhindih	06	06	08	0	06	17
	Dabhara	06	02	02	0	02	02
	Jaijaipur	09	04	05	0	04	07
	Malkharoda	05	04	02	0	04	07
	Nawagarh	14	10	12	03	10	34
	Pamgarh	05	09	12	05	09	18
	Sakti	05	08	04	0	08	10
TOTAL		**63**	**51**	**53**	**9**	**51**	**116**

1.6 Rainfall

Janjgir – Champa is endowed with high rainfall. Areas of chronic shortfall are few and localized. The district receives its rainfall mainly from the south-west monsoon which usually sets in the third/fourth week of June and spread over a period from mid June to mid September with heaviest shower in the months of July and August. The average annual rainfall in the district is 1071 mm in the year 2018. The district experiences a hot and semi humid climate. The annual temperature of the district varies between 8^0C and 46^0C.The maximum temperature is observed in the month of May and June where as the minimum is observed in the months of December and January

Figure 2. *Source: Statistical handbook*

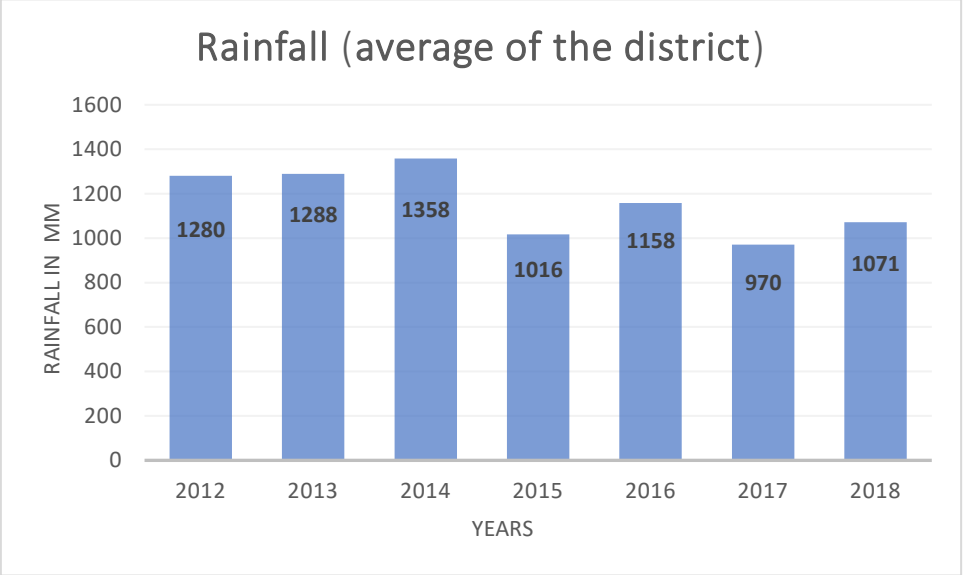
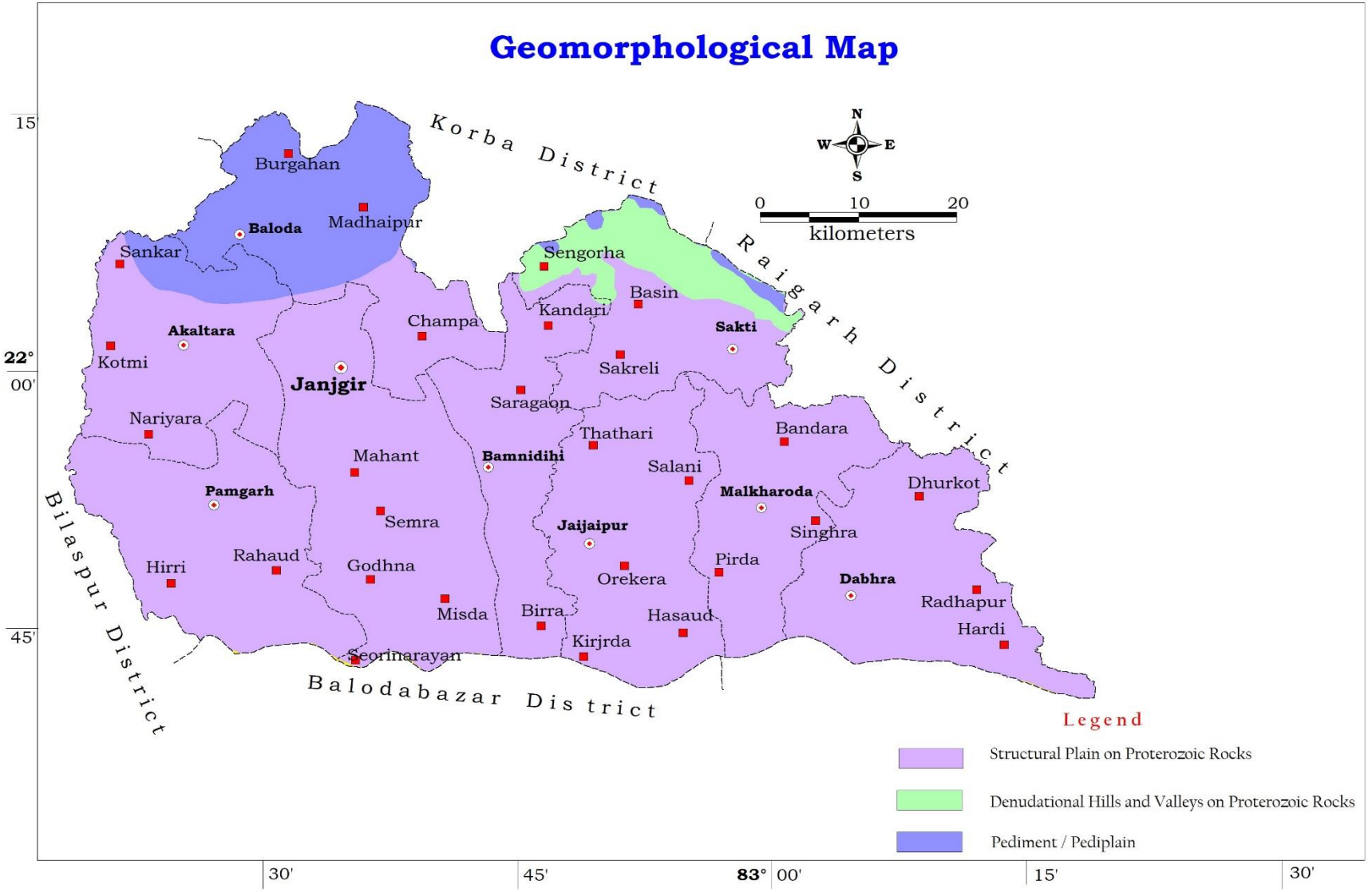


Figure 1 Avg. Rainfall in Janjgir Champa District

1.7 Physiography/Geomorphology

Physigraphically the district forms part of the Chhattisgarh plain and extension of Maikhel hill ranges. The general elevation of the district lies between 210 and 350 m amsl (metres above mean sea level). The elevation of northern part of the district is higher than the remaining parts. The general slope is towards south and south-east. The highest point of the district is in Kumhar Pahar (865 m amsl), located at Sakti block on northern boundary of the district. The prominent hills (Maikhel range) trend roughly ENE- & EW along the northern boundary of the district. The lowest point (200m amsl) is situated in the south-eastern corner of the district on the bank of Mahanadi near Chandarpur in Dabhra block. Geomorphologically the district is having matured type of land forms and can be broadly divided into four prominent geomorphic units. These are 1. Residual Hills (Igneous & Metamorphics) formed by Archaean Crystalline and Metamorphics, 2. Structural Hills (Vindhyans of Chhattisgarh) formed by Proterozoic sandstones, 3. Dissected Pediplain (Vindhyans of Chhattisgarh) made by Proterozoic shale-limestone-dolomite area and 4. Alluvial Plain formed by Mahanadi Alluvium.



Figur 3 Geomorphology Map of the Study area

1.8 Land use

There is **9916** ha revenue forest, protected forest and other forest in the district. Area not available for cultivation is **37567** ha. Details are presented in Table no.2. Figure 4 shows the Landuse pattern in the study area.

Table 2 Land use pattern (in ha)

Tehsils	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)	Fallow land	Net sown area (In ha)	Double cropped area (In ha)	Gross cropped area (In ha)
Janjgir	26947	45	2258	3590	5034	1098	18373	1319	19692
Akaltara	39699	2203	3764	5177	3603	1870	24316	808	25124
Baloud	26072	2324	7380	2998	3911	720	16358	429	16787
Nawagarh	37816	72	3399	4400	5806	1039	27500	1925	29425
cHampa	38867	598	4208	3962	5706	2035	26320	1252	27572
Sakti	33411	2914	2655	2519	4054	1318	22470	1002	23472
Pamgarh	44533	640	3258	6114	7639	1159	31837	1089	32926
Dabhara	42064	30	4781	2604	4823	2365	30065	2047	32112
Malkharoda	34068	20	2740	3036	4123	1169	26016	3393	29409
Jaijaipur	44026	1070	3124	3598	5092	763	33977	2852	36829
Jajgir Champa (Total)	**367503**	**9916**	**37567**	**37998**	**49791**	13536	**257232**	**16116**	**273348**

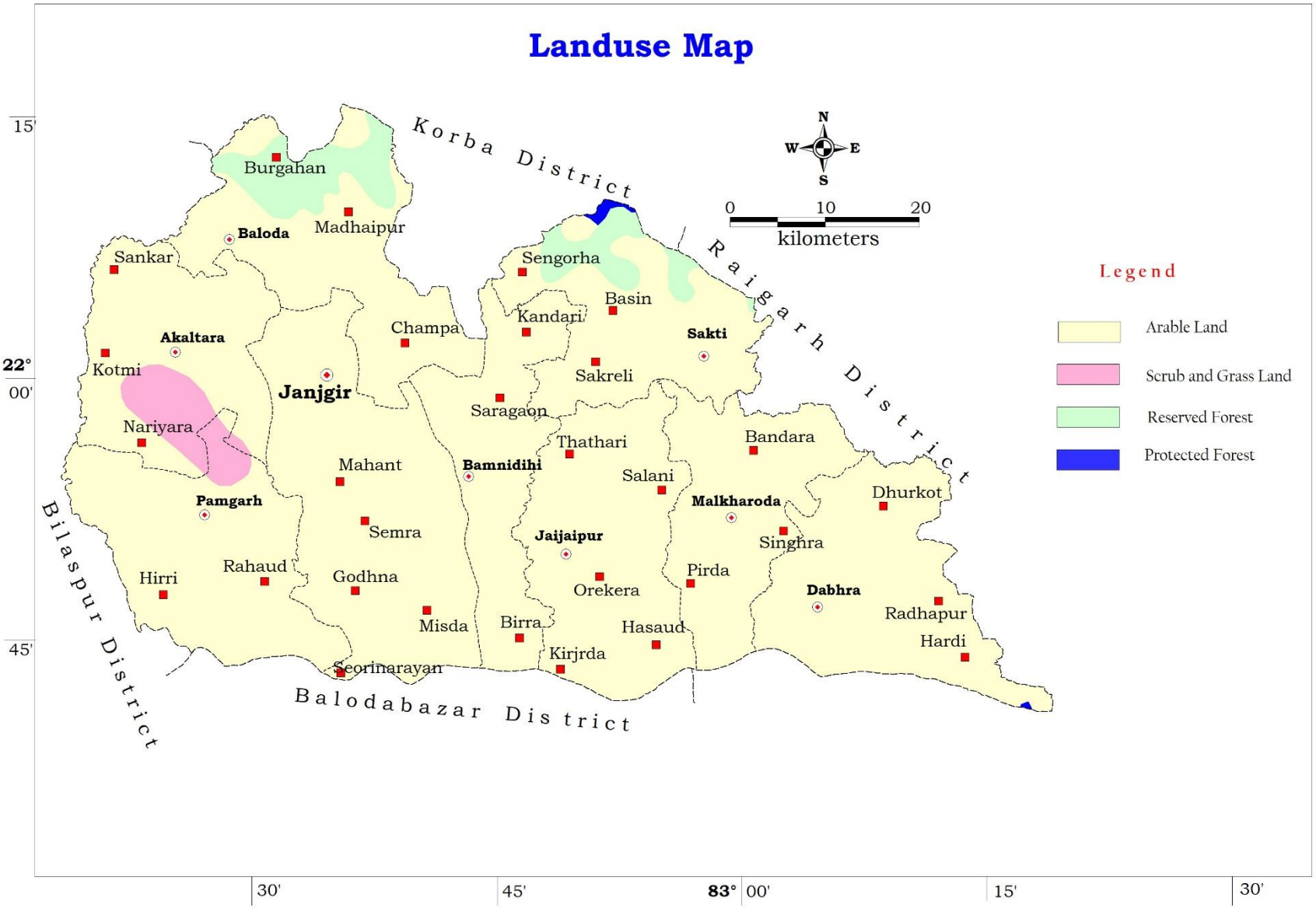


Figure 4 Landuse map of the study area

1.9 Soil

The soils in the district are having wide variations. In all four types of soils are abundant in the study area and are mostly insitu in nature.

1. **Vertisol:** The vertisol are mostly found in western parts of the district mainly in Pamgarh and Akaltara blocks. They range from grey/red to deep black colour and are almost impermeable when saturated. They are sticky in wet season and are very hard in dry season.
2. **Ultisol:** The ultisol types of soil are dominantly occur in the the district and is red to yellow in colour.Red and Yellow soils are the major soil types in the district. This colour is attained mainly due to the accumulation of iron oxide, which is highly insoluble in water.
3. **Alfisol:** The alfisol are mostly found in northen and north western part of the district mainly in Baloda and Sakti blocks. Alfisol soils are fertile leached soils found in humid areas where annually dropping leaves form a thick humus layer. These soils cover maximum area in the northern and central parts of the district.

   In general it can be said that the district is covered by red gravely soils, red sandy soils, lateritic soils, red and yellow soils and black soils.Figure 5 represents the different kind of soil that present in the study area.

Table 3 Details of different kind of soil

Si No	US Soil taxonomy	Indian equivalent
1	Vertisol	Deep black soil
2	Ultisol	Lateritic soil
		Red and yellow soil
3	Alfisol	Red gravelly soil
		Red sandy soil

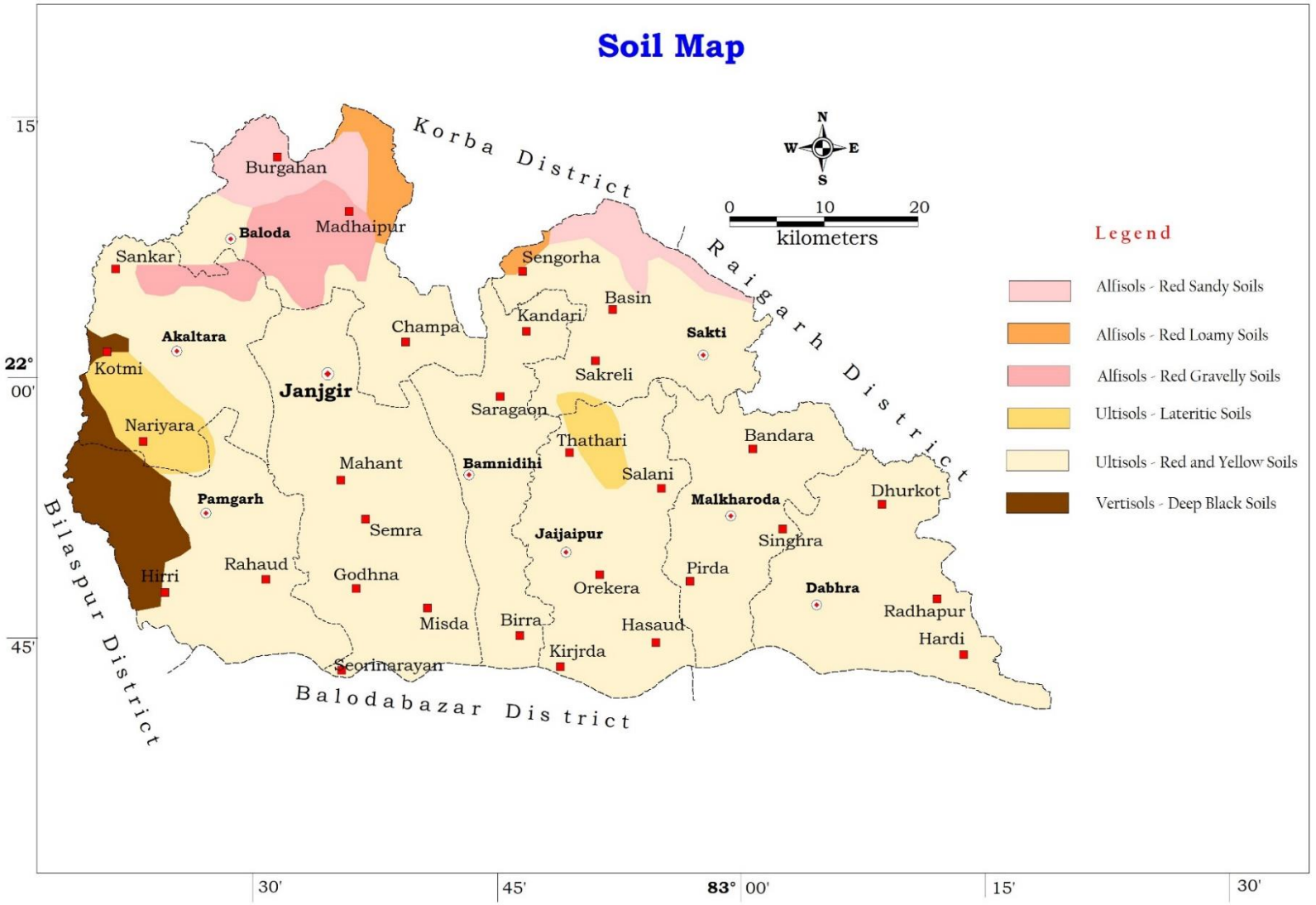


Figure 5 Soil map of the study area

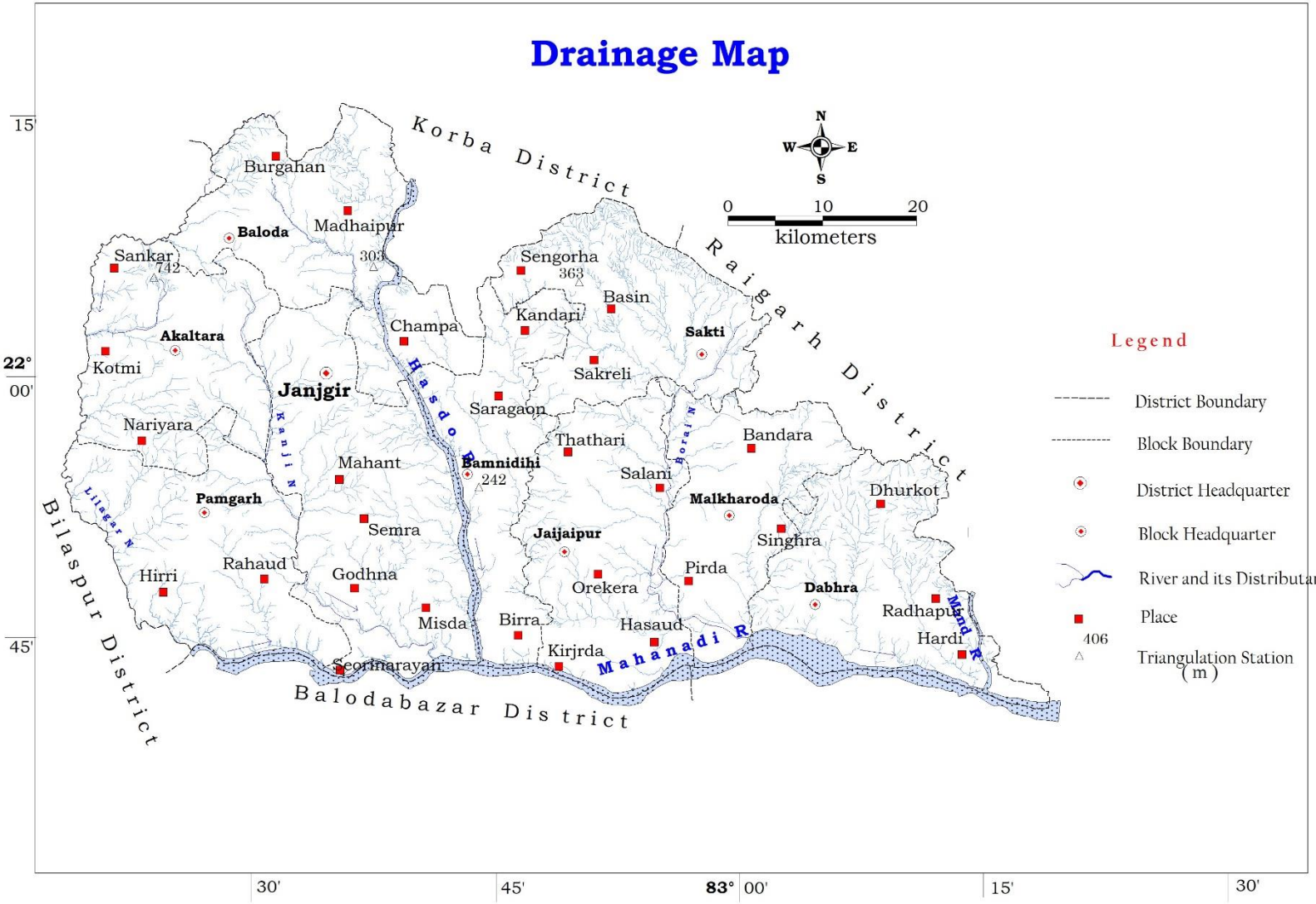


Figure 2 Drainage map of the study area

1.10 Drainage

Physiographically, the area to the north exhibits landforms of low-level structural plateaux, structural plains, pediment/pediplain, denudational hills and valleys. Flood plains are restricted along the course of Mahanadi River and its tributaries like Hasdeo, Kanji, Son, Borai, Bangan and Kutri. The maximum elevation observed in the area is 376 m amsl as seen in the north-eastern part of the district and the minimum elevation is less than 240 m, amsl seen along the Mahanadi River in the southernmost part of the district.

The major drainage pattern is dendritic type.The northern part of the district is characterised by dendritic pattern with high drainage density and the southern part by low drainage density. The drainage density drastically reduces in the plains suggesting the pervious nature of the underlying formations (shale, limestone and dolomite) than the formations on the northern part of the district (granites, gneisses, schists and quartzites).

1.11 Geology

Geologically the district can be categorised into three groups.

- The Archaean rocks consisting of granites, schists and metamorphics
- Proterozoic sediments belonging to Chhattisgarh Supergroup mainly consisting of limestone, shales, dolomites and sandstones.
- The unconsolidated alluvium along the major river courses of Hasdeo and Mahanadi.

4.1.1

i. The Archaean Crystallines: It consists of granites, gneisses, schists, phyllites and quartzites. Bastar gneiss and unclassified metamorphics present in the northen part of janjgir champa district. The Archaean crystallines covers around 9% of the area of the district in the northern part. These are mainly dominated by granitic gneisses and mica schists with occasional pegmatite and quartz veins Generally occurs in Balouda,Sakti and Akaltara blocks of Janjgir champa district

ii. Proterozoic Sedimentaries: Around 89% of the total area of the district is covered with these rocks. These rocks belong to Chhattisgarh Supergroup and are marine in origin and mainly consist of sandstone, limestone, shale and dolomites.Generally occurs in all the blocks in Janjgir Champa district.

4.1.2 Unconsolidated Sediments: The district of Janjgir – Champa is covered by very little alluvium blanket (around 2% of the area of the district) along the banks of Hasdeo and Mahanadi. Alluvium along these river channels in the district occurs as detached patches

i. Archaean Crystallines:

- **Bastar gneisses:** The Bastar gneisses occur in Dantewara, Sukma and Bijapur, Bastar, Narayanpur, Kondagaon, Kanker, Rajnandgaon, Durg, Kawardha, Janjgir Champa, Janjgir-Champa, Mahasamund, Korba and parts of Raigarh district. Bastar gneiss is also known as gneiss-migmatite complex having the major rock type as granite and gneiss.
- **Unclassified metamorphics:** Isolated patches and linear metamorphic belt running parallel to the Central Indian Suture occurs in Janjgir Champa, Janjgir-Champa, Raigarh, Surguja and Koriya districts. These rocks in Janjgir Champa –Katghora area having schist occurs as isoclinal anticlines and these folds were occupied by the intrusive grey granite, converting them into gneisses of varying composition. These unclassified rocks occupy small area only.

ii. Precambrian Sedimentaries

Chandrapur Group: The Chandrapur Group can be classified into three formations viz. Lohardih, Chaporadih and Kansa Pathar (Murti, 1987) arranged in ascending order of superposition The maximum thickness is attained in the SE part, thinning westward as well as in northern side and directly overlying the crystalline basement. Generally occurs in Sakti block of Janjgir champa district. It mainly comprise of conglomerate, sandstone, siltstone and shale.

Raigarh formation: The formation is widely developed in Baradwar sub-basin, comprising dominantly friable calcareous purple shale with limestone intercalations. The formation can be classified into a lower shale flaggy carbonate-arenite member which is followed upward by a purple calcareous shale member. In Janjgir Champa district it occurs in Akaltara, Nawagarh, Bamhindih, Baloud, Sakti, Malkharoda and Sakti blocks.

Raigarh formation(Sandstone)- It generally occurs in Dabhara and Malkharoda blocks in Janjgir Champa district.

Charmuria Formation*:* This dominantly carbonate sequence is represented by Sirpur clay-chert member at the base followed upward by Ranidhar cherty limestone, Kasdol dark grey limestone and Bagbura purple argillaceous limestone.

Gunderdehi Formation: Gunderdehi Formation, which is dominantly a calcareous argillite developed as distinct facies in the sub-basin. Although the purple-colored shale with intercalated limestone is the dominate member, a buff-colored shale and a ferruginous arenite are also two prominent members occurring at the middle of the formation.It generally occur in Pamgarh,Nawagarh and Dabhara blocks of Janjgir Champa district.

Bamandih Formation: The Raigarh Formation is overlain by another shale dominant unit designated as Bamandih containing stromatolitic limestone as pocket and lens, which is interpreted as facies variant of Chandi Formation, developed in Baradwar sub-basin. The shale is generally purple, but at places greenish shale is also present. Stromatolitic limestone is pink colored composed mainly of micritic carbonate with minor sparite. Argillaceous material is also present. It generally occurs in Nawagarh, Bamnidih, Jaijaipur and Balouda blocks of Janjgir Champa.

Chandi Formation: This comprises a major stromatolitic limestone sequence developed around southern side of depocentre of Hirri sub-basin as arcuate outcrop pattern. Throughout the eastern part, the carbonate facies disappears and is only present as intercalated discrete pockets or lenses in calcareous argillite. It generally occurs in Nawagarh, Pamgarh and Akaltara blocks of Janjgir Champa.

Saradih Formation: The formation forms N-S trending sub-elliptical outcrop around the depocentre of Baradwar sub-basin. The formation comprises bedded dolomite interbedded with green shale and chert followed by limestone, black shale intercalation and massive dolomite. It generally occurs in Dabhara, Malkharoda, Jaijaipur and Sakti blocks of Janjgir Champa district.

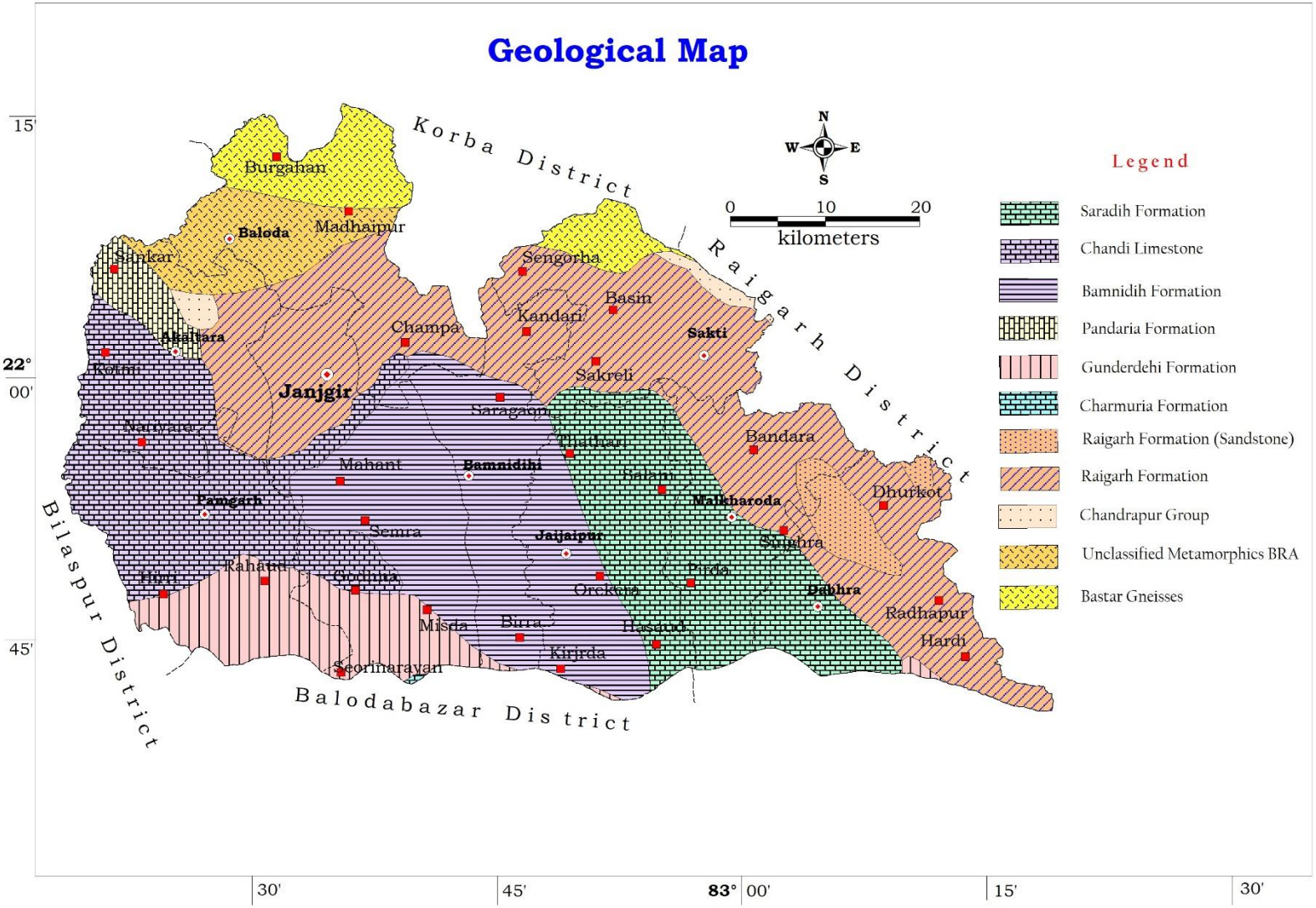


Figure 3 Geological map of the study area

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 Janjgir Champa district is given in Table No. 3 (A, B, C).

Table No. 4(A) Cropping pattern (in ha)

			Cereal									
Kharif	**Rabi**	**Paddy**	**Wheat**	**Jowar & Maize**	**Kodo Kutki**	**Others**	**Pulses**	**Tilhan**	**Fruits Vegetables**	**Reshe**	**Mirch Masala**	**Sugarcane**
257175	16173	261169	1427	315	0	0	24428	1678	5681	17	376	1430

Table No. 4(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 Ponds**	**Irrigated area**	**Irrigated area by other sources**	**Net Irrigated area**	**% of irrigated area wrt. Net sown area**
31	206020	10537	10466	8661	1715	4559	739	2733	221673	80

Table No. 4(C) Contribution of Groundwater in Irrigation Pattern (in ha)

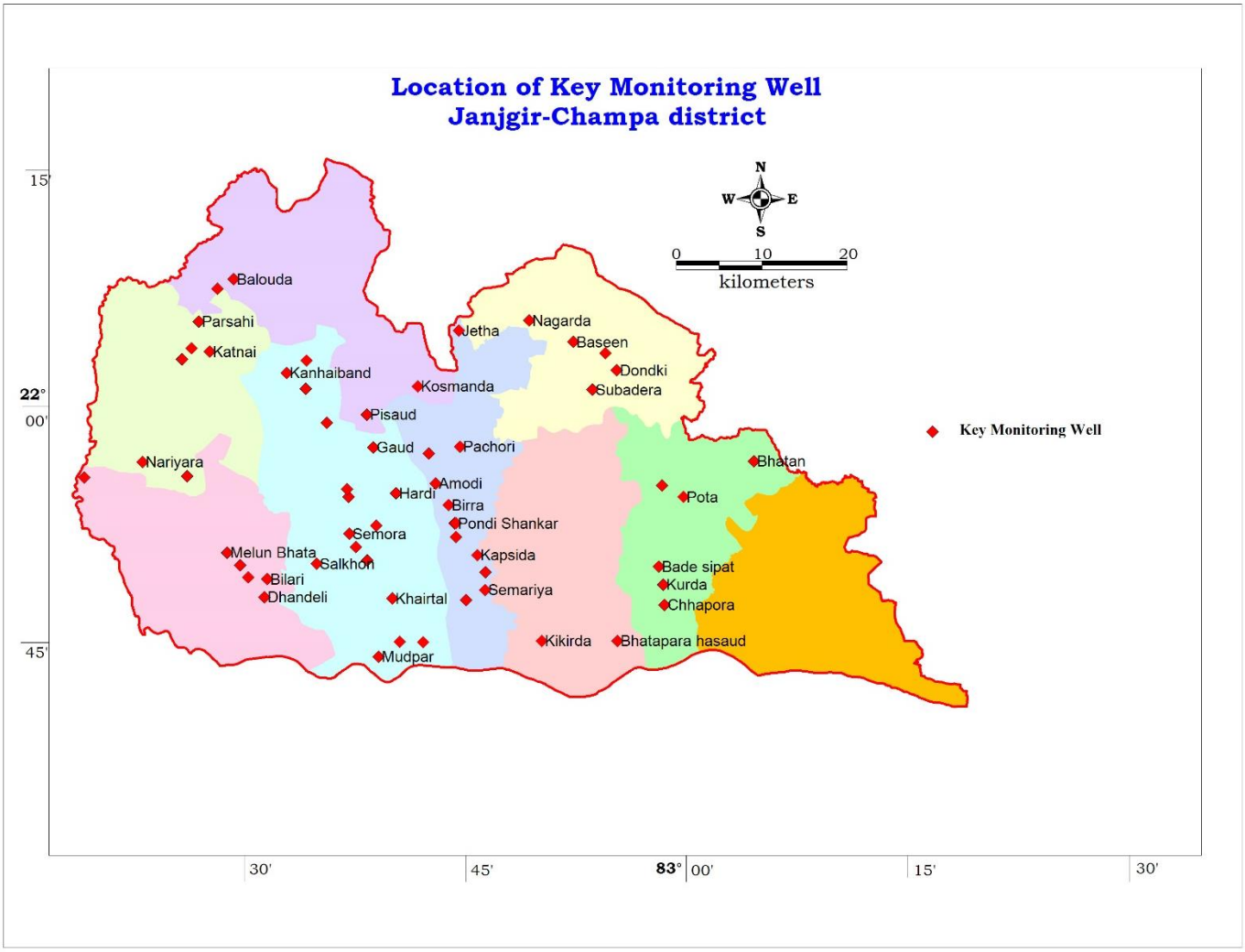
Area Irrigated through Borewells/Tube wells	**Area Irrigated through Dug wells**	**Area Irrigated through Groundwater**	**Net Area Irrigated through all sources**	**% Groundwater contribution in Irrigation wrt Net Irrigated Area**
10466	1715	12181	221673	5.49

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 aquiers which are not well connected are of different thickness as well as of varying horizontal extent. The details of exploration are shown in Annexure 3. In the study area, key wells were established during the pre-monsoon period and have been subsequently monitored in the post-monsoon period (Annexure-1). The key wells are distributed throughout the study area (Figure 8) covering all the geological formations.

Figure 4 Key Wells of the study area



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 2021):

In the pre-monsoon period, it has been observed that in the study area water level in Phreatic aquifer vary between 1.0 to 12.8 m bgl with average water level of 5.37m bgl . In deeper semi-confined aquifer, water level varies between 2.00 to 31.53 m bgl with average water level of 7.82 m bgl shown in Table No. 4(A).

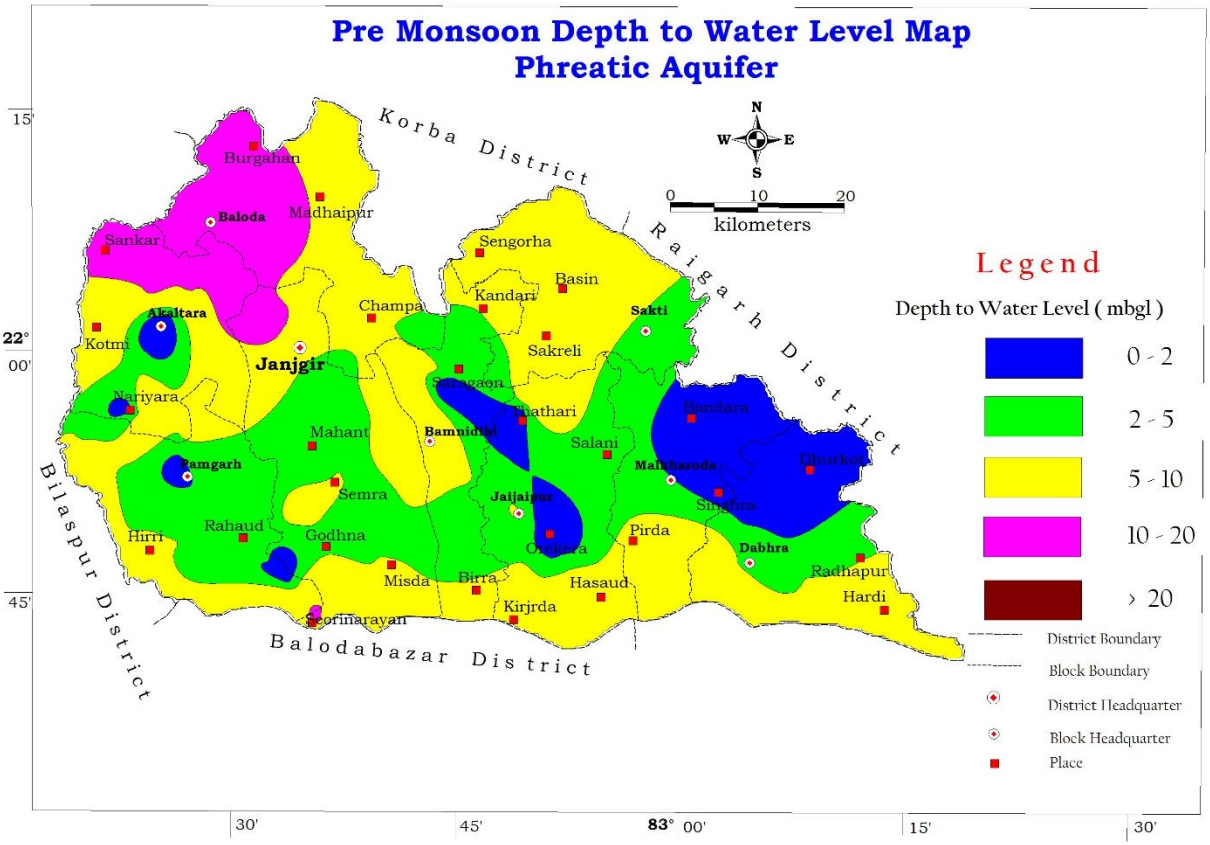


Figure 5 Pre monsoon Water Level Maps of Phreatic Aquifer

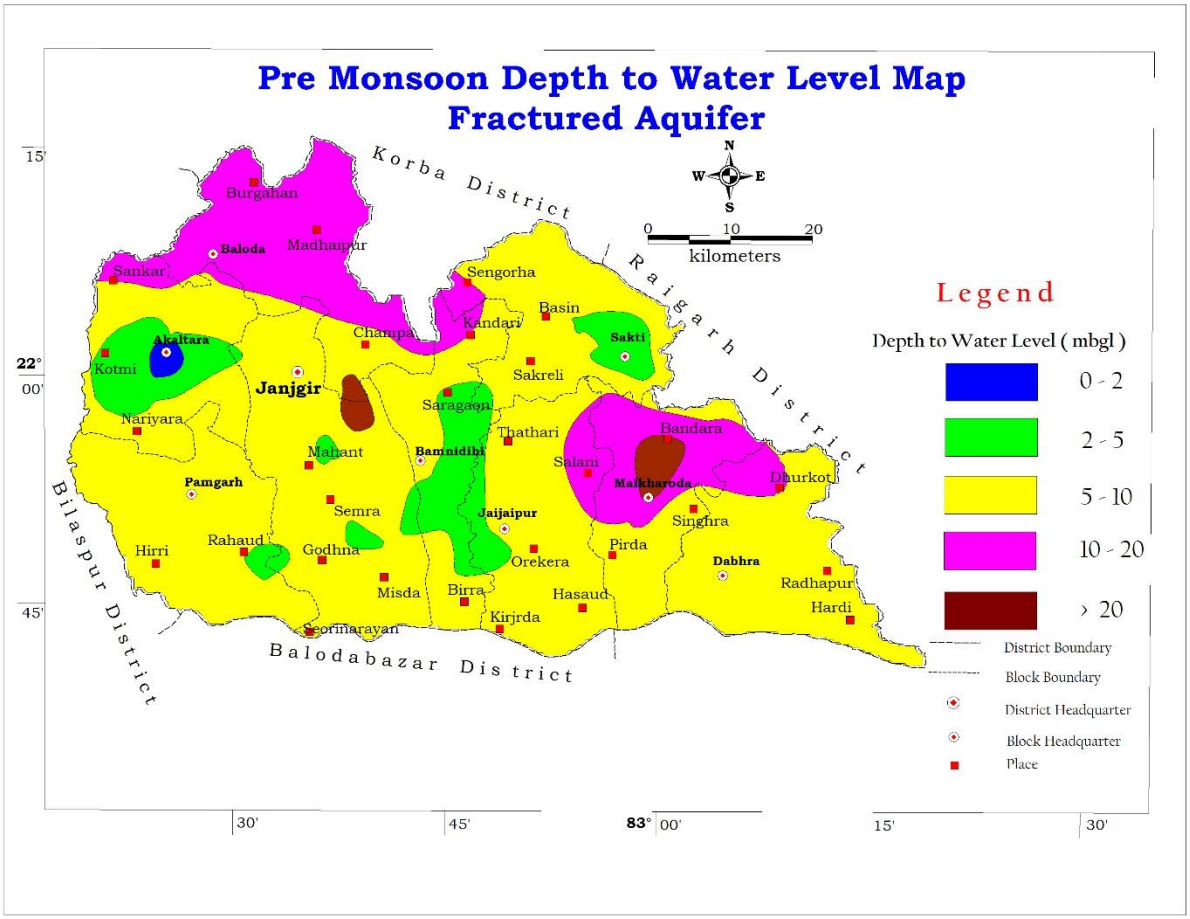


Figure 6 Pre monsoon Water Level Maps of Semi-Confined Aquifer

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

District	Aquifer Type	Min (m. bgl)	Max (m. bgl)	Avg (m. bgl)
Janjgir Champa	Phreatic aquifer	1.00	12.8	5.37
	Fractured Aquifer	2.00	31.53	7.82

ii. Post- monsoon water level (Nov 2019):

In the post-monsoon period, it has been observed that in the study area, water level in phreatic aquifer varies between 0.60 to 11.05 m bgl with average water level of 3.40 m. In deeper semi-confined aquifer, water level varies between 1.40 to 25.80 m bgl with average water level of 4.83 m bgl shown in Table No. 4(B).

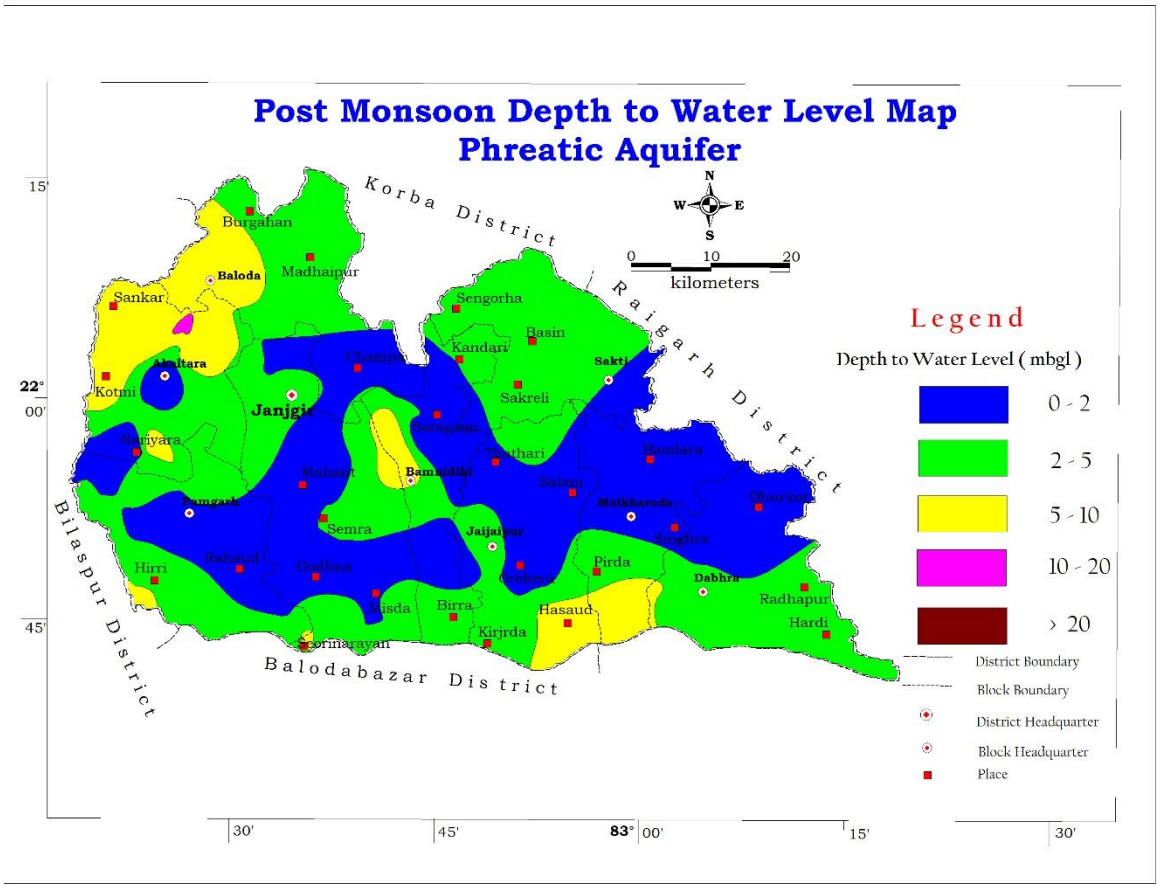


Figure 7 Post monsoon Water Level Map of Phreatic Aquifer

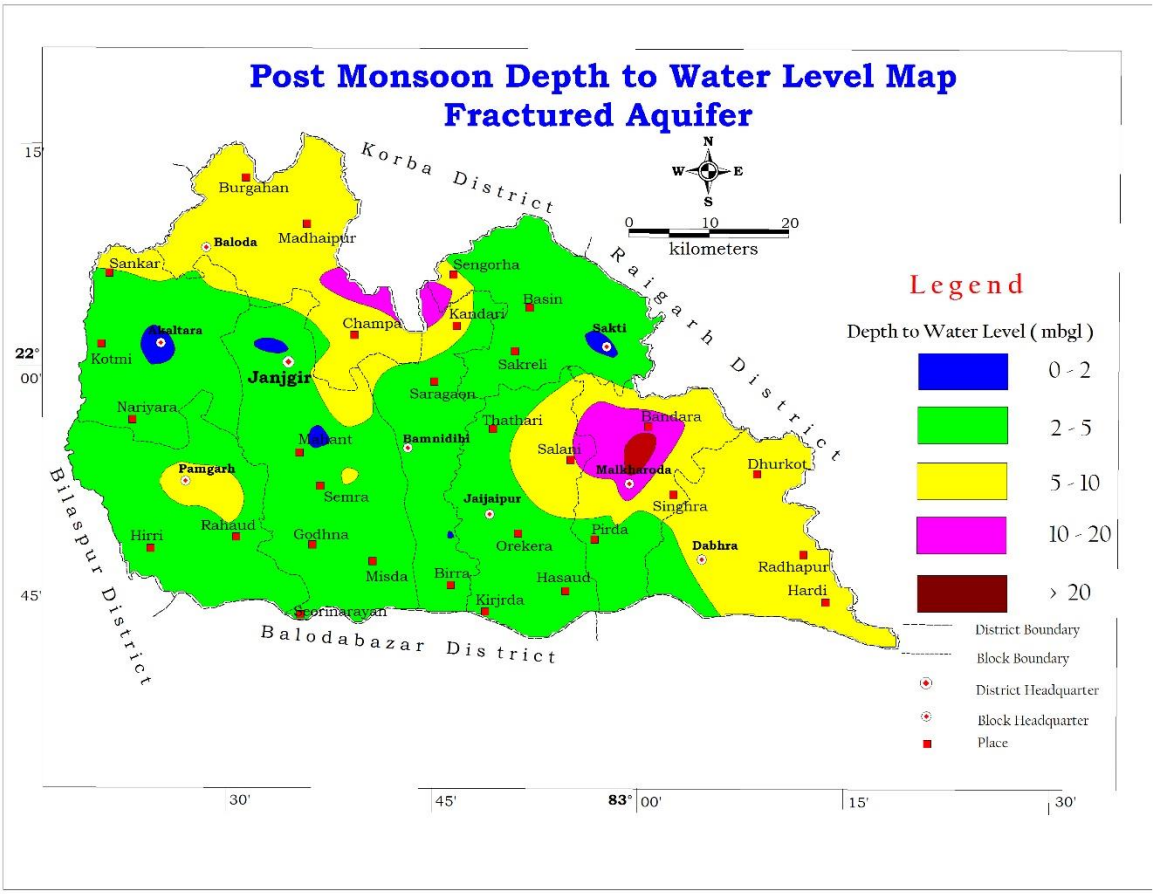


Figure 8 Post monsoon Water Level Maps of Semi-Confined Aquifer

Table No. 5(B) - Aquifer wise Depth to Water Level (Post-monsoon)

District	Aquifer Type	Min (m. bgl)	Max (m. bgl)	Avg (m. bgl)
Janjgir Champa	Phreatic aquifer	0.60	11.05	3.40
	Fractured Aquifer	1.40	25.80	4.83

iii.Seasonal water level fluctuation:

The water level fluctuation data indicates that in the study area, water level fluctuation in phreatic aquifer varies from 0.05 to 9.38m with an average fluctuation of 1.98m. Water level fluctuation in semi-confined aquifer varies from 0.32 to 8.60 m with an average fluctuation of 2.99m shown in Table No. 4(C).

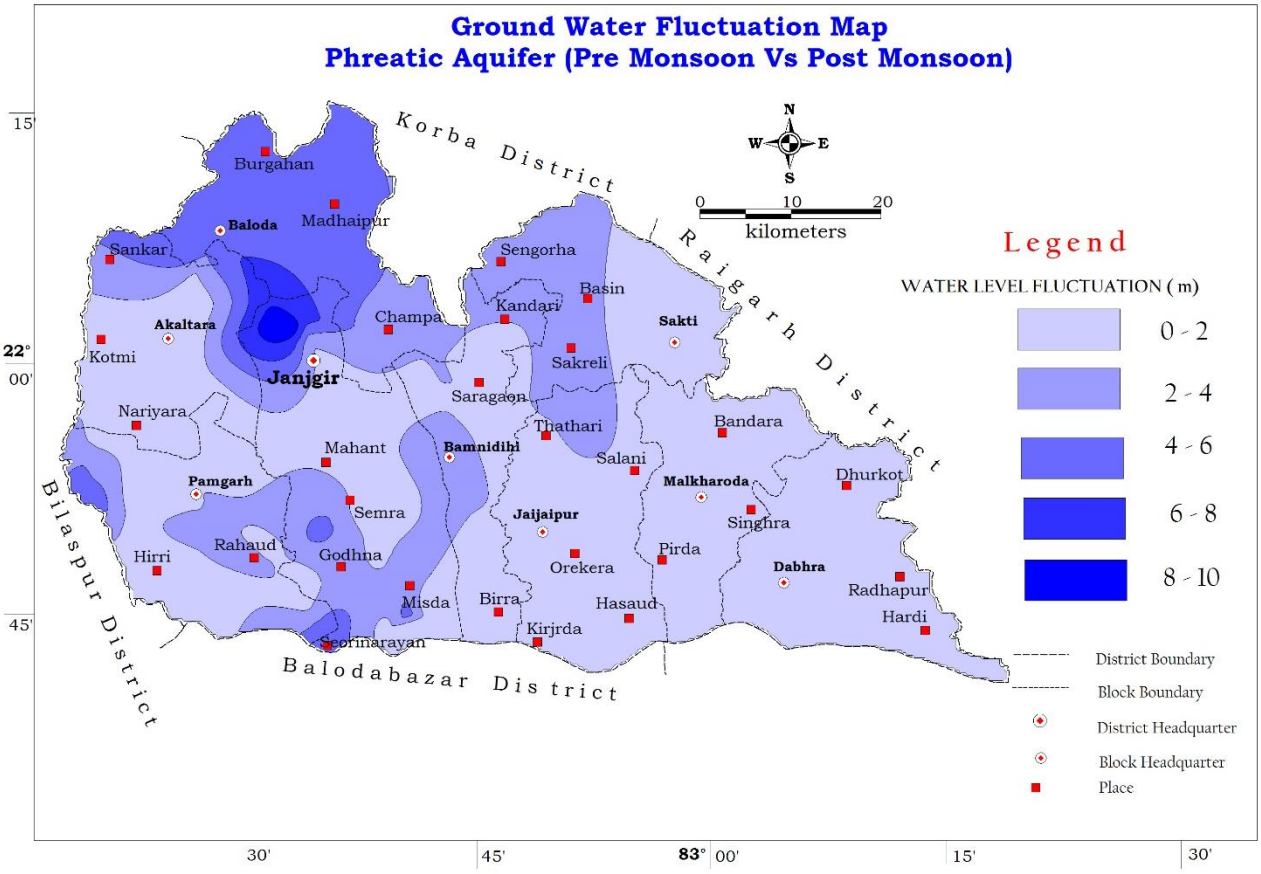


Figure 9 Water level fluctuation of Phreatic aquifer 2021

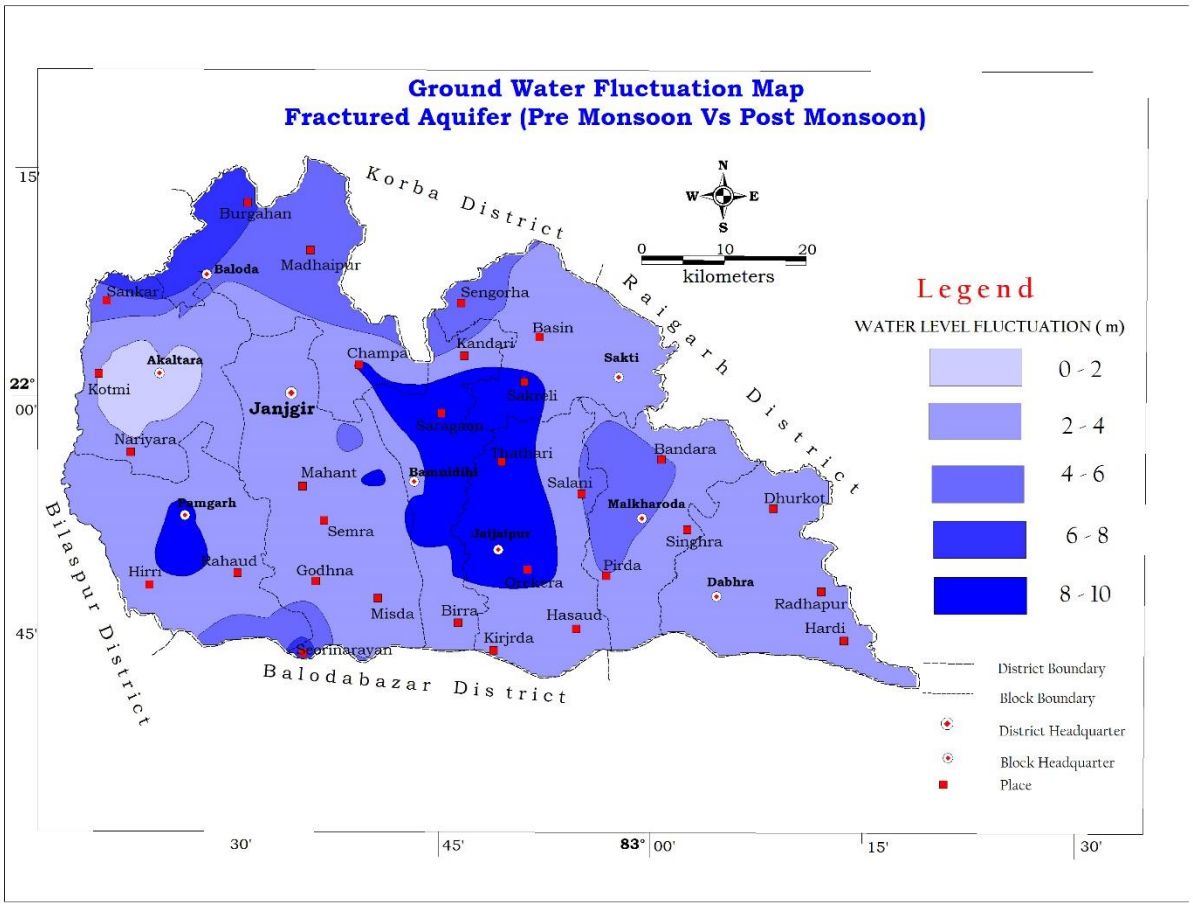


Figure 10 Water level fluctuation of Semi-confined aquifer 2021

Table No. 5(C) - Aquifer wise Depth to Water Level Fluctuation

District	Aquifer Type	Min (m.bgl)	Max (m.bgl)	Avg (m.bgl)
Janjgir Champa	Phreatic aquifer	0.05	9.38	1.98
	Fractured Aquifer	0.32	8.60	2.99

3. AQUIFER DEPOSITION AND GROUND WATER RESOURCES

3.1 Aquifer Geometry and Characterization

Based on the exploratory drilling data generated for the blocks (Annexure 3), 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 is 1. Shale (Raigarh, Gunderdehi and Bamindih), 2. Limestone (Pandaria, Charmuria and Chandi) 3. Sandstone (Raigarh and Chadrapur) and Bastar gneiss. Details are represented in Table no. 5.

Table 6 Aquifer Characteristics of Janjgir Champa District

CHARACTERISTICS	AQUIFER SYSTEM	
	Weathered	**Fractured**
Major Rock type	Shale, Limestone, Granite	Shale, Limestone, Granite
Weathered thickness (mbgl)	4.5 to 37	-
Depth range of the aquifer (mbgl)	4.5 to 31	10 to 146
Fracture encountered (mbgl)	-	10 to 146
No. of waterbearing zones	-	1 to 8
Transmissivity (m^2/day)	-	5.40 to 1125.65
Yield	10 to 130 m3/day	Up to 21 lps
Sustainability	1 to 4 hours	0.5 to 7 hours

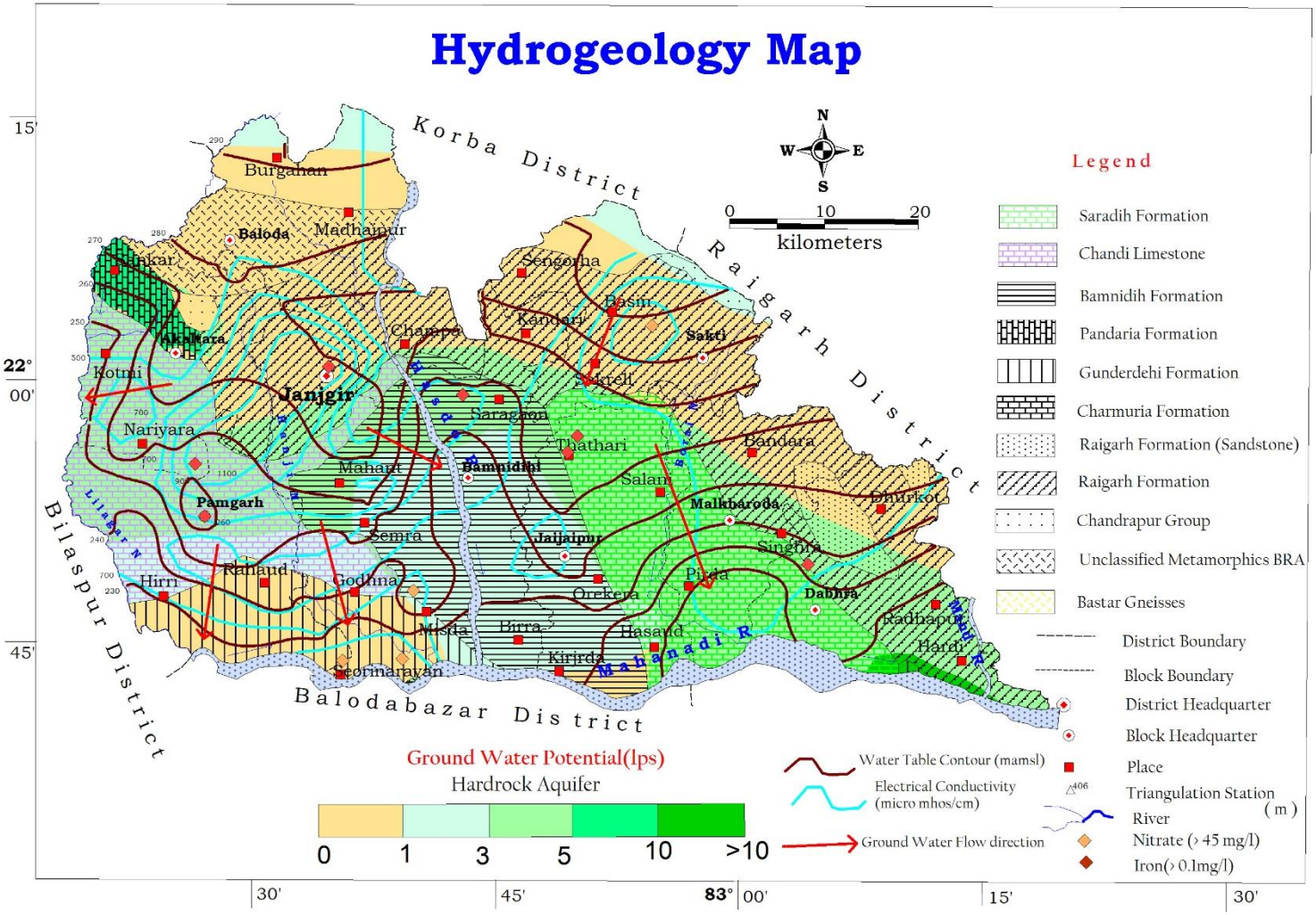


Figure 15 Hydrogeology Map of Study Area

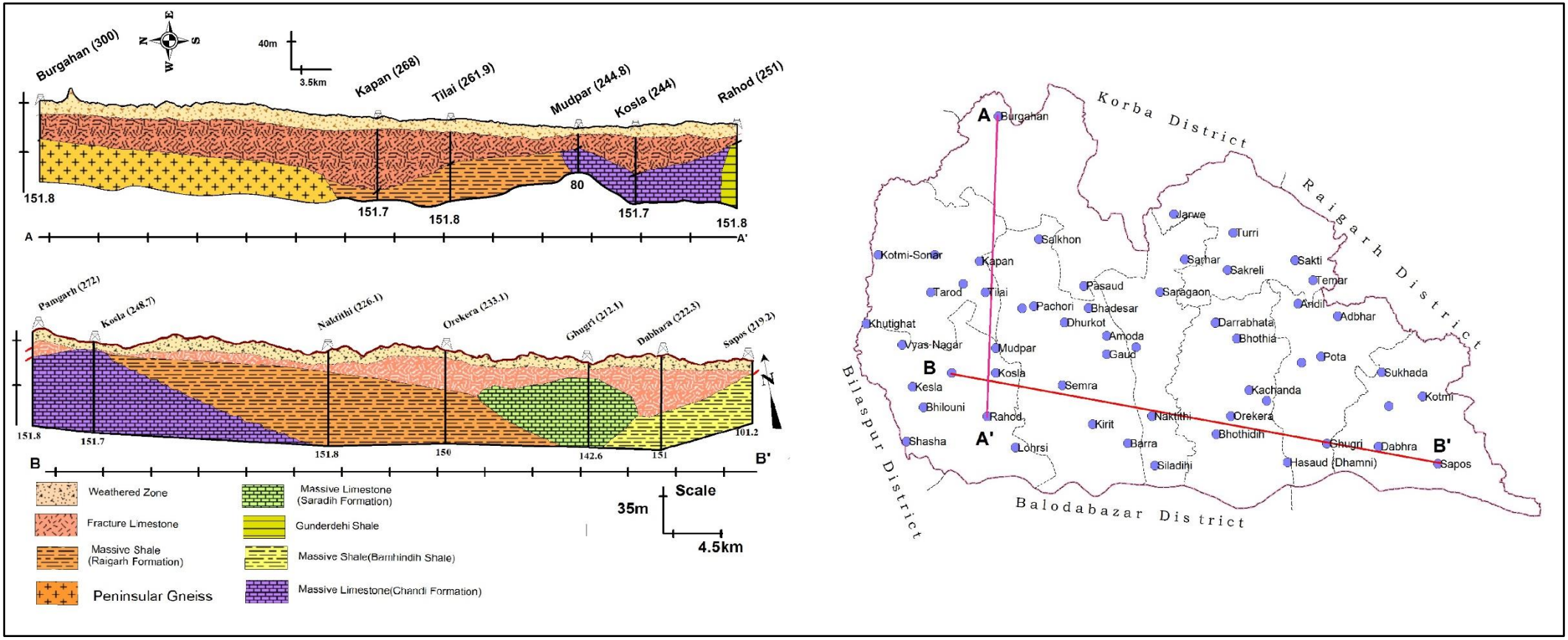


Figure 11 A Cross-section of Study area

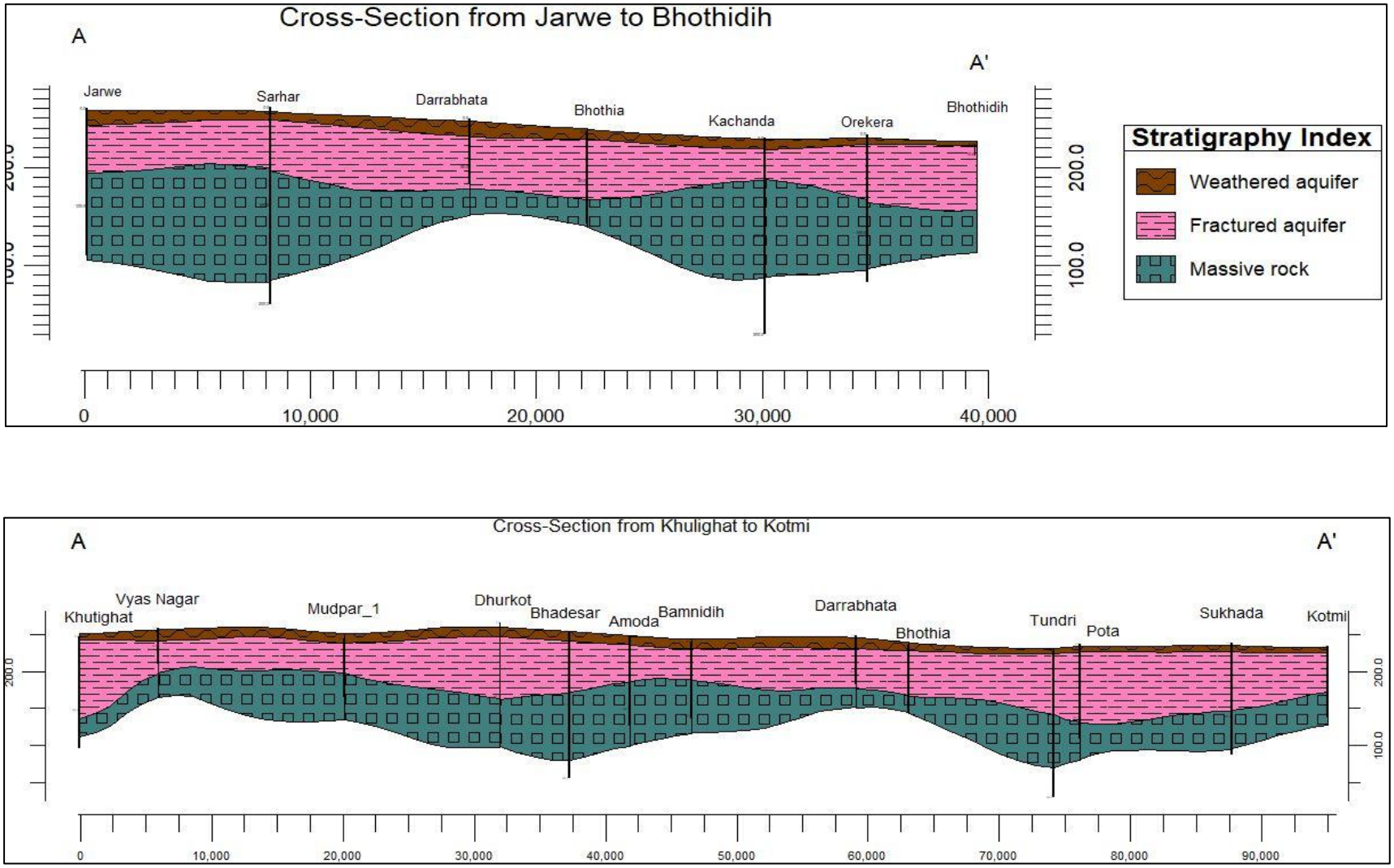


Figure 12 B Cross-section of Study area

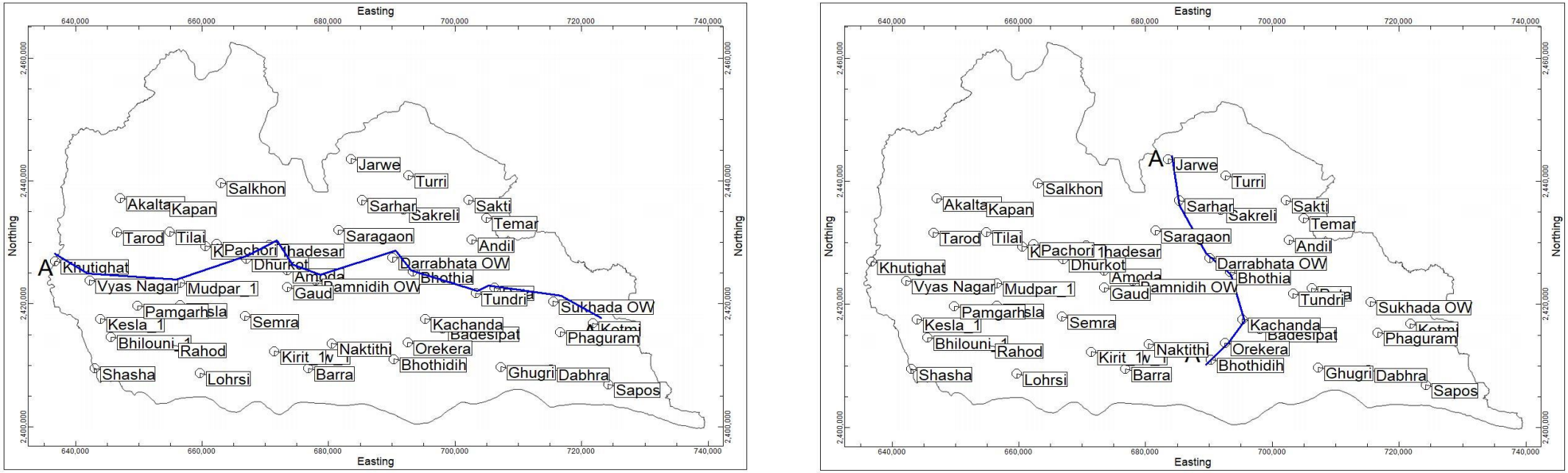


Figure 13 C Cross-section of Study area

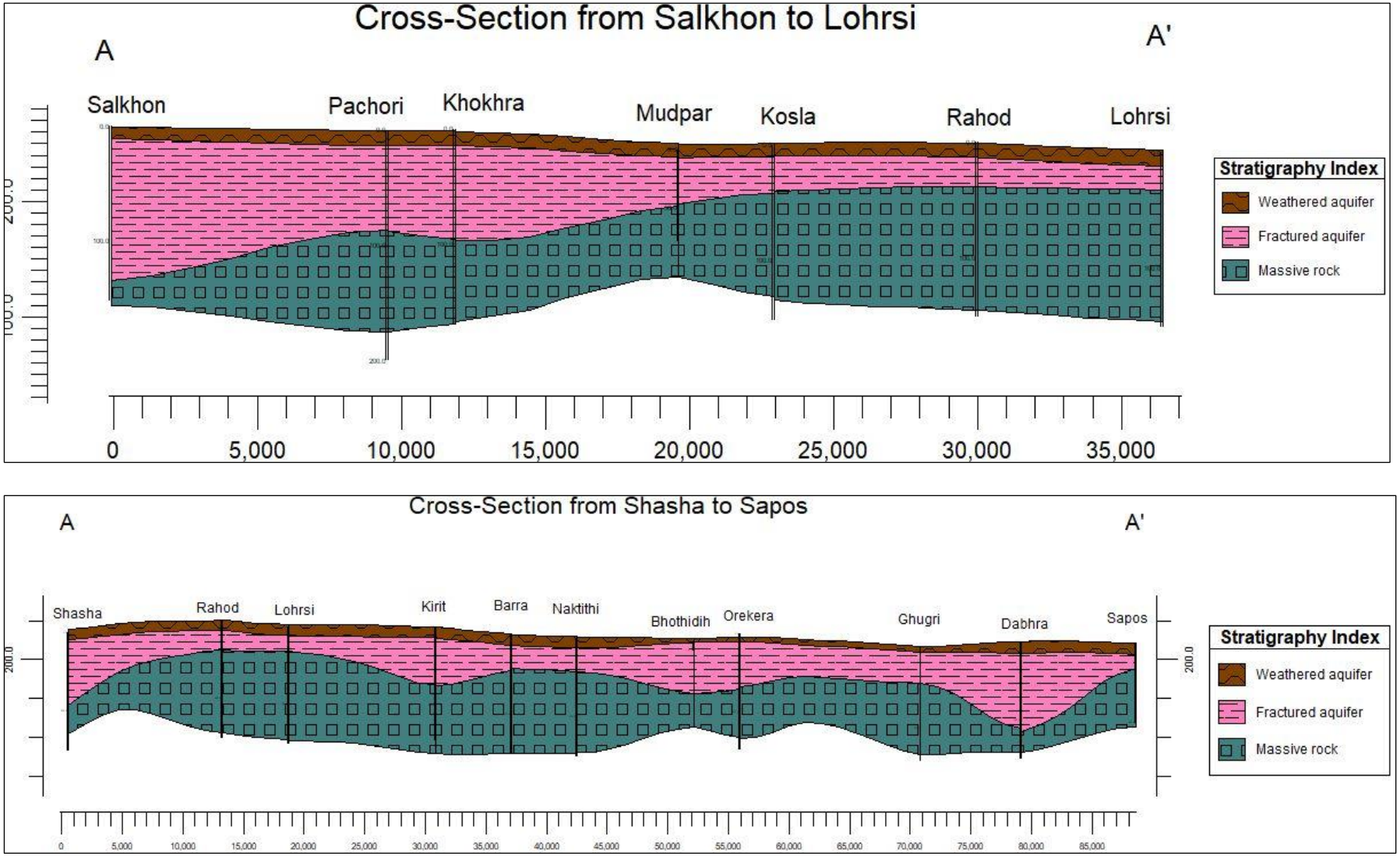


Figure 14 D Cross-section of Study area

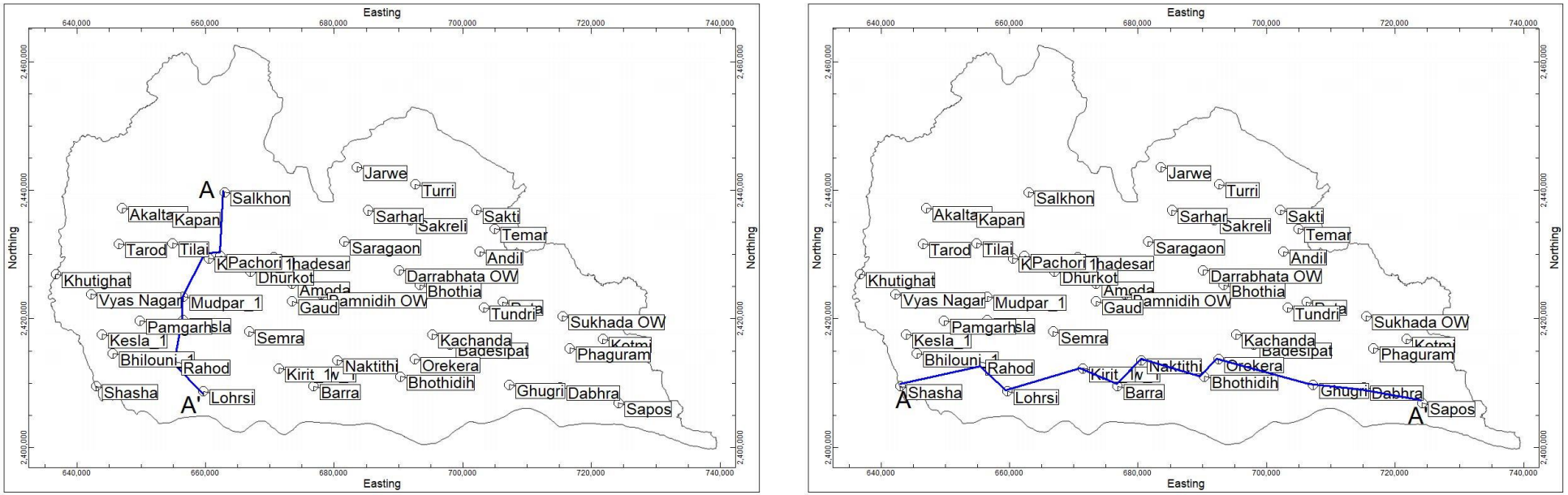


Figure 15 E Cross-section of Study area

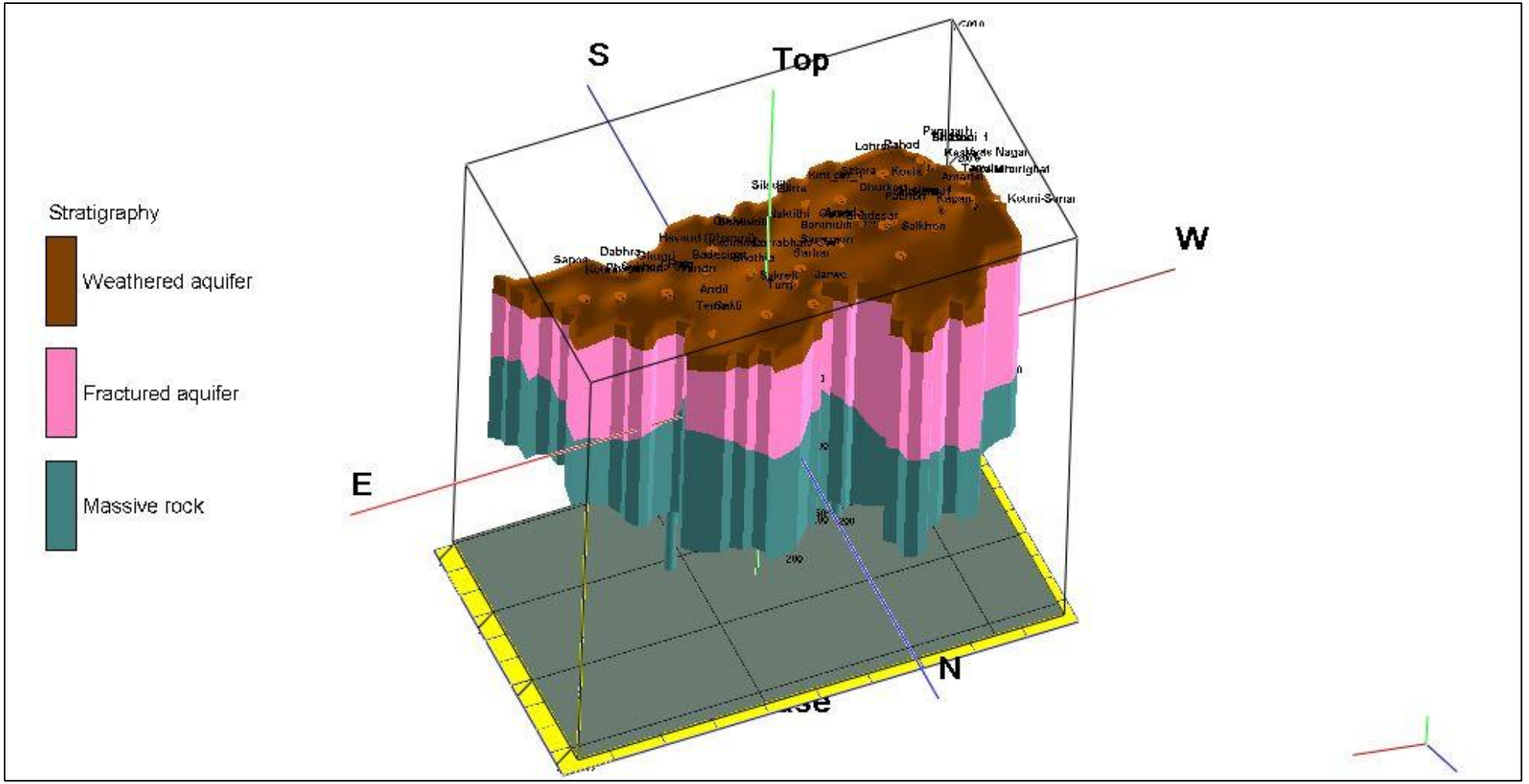


Figure 17 A 3D Disposition of Aquifers in Study area

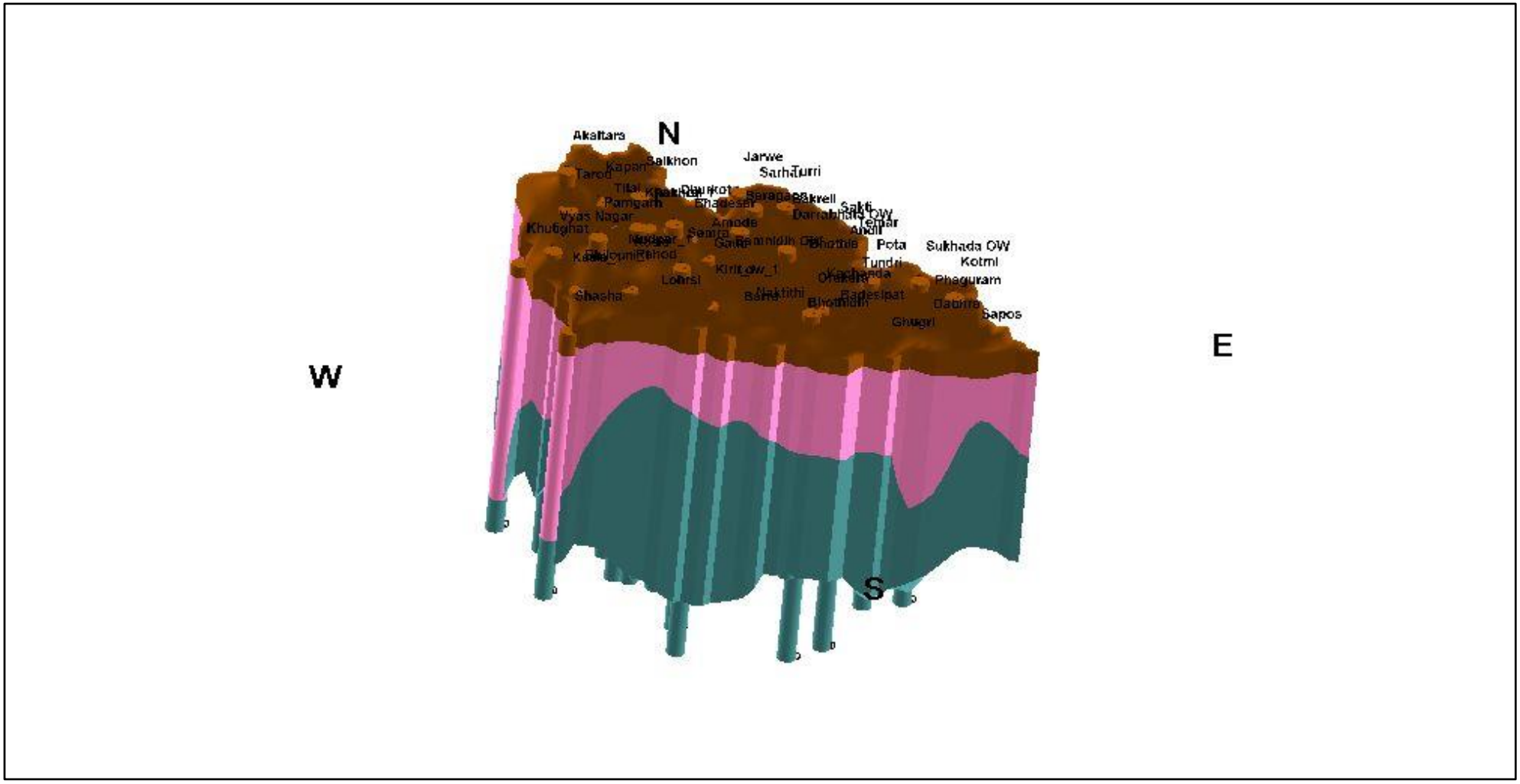
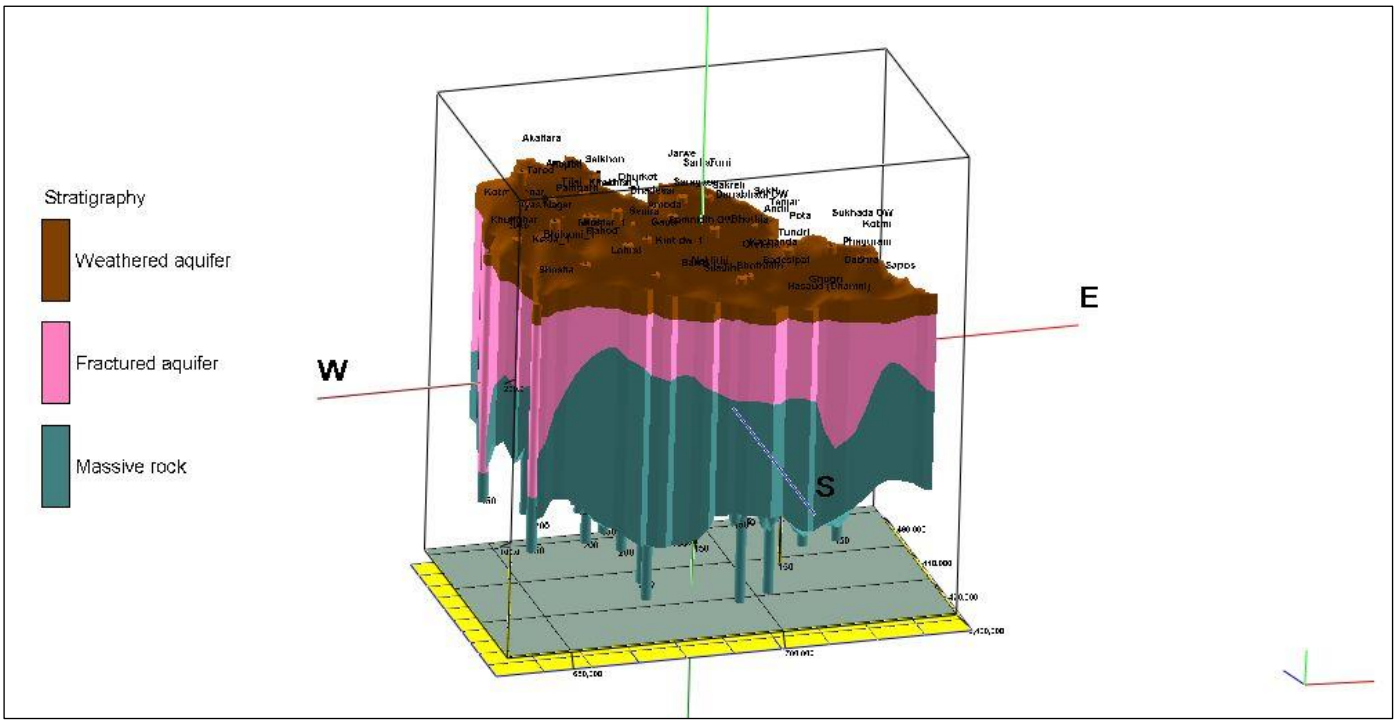


Figure 17 B 3D Disposition of Aquifers in Study area



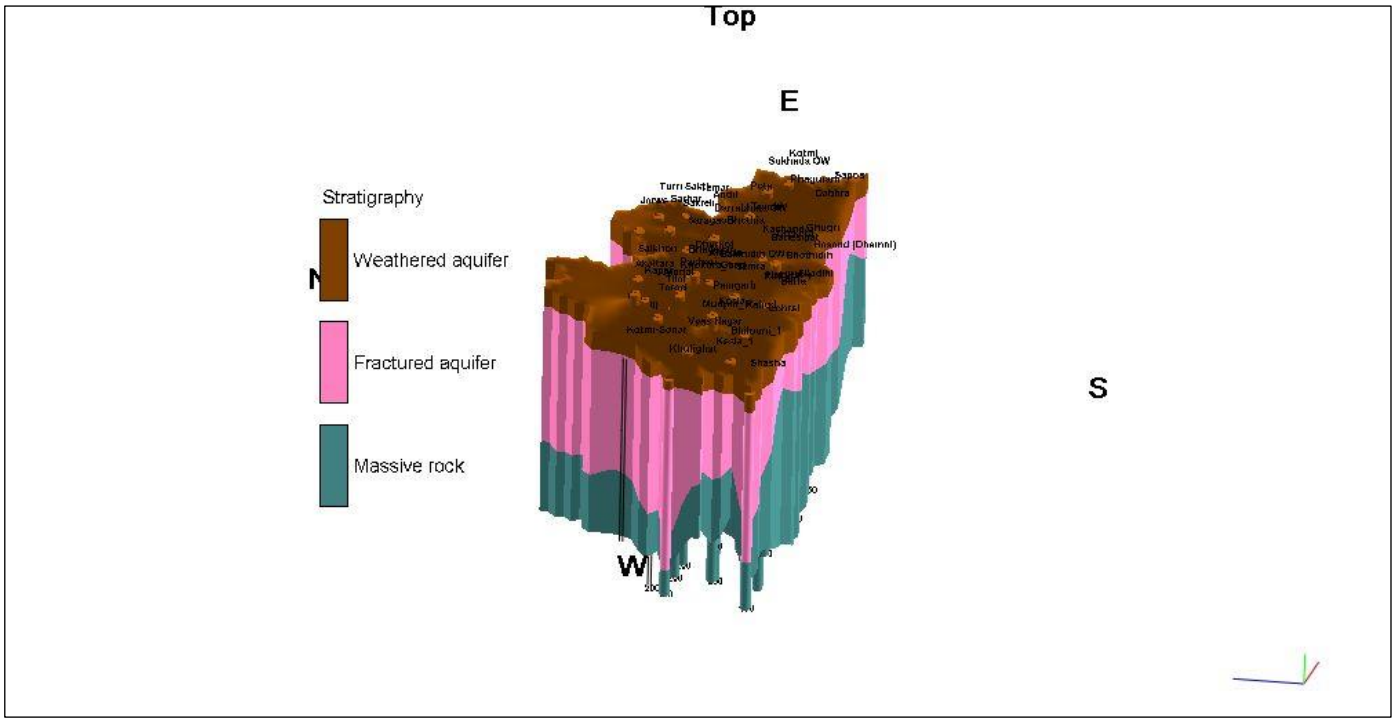


Figure 17 C 3D Disposition of Aquifers in Study area

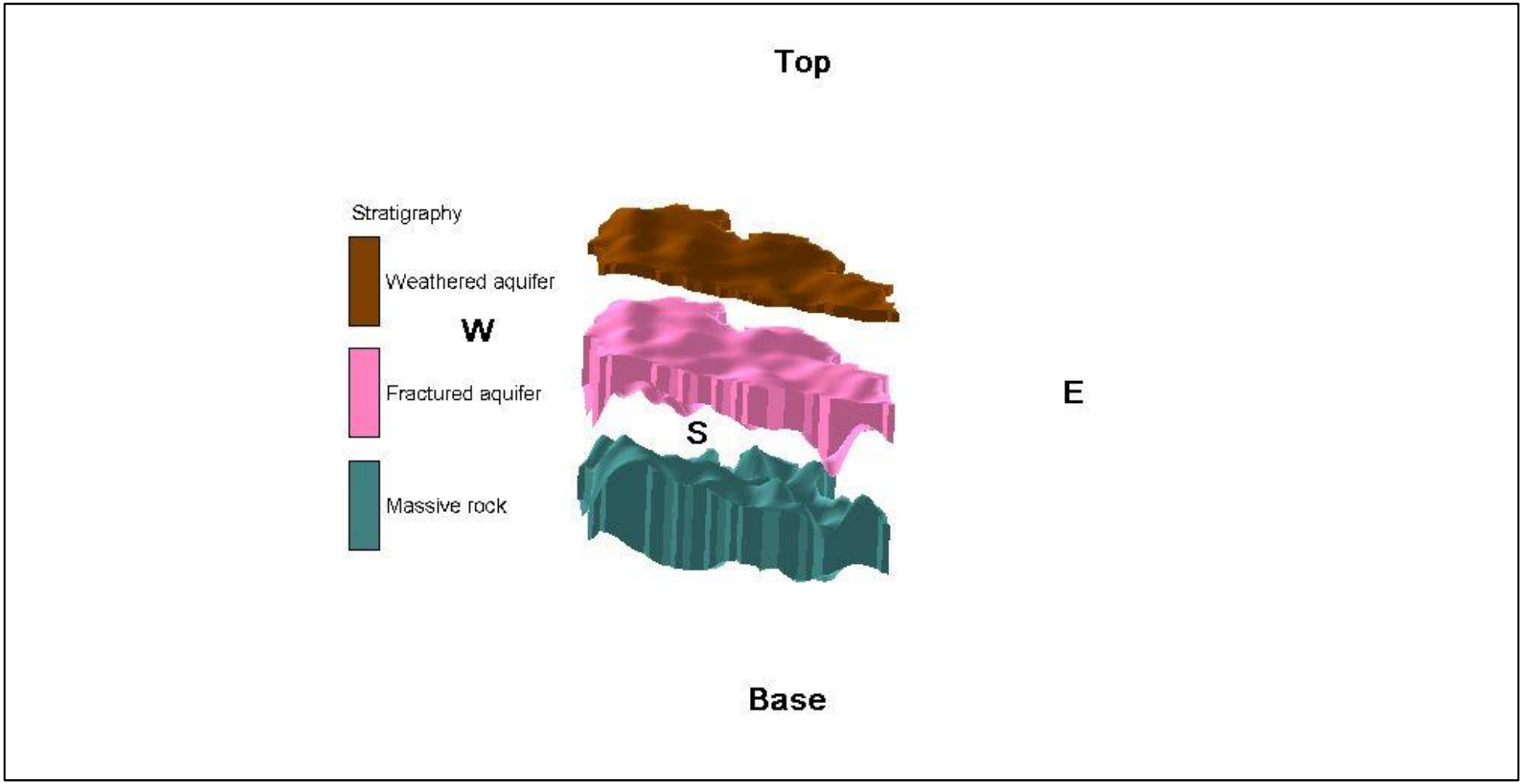


Figure 17 D 3D Disposition of Aquifers in Study area (Explode map)

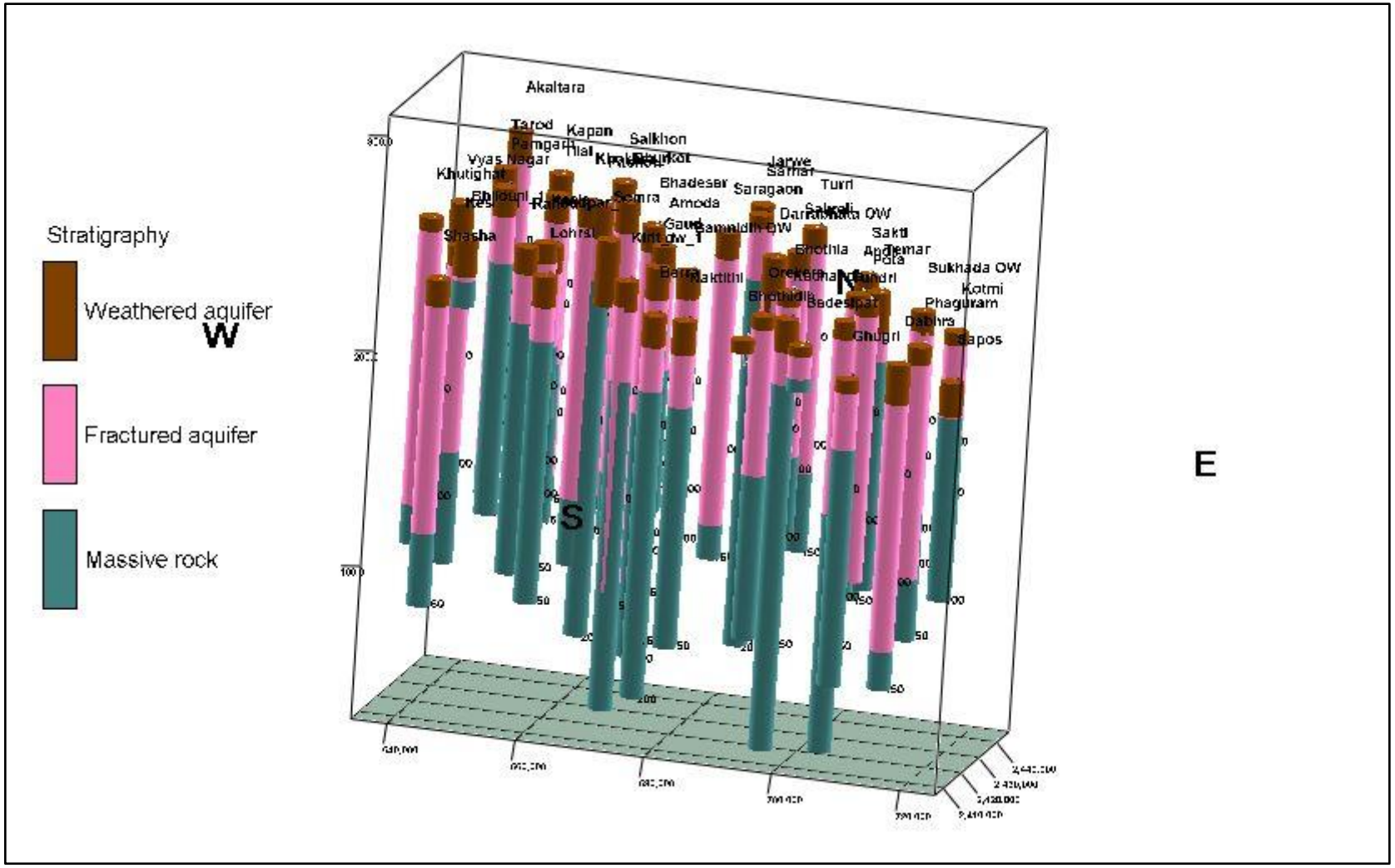


Figure 17 E 3D Disposition of Aquifers in Study area (Log map)

3.2 Groundwater Resources Availability and Extraction

In the ground water resource estimation, the unit of assessment to ground water resources has been taken as the smallest administrative unit i.e. Block. The hilly areas (slope greater than 20%) have been excluded from the computations. The assessment unit has been divided into command and non-command areas and ground water resources have been estimated separately for command and non-command areas. The ground water recharge in the monsoon season and non- monsoon season has also been estimated separately.

The water level data collected by CGWB through NHS monitoring and from state ground water survey, has been utilized for resource estimation. The rainfall data from Indian Meteorological Department has been incorporated in the assessment. The irrigation data for tube wells and dug wells were provided by Water Resources Department. The state could not get success to obtain the stream data from the concern department. The domestic dug wells & bore wells data are not available, therefore per capita consumption of 60 liters per day per person for rural areas and 100 liters per day per person for urban areas have been taken into consideration. The data of ground water withdrawal for industries incorporated from the NOC issued by CGWA and from State Industries Department.

Stage of ground water extraction of the Bilaspur district is 55.72%. The category and stage of ground water extraction of all the blocks in the district are given in the Table 7. Based on the resource assessment made, the resource availability in Block wise in Janjgir Champa district upto 200m depth is given in Table 8.

Table 7 Blockwise stage of extraction and Category

District	Block Name	Stage of Ground Water Extraction (%)	Category
Janjgir Champa	AKALTARA	42.01	Safe
	BALOUDA	51.16	Safe
	BAMHANIDIH	52.48	Safe

	DABHARA	74.04	Semi-Critical
	JAIJAIPUR	66.10	Safe
	JANJGIR (NAWAGARH)	34.25	Safe
	MALKHARODA	73.41	Semi-Critical
	PAMGARH	37.36	Safe
	SAKTI	70.64	Semi-Critical

Table 8 Groundwater Resource up to 200m bgl (MCM)

District	**Block**	**Dynamic Resources (MCM)**		**Insitu Resources (MCM)**		**Total Resources (MCM)**
		Aquifer I	**Aquifer II**	**Aquifer I**	**Aquifer II**	
Janjgir Champa	Akaltara	13.18	28.89	127.93	1884.52	2054.52
	Balouda	33.34	49.75	113.51	1685.03	1881.63
	Bamhanidih	17.48	18.34	120.77	1632.43	1789.02
	Dabhara	8.28	17.90	155.22	2069.55	2250.95
	Jaijaipur	12.78	38.20	162.41	2106.40	2319.79
	Janjgir (Nawagarh)	43.95	60.73	213.23	2861.91	3179.82
	Malkharoda	8.46	27.52	134.51	1545.05	1715.54
	Pamgarh	18.95	25.90	167.50	2114.84	2327.19
	Sakti	13.39	22.41	127.15	1637.44	1800.39

3.3 Existing and Future Water Demand (2025)

Table 9 Ground Water Resources of the Study area in Ham

Block	Total Annual Ground Water (Ham) Recharge	Total Natural Discharge (Ham)	Annual Extractable Ground Water Resourse (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 Extraction 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	
Akaltara	4895.58	489.55	4406.02	1317.139	61.2	472.6057	1850.95	538.11	2489.57	42.01
Balouda	4282.1	428.22	3853.88	1644.575	38.10951	288.8238	1971.52	340.68	1830.5	51.16
Bamhanidih	4420.84	373.33	4047.51	1528	8.928	587.4255	2124.33	678.09	1832.52	52.48
Dabhara	5400.31	392.3	5008.01	3273.122	0.75	434.0514	3707.93	488.76	1245.37	74.04
Jaijaipur	6213.11	426.66	5786.45	3360.636	1.957324	462.1378	3824.73	554.73	1869.13	66.10
Janjgir (Nawagarh)	7435.56	743.56	6691.99	1427.554	0	864.3919	2291.93	1008.27	4256.18	34.25
Malkharoda	5163.36	516.33	4647.03	3001.77	0.216	409.3614	3411.33	485.36	1159.7	73.41
Pamgarh	5605.75	496.86	5108.89	1469.625	0.072	438.8045	1908.49	495.02	3144.18	37.36
Sakti	4367.65	436.76	3930.89	2292.778	0	483.9663	2776.75	557.62	1080.49	70.64
TOTAL	47784.26)	4303.57	43480.67	19315.2	111.2328	4441.568	23867.96	5146.64	18907.64	55.72

The existing demand for irrigation in the area is 19315.2 Ham while the same for domestic use is 4441.56 Ham and for industrial field is 111.232 Ham. To meet the future demand for ground water, a total quantity of 18907.64 ham of ground water is available for future use.

4. GROUND WATER RELATED ISSUES

- **Drying of Dugwells and handpumps during summer-** At several places of Kota and northern part of Champa, Janjgir Nawagarh,and Bamindih blocks phreatic aquifer i.e. zone of dugwells dried up in summer due to large number of shallow borewells in the area.
- **Inherent hydrogeological character of aquifer-** The fractures are also very localised which results very low yield and less transmissivity in aquifers.Good potential zone

confined in structurally low laying areas where limestone occur whereas in shale formation areas, it is poorly yielding.

- **Fluoride concentration** – Fluoride observed at some palces of Janjgir Champa district Jhulan Pkariya(Pamgarh Block) Janjgir(Nawagarh Block) Darrabhata(Jaijaipur Block),Afrid(Bamindih Block),, (Annexure-4).
- **Nitrate contamination:** More than permissible limit found in villages Adhbhar (Malkharoda Block), Asunda (Sakti Block). Shown in Annexure 4.

5. GROUND WATER MANAGEMENT STRATEGY

- It has been observed during fieldwork, there is colossal wastage of groundwater through private well and public water supply system. So, Information, Education and Communication (IEC) activities need to be organized to sensitize people on the issues of depleting groundwater resource. Massive awareness campaigns are essential to aware people about the importance of community participation in saving water.
- 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.
- It has been observed that the demand of ground water is increasing for irrigation, industrial and domestic uses. At locations where water level is declining, 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 8. Probable sites are also identified for the construction of Artificial Recharge structure such as percolation tank, Nala bunding/ cement plug/ check dam, Gully Plugs/ gabion structures in district as shown in figure 18 and details of the sites has been provided in Annexure 2.

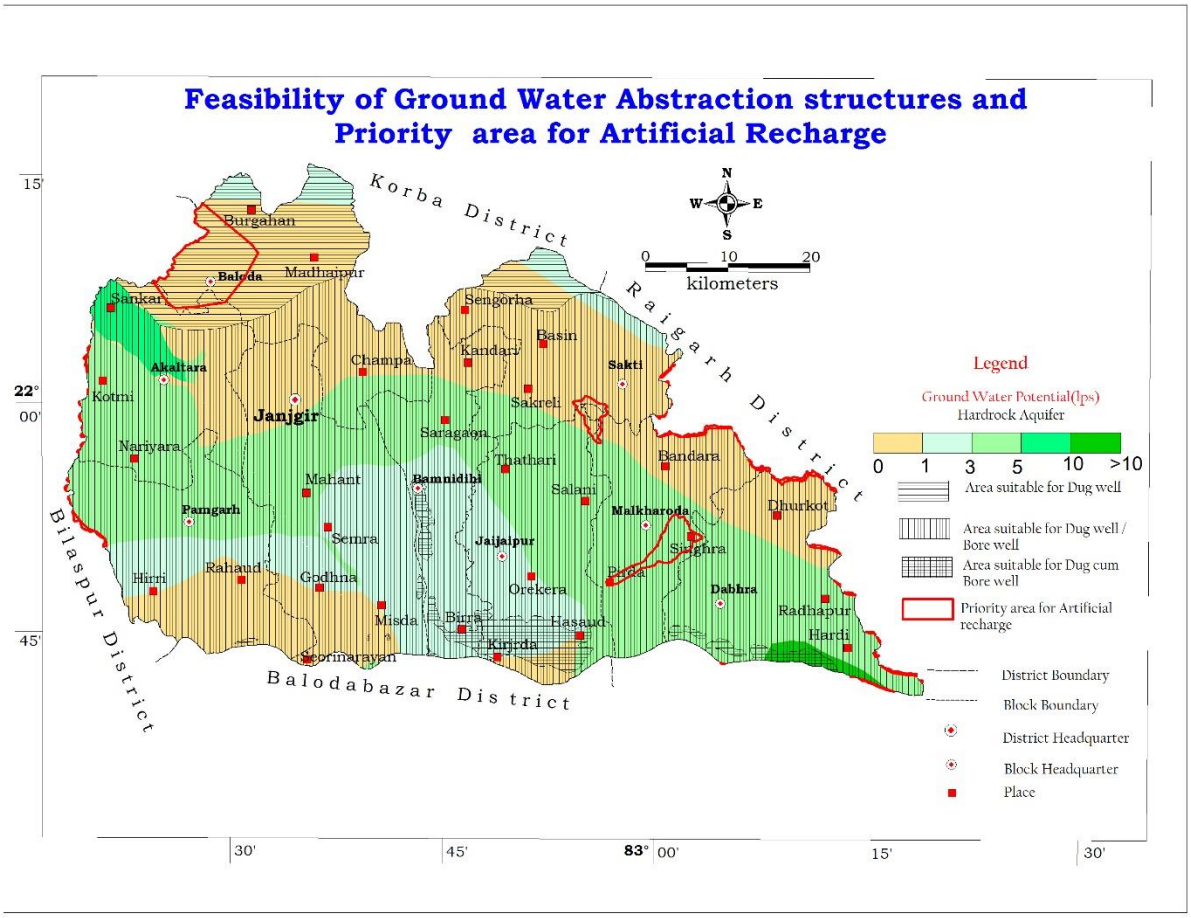


Figure 18 Probable site for Artificial Recharge structure in the study area

Table 10 Types of Artificial Recharge structures feasible

Block/District	Area Identified for Artificial recharge (sq.km)	Vol. of Sub Surface Potential for Artificial recharge (MCM)	Types of Structures Feasible and their Numbers			
			Percolation tank	Nalas bunding cement plug/ check dam	Gravity head /Dug well/ tube well/Recharge shaft	Gully plugs Gabion structures
Recharge Capacity - (MCM)/structure			**0.2192**	**0.0326**	**0.00816**	**0.0073**
Akaltara	4.54	7	0	1	3	2
Balouda	82.54	124	6	19	43	33
Bamhanidih	25.00	38	2	7	16	12
Dabhara	5.71	9	0	2	4	3
Jaijaipur	25.00	38	1	5	10	8
Janjgir (Nawagarh)	30.00	45	2	6	13	10
Malkharoda	3.09	5	0	1	2	2
Pamgarh	25.00	38	2	7	15	11
Sakti	6.67	10	0	2	3	3
Total (Janjgir Champa)	**207.55**	**314**	**13**	**50**	**109**	**84**

- Abandoned tube well and dug well may be used for the recharge through shaft especially in urban and water stressed areas.
- Fluoride and Iron filter plant may be installed in the villages having higher value of contaminants.
- In urban areas STP may be installed for the treatment of sewage water in proper numbers to avoid contamination of ground water. Treatment of sewage water in village through soak pit for the individual houses and Seechewal model or similar model for community level may be adopted to avoid contamination of ground water. Treated water may also be reused for irrigation and other industrial purposes.
- Since the stage of development in the district is 55.72 %. There is scope of utilizing more ground water for future irrigation purpose. Additional number of Ground water abstraction structure may be developed for the effective utilization of ground water resources in the block. The ground water is presently developed through dug wells and tube wells. Yield potential for the block has been shown in Aquifer map (Figure 16). Sites for wells need to be selected only after proper scientific investigation. The ground water quality also needs to be ascertained and the wells used for water supply should be first checked for Iron, Fluoride and other pollutants.

Table 11 Potential of Additional GW abstraction structure creation

Block	Annual Extractable Ground Water Resource (ham)	Stage of ground water Development (%)	Present ground water draft (ham)	Ground water draft at 60% stage of development (ham)	Surplus ground water at present Stage of Development (ham)	Number of TW Recommended in each block (Assuming unit draft as 1.6 ham/structure/ year)	Number of DW Recommended in each block (Assuming unit draft as 0.72 ham/structure/ year)	Additional Irrigation potential creation for Maize/ wheat in winter season in Ha (Assuming 500 mm water requirement)	Additional Irrigation potential creation for Paddy in Ha (Assuming 900 mm water requirement)
Akaltara	4406.02	42.01	1850.95	2643.612	792.662	297.24825	440.3677778	1585.324	713.3958
Balouda	3853.88	51.16	1971.52	2312.328	340.808	127.803	189.3377778	681.616	306.7272
Bamhanidih	4047.51	52.48	2124.33	2428.506	304.176	114.066	168.9866667	608.352	273.7584
Dabhara	5008.01	74.04	3707.93	3004.806	-703.124	-263.6715	-390.6244444	-1406.248	-632.8116
Jaijaipur	5786.45	66.10	3824.73	3471.87	-352.86	-132.3225	-196.0333333	-705.72	-317.574
Janjgir (Nawagarh)	6691.99	34.25	2291.93	4015.194	1723.264	646.224	957.3688889	3446.528	1550.9376
Malkharoda	4647.03	73.41	3411.33	2788.218	-623.112	-233.667	-346.1733333	-1246.224	-560.8008

Pamgarh	5108.89	37.36	1908.49	3065.334	1156.844	433.8165	642.6911111	2313.688	1041.1596
Sakti	3930.89	70.64	2776.75	2358.534	-418.216	-156.831	-232.3422222	-836.432	-376.3944
Total (Janjgir Champa)	**43480.67**	**55.72**	**23867.96**	**26088.4**	**2220.442**	**832.66575**	**1233.578889**	**4440.884**	**1998.3978**

6. CONCLUSION:

For effective utilization of Ground water existing draft for irrigation may be coupled with micro irrigation system. Change in irrigation pattern, optimum use of available resource, use of ground water potential created after artificial recharge can lead to groundwater savings and increase in gross cropped area of the district (Table 12).

Table 12 Detail of groundwater saved through change in cropping pattern and other interventions

Block	Existing Gross Ground Water Draft for Irrigation in Ham	Additional Saving of GW after using Micro Irrigation methods in Ham(Assuming 30 % saving)	GW recharge through Artificial recharge structure in Ham	Total GW Resource Enhancement	Stage of Ground Water Extraction (%) As per 2020 GWRE	Expected Stage of Ground Water Extraction (%) after intervention
Akaltara	1317.139	395.1416	12.9	408.042	42.01	20.85
Balouda	1644.575	493.3725	173.3	666.673	51.16	39.49
Bamhanidih	1528	458.4	63.8	522.200	52.48	43.21
Dabhara	3273.122	981.9366	14.6	996.537	74.04	51.90
Jaijaipur	3360.636	1008.191	41.3	1049.491	66.10	39.50
Janjgir (Nawagarh)	1427.554	428.2663	54	482.266	34.25	15.58
Malkharoda	3001.77	900.5311	8.4	908.931	73.41	57.74
Pamgarh	1469.625	440.8875	60	500.888	37.36	19.52
Sakti	2292.778	687.8334	14	701.833	70.64	36.04
Total (Janjgir Champa)	19315.2	5794.56	442.3	6236.860	55.71667	35.98111

Annexure 1 Details of key wells established

S.No	District	Block	Village	Long	Lat	May	Nov	Fluctuation	Type of well
1	Janjgir Champa	Janjgir	Kanhaiband	82.548755	22.0364700	12.28	2.90	9.38	DW
2	Janjgir Champa	Janjgir	Sarkhon	82.571252	22.0494890	9.02	2.40	6.62	DW
3	Janjgir Champa	Janjgir	Pali	82.532197	22.6662027	2.45	1.11	1.34	DW
4	Janjgir Champa	Akaltara	Katnai	82.461657	22.0589050	9.55	7.88	1.67	DW
5	Janjgir Champa	Akaltara	Khatola	82.429964	22.0508060	5.6	3.60	2.00	DW
6	Janjgir Champa	Akaltara	Nariyara	82.385613	21.9423380	2.7	1.50	1.20	DW
7	Janjgir Champa	Pamgarh	Konargad	82.319436	21.9260510	4.48	2.38	2.10	DW
8	Janjgir Champa	Pamgarh	Bilari	82.526635	21.8182600	4.12	2.89	1.23	DW
9	Janjgir Champa	Nawagarh	Salkhon	82.582533	21.8343778	5.4	1.12	4.28	DW
10	Janjgir Champa	Janjgir	Kosmanda	82.697567	22.0220770	4.56	2.29	2.27	DW
11	Janjgir Champa	Champa	Pachori	82.745285	21.9581890	1.75	0.60	1.15	DW
12	Janjgir Champa	Champa	Pondi Shankar	82.739028	21.8769300	5.6	3.25	2.35	DW
13	Janjgir Champa	Bamindih	Birra	82.732257	21.8962728	5.46	3.33	2.13	HP
14	Janjgir Champa	Sakti	Chhapora	82.976418	21.7900750	5.45	3.22	2.23	HP
15	Janjgir Champa	Malkharoda	Pota	82.998602	21.9039860	31.53	25.80	5.73	HP
16	Janjgir Champa	Malkharoda	Bhatan	83.078437	21.9417650	10.25	8.11	2.14	HP
17	Janjgir Champa	Sakti	Subadera	82.895484	22.0178010	5.32	3.22	2.10	HP
18	Janjgir Champa	Janjgir	Pisaud	82.639687	21.9920750	10.35	7.34	3.01	HP
19	Janjgir Champa	Nawagarh	Gaud	82.647071	21.9575360	11.52	7.11	4.41	HP
20	Janjgir Champa	Nawagarh	Hardi	82.672738	21.9088120	5.1	3.22	1.88	HP
21	Janjgir Champa	Nawagarh	Hiragarhturi	82.650060	21.8748720	8.85	5.35	3.50	HP
22	Janjgir Champa	Nawagarh	Rachhabhatan	82.639751	21.8376910	4.89	2.22	2.67	HP
23	Janjgir Champa	Janjgir	Naila	82.570314	22.0195458	5.44	1.92	3.52	HP
24	Janjgir Champa	Janjgir	Balouda	82.488648	22.1355320	11.45	7.40	4.05	HP
25	Janjgir Champa	Baloda	Buchihardi	82.470277	22.1255867	11.56	7.51	4.05	HP
26	Janjgir Champa	Baloda	Parsahi	82.449311	22.0908430	7.45	3.40	4.05	HP
27	Janjgir Champa	Akaltara	Kotgarh	82.441020	22.0626696	6.44	4.30	2.14	HP
28	Janjgir Champa	Akaltara	Khatola	82.4301939	22.0509106	5.66	2.40	3.26	HP
29	Janjgir Champa	Akaltara	Tarod	82.432232	22.9924112	13.21	7.52	5.69	HP
30	Janjgir Champa	Akaltara	Pakariya	82.4357223	21.9271417	7.85	4.55	3.30	HP

31	Janjgir Champa	Pamgarh	Melun Bhata	82.4814664	21.8463034	3.88	1.70	2.18	DW
32	Janjgir Champa	Pamgarh	Mehandi	82.4960864	21.8330940	9.35	5.55	3.80	HP
33	Janjgir Champa	Pamgarh	Rahud	82.5050122	21.8201977	7.39	4.90	2.49	HP
34	Janjgir Champa	Pamgarh	Dhandeli	82.5234631	21.7991374	4.31	2.10	2.21	HP
35	Janjgir Champa	Nawagarh	Mudpar	82.6523667	21.7360326	6.67	4.30	2.37	HP
36	Janjgir Champa	Nawagarh	Kera	82.7028388	21.7514059	5.35	2.10	3.25	HP
37	Janjgir Champa	Nawagarh	Misda	82.6766470	21.7516084	6.44	2.02	4.42	DW
38	Janjgir Champa	Nawagarh	Khairtal	82.6681904	21.7974979	5.88	1.86	4.02	DW
39	Janjgir Champa	Nawagarh	Semora	82.6269799	21.8521488	6.62	2.92	3.70	HP
40	Janjgir Champa	Nawagarh	Semora	82.6198576	21.8660001	5.61	3.84	1.77	DW
41	Jaspur	Nawagarh	Budena	82.6188666	21.9049790	5.69	2.96	2.73	HP
42	Jaspur	Nawagarh	Jagmandha	82.6170903	21.9131970	4.35	1.40	2.95	HP
43	Jaspur	Nawagarh	Pendri	82.5943649	21.9837340	6.88	4.60	2.28	HP
44	Jaspur	Bamhinidih	Piparda	82.709711	21.9508166	5.99	3.90	2.09	HP
45	Jaspur	Bamhinidih	Amodi	82.7177033	21.9191476	6.83	4.10	2.73	HP
46	Jaspur	Bamhinidih	Pondishankar	82.7404414	21.8772313	3.22	2.90	0.32	HP
47	Jaspur	Bamhinidih	Paraspali	82.740441	21.8624581	4.25	2.45	1.80	HP
48	Jaspur	Bamhinidih	Kapsida	82.7645873	21.8433962	4.44	2.45	1.99	HP
49	Jaspur	Bamhinidih	Bansula	82.7740025	21.8251214	3.11	1.80	1.31	DW
50	Jaspur	Bamhinidih	Semariya	82.7734181	21.8065862	3.89	1.94	1.95	HP
51	Jaspur	Bamhinidih	Taldeori	82.7516758	21.7958611	5.92	3.58	2.34	HP
52	Jaspur	Jaijaipur	Kikirda	82.8371819	21.7523274	5.58	3.90	1.68	DW
53	Jaspur	Jaijaipur	Bhatapara hasaud	82.9229087	21.7521748	5.87	3.10	2.77	HP
54	Jaspur	Malkharoda	Kurda	82.9749342	21.8114051	7.13	4.90	2.23	HP
55	Jaspur	Malkharoda	Bade sipat	82.9700321	21.8304604	9.65	5.00	4.65	HP
56	Jaspur	Malkharoda	Amandula	82.9743112	21.9163165	19.65	13.95	5.70	HP
57	Jaspur	Sakti	Dondki	82.923324	22.0382926	5.32	2.20	3.12	HP
58	Jaspur	Sakti	Asonda	82.9105397	22.0565189	4.88	2.31	2.57	HP
59	Jaspur	Sakti	Baseen	82.874347	22.0683964	6.58	4.15	2.43	HP
60	Jaspur	Sakti	Nagarda	82.824142	22.0912695	7.29	3.30	3.99	HP
61	Jaspur	Bamhinidih	Jetha	82.744243	22.0808604	19.63	13.85	5.78	HP

Annexure 2 Details of Exploration in Janjgir Champa District

Sl_No	District	Block	location	LAT	LONG	Year_of_Construction	Depth (m)	casing (m)	Formation	Zone_encountered	SWL	Discharge (lps)
1	JANJGIR-CHAMPA	Nawagarh	Andhiyarkhor	21.8361	81.6000	1992	269.5	9.7	Maniyari Fm	25-84.09	11.41	18.00
2	JANJGIR-CHAMPA	Nawagarh	AndhiyarkhorOW	21.8361	81.6000	1992	84.2	9.9	Maniyari Fm	23.4-76.7	11.66	
3	JANJGIR-CHAMPA	Nawagarh	Sambalpur	21.9250	81.7333	1992	144.9	20.0	Maniyari Fm	15-18, 25.92-84.12	8.14	10.50
4	JANJGIR-CHAMPA	Nawagarh	Nawagarh	21.9083	81.6000	1992	259.1	8.9	Maniyari Fm	22-24, 34.6-53.8,76.6-87.8	4.96	7.86
5	JANJGIR-CHAMPA	Nawagarh	Amlidih	21.8331	81.9112	1992	122.1	8.0	Tarenga shale and Chandi Lst	23.3,27.9,38.5-42.1,67.3-68.9,73.52-74.52,110.5-122.10	1.99	12.50
6	JANJGIR-CHAMPA	Malkharoda	Ghugri	21.7792	83.0042	2001	142.6	6.1	Shale Saradih formation	14-16,32.5	13.68	Seepage
7	JANJGIR-CHAMPA	Akaltara	Tilai	21.9833	82.5000	2001	151.8	12.5	Bamnidhi shale	14-18.,36.8 & 78.2	3.21	1.80
8	JANJGIR-CHAMPA	Malkharoda	Adbhar	21.9500	83.0208	2001	101.2	6.1	Raigarh shale	49.0- 50.00	10.94	8.70
9	JANJGIR-CHAMPA	Sakti	Jarwe	22.0875	82.7792	2001	150.0	18.3	Raigarh Fractured shale	20-24.0, 59.0	3.03	4.50
10	JANJGIR-CHAMPA	Balod	Latabod	20.7833	81.2583	2001	150.8	33.4	Charmuria Formation	16-18, 53.5,55,67-76	9.95	1.89
11	JANJGIR-CHAMPA	Akaltara	Khutighat	21.9412	82.3241	2001	151.7	6.2	Chandi quartzite	14-16, 133.3	-	Negli-gible
12	JANJGIR-CHAMPA	Nawagarh	Dhurkot	21.9426	82.6167	2001	151.8	14.5	Bamnidihi limestone	14-18.,126	21.47	1.80
13	JANJGIR-CHAMPA	Malkharoda	Andil	21.9667	82.9625	2001	142.0	6.1	Saradihi Fractured shale	14-16,53, 63, 78	12.63	5.75
14	JANJGIR-CHAMPA	Nawagarh	Barra	21.7803	82.7102	2001	151.8	14.5	Bamnidihi shale	18.4,23,35	3.44	0.50
15	JANJGIR-CHAMPA	Bamhnidih	Siladihi	21.7506	82.7500	2001	151.8	9.1	Bamnidih shale	32-35, 55, 92 & 96	1.18	1.18
16	JANJGIR-CHAMPA	Balod	Jhalmala	20.7103	81.2406	2001	141.7	20.7	Chandrapur sst and Granite	16-18, 123-131	7.45	0.82
17	JANJGIR-CHAMPA	Dabhra	Sapos	21.7514	83.1681	2001	101.2	15.4	Raigarh Shale	14-16,	29.10	Seepage
18	JANJGIR-CHAMPA	Bamhnidih	Saragaon	21.9833	82.7583	2001	151.7	12.3	Bamnidih shale	18-21.5, 40, 105, 114 & 136	7.74	4.20

19	JANJGIR-CHAMPA	Pamgarh	Kosla	21.8750	82.5153	2001	151.7	9.3	Chandi fractured cavernous limestone	18.32, 22.9,35	10.04	6.50
20	JANJGIR-CHAMPA	Jaijaipur	Orekera	21.8167	82.8625	2001	150.0	6.1	Bamnidihi Raigarh shale	14-18.,74	2.66	0.20
21	JANJGIR-CHAMPA	Nawagarh	Salkhon	22.0544	82.5792	2001	151.7	9.5	Limestone	22-25. 5. 41. 2 & 146	6.92	1.72
22	JANJGIR-CHAMPA	Nawagarh	Sambalpur OW	21.9250	81.7333	2001	300.8	20.5	Maniyari Fm	14-16,25.9-84.1		4.33
23	JANJGIR-CHAMPA	Pamgarh	Lohrsi	21.7750	82.5444	2001	151.8	14.2	Gunder-dehi shale	25-27.6,30	5.40	0.40
24	JANJGIR-CHAMPA	Dabhra	Kotmi	21.8417	83.1458	2001	96.6	6.1	Saradihi Fractured limestone	14-16,32, 48.75	9.70	5.00
25	JANJGIR-CHAMPA	Akaltara	Kotmi-Sonar	22.0333	82.3417	2001	128.7	13.3	Chandi cavernous limestone & dolomite	14-16, 65,72 & 80.5	8.00	6.73
26	JANJGIR-CHAMPA	Sakti	Turri	22.0625	82.8667	2001	150.0	9.0	Raigarh shale	21, 64, 103, 108, 114	4.38	3.00
27	JANJGIR-CHAMPA	Pamgarh	Shasha	21.7833	82.3833	2001	151.8	12.3	Bamnidih shale	14-19, 32, 118	4.90	1.20
28	JANJGIR-CHAMPA	Balod	Daihan	20.7151	81.1374	2001	128.0	9.7	Chandrapur sst and Granite	22-24,35	9.57	0.23
29	JANJGIR-CHAMPA	Bamhnidih	Naktithi	21.8167	82.7458	2001	151.8	15.6	Bamnidih shale	14-18.,40	-	Negli-gible
30	JANJGIR-CHAMPA	Nawagarh	Semra	21.8583	82.6139	2001	32.2	30.5	Chandi Cavernous limestone	27.6 to 32.2,40	10.00	10.00
31	JANJGIR-CHAMPA	Pamgarh	Pamgarh	21.8750	82.4500	2001	151.8	13.2	Bamnidih shale	14-18.,35	-	Negli-gible
32	JANJGIR-CHAMPA	Balod	Karhi Bhadar	20.7000	81.3167	2001	139.5	19.5	Sandstone	15-19,35	-	Negligible
33	JANJGIR-CHAMPA	Balod	Sakara (J)	20.8000	81.2167	2001	45.2	18.3	Charmuria Formation	24-75- 26.95,35	5.20	12.38
34	JANJGIR-CHAMPA	Sakti	Sakreli	22.0125	82.8583	2001	132.8	9.2	Saradih Formation	33.0, 63.50, 79.00, 91.00, 95.00	5.88	12.00
35	JANJGIR-CHAMPA	Sakti	Sakti	22.0250	82.9583	2001	150.0	9.0	Raigarh Shale	17-20.5,35	7.45	0.50
36	JANJGIR-CHAMPA	Dabhra	Dabhra	21.7750	83.0806	2001	151.0	18.3	Raigarh Shale	14-16,71.5, 133	6.12	0.40
37	JANJGIR-CHAMPA	Jaijaipur	Hasaud (Dhamni)	21.7542	82.9458	2001	150.0	12.2	Bamnidihi Shale	10--15,32	6.05	0.20
38	JANJGIR-CHAMPA	Balod	Bori	20.7862	81.2971	2001	137.1	10.0	Charmuria Formation	22- 24,30	2.91	2.25
39	JANJGIR-CHAMPA	Dabhra	Phaguram	21.8292	83.0958	2001	109.7	8.3	Raigarh shale	24, 64, 91,108	4.90	11.00

40	JANJGIR-CHAMPA	Akaltara	Akaltara	22.0333	82.4250	2001	143.0	13.3	Chandi cavernous limestone	14-16,55-70	26.52	52.00
41	JANJGIR-CHAMPA	Akaltara	Tarod	21.9833	82.4194	2001	151.7	12.3	Bamnidih	14-18.,115 & 133	14.91	1.00
42	JANJGIR-CHAMPA	Balod	Piperchhedi	20.7522	81.3300	2001	125.7	18.3	Charmuria Formation	20-22, 24,40	18.68	3.05
43	JANJGIR-CHAMPA	Sakti	Temar	21.9985	82.9849	2001	138.0	18.9	Raigarh shale	20-24,32	10.65	0.20
44	JANJGIR-CHAMPA	Malkharoda	Pota	21.8958	82.9958	2001	130.0	6.1	Saradihi formation	14-16,33.50, 88.0, 129.50	17.63	16.00
45	JANJGIR-CHAMPA	Pamgarh	Rahod	21.8167	82.5028	2001	151.8	12.3	Bamnidih shale	14-18.,35	--	Negli-gible
46	JANJGIR-CHAMPA	Akaltara	Kapan	22.0250	82.4917	2001	151.7	13.8	Bamnidihi shale	24-28, 38, 64, 127, to 129 & 140	5.71	2.00
47	JANJGIR-CHAMPA	Nawagarh	Gaud	21.9000	82.6792	2006	200.0	15.0	Bamnidih Shale	14-18.,30	-	Dry
48	JANJGIR-CHAMPA	Jaijaipur	Darrabhata	21.9422	82.8408	2006	66.8	26.0	Saradih Dolomite and shale	33.0-36.0, 39.6-42.0, 55.0-56.0	3.89	12.20
49	JANJGIR-CHAMPA	Jaijaipur	Darrabhata OW	21.9422	82.8408	2006	66.8	17.0	Saradih Dolomite and shale	33.0-36.0, 39.6-42.4, 56.0-63.80	3.97	10.97
50	JANJGIR-CHAMPA	Jaijaipur	Bhothia	21.9208	82.8717	2006	93.3	6.0	Saradih Dolomite and shale	24.1-25.5, 35.8-36.5, 79.0-80.0	0.30 agl	6.70
51	JANJGIR-CHAMPA	Jaijaipur	Bhothidih	21.7925	82.8408	2006	12.0	12.0	Saradih Dolomite and shale	14-16	-	-
52	JANJGIR-CHAMPA	Malkharoda	Tundri	21.8881	82.9675	2007	200.0	8.0	Raigarh Sandstone & shale	19.3-19.8, 32.5-33.0, 88.8-89.5	8.30	4.00
53	JANJGIR-CHAMPA	Jaijaipur	Darrabhata OW	21.9419	82.8400	2006	66.8	18.0	Saradih Dolomite and shale	33.0-36.0, 39.6-42.4, 56.0-63.80	4.07	7.70
54	JANJGIR-CHAMPA	Nawagarh	Pachori	21.9647	82.5719	2006	200.0	15.0	Bamnidih Shale	14-18.,35	14.89	Seepage
55	JANJGIR-CHAMPA	Bamhnidih	Sarhar	22.0267	82.7950	2007	200.0	6.0	Bamnidih shale	21.00-21.20,30	7.05	0.50
56	JANJGIR-CHAMPA	Nawagarh	Amoda	21.9247	82.6792	2006	123.0	12.5	Bamnidih Shale	21.5-22.0, 26.0-26.5, 57.25-57.5	4.45	1.73
57	JANJGIR-CHAMPA	Jaijaipur	Kachanda	21.8514	82.8894	2007	200.0	15.0	Bamnidih Shale	14-18.,30	6.35	Seepage
58	JANJGIR-CHAMPA	Dabhra	Sukhada	21.8744	83.0856	2007	153.0	9.0	Raigarh Dolomite, shale & younger intrusives	15.5 -16.00, 60.20-60.80 91.50-92.00	6.50	5.00

59	JANJGIR-CHAMPA	Dabhra	Sukhada OW	21.8744	83.0856	2007	143.3	11.0	Raigarh Dolomite, shale & younger intrusives	15.5 -16.00, 60.20-60.80 91.50-92.00	6.52	5.00
60	JANJGIR-CHAMPA	Nawagarh	Bhadesar	21.9619	82.6525	2006	200.0	12.0	Bamnidih Shale	14-18, 57.5-58.0, 86.5-87.0	3.40	1.40
61	JANJGIR-CHAMPA	Jaijaipur	Badesipat	21.8369	82.9156	2007	21.0	4.5	Saradih Dolomite and shale	14-15	7.20	-
62	JANJGIR-CHAMPA	Bamhnidih	Bamnidih	21.9094	82.7228	2006	105.0	13.0	Bamnidih Shale	15.1-16.5, 44.0-44.5	4.60	3.70
63	JANJGIR-CHAMPA	Bamhnidih	Bamnidih OW	21.9094	82.7228	2006	105.0	12.5	Bamnidih Shale	15.1-16.5, 44.0-44.5	4.10	3.70
64	JANJGIR-CHAMPA	Nawagarah	Kirit	21.806261	82.658121	2021	147.1	11.7	Shale	15.90-19.00, 28.10-31.20, 83.00-86.10, 92.20-93.20, 144.00-147.10	2.45	4.772
65	JANJGIR-CHAMPA	Nawagarah	Kirit	21.806261	82.658121	2021	199	13.7	Shale	19.00-22.00, 43.40-46.40,	2.45	1.267
66	JANJGIR-CHAMPA	Pamgarh	Kesla	21.856377	82.392686	2021	147.1	9	Shale	92.20-95.20	1.12	Seepage
67	JANJGIR-CHAMPA	Pamgarh	Bhilouni	21.8290343	82.4086203	2021	31.3	17	Limestone	15.90-19.00	8.4	17
68	JANJGIR-CHAMPA	Pamgarh	Vyas Nagar	21.912912	82.376713	2021	49.5	19.01	Shale, Limestone	12-13,18-19	4.12	2.4
69	JANJGIR-CHAMPA	Pamgarh	Mudpar	21.908337	82.5154768	2021	80	12.06	Limestone	11.50-12.90, 37.30-40.40,43.40-46.50	2.28	21.2
70	JANJGIR-CHAMPA	Nawagarah	Khokhra	21.9617241	82.5544976	2022	168.4	11.5	Shale	25.10-28.20, 61.70-64.80, 134.90-137.90	6.55	1.9
71	JANJGIR-CHAMPA	Akaltara	Amartal	21.994418	82.467229	2022	200	11.5	Shale	15.90-19.00, 28.10-31.20, 83.00-86.10, 92.20-93.20, 144.00-147.10	8.19	Seepage

Annexure 3 Details of Chemical Analysis

District	Block	Location	Long	Lat	PH	EC	CO3	HCO3	Cl	No3	SO4	F	TH	Ca	Mg	Na	K	Si	Po4
(In ppm)																			
Jangir-champa	Nawagarh	Negurdih	82.651	21.8155	7	459	0	165	57	28	18	0.71	190	56	12	31	1.22	30	0
Janjgir-Champa	Malkharoda	Adbhar	82.0831	21.6593	7.3	1004	0	415	71	70	56	0.65	370	96	31	69	25	18	0
Janjgir-Champa	Bamnidih	Afrid	82.7175	21.98639	7.4	788	0	317	57	9	45	1.67	250	56	26	57	2.08	11	0
Janjgir-Champa	Akaltara	Akaltara	82.4222	22.0264	8	424	0	207	21	13	13	1.1	190	52	14	17	0.6	15	0
Janjgir-Champa	Akaltara	Amora	82.3725	21.96972	7	979	0	317	125	16	62	0.56	380	104	29	63	1.1	10	0
Janjgir-Champa	Shakti	Asunda	82.9119	22.0521	7.1	1045	0	305	99	87	53	0.96	450	100	48	42	3.3	20	0
Janjgir-Champa	Baloda	Baloda	82.4778	22.1333	7.3	474	0	281	7	5.4	8	0.75	165	40	16	39	2.5	11	0
Janjgir-Champa	Akaltara	Bamhani	82.4481	22.0844	7.1	408	0	238	14	0	6.7	0.63	165	48	11	28	0.7	17	0
Janjgir-Champa	Bamhnidih	Bamhanidihi	82.72358	21.91898	7	442	0	244	21	0	7	0.82	185	52	13	26	0.66	14	0
Janjgir-Champa		Bhaiso	82.3394	21.8832	7.08	426	0	232	7	12	13	0.94	190	48	17	16	0.56	17	0
Janjgir-Champa	Nawagarh	Budena	82.62306	21.89694	7.11	1024	0	256	128	33	80	0.71	340	120	9.6	71	4.1	12	0
Janjgir-Champa	Bamhnidih	Champa	82.6611	22.0353	7.4	345	0	122	28	13	18	0.82	150	40	12	9.2	0.46	10	0
Janjgir-Champa	Dabhra	Dabra	83.0833	21.7833	7.6	557	0	244	43	12	33	0.8	210	64	12	43	4	10	0
Janjgir-Champa	Jaijaipur	Darra Bhata	82.83521	21.94697	7.3	767	0	305	64	8	42	1.7	270	48	14	56	2	12	0
Janjgir-Champa	Shakti	Damau	82.8594	22.1356	7	463	0	244	21	12	13	0.65	215	48	23	15	4	10	0
Janjgir-Champa	Nawagarh	Dhardei	82.525	21.7972	7.2	324	0	183	7	3.7	7.1	0.54	145	38	12	12	0.51	13	0
Janjgir-Champa	Nawagarh	Dhurkot	82.62	21.9339	7.5	571	0	195	50	28	27	0.84	220	60	17	29	1	9.7	0
Janjgir-Champa	Pamgarh	Dongakahrod	82.45806	21.84667	7	343	0	146	28	12	18	0.9	170	36	22	10	0.46	9.7	0
Janjgir-Champa	Malkharoda	Ghoghari	83.0097	21.7833	7.6	792	0	317	57	18	52	0.9	300	60	36	45	41	12	0

Janjgir-Champa	Jaijaipur	Hasoud	82.9125	21.7514	7.1	501	0	329	71	4.3	8	0.77	290	44	43	42	3	12	0
Janjgir-Champa	Jaijaipur	Jaijaipur	82.8208	21.8333	7.7	755	0	336	64	2.8	42	1.2	190	40	22	102	3	10	0
Janjgir-Champa	Akaltara	Jairamnagar	82.34	22.0331	7.8	460	0	207	28	11	15	0.37	215	44	25	16	4.1	10	0
Janjgir-Champa	Nawagarh	Janjgir	82.5799	22.0133	7.8	1259	0	549	64	1	36	2.93	130	20	19	230	2.9	9	0
Janjgir-Champa	Pamgarh	Jewara	82.3828	21.8528	7.3	571	0	244	43	10	30	0.49	195	56	13	46	4	10	0
Janjgir-Champa	Pamgarh	Jhulanpakariya	82.4431	21.9208	7.9	1260	0	549	71	1	87	3.3	100	12	17	251	2.2	13	0
Janjgir-Champa	Balod	Kamrid	74.02	26.05	7.8	1054	0	354	121	30	81	0.5	400	120	24	74	4.1	11	0