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

केन्द्रीय भूमि जल बोर्ड

Central Ground Water Board

सूरजपुर जिला, छत्तीसगढ़ के जलभृत नक्शे एवं भूजल प्रबंधन योजना

Aquifer Maps and Ground Water Management Plan of Surajpur District, Chhattisgarh

केन्द्रीय भूमि जल बोर्ड

उत्तर मध्य छत्तीसगढ़ क्षेत्र

द्वितीय तल, एल. के. कॉरपोरेट एवं लांजिस्तिक पार्क,

धमतरी रोड, डूमरतराई, रायपुर (छत्तीसगढ़)-492015

फोन-0771-2974405, फैक्स-2974405, ईमैल-rdnccr-cgwb@nic.in

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 Surajpur 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 SURAJPUR DISTRICT, CHHATTISGARH" is prepared by Sh Mukesh Anand, Scientist-B under the supervision of Dr. Prabir K. Naik (Regional Director), Sh. A.K. Biswal (Scientist-E), and Smt. Prachi Gupta (Scientist-B & OIC-NAQUIM). 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 Surajpur 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. Prabir K. Naik
(REGIONAL DIRECTOR)

कार्यकारी सारांश

राष्ट्रीय जलभृत नक्शा ऐवम भूजल प्रबंधन योजना एक बहु-विषयक वैज्ञानिक प्रक्रिया है जिसमें भूगर्भीय, जल-भूवैज्ञानिक, भूभौतिकीय, जल विज्ञान और गुणवत्ता जानकारी के संयोजन को एक्वीफर्स में भूजल की मात्रा, गुणवत्ता और गति को चिह्नित करने के लिए एकीकृत किया जाता है। हालांकि, पिछले एक दशक में विकास से भूजल प्रबंधन पर ध्यान केंद्रित करने के कारण, स्थानीय स्तर पर भूजल संसाधनों के न्यायसंगत और टिकाऊ प्रबंधन के लिए बड़े पैमाने पर अधिक विश्वसनीय और व्यापक जलभृत मानचित्रों की आवश्यकता महसूस की गई है। भूजल का बड़ा मूल्यांकन और भविष्य के विकास और प्रबंधन के लिए रणनीति जलभृत मानचित्रण के प्राथमिक उद्देश्य हैं।

जलभृत मानचित्रण कार्यक्रम के तहत, सूरजपुर जिले के सभी विकास खंड अर्थात् सूरजपुर, प्रतापपुर, प्रेमनगर, रामानुजनगर, भैयाथन और ओडगी को 2786.76 वर्ग किमी के क्षेत्र में शामिल किया गया था। यह सर्वे ऑफ इंडिया के डिग्री शीट नंबर 64I, 64M, 64N, 64J में भागों (1:250000 स्केल) में अक्षांश 22°47'46' से 23°55'06"N और देशांतर 82°29'56" से 83°21'30" पूर्व के बीच आता है। यह जिला उत्तर में बलरामपुर जिले और मध्य प्रदेश राज्य, पश्चिम में कोरिया जिले और दक्षिण-पूर्व और दक्षिण में क्रमशः सरगुजा और कोरबा जिले से घिरा है। हालांकि जिला सड़क मार्ग से राज्य के भीतर सरगुजा और रायपुर जैसे आसपास के जिलों से जुड़ा हुआ है, रेलवे कनेक्टिविटी खराब है और निकटतम रेलवे स्टेशन अंबिकापुर (छ.ग.) और गढ़वा (झारखंड) में है। राज्य के भीतर निकटतम हवाई अड्डा रायपुर की राजधानी है जो रायपुर से लगभग 400 किमी दूर है। जिले के सभी महत्वपूर्ण स्थान राज्य के राजमार्गों और अन्य सभी सड़कों के नेटवर्क से अच्छी तरह से जुड़े हुए हैं।

2011 की जनगणना के अनुसार 789043 (पुरुष-398381, स्त्री-390662) की कुल जनसंख्या 547 गांवों में निवास करती है। जिले का जनसंख्या घनत्व 283 व्यक्ति/वर्ग किमी है। जनगणना के अनुसार। जनगणना के अनुसार साक्षरता दर 60.95% है, हालांकि लिंगानुपात प्रति 1000 पुरुषों पर 980 महिलाओं के अनुरूप है।

अध्ययन क्षेत्र उपोष्णकटिबंधीय जलवायु का अनुभव करता है। अध्ययन क्षेत्र के लिए औसत वार्षिक वर्षा लगभग 1300 मिमी (पिछले पांच वर्षों का औसत यानी 2013 से 2017 तक) है।

भू-आकृति विज्ञान की दृष्टि से अध्ययन क्षेत्र के उत्तरी, दक्षिणी और मध्य भाग पेडिमेंट/पेडीप्लेन प्रदर्शित करते हैं। ओडगी ब्लॉक के प्रमुख भाग पर निम्न स्तर का संरचनात्मक पठार मौजूद है। केंद्रीय पेडिमेंट/पेडीप्लेन के उत्तरी भाग में डेन्यूडेशनल हिल्स और घाटियाँ मौजूद हैं। जिले के शेष भाग पर गोंडवाना चट्टानों के संरचनात्मक मैदानों का कब्जा है। शुद्ध बुवाई क्षेत्र 170399 हेक्टेयर है, जबकि दो फसली क्षेत्र 19076 हेक्टेयर है। कुल बोए गए क्षेत्र के लगभग 75% भाग में चावल बोया जाता है।

अध्ययन क्षेत्र में कुल सिंचित क्षेत्र 17495 हेक्टेयर है जहां भूजल का योगदान 1572 हेक्टेयर ही है। शुद्ध सिंचित क्षेत्र की तुलना में भूजल द्वारा सिंचित क्षेत्र का प्रतिशत 9% है। शुद्ध बुवाई क्षेत्र के संबंध में लगभग 90% क्षेत्र केवल वर्षा पर निर्भर है।

ब्लॉकों के लिए उत्पन्न अन्वेषणात्मक ड्रिलिंग डेटा के आधार पर, क्षेत्र में मौजूदा एक्वीफर सिस्टम को फ्रीटिक और सेमीकॉन्फ़िंड एक्विफ़र में विभाजित किया जा सकता है। अध्ययन क्षेत्र में मौजूद प्रमुख जलभृत गोंडवाना सुपरग्रुप और छोटानागपुर ग्रेनाइट जेनिस हैं। सैंडस्टोन में डिस्चार्ज नगण्य से 9.8 एलपीएस और अपक्षय ग्रेनाइट में 5.9 एलपीएस तक भिन्न होता है, सैंडस्टोन में 23.27 मीटर का औसत ड्रॉडाउन 12.96 मीटर अपक्षयित ग्रेनाइट में होता है और उच्च पैदावार प्राप्त होती है जहां मोटे मौसम वाले क्षेत्र बेडरॉक फ्रैक्चरिंग से जुड़े होते हैं।

2020 के अनुसार अध्ययन क्षेत्र में भूजल विकास का भूजल संसाधन गणना चरण 59.78% है। इसलिए, यह खतरनाक आंकड़ा है और अध्ययन क्षेत्र में भूजल के मसौदे को संतुलित करने और भूजल संरक्षण संरचनाओं के निर्माण पर ध्यान केंद्रित करने की आवश्यकता है क्योंकि चरण अर्ध-महत्वपूर्ण वर्गीकरण की ओर बढ़ रहा है।

क्षेत्र में सिंचाई की मौजूदा मांग 17896.36 हैम है जबकि घरेलू उपयोग के लिए 2053.19 हैम और औद्योगिक क्षेत्र के लिए 566.68 हैम है। भविष्य में भूजल की मांग को पूरा करने के लिए कुल 20516.25 हैम भूजल भविष्य में उपयोग के लिए उपलब्ध है।

अध्ययन क्षेत्र में सर्वेक्षण के दौरान पहचाने गए प्रमुख भूजल मुद्दे इस प्रकार हैं: (i) गर्मियों के दौरान कुओं और हैंडपंपों का सूखना। (ii) जलभृत का अंतर्निहित जल भूवैज्ञानिक लक्षण। (iii) फ्लोराइड सांद्रता। (iv) लौह संदूषण। (v) नाइट्रेट संदूषण।

अध्ययन क्षेत्र में जटिल जल भूगर्भीय परिस्थितियों के कारण भूमि की उपलब्धता बिखरी हुई है। उस क्षेत्र में जहां भूजल की उपलब्धता सीमित है, सतही जल का संरक्षण और उपयोग किया जा सकता है। कई स्थानों से फ्लोराइड और आयरन के उच्च मूल्य की सूचना मिली है। बलुआ पत्थर जलभृत प्रणाली में कई स्थानों पर भूगर्भीय कारणों से भूजल फ्लोराइड से दूषित होता है। पीने के पानी में फ्लोराइड संदूषण की समस्या से प्रभावित गांवों में छोटी डीफ्लोरिनेशन इकाइयों की स्थापना करके या वैकल्पिक स्रोत की पहचान की जा सकती है। इसी प्रकार, उच्च लौह सांद्रता वाले गांवों के लिए आयरन फिल्टर का उपयोग किया जा सकता है। नियमित भूजल गुणवत्ता निगरानी की भी आवश्यकता है।

जहां तक भूजल उपलब्धता के लिए प्रबंधन रणनीतियों का संबंध है, भूजल के प्रभावी उपयोग के लिए सिंचाई के लिए मौजूदा ड्राफ्ट को सूक्ष्म सिंचाई प्रणाली के साथ जोड़ा जा सकता है। सिंचाई पद्धति में परिवर्तन, उपलब्ध संसाधनों का इष्टतम उपयोग, कृत्रिम पुनर्भरण के बाद निर्मित भूजल क्षमता के उपयोग से भूजल की बचत हो सकती है और जिले के सकल फसल क्षेत्र में वृद्धि हो सकती है।

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 Surajpur District namely Surajpur, Pratappur, Premnagar, Ramanujnagar, Bhaiyathan and Odgi were taken up covering an area of 2786.76 sq. km. It falls in the Survey of India's Degree Sheet No. 64I, 64M, 64N, 64J in parts (1:250000 Scale) between latitudes 22°47'46'to 23°55'06''N and longitudes 82°29'56''to 83°21'30''E. The district is bounded by Balrampur district and Madhya Pradesh State in the north, Koriya district in the west and Surguja & Korba district in the south-east & south respectively. Though the district is well connected by road to adjoining districts such as Surguja and Raipur within the state, the railway connectivity is poor and the nearest railway station is in Ambikapur (Chhattisgarh) and Garhwa (Jharkhand). The nearest airport within the state is the capital of Raipur which is around 400 km from Raipur. All-important places within the district are well connected by a network of the state highways and all-other roads.
According to the Census 2011, total population of 789043 (Male – 398381, Female – 390662) dwells in 547 villages. The Population density of the district is noted as 283 persons/sq.km. as per the census. The literacy rate as per the census is 60.95%, however the sex ratio corresponds to 980 females per 1000 males.

The study area experiences sub-tropical climate. The average annual rainfall for the study area is around 1300 mm (Average of the last five years i.e., 2013 to 2017)

Geomorphologically the Northern, Southern and Central parts of the study area displays Pediment/Pediplain. Low level structural plateau exists on major part of Odgi block. Denudational Hills and Valleys are present in northern part of Central pediment/pediplain. Remaining part of the district is occupied by structural plains of Gondwana rocks.

The net sown area is 170399 hectares, while double-cropped area is 19076 hectares. Rice is sown in nearly 75% of the net sown area.

The net irrigated area in the study area is 17495 hectares where ground water contribution is 1572 Ha only. Percentage of Area Irrigated by ground water with respect to net irrigated area is 9%. About 90% area with respect to net sown area is dependent on rain only.

Based on the exploratory drilling data generated for the blocks, the existing aquifer systems in the area may be divided into phreatic and semiconfined aquifer. The major aquifers present in the study area are Gondwana supergroup and Chotanagpur Granite Geneiss. Discharge varies from negligible to 9.8 lps in Sandstone and 5.9 lps in weathered granite, having Average Drawdown of 23.27 m in Sandstone 12.96 m in weathered granite and higher yields are obtained where thick weathered zones are associated with bedrock fracturing.

As per 2020 ground water resource calculation stage of ground water development in the study area is 59.78 %. So, this is alarming figure and need to be focused on to balance the groundwater draft and construct groundwater conservation structures in the study area as stage is increasing towards Semi-critical categorization.

The existing demand for irrigation in the area is 17896.36 Ham while the same for domestic use is 2053.19 Ham and for industrial field is 566.68 Ham. To meet the future demand for ground water, a total quantity of 20516.25 Ham 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) Fluoride concentration. (iv) Iron contamination. (v) Nitrate contamination.

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 Iron has been reported from several locations. In Sandstone 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. Similarly, Iron filter may be used for the villages having high Iron concentration. 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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Mukesh Anand/*मुकेश आनंद*

Scientist-B (JHG)/*वैज्ञानिक-ख*

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

(06 BLOCKS-SURAJPUR, PRATAPPUR, PREMNAGAR, RAMANUJNAGAR, BHAIYATHAN & ODGI)

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

Principal Author

Mukesh Anand	:	Junior Hydrogeologist / Scientist-B

Supervision & Guidance

Dr. Prabir Kumar Naik	:	Regional Director
A K Biswal	:	Scientist-E & TS
Prachi Gupta	:	Scientist-B & OIC NAQUIM
Uddeshya Kumar	:	Scientist-B & OIC NAQUIM (April 2021-January 2022)
Sidhanta Kumar Sahu	:	Junior Hydrogeologist/ Scientist-B

Groundwater Exploration 2021-22, Surajpur district

Mukesh Anand	:	Junior Hydrogeologist/ Scientist-B

Chemical Analysis

Rakesh Dewangan	:	Scientist B (Chemist)

Section Finalization / Map Digitization

Prachi Gupta	:	Scientist-B
Mukesh Anand	:	Scientist-B
T S Chauhan	:	Draftsman

Contents

1. INTRODUCTION 1
1.1 Objective 1
1.2 Scope of study 1
1.3 Approach and Methodology 2
1.4 Area Details 3
1.4.1 Administrative Division 3
1.5 Data Availability, Data Adequacy and Data gap Analysis 5
1.6 Rainfall 5
1.7 Physiography/Geomorphology 6
1.8 Land use 7
1.9 Soil 9
1.10 Hydrology and Drainage 10
1.11 Geology 13
1.12 Agriculture, Irrigation, Cropping Pattern 18
2. DATA GENERATION513, DATA INTERPRETATION AND DATA INTEGRATION 19
2.1 Hydrogeological Data 19
2.1.1 Water level behavior 20
3. AQUIFER DEPOSITION AND GROUND WATER RESOURCES 29
3.1 Aquifer Geometry and Characterization 29
3.2 Groundwater Resources Availability and Extraction 35
3.3 Existing and Future Water Demand (2025) 36
4. GROUND WATER RELATED ISSUES 37
5. GROUND WATER MANAGEMENT STRATEGY 37
6. SPECIAL STUDY ON CHINDIYA GRAM PANCHAYAT, SURAJPUR DISTRICT 42
7. CONCLUSION 51

List of Tables

Table 1 Data Integration 5
Table 2 Land use pattern (in ha) 7
Table 3 Generalized Geological sucession of Surajpur district **15**
Table 4(A) Cropping Pattern (in ha) 18
Table 4(B) Area irrigated by various sources (in ha) 18
Table 4(C) Contribution of Groundwater in Irrigation Pattern (in ha) 18
Table 5(A)- Aquifer wise Depth to Water Level (Pre monsoon) 22
Table 5(B)- Aquifer wise Depth to Water Level (Post monsoon) 22
Table 6 Aquifer Characteristics of Surajpur District 29
Table 7 Groundwater Resource up to 100m bgl (MCM) 35
Table 8 Ground Water Resources of the Study area in Ham 36
Table 9 Types of Artificial Recharge structures feasible 40
Table 10 Potential of Additional GW abstraction structure creation 41
Table 11 Detail of groundwater saved through change in cropping pattern and other interventions 51

List of Figures

Figure 1 Administrative Map of Surajpur District 4
Figure 2 Avg. Rainfall in Surajpur District 5
Figure 3 Geomorphology Map of the Study area 6
Figure 4 Landuse map of the study area 8
Figure 5 Soil map of the study area 9
Figure 6 Drainage map of the study area 12
Figure 7 Geological map of the study area 17
Figure 8 Groundwater Contribution in Irrigation 19
Figure 9 Hydrogeological Map of Study Area 20
Figure 10 Key Wells of the study area 21
Figure 11 Pre monsoon Water Level Maps of Phreatic Aquifer 23
Figure 12 Pre monsoon Water Level Maps of Fractured Aquifer 24
Figure 13 Post monsoon Water Level Map of Phreatic Aquifer 25
Figure 14 Post monsoon Water Level Maps of Fractured Aquifer 26
Figure 15 Water level fluctuation of Phreatic aquifer 2018 27
Figure 16 Water level fluctuation of Fractured aquifer 2018 28
Figure 17(A&B) Cross-section of Study area along North-South Direction 30
Figure 18(A&B) Cross-section of Study area along East-West Direction 31
Figure 19 3D model daigram of the study area 32
Figure 20 Fence diagram of Study area 33
Figure 21 Strip log of the Study area 33
Figure 22 3D-Explode section of the study area 34
Figure 23 Glimpses of PIP conducted in Surajpur district 37
Figure 24 Ground water feasibility for abstraction structures 40

Annexure 1 Details of Key wells established.....52
Annexure 2 Details of Exploration in Surajpur District.....55
Annexure 3 Details of Chemical Analysis.....58

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 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, all the development blocks of Surajpur District namely Surajpur, Pratappur, Premnagar, Ramanujnagar, Bhaiyathan and Odgi were taken up covering an area of 2786.76 sq. km. It falls in the Survey of India's Degree Sheet No. 64I, 64M, 64N, 64J in parts (1:250000 Scale) between latitudes 22°47'46'to 23°55'06''N and longitudes 82°29'56''to 83°21'30''E. The district is bounded by Balrampur district and Madhya Pradesh State in the north, Koriya district in the west and Surguja & Korba district in the south-east & south respectively (**Plate 1**). Though the district is well connected by road to adjoining districts such as Surguja and Raipur within the state, the railway connectivity is poor and the nearest railway station is in Ambikapur (Chhattisgarh) and Garhwa (Jharkhand). The nearest airport within the state is the capital of Raipur which is around 400 km from Raipur. 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

District includes 06 blocks and it is further divided in 424 village panchayats and 547 villages. The names of the 6 blocks are given below.

1. Surajpur Block
2. Pratappur Block
3. Premnagar Block
4. Ramanujnagar Block
5. Bhaiyathan Block
6. Odgi Block

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

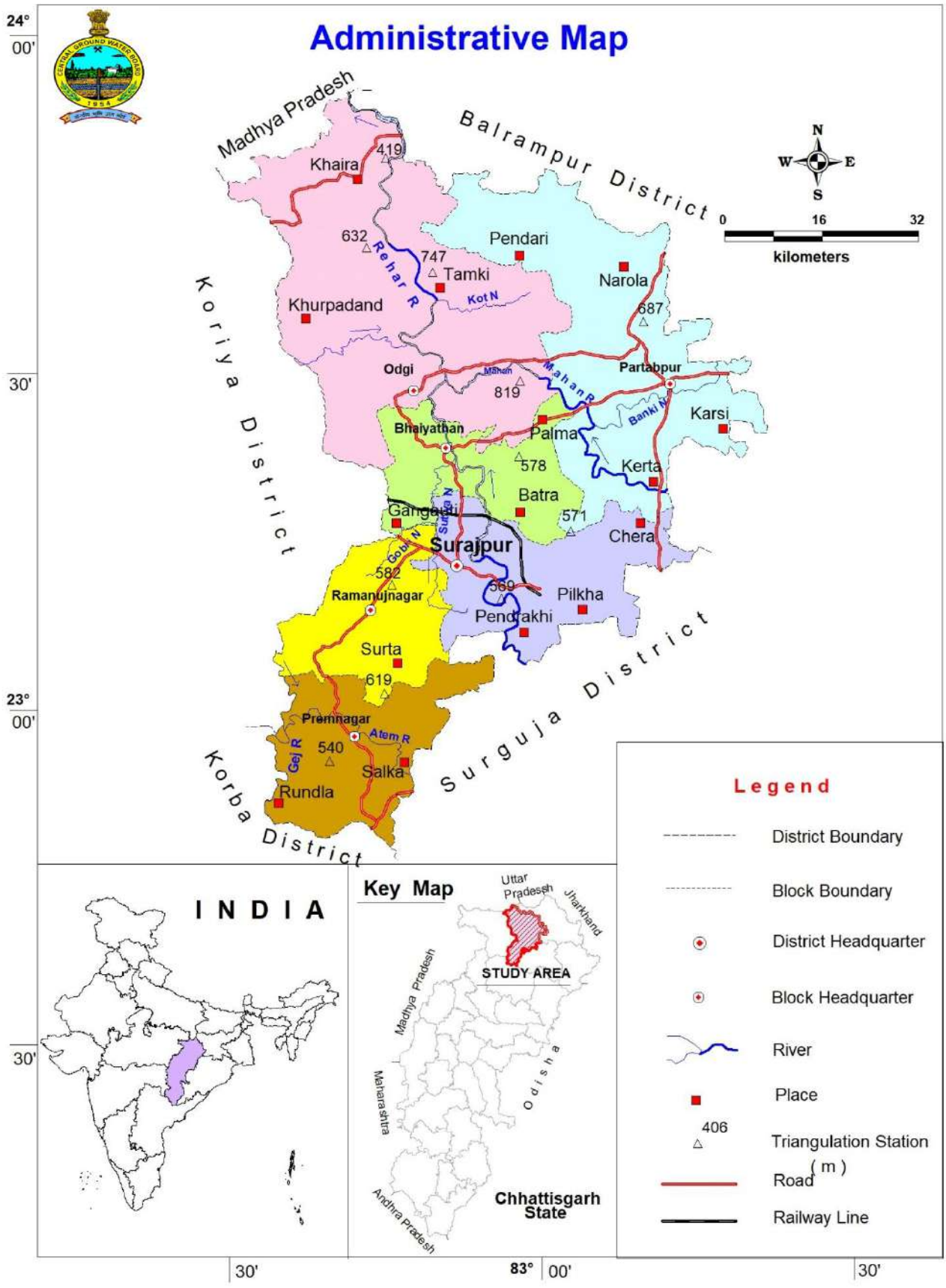


Figure 1 Administrative Map of Surajpur District

1.5 Data Availability, Data Adequacy and Data gap Analysis

Table 1 Data Integration

Blocks	Existing			Data Generation	
	EW	Chem	WL	EW	WL
Pratappur	9	15	18	0	15
Bhaiyathan	7	4	7	1	11
Surajpur	15	13	16	0	15
Ramanujnagar	1	2	4	0	10
Odgi	1	1	1	2	09
Premnagar	4	7	12	0	06
Total	**37**	**42**	**58**	**03**	**66**

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 1043 mm (Average of the last five years i.e., 2015 to 2020) which is presented below in Figure 2. *Source: IMD. Raipur*

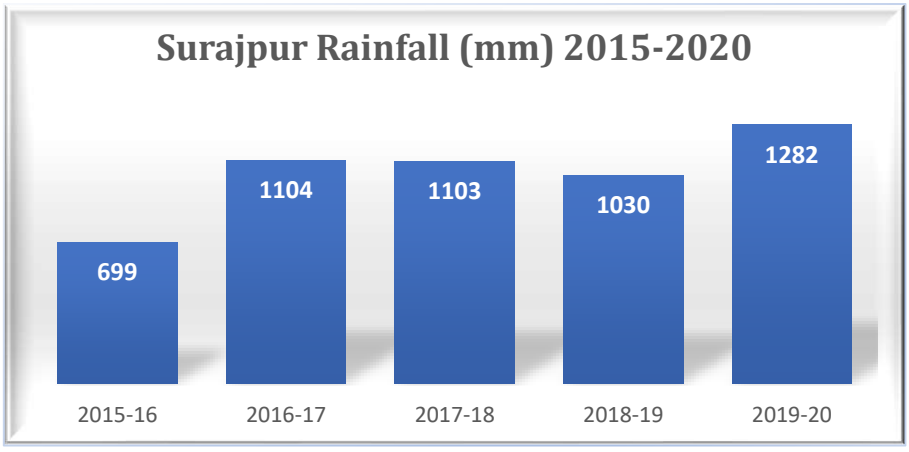


Figure 2 Avg. Rainfall in Surajpur District

1.7 Physiography/Geomorphology

Geomorphologically the study area displays: -

- Low level structural plateau exists on major part of Odagi tahsil
- Northern, southern and central part is pediment/pediplain
- Denudational hill and valley/structural hills and valleys are present in northern side of central pediment/pediplains
- Remaining part is occupied by structural plains of gondwana rocks

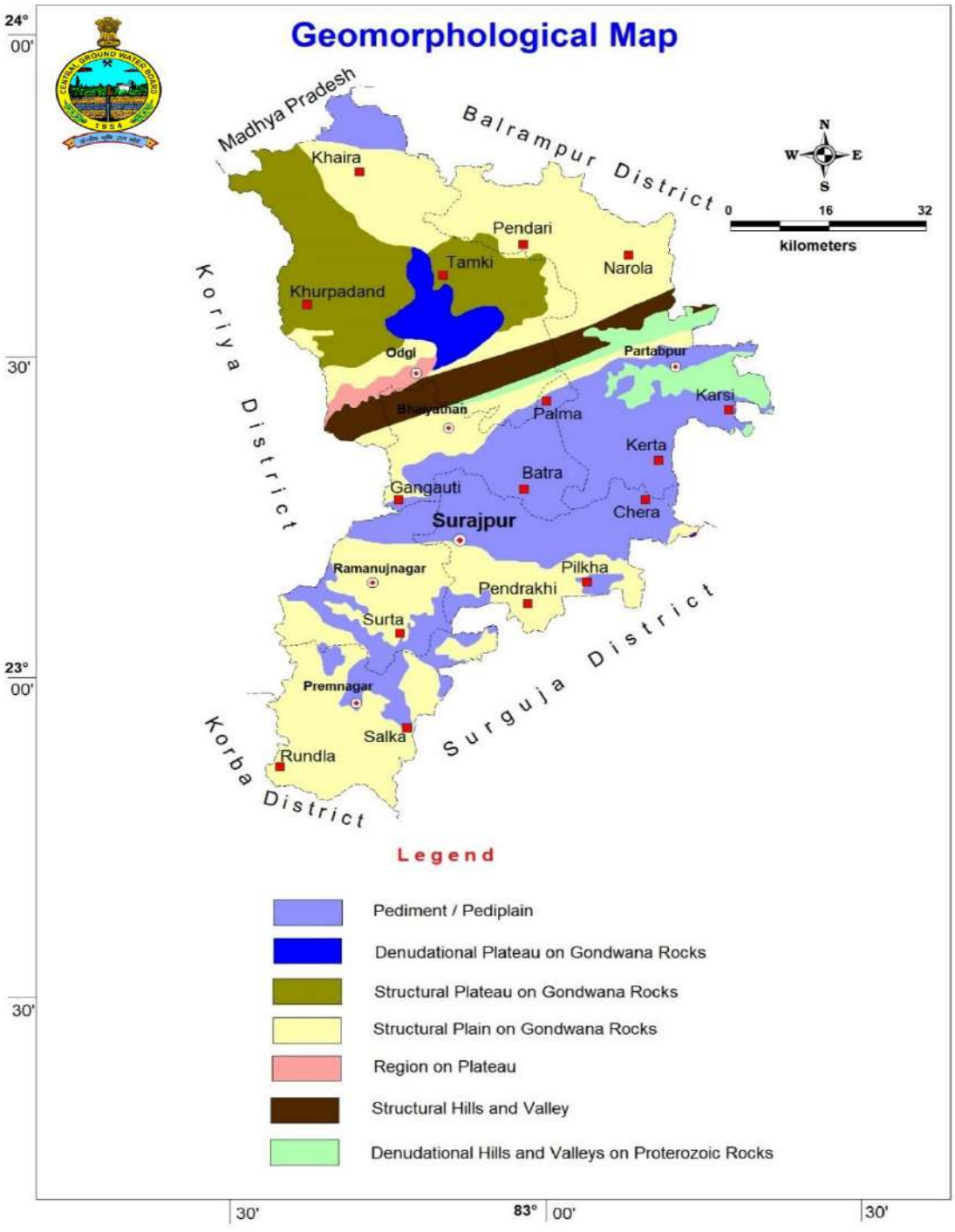


Figure 3 Geomorphology Map of the Study area

Geomorphologically the district displays Pediment/Pediplain, Structural plain, Structural Hills & Valleys, Structural Plateau, Denudational Plateau and Region of Plateau. The eastern and southern part of the district is represented by Pediment/Pediplain in patches. This unit is developed over Granite & Meta-morphic rocks. This unit has fractures & joints. They are having gently sloping, smooth surface of erosional bed rock between hill & plain with veneer of detritus. Structural plain on Gondwana rocks is formed in south, north and western part of the district. It is developed over rocks of Gondwana with extensive criss-crossed fractures and Joints. The broad gently sloping erosional surface is covered with detritus of rock and thin to moderate cover of soil. Structural Hills & Valleys on Gondwana rocks are formed in the central part in the form of east-west strip of the district. They are associated with folding /faulting etc. They are having high relief steep sided linear to arcuate hills showing definite trend lines covered with thin soil and forest.

The region of Plateau is developed in western part of the district. This unit is developed over Granite & Meta-morphic rocks. This unit has extensive cris-crossed fractures/ joints. It is having flat top and steep slope relief controlled by structure. Denudational Plateau on Gondwana rocks is developed in central part of the district. This unit is developed over Gondwana rocks. This unit has extensive cris-crossed fractures/ joints and lineaments. It is formed by extensive flat top and steep slopes, relief controlled by structure. The Structural Plateau on Gondwana rocks is developed in western part of the district. This unit is developed over Gondwana rocks. This unit has extensive cris-crossed fractures/ joints. It is having flat top and steep slope relief controlled by structure.

Overall, the topography in the district varies between 300 m to 1200 m amsl. The area has general slope towards north direction with average elevation of 800 m amsl.

1.8 Land use

There is 15219 ha revenue forest, protected forest and other forest in the district. Area not available for cultivation is 29239 ha. Details are presented in Table no.2 and Figure 4 shows the Landuse pattern in the study area.

Table 2 Land use pattern 2018-19 (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)
Surajpur	278520	15219	29239	53529	170399	10134	19076	172681

(*Due to Pandemic outbreak Latest Statistical Data publication is in progress)

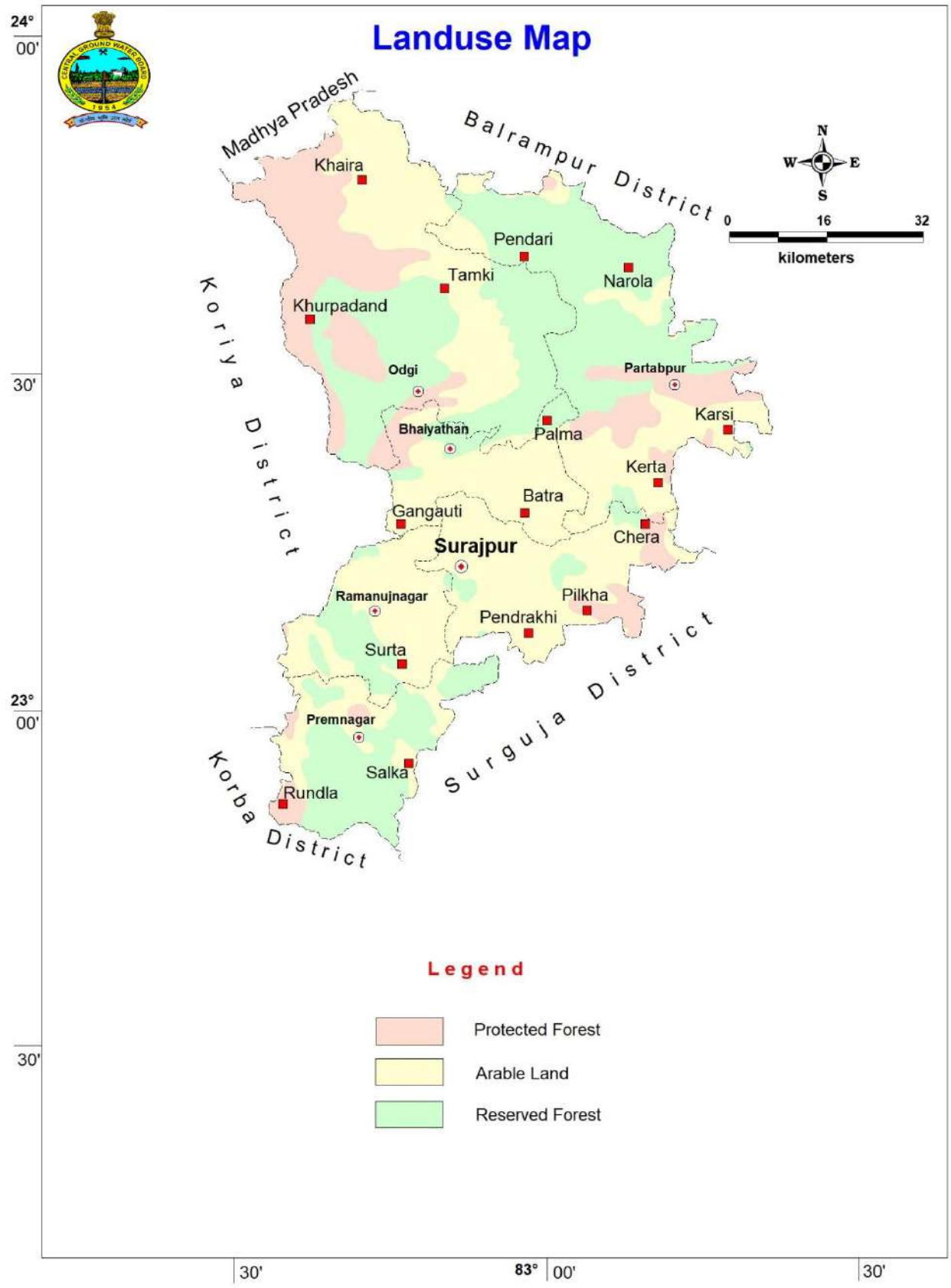


Figure 4 Landuse map of the study area

1.9 Soil

The soils in the district are having wide variations. In all three types of soils exist in the district and are mostly insitu in nature. Most of the area is covered by Red gravely/ sandy Alfisols. It occurs over the Suprabarakars (Mahadeva/ Suprapanchet/ Parsora formation) in the area. The Shallow black Inceptisols are present over the Panchet and the Barakar formations. The R and yellow Ultisols rich in iron oxide occurs on the Upper Pali and the Mahadeva/ Suprapanchet/ Parsora formations.

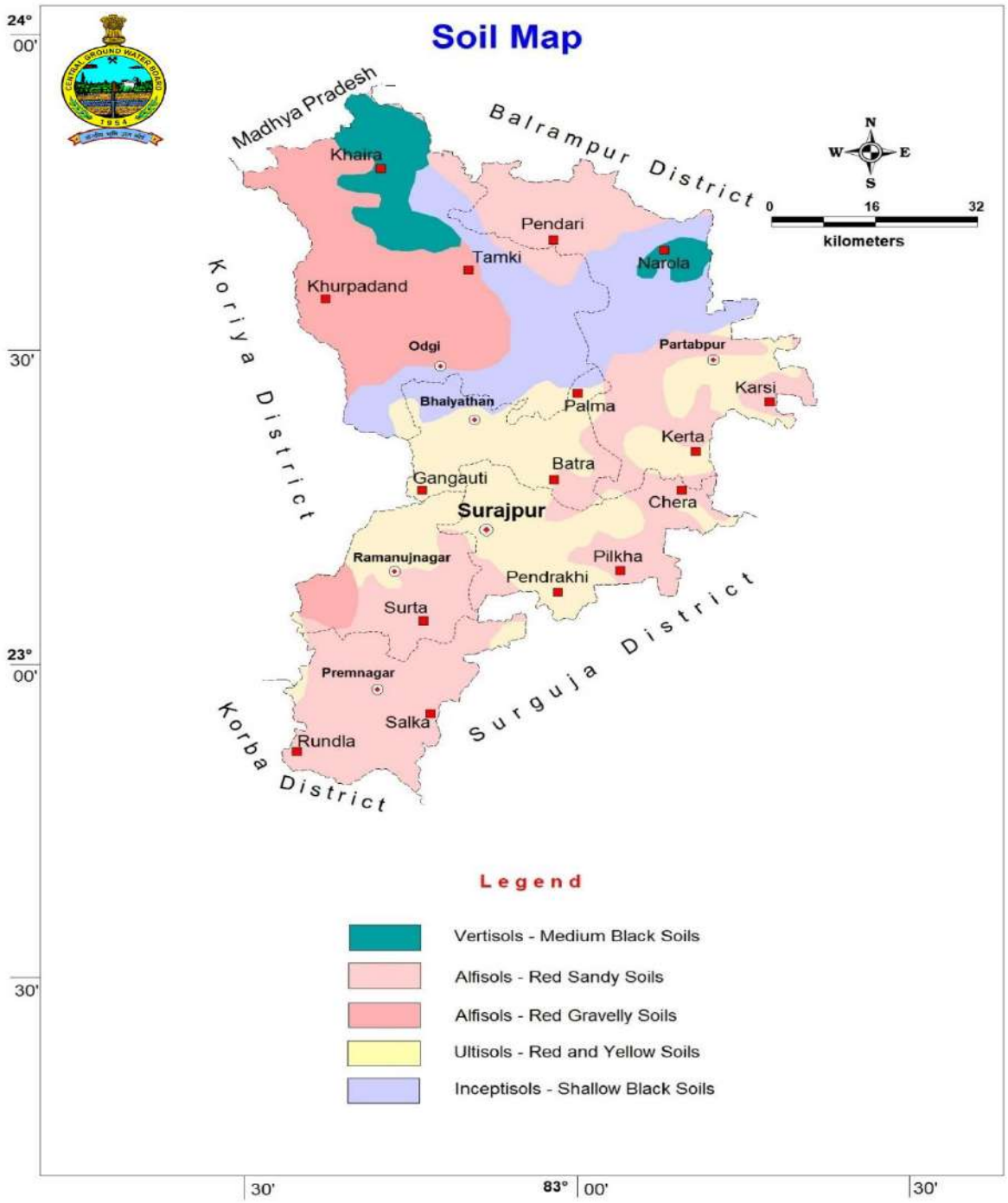


Figure 5 Soil map of the study area

1.10 Hydrology and Drainage

The general slope of the district comes under Lower Ganges river slope and is towards the north and locally in some places towards east. The Lower Ganges basin covers almost total area of the district. Rihand river Mahan rivers draining the district. All of them flow in north direction. The high drainage density in the northern part of the basin reflects the imperviousness of the bedrock as well as the high slope of the area resulting in high runoff. The drainage in the district is mainly of dendritic pattern and is young in nature.

Ground water in the district occurs under phreatic, semi confined and confined conditions. It is controlled by the local topography, drainage, lithology and disposition of

Structural features like fractures and joints. Similarly medium to coarse-grained sandstone forms good aquifers in which movement of ground water is controlled by inter-granular porosity. Basic dykes, and sills traversing the basement crystalline and gondwana formations also play significant role in sub-surface movement of groundwater. As such the aquifer system in the district constitutes two type aquifers.

The hydrogeological properties of the different lithological formations in the district are described as follows.

Chhota Nagpur Gneissic Complex & Unclassified Metamorphics of Bilaspur-Raigarh-Surguja belt: Ground water generally occurs under phreatic conditions in the weathered, jointed and fractured zones, ranging thickness from 10-40 meters in Archeans. These formations exposed in large parts of the district are hard and compact and poorly permeable rocks. Gneisses, granites and quartzites are susceptible to weathering and have weathered, jointed and fractured zones extending about 15 to 25 mbgl. The schists and phyllites are moderately permeable and the occurrence of groundwater in them is dependent on the intensity of fractures and development of weathered zone. Impervious bands of siliceous phyllites with vertical foliation at places acts as sub-surface barrier for ground water movements. Sites having such disposition are suitable for ground water development on its upstream side.

Gondwans Supergroup of rocks: Gondwanas comprise thick beds of sandstone, shales, clays and coal seams. Sandstones having felsdpathic composition and medium to coarse grained, it is then porous and permeable and forms good aquifers. Sandstone having siliceous matrix behave like impervious hard rocks. Shales are fine grained, compact and though porous lack in permeability and so do not form good aquifers. Among Gondwana formation the Barakar sandstones are the most important water bearing formations in the district. These sandstones are medium to coarse-grained felsdpathic and highly porous and permeable. The inter granular pore spaces, joints and fractures control ground water movement in them. Shale beds behave as confining layers and help to form

different aquifer systems. The ground water occurs under phreatic, semi confined and confined conditions.

Talchir sandstone which is very fine- grained and compact yields comparatively less ground water. Ground water is extracted by dug wells and tube wells for domestic and irrigation purposes. Shallow dug wells in the depth range 5-20 mbgl tapping Barakar sandstones can give a yield range of 25 to 15 m3/day. The depth to water level in these wells ranges from 4 to 16 mbgl.

Deccan Traps: Deccan trap basalts occur in patches in southern parts of the district. Ground water occurs in weathered zone, joints and fracture and vesicular zones under both phreatic and semi-confined conditions. Semi confined conditions are observed in interflow zones at shallow depths, whereas confined conditions are observed in the interflow zones at deeper depth. The bottom of each flow is massive, hard and compact in nature and the overlying vesicular basalt comprise rounded to oval shaped vesicles which are filled in by secondary minerals like quartz, calcite and zeolites. Thickness of vesicular horizon is limited. It is observed that ground water in Deccan Traps occur in Weathered loose morrum like material in upper weathered zone, Weathered amygdaloidal basalts in each flow, Exfoliated weathered zones covered by flows with columnar joints, Fractured massive basalt, dykes etc.

The shallow aquifers are tapped by open wells of depth range of 8 to 25 mbgl in which depth to water level range from1.5 to 21.0 mbgl. The yield of shallow dug wells ranges from 20 to 100 m^3/day, while those wells located in topographic lows near the confluences of streams or at intersection of fractures often yields from 50 to 150 m^3/day. The yield of shallow/ deep boreholes depends on the thickness of vesicular and jointed horizons and it’s interconnection with the overlying recharge zone.

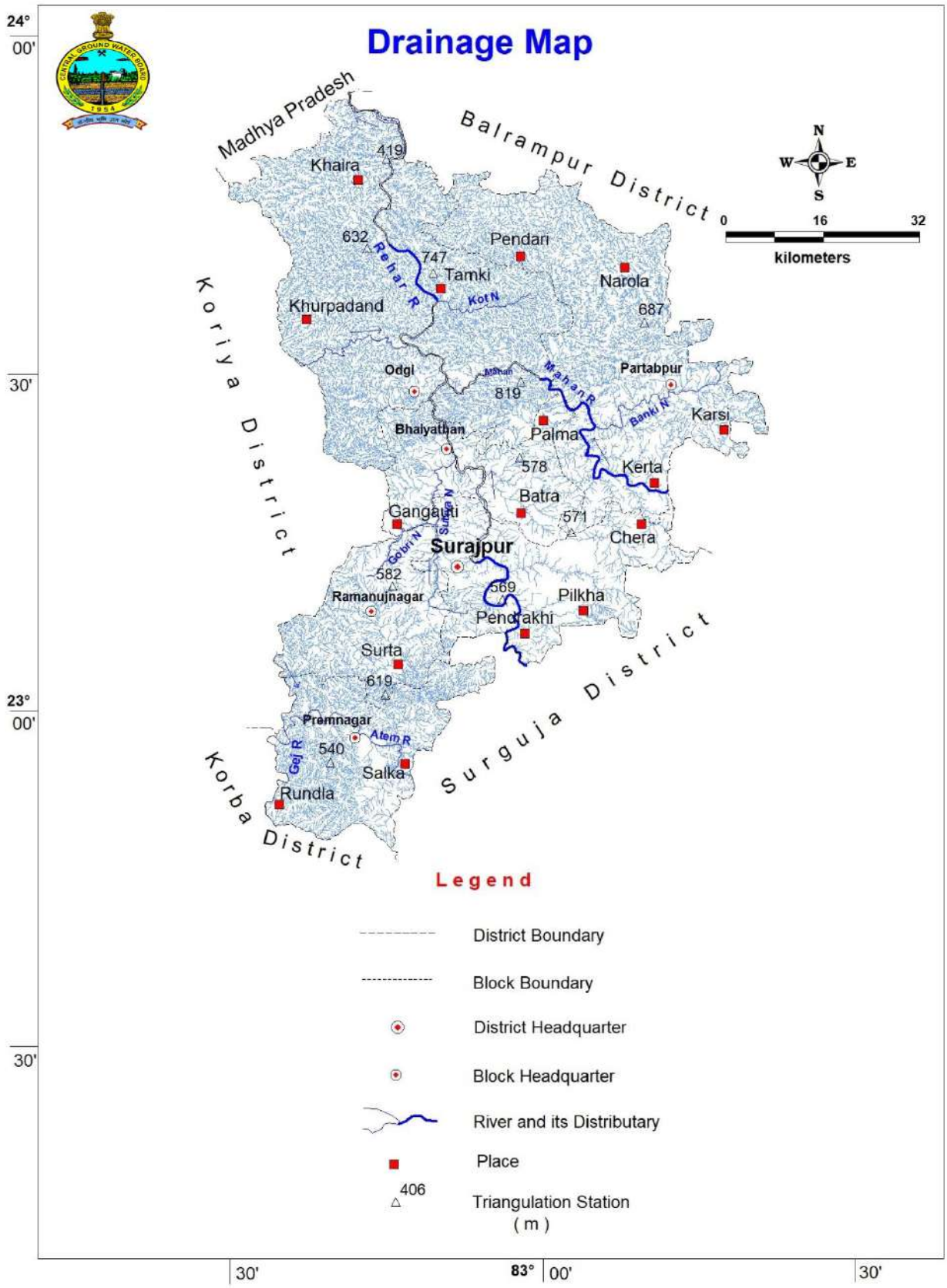


Figure 6 Drainage map of the study area

1.11 Geology

Geologically, the district comprises of rocks of Unclassified metamorphic of Bilaspur-Raigarh-Surguja formation and Chhota Nagpur Gneissic Complex of Archaen- Paleao Proterozoic age, Gondwana Supergroup of rocks especially Talchir formation, Barakar formation, Raniganj formation, Jabalpur-Parsora-Tikki formation of Paleozoic-Mesozoic age, Deccan Trap of Cenozoic age.

Unclassified metamorphic of Bilaspur-Raigarh-Surguja formation: The Archean rocks mainly comprising of gneisses, granite, schist and quartzite occupying the eastern & western portion of the district. The porphyritic gneiss is pink in coloured and contains phenocrysts in the area. The gneisses exhibit banded structure. The granite of the area comprises of quartz, felspar and biotite. The weathering of these rocks shows biotite altering to chlorite. It is observed that the weathering in these rocks extended down to a depth range of 30 mbgl with the average depth ranging from12 to 15 mbgl.

Chhotanagpur gneissic complex: A part (i.e. eastern & northern) of the district is covered by Chhotanagpur gneissic complex. These rocks are younger than Bastar gneisses.

These rocks have proposed geological sequence for the prominent Central Surguja Shear Zone extending for over 100 km from river Mahan in the west to Binda Nagar in the east in ENE-WSW direction. The CGC comprises of group of meta-sedimentary and gneissic rocks. This rock unit consists of granite gneiss, quartz-mica schist, chlorite- biotite schist, quartzite, calc-silicates and quartz-feldpathic cataclasites. The assemblages of these litho-units occur as isolated patches within the biotite gneiss. Two types of gray and pink colored granites occur as intrusive along with pegmatites, aplites and quartz veins.

The CGC is highly metamorphosed and highly disturbed and dominated by ENE-WSN trending lineaments. The CGC was thrown into isoclinal tight folds as a result of coming together of peninsular and Bundelkhand block during Satpura Orogeny. The crystallines of these areas suffered three phases of deformation and folding. During first phase of deformation, resulting due to N-S compressive stresses, tight isoclinal folds (F_1) having ENE-WSW trending axial plane foliation was produced. The phase was culminated by granite activity. The open to tight up right folds (F_2) with their axes aligned in the same direction of F_1 were superimposed during the second phase of deformation. F_2 folds depict variable low angle plunge towards East or West or both with axial plane shearing. The second phase was marked by emplacement of pink granite and pagmatites. The third phase of folding (F_3) is conspicuous shown by the closure of the outcrops along the strike, with their axes running perpendicular to F_1 axes. As a result of East-West compressive stresses, cross folds formed during the third phase with simultaneous generation of several cross faults and associated fractures. Intrusion of pegmatite, applites and dolerite dykes marked the culmination of this phase. Due to poly phase deformation mylonites, cataclasites and phyllonites can be recognized in Surguja area and they host uranium mineralization in this shear zone.

Gondwana Supergroup:

The Gondwana Supergroup of rocks are semi consolidated sedimentary rocks of carboniferous to Triassic age occupy the district large part. These rocks form a linear (nearly 200 km long and 50-150 km wide) strip deposited in rift basin characterized by horst and graben, open folds and are intruded by dolerites. These rudaceous- arenaceous -carbono- argillaceous sediments rest directly on Archean granites and gneisses.

i) Talchir Formation

The rocks of Gondwana Supergroup started depositing with the formation of conglomerates over the undulating basement crystallines, known as Tillite, composed of clasts of granite, gneisses, BHQ/BHJ breccia and pinkish quartzite, sandstone – khaki green, fine to medium grained sandstone with lenses of pebbles and clasts of shale. The conglomerate followed by shale and/or sandstone. The outcrop of this formation can be seen in detached pockets/patches. The niddle shape weathering patterns of the shales are typical in nature for this formation. The thickness of the Talchir Formation is generally few tens of meters but occasionally varies up to 100 meters and is exposed in south & northern part of the district.

ii) Barakar Formation

The Talchir Formation is overlained by coal bearing argillarenaceous formation known as Barakar Formation and is exposed in eastern & north-western part of the district. The Barakars have fine to course-grained, sub rounded to rounded, subarkosic semi consolidated sandstones. They are white, grey or pink to brown in colour, intercalated with shales and coal. Shales are many times bituminous in nature. The intercalation of sandstone & shale in various ratios produces sandstone, shale sandy shale, shaly sand etc. The total thickness of Barakar Formation varies from 100 to 800 m in the area.

iii) Raniganj

Small area of Surajpur district is covered by these formations as E-W linear patches of sandstone-shale with thin coal seams in faulted contact with Barakar Formation. It is exposed in eastern part of the district.

iv) Supra Panchet or Undifferentiated Tiki, Parsora and Jabalpur Formation

These formations are exposed in northern part of the district. The rocks are forming hills and traversed by dolerite intrusive. The sandstones are whitish and medium to course grained intercalated with micaceous siltstone.

Deccan Traps:

The Deccan Traps are younger than lametas (infratrappeans) and at places directly overlie the Archaean granite gneisses. These comprise layered basaltic lava flows, which are known as Deccan

Trap, due to their step like structure. These basalts are melanocratic, dense hard, medium grained composed of feldspar augite hornblned, quartz, etc. These rocks are also exposed in eastern & western part of the district in very small patch. Basic intrusive or dykes of dolerite, etc are seen exposed at a number of places in Gondwana formation. The lower parts of the flows are sandstones form prominent hill ranges generally massive, hard and compact in nature. The upper part of each flow is vesicular and comprises rounded to oval shaped vesicles, which are generally filled with zeolities, calcites or quartz.

Table 3 Generalized geological successions in Surajpur district

Lithology	**Stratigraphic status**		**Age**	**Nature and Characteristics**
Alluvium	Calc-tuff, alluvial sands		**Quaternary**	Sand, Silt, Clay & Pebble
Laterite				**Red, dark brown, pisolitic, massive, cavernous, hard, compact, ferrugenous**
Deccan Trap	**Basaltic flows**		**Cenozoic**	**The trap basalts are dark brownish black to grayish black, fine to medium grained, hard and compact rocks.**
Lameta Group	Infratrappean beds			
	Mahadevas	**Gondwana Supergroup**	**Paleozoic to Mesozoic**	
Sandstone, shale	**Panchet**			**Sandstones are whitish and medium to course grained intercalated with micaceous siltstone.**
	Kamthi			
Sand stone and shale thin coal seams	**Raniganj**			**Greyish to brown in colour, intercalated with shales and coal. Shales are many times bituminous in nature.**
	Supra Barakars			

Grits, sandstones with shale and coal	**Barakars**			**White, grey or pink to brown in colour, intercalated with shales and coal. Shales are many times bituminous in nature.**
	Karharbaris			
Boulder bed, sandstone , shale and tillite	**Talchirs**			**Clasts of granite, gneisses, BHQ/BHJ breccia and pinkish quartzite, sandstone – khaki green, fine to medium grained sandstone with lenses of pebbles and clasts of shale.**
Chhattisgarh Supergroup				
Granite gneiss, Quartz-mica schist, Chlorite- biotite schist, Quartzite, Calc-silicates and Quartz-feldpathic cataclasites	**Chhota Nagpur Gneissic Complex**		**Palaeo Proterozoic**	**Gray and pink in colored granites occur as intrusive along with pegmatites, aplites and quartz veins.**
Gneisses, Granite, Schist and Quartzite.	**Unclassified Metamorphics of Bilaspur-Raigarh-Surguja belt**		**Paleao Proterozoic to Archaean**	**Porphyritic gneiss is pink in coloured with phenocrysts. The gneisses exhibit banded structure. The granite of the area comprise of quartz, felspar and biotite.**
Archeans				

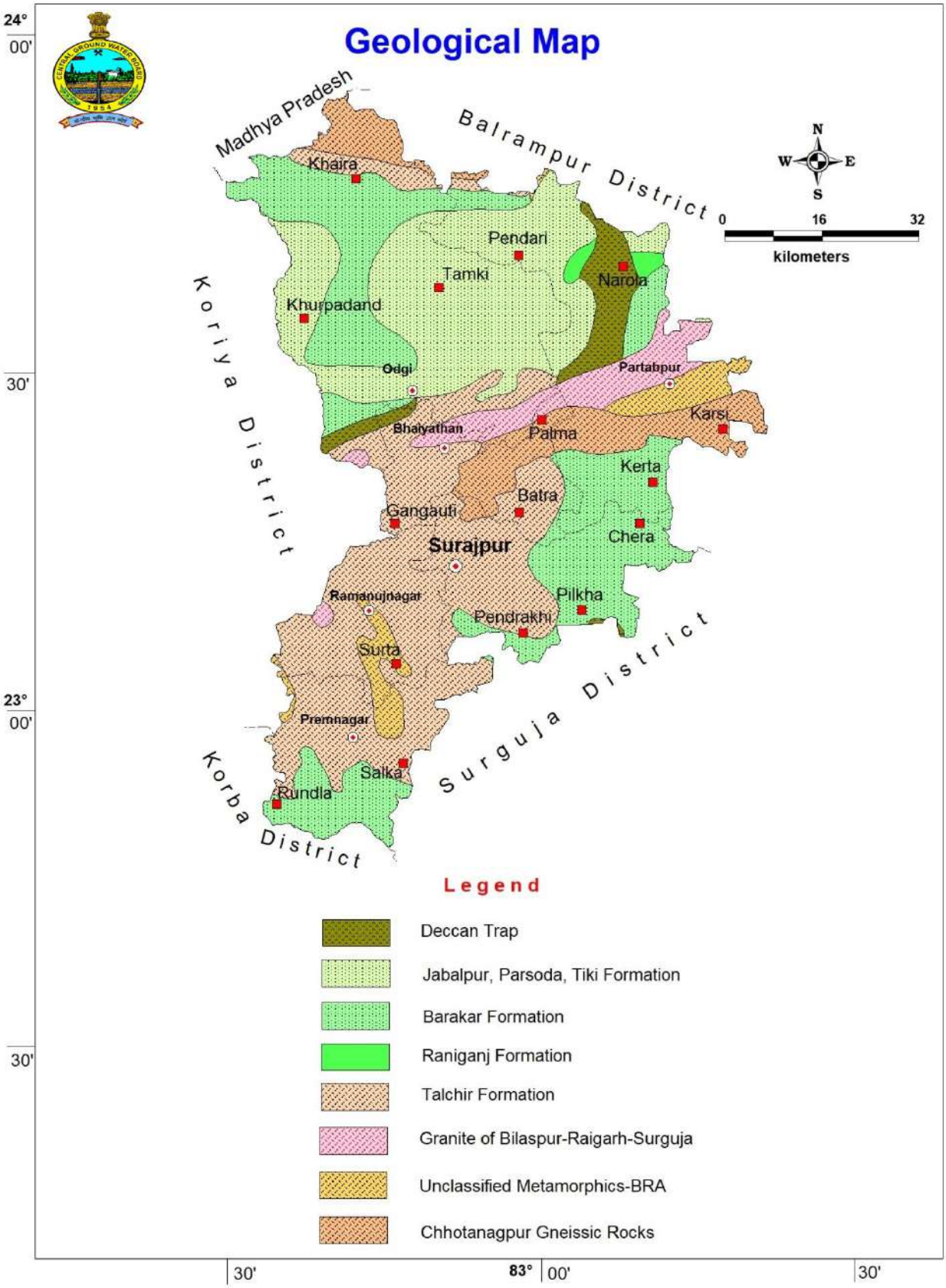


Figure 7 Geological map of the study area

1.12 Agriculture, Irrigation, Cropping Pattern

Agriculture is the prime source of livelihood for majority of the population. Rice, Wheat, Maize, Jaoo, Kodokutki are important Kharif crops grown in the district. In Surajpur district, rice is grown in 108067 hectares.

Wheat, Rice and Tuwar the main Rabi crops grown in the district. The gross & net irrigated area in the district is 19019 & 17495 hectares respectively. The Net irrigated area in the district as on June 2013 by Dug wells is 1572 ha, by Tube wells/ Bore wells is 593, by Tanks is 357, by canal is 1501 and by other sources is 13472 hectares.

In the district Rehand and Mahan rivers flows. No major dam is constructed in the Surajpur district. However, most of the agriculture is rainfed due to limited irrigation infrastructure, lack of multicropping and reliance on outdated agricultural technology and equipments. Many farmers are dependent on the rains and dug well/tube wells for irrigation.

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

			Cereal										
Kharif	**Paddy**	**Wheat**	**Jwar**	**Maize**	**Kodo Kutki**	**Others**	**Pulses**	**Tilhan**	**Fruits Vegetables**	**Reshe/Fibres**	**Mirch Masala**	**Sugarcane**	**Medicinal**
244058	111561	5594	289	9723	1277	2879	13854	13545	9196	418	1897	2436	12

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**
47	661	9989	10684	23215	2077	920	363	3774	15017	10.17

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**
10684	2077	12761	17559	73

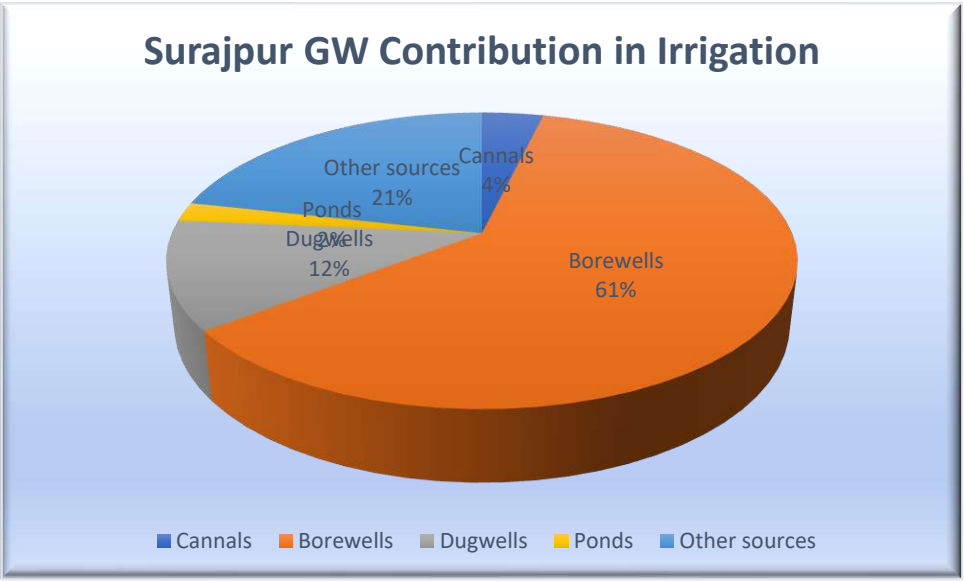


Figure 8 Area Irrigated by groundwater is 12761 ha i.e., 73% (12%-Borewell, 61%-Dugwell) of the total Irrigated area.

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. The details of exploration are shown in Annexure 2. 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 10) covering all the geological formations.

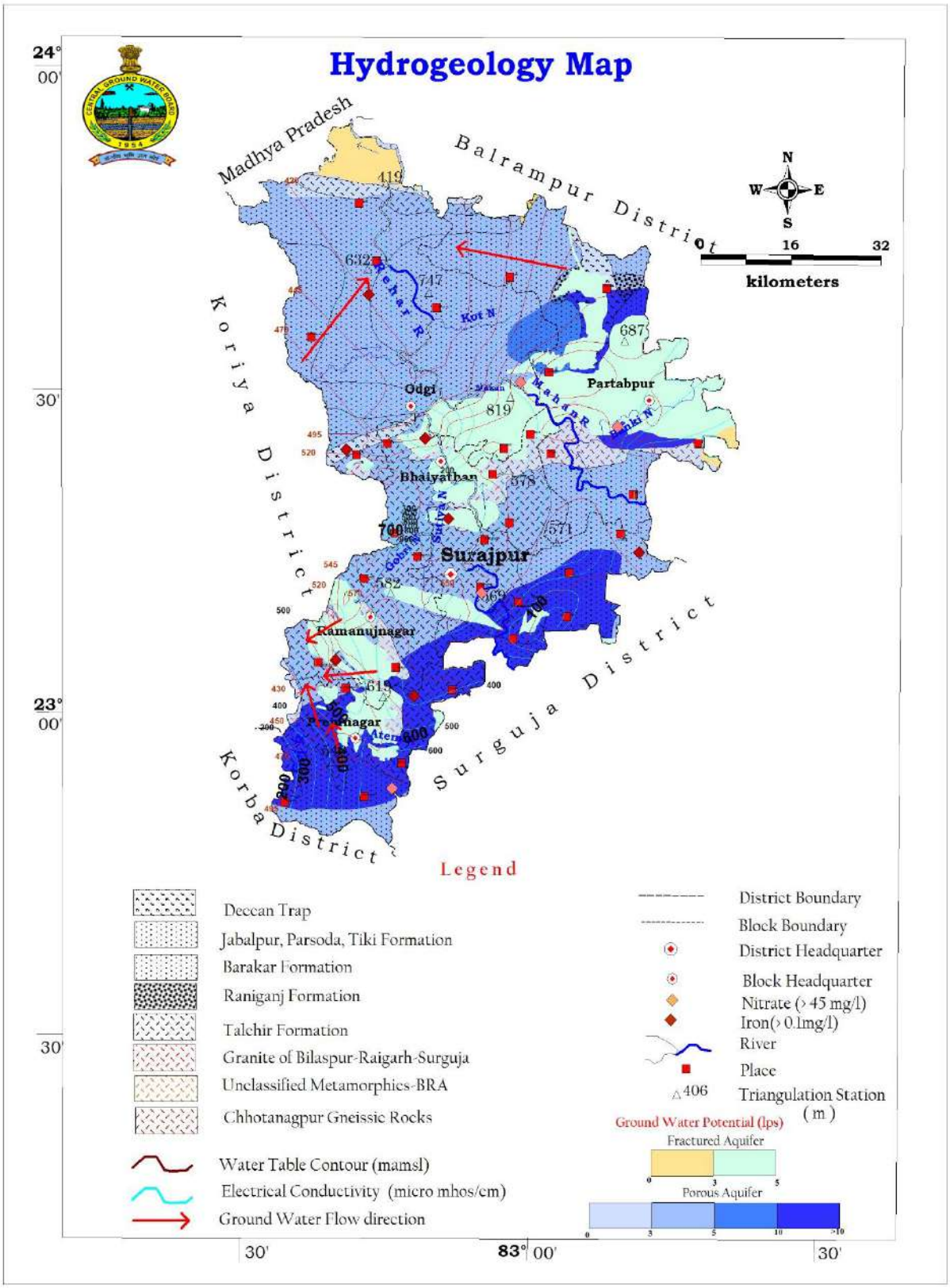


Figure 9 Hydrogeological map of the study area

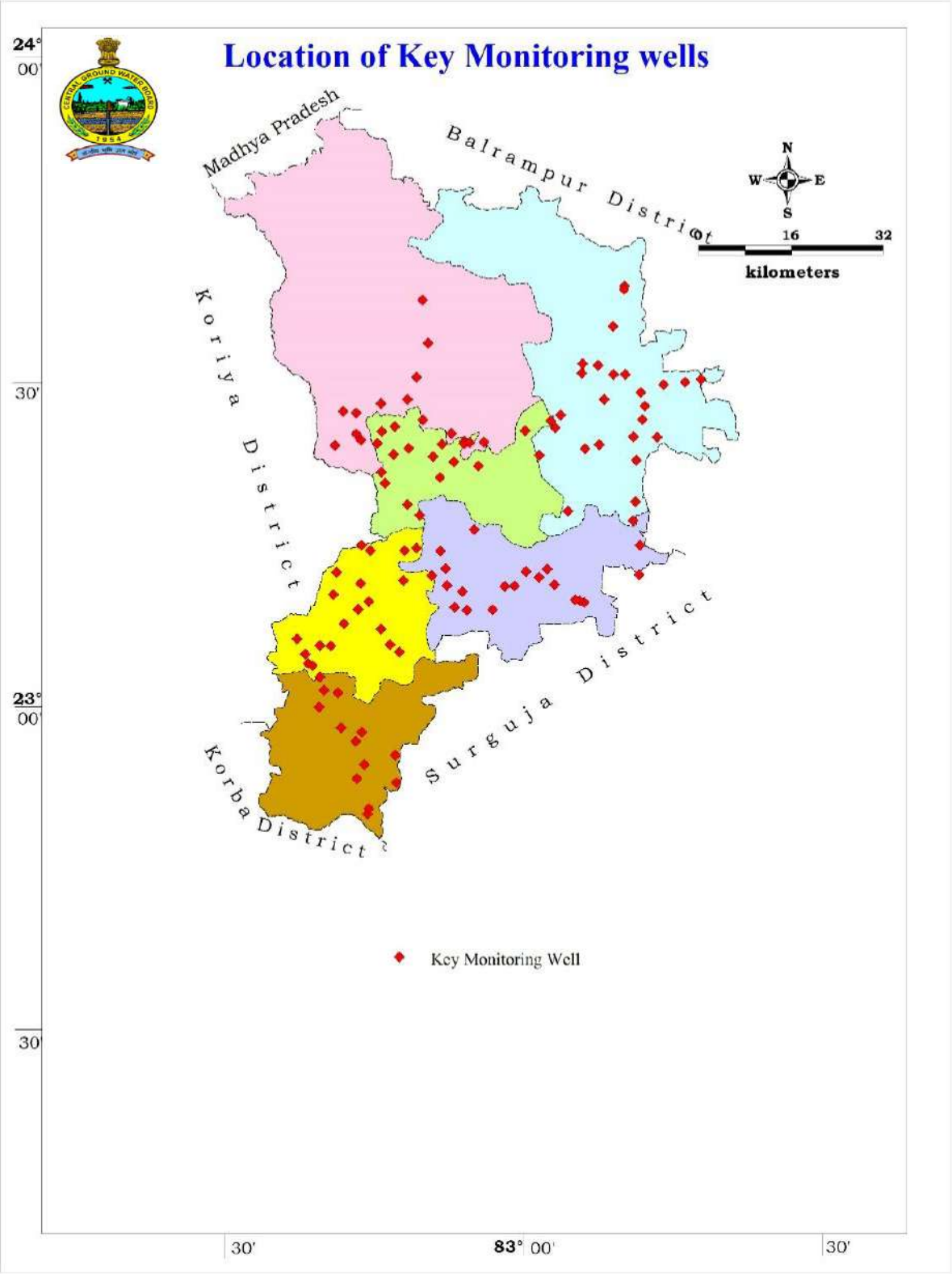


Figure 10 Key Wells established in the study area

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 2020):

In the pre-monsoon period, it has been observed that in the study area water level in Phreatic aquifer vary between 2.4 to 12.66 mbgl with average water level of 6.34 mbgl. In deeper semi-confined aquifer, water level varies between 2.56 to 32.3 m bgl with average water level of 12.55 m bgl shown in Table No. 5(A).

District	Aquifer Type	Min	Max	Avg
Surajpur	Phreatic aquifer	2.45	12.66	6.34
	Semi-confined Aquifer	4.67	22.6	10.23

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

ii. Post- monsoon water level (Nov 2020):

In the post-monsoon period, it has been observed that in the study area, water level in Phreatic aquifer varies between 1.0 to 7.88 m bgl with average water level of 3.75 m. In deeper semi-confined aquifer, water level varies between 2.15 to 15.3 m bgl with average water level of 6.15 m bgl shown in Table No. 5(B).

District	Aquifer Type	Min	Max	Avg
Surajpur	Phreatic aquifer	1.0	7.88	3.75
	Semi-confined Aquifer	2.15	15.3	6.15

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

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 8.86m with an average fluctuation of 2.5m. Water level fluctuation in semi-confined aquifer varies from 0.03 to 13.53 m with an average fluctuation of 4.08m shown in below mentioned table.

District	Aquifer Type	Min	Max	Avg
Surajpur	Phreatic aquifer	0.5	8.25	3.25
	Semi-confined Aquifer	0.02	11.2	4.60

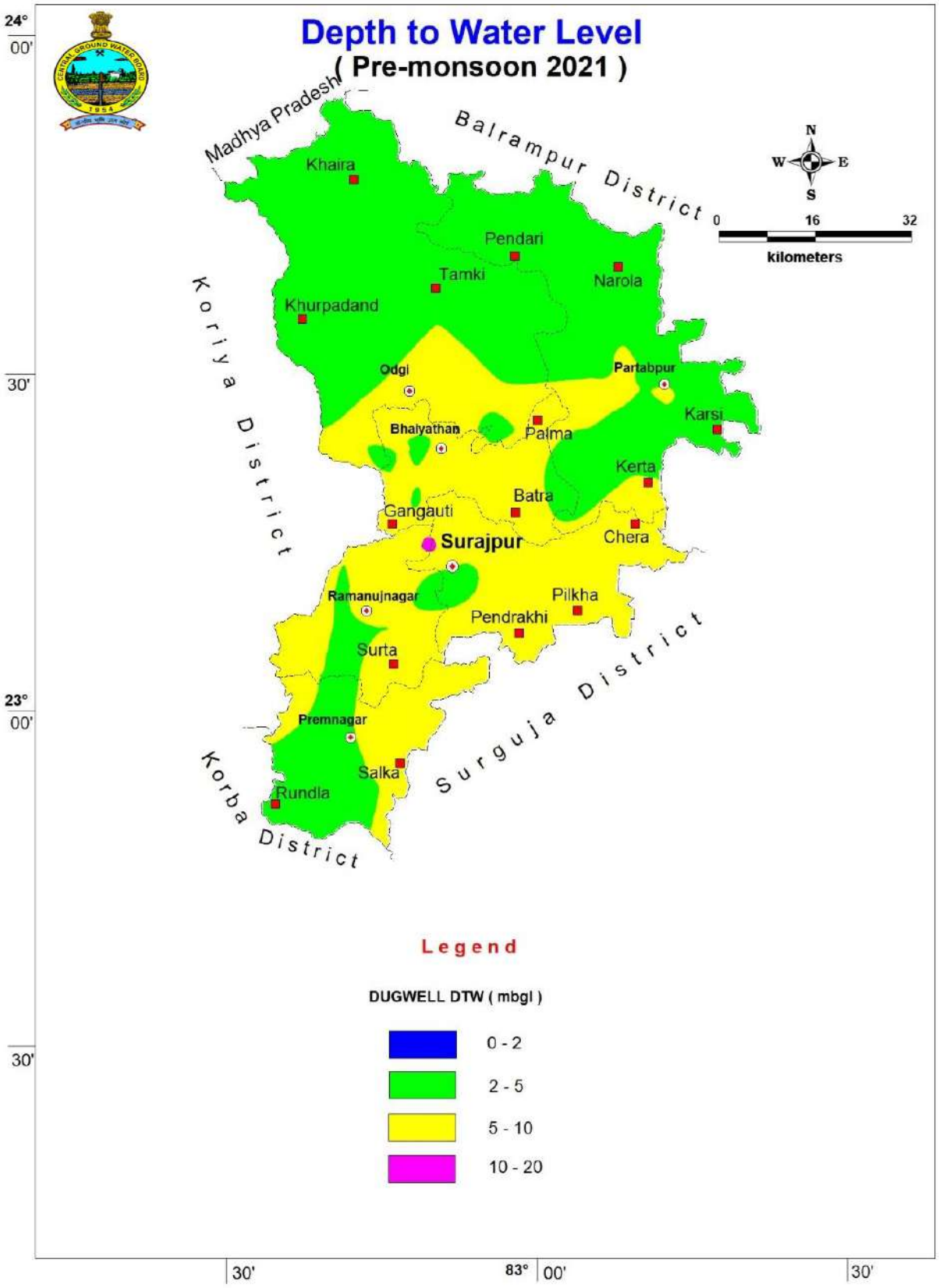


Figure 11 Pre monsoon Water Level Maps of Phreatic Aquifer

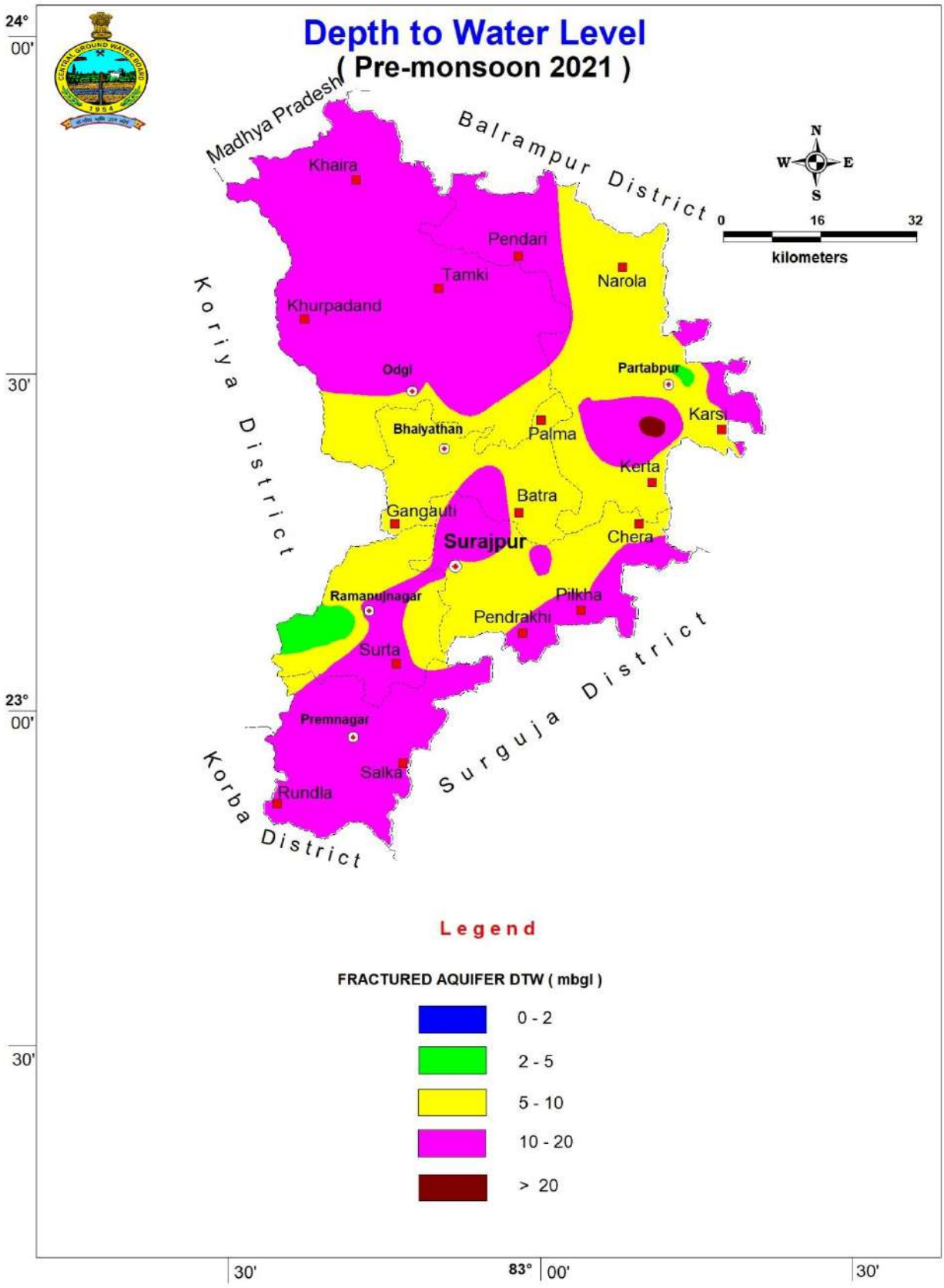


Figure 12 Pre monsoon Water Level Maps of Fractured Aquifer

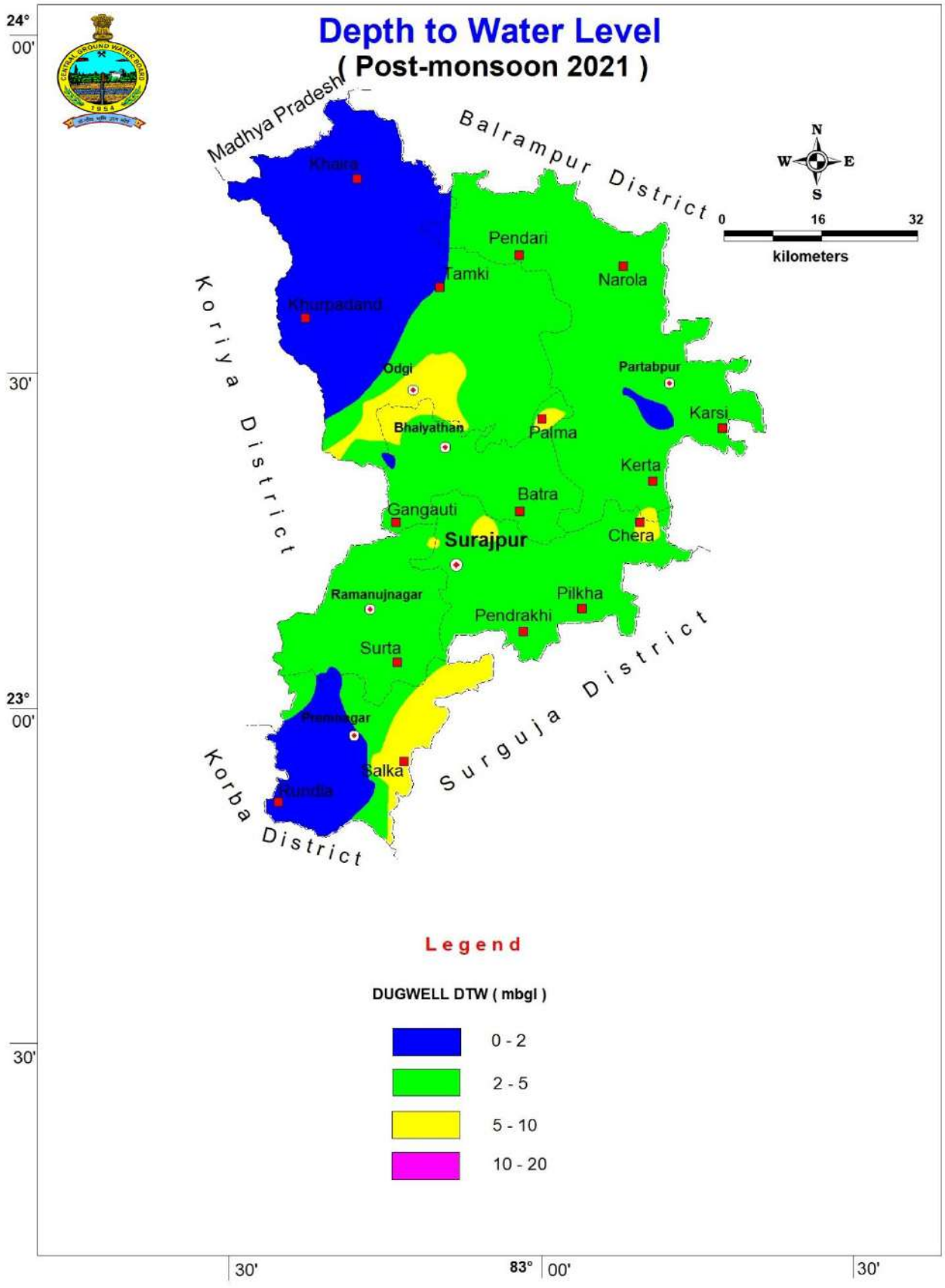


Figure 13 Post monsoon Water Level Map of Phreatic Aquifer

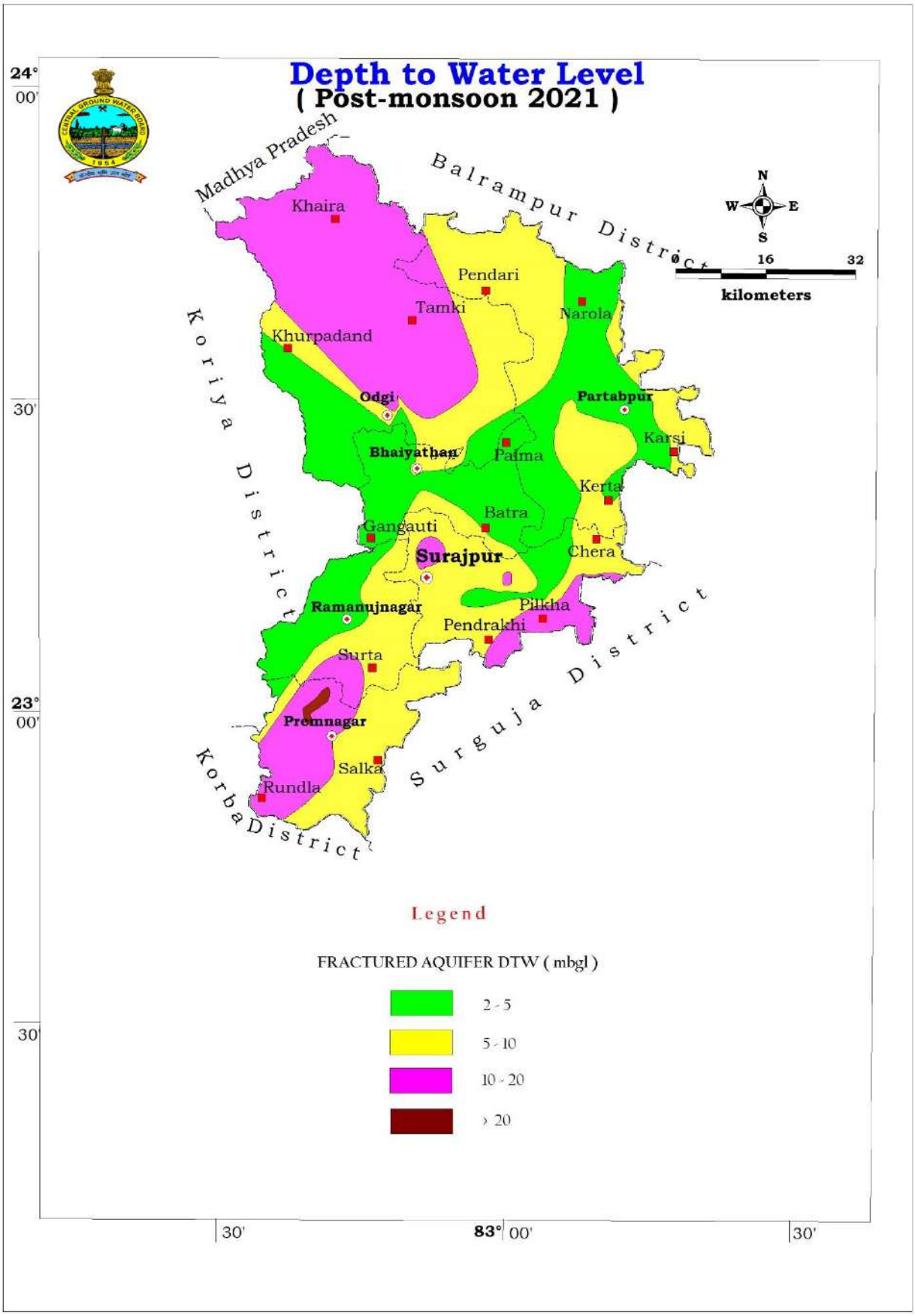


Figure 14 Post monsoon Water Level Maps of Fractured Aquifer

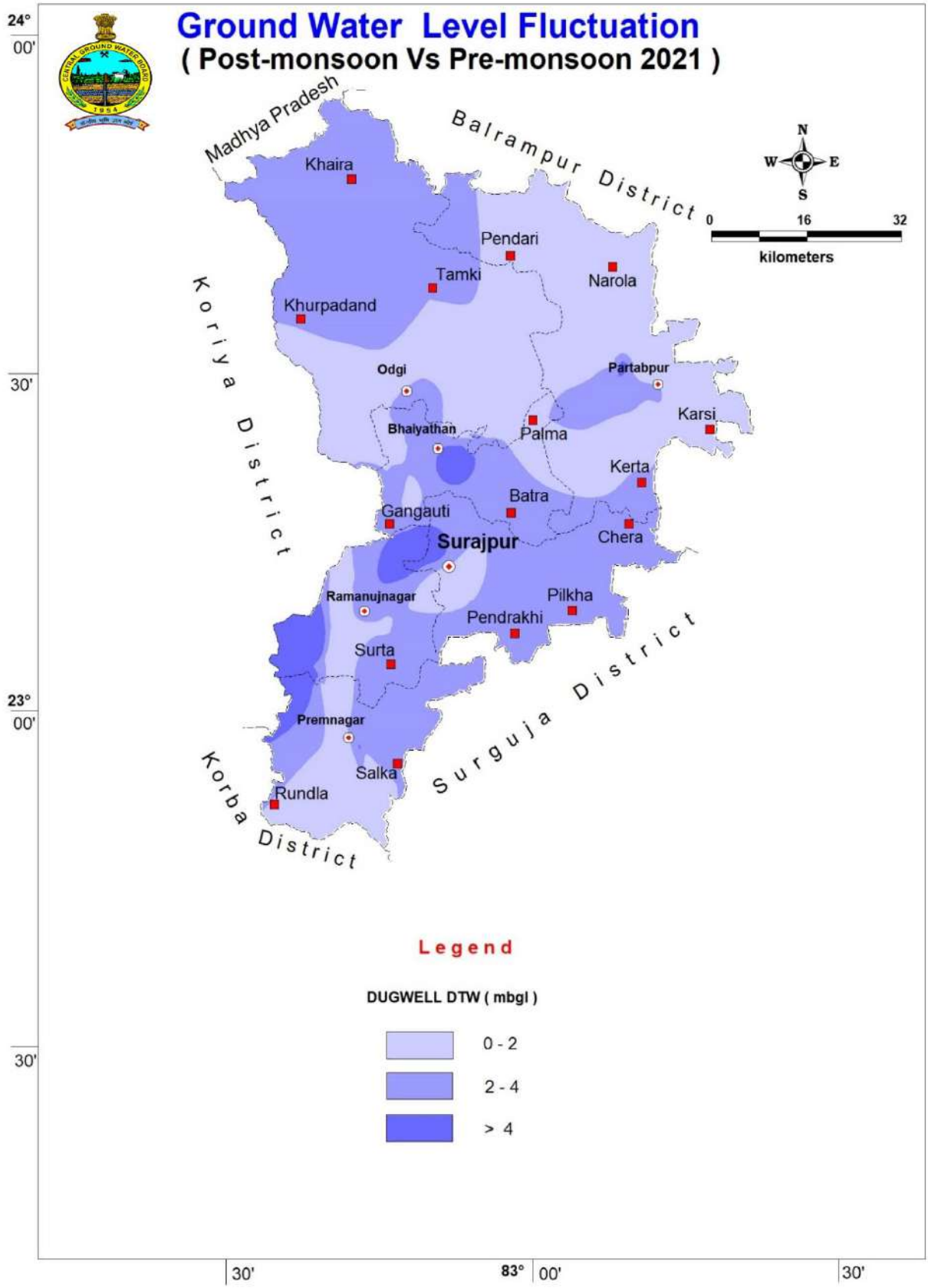


Figure 8 Water level fluctuation of Phreatic aquifer 2020

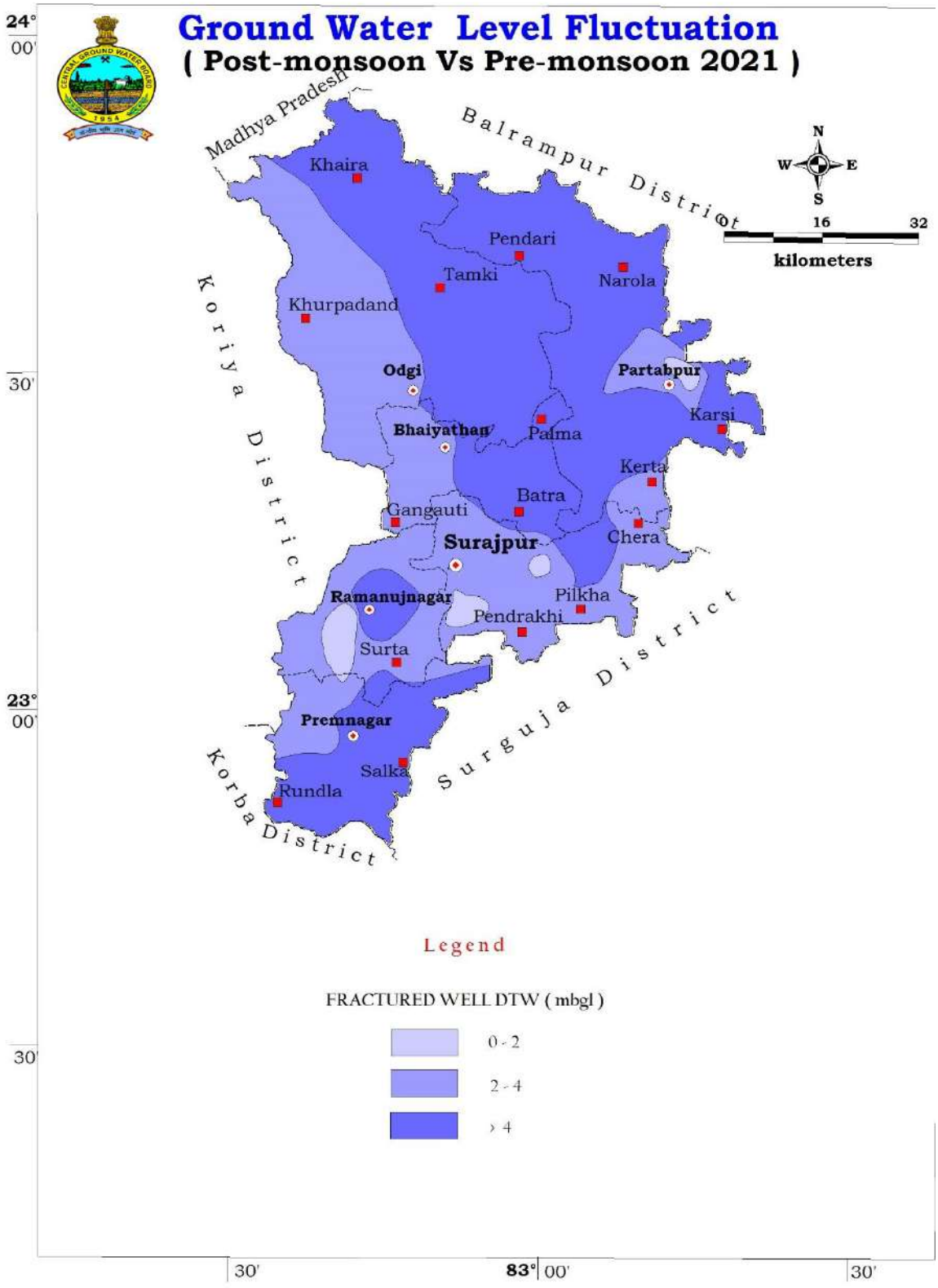


Figure 16 Water level fluctuation of Fractured aquifer 2020

3. AQUIFER DEPOSITION AND GROUND WATER RESOURCES

3.1 Aquifer Geometry and Characterization

Based on the exploratory drilling data generated for the blocks (Annexure 2), 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) Gondwana formation, (2) Basement Crystalline. Details are represented in Table no. 6.

Table 6 Aquifer Characteristics of Surajpur District

CHARACTERISTICS	**AQUIFER SYSTEM**	
	Sandstone and shale with coal bed	**Geneissic Complex**
Major Geological Formation	Gondwana formation	Chotanagpur Geneissic Complex
Major Rock type	Sandstone	Granite Geneiss
Avg Weathered Thickness (m)	104.09	18.126
Transmissivity (m^2/day)	1 to 113	14 to 44
Average Drawdown (m)	21.6	17.62
Discharge	Negligible to 9.8 lps	23.93 lps
No. of Potential Zone	1 to 2 set < 50 m 1 to 2 set: 50m to 100m 2 to 3 set: 100m to 200m (Most potential zone- 100 to 150m)	1 set >100 m 1 to 2 set: 0 to 50m 2 to 3 set: 50 m to 100m (Most potential zone- 50 to 100m)

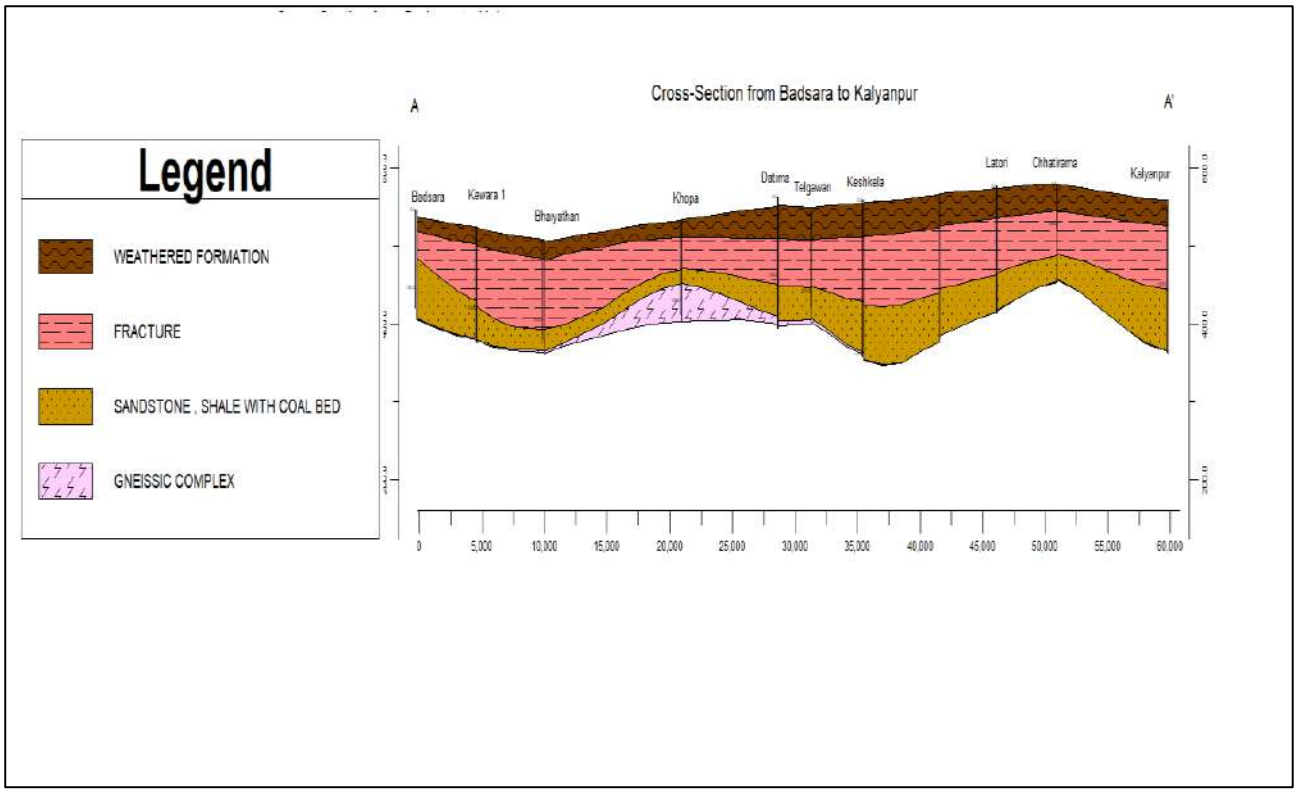


Figure 17(A) Cross-section of Study area along North-South direction (Badsara-Kalyanpur)

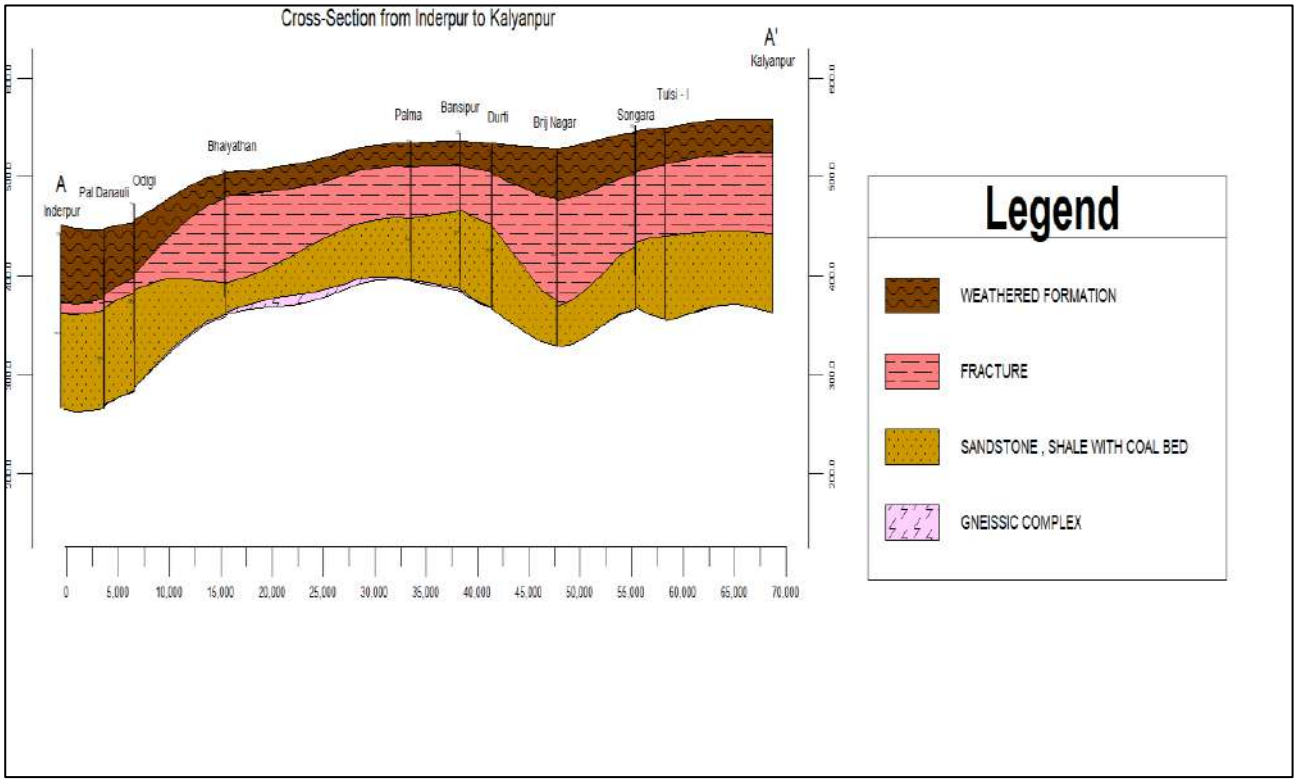


Figure 17(B) Cross-section of Study area along North-South direction (Inderpur-Kalyanpur)

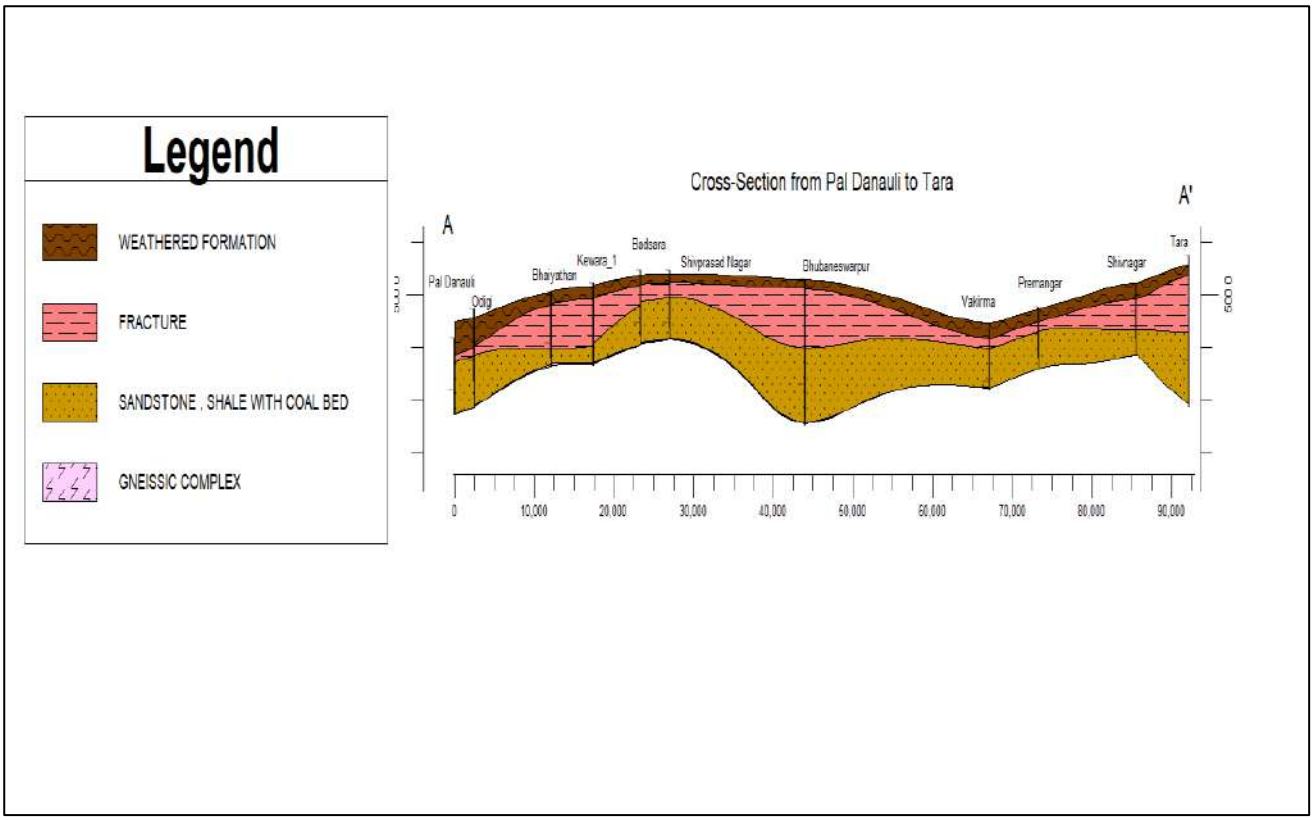


Figure 18(A) Cross-section of Study area along East-West direction (Pal Danauli-Tara)

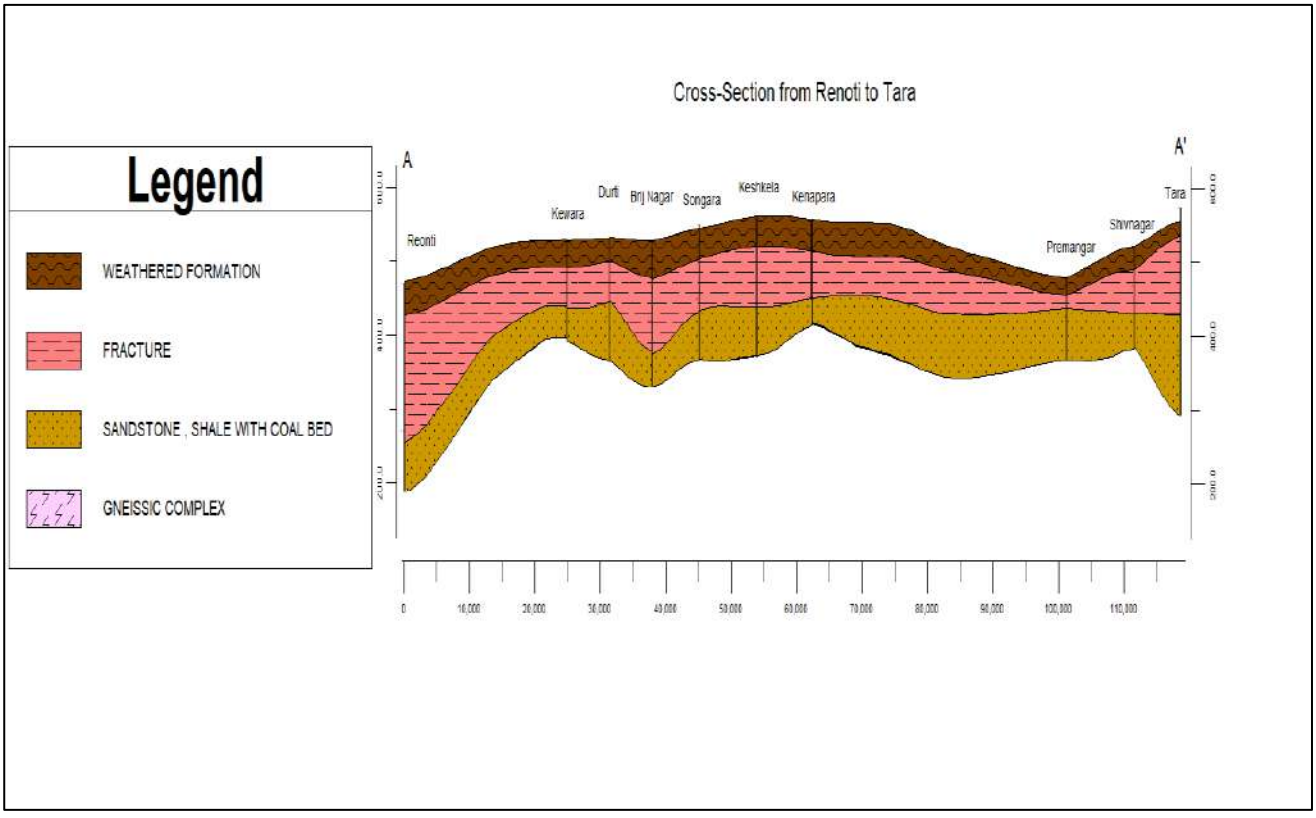
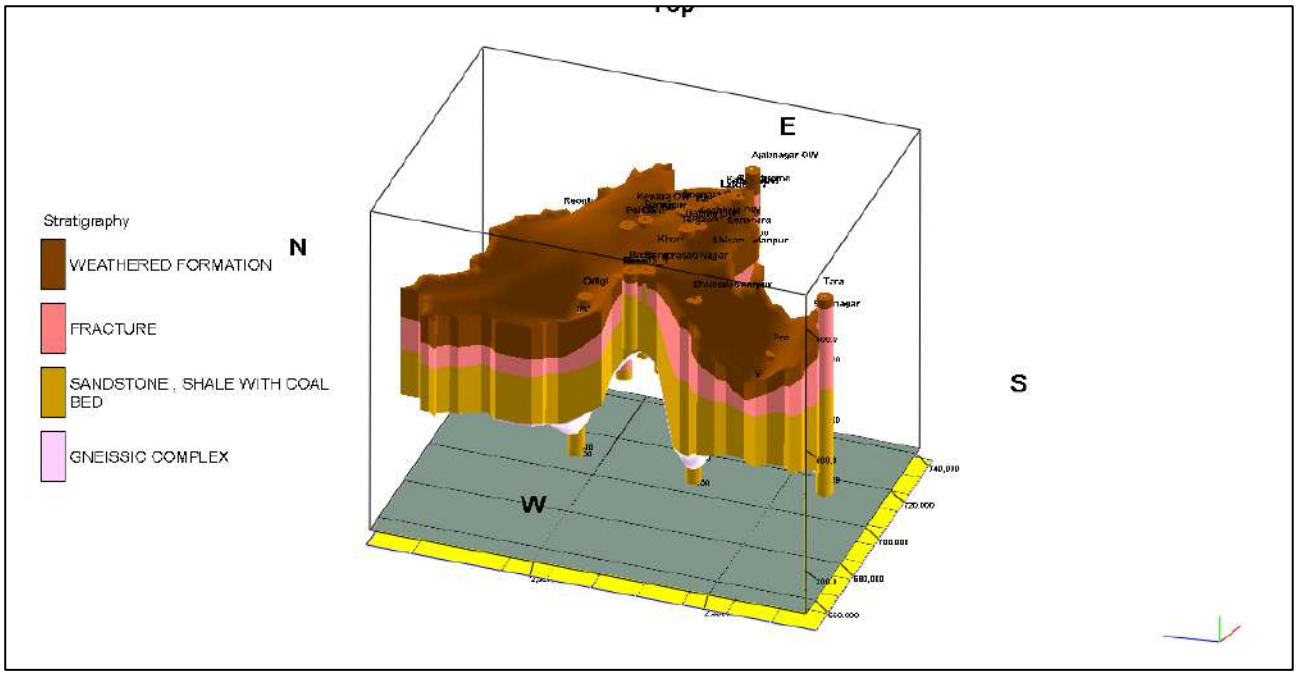


Figure 18(B) Cross-section of Study area along East-West direction (Reonti-Tara)



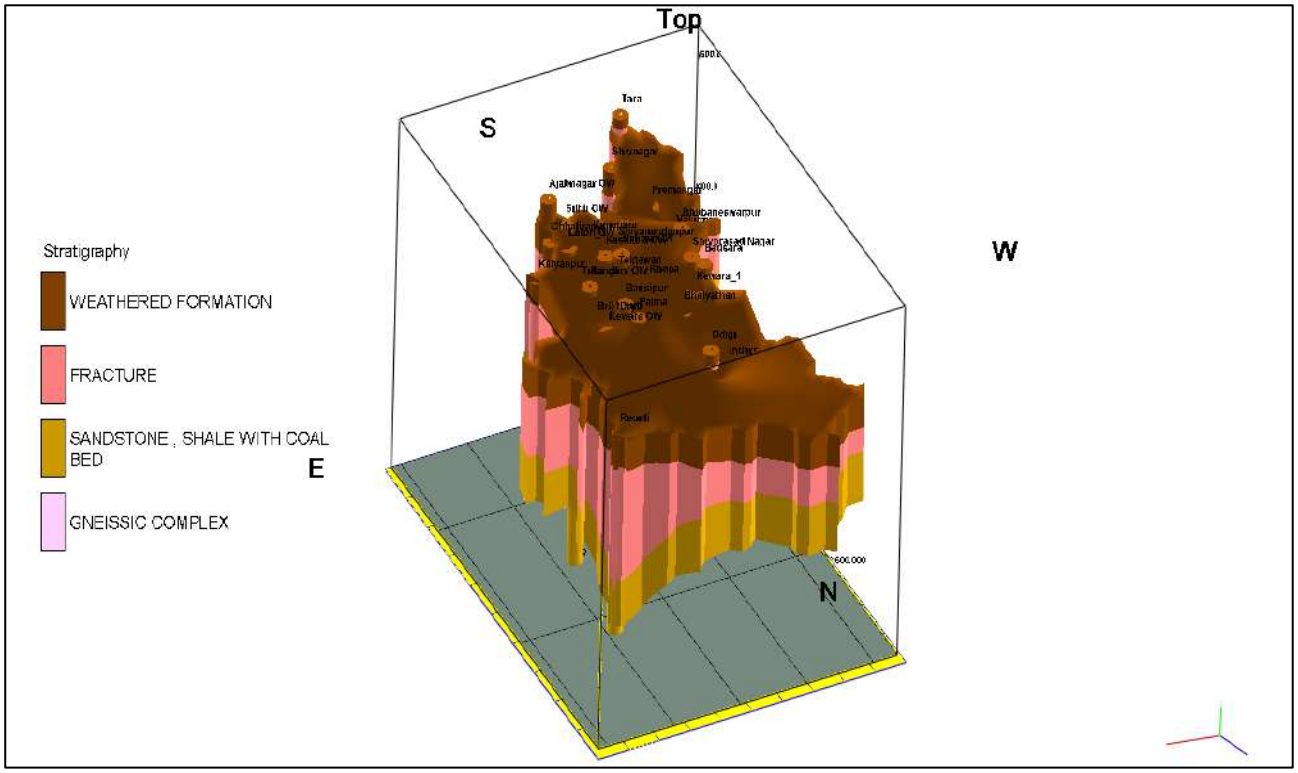


Figure 19: 3-D Section of Suajpur District

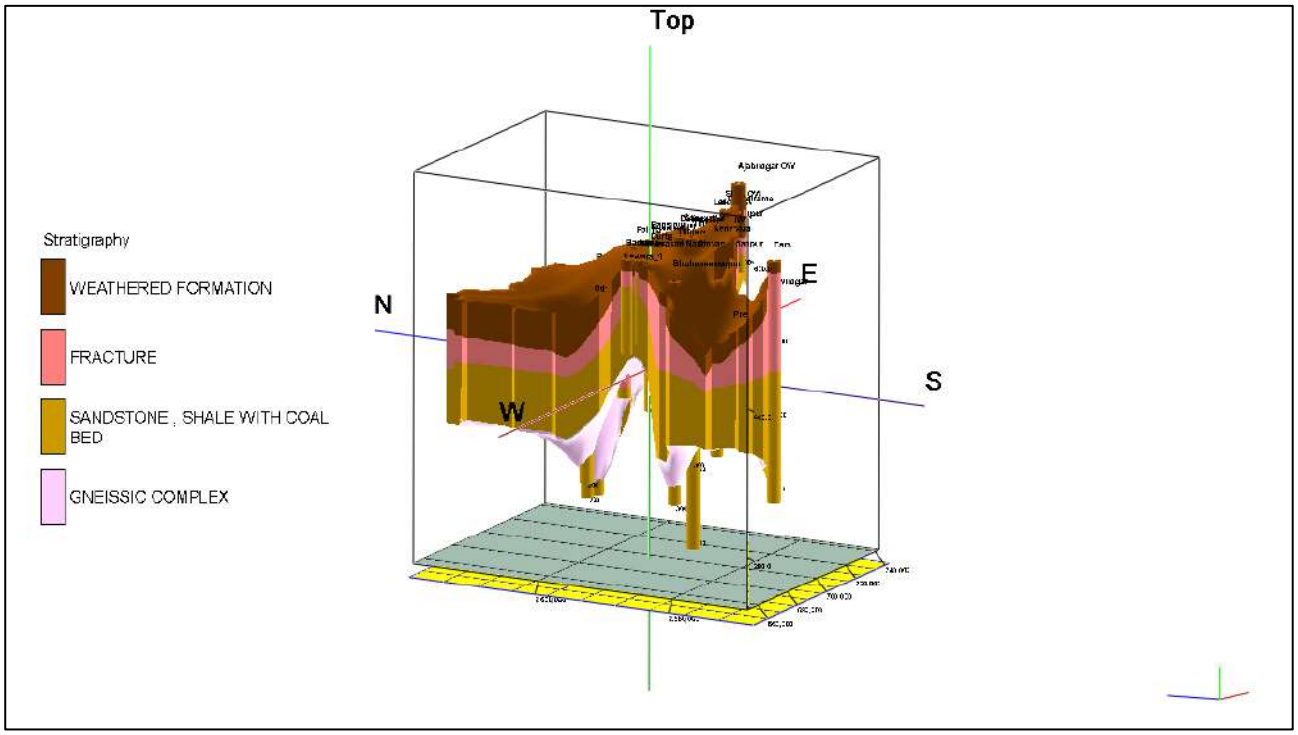


Figure 20: Fence structure of Surjarpur district

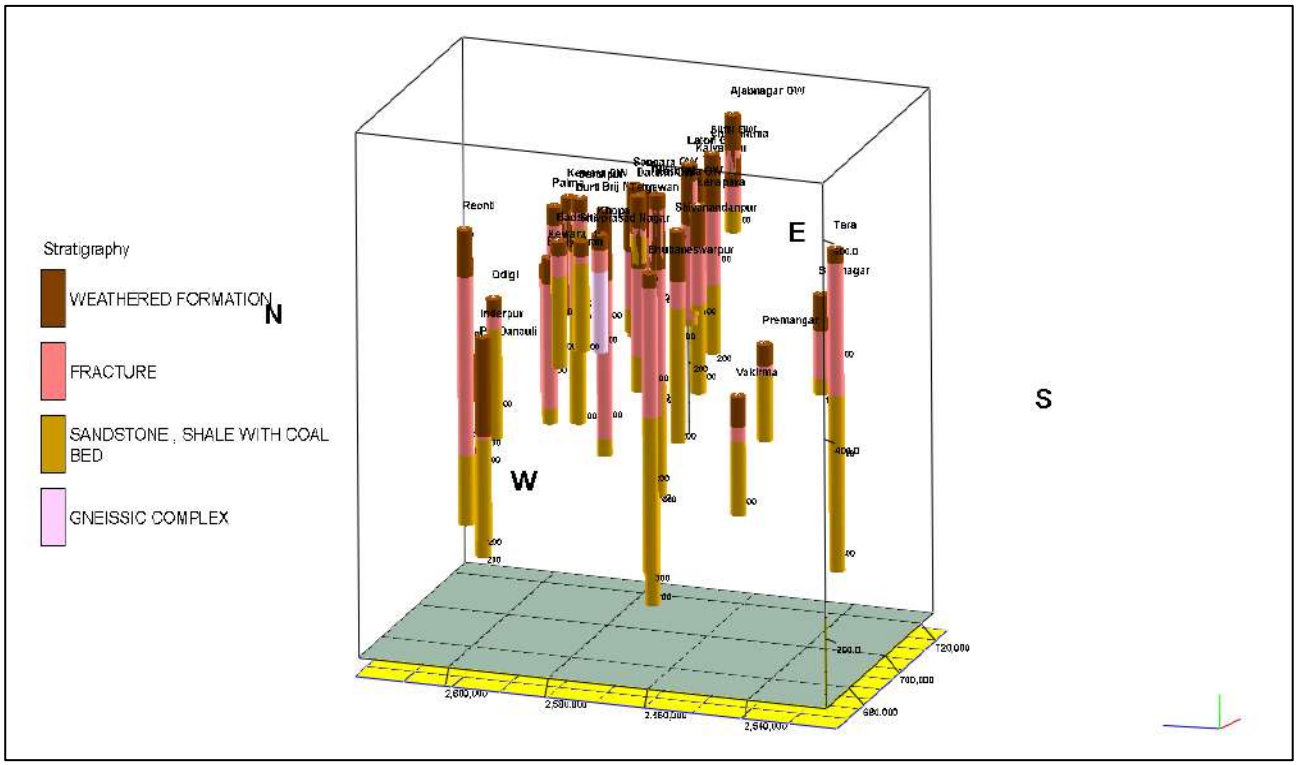


Figure 21: Strip log of Surjarpur district

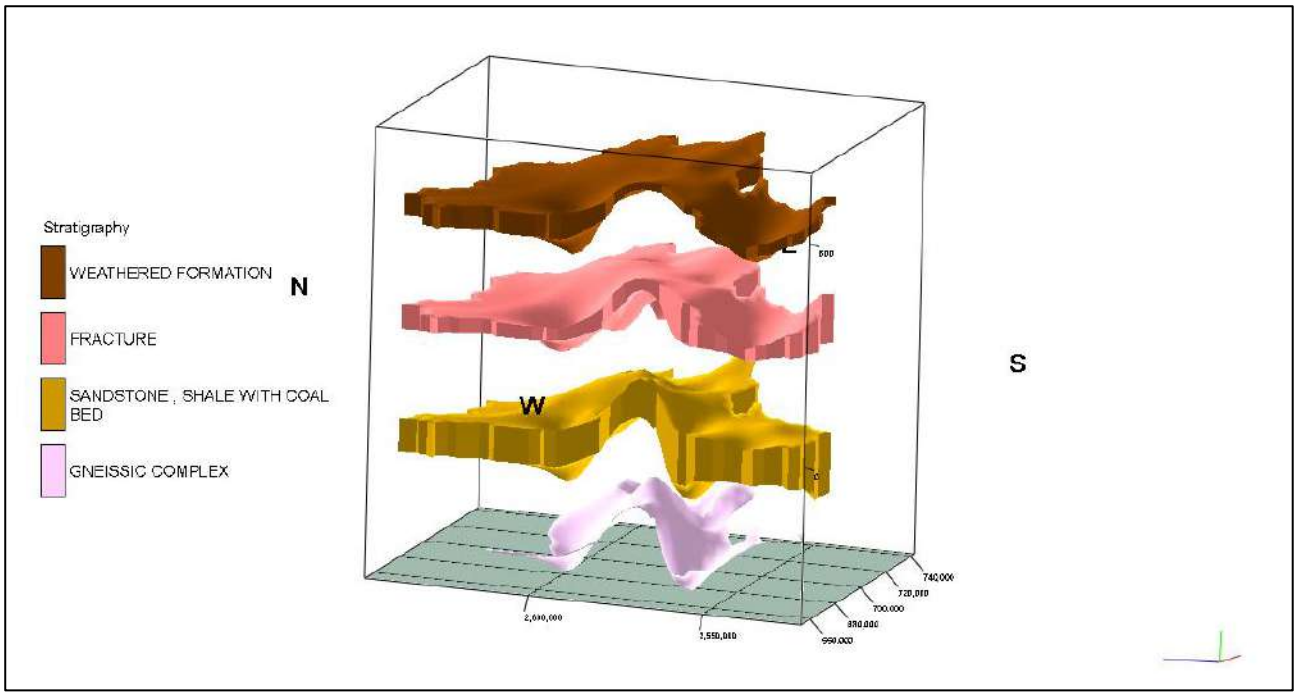


Figure 22: Explode 3-D section of Surjarpur district

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.

The district is mainly underlain by crystalline rocks of Proterozoic age belonging to Chota Nagpur gneissic complex. Presence of sandstone and Limestone of Lameta Formation (infra-trappeans) and Deccan trap basalt though insignificant, have also been reported. Extensive lateritisation with occasional bauxite deposits are also found. Laterite, which forms the phreatic aquifer, is extensive and is exploited through dug wells. Average thickness of laterite is 15m. At places it is as high as 30m. Potential of the basalts as aquifer material has not been explored properly as this part is covered mostly by forests and is thinly populated. Total Annual Ground Water Recharge and Annual Extractable Ground Water Recharge of the district have been estimated to be 39433 Ham and 35676 Ham respectively. Gross ground water Extraction for all uses in the district is only 13944 Ham. Stage of ground water extraction in the district is 39.09%. All the blocks in the district have been categorized as 'safe'.

Based on the resource assessment made, the resource availability in Block wise in Surajpur district upto 100m depth is given in Table no 7.

Table 7 Groundwater Resource up to 200m bgl (MCM)

Block	Dynamic Resources (MCM)		Insitu Resources (MCM)		Total Resources (MCM)
	Aquifer I	Aquifer II	Aquifer I	Aquifer II	
Bhaiyathan	23.00	41.76	146.57	20.31	508.16
Odgi	13.92	25.24	134.31	18.31	145.96
Pratappur	37.05	40.21	211.84	28.82	173.34
Premnagar	14.36	18.48	97.57	13.42	150.02
Ramanujnagar	37.63	46.21	126.11	18.67	159.20
Surajpur	43.48	46.73	186.63	27.16	246.47

3.3 Existing and Future Water Demand (2025)

Table 8 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	
Surajpur	8552.84	499.36	8053.48	5140.44	200.45	600.78	5941.67	659.44	2132.1	73.78
Pratappur	8550.51	855.05	7695.46	4715	84	398.75	5197.75	456.08	2440.38	67.54
Premnagar	3483.35	348.55	3135.02	743.68	0.072	172.40	916.16	196.27	2194.99	29.22
Ramanujnagar	5547.05	302.76	5244.29	2169.68	17.32	313.06	2950.07	349.50	2258.04	56.25
Bhaiyathan	6315.54	339.85	5975.79	3332.71	264.48	335.65	3932.85	369.94	2008.65	65.81
Odgi	4686.05	468.81	4217.44	1344.84	0.36	232.55	1577.75	267.05	2605.19	37.41
TOTAL	**37135.44**	**2813.96**	**34321.48**	**17896.36**	**566.68**	**2053.19**	**20516.25**	**2298.05**	**13639.35**	**59.78***

***Stage represents average of stage of GW Extraction for all 06 blocks**

The existing demand for irrigation in the area is 17896.36 Ham while the same for domestic use is 2053.19 Ham and for industrial field is 566.68 Ham. To meet the future demand for ground water, a total quantity of 13639.35 ham of ground water is available for future use.

4. GROUND WATER RELATED ISSUES

- **Drying up of Dugwells and handpumps during summer-** Dugwells dug in Granitic aquifers and also in Gondwanas due to presence of massive consolidated sandstone gradually becomes dry in lean period in Summer. Hence the number of Dugwells are decreasing gradually.
- **Inherent hydrogeological character of aquifer-** The aquifer itself is a low yielding one in Odgi and Ramanujnagar blocks. Somewhere it yielded which indicate uneven distribution of yield potential in consolidated Chotanagpur granite gneiss. Good potential zone confined in structurally low laying areas whereas in higher elevation, it is poorly yielding.
- **Fluoride concentration** – Fluoride observed in Gondwanas and granitic terrain at palces of Surajpur district (Annexure-4). More than permissible limit found at Songara (Pratappur block) and Tara (Premnagar block) and also in some parts of Bhaiyathan block.
- **Iron contamination-** More than permissible limit found in villages Dalbahara (Bhaiyathan block), Narayanpur, Newara and Surajpur (Surajpur block),

Samauli(Bhaiyathan) Fulkona (Premnagar) and Gonda (Pratappur Block). Shown in Annexure 4.

- **Nitrate contamination:** More than permissible limit found in villages Sumouli (Bhaiyathan Block), Biharpur and Surajpur (Surajpur Block). Shown in Annexure 4.
- **Heavy Metals:** Arsenic was traced out in Bhediya village (Pratappur block), Lead was found in Dawankera village (Pratappur block), Narayanpur, Surajpur, Kalyanpur villages (Surajpur block) and Uranium was also found in Ganeshpur village of Ramanujnagar 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.

Figure 23 Public Interaction Program has been successfully conducted at Government College, Silphili, Surajpur in which 158 participants have graced the event.

- 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 10 and Figure 27 shows Ground water feasibility of Abstraction structures and priority areas for artificial recharge.

Table 9 Types of Artificial Recharge structures feasible

Block/District	Area Feasible for 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**
Bhaiyathan	234.34	401	27	89	200	152
Odgi	406.13	844	56	187	421	321
Pratappur	66.66	192	13	43	96	73
Premnagar	275.31	1018	64	214	482	367
Ramanujnagar	0.00	0.00	0	0	0	0
Surajpur	344.25	564	47	156	352	268
Total (Surajpur)	**1326.7**	**3019**	**207**	**689**	**1551**	**1181**

- 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 39.09 %. 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 24). 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.

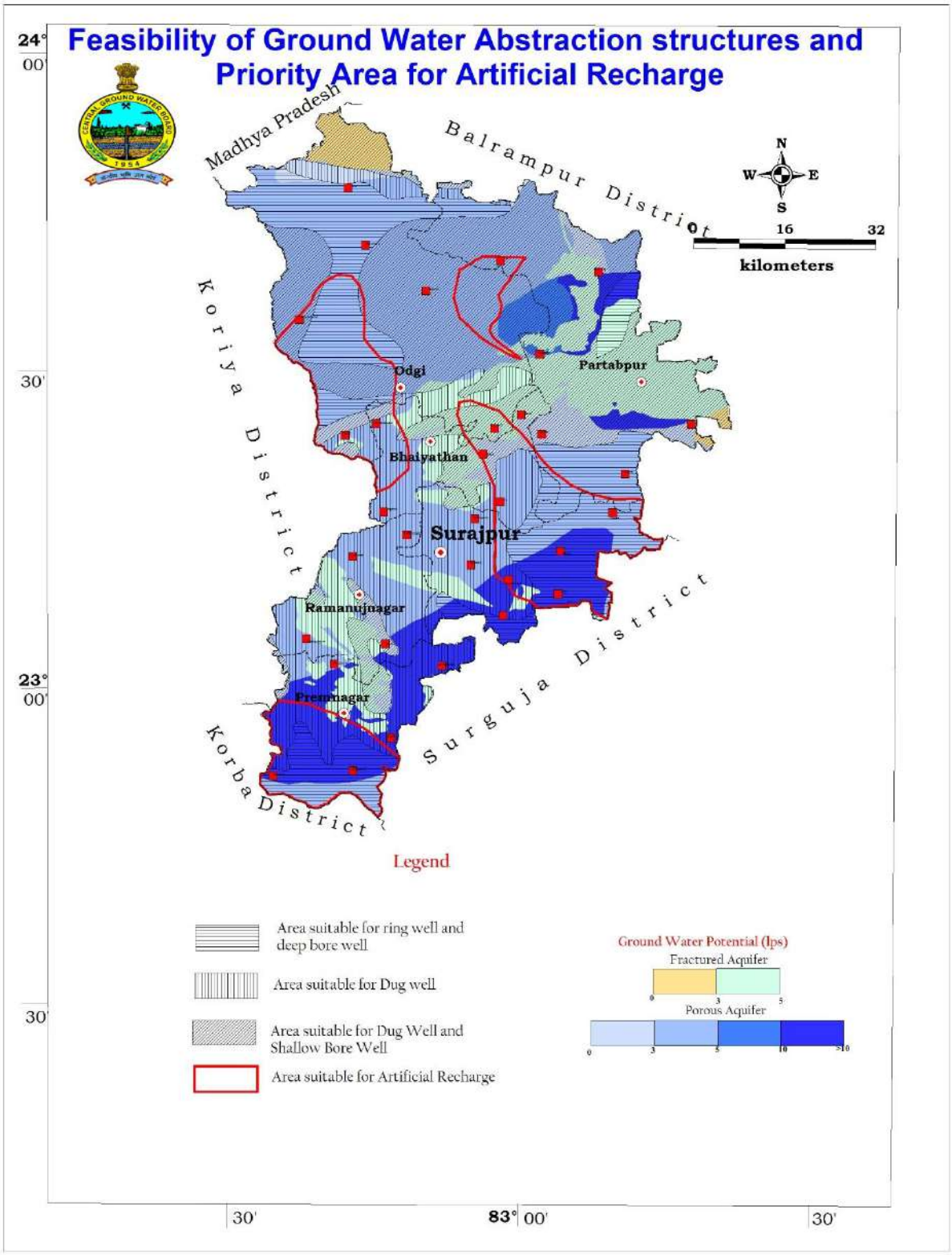


Figure 24 Ground water feasibility of Abstraction structures

Table 10 Potential of Additional GW abstraction structure creation

Block	Net Groundwater availability (ham)	Present Stage of ground water Development (%)	Present ground water draft (Ham)	Ground water draft at 50% stage of development (ham)	Surplus ground water at present Stage of Development (ham)	Number of TW/BW 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)
Bhaiyathan	2008.65	65.81	3298	253	3212	76	89
Odgi	2605.19	37.41	2039	1481	1944	444	518
Pratappur	2440.38	67.54	4271	106	4036	32	37
Premnagar	2194.99	29.22	714	2154	714	646	754
Ramanujnagar	2258.04	56.25	2404	503	2434	151	176
Surajpur	2132.1	73.78	5635	0.00	5604	0	0
Total (Surajpur)	**13639.35**	**59.78**	**18361**	**4497**	**17944**	**4136**	**1574**

6. SPECIAL STUDY ON NATIONAL WATER AWARDEE CHINDIYA GRAM PANCHAYAT, RAMAMNUJNAGAR BLOCK, SURAJPUR DISTRICT

Chindiya Village Pachayat, Block-Ramanujnagar, District-Surajpur

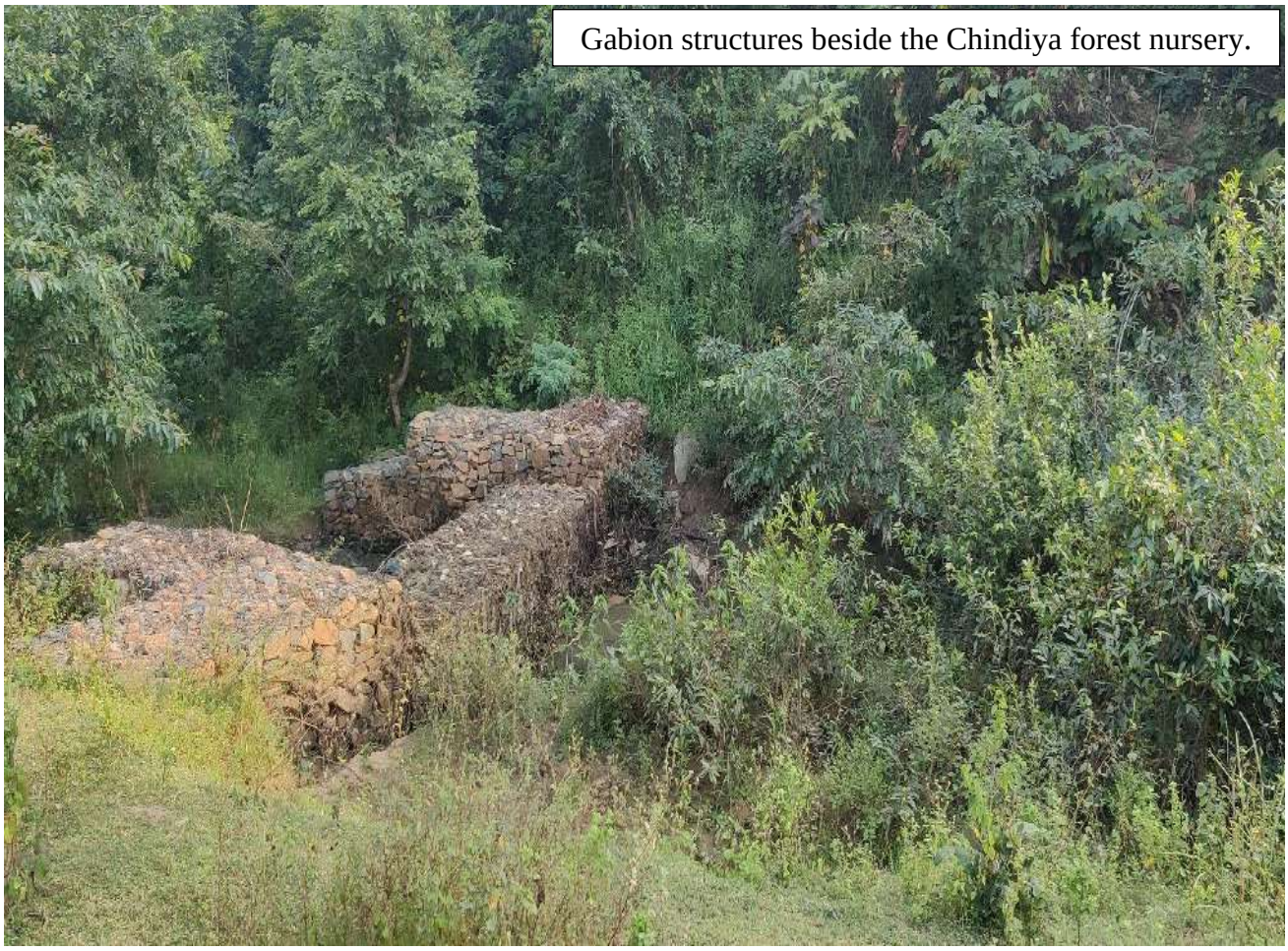
Chhindiya is a Village in **Ramanujnagar** Tehsil in **Surajpur** District of **Chhattisgarh** State, India. It is located 5 KM from **Ramanujnagar** and 30 KM towards South from District headquarters **Surajpur**. It falls under the agro ecological zone of **Platue of Baghelkhand** of Chhattisgarh State.

Panchayat	Chhindiya
Tehsils	Ramanujnagar
District	Surajpur
State	Chhattisgarh
Lattitude	23.118562
Longitude	82.683642
Population	2012
Female Population	989
Male population	1023
ST Population	1682
SC Population	8
OBC	300
Other	22
Literacy rate	41%
Geographical area	854.34 ha
Agricultural land	642.27 ha

Non- agricultural land	32.55 ha
Forest area	11.18 ha
Barren land	0.4 ha
Irrigated area	642.27 ha
Percentage of net shown area	75.18%

The district administration utilizing the funds from MGNREGA have constructed many water conservation structures constructed on ***Chindiyaa-Rampa naala*** which originates ***Tiuragadi Gram Panchayat*** and ends up in ***Jheek*** river via ***Chindiya*** and ***Panchvati*** Gram Panchayat.

The Gabion structure and Stop dam inside the forest area have been constructed to channelize the flow of *Chindiya Rampa naala* for flowering and nursery as there these structures were situated beside the forest nursery of Chindiya Gram Panchayat. The efforts of MGNREGA team and Janpad Panchayat resulted into a beautiful nursery and blossom of flower inside the dense forest which also gave employment to local villagers.



Gabion structures beside the Chindiya forest nursery.

Stop Dam beside forest nursery Chindiya Gram Panchayat

Check dam inside the forest beside Chindiya forest nursery

The second Gabion structure were constructed just outside the forest boundary touching its periphery. The efforts of the MGNREGA team gave villagers the gift of irrigation for the agricultural practices and as result after channelizing the flow of Chindiya-Rampa Naala the lush green cultivation of rice was observed which was not possible in earlier times as per the local stakeholders and Groundwater level was also elevated which was observed in near dug well.

2nd Gabion structure

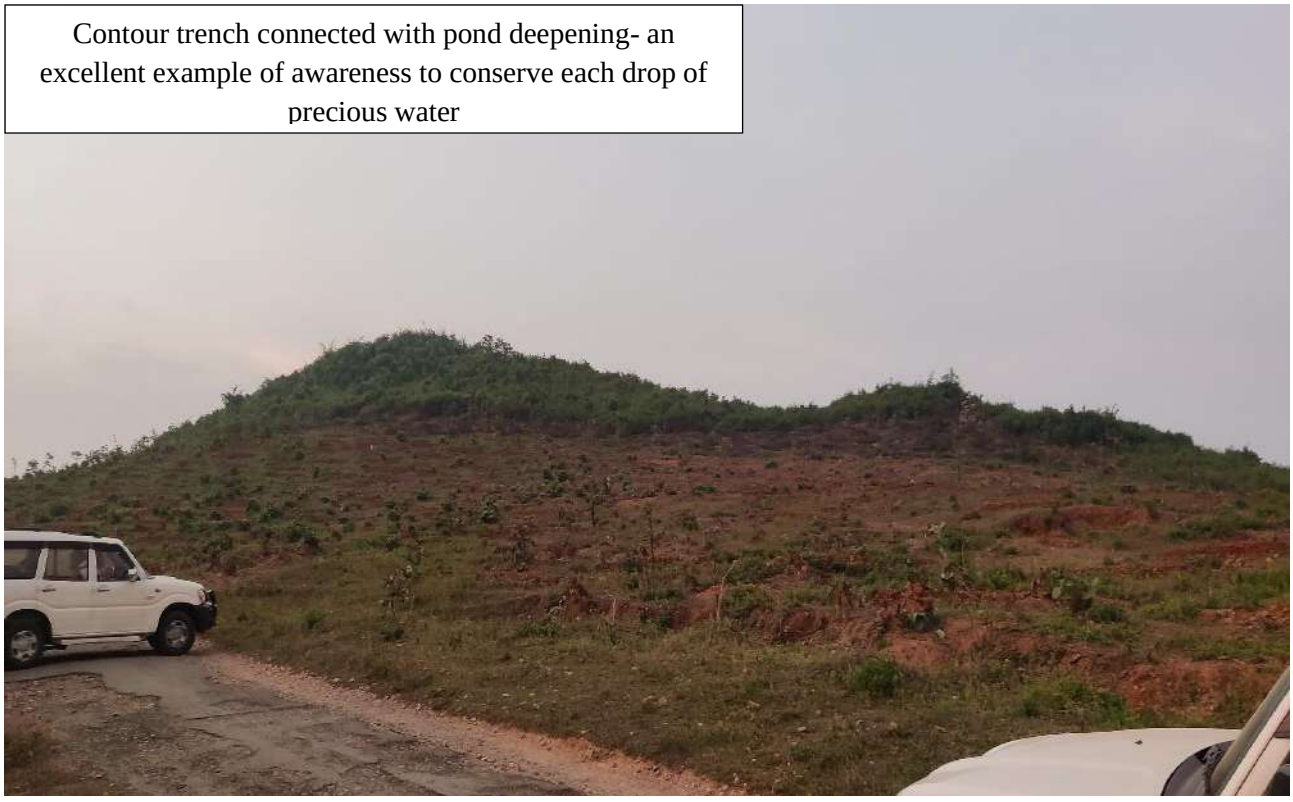
Several farm ponds have also been created and pond deepening works were going on. In between all this there was a game changer stop dam which beneficiated a lot the villagers that enabled them for farming in the nearby area which changed their life and provided them employment and better education to the children. All was mentioned by local stakeholders and this stop dam was a success story also and you tube video link (https://youtu.be/kWbM_adwG0o) is also attached of this story.

Success story video link

The game changer Stop dam

Lush green field near stop dam

Pond (*taalab*)



Contour trench connected with pond deepening- an excellent example of awareness to conserve each drop of precious water

Pond Deepening

Dug well-constructed with the help of local stakeholders

Farm pond (*Dabri*)

Farm pond (*Dabri*)

Small LBCD Structure to control the gradient of stream and utilize it in the agricultural practices

Roof top rainwater harvesting installed in government building

Concluding Remarks:-

The special study was taken up in the Chindiya Gram Panchayat, Ramanujnagar Jan pad, Surajpur district with the aim to learn and highlight the water conservation practices done in the above mention village. The Jan pad Panchayat and team of MGNREGA have efficiently used the government funds and constructed the water conservation structures and there was not any compromise found in terms of quality and quantity of the structures. It was very cherishing to see that local stake holders are highly benefited with these practises, and nearby gram panchayats were also inspired with these works. Many barren lands got changed into agricultural land by channelizing the flow of Chindiya Rampa naala with help of these proposed structures. The awareness was created and government efforts were taken up for conservation of this precious element of life. It was a great learning that how to work for good cause in any situation as we know that Surajpur is hilly area which bears rugged and undulating topography and covered by huge and dense forests, but then also highly commendable and appreciable efforts were made by Jan pad Panchayat and highly efficient and energetic team of MGNREGA is continuously working for conservation of water to benefit the local stakeholders. Their efforts are highly inspiring for other gram panchayats also.

The observations made in compliance with the criteria taken up for the study are as under: -

Criteria	Observations
1. Number of water bodies revived with community participation.	Water bodies revived with community participation.
2. Innovative practices for enhancing ground water. Furnish data & documents to substantiate.	Underground dyke and Recharge pits are constructed.
3. Number of new water conservation structures and their storage capacity.	LBCD, Gully plug, Dyke cum Boulder check, Gabion structure, Stop Dams & 15 nos. Farm Ponds (Dabari) having capacity of 24300 cumec constructed.
4. Community mobilization for adopting of water efficient cropping pattern, and efficient water management practices, and results thereof.	Beneficiaries of community farming are cultivated vegetable on their own land which increases their income
5. Water Shed development activities (contour bunding/trenching), and tree plantation.	Gabion and Boulder check Dams constructed including creation of nursery near water storage.
6. Number of new ponds created and capacity in Cum., and mechanism for sustainment of creations.	15 nos. Farm Ponds (Dabari) having capacity of 24300 cumec constructed and 2 nos. pond deepening having 9000 cumec capacity.
7. Mass sensitization and capacity building in water conservation and management, including water budgeting. Furnish details of activities and impact thereof.	Mass sensitization program executed & rain water harvesting in government building and private building and also construction of soak pit.

7. 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 10).

Table 11 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 Potential created after Artificial recharge structure in Ham	Development by new GW abstraction structure	Additional GW irrigation Potential created in Ham	Additional Irrigation potential creation for Maize/ wheat in winter season in Ha (Assuming 500 mm water requirement)	Percent increase in Crop area compare to Gross cropped area
Bhaiyathan	3332.71	999.81	6851	4202.58	7930	10172.21	19.08%
Odgi	1344.84	403.45	6851	678.31	7254	2865.2	16.48%
Pratappur	4715	1414.50	8285	495.66	9699	2440.23	10.38%
Premnagar	743.68	223.11	5736	865.54	5959	3118.95	12.36%
Ramanujnagar	2619.68	785.90	5514	600.46	6299	2523.5	9.18%
Surajpur	5140.43	1542.13	10463	1568.36	12005	4827.07	18.33%
Total (Surajpur)	**17896.34**	**5368.91**	**43780**	**11028.75**	**49418**	**34020.74**	**13.24%**

Annexure 1 Details of key wells established

DISTRICT	BLOCK	VILLAGE	LATITUDE	LONGITUDE	WELL TYPE	Pre monsoon WL	Post monson WL	FLUCTUATION
Surajpur	Pratappur	Bharda	23.402789	83.132169	DW	4.25	3.31	0.94
Surajpur	Pratappur	Paldha	23.39666	83.108488	DW	3.84	2.38	1.46
Surajpur	Pratappur	Kanaknagar	23.413689	83.230208	DW	4.19	2.28	1.91
Surajpur	Pratappur	Godgavan	23.462078	83.209525	DW	5.8	3.5	2.3
Surajpur	Pratappur	Semra Kala	23.498516	83.277867	DW	4.25	3.39	0.86
Surajpur	Pratappur	Mayapur	23.510948	83.17694	DW	4.14	2.35	1.79
Surajpur	Pratappur	Pakni	23.527738	83.105065	DW	4.24	3.2	1.04
Surajpur	Pratappur	Sarhari	23.472858	83.140893	DW	5.84	2	3.84
Surajpur	Pratappur	Deori	23.525094	83.131125	DW	5.4	4.7	0.7
Surajpur	Pratappur	Chitkabahara	23.441142	83.205157	DW	2.9	1.23	1.67
Surajpur	Pratappur	Khadgawan	23.314107	83.193041	DW	5.68	2.75	2.93
Surajpur	Bhaiyathan	Palma	23.424837	83.007503	DW	6	5.15	0.85
Surajpur	Bhaiyathan	Patiadandh	23.408801	82.904593	DW	5.86	3.5	2.36
Surajpur	Bhaiyathan	Salka	23.370769	82.928276	DW	6.85	3.2	3.65
Surajpur	Bhaiyathan	Satyanagar	23.377314	82.886688	DW	8.5	3.32	5.18
Surajpur	Bhaiyathan	Jamdi Darripara	23.398123	82.810893	DW	4.88	2.1	2.78
Surajpur	Bhaiyathan	Tarkapara	23.388748	82.78519	DW	6.13	4.9	1.23

Surajpur	Bhaiyathan	Sava Rawa	23.420923	82.721762	DW	7.1	5.5	1.6
Surajpur	Bhaiyathan	Birnidand	23.440263	83.050609	DW	8.3	5	3.3
Surajpur	Bhaiyathan	Dawna	23.407451	82.937649	DW	4.95	2.82	2.13
Surajpur	Bhaiyathan	Govindgarh	23.40624	82.757889	DW	3.3	3.1	0.2
Surajpur	Surajpur	Baskar	23.36125	82.764731	DW	2.8	1	1.8
Surajpur	Surajpur	Karampur	23.40624	82.757889	DW	9.9	7.84	2.06
Surajpur	Surajpur	Ajabnagar	23.161587	83.098517	DW	6.2	2.9	3.3
Surajpur	Surajpur	Beltikri	23.1765	82.900491	DW	5.23	3.6	1.63
Surajpur	Surajpur	Bharatpur	23.148018	82.908022	DW	6.63	4.1	2.53
Surajpur	Surajpur	Unchdeeh	23.295022	82.828731	DW	6.53	3.75	2.78
Surajpur	Surajpur	Lanchi	23.186218	82.874304	DW	3.45	2.9	0.55
Surajpur	Surajpur	Shivsagarpur	23.210846	83.043283	DW	5.82	2.35	3.47
Surajpur	Surajpur	Banja	23.31152	82.80828	DW	5.21	3.55	1.66
Surajpur	Ramanujnagar	Pandri	23.240513	82.745848	DW	8.62	4.6	4.02
Surajpur	Ramanujnagar	Madneshwarpur	23.189804	82.728856	DW	7.4	3.69	3.71
Surajpur	Ramanujnagar	Nakna	23.172749	82.683118	DW	5	4.1	0.9
Surajpur	Ramanujnagar	Patrapali	23.118889	82.763241	DW	5.42	3.63	1.79
Surajpur	Ramanujnagar	Parshurampur	23.095339	82.778194	DW	7.4	3.6	3.8
Surajpur	Ramanujnagar	Madanpur	23.093475	82.678439	DW	3.95	2.65	1.3
Surajpur	Ramanujnagar	Hanumangarh	23.066351	82.640548	DW	8.2	2	6.2
Surajpur	Odgi	Devansara	23.405052	82.904241	DW	6.3	4.16	2.14
Surajpur	Odgi	Bhandi	23.420558	82.882681	DW	5.85	5.12	0.73
Surajpur	Odgi	Dharsedi	23.410879	82.730024	DW	6.73	5.88	0.85
Surajpur	Odgi	Chabda	23.453213	82.721762	DW	7.1	5.48	1.62
Surajpur	Odgi	Bhavarkhor	23.455313	82.699998	DW	3.47	1.4	2.07
Surajpur	Odgi	Masanaki	23.5607	82.843955	DW	5.5	4.95	0.55
Surajpur	Odgi	Tamki	23.627134	82.8350347	DW	4.47	2	2.47
Surajpur	Premnagar	Kanchanpur	23.045118	82.660029	DW	3.92	1.1	2.82
Surajpur	Premnagar	Raghunathpur	22.945876	82.720358	DW	5.82	1.6	4.22
Surajpur	Premnagar	Namna	22.959843	82.730309	DW	7.82	4.25	3.57
Surajpur	Premnagar	Mendra	22.88821	82.7222	DW	2.8	1.2	1.6
Surajpur	Prem Nagar	Katarouli (Harrapara)	22.5778	82.5557	DW	6.55	6.5	0.05
Surajpur	Premnagar	Abhaypur	22.9097	82.7347	DW	6.34	6.16	0.18
Surajpur	Pratappur	Banshipur	23.2487	82.7303	DW	10.6000	5.28	5.32
Surajpur	Pratappur	Bhediya	23.5854	83.1566	DW	4.91	4.6	0.31
Surajpur	Bhaiyathan	Dalabahara(Bhaskar)	23.4029	82.6862	DW	7	4.95	2.05
Surajpur	Bhaiyathan	Khandapara	23.3543	82.6528	DW	4.62	4.29	0.33
Surajpur	Pratappur	Podi	23.3957	83.6237	DW	8.74	3.28	5.46
Surajpur	Surajpur	Surajpur	23.1775	82.3673	DW	6.54	2.78	3.76
Surajpur	Pratappur	Dwarikanagar	23.2850	83.1885	DW	9.27	5.7	3.57
Surajpur	Surajpur	Krishnapur(Kalwa)	23.2439	82.8233	DW	12.26	5.18	7.08
Surajpur	Premnagar	Shivnagar	22.8815	82.7882	DW	10.1	7.88	2.22
Surajpur	Surajpur	Badsara	23.3444	82.7708	DW	8.1	4.86	3.24
Surajpur	Surajpur	Biharpur	23.2721	82.9210	DW	7.4	5.1	2.3
Surajpur	Surajpur	Bishrampur	23.1850	82.9883	DW	7	3.87	3.13
Surajpur	Pratappur	Chandora	23.5111	83.1569	DW	8	3.1	4.9
Surajpur	Pratappur	Darhora	23.4421	82.8346	DW	9	5.1	3.9

Surajpur	Surajpur	Deonagar	23.2400	82.8033	DW	8	2.2	5.8
Surajpur	Premnagar	Fulkona	23.0250	82.6672	DW	2.4	1.9	0.5
Surajpur	Ramanujnagar	Ganeshpur	23.0806	82.6353	DW	11.66	2.8	8.86
Surajpur	Premnagar	Hanumangarh	23.0629	82.6476	DW	8.32	4.86	3.46
Surajpur	Pratappur	Jagannathpur	23.3786	83.1950	DW	4.8	3.16	1.64
Surajpur	Surajpur	Kaliyanpur	23.2472	83.2000	DW	8.5	4.92	3.58
Surajpur	Surajpur	Majeera	23.1482	82.9514	DW	7.5	3.7	3.8
Surajpur	Bhaiyathan	Satipara(Bhaingamunda)	23.1997	82.6074	DW	7.66	5.16	2.5
Surajpur	Bishrampur	Bishrampur	23.1618	82.7425	DW	7.76	3.87	3.89
Surajpur	Pratappur	Madannagar	23.41488	83.190387	HP	22.8	9.27	13.53
Surajpur	Pratappur	Baikuna	23.494731	83.241518	HP	4.67	4.28	0.39
Surajpur	Pratappur	Silauta	23.502734	83.304696	HP	14	7.28	6.72
Surajpur	Pratappur	Satipara	23.448956	83.06743	HP	10.68	4.86	5.82
Surajpur	Bhaiyathan	Baijnathpur	23.431908	82.78742	HP	6.23	4.26	1.97
Surajpur	Surajpur	Ajabnagar	23.15961	83.10604	HP	14.63	12.32	2.31
Surajpur	Surajpur	Kumda	23.207155	83.007717	HP	12.15	11.26	0.89
Surajpur	Surajpur	Parri	23.23964	82.863951	HP	13.33	11.23	2.1
Surajpur	Surajpur	Ketka	23.152421	82.887189	HP	7.78	5.95	1.83
Surajpur	Surajpur	Pampapur	23.201219	82.848765	HP	10.7	8.56	2.14
Surajpur	Surajpur	Birpur	23.198544	83.029926	HP	9.18	6.32	2.86
Surajpur	Ramanujnagar	Manja	23.20685	82.688321	HP	6.58	3.3	3.28
Surajpur	Ramanujnagar	Chindiya	23.127707	82.700525	HP	4.68	4.65	0.03
Surajpur	Ramanujnagar	Arjunpur	23.104155	82.621373	HP	4.65	2.23	2.42
Surajpur	Odgi	Kharra	23.508177	82.824111	HP	16.88	12.77	4.11
Surajpur	Premnagar	Bhagwanpur	23.020677	82.689915	HP	17.41	15.3	2.11
Surajpur	Premnagar	Nayandihri	22.998732	82.658309	HP	17.88	15.22	2.66
Surajpur	Bhaiyathan	Bhaiyathan	23.4042	82.8667	PZ	9.7	5.7	4
Surajpur	Surajpur	Surajpur	23.2119	82.8728	PZ	9.36	5.48	3.88
Surajpur	Premnagar	Tara	22.8333	82.7397	PZ	15.76	8.17	7.59
Surajpur	Premnagar	Premnagar	22.9667	82.6958	PZ	19.02	10.25	8.77
Surajpur	Bhaiyathan	Baijnathpur	23.43083	82.78833	PZ	6.41	3.45	2.96
Surajpur	Odgi	Odgi	23.47722	82.82056	PZ	7.21	2.15	5.06
Surajpur	Pratappur	Dandkarwa	23.63417	83.1477	PZ	9.5	4.81	4.69
Surajpur	Pratappur	Pondi	23.47611	83.11417	PZ	8.8	5.05	3.75
Surajpur	Pratappur	Jagannathpur	23.36667	83.20111	PZ	6.88	3.1	3.78
Surajpur	Surajpur	Surajpur	23.2125	82.86056	PZ	9.97	3.5	6.47
Surajpur	Bhaiyathan	Palma	23.43111	83.00194	PZ	7.96	3.4	4.56
Surajpur	Bhaiyathan	Bhaiyathan	23.39111	82.84417	PZ	8.4	5.05	3.35
Surajpur	Bhaiyathan	Khadgawa	23.30528	82.79861	PZ	7.05	3.7	3.35
Surajpur	Bhaiyathan	Salka	23.36806	82.95139	PZ	10.5	3.06	7.44
Surajpur	Bhaiyathan	Sudamanagar	23.285	83.01667	PZ	8.85	4.03	4.82
Surajpur	Pratappur	Khadagawakalan	23.3125	83.18361	PZ	8.77	5.95	2.82
Surajpur	Pratappur	Pratappur	23.48278	83.22444	PZ	6.67	3.6	3.07
Surajpur	Pratappur	Silphili	23.41611	83.25806	PZ	8.05	3.92	4.13
Surajpur	Ramanujnagar	Ramanujnagar	23.14694	82.72333	PZ	11.23	4.1	7.13
Surajpur	Surajpur	Bishrampur	23.185	82.98933	PZ	6.95	4.01	2.94
Surajpur	Surajpur	Silphili	23.1825	83.06417	PZ	8.2	4.15	4.05

Annexure 2 Details of Exploration in Surajpur District

Location	Block	LONG	LAT	Depth	Casing	Formation	Zone_encountered	Discharge	Stratigraphy	Lithology
Tulsi - I	Prata ppur	83.1	23.2833	413.5	143	Barakar Fm	14-21,100-118,128-131,140-143	7.95	Barakar	Sandstone, Shale with Coal bed
Tulsi - II	Prata ppur	83.1	23.2833	80.45	76	Barakar Fm	43.5-52.5,64.5-73.5	5.9	Barakar	Sandstone, Shale with Coal bed
Durti	Prata ppur	83.05	23.4	212.6	105	Barakar Fm	40-46,56-70,79-80,86-105	2.4	Barakar	Sandstone, Shale with Coal bed
Kenapara	Surajpur	83	23.1667	104	100	Barakar Fm	40-50,65-70,92-98	0.47	Barakar	Sandstone, Shale with Coal bed
Tara	Premnagar	82.7333	22.8333	323.59	147	Barakar Fm	14-16,45-60,68-76,90-105,116-147	3.5	Barakar	Sandstone, Shale with Coal bed
Bhubaneswarpur	Ramanujnagar	82.7364	23.1692	300	120	Talchir Fm	14-16,106-111,121-125,138-144		Barakar	Sandstone, Shale with Coal bed
Kalyanpur	Surajpur	83.1973	23.2309	222	127	Barakar Fm	30-42, 49-57,66-111,119-124	3.68	Barakar	Sandstone, Shale with Coal bed
Bansipur	Bhaiyathan	83.0253	23.3872	150	150	Barakar Fm	14-16, 30		Barakar	Sandstone, Shale with Coal bed
Ajabnagar	Surajpur	83.1194	23.1417	117.64	98	0-101.66 Barakar Fm 101.66-117.64 Talchir	71-76,87-95	3.25	Barakar	Sandstone, Shale with Coal bed
Ajabnagar OW	Surajpur	83.1194	23.1417	59.3	58	Barakar Fm	35-41, 47-56	1.77	Barakar	Sandstone, Shale with Coal bed
Datima	Surajpur	82.9667	23.2625	196.05	163	Barakar Fm.	72-82,86-96,118-122,125-129,132-140,150-160	1.16	Barakar	Sandstone, Shale with Coal bed
Datima OW	Surajpur	82.9667	23.2625	67.09	67	Barakar Fm	31-35.5,40		Barakar	Sandstone, Shale with Coal bed
Reonti	Prata ppur	83.1847	23.6458	296.2	229	Barakar Fm	47-50,68-71,100-105,114-116,127-137,140-142,143-150,159-162,165-171,174-180,188-204,216-226	4.04	Barakar	Sandstone, Shale with Coal bed
Latori	Surajpur	83.0989	23.2142	272.08	155	Barakar Fm	75-94,129-140,157-176,193-196,207-213,263-270	7.4	Barakar	Sandstone, Shale with Coal bed
Brij Nagar	Prata ppur	83.0983	23.3678	246	232	Barakar Fm	70-82,90-116,123-141,147-153,164-180,190-198,219-229	8.7	Barakar	Sandstone, Shale with Coal bed
Chhatirama	Surajpur	83.1333	23.1833	60.02	35	0-55.25 Barakar Fm. 55.25-60.02 Talchir Fm.	23-32,55.25-60.02	1.1	Barakar	Sandstone, Shale with Coal bed
Kewara	Prata ppur	83.1	23.4306	118	75	Barakar Fm	49-55,57-61,63-73	0.78	Barakar	Sandstone, Shale with Coal bed
Kewara OW	Prata ppur	83.1	23.4306	62.83	60	Barakar Fm	16-18, 37-58	1.37	Barakar	Sandstone, Shale with Coal bed
Silfili	Surajpur	83.0833	23.1667	200.25	134	0-198 Barakar Fm198-200.25 Talchir	57-66,75-93,97-106,122-131	3.6	Barakar	Sandstone, Shale with Coal bed
Silfili OW	Surajpur	83.0833	23.1667	140.08	134	Barakar Fm	51-54,57-66,75-93,97-106,122-131	2.12	Barakar	Sandstone, Shale with Coal bed

Shivanandanpur	Surajpur	82.9333	23.1833	211.76	80	0-211.66 Barakar Fm211.66-211.76 Talchir Boulder bed	50-77	2.95	Barakar	Sandstone, Shale with Coal bed
Keshkela	Surajpur	83.005	23.2417	301.69	223	Barakar Fm	74-92, 99-114,117-140,157-175,179-194,200-205,216-220	5.9	Barakar	Sandstone, Shale with Coal bed
Keshkela OW	Surajpur	83.005	23.2417	301.69	223		14-16,70-92,99-116,117-140,	15	Barakar	Sandstone, Shale with Coal bed
Latori OW	Surajpur	83.0989	23.2142	160.78	157	Barakar Fm	60-72,82-92,100-106,136-148,151-155	5.17	Barakar	Sandstone, Shale with Coal bed
Songara	Pratappur	83.0875	23.3083	151.21	101	Barakar Fm	47-50,54-60,63-66,70-79,82-88,95-98	2.45	Barakar	Sandstone, Shale with Coal bed
Songara OW	Pratappur	83.0875	23.3083	105.85	101	Barakar Fm	45-50,54-60,63-66,70-79,82-88,95-98	3	Barakar	Sandstone, Shale with Coal bed
Telgawan	Bhaiyathan	82.9917	23.2833	121.29	101	0-100.64 Baraker100.64-121.29 TalchirBoulder bed	40-49,55-67,73-89,92-98	1.5	Barakar	Sandstone, Shale with Coal bed
Khopa	Bhaiyathan	82.9172	23.3178	117.92	12.06	Fractured granite	15-21,37	3	Chhotanagpur Gneissic Complex	Gneissic Complex
Vakirma	Premnagar	82.645	22.9819	119.31	30.02	Shale	45-130	1	Talchir	Tillite, Sandstone, Siltstone and Bou
Badsara	Bhaiyathan	82.7681	23.3436	126.82	22.49	Shale	14-16,35	0.5	Barakar	Sandstone, Shale with Coal bed
Odigi	Odgi	82.8169	23.4762	140.8	9.7	Fractured granite	16-18, 30	0.5	Barakar	Sandstone, Shale with Coal bed
Palma	Bhaiyathan	83.0086	23.4281	113.59	24.1	Fractured granite	18-20, 42.42.2-53.5-54,71.2-71.5	5.59	Chhotanagpur Gneissic Complex	Gneissic Complex
Shivprasad Nagar	Bhaiyathan	82.7844	23.3078	109.87	21.23	Shale	14-16, 20-21	0.5	Talchir	Tillite, Sandstone, Siltstone and Bou
Premangar	Premnagar	82.7039	22.9531	96.9	21.82	Weathered granite	21-23,30	3.26	BRA Belt	Undifferentiated metasedimentaries/Un
Bhaiyathan	Bhaiyathan	82.8522	23.3897	127.65	22.95	Granite	14-18, 63-63.50, 125-126	1.2	Chhotanagpur Gneissic Complex	Gneissic Complex
Shivnagar	Premnagar	82.7806	22.875	100	87	Barakar Fm.	36-54,66-84	4.55	Barakar	Sandstone, Shale with Coal bed
Latori	Surajpur	83.0995	23.2136	153	31.25	Chhota Nagpur Granite Gneiss.	16-18, 69.4-70.4		Barakar	Sandstone, Shale with Coal bed
Kewara	Bhaiyathan	82.8083	23.3774	166	14.5	Sandstone	25.80-28.80, 80.70-83.70, 147.70-150.70	9.8	Talchir	Sandstone, Siltstone
Inderpur	Odgi	82.7662	23.4806	202.7	12.5	Consolidated Sandstone			Panchet	Sandstone
Pal Danauli	Odgi	82.8060	23.4950	202.7	30.5	Sandstone	99-102, 114.20-117.30	3.2	Panchet	Sandstone

Annexure 3 Details of Chemical Analysis

Sl. no.	District	Block	Location	Long	Lat	Ph	EC	CO3	HCO3	Cl	No3	SO4	F	TH	Ca	Mg	Na	K	Si	Po4	Cr	Mn	Fe	Ni	Cu	67Zn (KED)	70Zn (KED)	As	Se	Ag	Cd	Pb	U
846	Surajpur	Premnagar	Katarouli (Harrapara)	82.5557	22.9097	7.21	138	0	24.4	10.5	34.21	4.87	0.00	55	12	6	2.2	6.9	8.77	0.0	<0.0005	<0.03	<0.1	<0.0002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	<1
847	Surajpur	Premnagar	Abhaypur	82.7347	23.2487 2	8.2	183	0	54.9	24.5	6.42	6.12	0.00	65	16	6	8.3	2.4	5.93	0.0	<0.0005	0.03	<0.1	<0.0002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	<1
848	Surajpur	Pratappur	Banshipur	82.7302 8	23.5854	8.11	148	0	36.6	14	8.06	9.21	0.00	50	12	4.8	7.3	3.5	8.51	0.1	<0.0005	<0.03	<0.1	<0.0002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	<1
849	Surajpur	Pratappur	Bhediya	83.1566	23.4028 7	8.11	411	0	195.2	21	0.28	15.69	0.63	160	34	18	13.7	7.4	16.07	0.0	<0.0005	0.21	<0.1	<0.0002	<0.15	<0.5	<0.5	1.01	<1	<1	<1	<1	<1
850	Surajpur	Bhaiyathan	Dalabahara(Bhaskar)	82.6861 8	23.4071 2	7.76	392	0	201.3	10.5	2.17	10.2	0.39	140	26	18	24.1	0.9	9.17	0.1	<0.0005	0.18	11.47	<0.0002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	<1
851	Surajpur	Pratappur	Dawankera	82.9133 9	82.6528 2	8.01	331	0	91.5	28	33.41	17.07	0.20	130	28	14.4	12.9	3.4	21.81	0.1	<0.0005	<0.03	<0.1	<0.0002	<0.15	1.47	1.31	<1	<1	<1	<1	1.82	<1
852	Surajpur	Bhaiyathan	Khandapara	23.3542 6	23.1894 5	8.05	82	0	24.4	10.5	3.95	4.77	0.00	35	10	2.4	2.1	2.5	10.34	0.0	<0.0005	0.02	<0.1	<0.0002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	<1
853	Surajpur	Surajpur	Narayanpur	82.6353	23.3957 3	8.03	177	0	36.6	17.5	31.91	2.2	0.00	55	12	6	6.8	10.8	13.24	0.0	<0.0005	<0.03	1.38	0.03	<0.15	<0.5	<0.5	<1	<1	<1	<1	1.51	<1
854	Surajpur	Pratappur	Podi	83.6237 2	82.3672 7	7.87	181	0	48.8	21	17.55	6.05	0.05	50	14	3.6	15.9	0.9	27.04	0.1	<0.0005	<0.03	<0.1	<0.0002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	<1
855	Surajpur	Surajpur	Surajpur	23.1775 1	23.285	7.72	402	0	122	42	26.8	8.46	0.00	170	52	9.6	9.8	2.0	27.04	0.0	<0.0005	<0.03	<0.1	<0.0002	<0.15	<0.5	<0.5	<1	<1	<1	<1	1.26	<1
856	Surajpur	Pratappur	Dwarikanagar	83.1885	23.2439	8.05	129	0	48.8	7	13.24	4.55	0.00	50	10	6	5.3	3.6	8.96	0.0	<0.0005	<0.03	<0.1	<0.0002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	<1
857	Surajpur	Surajpur	Krishnapur(kalwa)	82.8233	23.4244 2	8	740	0	189.1	98	2.76	70.26	0.00	140	44	7.2	95.4	2.1	10.81	0.0	<0.0005	0.07	0.12	<0.0002	<0.15	0.52	<0.5	<1	<1	<1	<1	<1	<1
858	Surajpur	Bhaiyathan	Samouli(Bhayathan)	82.7652 1	22.8815	8.12	684	0	189.1	73.5	69.74	24.89	0.00	225	68	13.2	38.5	2.6	22.33	0.0	<0.0005	0.10	2.49	<0.0002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	<1

859	Surajpur	Premnagar	Shivnagar	82.7882	23.33444	8.03	81	0	18.3	7	9.48	3.5	0.00	25	6	2.4	2.4	6.5	13.98	0.0	<0.0005	<0.03	<0.1	<0.0002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	<1
860	Surajpur	Surajpur	Badsara	82.7708 3	23.2721	7.911	908	0	237.9	133	18.07	44.69	0.002	220	70	10.8	92.6	4.9	12.17	0.0	<0.0005	<0.03	<0.1	<0.0002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	<1
861	Surajpur	Surajpur	Biharpur	82.921	23.185	8.06	444	0	91.5	42	79.58	25.33	0.000	160	52	7.2	16.9	11.0	10.84	0.0	<0.0005	<0.03	<0.1	<0.0002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	<1
862	Surajpur	Surajpur	Bishrampur	82.9883 3	23.5111 1	8.05	427	0	97.6	56	47.37	15.22	0.000	165	44	13.2	20.9	2.0	22.83	0.0	<0.0005	<0.03	<0.1	<0.0002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	<1
863	Surajpur	Pratappur	Chandora	83.1569 4	23.4421	7.76	474	0	109.8	49	46.22	22.95	0.28	190	40	21.6	22.0	1.1	29.28	0.0	<0.0005	<0.03	0.13	<0.0002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	<1
864	Surajpur	Pratappur	Darhora	82.8346	23.24	7.89	308	0	122	28	8.28	5.44	0.000	135	36	10.8	6.2	2.4	12.83	0.0	<0.0005	0.06	<0.1	<0.0002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	<1
865	Surajpur	Surajpur	Deonagar	82.8033 3	23.025	8.11	389	0	122	63	0.31	3.85	0.20	130	32	12	36.2	0.9	18	0.0	<0.0005	<0.03	0.16	<0.0002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	<1
866	Surajpur	Premnagar	Fulkona	82.6672	23.0805 6	8.06	690	0	170.8	91	23.55	12.76	0.35	205	44	22.8	53.5	1.0	16.33	0.0	<0.0005	0.32	4.57	<0.0002	<0.15	0.75	0.64	<1	<1	<1	<1	<1	<1
867	Surajpur	Ramanujnagar	Ganeshpur	82.6352 8	23.4291 7	7.78	95	0	30.5	7	13.68	3.5	0.00	30	8	2.4	4.7	4.2	11.01	0.1	<0.0005	0.17	0.22	<0.0002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	3.95
868	Surajpur	Pratappur	Gonda	83.0583 3	23.0629	8.01	490	0	213.5	24.5	17.39	10.52	1.00	165	48	10.8	35.9	0.7	14.67	0.0	<0.0005	<0.03	1.49	<0.0002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	<1
869	Surajpur	Premnagar	Hanumangarh	82.6476	23.3786 1	8.06	360	0	176.9	21	4.71	9.74	0.34	150	46	8.4	12.6	6.0	9.66	0.0	<0.0005	<0.03	<0.1	<0.0002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	<1
870	Surajpur	Pratappur	Jagannathpur	83.195	23.2472 2	7.75	165	0	48.8	14	18.77	5.07	0.000	65	14	7.2	4.1	5.6	9.45	0.0	<0.0005	<0.03	0.13	<0.0002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	<1
871	Surajpur	Surajpur	Kaliyanpur	83.2	23.1869	7.21	212	0	30.5	28	45.74	3.73	0.000	80	22	6	10.4	5.1	11.71	0.0	<0.0005	<0.03	0.19	<0.0002	<0.15	<0.5	<0.5	<1	<1	<1	<1	1.01	<1
872	Surajpur	Surajpur	Kanakpur	83.0555	23.1482	8.05	82	0	24.4	7	9.61	3.26	0.000	25	6	2.4	4.3	1.6	12.15	0.0	<0.0005	<0.03	<0.1	<0.0002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	<1
873	Surajpur	Surajpur	Majeera	82.9514	23.4833 3	8.21	326	0	97.6	21	30.1	11.37	0.000	115	36	6	19.4	1.4	20.25	0.0	<0.0005	0.24	<0.1	<0.0002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	<1

874	Surajpur	Pratappur	Pratappur	83.2027	22.9666	7.82	490	0	213.5	10.5	26.35	14.21	0.18	190	54	13.2	21.6	0.5	28.27	0.0	<0.005	<0.03	<0.1	<0.002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	<1
875	Surajpur	Premnagar	Premnagar	82.6958	23.15	8.02	556	0	195.2	66.5	0.83	14.71	0.04	200	56	14.4	31.0	0.7	16.83	0.0	<0.005	<0.03	<0.1	<0.002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	<1
876	Surajpur	Ramanujnagar	Ramanujnagar	82.725	23.6478	7.76	193	0	67.1	14	19.39	5.19	0.00	70	18	6	5.9	2.6	13	0.0	<0.005	0.19	5.66	<0.002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	<1
877	Surajpur	Pratappur	Reonti	83.1763	23.3527	7.21	248	0	91.5	14	21.42	8.89	0.01	90	30	3.6	12.3	0.6	19.94	0.1	<0.005	0.07	<0.1	<0.002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	<1
878	Surajpur	Surajpur	Sirsi	82.8630	23.3	8.02	120	0	30.5	10.5	24.54	3.26	0.00	45	10	4.8	6.0	4.9	13.69	0.1	<0.005	<0.03	0.20	<0.002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	<1
879	Surajpur	Pratappur	Songara	83.0791	23.2982	7.99	546	0	134.2	87.5	0	31.85	1.888	145	46	7.2	60.8	5.5	8.51	0.0	<0.005	<0.03	<0.1	<0.002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	<1
880	Surajpur	Surajpur	Newara	82.5715	21.1920	7.88	278	0	48.8	21	60.21	5.71	0.85	90	20	9.6	9.4	18.0	9.34	0.0	<0.005	0.05	0.25	<0.002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	<1
881	Surajpur	Premnagar	Tara1	81.7198	23.1996	7.33	647	0	213.5	66.5	2.13	36.1	1.455	190	50	15.6	58.0	2.3	16.31	0.0	<0.005	<0.03	<0.1	<0.002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	<1
882	Surajpur	Bhaiyathan	Satipara(Bhaingamunda)	82.6073	23.6423	7.97	217	0	85.4	14	15.69	5.65	1.09	85	22	7.2	10.9	1.6	10.51	0.0	<0.005	0.58	<0.1	<0.002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	<1
883	Surajpur	Pratappur	Dhondha	83.1754	23.1632	7.75	182	0	24.4	21	33.81	5.2	0.83	55	18	2.4	11.2	11.4	13.95	0.0	<0.005	<0.03	<0.1	<0.002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	<1
884	Surajpur	Surajpur	Madanpur	83.0906	23.1617	7.74	208	0	54.9	24.5	19.27	7.87	0.83	75	16	8.4	11.3	7.7	13.93	0.0	<0.005	0.03	<0.1	<0.002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	<1
885	Surajpur	Pratappur	Dharampur	83.1985	23.3867	7.87	123	0	36.6	10.5	11.95	3.61	0.81	50	10	6	3.7	5.2	13.93	0.0	<0.005	<0.03	<0.1	<0.002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	<1
886	Surajpur	Pratappur	Durti	83.0314	23.1083	7.81	102	0	24.4	7	18.46	3.09	0.82	45	12	3.6	2.4	3.1	10.21	0.0	<0.005	<0.03	<0.1	<0.002	<0.15	<0.5	<0.5	<1	<1	<1	<1	<1	<1

SOME GLIMPSES OF FIELD WORK DURING NAQUIM STUDY IN THE DISTRICT

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