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

केन्द्रीय भूमि जल बोर्ड

Central Ground Water Board

धमतरी जिला, छत्तीसगढ़ के जलभृत मानचित्रण एवं भूजल प्रबंधन योजना

Aquifer Mapping and Ground Water Management Plan of Dhamtari District, Chhattisgarh

केन्द्रीय भूमि जल बोर्ड

उत्तर मध्य छत्तीसगढ़ क्षेत्र

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FOREWORD

Groundwater resources are being developed over years in order to meet domestic, irrigation and industrial requirements. The spatial distribution of availability of groundwater 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 groundwater 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 groundwater resources of Chhattisgarh. Based on this experience aquifer mapping of Dhamtari district was prepared with the vast amount of data generated and available with North Central Chhattisgarh Region. The report embodies all the features of groundwater and related aspects of the study area including physiography, meteorological conditions, hydrology, drainage, geomorphology, geology, hydrogeology, groundwater resources, geophysics, groundwater problems etc.

The report titled "AQUIFER MAPPING AND GROUNDWATER MANAGEMENT PLAN OF DHAMTARI DISTRICT, CHHATTISGARH" is prepared by Shri Sudeepta Sundar Parida, Assistant Hydrogeologist under supervision of Mrs. Prachi Gupta, Scientist-C. 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 Dhamtari district and would be a useful document for academicians, administrators, planners and all the stakeholders in groundwater.

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 Kumar Naik
(REGIONAL DIRECTOR)

कार्यकारी सारांश

जलभृत मानचित्रण एक बहुआयामी वैज्ञानिक प्रक्रिया है जिसमें जलभृतों में भूजल की मात्रा, गुणवत्ता और संचलन को चिह्नित करने के लिए भूवैज्ञानिक, जल विज्ञान, भूभौतिकीय, जल विज्ञान और गुणवत्ता डेटा के संयोजन को एकीकृत किया जाता है। हालांकि, पिछले एक दशक में विकास से भूजल के प्रबंधन पर ध्यान केंद्रित करने के प्रतिमान 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 वॉल्यूमेट्रिक मूल्यांकन और भविष्य के विकास और प्रबंधन के लिए रणनीतियाँ जलभृत मानचित्रण के प्राथमिक उद्देश्य हैं।

जलभृत मानचित्रण कार्यक्रम के तहत, धमतरी जिले के सभी विकास खंडों अर्थात् धमतरी, कुरुद, मगरलोड और नागरी को 4082 वर्ग किमी के क्षेत्र में अध्ययन के लिए लिया गया था। धमतरी जिला छत्तीसगढ़ राज्य के दक्षिणी भाग में स्थित है। यह देशांतर 81°24'43" E और 82°10'29" E और अक्षांशों से 20°02'45" N और 21°01'33" N डिग्री शीट संख्या 64, G(12) में गिरता है। 64 जी (12,16), एच (5,6,9,10,11,13,14,15,16) और एल (2,3,4)। धमतरी उत्तर और पूर्व में रायपुर जिले से, उत्तर-पश्चिम में दुर्ग जिले से, दक्षिण-पश्चिम में कांकेर के साथ-साथ बस्तर और दक्षिण में ओडिशा राज्य के हिस्से से घिरा हुआ है (चित्र 1)। जिले को 3 नं में विभाजित किया गया है। तहसीलों की संख्या 4 नं. सामुदायिक विकास खंड और 653 नं। राजस्व गांवों की ब्लॉक मुख्यालय धमतरी, कुरुद, मगरलोड और नगरी हैं। जिला मुख्य रूप से अपने चावल उत्पादन और वन उपज के लिए जाना जाता है। जिले के भीतर सभी महत्वपूर्ण स्थान राज्य राजमार्गों और अन्य सभी सड़कों के नेटवर्क से अच्छी तरह से जुड़े हुए हैं।

2011 की जनगणना के अनुसार अध्ययन क्षेत्र की कुल जनसंख्या 7,99,781 है, जिसमें ग्रामीण जनसंख्या 6,50,586 (81.35%) तथा शेष शहरी जनसंख्या 149,195 (18.65%) है।

अध्ययन क्षेत्र उपोष्णकटिबंधीय आर्द्र और शुष्क जलवायु का अनुभव करता है; मार्च से जून को छोड़कर, जो अत्यधिक गर्म हो सकता है, पूरे वर्ष तापमान मध्यम रहता है। अध्ययन क्षेत्र में औसत वार्षिक वर्षा लगभग 1208.86 मिमी है। (पिछले दस वर्षों का औसत अर्थात 2011-12 से 2020-21)

जिले में विकसित मुख्य भू-आकृतिक विशेषताएं और भू-आकृतियाँ हैं पेडीप्लेन, पेडिमेंट्स, अवशिष्ट पहाड़ियाँ, संरचनात्मक पहाड़ियाँ और बाढ़ के मैदान जिनकी ऊँचाई 297 से 748 amsl तक है।

शुद्ध बोया गया क्षेत्र 1,42,641 हेक्टेयर है। शुद्ध सिंचित फसल क्षेत्र 1,63,934 हेक्टेयर है, जबकि भूजल सिंचाई के तहत क्षेत्र 56,109 हेक्टेयर है जो शुद्ध सिंचित क्षेत्र का लगभग 39.70% है।

शुद्ध सिंचित फसल क्षेत्र 1,63,934 हेक्टेयर है, जबकि भूजल सिंचाई के तहत क्षेत्र 56,109 हेक्टेयर है जो शुद्ध सिंचित क्षेत्र का लगभग 39.70% है। ब्लॉकों के लिए उत्पन्न खोजपूर्ण ड्रिलिंग डेटा के आधार पर, क्षेत्र में मौजूदा जलभृत प्रणाली हो सकती है दो में बांटा गया है, अर्थात् अग्निमय और गहरा खंडित जलभृत। अध्ययन क्षेत्र में मौजूद प्रमुख जलभृतों में छत्तीसगढ़ सुपर ग्रुप के बलुआ पत्थर, शेल, चूना पत्थर, चंद्रपुर समूह के बलुआ पत्थर, शेल, कांग्लोमरेट और डोंगरगढ़ सुपर समूह के ग्रेनाइट और गनीस हैं। खंडित जलभृत में निर्वहन नगण्य से 11 एलपीएस और अपक्षय जलभृत में 10 से 100 घन मीटर/दिन तक भिन्न होता है। उच्च पैदावार प्राप्त की जाती है जहां मोटे अपक्षय वाले क्षेत्र बेडरॉक फ्रैक्चरिंग, जोड़ों और संरचनाओं के बीच संपर्क क्षेत्रों से जुड़े होते हैं।

2022 के अनुसार अध्ययन क्षेत्र में भूजल विकास का भूजल संसाधन गणना चरण 80.22% है। इसलिए, भविष्य के सिंचाई उद्देश्यों और अन्य उद्देश्यों के लिए अधिक भूजल का उपयोग करने की सीमित गुंजाइश है। वर्षा जल संचयन और कृत्रिम पुनर्भरण संरचनाओं के साथ भूजल संसाधनों के प्रभावी उपयोग के लिए अतिरिक्त संख्या में भूजल अवशोषण संरचनाएं विकसित की जा सकती हैं।

क्षेत्र में सिंचाई की मौजूदा मांग 32298.86 हैम है जबकि घरेलू उपयोग के लिए 2068.02 हैम और औद्योगिक क्षेत्र के लिए 13.94 हैम है। भूजल की भविष्य की मांग को पूरा करने के लिए कुल 10199.85 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 के अंतर्निहित हाइड्रोजियोलॉजिकल चरित्र, (iii) उच्च फ्लोराइड सांद्रता, (iv) नाइट्रेट संदूषण और (v) उच्च टीडीएस।

अध्ययन क्षेत्र में जटिल हाइड्रोजियोलॉजिकल परिस्थितियों के कारण जमीन की उपलब्धता बिखरी हुई है। जिन क्षेत्रों में भूजल की उपलब्धता सीमित है, सतही जल का संरक्षण और उपयोग किया जा सकता है। कई स्थानों से टीडीएस, फ्लोराइड और नाइट्रेट के उच्च मूल्य की सूचना मिली है। बलुआ पत्थर, ग्रेनाइट, शेल जलभृत प्रणाली में कई स्थानों पर भूजल भूगर्भीय कारणों से फ्लोराइड से दूषित होता है। पीने के पानी में फ्लोराइड संदूषण की समस्या का समाधान प्रभावित गांवों में छोटी फ्लोराइडीकरण इकाइयों की स्थापना करके किया जा सकता है या

वैकल्पिक स्रोत की पहचान की जा सकती है। इसी प्रकार, नियमित भूजल गुणवत्ता निगरानी भी आवश्यक 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 और फसल रोटेशन प्रणाली के साथ जोड़ा जा सकता है। सिंचाई पैटर्न में बदलाव, उपलब्ध संसाधनों का इष्टतम उपयोग, कृत्रिम पुनर्भरण के बाद निर्मित भूजल क्षमता के उपयोग से भूजल की बचत और जिले के सकल फसली क्षेत्र में वृद्धि हो सकती है। भूजल पुनर्भरण और सिंचाई के लिए पानी के उपयोग के लिए गांवों में तालाबों और तालाबों के जीर्णोद्धार और जीर्णोद्धार को प्रोत्साहित किया जाना चाहिए जिससे भूजल पर निर्भरता कम होगी। चावल और गन्ने जैसी जल सघन फसलों के स्थान पर बाजरा, रागी, मक्का, रोपण फसलों, फलों, सब्जियों जैसी उच्च मूल्य वाली फसलों की खेती की जानी चाहिए।

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 groundwater in aquifers. However, due to paradigm shift in focus from development to management of groundwater 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 groundwater resources at local scale. Volumetric assessment of groundwater and strategies for future development and management are the primary objectives of aquifer mapping.

Under the aquifer mapping Programme, all the development blocks of Dhamtari district namely Dhamtari, Kurud, Magarlod and Nagri were taken up for study covering an area of 4082 sq. km. Dhamtari district is located in the southern part of Chhattisgarh state. It is bounded by longitudes 81°24'43" E & 82°10'29" E and by latitudes 20°02'45" N & 21°01'33" N falling in the Degree sheet No. 64, G(12,16), H(5,6,9,10,11,13,14,15,16) and L(2,3,4). Dhamtari district is surrounded by Raipur district in North & East, Durg district in North-West, Kanker as well as Bastar districts in South-West and part of Odisha state in the South (Fig.1). The district is divided into 3 no. of tehsils, 4 no. of Community Development blocks and 653 no. of revenue villages. The block headquarters are Dhamtari, Kurud, Magarlod and Nagri. The district is known mainly for its rice production and forest produce. The district is well connected by all weathered roads.

The total population of the study area as per 2011 Census is 7,99,781 out of which rural population is 6,50,586 (81.35%) and remaining is urban population of 1,49,195 (18.65 %).

The study area experiences sub-tropical wet and dry climate; temperatures remain moderate throughout the year, except from March to June, which can be extremely hot. The average annual rainfall for the study area is around 1208.86 mm. (Average of the last ten years i.e. 2011-12 to 2020-21)

The main geomorphological features and landforms developed in the district are pediplains, pediments, residual hills, structural hills and flood plains with an elevation ranging from 297 to 748 amsl.

The net sown area is 1,42,641 Ha. The net irrigated cropped area is 1,63,934 Ha, while the area under groundwater irrigation is 56,109 Ha which is about 39.70 % of net irrigated area.

Based on the exploratory drilling data generated for the blocks, the existing aquifer systems in the area may be divided into two namely phreatic and deeper fractured aquifer. The major aquifers present in the study area is Sandstone, Shale, Limestone of the Chhattisgarh Super Group, Sandstone, Shale, Conglomerate of Chandrapur Group and Granite and Gneisses of Dongargarh Super Group. Discharge varies from negligible to 11 lps in fractured aquifer and 10 to 100 m^3/day in weathered aquifer. Higher yields are obtained where thick weathered zones are associated with bedrock fracturing, joints and contact zones between formations.

As per 2022 groundwater resource calculation stage of groundwater development in the study area is 80.22 %. So, there is limited scope of utilizing more groundwater for future irrigation purpose and other purposes. Additional number of groundwater abstraction structure may be developed for the effective utilization of groundwater resources with rain water harvesting and artificial recharge structures.

The existing demand for irrigation in the area is 32298.86 Ham while the same for domestic use is 2068.02 Ham and for industrial field is 13.94 Ham. To meet the future demand for groundwater, a total quantity of 10199.85 Ham of groundwater is available for future use.

The major groundwater 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) High Fluoride concentration, (iv) Nitrate contamination and (v) High TDS.

In study area because of complex hydrogeological conditions ground availability is scattered. In area where groundwater availability is limited, surface water may be conserved and utilized. High value of TDS, fluoride and nitrate has been reported from several locations. In sandstone, granite, shale aquifer system at many places groundwater is contaminated with fluoride because of geogenic reasons. The problem of fluoride contamination in drinking water may be tackled by setting up of small defluordination units in affected villages or

alternate source may be identified. Similarly, Regular groundwater quality monitoring is also required.

So far as management strategies are concerned for groundwater availability, for effective utilization of groundwater existing draft for irrigation may be coupled with micro-irrigation system and crop rotation system. Change in irrigation pattern, optimum use of available resource, use of groundwater potential created after artificial recharge can lead to groundwater savings and increase in gross cropped area of the district. Desiltation and rejuvenation of ponds and percolation tanks in villages should be encouraged for groundwater recharge and utilization of water for irrigation which will thereby reduce the dependency on groundwater. Farming of high value crops like millets, ragi, maize, plantation crops, fruits, vegetables should be practiced instead of water intensive crops like rice and sugarcane.

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AQUIFER MAPPING AND GROUNDWATER MANAGEMENT PLAN, DHAMTARI DISTRICT, CHHATTISGARH

(04 BLOCKS- DHAMTARI, KURUD, MAGARLOD & NAGRI)

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ABBREVIATIONS

a msl	above mean sea level
BDR	Basic Data Report
BW	Borewell
CGWB	Central Ground Water Board
Dia	Diameter
DTW	Depth to Waterlevel
DW	Dugwell
EC	Electrical Conductivity
EW	Exploratory Wells
GS	Gabion structures
GW/ gw	Groundwater
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

Groundwater is the most valuable resource for the country. However, due to rapid and uneven development, this resource has come under stress in several parts of the country. Central Ground Water Board (CGWB) is, therefore, involved in hydrogeological investigations for the re-appraisal of groundwater regime. CGWB has also carried out groundwater 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 groundwater 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 groundwater resources at local scale.

1.2 Scope of study

The demand for groundwater for various types of use is increasing day by day; consequently, indiscriminate development of groundwater has taken place and the groundwater resource has come under stress in several parts of the country. On the other hand, there are also areas where adequate development of groundwater 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 groundwater in aquifers. It primarily depends on the existing data that are assembled, analyzed and interpreted from available sources. The data gap analysis helped to generate data 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.

The groundwater management plan includes groundwater recharge, conservation, harvesting, development options and other protocols of managing groundwater. These protocols will be the real derivatives of the aquifer mapping exercise and will find a place in the output i.e, the aquifer mapping and management plan. The main activities under NAQUIM are as follows:

a) Identifying the aquifer geometry

b) Aquifer characteristics and their yield potential

c) Quality of water occurring at various depths

d) Assessment of groundwater resources

e) Preparation of aquifer maps and

f) Formulate groundwater management plan

The demarcation of aquifers and their potential will help the agencies involved in water supply in ascertaining, how much volume of water is under their control. The robust and implementable groundwater management plan will provide a "Road Map" to systematically manage the groundwater resources for equitable distribution across the spectrum.

1.3 Approach and Methodology

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

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

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

ii) Aquifer map preparation: On the basis of integration of data generated through various hydrogeological and geophysical studies, aquifers have been delineated and characterized in terms of quality and potential. Various maps have been prepared bringing out the Characterization of Aquifers. These maps may be termed as Aquifer Maps depicting spatial (lateral and vertical) variation of the aquifers existing within the study area, quality, water level and vulnerability (quality and quantity).

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

1.4 Area Details

Under the aquifer mapping Programme, an area comprising of 4 no of blocks of Dhamtari district was taken up covering an area of 4082 sq. km. Dhamtari district is situated in the fertile plains of Chhattisgarh Region. It is located in the southern part of

the Chhattisgarh state. It is bounded by longitudes 81°24'43" E & 82°10'29" E and by latitudes 20°02'45" & 21°01'33" N falling in the Degree sheet No. 64, G(12,16), H(5,6,9,10,11,13,14,15,16) and L(2,3,4). Dhamtari is surrounded by Raipur district in North & East, Durg district in North-West, Kanker as well as Bastar in South-West and part of Odisha state in the South (Fig-1). For the convenience of administration, the district is divided into 3 no. of tehsils, 4 no. of Community Development blocks and 653 no. of revenue villages. The block headquarters are Dhamtari, Kurud, Magarlod and Nagri. The district is known mainly for its rice production and forest produce. The district is well connected by all weathered roads.

The Dhamtari town which is the district headquarter is covered by Municipal Corporation. According to the 2011 census, the total population of the district is 7,99,781 out of which rural population is 6,50,586 (81.35%) and remaining is urban population of 1,49,195 (18.65%). The decadal growth of population is 13.19%.

1.4.1 Administrative Division

For administrative convenience, the district is divided into 4 blocks, 370 grampanchayats, 653 villages and 5 nagar panchayats and 1 municipal corporation.

The name of the 4 blocks are given below.

1. Dhamtari
2. Kurud
3. Magarlod
4. Nagri

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

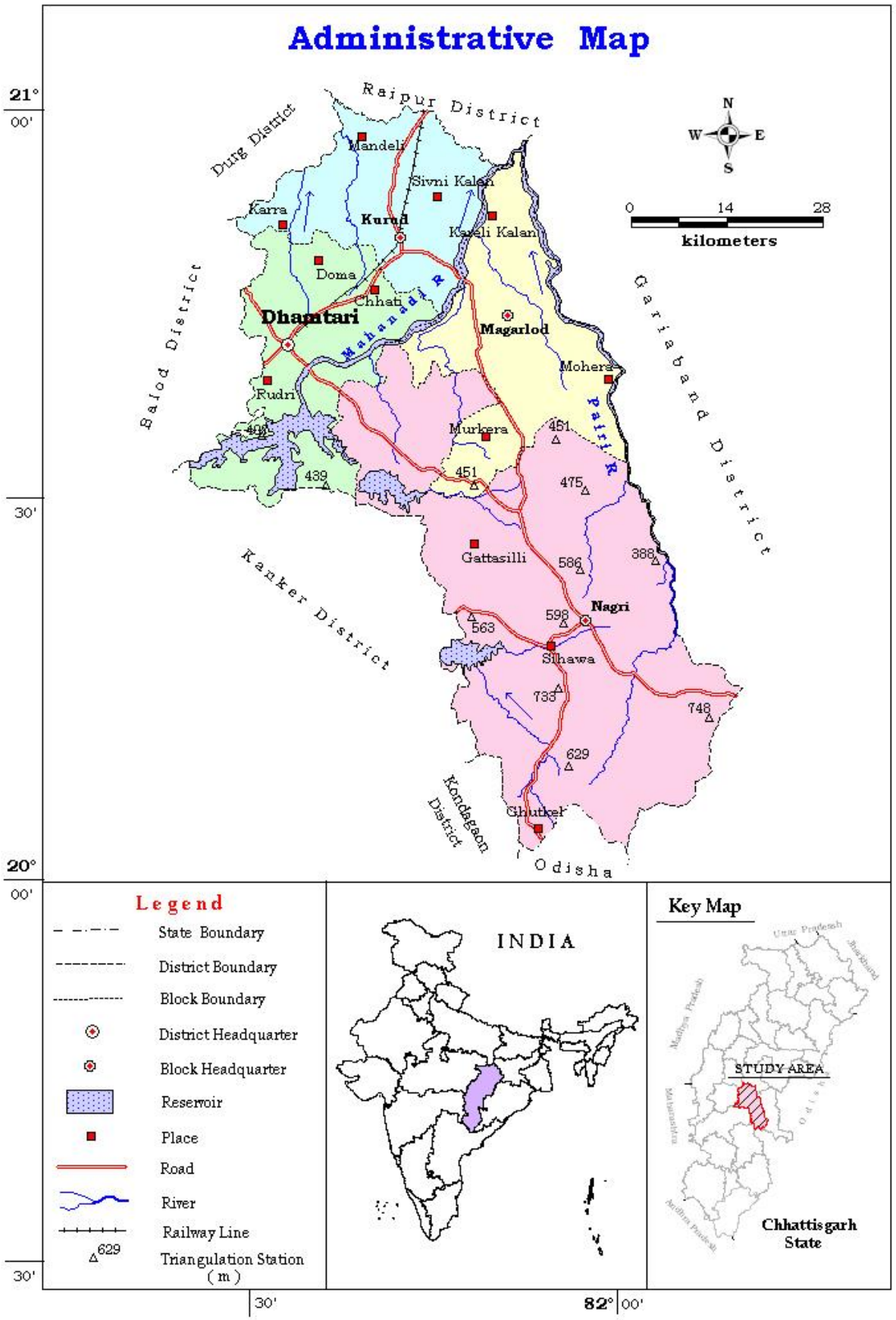


Figure 1 Administrative Map of Dhamtari District

1.5 Data Availability, Data Adequacy and Data gap Analysis

Table 1 Data Integration

District	Blocks	Existing				Data Generation			
		EW& OW	**Chem**	**VES**	**WL**	**EW & OW**	**Chem**	**VES**	**WL**
Dhamtari	Dhamtari	33	6	78	29	-	-	-	-
	Kurud	30	9	2	29	-	-	-	-
	Magarlod	13	5	12	8	-	19	-	19
	Nagri	21	14	4	22	-	20	-	20
TOTAL		**97**	**34**	**96**	**88**	**-**	**39**	**-**	**39**

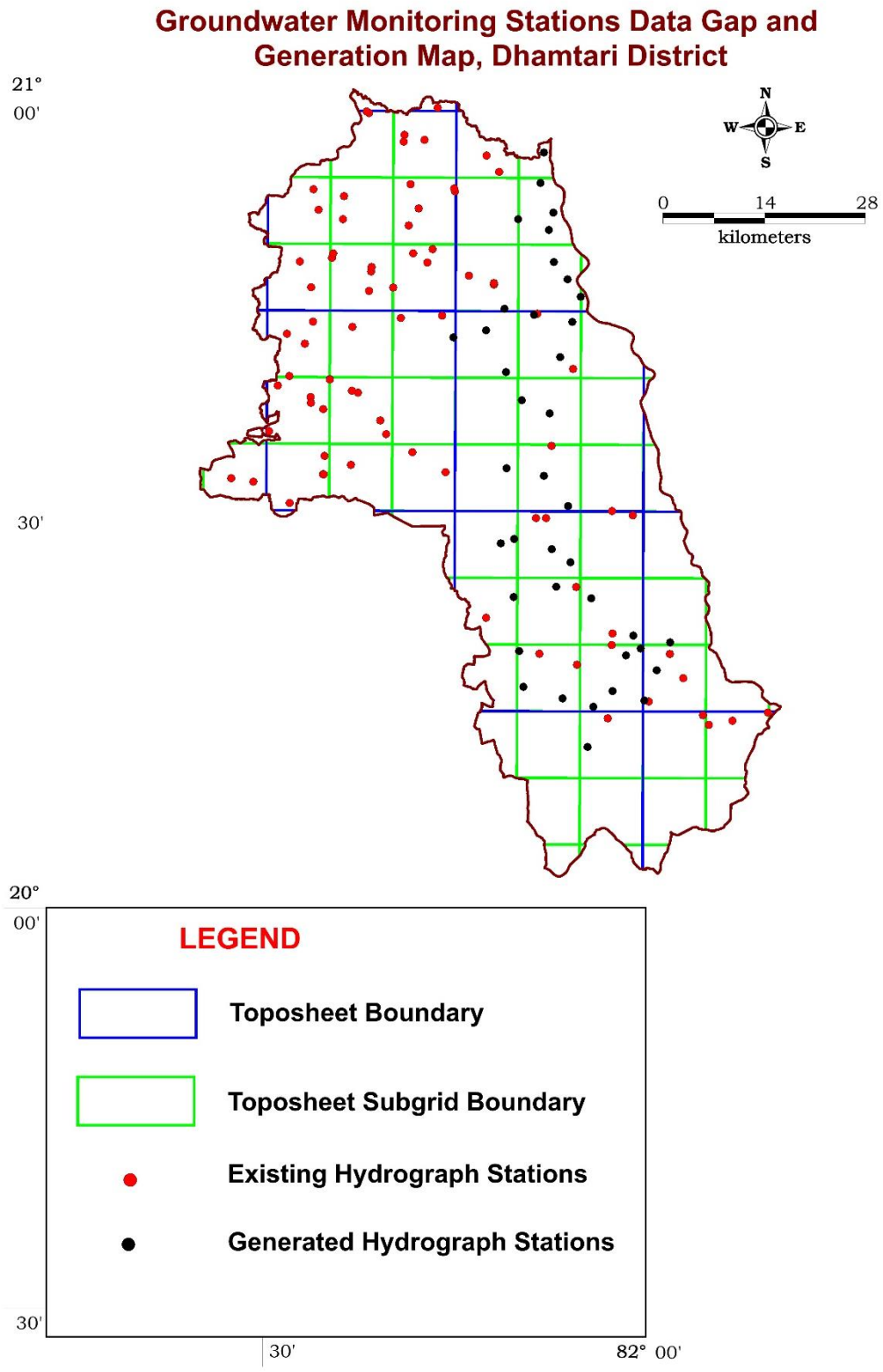


Figure 2 GW Monitoring Stations Data Gap and Generation Map of Dhamtari District

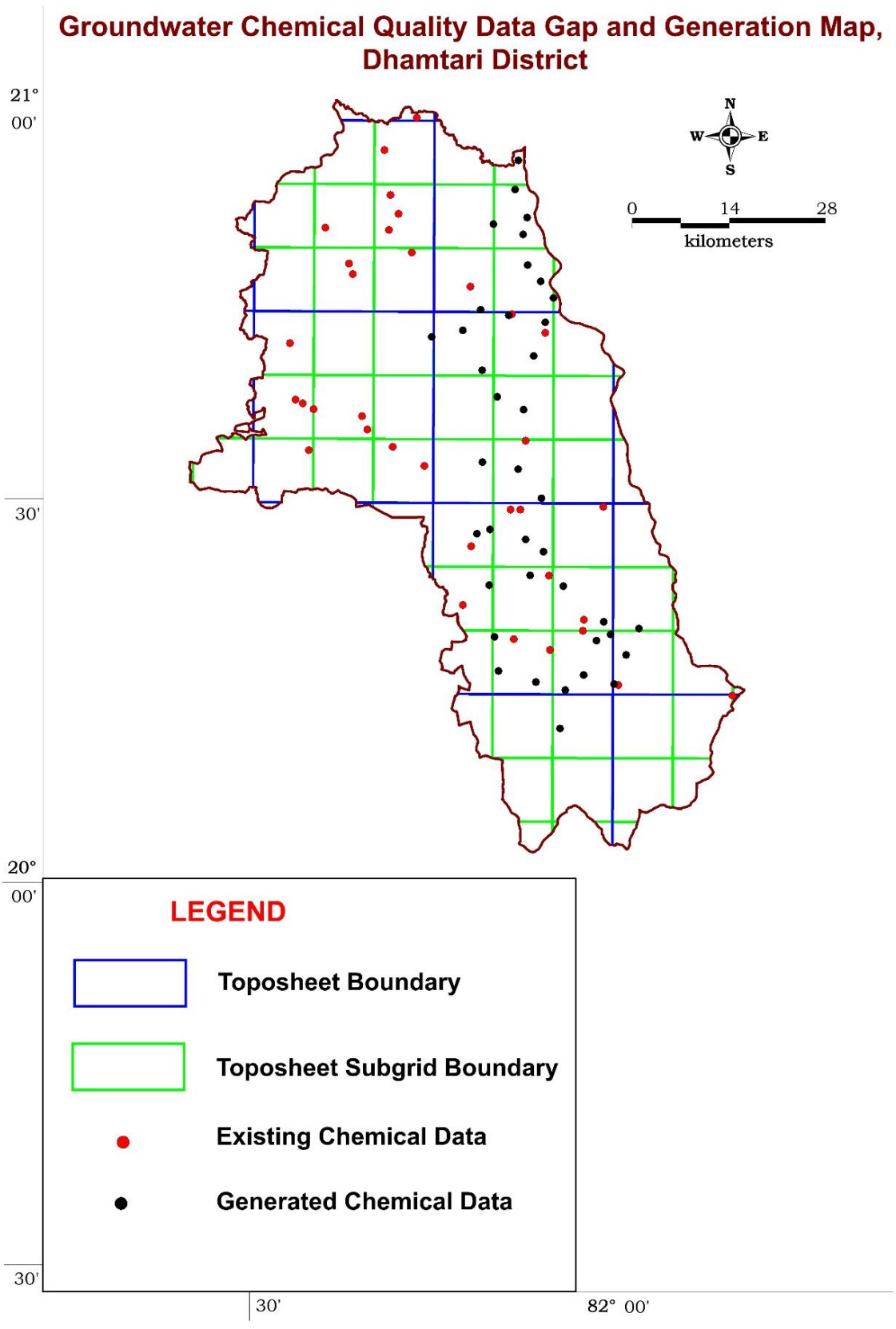


Figure 3 GW Chemical Quality Data Gap and Generation Map of Dhamtari District

1.6 Rainfall & Climate

Dhamtari is endowed with high rainfall. Areas of chronic shortfall are few and localized. The district receives its rainfall mainly from the south-west monsoon which usually sets in the third/fourth week of June and spread over a period from late June to early October with heaviest shower in the months of July and August. The annual average rainfall from 2011-12 to 2020-21 in the district is 1208.86 mm and the rainfall is 977 mm in the year 2020-21 which is presented below in Figure 4(Source: Statistical handbook Dhamtari district 2020-21).

Dhamtari district has a sub-tropical wet and dry climate; temperatures remain moderate throughout the year, except from March to June, which can be extremely hot. The highest temperature goes up to 46°C and observed in the months of May and June. Winters last from November to January and are mild and the lowest falls up to 10 °C and observed in the months of December and January. The relative humidity varies from 86 % in rainy season to 30-35 % during winter.

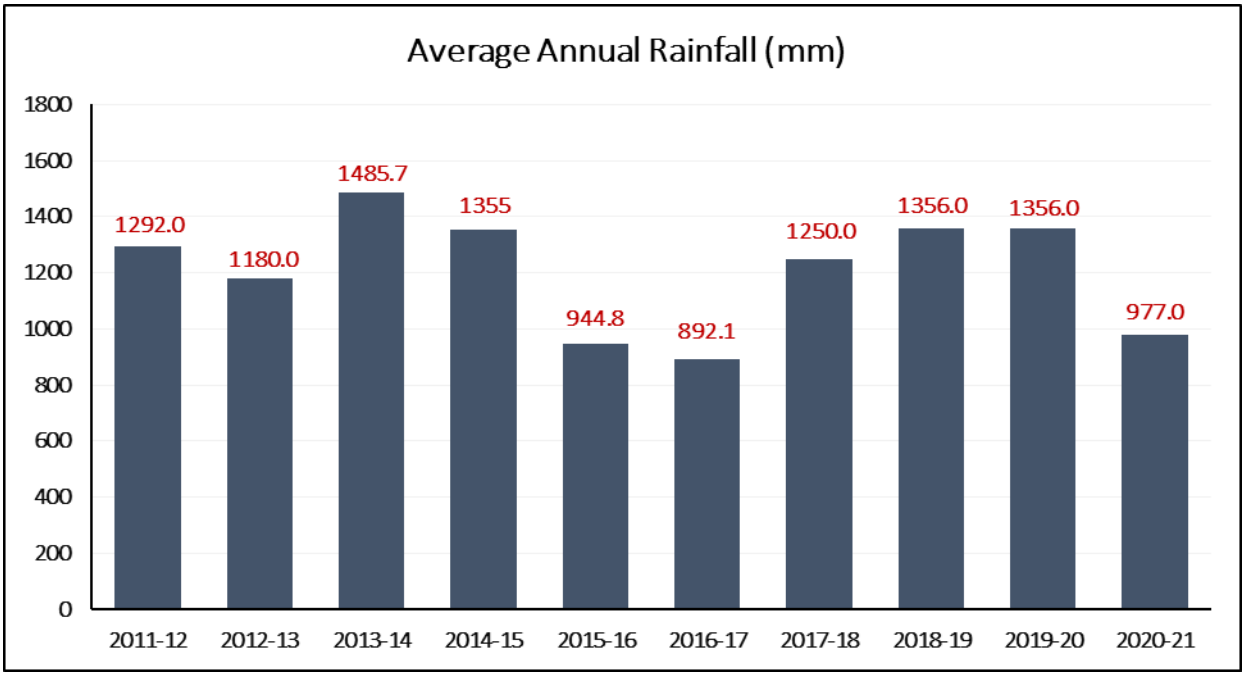


Figure 4 Avg. Rainfall in Dhamtari District

1.7 Physiography/Geomorphology

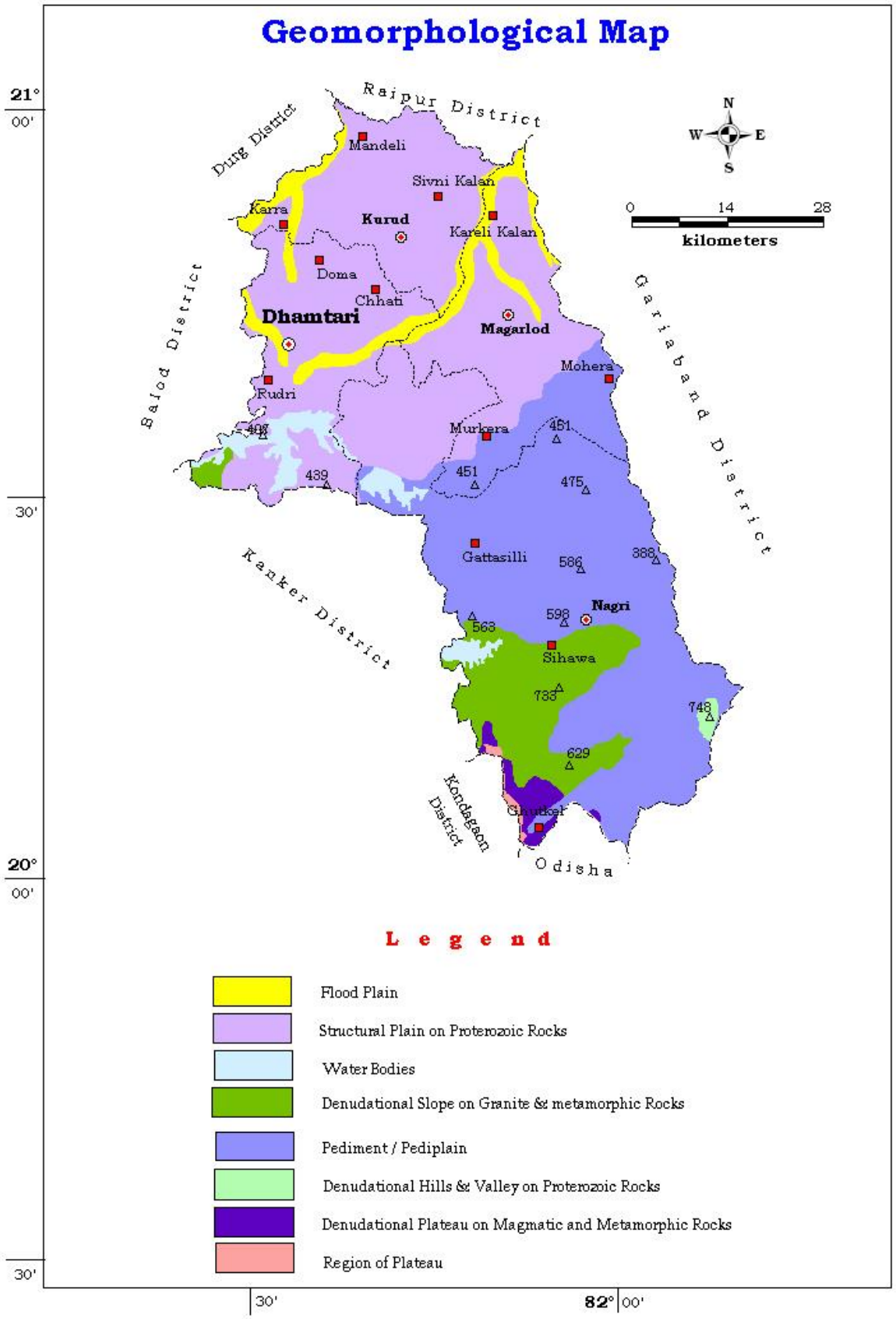


Figure 5 Geomorphology Map of the study area

Geomorphologically the district is having matured type of land forms and can be broadly divided into two prominent geomorphic units. These are

1. Chhattisgarh plains in the northern part of the district.
2. Bastar plateau in the southern part of the district.

The northern part of the district represents Chhattisgarh plains, with an elevation ranging between 290 and 320 m amsl. The Mahanadi River flows from southwest to northeast direction and divides the plains into two halves. The southern half of the district is predominantly a part of Bastar plateau. This is characterized by hilly tracks and intermediate plateau, flanked by high mounds and hillocks rising to an altitude of 700 meters. The elevation of this region ranges from 400 to700 meters.

The slope is towards northeast and northwest thus forming a NNW-SSE trending major surface divide in this region. The main geomorphological features and landforms developed in the district are Pediplains, Pediments, Residual hills, Structural hills and Flood Plains.

Physiographically, the northen part of the district exhibits structural plain with denudational slope and flood plain (including river beds). The southern part of district exhibits Pediment/Pediplain with denudational slope and plateau in the southwestern part and denudational hills and valleys in the southeastern part. The district forms a part of Mahanadi basin. Mahanadi River and its tributaries drain the district. The general slope of the area is toward north. The maximum elevation in the area is 748m above mean sea level as recorded in southwestern part of the district while the minimum elevation of 297m above mean sea level is noted in the northeastern part of the district.

1.8 Land use

There is 408193 ha revenue forest, protected forest and other forest in the district. Area not available for cultivation is 14893 ha. Details are presented in Table 2. Figure 6 shows the Landuse pattern in the study area.

Table 2 Land use pattern (in ha)

Blocks	Total Geogra-phical Area	Revenue forest area	Area not available for cultivation	Non-agricultural & Fallow land	Agricultural Fallow land	Net sown area	Double cropped area	Gross cropped area
	(In ha)	(In ha)	(In ha)	(In ha)	(In ha)	(In ha)	(In ha)	(In Ha)
Dhamtari	67883	1238	3830	768	904	34191	26221	60413
Kurud	59242	0	6043	406	618	46413	30061	76473
Magarlod	88191	5967	4163	355	334	25964	10834	36798
Nagri	192877	7688	2081	1174	2535	36073	6965	43038
Dhamtari (Total)	**408193**	**14893**	**16117**	**2703**	**4391**	**142641**	**74081**	**216722**

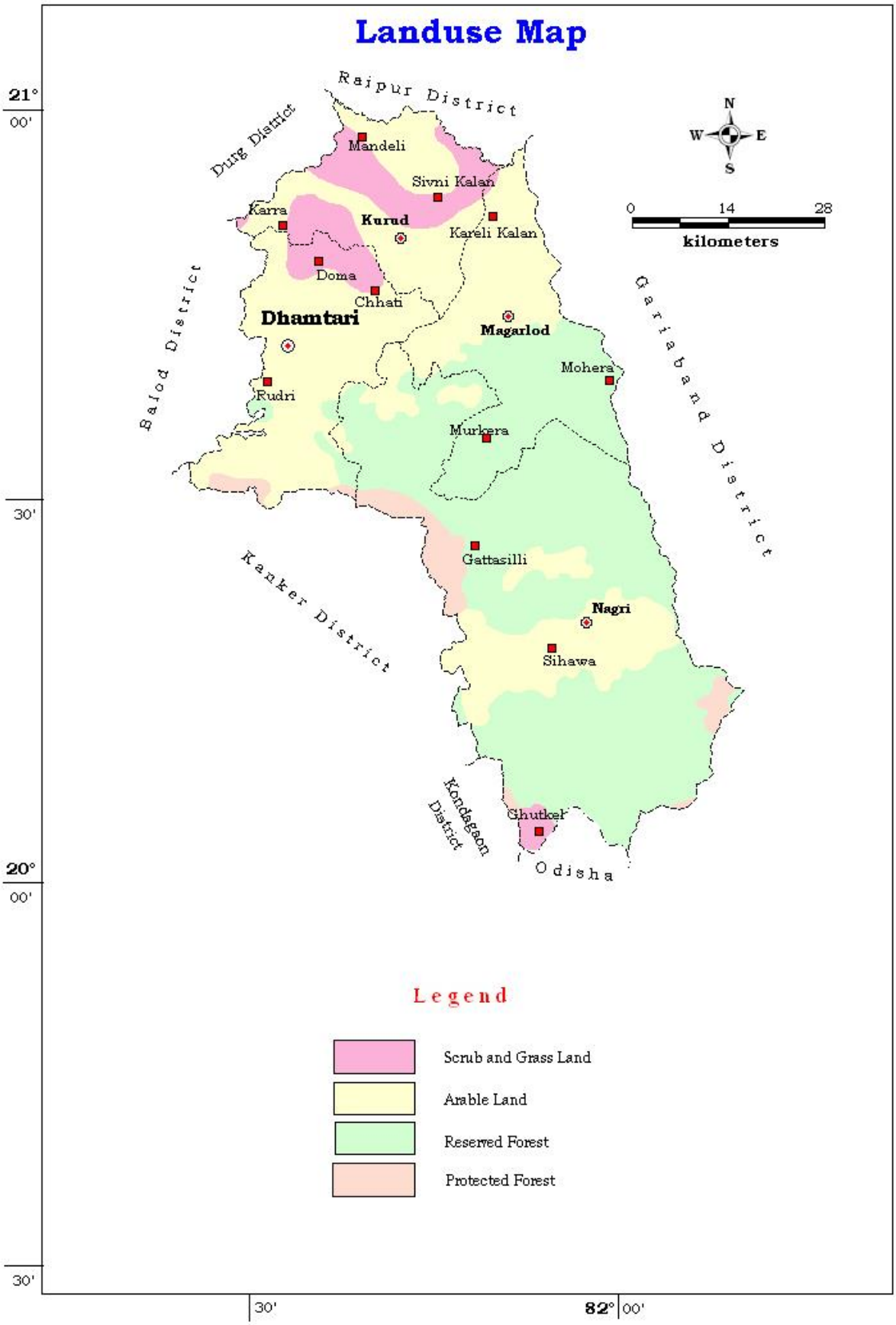


Figure 6 Landuse map of the study area

1.9 Soil

The soils in the district are having wide variations. As per US soil taxonomy, three types of soils occur in the district viz. Alfisols, Vertisols and Ultisols.

1. **Alfisols**

About 54% of the district area, mostly in central and southern parts, is covered by yellowish to reddish Alfisols, locally known as 'Dorsa'. These soils are derived from weathering of crystallines and metamorphic rocks.

2. **Vertisols**

They are characterized by a high content of expanding and shrinking clay known as montmorillonite that forms deep cracks in certain seasons. The Indian equivalents of Vertisols which are available in the district are deep and medium black & light to dark grey soils. These soils cover maximum parts of Dhamtari and Kurud blocks. These soils are produced through long continued weathering and disintegration of limestone and shales and due to its moderate moisture retention capacity and fertility, suitable for taking double crops.

3. **Ultisols**

The word "Ultisol" is derived from "ultimate", because Ultisols were seen as the ultimate product of continuous weathering of minerals in a humid temperate climate. This is a highly weathered and leached acid soil with high levels of clay below the top layer. They are characterized by a humus-rich surface horizon (the uppermost layer) and by a layer of clay that has migrated below the surface horizon. The Indian equivalent of Ultisols which are available in the district are Lateritic soil and covers mostly northeastern & northwestern parts of the district.

Table 3 Details of different kind of soil

Sl. No.	US Soil taxonomy	Indian equivalent
1	Vertisols	Deep black soil
		Light to dark grey soil
2	Ultisols	Lateritic soil
		Red and yellow soil
3	Alfisol	Yellowish to reddish

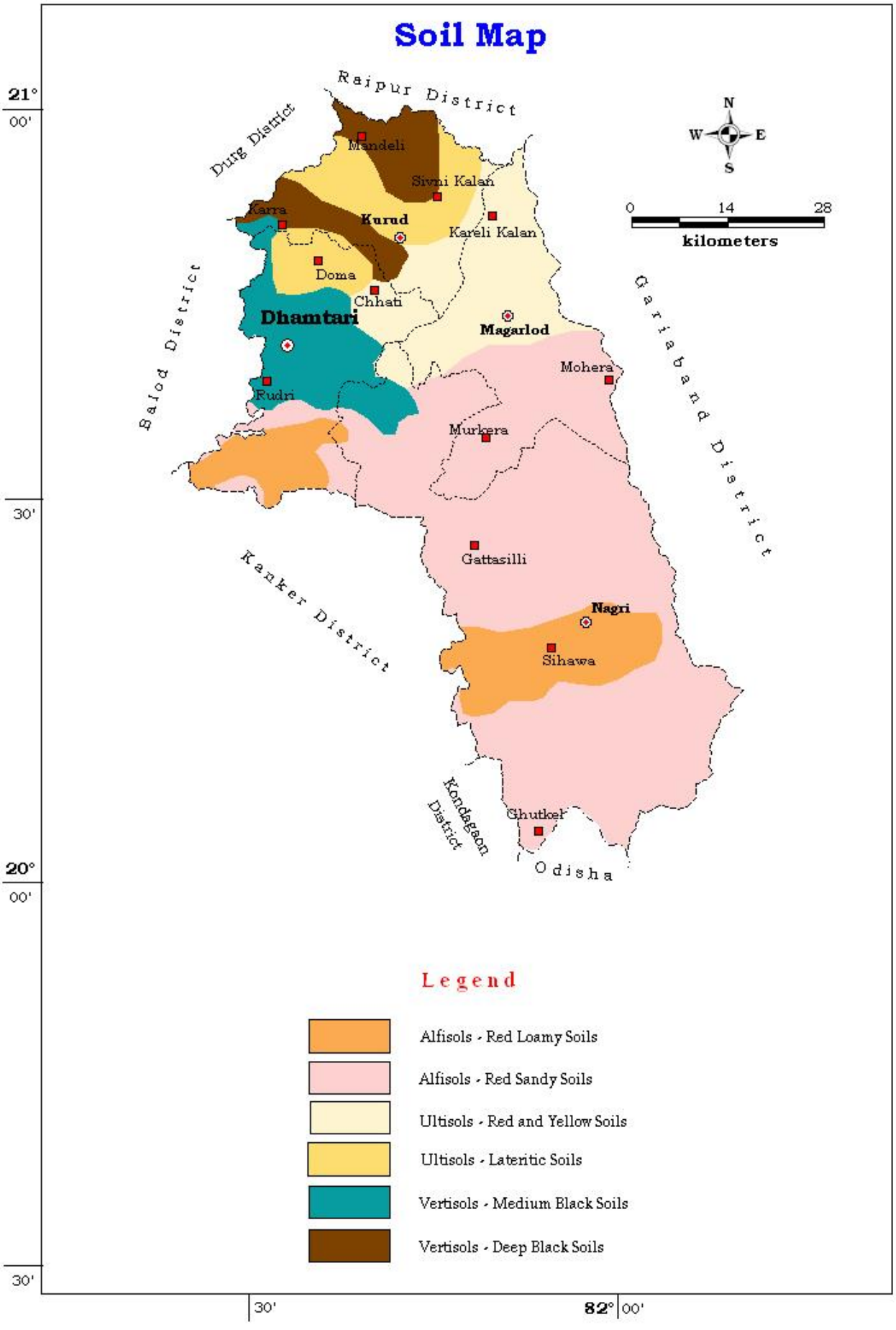


Figure 7 Soil map of the study area

1.10 Hydrology and Drainage

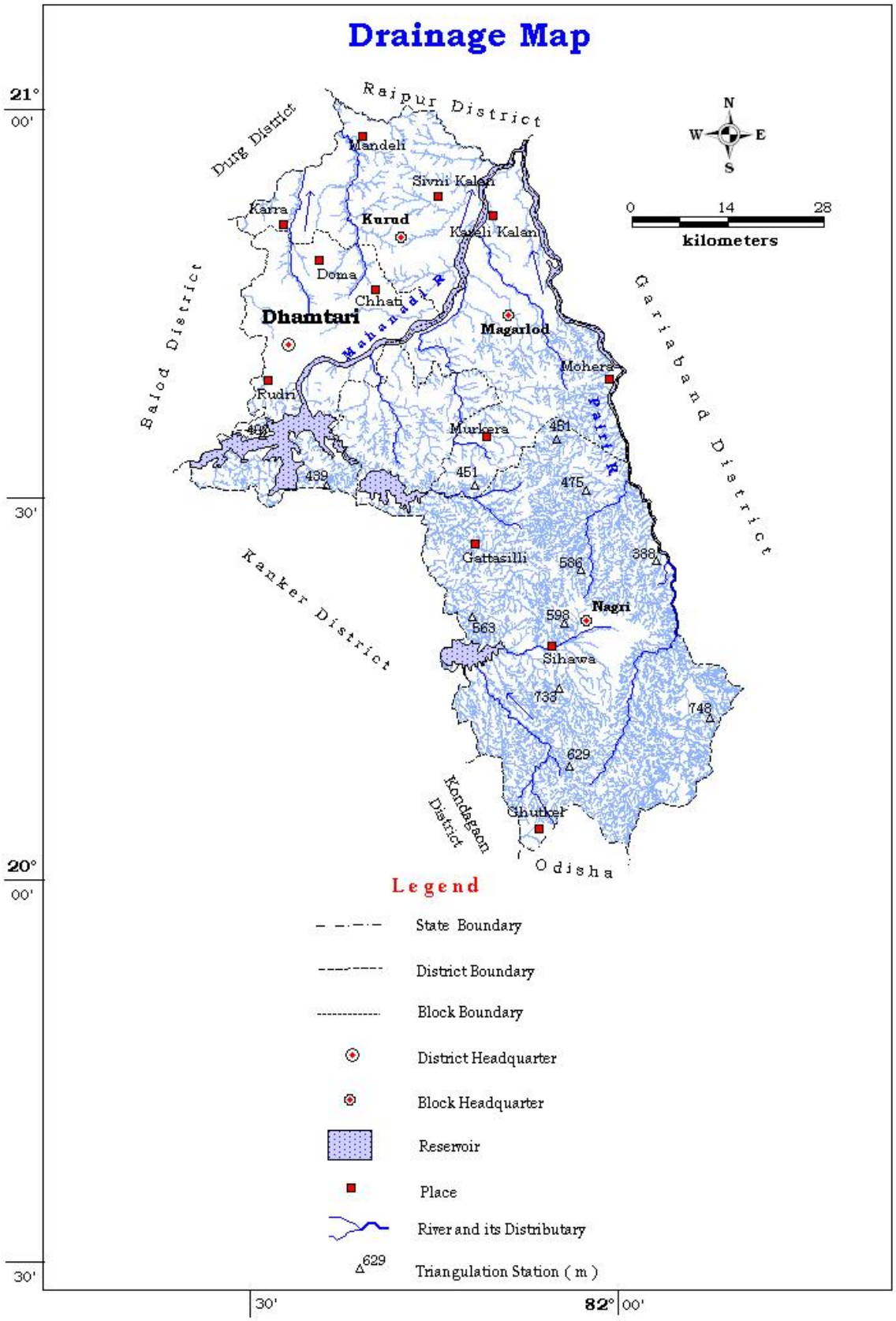


Figure 8 Drainage map of the study area

Mahanadi is the principal river of this district. Its tributaries are Pairy, Sondur and Kharun rivers. The fertility of lands of Dhamtari district can be attributed to the presence of these rivers. Mahanadi originating in the hills of Sihava flows in the direction of north east throughout its length in the district. River Kharun forms part of western boundary of Dhamtari district with Durg district. The tributaries for Sondhur are Sita Nala, Kajal Nala, Bindra Nala and Sukha Nala whereas Sefari, Ama Nala, Pawai and Bagbura Nala directly join with River Mahanadi.

The drainage pattern is typically dendritic and is controlled by initial slope. The drainage density is very high in the hilly areas of south and southeast indicating that the infiltration is low. A major irrigation project, named Mahanadi Reservoir Complex Project is constructed on River Mahanadi, 10 kms away from the district headquarter, Dhamtari. The main reservoir, named as Ravishankar Sagar, is spread over an area of 86.52 sq.kms and the gross catchment area of the reservoir is 3700 sq.kms.

1.11 Geology & Stratigraphy

The district is underlain mainly by three distinct geological formations ranging in age from Archean to recent. The crystalline basement, occupy major parts of the district, comprising of granite and granitic rocks belonging to Dongargarh group, severally intruded by the quartz veins and basic dykes. The rocks of Chhattisgarh Super group are unconformably overlying the basement crystalline and are represented by the sandstone, limestone and shale sequence occupying the north central and central part of the district. A thin layer of alluvium / laterite belonging to the Quaternary age occur along the flood plains of major rivers and its tributaries.

The oldest rocks in the area are represented by Bengpal Group of Archaean age (4000-2500 m.y.), which are exposed in the southeastern part of the district. Bengpal Group comprises granite gnesis (ranging in the composition from biotite, amphibole gnesis to granodiotrite gnesis) and migmatite with enclave of meta-ultramafic, meta-basic, quartzite mica schist, branded magnetite quartzite and anthophyllite schist. Dongargarh granite of Palaeo Proterozoic age (2500-2000 m.y.) occupy the southern part of the district and comprise leucogranite, biotite and hornblende granite, granodiorite and granophyre. Younger intrusives of Meso Proterozoic age (2000-1600 m.y.) intruding gnesis and granitoids and exposed in the southeastern part of the district and include basic dykes of gabbroic, doleritic and basaltic composition, quartz vein and pegmatitic pink granite.

Undeformed and unmetamorphosed sedimentary sequences of rocks belonging to Chhattisgarh Supergroup of Meso to Neo Proterozoic age (2000-900 m.y.) overlie the granitoids. They occupy the northern part of the area and are represented by Chandarpur and Raipur groups. Chandarpur Group is further classified in Lohardih and Kansapathar formations. Lohardih Formation is mostly arenitic in nature and comprises ferruginous purple arkosic and gritty wacke arenite with shale partings and a basal conglomerate. Kansapathar Formation comprises highly matured, ferruginous and well sorted glauconitic quartz arenite. The Raipur Group is classified into Charmuria and Guderdehi formations. Charmuria Formation is dominantly a carbonate facies and is represented by the cherty limestone, dark grey, bedded, pyritiferous and argillaceous limestone and purple phosphatic limestone at places. Gunderdehi Formation is dominantly calcerous argillite distinct facies. It comprises buff to purple coloured shale withintercalated limestone and ferruginous arenite. Lenses of intraformational conglomerate are seen in the upper part.

There are no economic mineral deposits of any significance except limestone at Sonadihi, Gotra and Amlidihi and clay at Kosagonda.

Table 4 Generalized Geological Succession in Dhamtari District

Age	Group/Super Group		Formation	Member	Nature and Characteristics
Recent			Alluvium/Laterite		Clay, sand and silt
Upper Proterozoic	CHHATTISGARH SUPERGROUP	Raipur Group	Gunderdehi Formation		Purple Shale
			Charmuria Formation	Bagbura	Purple Limestone
				Kasdol	Dark grey bedded Limestone
				Ranidhar	Cherty Limestone
				Sirpur	Chert and clay intercalations
Middle Proterozoic		Chandrapur Group	Kansapathar Formation		Glauconitic quartz arenite
			Chopardih Formation		Silicified quartz arenite with black shale intercalation
			Lohardih Formation		Gritty wacke arenite and conglomerate at base
			Lingdori Formation		Sandstone, Orthoquartzite
UNCONFORMITY					
Archaean and Lower Proterozoic Basement – Bengapal Group, Dongargarh Granite					Granite, Gneiss, Migmatite

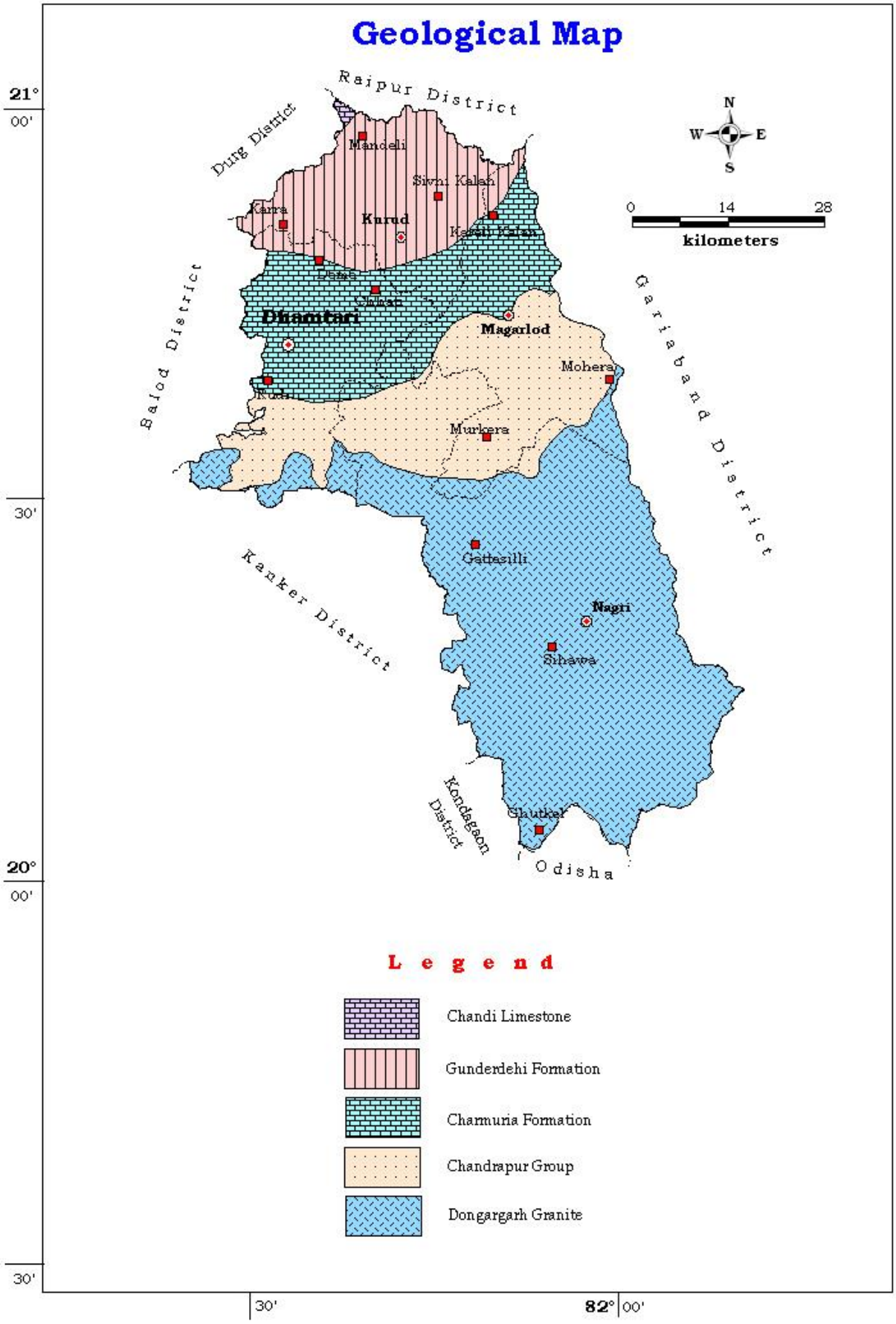


Figure 9 Geological map of the study area

1.12 Agriculture, Irrigation, Cropping Pattern

Agriculture is practiced in the area during Kharif and Rabi season every year. During the Kharif, cultivation is done through rainfall while during the Rabi season, it is done through groundwater as well as partly through surface water like canals and other sources. The groundwater abstraction structures are generally Dugwells, Borewells/Tubewells. The principal crops are paddy, wheat, maize, vegetables and pulses. In some areas, double cropping is also practiced. The agricultural pattern, cropping pattern and area irrigated data of Dhamtari district is given in Table No. 5,6,7.

Table 5 Cropping pattern (in ha)

		Cereal										
Kharif	**Rabi**	**Paddy**	**Wheat**	**Jowar & Maize**	**Kodo Kutki**	**Others**	**Pulses**	**Tilhan**	**Fruits Vegetables**	**Reshe**	**Mirch Masala**	**Sugarcane**
142558	812	139899	772	635	1	45	16752	828	1679	0	131	11

Table 6 Area irrigated by various sources (in ha)

No. of canal s (private and Govt.)	**Irrigated area**	**No.of Hand pumps/ 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**
11	106692	27751	55466	1617	643	35	123	1010	163934	114.93

Table 7 Contribution of Groundwater in Irrigation (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**
55466	643	56109	6739	34.23

2. DATA COLLECTION, DATA GENERATION, DATA INTEGRATION AND DATA INTERPRETATION

2.1 Hydrogeological Data

The Dhamtari district is underlain by Crystalline basement comprising granites and gneisses belonging to Dongargarh Group, overlain by rocks of Chandarpur Group of middle Proterozoic age. These are in turn succeeded unconformably by Charmuria and Gunderdehi formation of Raipur group belonging to upper Proterozoic age. The unconsolidated formation of of quaternary age comprising alluvium, clay, silt and laterite form thin unconfined aquifers in several isolated patches with thickness upto 25-30 m bgl. The Dongargarh Group of rocks is intruded by dykes of basic to ultrabsic composition specillay dolerite dykes which extend in NW-SE directions.

The Archean Crystalline comprising granites and gneisses, etc. form major litho unit of the district. They cover about 46.4 % of the total geographical area of the district and seen in exposed parts of Sihawa (Nagri), Magarlod and Dhamtari blocks. Two sets of joints are often prominent in these rocks. Joints are open at the surface but they close at depth as seen well sections. The thickness of weathered mantle extends upto a depth of 15 m bgl. Dolerite dykes extend in NW-SE direction. The outcrops of these dykes can be seen around Arsi Kanhar, Paudwar, Ghatula, etc.

The contact between the Archean and overlying Proterozoic sedimentaries is a faulted one indicated by the presence of highly sheared and brecciated rocks. Unconformity between Archean and Chhattisgarh formation is quite evident by the presence of pebbly conglomerate bed at the basal portion of the sedimentaries. The rocks of Chhattisgarh Supergroup consist of varied meta-sediments and form marked and distinct litho-unit. The Chhattisgarh Supergroup in the district consists of two groups (1) Chandarpur Group, (2) Raipur Group. The Chandarpur Group of rocks occupies part of Magarlod, Dhamtari and Sihawa (Nagri) blocks. The rocks of this group are essentially arenaceous in nature. They are hard, compact and unmetamorphosed. They are horizontally bedded and occupy higher elevations in the form of ridges. The sandstones are pale and purple in colour, ferruginous, sub-arkosic to orthoquartzic in composition, highly silicified and compact and devoid of primary porosity. Basal Conglomerate nad feldspathic-grit horizon carrying in thickness from 6 to 12 m and occurring between contacts of Archean crystalline and Proterozoic sedimentary indicate the unconformable nature.

The Raipur Group in the district comprises argillite-Carbonate sequence of Charmuria and Gunderdehi formation. It has a sharp contact with the underlying Chandarpur Group. The Charmuria formation is the oldest member in Raipur Group. It chiefly comprise grey to black flaggy limestone and purple shale. It is thinly laminated and horizontally bedded in nature with dip towards the center of the basin. The Charmuria limestone covers 18.79 % of the district in Magarlod, Kurud and Dhamtari blocks. Due to ven bedding and jointing it comes out as slabs and quarried locally. The Gunderdehi formation of Raipur Group occupy 10.9 % of the district. It comprises purple coloured calcareous and brittle shale. Association of thin band of siltstone of greenish and pale greyish colour are seen in the upper portion. The contact between Gunderdehi and Charmuria formation is gradational. The recent to sub-recent deposits of laterite and alluvium are found occasionally.

The groundwater mainly occurs in unconfined/phreatic (water table) conditions and at places under semi-confined conditions. In granites the weathered thickness varies from 18 to 40 m and the weathered and fractured formation constitutes the aquifers. Invariably the fractures are limited to a depth of 10 to 185 m. In sedimentary formations the weathered thickness varies from 9 to 33 meters.

Hard rock areas in the district have been proved to be potential aquifers. Under groundwater exploration program Central Ground Water Board has drilled 97 Exploratory wells. These wells in the depth range of 45-185 m have yielded 0.5 to 11 lps. The yield of the wells drilled by CGWB in Chhattigarh formation varies from 0.8 to 11 lps. The transmissivity of these formations ranges from 4 to 336 m^2/day. Nearly 30% of the exploratory wells drilled by the department yielded less than 1 lps. About 20% wells recorded yield in the range of 1 to 3 lps and 10% in the range of 1-5 lps whereas in the remaining 40 % it was more than 5 lps.

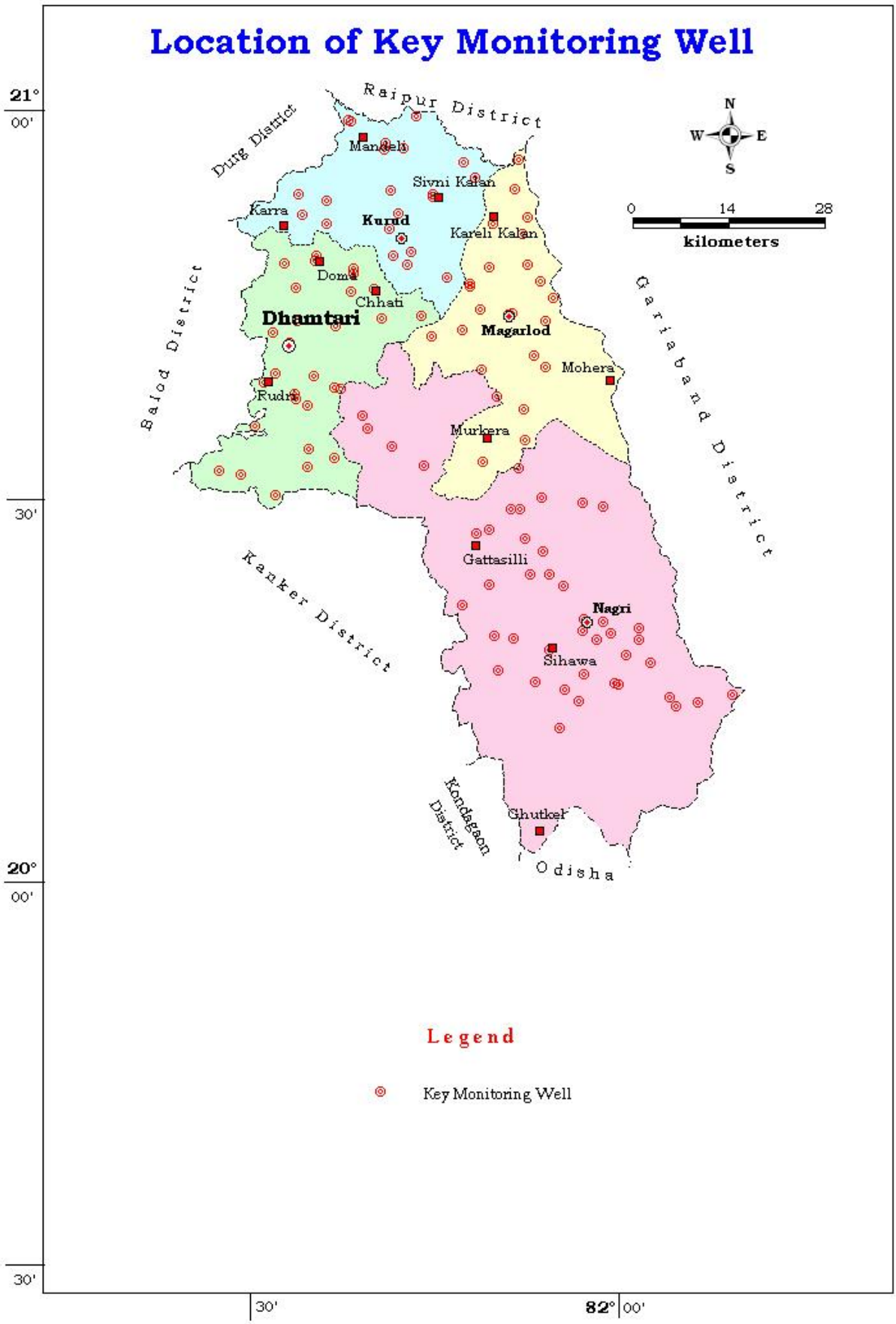


Figure 10 Key Montoring Wells of the study area

2.1.1 Water level behavior

Pre-monsoon depth to water level maps have been prepared on the basis of the depth to waterlevel monitored data of the key wells established in the study area.

i. Pre- monsoon waterlevel (May 2022)

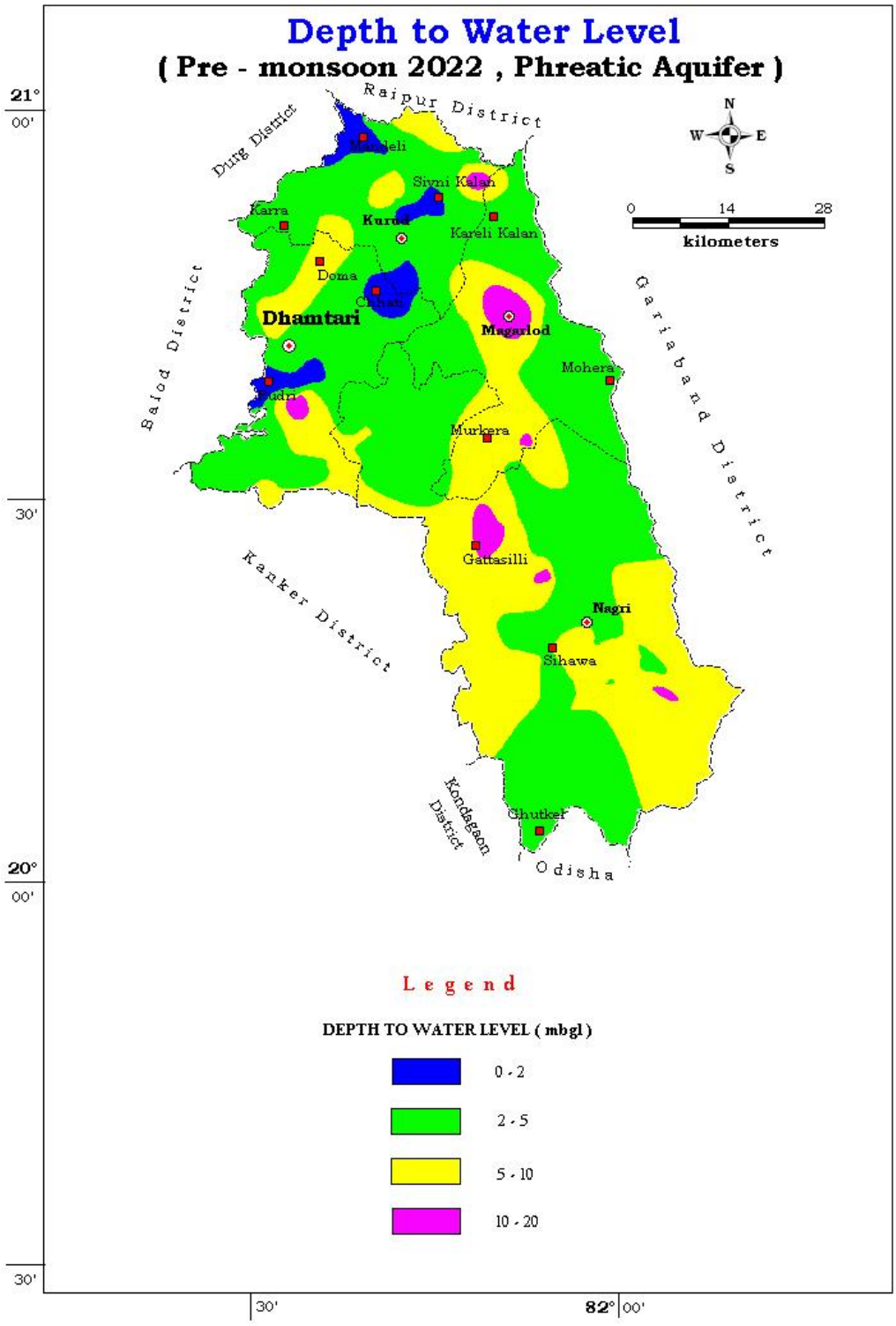


Figure 11 Pre-monsoon Waterlevel Map of Phreatic Aquifer

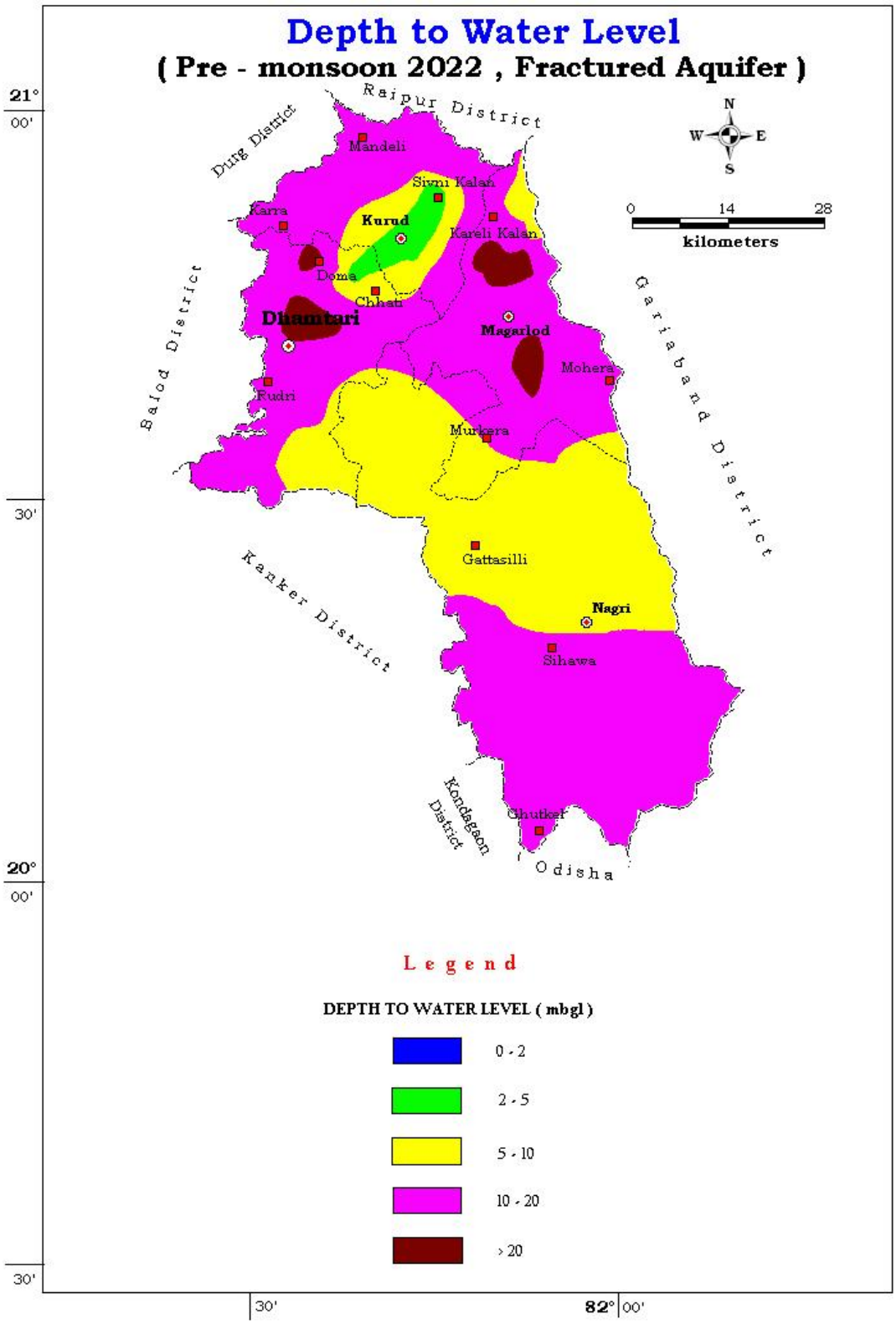


Figure 12 Pre monsoon Water Level Map of Fractured Aquifer

In the pre-monsoon period, it has been observed that in the study area water level in phreatic aquifer vary between 0.35 to 13.68 m bgl with average water level of 5.94 m bgl. In deeper fractured aquifer, water level varies between 3.40 to 23.12 m bgl with average water level of 13.47 m bgl shown in Table 8.

Table 8 Aquifer wise Depth to Waterlevel (Pre-monsoon)

District	Aquifer Type	Min (m. bgl)	Max (m. bgl)	Avg (m. bgl)
Dhamtari	Phreatic aquifer	0.35	13.68	5.94
	Fractured Aquifer	3.40	23.12	13.47

i. Post- monsoon waterlevel (November 2022)

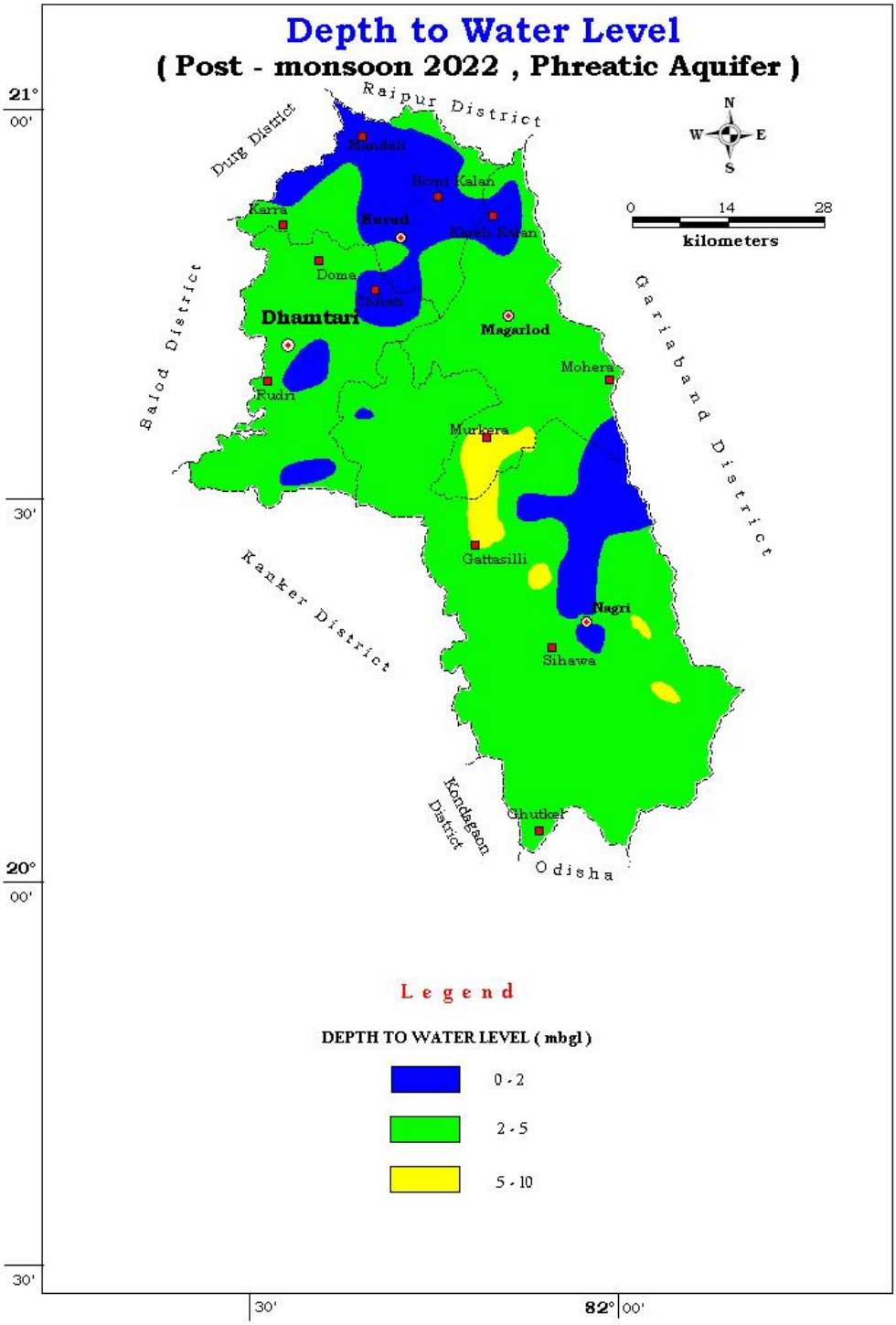


Figure 13 Post-monsoon Water Level Map of Phreatic Aquifer

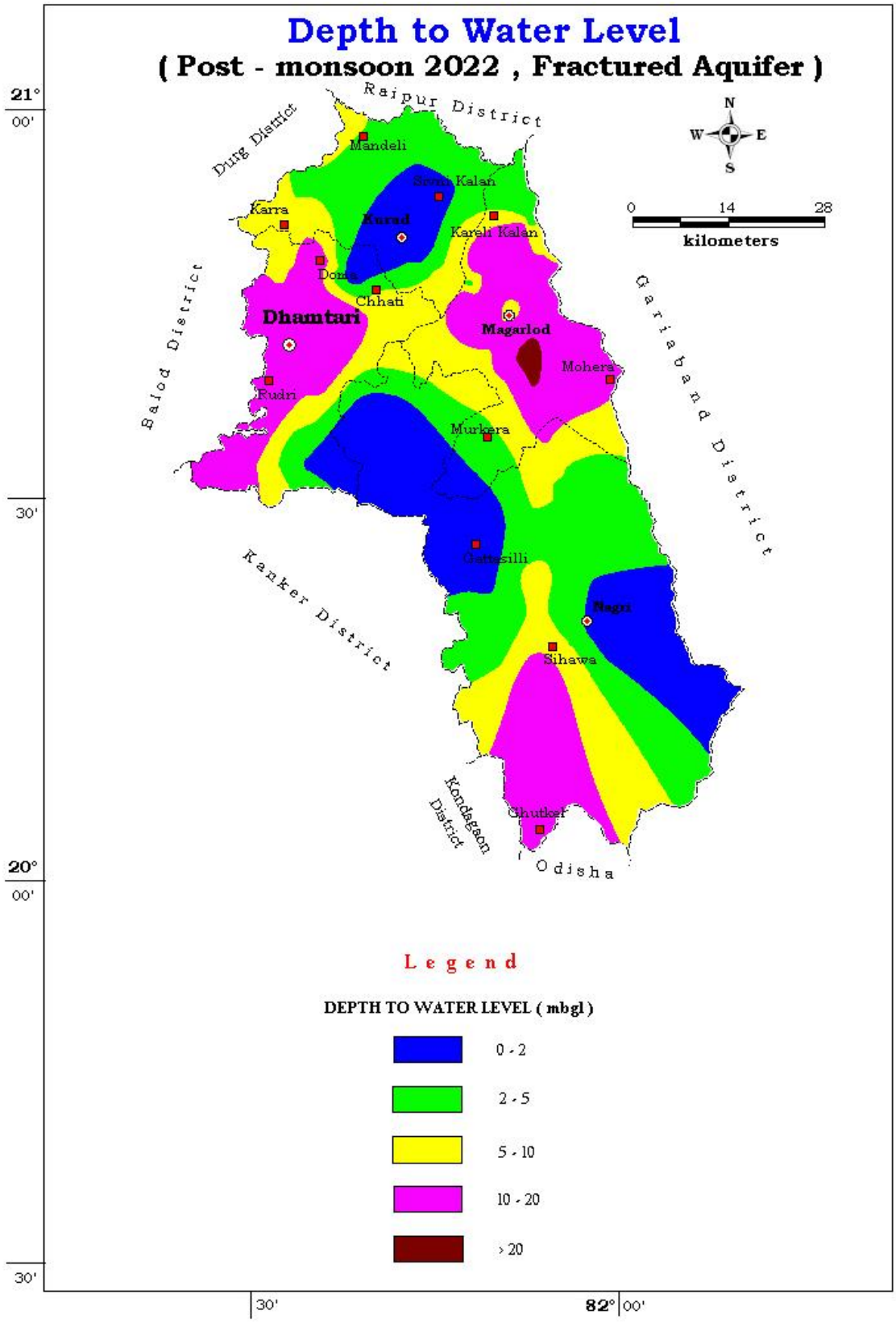


Figure 24 Post-monsoon Water Level Map of Fractured Aquifer

In the post-monsoon period, it has been observed that in the study area, water level in phreatic aquifer varies between 0.28 to 8.70 m bgl with average water level of 3.36 m. In

deeper fractured aquifer, water level varies between 1.84 to 23.90 m bgl with average water level of 9.40 m bgl shown in Table 9.

Table 9 Aquifer wise Depth to Water Level (Post-monsoon)

District	Aquifer Type	Min (m. bgl)	Max (m. bgl)	Avg (m. bgl)
Dhamtari	**Phreatic aquifer**	0.28	8.70	3.36
	Fractured Aquifer	1.84	23.90	9.40

ii. Seasonal water level fluctuation:

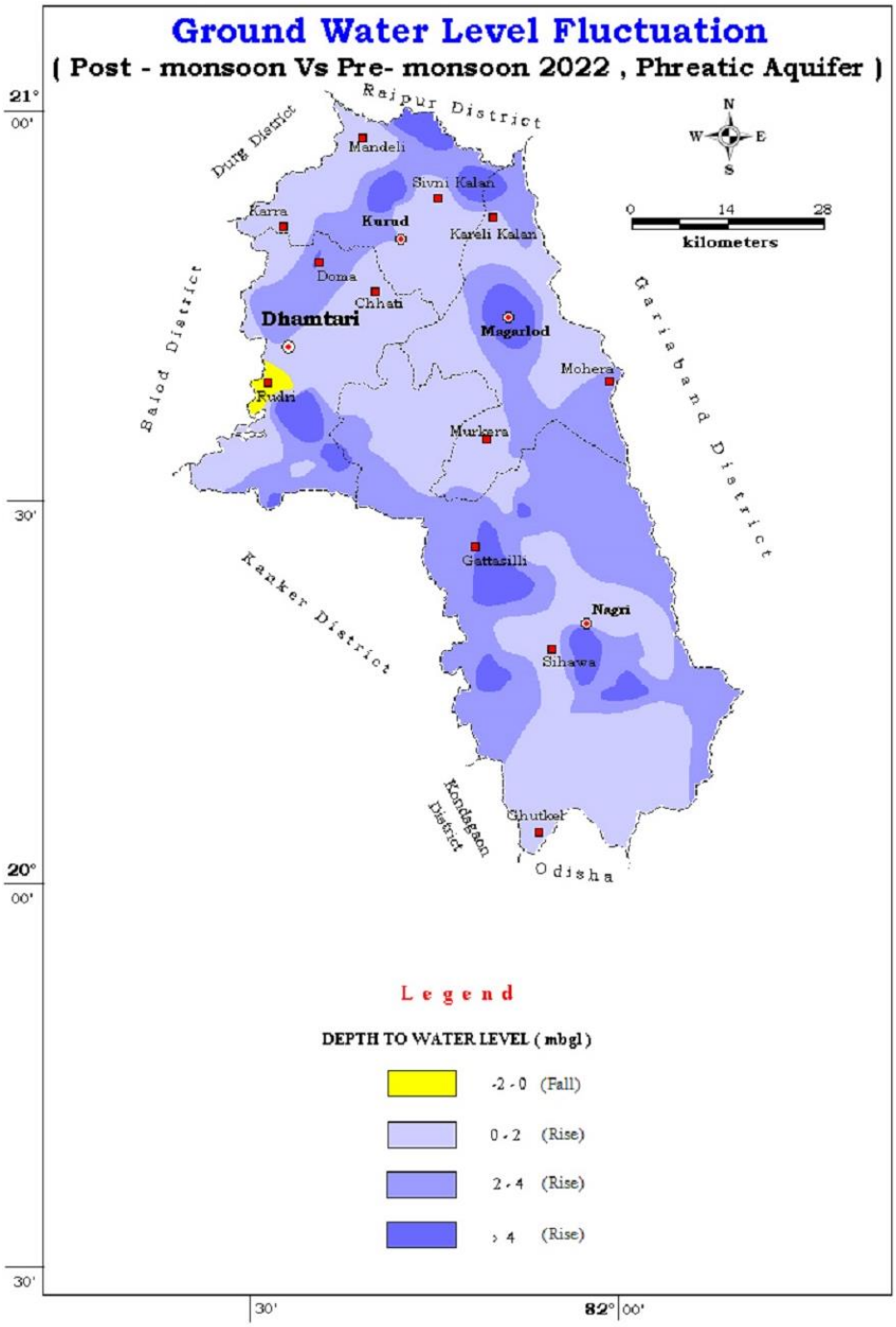


Figure 3 Water level fluctuation of phreatic aquifer

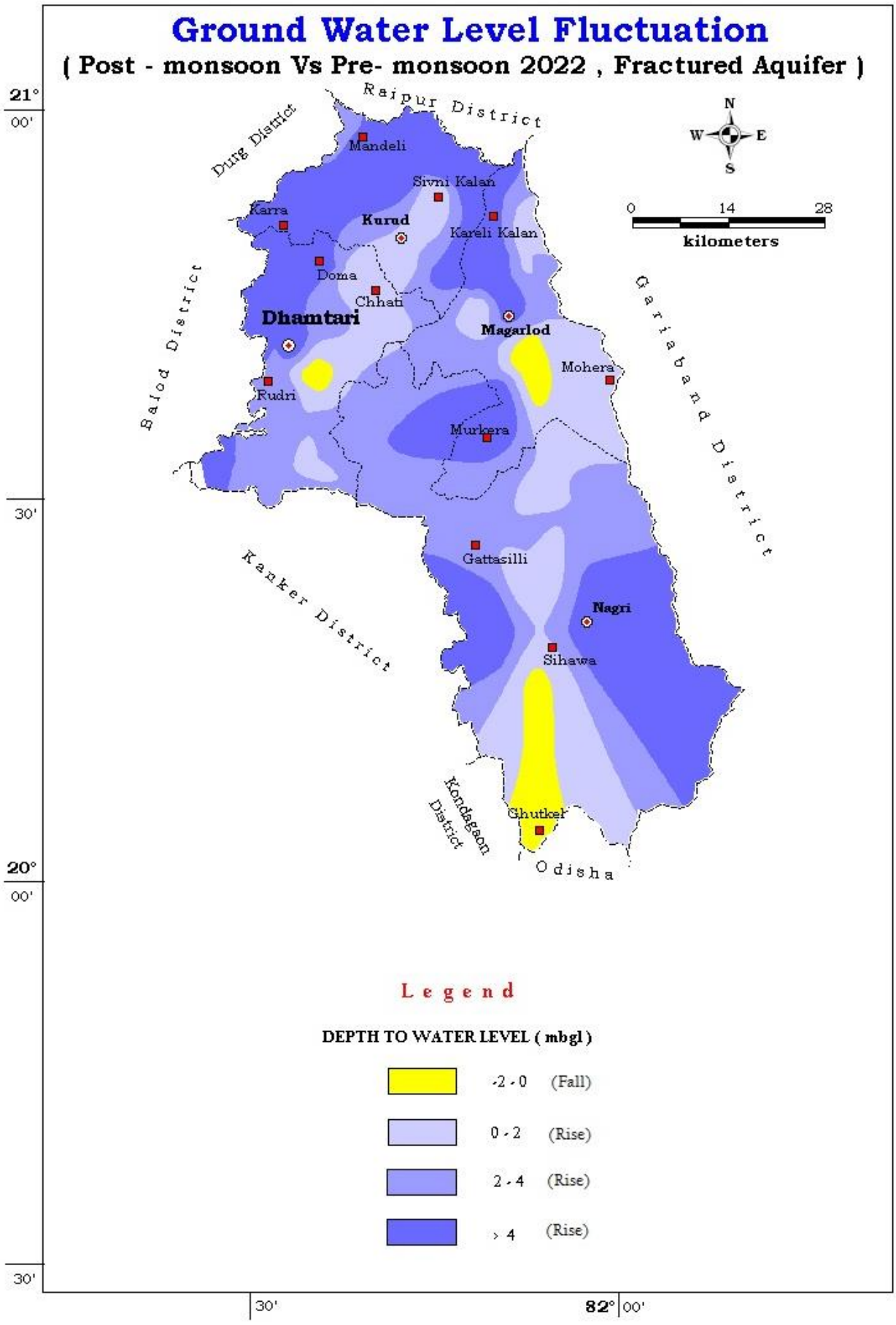


Figure 16 Water level fluctuation of fractured aquifer

The water level fluctuation data indicates that in the study area, water level fluctuation in phreatic aquifer varies from -1.74 to 8.99 m with an average fluctuation of 2.58 m. In deeper fractured aquifer, water level varies from -2.00 to 12.00 m with an average fluctuation of 4.07 m shown in Table 10.

Table 10 Aquifer wise Depth to Water Level Fluctuation

District	Aquifer Type	Min (m)	Max (m)	Avg (m)
Dhamtari	**Phreatic aquifer**	-1.74 (Fall)	8.99	2.58
	Fractured Aquifer	-2.00 (Fall)	12.00	4.07

2.2 Exploratory Data

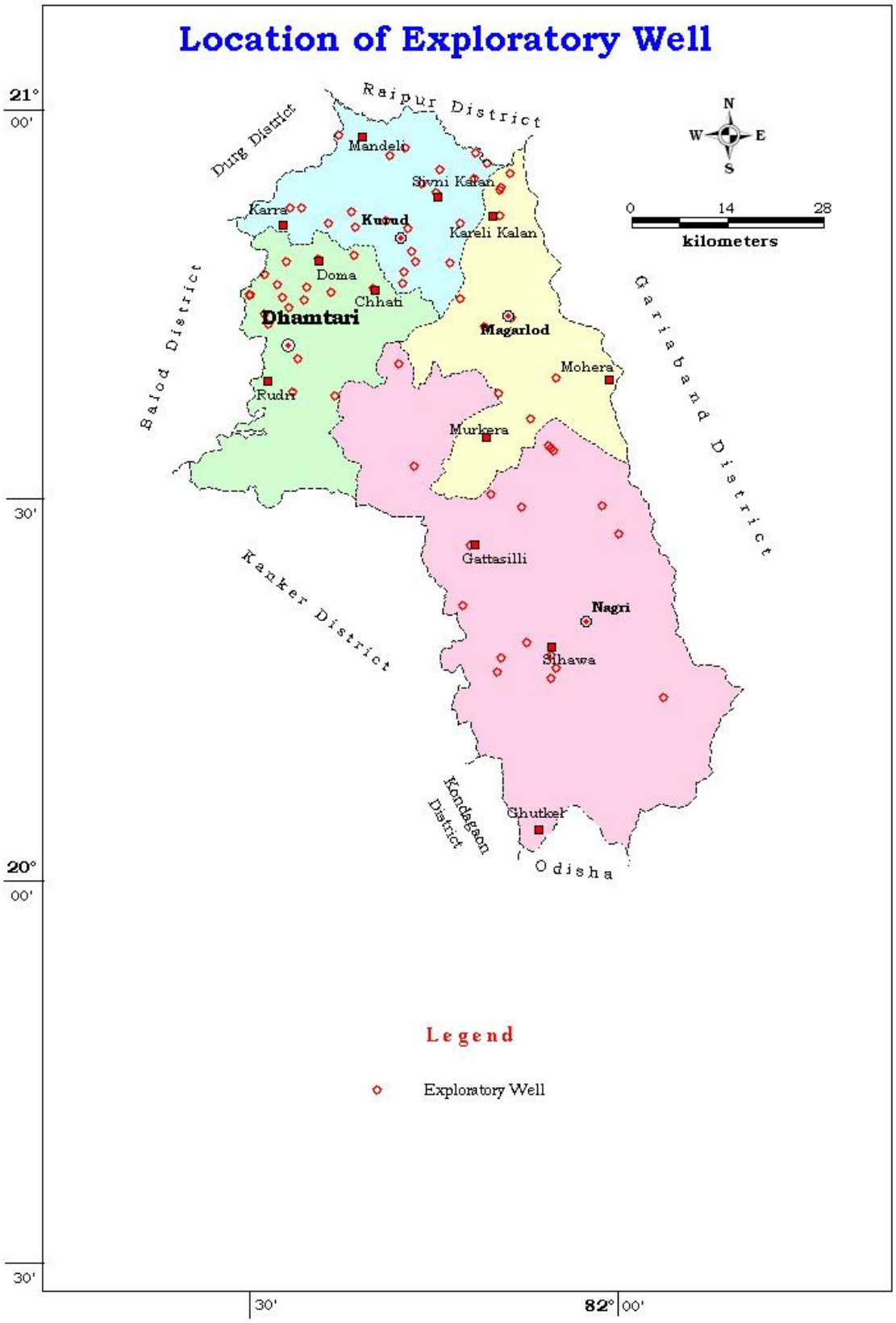


Figure 17 Location of Exploratory wells in the study area

A total of 97 Exploratory well exist in the study area. Location of the exploratory wells shown in Figure 17. The results and findings are presented in Annexure 2.

2.3 Geophysical Data

Geophysical surveys (Vertical Electrical Sounding or VES) have been conducted in the study area in Dhamtari district to delineate the disposition of the existing aquifer system and lithology of the area. A total of 96 nos. of soundings (VES) were carried out in Dhamtari, Kurud, Magarlod and Nagri blocks of Dhamtari district.

Table 11 Block wise Distributions of VES in Dhamtari District

Sl. No.	Block	No. of VES
1	Dhamtari	78
2	Kurud	2
3	Magarlod	12
4	Nagri	4
Total		**96**

To obtain the sub-surface hydrogeological formations for groundwater exploration, surface resistivity survey has been conducted in Dhamtari district. Ninety six VESs were carried out in Schlumberger Configuration with maximum spread length (AB/2) of 150 m using CRM 500 (an indigenous microprocessor based resistivity meter). The block wise distribution of Vertical Electrical Sounding (VES) is given in Table-11. To know the true resistivity and thickness of various horizons, the VES data obtained from the district were plotted on double logarithmic graph paper and matched with standard master curves. Computer softwares SCHLUM and AIMREV have also been to refine the interpreted layer parameters of VES data. The resistivity and thicknesses of different layers obtained from VES curves are given in Table-12.

The southern part of the district is occupied by granitic terrain. In granitic terrain the total numbers of three VES have been carried out. At all the three sites, the hard and massive granite has indicated resistivity value of the order of 2500 ohm-m with varying depth. The VES curve carried out at Govindpur in Nagari block is showing four layers earth model Fig. 18. The first layer is topsoil. The second layer with resistivity value 108 ohm-m and thickness 4.5 m indicates sandy (coarser) soil horizons. The third layer with resistivity value 185 ohm-m and thickness 32 m shows weathered/fractured nature of Granite. The fourth layer is hard and massive Granite with resistivity value 2500 ohm-m. Similarly the VES carried out at Dugli shows weathered zone of 21 m thickness followed by hard and massive granite. Whereas the VES curve of Birgudi is showing weathered thickness as 8 m only.

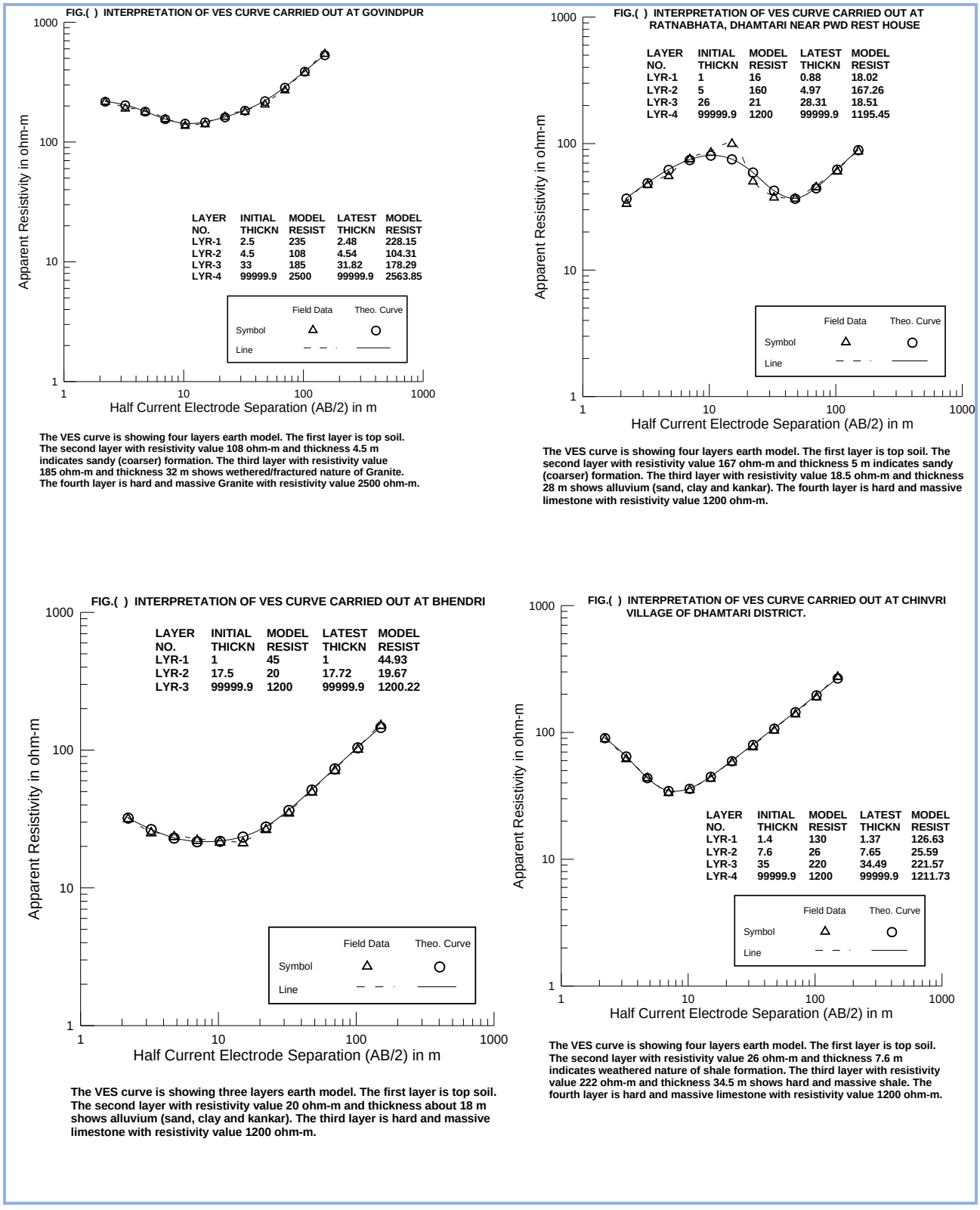


Figure 18 Representative VES curves in Dhamtari District

The area lies in south of Mahanadi River is occupied by sandstone (Chandrapur). A total number of 96 VES are carried out in this particular terrain of sandstone followed by granite. Between these two formations a low resistive layer with resistivity rang 190 –300 ohm-m has been encountered (within the depth range 23 – 42 m). This zone in adjacent to

granitic terrain may be the Older Chandrapur formation comprising of black shale. Granite is hard and massive in nature with resistivity value 2500 ohm-m. From the result of VES-14 carried out near Achhota village, which is very near to Mahanadi River towards southern side, the massive sandstone formation is encountered at a depth of 5 m bgl. In South of Dhamtari town, Mahanadi river is flowing almost along the contact of limestone (Charmuria) and sandstone (Chandrapur).

Table-12 Interpreted layer parameters of VES Curves in Dhamtari district

Sl. No.	Name of the Sites	VES No.	Respective layer Resistivity in (ohm-m)				Respective layer Depth in (m)		
			ρ1	ρ2	ρ3	ρ4	D1	D2	D3
1	Lahshunwahi	1	450	28	2500	-	3	14	-
2	Banroud	2	75	600	250	2500	0.5	4	23
3	Govindpur	3	235	108	185	2500	2.5	7	40
4	Birgudi	4	9	18	2500	-	1.5	8	-
5	Shayamtarai	5	7.5	21	1200	-	8	16.5	-
6	Dharamkanta	6	20	6.5	1200	-	0.6	11.6	-
7	Ratanbhata (R/H)	7	18	167	18.5	1200	0.9	6	34
8	Sambalpur	8	9	5.5	600	-	1.3	11.3	-
9	Arjuni (Rice-mill)	9	6.5	26	600	-	4.7	45	-
10	Singhpur	10	26	190	2500	-	5	35	-
11	Dugli	11	325	80	2500	-	2	21	-
12	Palwadi	12	500	1200	300	2500	1	4	29
13	Kumhda	13	44	850	230	2500	1.7	10	42
14	Achhota	14	6	2500	-	-	5	-	-
15	Bhendri	15	45	20	1200	-	1	18.5	-
16	Chinvri	16	126	26	222	1200	1.4	9	44

The VES curve carried out at Ratnabhata near PWD house is showing four layers earth model Fig. 16. The first layer is topsoil. The second layer with resistivity value 167 ohm-m and thickness 5 m indicates sandy (coarser) soil horizons. The third layer with resistivity value 18.5 ohm-m and thickness 28 m shows alluvium (sand, clay and kankar). The fourth layer is hard and massive limestone with resistivity value 1200 ohm-m. The interpreted layer parameters are corroborating with the litho log of drilled piezometer in premises of PWD rest house. It is also noted that the thickness of alluvium is increasing towards north and northeast of Dhamtari town. At VES-09 near Arjuni the alluvium thickness is about 45 m and decreasing towards Sambalpur (VES-08) where its thickness is about only 11.3 m. The VES curve obtained from Bhendri in Magarlod block is showing three layers earth model Fig. 18. The first layer is topsoil. The second layer with resistivity value 20 ohm-m and thickness about 18 m shows alluvium (sand, clay and kankar). The third layer is hard and massive limestone with resistivity value 1200 ohm-m.

The northern part of the district is having Gunderdehi Shale. A VES carried out in this formation at Chinvri in Kurud block is showing four layers earth model Fig. 18. The first layer is topsoil. The second layer with resistivity value 26 ohm-m and thickness 7.6 m indicates weathered nature of shale formation. The third layer with resistivity value 222 ohm-m and thickness 34.5 m shows hard and massive shale. The fourth layer is hard and massive limestone with resistivity value 1200 ohm-m. This VES curve clearly delineates the two geological formations at a depth of 44 m.

The geophysical investigation conducted in the district indicated that the application of the vertical electrical soundings proved to be an effective geophysical tool for the delineation of groundwater zones in Dhamtari district. The study suggests that Vertical Electric sounding combined with hydrogeological and remote sensing studies give better results in delineation of groundwater potential zones in the district. The salient features obtained through geophysical survey are as follows:

- In granites terrain the weathered zone is contributing the aquifer zones. The sites at Govindpur and VES-11 Dugli are suitable for groundwater exploration as weathered thickness obtained is quite substantial which is about 40 m and 21 m respectively.
- The area occupied by limestone (Charmuria) with resistivity value below 600 ohm-m is hard and massive in nature, but having good water bearing zones.
- The small area of limestone overlain by thick bed of alluvium mainly around Dhamtari urban area, is contributing good potential to aquifer zones. Thickness of Alluvium is

increasing towards north and northeast of Dhamtari Township. The maximum alluvium thickness is obtained about 45 m near Arjuni village. More geophysical surveys will be helpful to delineate the alluvium cover in the area.

- Gunderdehi shale and Chandrapur sandstone form poor aquifers in the district.

2.3.1 Dhamtari Urban Area

To study the groundwater in Dhamtari urban area systematic geophysical surveys have been conducted. Amdi nala is a tributary to Kharun River flowing very close to Dhamtari Urban Area. It is a first order stream, but is highly sinusoidal, which is unlikely of a lower order stream. Thick deposit of alluvium is encountered around Amdi Nala. Earlier studies have confirmed that this alluvium deposit forms the palaeochannel of Mahanadi, over which the present Amdi Nala flows. Present study is aimed at defining the extent of this alluvium and its groundwater potential. 48 vertical electrical resistivity soundings were carried out in the study area. From these surveys, alluvium thicknesses at different locations were interpreted. Maximum depth of alluvium in the channel was found to be 55m.

Dhamtari district is covered by mostly Crystallines and Precambrian sedimentary rocks. These rocks, by and large are poor in groundwater potentiality. Alluvium along major River courses like Mahanadi and Arpa, though limited in extent form potential aquifers. The study area is occupied by Sandstone, Limestone and Shale belonging to Precambrian Chhattisgarh Supergroup Fig. 19. The oldest rock types in the area are sandstones belonging to Chandarpur Formation overlain by Charmuria Limestone. Younger to the Charmuria Limestone is Gunderdehi Shale, which occupies the northern part of the study area. Contacts between the above formations are gradational. A larger part of the study area is covered by alluvium.

Choraha Nala, Devrani Jethani Nala, Ama Nala, Belghari Nala and Amdi Nala are the major drainages flowing through the study area. All these rivers are tributaries to the Kharun River. Mahanadi in the southeastern corner of the study area flows towards east. Drainage pattern in the area is mostly dendritic. In comparison to the surrounding drainages, Amdi Nala shows anomalous sinuosity, though it is only a first order stream.

There are several examples in the literature, where courses of buried channels were mapped on the basis of electrical soundings. In the arid regions of Rajasthan, India,

groundwater resources have been estimated using resistivity survey. In the study area 48 VES were carried out using Schlumberger configuration. The maximum current electrode separation, AB was taken as 300 m and a D.C. Resistivity meter "CRM-500" was used for data acquisition. Most of the curves reflect the presence of three to four geoelectric layers. The data were interpreted using conventional partial curve matching with the two and three layer master curves and auxiliary charts. The initial estimates of the resistivity and thickness of the various geoelectric layers were obtained through this procedure. These parameters were used as a starting model for the computer programme 'AIMREV', which is based on iterative techniques, for obtaining the final model. These layer parameters have been corroborated with the available lithologs of boreholes. Interpreted layer parameters are given in Table 13.

Based on the geophysical data, the thickness of alluvium in this area was estimated at different points. These point data then were extrapolated by natural neighbourhood method using vertical mapper in Mapinfo 6.5 Fig. 20. For the purpose of preparation of the contour map of alluvium thickness, the boundary of alluvium traced by Bhate2 was taken as the line of zero thickness. It was found that the length of the palaeo channel is nearly 25 Km. and the width varies from 4 to 8 Km. Along the identified palaeochannel, maximum thickness of alluvium is 55m. The depth to basement varies at different places. A longitudinal section and two transverse sections of the channel are shown in Fig. 21.

In the present study, geophysical resistivity surveys carried out in this area showed that the length of this palaeochannel is around 25 Km. Thickness of alluvium in the channel ranges from 0 to 55 m. The alluvium fill offers two advantages: because of its potential and ease of exploitability, shallow tubewells tapping the alluvium are highly successful. Further, this alluvium is in hydrogeological continuity with the underlying cavernous limestone. The alluvium cover facilitates better recharge of the underlying limestone formations.

Table 13 Interpreted layer parameters of the VES carried out in Dhamtari Urban area

VES No.	Location	Respective layer resistivity (ohm-m)					Respective layer depth (m)			
		ρ_1	ρ_2	ρ_3	ρ_4	ρ_5	D_1	D_2	D_3	D_4
GS01	Shyamtarai	7.5	2000	-	-	-	11	-	-	-
GS02	Dharamkanta	7	2000	-	-	-	13	-	-	-
GS03	Ratnabhata	15	120	18.5	1500	-	0.7	8	35	-
GS04	Sambalpur	6.5	1000	-	-	-	13	-	-	-
GS05	Arjuni	6.5	26	1000	-	-	4.9	46	-	-
GS06	Mujhgahan	430	167	930	72	2000	0.8	4	12	47
GS07	Potiyadih	3.5	160	40	2000	-	0.8	5	30	-
GS08	B/w Potiyadih & Amdi	65	650	40	1000	-	2	12	35	-
GS09	Amdi	800	380	60	1200	-	0.6	4	22	-
GS10	Palari	155	460	60	1200	-	1.7	13	51	-
GS11	Sanaud/Palari	380	1000	300	85	2500	2	3.5	20	43
GS12	Khartuli	12	2000	-	-	-	23	-	-	-
GS13	Pendarwani	42	115	165	-	-	3	23	-	-
GS14	Kanwar	60	230	40	2000	-	2	16	51	-
GS15	Sangali	34	240	53	2000	-	2.5	10	45	-
GS16	Tarsiva	9	34	1050	-	-	4	22	-	-
GS17	Rawan	15	58	1200	-	-	4	29	-	-
GS18	Kurra	8	60	2000	-	-	2.8	60	-	-
GS19	Tilkhain	11	24	1500	-	-	2	16	-	-
GS20	Kosagondi	2000	650	350	2500	-	4	20	37	-
GS21	Mohara	30	2500	-	-	-	15	-	-	-
GS22	Ojhagahan	12	55	2500	-	-	4.8	20.5	-	-
GS23	Basin	8	2000	-	-	-	13	-	-	-
GS24	Kochera	7	22	2500	-	-	10	44	-	-
GS25	Gangoripar	7.5	40	2000	-	-	6.5	44	-	-
GS26	Pursoli	10	6	2500	-	-	2.8	12	-	-
GS27	Darra	5	70	2000	-	-	2.2	42	-	-
GS28	Loharsi	70	220	52	2500	-	0.5	24	42	-
GS29	Arkar	10	2500	-	-	-	12	-	-	-
GS30	Nasda	13	128	1200	-	-	7	56	-	-
GS31	Bhirai	12	50	2000	-	-	5	23	-	-
GS32	B/w Rawan & Amdi	20	8.5	22	1200	-	1	7.5	28	-
GS33	Bhanpuri	5	21	2000	-	-	4	15	-	-
GS34	B/w Rawan & Taresar	12	34	2500	-	-	1.8	22	-	-
GS35	Demar	11	36	2000	-	-	5	28	-	-
GS36	Dargahan	8.5	45	2000	-	-	2	28	-	-
GS37	Bhendra	13	25	2000	-	-	4	33	-	-
GS38	Korra	30	2500	-	-	-	17.5	-	-	-
GS39	Charota-Hirra	17	48	2500	-	-	2.8	31	-	-
GS40	Gujra	10	50	2500	-	-	6	37	-	-
GS41	Doma	6.7	35	650	-	-	9	21	-	-
GS42	Piparchhedi	9	28	2500	-	-	0.8	24	-	-
GS43	Parsada	5.5	2500	-	-	-	4.5	-	-	-
GS44	Belaudi	8	26	470	-	-	0.5	12.5	-	-
GS45	Amarikhurd	16	500	-	-	-	10	-	-	-
GS46	Batrel	90	29	2500	-	-	2	12	-	-
GS47	Rajoli	15	70	2500	-	-	7	32	-	-
GS48	Borgahan	222	90	3000	-	-	3	48	-	-

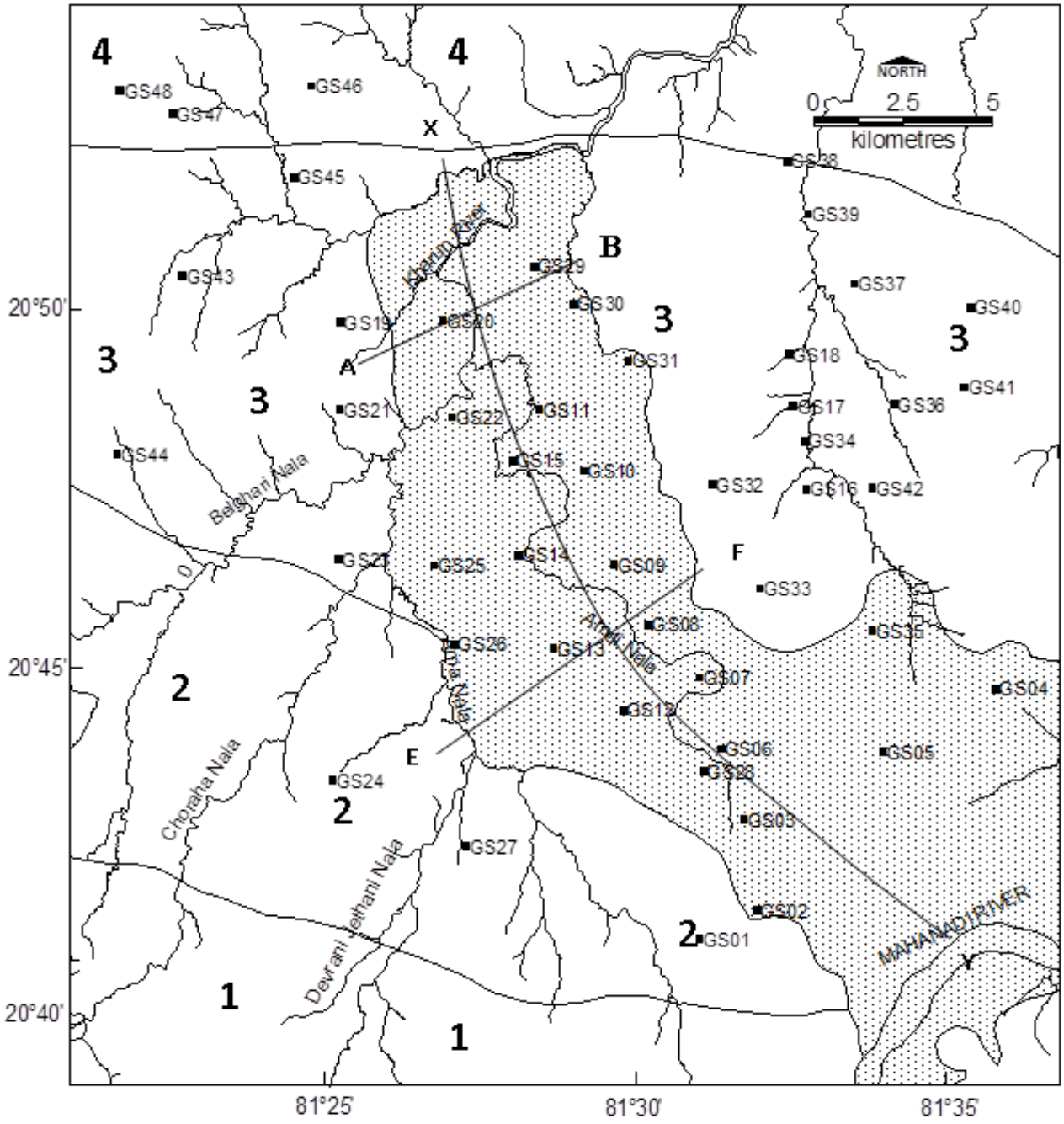


Figure 19 Drainage pattern, geology, extent of alluvium (dotted) and the locations of VES in the study area. 1: Chandarpur Sandstone, 2: Charmuria Limestone (Cherty), 3: Charmuria Limestone (Flaggy), 4: Gunderdehi Shale. AB, EF and XY are the section lines. The cross sections are shown in Figure 21.

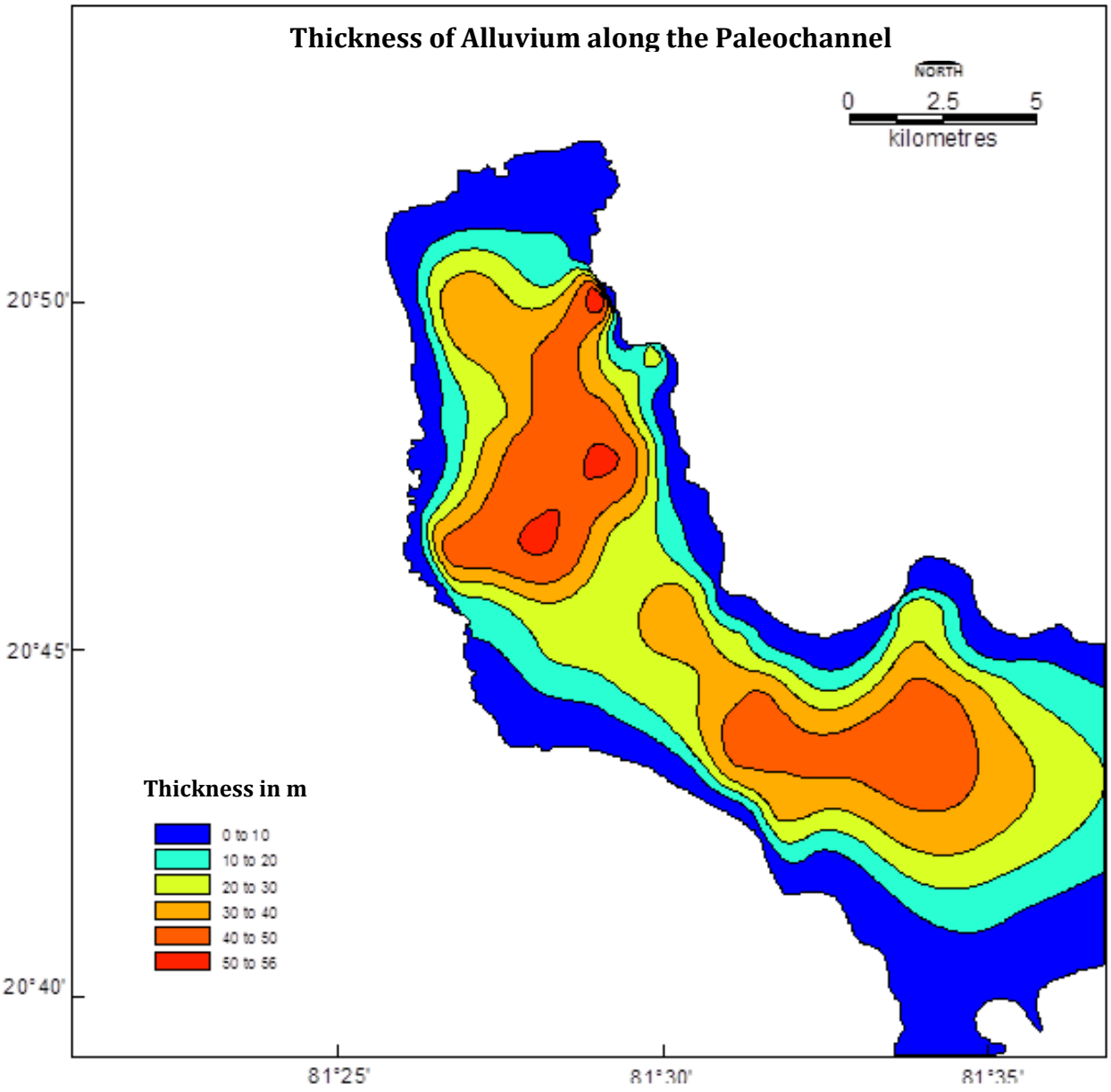


Figure 20 Thickness of Alluvium along the Paleochannel

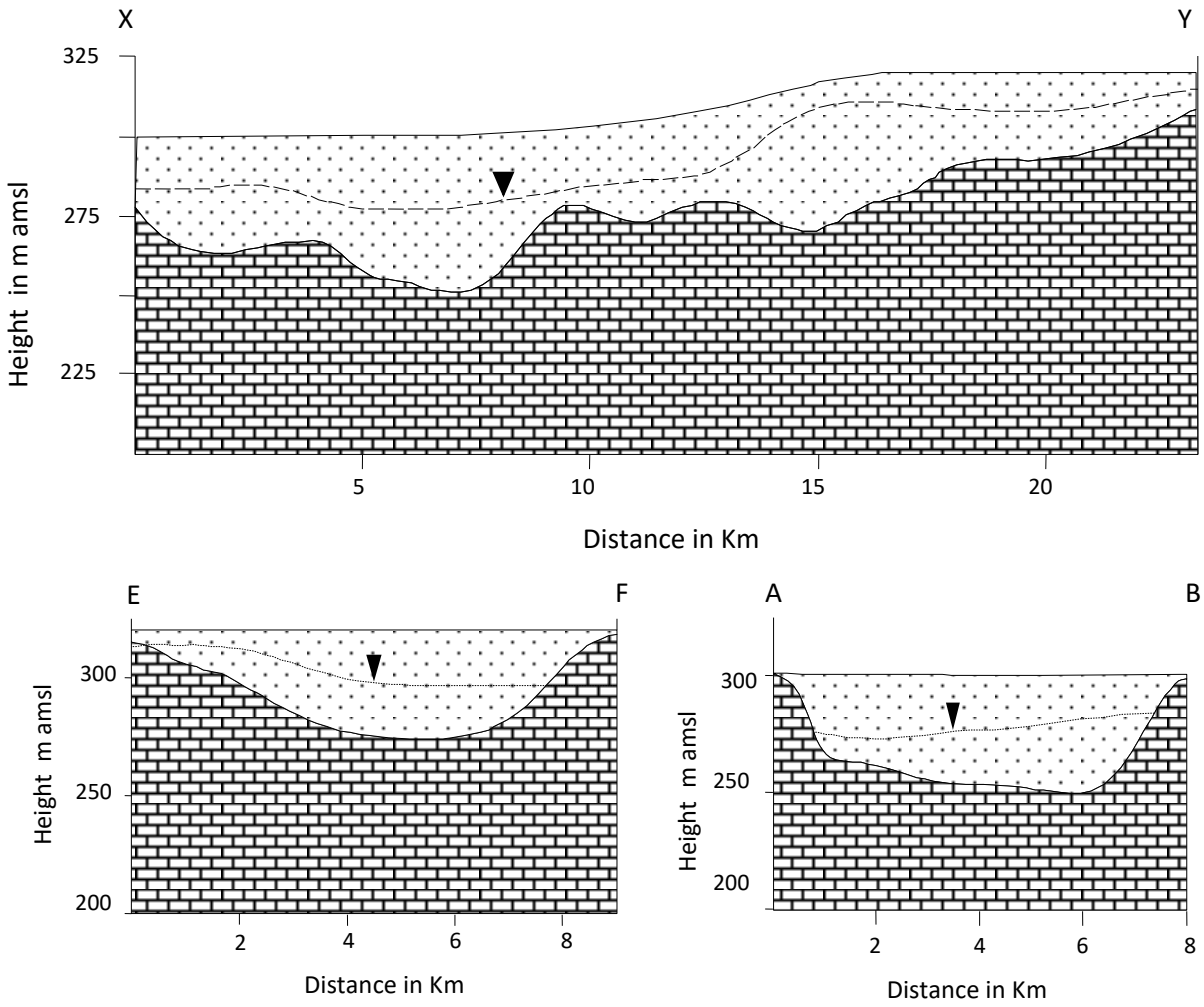


Figure 21 Cross sections of the palaeo channel along XY, AB ang EF showing the variation in alluvium thickness over limestone. The section lines are given in Figure 19. The dotted lines show the premonsoon (May) water table.

2.4 Ground Water Quality

2.4.1 Drinking Water Quality

Groundwater quality sampling was carried out in 73 locations including National Hydrograph Monitoring in 2021-22. The overall chemical quality of the Dhamtari district is good and safe for drinking, except in a few areas where the fluoride and nitrate concentrations were found above the permissible limits. The minimum and maximum values and overall groundwater quality is summarized in table 14.

Table 14 Groundwater Quality Comparison for drinking water

Parameters	Maximum	Minimum	Average	No of wells above acceptable Limit	No of wells above permissible limit	Acceptable Limit	Permissible limit	% of Sample above acceptable Limit	% of Sample above permissible limit
PH	8	7	7.50	73	0	6.5	8.5	100	0.00
EC (µS/cm)	944	90	90.00	NA	NA	NA	NA	NA	NA
Cl (mg/l)	148.9	7	36.30	0	0	250	1000	0	0.00
SO4 (mg/l)	68.6	2.4	16.40	0	0	200	400	0	0.00
CO3 (mg/l)	0	0	0.00	NA	NA	NA	NA	NA	NA
HCO3(mg/l)	292.8	30.5	157.40	NA	NA	NA	NA	NA	NA
F (mg/l)	1.6	0	0.60	17	3	1	1.5	23.29	4.11
TH (mg/l)	355	15	150.50	17	0	200	600	23.29	0.00
Ca (mg/l)	92	4	35.40	4	0	75	200	5.48	0.00
Mg (mg/l)	66	1.2	17.10	9	0	30	100	12.33	0.00
Na (mg/l)	63.1	3.9	26.40	NA	NA	NA	NA	NA	NA
K (mg/l)	17.2	0.4	2.80	NA	NA	NA	NA	NA	NA
Si (mg/l)	35	1.2	12.10	NA	NA	NA	NA	NA	NA
PO4 (mg/l)	0	0	0.00	NA	NA	NA	NA	NA	NA
NO3 (mg/l)	62	0	12.30	NA	5	NA	45	NA	6.85
U (ppm)	18.6	0	0.70	0	0	30	60	0	0.00
TDS (mg/l)	604.2	57.6	261.30	0	49	500	2000	0	67.12
Total No. of Samples-73						**NA- Not Applicable**			

Fluoride: Fluoride in the study area ranges between 0.00 to 1.60 mg/l, with 3 samples above the permissible limit. More than permissible limit of Fluoride reported in HPs at Basikhai, Sonewara of Magarlod block, Nayapara of Nagri block in Dhamtari district.

Nitrate: Nitrate in the study area ranges between 0.00 to 62.00 mg/l, with 5 samples above the permissible limit. More than permissible limit of Nitarte was recorded at Mega in Kurud block, Bhendri in Magarlod block, Dinkarpur, Gedra and Sambalpur in Nagri block of Dhamtari district.

2.4.2 Agriculture Water Quality

a) Salinity Hazard

Table 15 Salinity Hazard of Dhamtari district

EC	Salinity Hazard	No. of Sample	Percentage of sample
100-200	Low	7	6.80
200-750	Medium	61	59.22
750-2250	High	4	3.88
>2250	Very High	0	0.00

b) Sodium Percentage

Table 16 % of Na of Dhamtari district

% of Sodium	Criteria	No. of Sample	Percentage of sample
< 20	Excellent	23	22.33
20- 40	Good	21	20.39
40- 60	Permissible	16	15.53
60- 80	Doubtful	10	9.71

c) Sodium adsorption Ratio (SAR)

Table 17 Sodicity Hazard Dhamtari district

SAR	Sodicity Hazard	No. of Sample	Percentage of sample
< 10	Low	67	65.05
10 to 18	Medium	5	4.85
18 to 26	High	1	0.97
> 26	Very High	0	0.00

d) Residual Sodium Carbonate (RSC)

Table 18 RSC of Dhamtari District

RSC	Criteria	No. of Sample	Percentage of sample
< 1.25	Safe	10	9.71
1.25 - 2.50	Marginal	0	0.00
> 2.5	Unsuitable	63	61.17

e) Mg ratio

Table 19 MAR of the Dhamtari District

Mg Ratio	Criteria	No of Sample	Percentage of sample
< 50	Suitable for Irrigation	56	54.37
> 50	Unsuitable for irrigation	17	16.50

f) Permeability Index

Table 20 Permeability Index of the Study area

PI	Criteria	No. of Sample	Percentage of sample
> 25	Suitable	69	66.99
< 25	Unsuitable	4	3.88

g) Soluble Sodium Percentage (SSP)

Table 21 Soluble Sodium percentage

SSP	Criteria	No of Sample	Percentage of sample
< 60	Good	64	62.14
> 60	Poor	9	8.74

h) Kelly ratio

Table 22 Kelly ratio

Kelly Ratio	Criteria	No of Sample	Percentage of sample
< 1	Suitable for irrigation	53	51.46
> 1	Unsuitable for irrigation	20	19.42

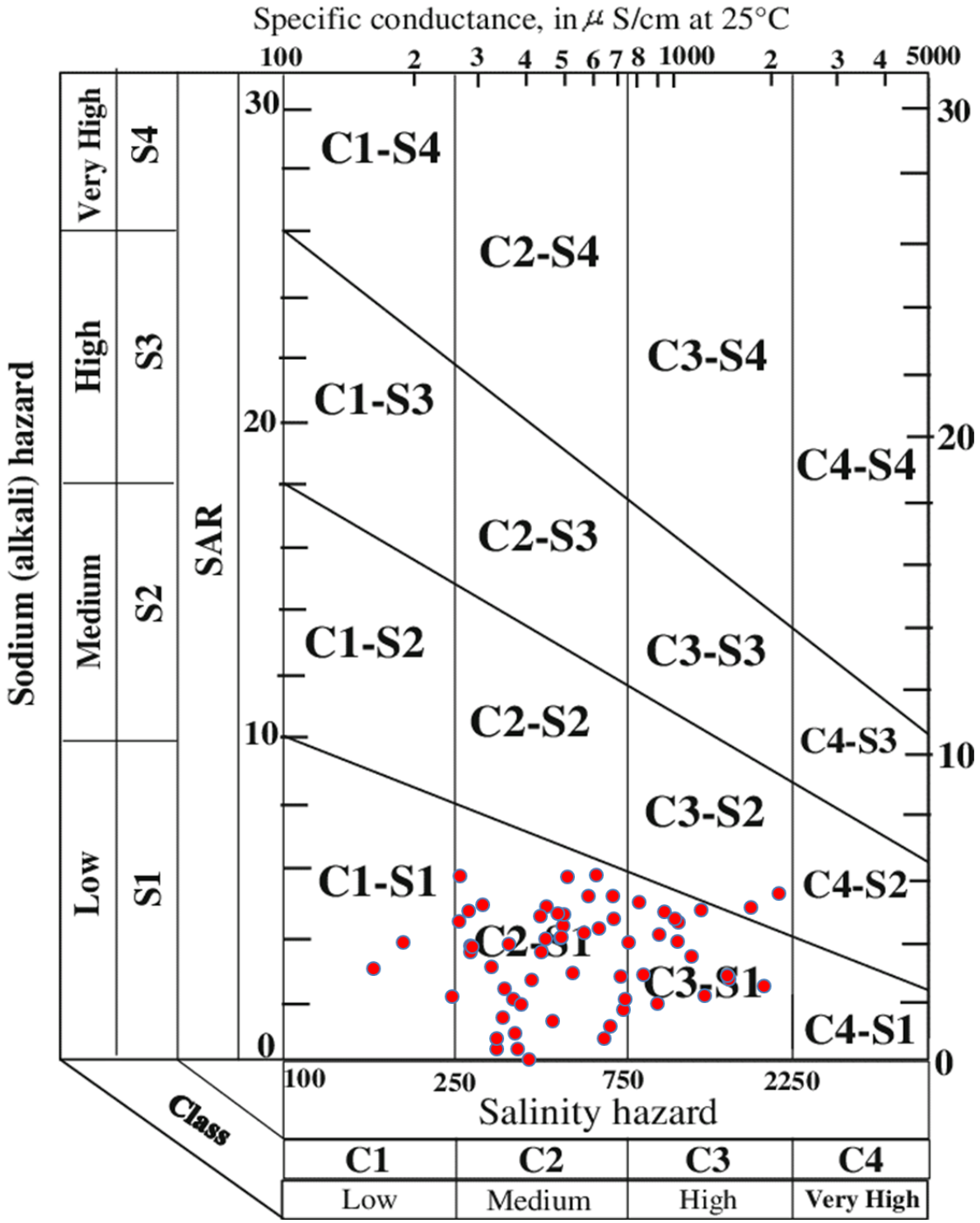
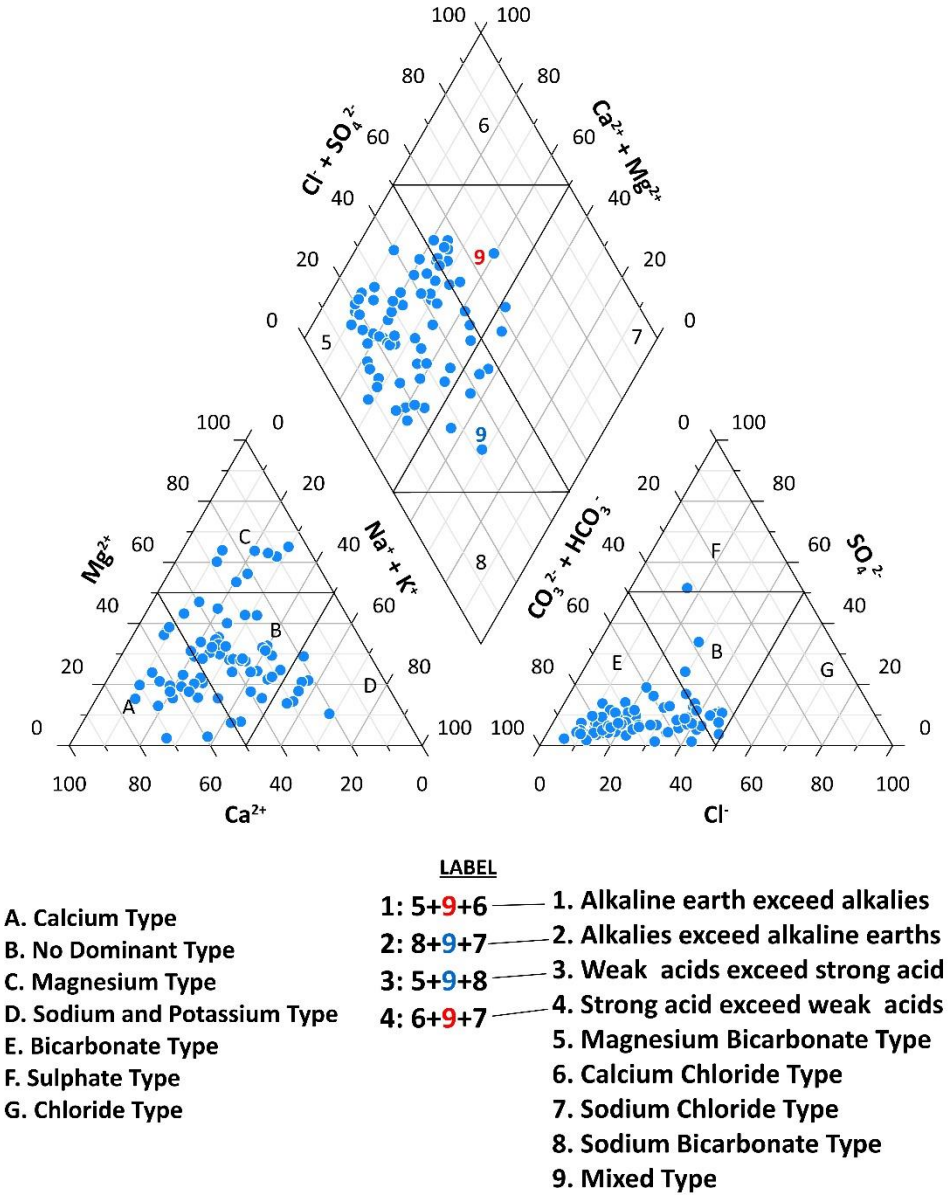


Figure 22 US salinity diagram



LABEL

A. Calcium Type
B. No Dominant Type
C. Magnesium Type
D. Sodium and Potassium Type
E. Bicarbonate Type
F. Sulphate Type
G. Chloride Type

1: 5+9+6 — 1. Alkaline earth exceed alkalies
2: 8+9+7 — 2. Alkalies exceed alkaline earths
3: 5+9+8 — 3. Weak acids exceed strong acid
4: 6+9+7 — 4. Strong acid exceed weak acids
5. Magnesium Bicarbonate Type
6. Calcium Chloride Type
7. Sodium Chloride Type
8. Sodium Bicarbonate Type
9. Mixed Type

Figure 23 Piper Trilinear Plot

The chemical samples analyzed for agriculture water quality reveal that the Sodium Adsorption Ratio (SAR) is less than 10 meq/l for 67 samples and the Kelly Ratio is less than one for 53 samples, which means that the groundwater is suitable for irrigation. Sodium hazard is low and Salinity hazard ranges from low to medium. The percent sodium plot in all the samples falls under permissible to excellent field.

The piper trilinear diagram (Figure-23) reveals that the groundwater is magnesium bicarbonate type and mixed type. The US salinity diagram (Figure-22) shows most of the samples comes under C2S1 and C3S1 box. It is showing medium to high salinity hazard and low Sodium Hazard.

3. AQUIFER DISPOSITION AND GROUNDWATER 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 Granite, Limestone/Dolomite, Shale with Sandstone, Sandstone, Conglomerate, Fluvial alluvium, Laterite/Ferruginous conretions Details are represented in Table 23.

Table 23 Aquifer Characteristics of Dhamtari District

CHARACTERISTICS	AQUIFER SYSTEM	
	Weathered	**Fractured**
Major Rock type	Fluvial alluvium, Laterite/Ferruginous concretions, Granite, Limestone, Shale, Ferruginous Sandstone	Granite, Limestone, Shale, Ferruginous Sandstone
Weathered thickness (mbgl)	5.5 to 40	-
Depth range of the aquifer (mbgl)	5.5 to 40	10 to 185
Fracture encountered (mbgl)	-	10 to 185
No. of waterbearing zones	-	1 to 5
Transmissivity (m^2/day)	-	4 to 335.96
Yield	10 to 100 m^3/day	0 to 11 lps Average- 1 to 5 lps
Sustainability	1 to 4 hours	0.5 to 6 hours
Storativity	-	5.8 X 10^{-4}

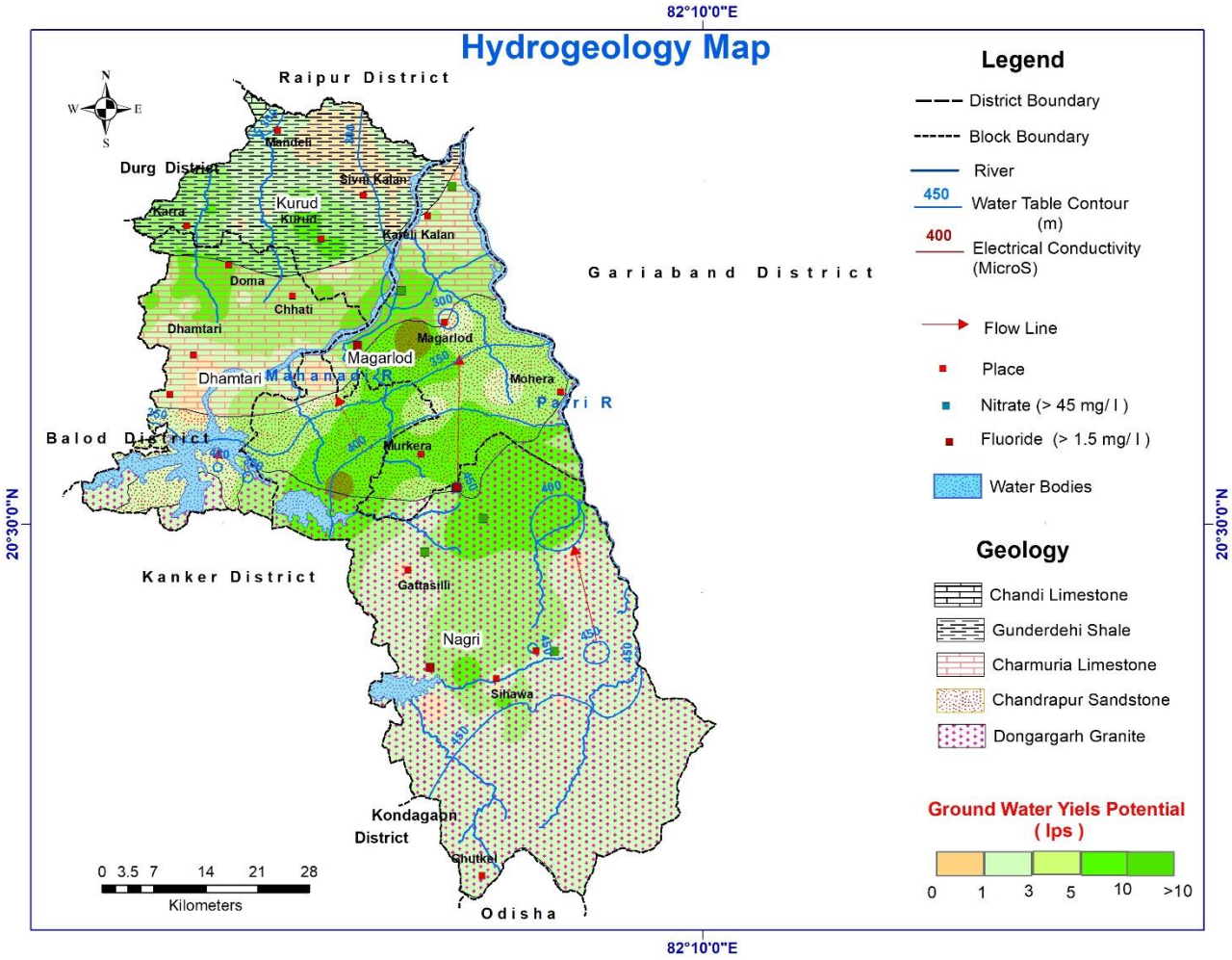


Figure 24 Aquifer Map of the study area

2D Disposition of Aquifer in Dhamtari District

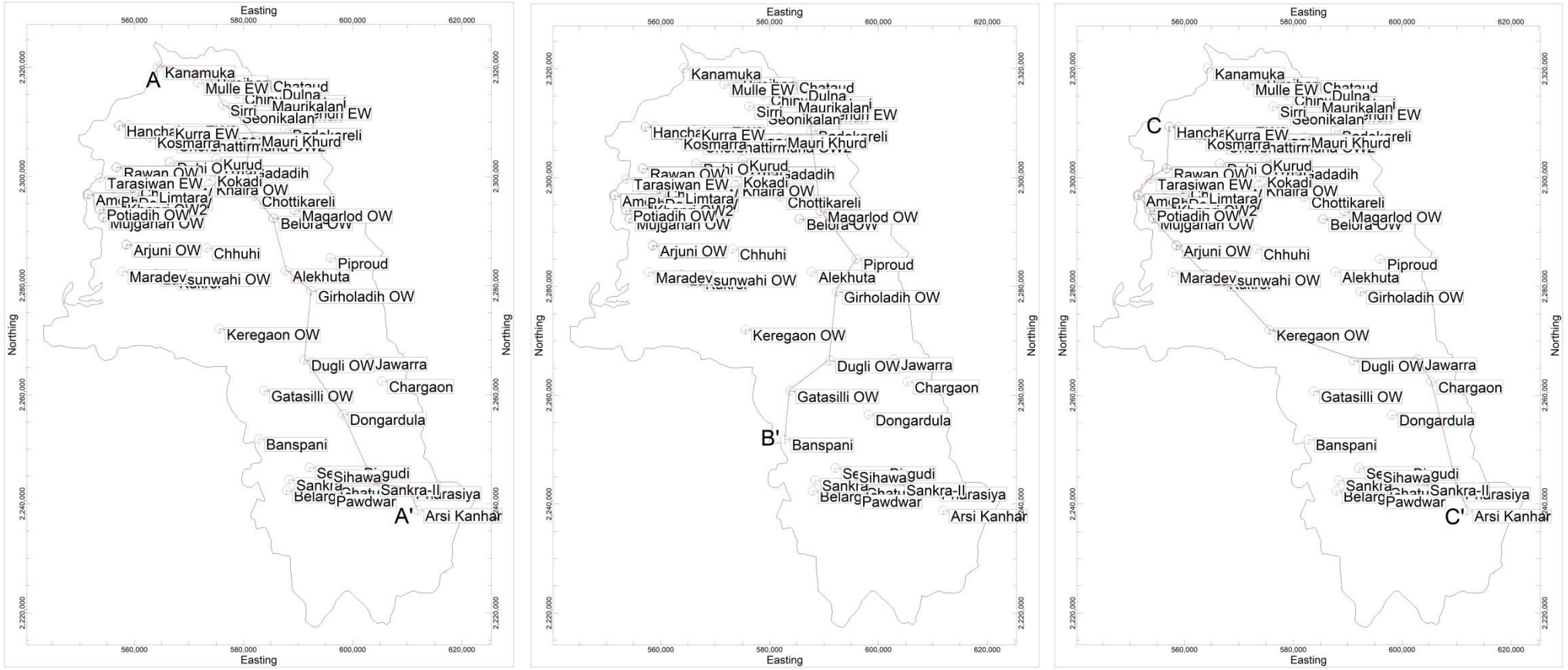


Figure 25(A) 2D Disposition of Aquifer in the study area

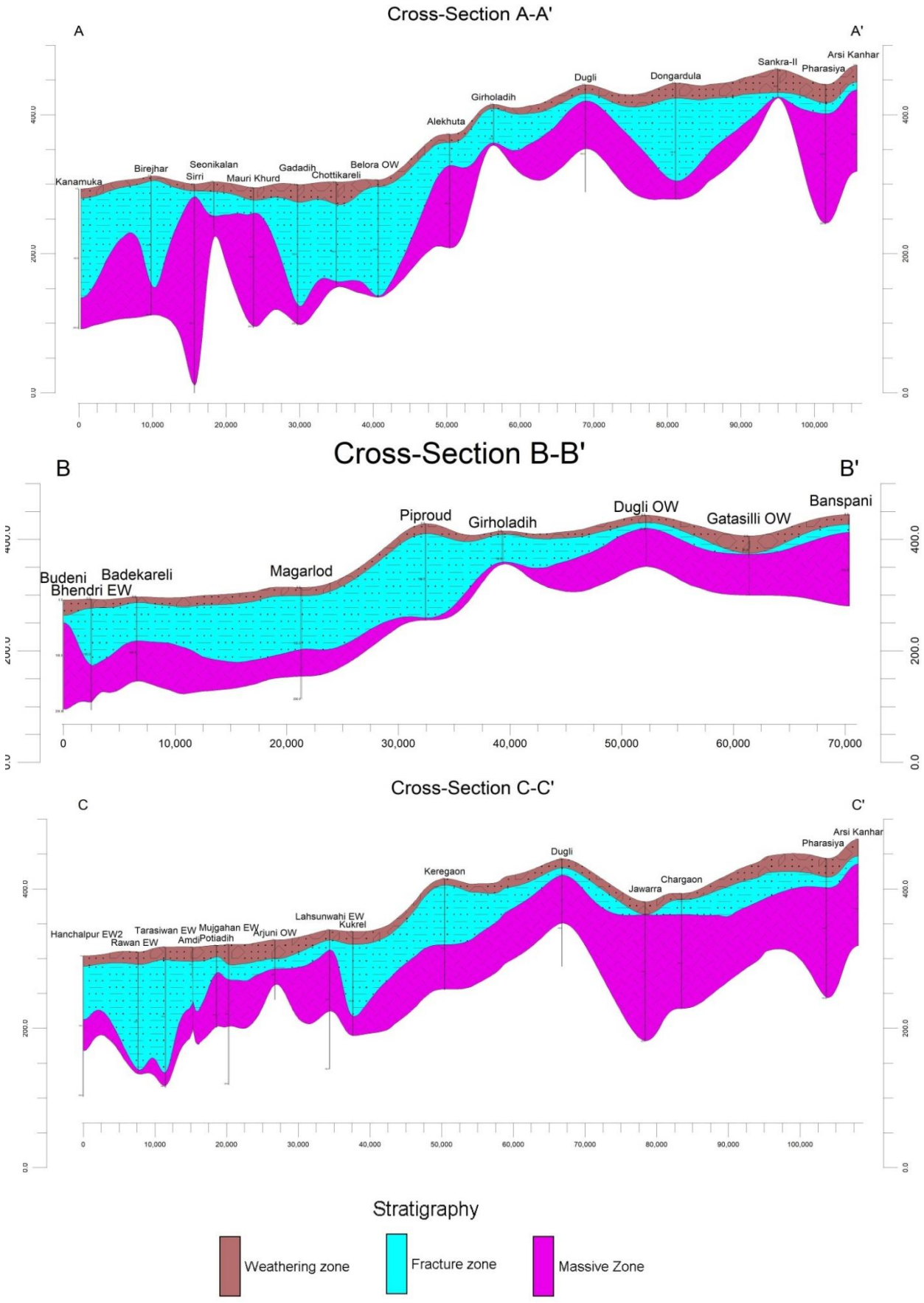


Figure 25(B) 2D Disposition of Aquifer in the study area

3D Disposition of Aquifer in Dhamtari District

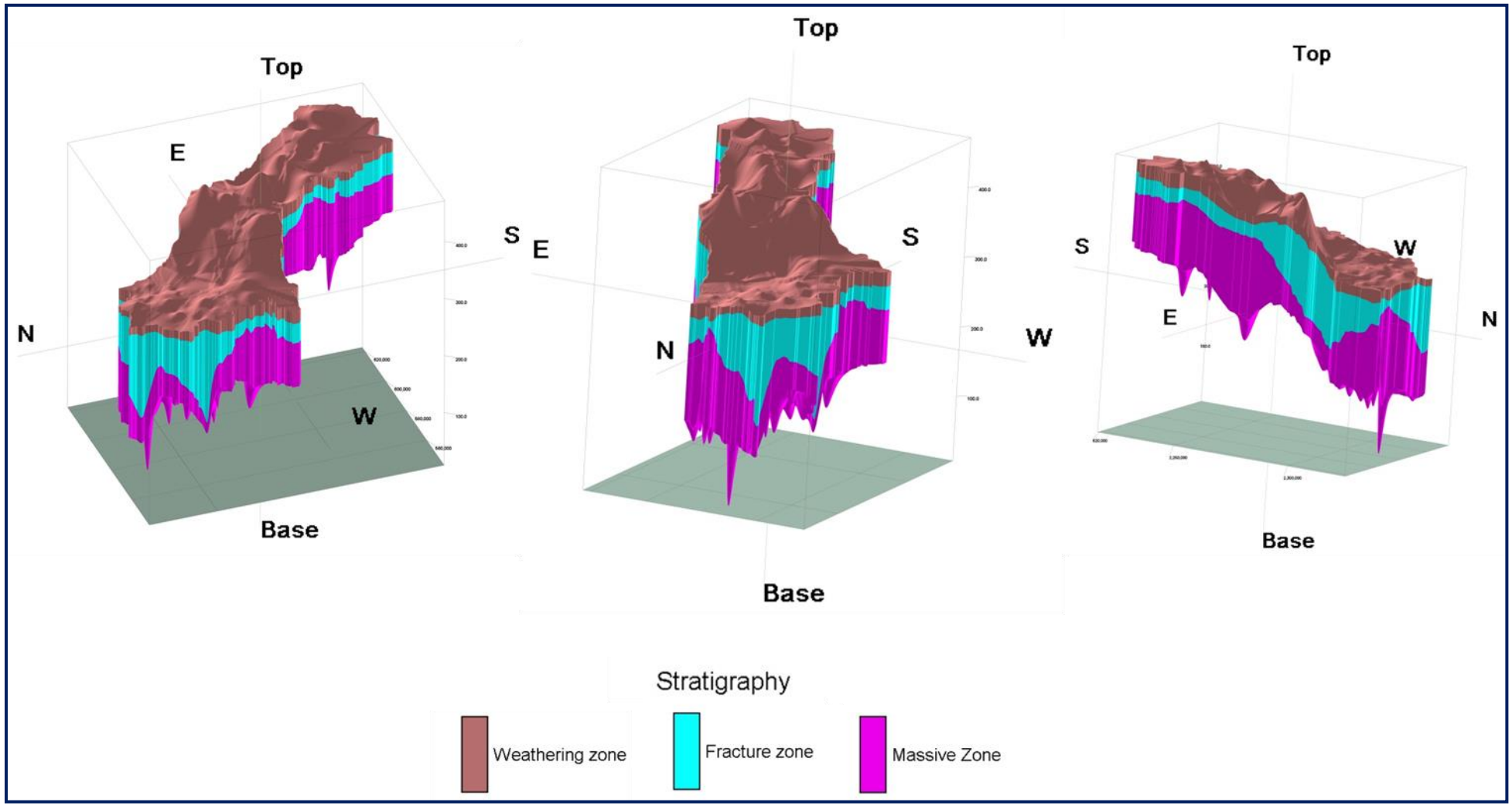


Figure 26(A) 3D Disposition of Aquifer in the study area

3D Disposition of Aquifer in Dhamtari District

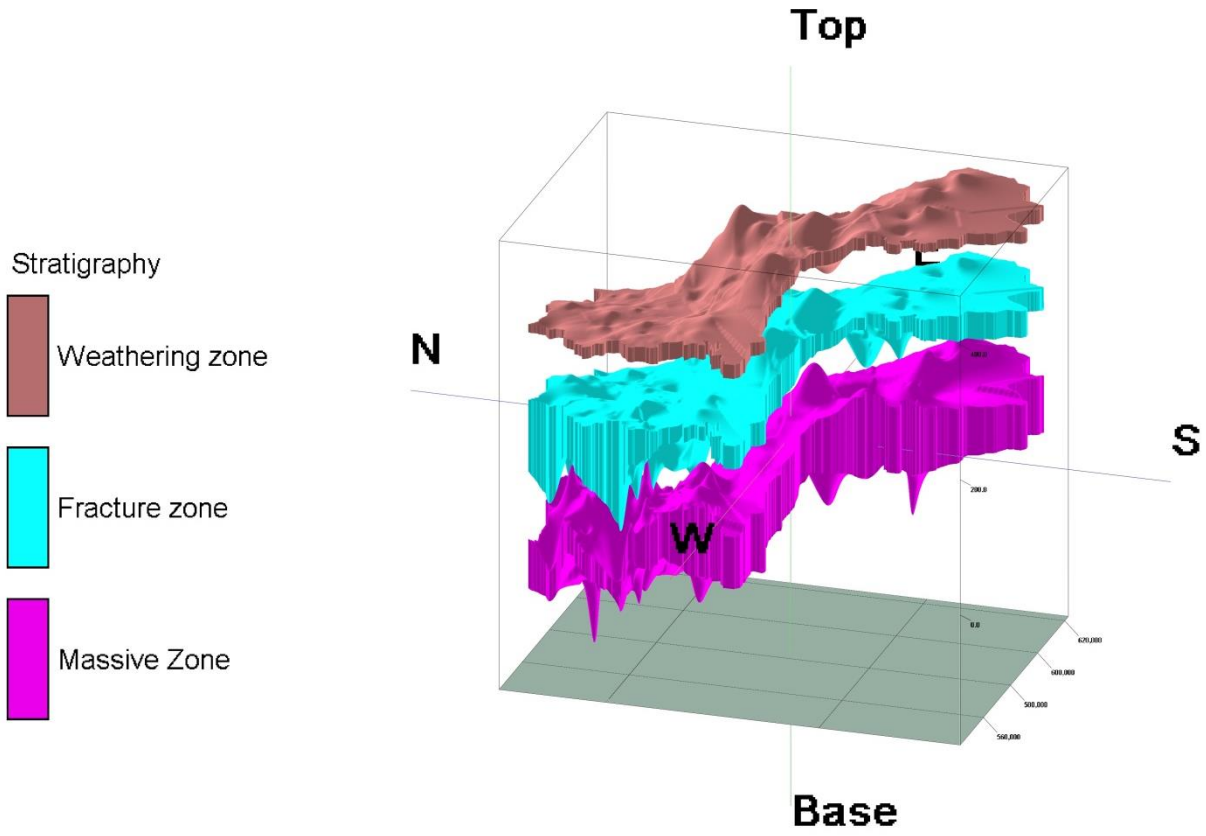


Figure 26(B) 3D Disposition of Aquifer in the study area (Explode map)

3.2 Groundwater Resources Availability and Extraction

In the groundwater resource estimation, the unit of assessment to groundwater 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 groundwater resources have been estimated separately for command and non-command areas. The groundwater 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 groundwater 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 groundwater withdrawal for industries incorporated from the NOC issued by CGWA and from State Industries Department.

As per GWR 2022,Stage of groundwater extraction of the Dhamtari district is 80.22 %. The category and stage of groundwater extraction of all the blocks in the district are given in the Table 24. Based on the resource assessment made, the Block wise resource availability in Dhamtari district upto 200m depth is given in Table 25.

Table 24 Blockwise Stage of Extraction and Category

District	Block Name	Stage of Groundwater Extraction (%)	Category
Dhamtari	Dhamtari	94.62	critical
	Kurud	88.51	semi_critical
	Magarlod	69.85	safe
	Nagri	62.87	safe

Table 25 Groundwater Resource up to 200m bgl (MCM)

District	Block	Dynamic Resources (MCM)		Insitu Resources (MCM)		Total Resources (MCM)
		Aquifer I	Aquifer II	Aquifer I	Aquifer II	
Dhamtari	Dhamtari	30.95	64.65	259.77	3090.15	3445.52
	Kurud	36.15	80.97	219.42	2748.90	3085.44
	Magarlod	53.03	77.38	293.53	3991.16	4415.10
	Nagri	24.67	27.71	107.35	1566.12	1725.85

3.3 Existing and Future Water Demand (2025)

Table 26 Groundwater Resources of the Study area in Ham

Block	Total Annual GW (Ham) Recharge	Total Natural Discharges (Ham)	Annual Extractable GW (Ham) (3=1-2)	Current Annual Groundwater Extraction (Ham)				Annual GW Allocation for Domestic Use as on 2025	Net GW Availability for future use (9=3-4-5-8)	Stage of GW 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	
Dhamtari	13992.87	1399.28	12593.59	11172.72	4.22	738.68	11915.62	774.76	1521.23	94.62
Kurud	11461.43	1146.14	10315.29	8556.47	8.85	564.63	9129.94	598.16	2104.49	88.51
Magarlod	12121.97	779.23	11342.74	7606.21	0.81	315.43	7922.45	336.5	3399.22	69.85
Nagri	9565.64	956.57	8609.07	4963.46	0.06	449.28	5412.8	470.63	3174.91	62.87
TOTAL	**47141.91**	**4281.22**	**42860.69**	**32298.86**	**13.94**	**2068.02**	**34380.81**	**2180.05**	**10199.85**	**80.22**

Total annual groundwater recharge and annual extractable groundwater resource of the district have been estimated to be 47,141.91 Ham and 42,860.69 Ham respectively. Gross groundwater extraction for all uses in the district is 34,380.81Ham. The existing demand for irrigation in the area is 32,298.86 Ham while the same for domestic use is 2,068.02 Ham and for industrial field is 13.94 Ham. To meet the future demand for groundwater, a total quantity of **10,199.85** Ham of groundwater is available for future use.

4. GROUNDWATER RELATED ISSUES

- **Drying of Dugwells and handpumps during summer-** At several places of Dhamtari, Kurud, Magarlod and Nagri blocks phreatic aquifer i.e. zone of dugwells dried up in summer due to large number of shallow borewells in the area and pumping of groundwater by borewell for cultivation of paddy crop during Kharif season.
- **Inherent hydrogeological character of aquifer-** The fractures are also very localised which results very low yield and less transmissivity in aquifers. In Nagri block, the lithology of most of the area is Granite where yield is negligible because of inherent properties of rock and lack of localized fractures in Dongargarh Granite.
- **Fluoride concentration-** More than permissible limit of Fluoride reported in HPs at Basikhai, Sonewara of Magarlod block, Nayapara of Nagri block in Dhamtari district. (Annexure-3)
- **Nitrate contamination-** More than permissible limit found in villages like Mega in Kurud block, Bhendri in Magarlod block, Dinkarpur, Gedra and Sambalpur in Nagri block of Dhamtari district. (Annexure-3)
- **TDS-** More than 600 mg/l TDS reported in locations like Mega Village of Kurud block. (Annexure-3)

5. GROUNDWATER MANAGEMENT STRATEGY

- Desiltation and rejuvenation of existing check dams, tanks and talabs (ponds) to be carried out for efficient storage of rainwater and recharge of groudwater. Rain water harvesting structures may be constructed in villages to reduce stress on groundwater.
- It has been observed that the demand of groundwater is increasing for irrigation, industrial and domestic uses. At locations where water level is declining, artificial recharge on a long-term sustainability basis has to be implemented. Artificial Recharge structures may be constructed at suitable locations especially in the areas where the water level remains deeper more than 3m in the post-monsoon period in the district to arrest the huge non-committed run-off and augment the groundwater storage in the area. The different types of artificial recharge structures feasible in the block are described in Table 27.

Table 27 Types and number of Artificial Recharge structures feasible

Block/District	Area Identified for Artificial recharge (sq. km)	Vol. of Sub Surface Potential for Artificial recharge (MCM)	Types of Structures Feasible and their Numbers			
			Percolation tank	Nalas bunding cement plug/ check dam	Gravity head /Dug well/ tube well/Recharge shaft	Gully plugs Gabion structures
Recharge Capacity - (MCM)/structure			**0.2192**	**0.0326**	**0.00816**	**0.0073**
Dhamtari	428.46	43.20	144	479	1077	821
Kurud	262.21	7.473	25	83	186	142
Magarlod	202.02	5.753	19	64	143	109
Nagri	104.00	1.716	6	19	43	33
Total (Dhamtari)	**996.69**	**58.14**	**194**	**645**	**1449**	**1105**

Table 28 Detail of groundwater saved through change in cropping pattern and other interventions

Block	Existing Gross GW Draft for Irrigation in Ham	Additional Saving of GW after using Micro Irrigation methods in Ham(Assuming 30 % saving)	GW recharge through Artificial recharge structure in Ham	Total GW Resource Enhancement in Ham	Stage of GW Extraction (%) As per 2022 GWRE	Expected Stage of GW Extraction (%) after intervention
Dhamtari	11172.72	3351.82	4320.00	7671.82	94.62	58.80
Kurud	8556.47	2566.94	747.30	3314.24	88.51	66.99
Magarlod	7606.21	2281.86	575.30	2857.16	69.85	55.79
Nagri	4963.46	1489.04	171.60	1660.64	62.87	52.71
Total (Dhamtari)	**32298.86**	**9689.66**	**5814.20**	**15503.86**	**80.22**	**58.91**

- Abandoned tube well and dug well may be used for the recharge through shaft especially in urban and water stressed areas.
- Fluoride filter plant (defluordination units) in 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 groundwater. 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 groundwater. Treated water may also be reused for irrigation and other industrial purposes.

- Since the stage of development in the district is 80.22 %. There is limited scope of utilizing more groundwater for future irrigation purpose. The groundwater is presently developed through dug wells, borewells 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 groundwater quality also needs to be ascertained and the wells used for water supply should be first checked for Iron, Fluoride, Nitrate and other pollutants.
- Contour trenches is one of the best artificial recharge method in hilly areas of Dhamtari district especially in Nagri block where slope is high. Gully plugs and Nala bunds need to be constructed more in number in villages to augment irrigation and domestic uses and to recharge the groundwater.
- Desiltation and rejuvenation of ponds and percolation tanks in villages should be encouraged by providing subsidy to the people in villages and urban areas for groundwater recharge and utilization of water for irrigation which will thereby reduce the dependency on groundwater.
- Farming of high value crops like millets, ragi, maize, wheat, plantation crops, fruits, vegetables should be practiced instead of water intensive crops like rice and sugarcane especially in rabi season.
- 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.

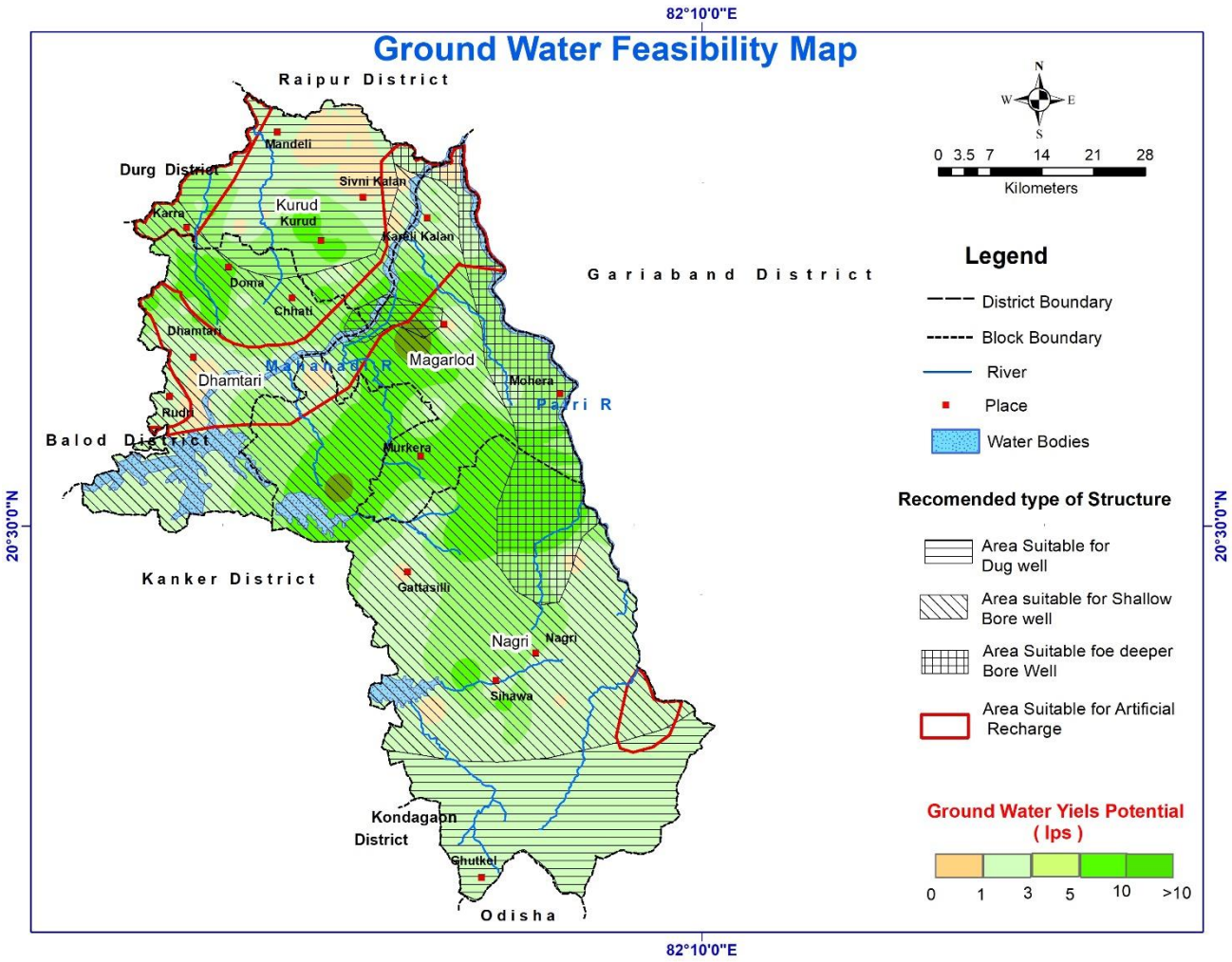


Figure 27 Feasibility of GW Abstraction and Area Identified for Artificial Recharge Map

6. CONCLUSION:

For effective utilization of groundwater existing draft for irrigation may be coupled with micro irrigation system and crop rotation, rain water harvesting and artificial recharge. Change in irrigation pattern, crop rotation, optimum use of available resource, use of groundwater potential created after artificial recharge can lead to groundwater savings and increase in gross cropped area of the district (Table 28). Desiltation and rejuvenation of ponds and percolation tanks in villages should be encouraged for groundwater recharge and utilization of water for irrigation which will thereby reduce the dependency on groundwater. Farming of high value crops like millets, ragi, maize, plantation crops, fruits, vegetables should be practiced instead of water intensive crops like rice and sugarcane especially in rabi season.

Annexure 1 Details of Key Wells established in Dhamtari District (2022)

Sl. No.	Block	Village	Latitude	Longitude	May WL mbgl	Nov WL mbgl	Pre-Post Fluctuation	RL	WT	Type of well
1	Dhamtari	Marradev	20.64163	81.55783	2.55	2.28	0.27	333.6	331.05	DW
2	Dhamtari	Chhati	20.7792	81.6667	0.35	0.28	0.07	319.9	319.55	DW
3	Dhamtari	Gangrel	20.6346	81.5583	11.94	2.95	8.99	335.7	323.76	DW
4	Dhamtari	Khadadaha	20.5733	81.6933	3.2	2.43	0.77	392	388.8	DW
5	Dhamtari	Siyadehi	20.64776	81.62055	6	4.28	1.72	334.4	328.4	DW
6	Dhamtari	Puri	20.77476	81.63482	4.55	2.62	1.93	317.4	312.85	DW
7	Dhamtari	Bhoyna	20.6499	81.61269	3.5	3.45	0.05	345.4	341.9	DW
8	Dhamtari	Acchota	20.66421	81.5834	1.7	1.06	0.64	329	327.3	DW
9	Dhamtari	Urputti	20.5574	81.61189	6.9	2.31	4.59	355.5	348.6	DW
10	Dhamtari	Barbandha	20.54522	81.57491	2.5	1.32	1.18	354.2	351.7	DW
11	Dhamtari	Bhirawar	20.50932	81.53067	6.82	2.5	4.32	358.7	351.88	DW
12	Dhamtari	Kodegaon_R	20.5356	81.48249	6	3.87	2.13	380.5	374.5	DW
13	Dhamtari	Soram	20.65602	81.51434	0.9	2.64	-1.74	332.2	331.3	DW
14	Dhamtari	Tumrabahar	20.59864	81.50288	3.2	2.82	0.38	368	364.8	DW
15	Dhamtari	Mujhgahan	20.72081	81.52591	6.55	4.05	2.5	322.2	315.65	DW
16	Kurud	Bhatagaon	20.87833	81.700278	1.65	0.95	0.7	313.7	312.05	DW
17	Kurud	Gadadih	20.82194	81.693121	4.8	4.38	0.42	317.3	312.5	DW
18	Kurud	Kondapar	21.0042	81.725	8.45	2.72	5.73	309	300.55	DW
19	Kurud	Kosmarra	20.86428	81.59962	7.9	3.74	4.16	312.9	305	DW
20	Kurud	Kurud	20.8275	81.7189	3.8	2.25	1.55	310.2	306.4	DW
21	Kurud	Mega	20.7833	81.8005	8.45	6.06	2.39	302	293.55	DW
22	Kurud	Aouri	20.857	81.687	4.1	0.95	3.15	309.6	305.5	DW
23	Kurud	Doma	20.81598	81.5853	7.8	3.5	4.3	316.2	308.4	DW
24	Kurud	Bhakhara	20.89338	81.60098	3.5	2.75	0.75	306.7	303.2	DW
25	Kurud	Kachna	20.99722	81.63352	1.88	1.83	0.05	295.7	293.82	DW
26	Kurud	G. Jamgaon	20.97002	81.68117	2.47	1.75	0.72	311	308.53	DW
27	Kurud	Birejhar	20.96388	81.70758	3.85	1.35	2.5	313.8	309.95	DW
28	Kurud	Marod	20.9083	81.68943	8.5	1.75	6.75	318.4	309.9	DW
29	Kurud	Charra (abasparra)	20.8107	81.71225	1.94	1.55	0.39	315.7	313.76	DW
30	Kurud	Sivnikala	20.89973	81.74832	2.03	1.15	0.88	307.6	305.57	DW
31	Kurud	Maurikala	20.92423	81.80702	11.82	3.55	8.27	291.3	279.48	DW
32	Kurud	Parsatti	20.94465	81.79005	6.14	2.22	3.92	292.6	286.46	DW
33	Kurud	Sivnikhurd	20.74447	81.73187	2.7	2.3	0.4	307.5	304.8	DW
34	Kurud	Darba	20.9615	81.68	2.15	2.05	0.1	303.8	301.65	DW
35	Magarlod	Banraud	20.5958	81.6583	6.8	4.12	2.68	356	349.2	DW
36	Magarlod	Baspara(Kukrel)	20.6131	81.6507	4.35	2.1	2.25	338.4	334.05	DW
37	Magarlod	Magarload	20.7472	81.8583	13.68	5.94	7.74	310.4	296.72	DW
38	Magarlod	Mulgaon	20.6783	81.9062	4.53	2.64	1.89	397.3	392.77	DW
39	Magarlod	Singhpur	20.5819	81.8778	10.68	7	3.68	441.4	430.72	DW
40	Magarlod	Nawagaon	20.94882	81.866438	4.89	4.22	0.67	288.5	283.61	DW
41	Magarlod	Bhendri	20.91055	81.862018	5.85	1.9	3.95	291	285.15	DW

Sl. No.	Block	Village	Latitude	Longitude	May WL mbgl	Nov WL mbgl	Pre-Post Fluctuation	RL	WT	Type of well
42	Magarlod	Amaldih	20.7687	81.915966	5.52	4.06	1.46	312.3	306.78	DW
43	Magarlod	Sarairukh	20.62258	81.875127	7.18	4.49	2.69	410.4	403.22	DW
44	Magarlod	Sonjhari	20.55377	81.818079	8.13	7.66	0.47	442.7	434.57	DW
45	Magarlod	Basikhai	20.54452	81.867702	5.41	3.99	1.42	457.7	452.29	DW
46	Magarlod	Vijaypur (Jamli Para)	20.72615	81.790277	5.83	3.93	1.9	312.1	306.27	DW
47	Magarlod	Sonewara	20.71724	81.746959	5.09	3.16	1.93	309.6	304.51	DW
48	Magarlod	Kareli Badi	20.86519	81.832436	2.64	1.15	1.49	293.8	291.16	DW
49	Nagri	Gedra	20.46554	81.828784	11.4	7	4.4	431.9	420.5	DW
50	Nagri	Gajkanhar	20.43656	81.903292	5.87	4.75	1.12	441.1	435.23	DW
51	Nagri	Bilbhadar	20.39164	81.93095	2.58	0.8	1.78	439.8	437.22	DW
52	Nagri	Sambalpur	20.34521	81.986902	3.68	2.36	1.32	453.1	449.42	DW
53	Nagri	Nayapara	20.33661	82.035776	8.05	6.55	1.5	463.8	455.75	DW
54	Nagri	Mode	20.32048	81.977173	6.23	1.58	4.65	449.8	443.57	DW
55	Nagri	Bhainsa Sankara	20.30187	82.018052	8.54	5.84	2.7	452	443.46	DW
56	Nagri	Gahana Siyar	20.2638	82.001672	6.13	3.31	2.82	468.9	462.77	DW
57	Nagri	Umargaon	20.27559	81.959471	8.9	3.94	4.96	458.6	449.7	DW
58	Nagri	Ratawa	20.25581	81.934185	4.05	3.2	0.85	461.9	457.85	DW
59	Nagri	Amgaon	20.20565	81.926838	4.87	3.27	1.6	485.2	480.33	DW
60	Nagri	Belargaon	20.28057	81.841529	9.82	5.38	4.44	436	426.18	DW
61	Nagri	Ghotgaon	20.3928	81.82819	8.67	2.85	5.82	439.2	430.53	DW
62	Nagri	Kouhabahara	20.4916	81.8575	7.15	5.25	1.9	433.7	426.55	DW
63	Nagri	Kumhada	20.56839	81.576977	8.2	4.22	3.98	414.8	406.6	DW
64	Nagri	Tumribahar	20.34766	81.959515	2.8	2.4	0.4	456.3	453.5	DW
65	Nagri	Arjuni	20.2415	81.953481	7	4.31	2.69	464.3	457.3	DW
66	Nagri	Lilanj	20.29188	82.052972	5.5	3.64	1.86	441.3	435.8	DW
67	Nagri	Farsiya	20.32213	82.03526	10.5	3.09	7.41	452.6	442.1	DW
68	Nagri	Amali	20.32213	82.03526	2.4	1.9	0.5	452.6	450.2	DW
69	Nagri	Belar Bahara	20.2388	82.1184	8.2	3.96	4.24	461.3	453.1	DW
70	Nagri	Basin	20.249	82.1654	8.2	4.72	3.48	490.4	482.2	DW
71	Sihawa (Nagri)	Arsi-kanhar	20.2458	82.0792	11.75	8.7	3.05	469.9	458.15	DW
72	Sihawa (Nagri)	Banspani	20.3667	81.7917	8.65	5.12	3.53	451.7	443.05	DW
73	Sihawa (Nagri)	Birgudi	20.3222	81.8625	5.12	4.1	1.02	432.4	427.28	DW
74	Sihawa (Nagri)	Dorgardula	20.4056	81.9111	11.25	7.85	3.4	436.4	425.15	DW
75	Sihawa (Nagri)	Dugli	20.4917	81.8708	6.1	1.5	4.6	439.4	433.3	DW
76	Sihawa (Nagri)	Gattasilli	20.8759	81.5671	2.7	2.3	0.4	305.4	302.7	DW
77	Sihawa (Nagri)	Jabarra	20.4956	81.9858	5.56	1.9	3.66	381.3	375.74	DW
78	Sihawa (Nagri)	Keregaon	20.5486	81.7375	4.82	2.95	1.87	423.3	418.48	DW
79	Sihawa (Nagri)	Mechka (sondur)	20.2337	82.087	6.7	5.36	1.34	468	461.3	DW
80	Sihawa (Nagri)	Nagri	20.3333	81.9583	8.9	1.95	6.95	438.2	429.3	DW

Sl. No.	Block	Village	Latitude	Longitude	May WL mbgl	Nov WL mbgl	Pre-Post Fluctuation	RL	WT	Type of well
81	Sihawa (Nagri)	Sihawa	20.3083	81.9125	6.3	4.79	1.51	434	427.7	DW
82	Sihawa (Nagri)	Sankra	20.2625	82.0076	9.05	2.7	6.35	469.8	460.75	DW
83	Dhamtari	Dhamtari	20.70833	81.55	19.33	12.4	6.93	327	307.67	HP
84	Dhamtari	Gangrel	20.62667	81.574722	12.26	9.64	2.62	332	319.74	HP
85	Dhamtari	Acchota	20.66399	81.58337	12.7	13.4	-0.7	329	316.3	HP
86	Dhamtari	Barbandha	20.54522	81.57576	6.2	3.72	2.48	356.7	350.5	HP
87	Dhamtari	Koliyari	20.53968	81.45333	19.45	14.3	5.15	362.1	342.65	HP
88	Dhamtari	Bhatagaon	20.668	81.52936	18.5	14.8	3.7	334.9	316.4	HP
89	Dhamtari	Arjuni	20.73598	81.56046	22.7	17.56	5.14	323.1	300.4	HP
90	Dhamtari	Tarsiwan/Demar	20.7792	81.55796	19.14	13.98	5.16	316.3	297.16	HP
91	Dhamtari	Ravan	20.81104	81.54278	18.8	10.1	8.7	311.6	292.8	HP
92	Dhamtari	Mujhgahan	20.72081	81.52591	18.62	13.02	5.6	322.2	303.58	HP
93	Dhamtari	Bodrapuri	20.79909	81.63745	4.7	2.9	1.8	315.9	311.2	HP
94	Dhamtari	Kasahi	20.80488	81.63793	4.83	2.8	2.03	313.3	308.47	HP
95	Dhamtari	Boliyara	20.72977	81.61294	20.3	16.97	3.33	321.7	301.4	HP
96	Dhamtari	Jhiriya	20.74107	81.67701	11.8	9.54	2.26	311.2	299.4	HP
97	Kurud	Kurud	20.8275	81.718889	4.1	1.84	2.26	310	305.9	HP
98	Kurud	Doma	20.8215	81.58713	20.65	12.6	8.05	314.1	293.45	HP
99	Kurud	Rampur	20.90177	81.56027	13.22	6.8	6.42	302.9	289.68	HP
100	Kurud	Kachna	20.99903	81.63045	11.6	7.46	4.14	295.2	283.6	HP
101	Kurud	Birejhar	20.96388	81.70758	16.3	4.3	12	313.8	297.5	HP
102	Kurud	Charra	20.8107	81.71225	5.8	3.9	1.9	315.7	309.9	HP
103	Kurud	Sivnikala	20.90335	81.74748	3.4	2.85	0.55	306	302.6	HP
104	Kurud	Maurikala	20.92423	81.80702	12.8	4.26	8.54	291.3	278.5	HP
105	Kurud	Mandraud	20.79425	81.76738	13.6	7.7	5.9	302.7	289.1	HP
106	Kurud	Megha	20.78538	81.80061	12.3	6.5	5.8	302.2	289.9	HP
107	Magarlod	Mohrenga	20.87374	81.879088	8.41	6.43	1.98	296.2	287.79	HP
108	Magarlod	Hasda 1	20.85196	81.873507	16.4	14.6	1.8	299.1	282.7	HP
109	Magarlod	Nawagaon (Khisora)	20.81177	81.88009	23.12	20.81	2.31	304	280.88	HP
110	Magarlod	Kapalfodi	20.79039	81.898318	15.83	12.64	3.19	308	292.17	HP
111	Magarlod	Rengadih	20.73695	81.904846	17.55	14.92	2.63	315.3	297.75	HP
112	Magarlod	Pathar	20.69293	81.88882	21.9	23.9	-2	376.3	354.4	HP
113	Magarlod	Alekhuta	20.63903	81.83829	14.22	7.42	6.8	381.4	367.18	HP
114	Magarlod	Kusumkhuta	20.67388	81.817114	13.7	9.93	3.77	363.6	349.9	HP
115	Magarlod	Luge	20.75324	81.814783	16.83	15.26	1.57	303.4	286.57	HP
116	Magarlod	Khairjhit	20.80846	81.826126	21.35	13.25	8.1	296.6	275.25	HP
117	Magarlod	Banraud D	20.59583	81.658333	7.02	2.27	4.75	356	348.98	HP
118	Magarlod	Magarlod D	20.74583	81.854167	12.42	10.37	2.05	313	300.58	HP
119	Magarlod	Magarlod S	20.74583	81.854167	19.68	10.26	9.42	313	293.32	HP
120	Nagri	Dinkarpur	20.50674	81.900096	9.1	7.21	1.89	426.9	417.8	HP
121	Nagri	Kohinpara	20.45995	81.810911	5.64	2.32	3.32	423.7	418.06	HP
122	Nagri	Guhan Nala	20.45281	81.878536	9.05	5.45	3.6	440.4	431.35	HP

Sl. No.	Block	Village	Latitude	Longitude	May WL mbgl	Nov WL mbgl	Pre-Post Fluctuation	RL	WT	Type of well
123	Nagri	Parsapani	20.40592	81.8847	7.54	7.17	0.37	445.2	437.66	HP
124	Nagri	Tengna	20.32894	81.996561	10.58	2.77	7.81	447.6	437.02	HP
125	Nagri	Gidhawa	20.26619	81.893381	12.67	12.77	-0.1	459.9	447.23	HP
126	Nagri	Nayapara	20.3252	81.835629	11.69	4.5	7.19	433	421.31	HP
127	Sihawa (Nagri)	Nagari	20.50056	81.958333	8.4	5.49	2.91	405	396.6	HP

Annexure 2 Details of Exploration in Dhamtari District

Sl. No.	Block	Location	Latitude	Longitude	Depth (m bgl)	Casing (m)	Formation	Lithology	Zone_encountered (m bgl)	Discharge (lps)
1	Dhamtari	Demar	20.7636	81.5712	78	9	Charmuria Formation	Limestone	17-25, 30	11
2	Dhamtari	Chhati	20.7792	81.6667	70	12.5	Charmuria Formation	Limestone	14-16	meagre
3	Dhamtari	Tarsiwan	20.7833	81.5333	56.95	11	Charmuria Formation	Limestone	17 -29.55, 35	9
4	Dhamtari	Tarsiwan	20.7833	81.5333	56	15	Charmuria Formation	Limestone	17-25, 35	9
5	Dhamtari	Gujra	20.8167	81.5903	22.09	11	Charmuria Formation	Limestone	12.05 -13.15, 47.10-50	5.2
6	Dhamtari	Arjuni	20.686	81.562	65.24	14.5	Charmuria Lst &Chandrapur Sst	Limestone	10-12, 30	0.1
7	Dhamtari	Amdi	20.77	81.4944	45.08	30	Charmuria Formation	Limestone	23.20 – 24.80, 55	10.1
8	Dhamtari	Lahsunwahi(EW)	20.6378	81.6133	200.1	21.3	Chandrapur & Basementcrystlline	Ferrugineous Sandstone	15-17, 21-23	0.5
9	Dhamtari	Chhati (OW)	20.78	81.5742	159	10	Charmuria FmLimestone with shale	Limestone	14-16, 146.7-151	5.75
10	Dhamtari	Lahsunwahi(OW)	20.6378	81.6133	30.3	8	Chandrapur & Basementcrystlline	Ferrugineous Sandstone	22.5-24.5, 30	8
11	Dhamtari	Limtara	20.7736	81.6072	200	15.5	Charmuria FmLimestone with shale	Limestone	25-27, 30	1.75
12	Dhamtari	Chhati (EW)	20.78	81.5742	157.4	9.5	Charmuria FmLimestone with shale	Limestone	14-16, 154-157	8
13	Dhamtari	Tarasiwan (EW)	20.797	81.516	202.1	18.5	Alluvium and Charmuria fm Chandrapur Fm and Granite	Limestone	14-19, 92.20 , 185	2
14	Dhamtari	Potiadih	20.7447	81.515	118.7	18	Charmuria FmLimestone with shale	Limestone	12-25, 36	2.5
15	Dhamtari	Khapi (OWI)	20.753	81.55	202.1	27.5	Alluvium and Charmuria fm Chandrapur Fm and Granite	Limestone	28-31, 40	3
16	Dhamtari	Khapri (EW)	20.753	81.55	43.4	39.50 (Assembly)	Alluvium and Charmuria fm	Limestone	29.50-37.50, 40	2
17	Dhamtari	Demar (EW)	20.764	81.571	153.2	25.5	Alluvium and Charmuria fm Chandrapur Fm and Granite	Limestone	25-26-, 128-130	4
18	Dhamtari	Demar (OW)	20.764	81.571	61.7	37.50 (Assembly)	Alluvium and Charmuria fm	Limestone	23.00-35.00, 55	1

Sl. No.	Block	Location	Latitude	Longitude	Depth (m bgl)	Casing (m)	Formation	Lithology	Zone_encountered (m bgl)	Discharge (lps)
19	Dhamtari	Rawan (EW)	20.814	81.545	168	18	Alluvium and Charmuria fm Chandrapur Fm and Granite	Limestone	28-31, 110-113, 137-137, 165-168	7
20	Dhamtari	Rawan (OW)	20.814	81.545	183.7	18	Alluvium and Charmuria fm Chandrapur Fm and Granite	Limestone	20-36, 114, 134,177	3.5
21	Dhamtari	Arjuni (OW)	20.686	81.562	86.1	32	Alluvium and Charmuria fm	Limestone	14-19, 56	1
22	Dhamtari	Bhanpuri (EW)	20.766	81.54	202.1	22.5	Alluvium and Charmuria fm Chandrapur Fm and Granite	Limestone	14-16, 72	0.5
23	Dhamtari	Mujgahan (EW)	20.731	81.521	202	31.7	Alluvium and Charmuria fm Chandrapur Fm and Granite	Limestone	14-19, 72-73	1.5
24	Dhamtari	Mujgahan (OW)	20.731	81.521	31.2	30.00 (Assembly)	Alluvium and Charmuria fm	Limestone	23-27, 50	0.5
25	Dhamtari	Arjuni (EW)	20.686	81.562	37.3	22.5	Alluvium and Charmuria fm	Limestone	14-19,27	0.5
26	Dhamtari	Amdi (OW)	20.769	81.495	80	15.9	Alluvium and Charmuria fm	Limestone	70-73	2.5
27	Dhamtari	Amdi (EW)	20.769	81.495	16.9	31.5	Alluvium and Charmuria fm	Limestone	Abondoned	-
28	Dhamtari	Khapri (OWII)	20.753	81.55	131	28.5	Alluvium and Charmuria fm Chandrapur Fm and Granite	Limestone	14-16, 35	5.5
29	Dhamtari	Potiadih (OW)	20.7447	81.515	110	13	Charmuria Fm	Limestone	12-25, 36	Negligible
30	Dhamtari	Amdi	20.7692	81.4958	202.9	18.65	Limestone	Limestone	12-15, 123.6-129.7, 135.8-141.9	1.3
31	Dhamtari	Dahi EW	20.8219	81.6389	199.97	11.3	Limestone	Limestone	33.00-36.20	5.5
32	Dhamtari	Dahi OW	20.8219	81.6389	199.97	11	Limestone	Limestone	35.00-38.00	4
33	Dhamtari	Maradev	20.6419	81.5547	202	14.5	Ferrugineous Sandstone	Ferrugineous Sandstone	12-18.1,28	Negligible
34	Kurud	Dulna	20.9431	81.825	57.86	9.5	Gunderdehi and Charmuria Fm	Limestone	20-24,35	3
35	Kurud	Chorbhatti	20.8583	81.6417	67	10	Gunderdhi and Charmuria Formation	Shale	14.75 -15.40 ,15.7-17.30	3.1

Sl. No.	Block	Location	Latitude	Longitude	Depth (m bgl)	Casing (m)	Formation	Lithology	Zone_encountered (m bgl)	Discharge (lps)
36	Kurud	Bagtarai	20.8833	81.5667	55	9	Gunderdehi Sh,Charmuria Lst	Shale	22.5-23.7,30	6
37	Kurud	Hanchalpur	20.8833	81.55	78.87	11	Gunderdehi Formation	Shale	12.4 - 16.4,30	5
38	Kurud	Kosmarra	20.8639	81.6042	31.76	15	Charmuria Formation	Shale	9--10,35	0.1
39	Kurud	Seonikalan	20.9044	81.7539	69.05	14.5	Charumuria Formation	Shale	44.63 - 50.13	0.5
40	Kurud	Kurud	20.8275	81.7203	179	14.75	Charmuria Lst,Chandrapur Sst & granite	Limestone	14-16,155.5,170.5 and 178.8	10
41	Kurud	Charra	20.8139	81.725	160.1	9	Charmuria Lst,Chandrapur Sst & Granite	Limestone	10--15,35	0.83
42	Kurud	Charra(OW)	20.8139	81.725	190.1	9	Charmuria Lst,Chandrapur Sst & Granite	Limestone	10--15,36	<1
43	Kurud	Sirri	20.9167	81.7333	300.32	9.8	Gunderdehi Sh,Charmuria Lst,Chandrapur Sst &Granite	Shale	12--15	0.2
44	Kurud	Kokadi	20.8	81.7097	150.04	9.75	Charmuria Lst &Chandrapur Sst	Limestone	60.45	0.78
45	Kurud	Chinvri	20.9356	81.7586	150.04	6.7	Gunderdehi shale &Charmuria Lst	Shale	14-19,68.32	0.5
46	Kurud	Birejhar	20.9625	81.7097	200	6.5	Charmuria FmLimestone with shale	Shale	21-24,164.5-167.5	0.5
47	Kurud	Charmuria(EW)	20.8581	81.7144	63.7	16	Charmuria FmLimestone with shale	Limestone	24.27,32	5
48	Kurud	Charmuria(OW1)	20.8581	81.7144	200	24	Charmuria FmLimestone with shale	Limestone	21-22,30	8.7
49	Kurud	Charmuria(OW2)	20.8581	81.7144	27	21.5	Charmuria FmLimestone with shale	Limestone	14-16, 73-76	1
50	Kurud	Chataud	20.9565	81.8088	200	20.6	Charmuria FmLimestone with shale	Shale	20-25.65	2.5
51	Kurud	Khaira(EW)	20.7856	81.7078	200	14.5	Charmuria FmLimestone with shale	Limestone	21-24,88-91,158-161	5
52	Kurud	Khaira(OW)	20.7856	81.7078	161.4	15	Charmuria FmLimestone with shale	Limestone	16-18,	7
53	Kurud	Bhatagaon OW	20.8681	81.6839	202.8	50.2	Shale	Shale	44.10-47.10, 126.40-129.50, 178.30-181.30	2
54	Kurud	Bhatagaon	20.8681	81.6839	15	22	Shale	Shale	17-19,60-67,85-90	Negligible
55	Kurud	Bhatagaon EW	20.8681	81.6839	202.8	62	Shale	Shale	34.60-37.60, 74.20-77.30, 165.70-168.80	10

Sl. No.	Block	Location	Latitude	Longitude	Depth (m bgl)	Casing (m)	Formation	Lithology	Zone_encountered (m bgl)	Discharge (lps)
56	Kurud	Bhatagaon	20.8681	81.6839	49.5	20	Shale	Shale	17-19,48-49	3
57	Kurud	Mulle EW	20.9536	81.6894	199.97	8.5	Shale	Shale	12-15,25	Seepage
58	Kurud	Gadadih	20.8133	81.7736	202.6	25.8	Limestone	Limestone	18-21,31.90-34.90, 44.10-50.20, 175.10-178.20	5
59	Kurud	Hanchalpur	20.8834	81.5502	202	19.6	Shale	Shale	12-15,154.1-159	1.25
60	Kurud	Kurra EW	20.8789	81.6358	199.97	9.47	Shale	Shale	13.20-13.38,14.00-14.15,30	0.6
61	Kurud	Kanamuka	20.9801	81.6182	202	13.73	Shale	Shale	14-16,156.2-158	1.4
62	Kurud	Mauri Khurd	20.8654	81.7881	202	18.1	Limestone	Limestone	15-17,35	meagre
63	Kurud	Maurikalan	20.9237	81.8067	202	15.9	Limestone	Limestone	13-15, 32	Negligible
64	Magarlod	Belora OW	20.7292	81.8208	169	9.5	Chandrapur Sst & granite	Ferrugineous Sandstone	14-18, 45.0 ,162, 169	4
65	Magarlod	Belora	20.7292	81.8208	169	9	Chandrapur Sst & granite	Ferrugineous Sandstone	14-18, 32.4 - 43.4 ,141.3 - 169.0	3.57
66	Magarlod	Bhendri	20.9083	81.8417	150.04	12.7	Charmuria L.St.&shale	Limestone	23.25-26.8, 102.29- 106.30	4
67	Magarlod	Badekareli	20.8756	81.8425	150.04	10.05	Charmuria L.St.&shale	Limestone	14-18.,77-79.03	3.2
68	Magarlod	Chottikareli	20.7661	81.7878	150.04	33.15	Alluvium,Charmuria and Chandrapur Sst	Limestone	14-19,51.15- 55.75, 139.5-144.1	6.8
69	Magarlod	Alekhuta	20.6417	81.8417	164.4	12	Chandrapur S.St/Granite	Ferrugineous Sandstone	43.60-44	1.89
70	Magarlod	Girholadih	20.6083	81.8861	57.7	6	Chandrapur S.St/Granite	Ferrugineous Sandstone	18-22, 54-56	7.98
71	Magarlod	Girholadih OW	20.6083	81.8861	57.7	6	Chandrapur S.St/Granite	Ferrugineous Sandstone	16-22,51-54	7.98
72	Magarlod	Magarlod	20.7417	81.8583	200	9	Chandrapur S.St/Granite	Ferrugineous Sandstone	14-16, 52-54,136-138	0.63
73	Magarlod	Magarlod OW	20.7417	81.8583	118.7	21.6	Chandrapur S.St/Granite	Ferrugineous Sandstone	18-20,60-63,79-82	0.23
74	Magarlod	Piproud	20.6625	81.9208	173.6	18	Chandrapur S.St/Granite	Ferrugineous Sandstone	14-16, 70-73,168-170	1.04
75	Magarlod	Bhendri EW	20.9117	81.8436	199.92	17.4	Limestone	Limestone	12-15,128.00-131.00	1.2
76	Magarlod	Budeni	20.9296	81.857	202	30	Limestone	Limestone	28-31,35	Meagre

Sl. No.	Block	Location	Latitude	Longitude	Depth (m bgl)	Casing (m)	Formation	Lithology	Zone_encountered (m bgl)	Discharge (lps)
77	Nagri	Chhuhi	20.6803	81.7028	182.85	9.5	Chandrapur Sst and Granite	Ferrugineous Sandstone	10--12	Negligible
78	Nagri	Sankra	20.2958	81.8458	53.71	10.5	Granite	Gneissic Complex	14-16,	Dry
79	Nagri	Keregaon	20.5458	81.725	160.12	8.5	Chandarpur/Granite	Ferrugineous Sandstone	20-22 , 152.0	5.4
80	Nagri	Keregaon OW	20.5458	81.725	157	10	Chandarpur Granite	Ferrugineous Sandstone	5 -25,38.0	11
81	Nagri	Belargaon	20.2778	81.8417	220.92	5.5	Granite	Gneissic Complex	14-18	Dry
82	Nagri	Ghatula	20.2828	81.9228	88.41	8.95	Archean granite	Gneissic Complex	20-25,40	7.25
83	Nagri	Sihawa	20.3	81.9161	139.95	21.9	Archean granite	Gneissic Complex	14-18.,48.5 & 51.67	0.5
84	Nagri	Kukrel	20.5094	81.8308	150.04	18.75	Archean granite	Gneissic Complex	14-18.,43-45.5 & 120.8-124.2	1.5
85	Nagri	Semra Birgudi	20.3156	81.8819	107.28	10.2	Archean granite	Gneissic Complex	14-18., 97.35, 104.68	7.04
86	Nagri	Pawdwar	20.2689	81.9158	150.04	25.67	Archean granite	Gneissic Complex	14-18.,95-97.50	1.8
87	Nagri	Gatasilli	20.4436	81.8028	173.5	31.5	Granite	Gneissic Complex	22-28,34	Dry
88	Nagri	Gatasilli	20.4436	81.8028	38.8	31	Granite	Gneissic Complex	22.28,30	0.63
89	Nagri	Banspani	20.3636	81.7933	164.8	18	Granite	Gneissic Complex	27-27.5,32	2.64
90	Nagri	Arsi Kanhar	20.2439	82.0717	152.3	24	Granite	Gneissic Complex	26-28,35	2.44
91	Nagri	Jawarra	20.4956	81.9858	200	18	Granite	Gneissic Complex	18-18.5,106-112	8.44
92	Nagri	Chargaon	20.4581	82.0097	165	9	Granite	Gneissic Complex	23.5-24,30	0.18
93	Nagri	Dugli	20.4939	81.8733	155.3	9.5	Granite	Gneissic Complex	12--24,30	Dry
94	Nagri	Dugli OW	20.4939	81.8733	28	27	Granite	Gneissic Complex	12--24,35	7.1

Sl. No.	Block	Location	Latitude	Longitude	Depth (m bgl)	Casing (m)	Formation	Lithology	Zone_encountered (m bgl)	Discharge (lps)
95	Nagri	Sankra-II	20.2875	81.9939	39.4	39.4	Granite	Gneissic Complex	34-39.40	0.82
96	Nagri	Dongardula	20.4039	81.9406	167.9	22	Granite	Gneissic Complex	26.8-29.9,140-142	3.65
97	Nagri	Pharasiya	20.2806	82.0556	201.2	27	Granite	Gneissic Complex	14-18, 40-42	1.57

Annexure 3 Details of Chemical Analysis

Sl. No.	Block	Location/Village	Long	Lat	Source	pH	EC	CO3	HCO3	Cl	SO4	NO3	F	TH	Ca	Mg	Na	K	Si	PO4	U	TDS
							µs/cm	mg/l													µg/l	mg/l
1	Dhamtari	Dhamtari	81.5500	20.7083	BW	7.9	224	0	98	14	15.84	7	0.00	85	20	8	17	2	12	0.0	0.0	143.36
2	Dhamtari	Gangrel	81.5583	20.6346	BW	7.4	150	0	79	7	4.8	0	0.00	70	28	5	4	1	11	0.0	0.0	96
3	Dhamtari	Khadadaha	81.6933	20.5733	BW	7.0	193	0	98	7	3.36	0	1.35	70	20	5	11	2	16	0.0	0.0	123.52
4	Dhamtari	Marradev	81.5682	20.6295	HP	7.6	527	0	250	21	36	0	0.32	200	44	22	31	4	9	0.0	0.0	337.28
5	Dhamtari	Puri	81.3331	20.7385	BW	8.0	358	0	183	21	7.68	0	0.63	155	52	6	16	1	5	0.0	0.0	229.12
6	Dhamtari	Shankarda	81.4492	20.6220	BW	7.7	443	0	195	28	9.12	38	0.41	220	52	22	8	2	5	0.0	0.0	283.52
7	Kurud	Aouri	81.6870	20.8570	HP	7.7	454	0	256	21	7.68	1	0.62	145	28	18	49	0	6	0.0	0.0	290.56
8	Kurud	Bhatagaon	81.7003	20.8783	HP	7.7	917	0	244	149	48.96	22	0.18	355	80	43	46	17	9	0.0	0.0	586.88
9	Kurud	Kondapar	81.7250	21.0042	HP	7.7	467	0	256	14	17.76	6	0.38	230	76	10	13	0	7	0.0	0.0	298.88
10	Kurud	Kosmarra	81.5986	20.8597	BW	7.7	525	0	281	28	9.6	5	0.14	240	72	14	19	1	10	0.0	0.0	336
11	Kurud	Kurud	81.7189	20.8275	HP	7.6	468	0	256	21	8.64	0	0.60	145	40	11	49	0	5	0.0	0.0	299.52
12	Kurud	Marod	81.6889	20.9028	HP	7.6	929	0	232	135	42.72	27	0.11	330	92	24	46	12	6	0.0	0.0	594.56
13	Kurud	Mega	81.8005	20.7833	BW	7.4	944	0	281	113	37.92	59	0.22	340	84	36	58	9	8	0.0	0.0	604.16
14	Kurud	Dandesara	81.6317	20.8127	DW	7.5	438	0	232	21	8.64	1	0.23	185	56	11	19	1	16	0.0	0.0	280.32
15	Kurud	Darba	81.6800	20.9615	HP	7.7	459	0	244	21	17.76	4	0.50	220	64	14	13	0	11	0.0	0.0	293.76
16	Magarlod	Banraud	81.6583	20.5958	HP	7.4	414	0	220	21	12.96	0	0.32	175	48	62	21	4	12	0.0	0.0	264.96
17	Magarlod	Baspara(Kukrel)	81.6507	20.6131	HP	7.4	143	0	73	7	4.8	0	0.00	65	24	10	4	1	13	0.0	0.0	91.52
18	Magarlod	Budaraon	81.9047	20.7230	BW	7.7	281	0	128	14	15.84	0	0.87	110	40	29	14	3	14	0.0	0.0	179.84
19	Magarlod	Magarload	81.8583	20.7472	BW	7.9	282	0	146	14	13.92	1	0.74	120	36	7	14	3	8	0.0	0.0	180.48
20	Magarlod	Singhpur	81.8778	20.5819	HP	7.7	550	0	238	35	24	35	1.40	195	44	20	47	6	15	0.0	0.0	352
21	Magarlod	Alekhuta	81.8383	20.6390	BW	7.31	103	0	36.6	7	4.14	5.05	0.19	15	4	1.2	12.73	3.72	4.6	0	0	65.92
22	Magarlod	Amaldih	81.9160	20.7687	BW	7.23	112	0	54.9	7	6.36	8.53	0.02	30	8	2.4	15.272	3.97	12.1	0	0	71.68
23	Magarlod	Basikhai	81.8677	20.5445	BW	7.67	161	0	36.6	10.5	45.8	0.63	1.57	55	10	7.2	15.42	1.98	3.1	0	0.23	103.04
24	Magarlod	Bhendri	81.8620	20.9106	BW	7.87	820	0	195.2	105	32.31	61.04	0.60	320	18	66	54.88	2.36	9.2	0	5.4	524.8
25	Magarlod	Hasda 1	81.8735	20.8520	HP	7.21	664	0	219.6	80.5	17.14	2.86	0.03	200	6	44.4	37.2	1.64	7.2	0	0	424.96
26	Magarlod	Kapalfodi	81.8983	20.7904	BW	7.11	461	0	158.6	45.5	26.49	0.55	0.07	180	14	34.8	20.32	1.75	9.2	0	0	295.04
27	Magarlod	Kareli Badi	81.8324	20.8652	BW	7.91	531	0	146.4	63	29.12	10.51	0.54	190	44	19.2	39.63	2.87	5.2	0	0	339.84

Sl. No.	Block	Location/Village	Long	Lat	Source	pH	EC	CO3	HCO3	Cl	SO4	NO3	F	TH	Ca	Mg	Na	K	Si	PO4	U	TDS
							µs/cm	mg/l													µg/l	mg/l
28	Magarlod	Khairjhit	81.8261	20.8085	BW	7.57	342	0	134.2	28	10.39	6.21	1.04	105	24	10.8	24.63	1.51	8.4	0	0	218.88
29	Magarlod	Kusumkhuta	81.8171	20.6739	HP	7.41	90	0	30.5	14	2.36	0	0.12	20	4	2.4	10.97	1.99	2.5	0	0	57.6
30	Magarlod	Luge	81.8148	20.7532	BW	7.41	655	0	189.1	77	18.84	7.28	1.24	250	54	27.6	35.17	1.9	16.5	0	0	419.2
31	Magarlod	Mohrenga	81.8791	20.8737	HP	7.92	620	0	170.8	77	29.98	16.23	0.06	250	16	50.4	36.64	1.6	8.2	0	0	396.8
32	Magarlod	Nawagaon	81.8664	20.9488	BW	7.72	452	0	128.1	56	28.36	14.42	0.12	185	44	18	26.79	1.34	11.2	0	0	289.28
33	Magarlod	Nawagaon(Khisora)	81.8801	20.8118	BW	7.04	282	0	79.3	38.5	7.91	1.66	0.88	70	24	2.4	25.11	1.39	1.2	0	0.12	180.48
34	Magarlod	Pathar	81.8888	20.6929	BW	7.39	328	0	134.2	80.5	8.45	6.4	0.33	170	22	27.6	16.8	5.53	21.7	0	5.6	209.92
35	Magarlod	Rengadih	81.9048	20.7369	BW	7.47	418	0	115.9	42	47.29	0	0.05	125	28	13.2	27.59	5.01	17.2	0	0	267.52
36	Magarlod	Sarairukh	81.8751	20.6226	HP	7.41	296	0	67.1	42	13.13	2.01	0.01	65	18	4.8	31.21	8.12	25.2	0	0	189.44
37	Magarlod	Sonewara	81.7470	20.7172	BW	7.21	483	0	97.6	42	68.62	0.23	1.54	115	18	16.8	53.17	5.4	14.1	0	0	309.12
38	Magarlod	Sonjhari	81.8181	20.5538	DW	7.54	314	0	122	52.5	13.1	2.01	0.02	95	20	10.8	36.38	4.81	27.4	0	0	200.96
39	Magarlod	Vijaypur (Jamli Para)	81.7903	20.7261	BW	7.52	380	0	128.1	56	2.41	0	0.41	85	18	9.6	43.85	7.59	9.2	0	18.6	243.2
40	Nagri	Amgaon	81.9268	20.2056	BW	7.87	323	0	164.7	21	9.46	0.39	1.02	100	24	9.6	37.02	1.62	6.4	0	0	206.72
41	Nagri	Basin	82.1654	20.2490	BW	7.8	425	0	220	28	9.6	0	0.42	210	48	22	8	2	5	0.0	0.0	272
42	Nagri	Belargaon	81.8415	20.2806	BW	7.72	452	0	219.6	28	9.34	12.23	1.20	175	44	15.6	20.1	1.79	8.2	0	0	289.28
43	Nagri	Bhainsa Sankara	82.0181	20.3019	BW	7.51	497	0	176.9	56	9.48	0.12	0.12	110	26	10.8	63.09	1.72	8.9	0	0	318.08
44	Nagri	Bilbhadar	81.9310	20.3916	BW	7.14	533	0	158.6	56	18.29	38.24	0.21	175	28	25.2	30.65	1.77	10.1	0	0	341.12
45	Nagri	Dinkarpur	81.9001	20.5067	BW	7.7	383	0	85.4	38.5	15.47	58.2	1.16	150	58	1.2	23.6	1.79	12.1	0	0	245.12
46	Nagri	Gahana Siyar	82.0017	20.2638	BW	7.67	476	0	134.2	52.5	17.21	31.34	0.76	205	36	27.6	21.78	1.84	11.1	0	0	304.64
47	Nagri	Gajkanhar	81.9033	20.4366	DW	7.01	394	0	128.1	21	15.71	9.55	0.88	95	18	12	26.6	1.33	7.1	0	12.7	252.16
48	Nagri	Gedra	81.8288	20.4655	HP	7.87	534	0	146.4	45.5	26.24	62.02	0.12	175	26	26.4	36.3	1.76	18.6	0	0	341.76
49	Nagri	Ghotgaon	81.8282	20.3928	BW	7.42	528	0	189.1	52.5	3.01	34.14	1.26	220	24	38.4	26.46	4.16	8.2	0	0	337.92
50	Nagri	Gidhawa	81.8934	20.2662	BW	8.01	342	0	115.9	31.5	9.66	26.19	1.23	95	22	9.6	36.33	1.54	7.5	0	0	218.88
51	Nagri	Guhan Nala	81.8785	20.4528	BW	7.65	304	0	115.9	21	15.74	9.84	0.38	85	24	6	33.49	1.31	8.9	0	0	194.56
52	Nagri	Kohinpara	81.8109	20.4599	HP	7.62	373	0	109.8	42	29.18	16.24	1.50	120	28	12	34.17	6.8	19.2	0	0.36	238.72
53	Nagri	Kouhabahara	81.8575	20.4916	HP	7.6	590	0	293	21	27.84	17	1.33	210	64	12	47	6	14	0.0	0.0	377.6
54	Nagri	Kumhada	81.5770	20.5684	HP	7.5	402	0	232	14	10.56	1	0.14	175	56	8	20	4	6	0.0	0.0	257.28
55	Nagri	Mode	81.9772	20.3205	BW	7.41	310	0	189.1	17.5	7.48	0.05	0.02	115	22	14.4	33.98	1.69	7.2	0	0	198.4

Sl. No.	Block	Location/Village	Long	Lat	Source	pH	EC	CO3	HCO3	Cl	SO4	NO3	F	TH	Ca	Mg	Na	K	Si	PO4	U	TDS
							µs/cm	mg/l													µg/l	mg/l
56	Nagri	Nayapara	82.0358	20.3366	DW	7.06	253	0	128.1	7	5.08	3.94	0.87	90	28	4.8	15.28	2.05	7.6	0	0	161.92
57	Nagri	Nayapara	81.8356	20.3252	HP	7.04	290	0	97.6	17.5	3.48	10.23	1.51	75	18	7.2	21.43	1.38	6.4	0	0	185.6
58	Nagri	Parsapani	81.8847	20.4059	HP	7.12	422	0	134.2	31.5	28.83	3.25	0.47	145	32	15.6	21.61	2.27	6.5	0	0	270.08
59	Nagri	Ratawa	81.9342	20.2558	BW	7.71	412	0	189.1	21	9.46	0	1.30	115	40	3.6	37.6	1.24	1.2	0	4.67	263.68
60	Nagri	Sambalpur	81.9869	20.3452	DW	7.87	590	0	140.3	84	18.45	47.09	0.64	215	40	27.6	31.12	1.76	15.1	0	0	377.6
61	Nagri	Tengna	81.9966	20.3289	HP	7.21	271	0	97.6	31.5	5.48	0.19	0.09	95	24	8.4	21.53	1.61	6.2	0	0	173.44
62	Nagri	Tumribahar	81.9595	20.3477	HP	7.5	258	0	116	14	7.68	17	0.77	105	24	11	15	1	20	0.0	0.0	165.12
63	Nagri	Umargaon	81.9595	20.2756	DW	7.67	423	0	140.3	28	34.98	29.54	0.04	205	42	24	8.7	4.7	7.2	0	0	270.72
64	Sihawa (Nagri)	Banspani	81.7917	20.3667	HP	7.4	321	0	195	7	3.84	0	1.50	110	36	18	29	1	29	0.0	0.0	205.44
65	Sihawa (Nagri)	Birgudi	81.8625	20.3222	BW	7.3	260	0	85	14	7.2	31	0.95	90	32	50	17	0	28	0.0	0.0	166.4
66	Sihawa (Nagri)	Dorgardula	81.9111	20.4056	BW	7.5	279	0	110	14	6.72	32	0.95	110	32	7	17	0	35	0.0	0.0	178.56
67	Sihawa (Nagri)	Dugli	81.8708	20.4917	HP	7.4	427	0	171	43	13.92	10	0.90	180	56	10	20	1	29	0.0	0.0	273.28
68	Sihawa (Nagri)	Gattasilli	81.8028	20.4436	BW	7.4	309	0	171	14	2.88	0	1.42	105	40	1	29	0	27	0.0	0.0	197.76
69	Sihawa (Nagri)	Jabarra	81.9858	20.4956	HP	7.3	428	0	183	28	13.92	9	0.83	170	48	12	20	1	27	0.0	0.0	273.92
70	Sihawa (Nagri)	Keregaon	81.7375	20.5486	BW	7.2	195	0	110	7	3.84	0	0.00	80	20	7	10	2	15	0.0	0.0	124.8
71	Sihawa (Nagri)	Nagri	81.9583	20.3333	BW	7.4	258	0	146	28	8.64	2	0.65	140	32	14	16	1	19	0.0	0.0	165.12
72	Sihawa (Nagri)	Sankra	82.0076	20.2625	HP	7.6	607	0	268	57	18.72	1	0.34	260	64	24	26	3	8	0.0	0.0	388.48
73	Sihawa (Nagri)	Sihawa	81.9125	20.3083	BW	7.8	258	0	98	14	7.68	38	0.89	105	32	6	16	0	25	0.0	0.0	165.12